

Bacula Storage Management System

The Bacula[®] Storage Management System Version 1.34

It comes by night and sucks the vital essence from your computers

This document was last updated 25 April 2004.

If you are viewing this document with Netscape, it probably looks really poor.
I recommend that you use [Galeon](#) or [Mozilla](#) instead.

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The use of the name Bacula is restricted to software systems that agree exactly with the program presented here.

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Features

What is Bacula?

Bacula is a set of computer programs that permit you (or the system administrator) to manage backup, recovery, and verification of computer data across a network of computers of different kinds. In technical terms, it is a network Client/Server based backup program. Bacula is relatively easy to use and efficient, while offering many advanced storage management features that make it easy to find and recover lost or damaged files. Due to its modular design, Bacula is scalable from small single computer systems to systems consisting of hundreds of computers located over a large network.

Who Needs Bacula?

If you are currently using a program such as **tar**, **dump**, or **bru** to backup your computer data, and you would like a network solution, more flexibility, or catalog services, Bacula will most likely provide the additional features you want. However, if you are new to Unix systems or do not have offsetting experience with a sophisticated backup package, we do not recommend using Bacula as it is much more difficult to setup and use than **tar** or **dump**.

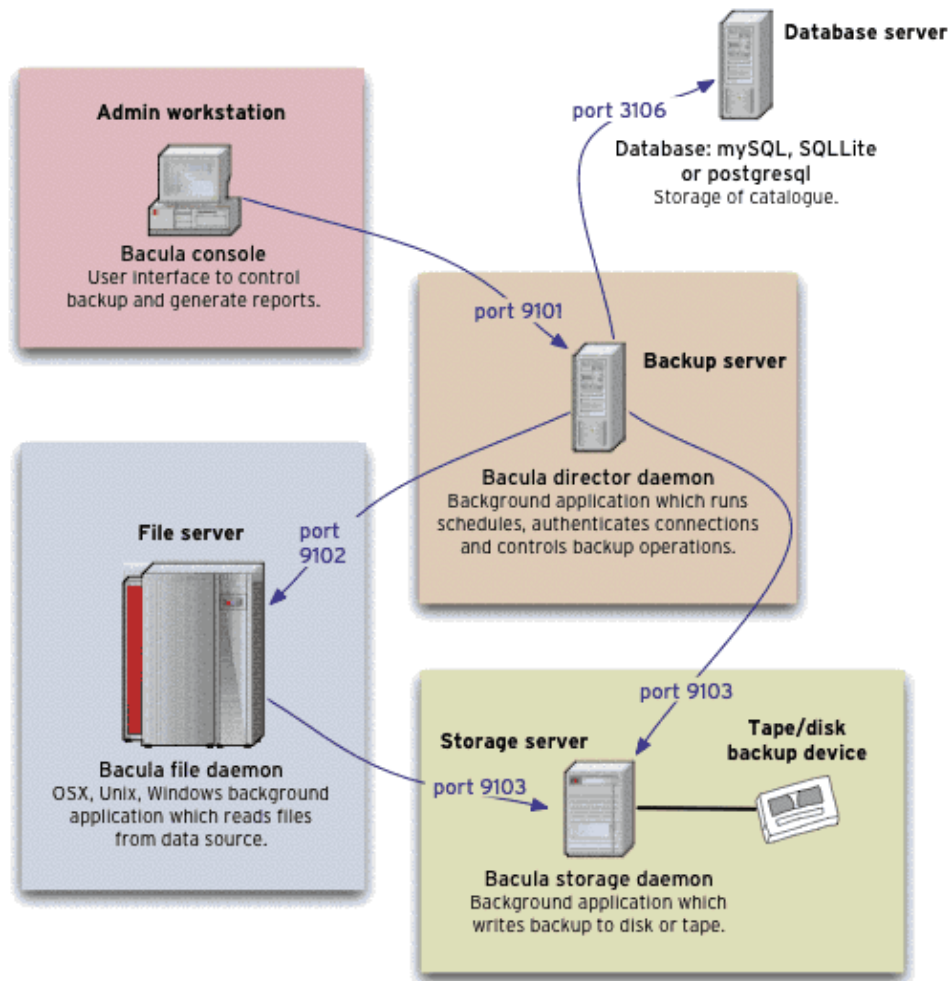
If you are running **Amanda** and would like a backup program that can write to multiple volumes (i.e. is not limited by your tape drive capacity), Bacula can most likely fill your needs. In addition, quite a number of our users report that Bacula is simpler to setup and use than other equivalent programs.

If you are currently using a sophisticated commercial package such as Legato Networker, ARCserveIT, Arkeia, or PerfectBackup+, you may be interested in Bacula, which provides many of the same features, and is free software available under the GNU Version 2 software license.

Bacula Components or Services

Bacula is made up of the following five major components or services:

Bacula Storage Management System



Bacula application interactions

Note that these applications may actually run on fewer machines than shown here. You could run everything on one machine if you only wanted to back up the local disk.

(thanks to Aristedes Maniatis for this graphic and the one below)

- **Bacula Director** service consists of the program that supervises all the backup, restore, verify and archive operations. The system administrator uses the Bacula Director to schedule backups and to recover files. For more details see the [Director Services Daemon Design Document](#). The Director runs as a daemon or a service (i.e. in the background).
- **Bacula Console** services is the program that allows the administrator or user to communicate with the **Bacula Director** (see above). Currently, the Bacula Console is available in two versions. The first and simplest is to run the Console program in a shell window (i.e. TTY interface). Most system administrators will find this completely adequate. The second version is a GNOME GUI interface that for the moment (23 November 2003) is far from complete, but quite functional as it has most the capabilities of the shell Console. For more details see the [Bacula Console Design Document](#).
- **Bacula File** services (or Client program) is the software program that is installed on the machine to be backed up. It is specific to the operating system on which it runs and is responsible for providing the file attributes and data when requested by the Director. The File services are also responsible for the file system dependent part of restoring the file

attributes and data during a recovery operation. For more details see the [File Services Daemon Design Document](#). This program runs as a daemon on the machine to be backed up, and in some of the documentation, the File daemon is referred to as the Client (for example in Bacula's configuration file). In addition to Unix/Linux File daemons, there is a Windows File daemon (normally distributed as in binary format). The Windows File daemon runs on all currently known Windows versions (95, 98, Me, NT, 2000, XP).

- **Bacula Storage** services consist of the software programs that perform the storage and recovery of the file attributes and data to the physical backup media or volumes. In other words, the Storage daemon is responsible for reading and writing your tapes (or other storage media, e.g. files). For more details see the [Storage Services Daemon Design Document](#). The Storage services runs as a daemon on the machine that has the backup device (usually a tape drive).
- **Catalog** services are comprised of the software programs responsible for maintaining the file indexes and volume databases for all files backed up. The Catalog services permit the System Administrator or user to quickly locate and restore any desired file. The Catalog services of Bacula set it apart from programs like tar and bru, since the catalog maintains a record of all Volumes used, all Jobs run, and all Files saved. Bacula currently supports three different databases, MySQL, PostgreSQL, and SQLite, one of which must be chosen when building **Bacula**. There also exists an Internal database, but it is no longer supported.

The three SQL databases currently supported (MySQL, PostgreSQL or SQLite) provide quite a number of features, including rapid indexing, arbitrary queries, and security. Although we plan to support other major SQL databases, the current Bacula implementation interfaces only to MySQL, PostgreSQL and SQLite. For more details see the [Catalog Services Design Document](#).

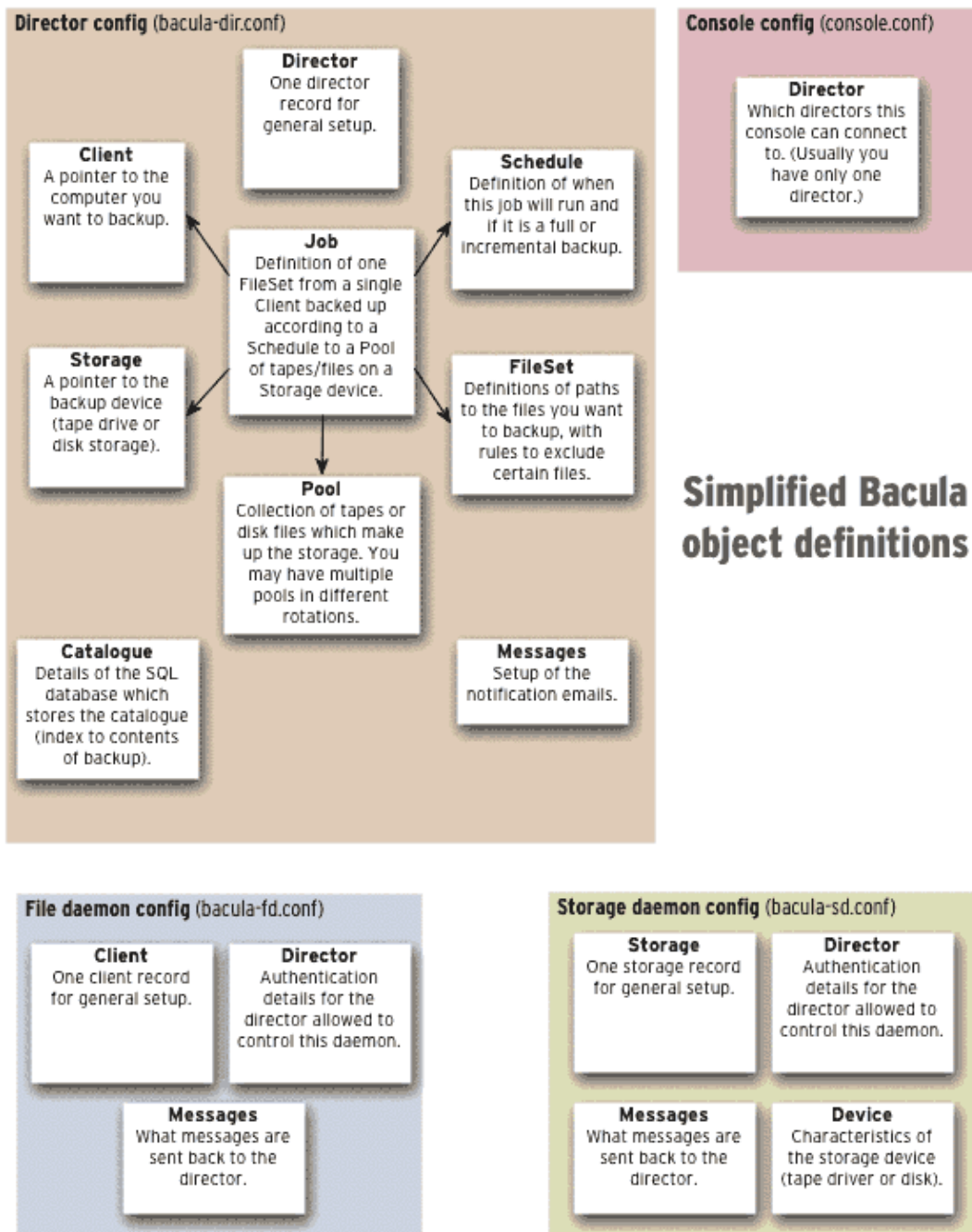
The RPMs for MySQL and PostgreSQL ship as part of the Linux RedHat release, or building it from the source is quite easy, see the [Installing and Configuring MySQL](#) chapter of this document for the details. For more information on MySQL, please see: www.mysql.com. Or see the [Installing and Configuring PostgreSQL](#) chapter of this document for the details. For more information on PostgreSQL, please see: www.postgresql.org.

Configuring and building SQLite is even easier. For the details of configuring SQLite, please see the [Installing and Configuring SQLite](#) chapter of this document.

To perform a successful save or restore, the following four daemons must be configured and running: the Director daemon, the File daemon, the Storage daemon, and MySQL, PostgreSQL or SQLite.

Bacula Configuration

In order for Bacula to understand your system, what clients you want backed up, and how, you must create a number of configuration files containing resources (or objects). The following presents an overall picture of this:



Conventions Used in this Document

Bacula is in a state of evolution, and as a consequence, this manual will not always agree with the code. If an item in this manual is preceded by an asterisk (*), it indicates that the particular feature is not implemented. If it is preceded by a plus sign (+), it indicates that the feature may be partially implemented.

If you are reading this manual as supplied in a released version of the software, the above paragraph holds true. If you are reading the online version of the manual, www.bacula.org/manual, please bear in mind that this version describes the current version in

development (in the CVS) that may contain features not in the released version. Just the same, it generally lags behind the code a bit.

Quick Start

To get Bacula up and running quickly, we recommend that you first scan the Terminology section below, then quickly review the next chapter entitled [The Current State of Bacula](#), then the [Quick Start Guide to Bacula](#), which will give you a quick overview of getting Bacula running. After which, you should proceed to the chapter on [Installing Bacula](#), then [How to Configure Bacula](#), and finally the chapter on [Running Bacula](#).

Terminology

To facilitate communication about this project, we provide here the definitions of the terminology that we use.

Administrator

The person or persons responsible for administering the Bacula system.

Backup

We use the term **Backup** to refer to a Bacula Job that saves files.

Bootstrap File

The bootstrap file is an ASCII file containing a compact form of commands that allow Bacula or the stand-alone file extraction utility (**bextract**) to restore the contents of one or more Volumes, for example, the current state of a system just backed up. With a bootstrap file, Bacula can restore your system without a Catalog. You can create a bootstrap file from a Catalog to extract any file or files you wish.

Catalog

The Catalog is used to store summary information about the Jobs, Clients, and Files that were backed up and on what Volume or Volumes. The information saved in the Catalog permits the administrator or user to determine what jobs were run, their status as well as the important characteristics of each file that was backed up. The Catalog is an online resource, but does not contain the data for the files backed up. Most of the information stored in the catalog is also stored on the backup volumes (i.e. tapes). Of course, the tapes will also have a copy of the file in addition to the File Attributes (see below). The catalog feature is one part of Bacula that distinguishes it from simple backup and archive programs such as **dump** and **tar**.

Client

In Bacula's terminology, the word Client refers to the machine being backed up, and it is synonymous with the File services or File daemon, and quite often, we refer to it as the FD. A Client is defined in a configuration file resource.

Console

The program that interfaces to the Director allowing the user or system administrator to control Bacula.

Daemon

Unix terminology for a program that is always present in the background to carry out a designated task. On Windows systems, as well as some Linux systems, daemons are called **Services**.

Directive

The term directive is used to refer to a record or a statement within a Resource in a

configuration file that defines one specific thing. For example, the **Name** directive defines the name of the Resource.

Director

The main Bacula server daemon that schedules and directs all Bacula operations. Occasionally, we refer to the Director as DIR.

Differential

A backup that includes all files changed since the last Full save started. Note, other backup programs may define this differently.

File Attributes

The File Attributes are all the information necessary about a file to identify it and all its properties such as size, creation date, modification date, permissions, etc. Normally, the attributes are handled entirely by Bacula so that the user never needs to be concerned about them. The attributes do not include the file's data.

File Daemon

The daemon running on the client computer to be backed up. This is also referred to as the File services, and sometimes as the Client services or the FD.

FileSet

A FileSet is a Resource contained in a configuration file that defines the files to be backed up. It consists of a list of included files or directories, a list of excluded files, and how the file is to be stored (compression, encryption, signatures). For more details, see the [FileSet Resource definition](#) in the Director chapter of this document.

Incremental

A backup that includes all files changed since the last Full, Differential, or Incremental backup started. It is normally specified on the **Level** directive within the Job resource definition, or in a Schedule resource.

Job

A Bacula Job is a configuration resource that defines the work that Bacula must perform to backup or restore a particular Client. It consists of the **Type** (backup, restore, verify, etc), the **Level** (full, incremental,...), the **FileSet**, and **Storage** the files are to be backed up (Storage device, Media Pool). For more details, see the [Job Resource definition](#) in the Director chapter of this document.

Resource

A resource is a part of a configuration file that defines a specific unit of information that is available to Bacula. For example, the **Job** resource defines all the properties of a specific Job: name, schedule, Volume pool, backup type, backup level, ...

Restore

A restore is a configuration resource that describes the operation of recovering a file (lost or damaged) from backup media. It is the inverse of a save, except that in most cases, a restore will normally have a small set of files to restore, while normally a Save backs up all the files on the system. Of course, after a disk crash, Bacula can be called upon to do a full Restore of all files that were on the system.

Schedule

A Schedule is a configuration resource that defines when the Bacula Job will be scheduled for execution. To use the Schedule, the Job resource will refer to the name of the Schedule. For more details, see the [Schedule Resource definition](#) in the Director chapter of this document.

Service

This is Windows terminology for a **daemon** — see above. It is now frequently used in Unix environments as well.

Storage Coordinates

The information returned from the Storage Services that uniquely locates a file on a backup medium. It consists of two parts: one part pertains to each file saved, and the other part pertains to the whole Job. Normally, this information is saved in the Catalog so that the user doesn't need specific knowledge of the Storage Coordinates. The Storage Coordinates include the File Attributes (see above) plus the unique location of the information on the backup Volume.

Storage Daemon

The Storage daemon, sometimes referred to as the SD, is the code that writes the attributes and data to a storage Volume (usually a tape or disk).

Session

Normally refers to the internal conversation between the File daemon and the Storage daemon. The File daemon opens a **session** with the Storage daemon to save a FileSet, or to restore it. A session has a one to one correspondence to a Bacula Job (see above).

Verify

A verify is a job that compares the current file attributes to the attributes that have previously been stored in the Bacula Catalog. This feature can be used for detecting changes to critical system files similar to what **Tripwire** does. One of the major advantages of using Bacula to do this is that on the machine you want protected such as a server, you can run just the File daemon, and the Director, Storage daemon, and Catalog reside on a different machine. As a consequence, if your server is ever compromised, it is unlikely that your verification database will be tampered with.

Verify can also be used to check that the most recent Job data written to a Volume agrees with what is stored in the Catalog (i.e. it compares the file attributes), *or it can check the Volume contents against the original files on disk.

**Archive*

An Archive operation is done after a Save, and it consists of removing the Volumes on which data is saved from active use. These Volumes are marked as Archived, and many no longer be used to save files. All the files contained on an Archived Volume are removed from the Catalog. NOT YET IMPLEMENTED.

**Update*

An Update operation causes the files on the remote system to be updated to be the same as the host system. This is equivalent to an **rdist** capability. NOT YET IMPLEMENTED.

Retention Period

There are various kinds of retention periods that Bacula recognizes. The most important are the **File** Retention Period, **Job** Retention Period, and the **Volume** Retention Period. Each of these retention periods applies to the time that specific records will be kept in the Catalog database. This should not be confused with the time that the data saved to a Volume is valid.

The File Retention Period determines the time that File records are kept in the catalog database. This period is important because the volume of the database File records by far use the most storage space in the database. As a consequence, you must ensure that regular "pruning" of the database file records are done. (See the Console **retention** command for more details on this subject).

The Job Retention Period is the length of time that Job records will be kept in the database. Note, all the File records are tied to the Job that saved those files. The File records can be purged leaving the Job records. In this case, information will be available about the jobs that ran, but not the details of the files that were backed up. Normally, when a Job record is purged, all its File records will also be purged.

The Volume Retention Period is the minimum of time that a Volume will be kept before it is reused. Bacula will normally never overwrite a Volume that contains the only backup copy of a file. Under ideal conditions, the Catalog would retain entries for all files backed up for all current Volumes. Once a Volume is overwritten, the files that were backed up on that Volume are automatically removed from the Catalog. However, if there is a very large pool of Volumes or a Volume is never overwritten, the Catalog database may become enormous. To keep the Catalog to a manageable size, the backup information should be removed from the Catalog after the defined File Retention Period. Bacula provides the mechanisms for the catalog to be automatically pruned according to the retention periods defined.

Scan

A Scan operation causes the contents of a Volume or a series of Volumes to be scanned. These Volumes with the information on which files they contain are restored to the Bacula Catalog. Once the information is restored to the Catalog, the files contained on those Volumes may be easily restored. This function is particularly useful if certain Volumes or Jobs have exceeded their retention period and have been pruned or purged from the Catalog. Scanning data from Volumes into the Catalog is done by using the **bscan** program. See the [bscan section](#) of the Bacula Utilities Chapter of this manual for more details.

Volume

A Volume is an archive unit, normally a tape or a named disk file where Bacula stores the data from one or more backup jobs. All Bacula Volumes have a software label written to the Volume by Bacula so that it can be sure what Volume it is really reading. (Normally there should be no confusion with disk files, but with tapes, it is easy to mount the wrong one).

What Bacula is Not

Bacula is a backup, restore and verification program and is not a complete disaster recovery system in itself, but it can be a key part if you plan carefully and follow the instructions included in the [Disaster Recovery](#) Chapter of this manual.

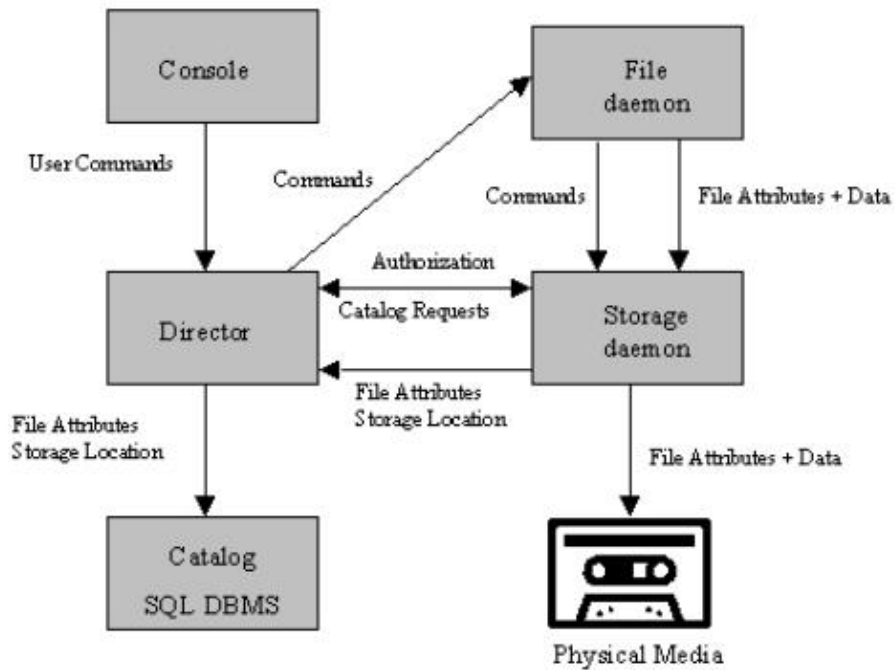
With proper planning, as mentioned in the Disaster Recovery chapter **Bacula** can be form a central component of your disaster recovery system. For example, if you have created an emergency boot disk, a Bacula Rescue disk to save the current partitioning information of your hard disk, and maintain a complete Bacula backup, it is possible to completely recover your system from "bare metal".

If you have used the **WriteBootstrap** record in your job or some other means to save a valid bootstrap file, you will be able to use it to extract the necessary files (without using the catalog or manually searching for the files to restore).

Interactions Between the Bacula Services

The following block diagram shows the typical interactions between the Bacula Services for a backup job. Each block represents in general a separate process (normally a daemon). In general, the Director oversees the flow of information. It also maintains the Catalog.

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The Network Backup Solution

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Introduction



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Getting Started

The Current State of Bacula

In other words, what is and what is not currently implemented and functional.

What is Implemented

- Network backup/restore with centralized Director.
- Internal scheduler for automatic [Job](#) execution.
- Scheduling of multiple Jobs at the same time.
- You may run one Job at a time or multiple simultaneous Jobs.
- Job sequencing using priorities.
- Restore of one or more files selected interactively either for the current backup or a backup prior to a specified time and date.
- Restore of a complete system starting from bare metal. This is mostly automated for Linux systems and partially automated for Solaris. See [Disaster Recovery Using Bacula](#).
- Listing and Restoration of files using stand-alone **bls** and **bextract** tool programs. Among other things, this permits extraction of files when Bacula and/or the catalog are not available. Note, the recommended way to restore files is using the restore command in the Console. These programs are designed for use as a last resort.
- Ability to recreate the catalog database by scanning backup Volumes using the **bscan** program.
- [Console](#) interface to the [Director](#) allowing complete control. Both a shell and GNOME GUI versions of the Console program are available. Note, the GNOME GUI program currently offers very few additional features over the shell program.
- Verification of files previously cataloged, permitting a Tripwire like capability (system break-in detection).
- CRAM-MD5 password authentication between each component (daemon).
- A comprehensive and extensible [configuration file](#) for each daemon.
- Catalog database facility for remembering Volumes, Pools, Jobs, and Files backed up.
- Support for SQLite, PostgreSQL, and MySQL Catalog databases.
- User extensible queries to the SQLite, PostgreSQL and MySQL databases.
- Labeled Volumes, preventing accidental overwriting (at least by Bacula).
- Any number of Jobs and Clients can be backed up to a single Volume. That is, you can backup and restore Linux, Unix, Sun, and Windows machines to the same Volume.
- Multi-volume saves. When a Volume is full, **Bacula** automatically requests the next Volume and continues the backup.
- [Pool and Volume](#) library management providing Volume flexibility (e.g. monthly, weekly, daily Volume sets, Volume sets segregated by Client, ...).
- Machine independent Volume data format. Linux, Solaris, and Windows clients can all be backed up to the same Volume if desired.
- A flexible [message](#) handler including routing of messages from any daemon back to the Director and automatic email reporting.
- Multi-threaded implementation.
- Programmed to handle arbitrarily long filenames and messages.
- GZIP compression on a file by file basis done by the Client program if requested before network transit.
- Computation of MD5 or SHA1 signatures of the file data if requested.
- Autochanger support using a simple shell interface that can interface to virtually any autoloader program. A script for **mtx** is provided.
- Support for autochanger barcodes — automatic tape labeling from barcodes.

- Raw device backup/restore. Restore must be to the same device.
- All Volume blocks (approx 64K bytes) contain a data checksum.
- Access control lists for Consoles that permit restricting user access to only their data.
- Data spooling to disk during back with subsequent write to tape from the spooled disk files. This prevents tape "shoe shine" during Incremental backups.

Advantages of Bacula Over Other Backup Programs

- Since there is a client for each machine, you can backup and restore clients of any type ensuring that all attributes of files are properly saved and restored.
- It is also possible to backup clients without any client software by using NFS or Samba. However, if possible, we recommend running a Client File daemon on each machine to be backed up.
- Bacula handles multi-volume backups.
- A full comprehensive SQL standard database of all files backed up. This permits online viewing of files saved on any particular Volume.
- Automatic pruning of the database (removal of old records) thus simplifying database administration.
- Any SQL database engine can be used making Bacula very flexible.
- The modular but integrated design makes Bacula very scalable.
- Since Bacula uses client file servers, any database or other application can be properly shutdown by Bacula using the native tools of the system, backed up, then restarted (all within a Bacula Job).
- Bacula has a built-in Job scheduler.
- The Volume format is documented and there are simple C programs to read/write it.
- Bacula uses well defined (registered) TCP/IP ports — no rpcs, no shared memory.
- Bacula installation and configuration is relatively simple compared to other comparable products.
- According to one user Bacula is as fast as the big major commercial application.
- According to another user Bacula is four times as fast as a another commercial application, probably because that application stores its catalog information in a large number of individual files rather than an SQL database as Bacula does.

Current Implementation Weaknesses

- The graphical user interface is currently in an preliminary stage.
- Typical of Microsoft, not all files can always be saved on WinNT and Win2000 when they are in use by another program. Anyone knowing the magic incantations please step forward. The files that are skipped seem to be in exclusive use by some other process, and don't appear to be too important.
- Windows Unicode filenames (e.g. Chinese) cannot be saved or restored.
- If you have over 4 billion file entries stored in your database, the database FileId is likely to overflow. This is a monster database, but still possible.

Other Items Not Implemented (but planned)

- Complete error checking on configuration files.
- Event handlers are not yet implemented (e.g. when Job terminates do this, ...)
- File System Modules (configurable routines for saving/restoring special files).

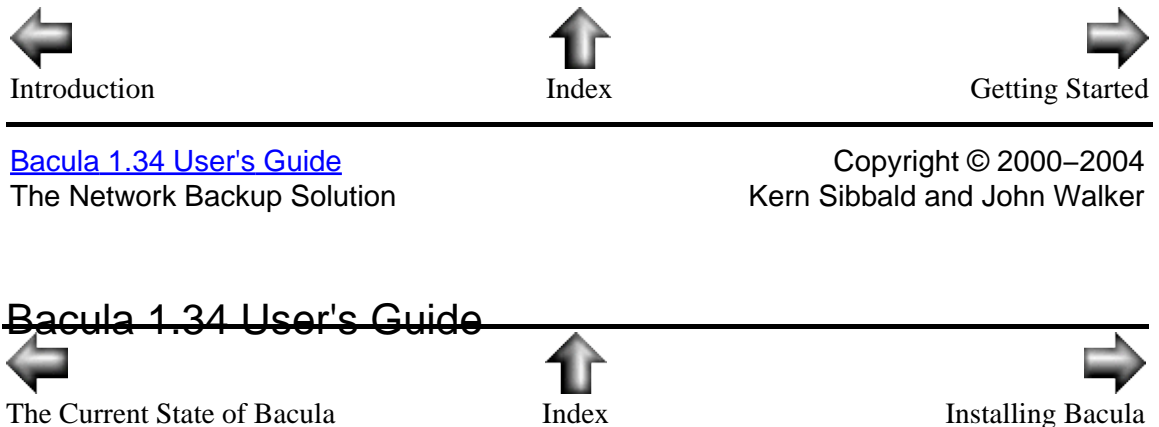
- Data encryption between the daemons.
- Data encryption of the Volume contents.
- Backing up each file to two or more devices simultaneously.
- Bacula cannot backup or restore files from two or more different storage devices or different media types.

Temporary Limitations or Restrictions

- All three daemons (DIR, FD, SD) must be running for a Job to run. If you use MySQL or PostgreSQL as the catalog, it must also be running. If you use SQLite as the catalog, it will be started automatically. This isn't very significant as most other programs have the same limitation.
- Unicode is not yet supported.
- Supports only IPv4.

Design Limitations or Restrictions

- Names (resource names, Volume names, and such) defined in Bacula configuration files are limited to a fixed number of characters. Currently the limit is defined as 127 characters. Note, this does not apply to filenames, which may be arbitrarily long.
- There is no concept of a Pool of backup devices (i.e. if device /dev/nst0 is busy, use /dev/nst1, ...).



Getting Started with Bacula

If you are like me, you want to get Bacula running immediately to get a feel for it, then later you want to go back and read about all the details. This chapter attempts to accomplish just that: get you going quickly without all the details. If you want to skip the section on Pools, Volumes and Labels, you can always come back to it, but please read to the end of this chapter, and in particular follow the instructions for testing your tape drive.

Supported Operating Systems

- Linux systems (built and tested on RedHat Enterprise Linux 3.0).
- If you have a recent Red Hat Linux system running the 2.4.x kernel and you have the directory **/lib/tls** installed on your system (normally by default), bacula will **NOT** run. This is the new pthreads library and it is defective. You must remove this directory prior to running Bacula, or you can simply change the name to **/lib/tls-broken**) then you must reboot your machine (one of the few times Linux must be rebooted).
- Most flavors of Linux (Gentoo, SuSE, Mandrake, Debian, ...).
- Solaris various versions.
- FreeBSD (tape driver supported in 1.30 — please see some important considerations in the [Tape Modes on FreeBSD](#) section of the Tape Testing chapter of this manual.) Note, the FreeBSD SCSI tape driver does not support multiple volume backups in that on some drives, significant amounts of data are lost at an end of tape condition. This is fixed with FreeBSD problem report number 56274.

Please see the file **platforms/freebsd/pthreads-fix.txt** in the main Bacula directory concerning important information concerning compatibility of Bacula and your system.

- Windows (Win95/98/Me, WinNT/2K/XP) Client (File daemon) binaries.
- MacOS X/Darwin (see <http://fink.sourceforge.net/> for obtaining the packages)
- OpenBSD Client (File daemon).
- Irix Client (File daemon) (available on Source Forge).
- Bacula is said to work on other systems (AIX, BSDI, HPUNIX, ...) but we do not have first hand knowledge of these systems.
- See the [Porting](#) Chapter of this manual for information on porting to other systems.

System Requirements

- **Bacula** has been compiled and run on Linux RedHat, FreeBSD, and Solaris systems.
- It requires GNU C++ version 2.95 or higher to compile. You can try with other compilers and older versions, but you are on your own. We have successfully compiled and used Bacula on RH8.0/RH9/RHEL 3.0 with GCC 3.2. Note, in general GNU C++ is a separate package (e.g. RPM) from GNU C, so you need them both loaded. On RedHat systems, the C++ compiler is part of the **gcc-c++** rpm package.
- There are certain third party packages that Bacula needs. Except for MySQL and PostgreSQL, they can all be found in the **depkgs** and **depkgs1** releases.
- If you want to build the Win32 binaries, you will need a Microsoft Visual C++ compiler (or Visual Studio). Although all components build (console has some warnings), only the File daemon has been tested.

- **Bacula** requires a good implementation of pthreads to work. This is not the case on some of the BSD systems. FreeBSD being the exception (see [Tape Modes on FreeBSD](#)).
- The source code has been written with portability in mind and is mostly POSIX compatible. Thus porting to any POSIX compatible operating system should be relatively easy.
- The GNOME Console program is developed and tested under GNOME 2.x. It also runs under GNOME 1.4 but this version is deprecated and thus no longer maintained.
- If you want to enable command line editing and history, you will need to have `/usr/include/termcap.h` and either the `termcap` or the `ncurses` library loaded (`libtermcap-devel` or `ncurses-devel`).

Supported Tape Drives

It is very difficult to supply a list of supported tape drives, or drives that are known to work with Bacula because of limited feedback (so if you use Bacula on a different drive, please let us know). Based on user feedback, the following drives are known to work with Bacula:

- Adic Scalar 100 DLT and Adic Fastor 22 DLT both HVD.
- Compaq DDS 2,3,4 drives (probably OEMed)
- Exabyte drives (except for those 10 years old or older)
- Exabyte VXA drives (formerly Ecrix).
- HP Colorado T4000S (Travan-4) drives with **Backward Space Record = No**
- HP DLT drives
- HP LTO Ultrium drive
- HP SureStore 6000 DDS (DAT2)
- Overland LoaderXpress LTO and Overland Neo2000 both LVD.
- OnStream drives, but see below for more on this drive.
- Quantum DLT-8000.
- Seagate Scorpio 40 DDS-4 on RH Linux.
- Sony DDS 2,3,4 drives
- Tandberg MLR3 on Linux
- Tandberg SLR6 on FreeBSD
- Tandberg SLR75 on a SunFire V210 Solaris 8 system.

Please check the [btape section](#) of this manual for procedures that you can use to verify if your tape drive will work with Bacula. Also there is a list of [supported autochangers](#) models in the [autochangers chapter](#) of this document, where you will find other tape drives that work with Bacula.

Unsupported Tape Drives

Previously OnStream IDE-SCSI tape drives did not work with Bacula. As of Bacula version 1.33 and the `osst` kernel driver version 0.9.14 or later, they now work. Please see the testing chapter as you must set a fixed block size.

QIC tapes are known to have a number of particularities (fixed block size, and one EOF rather than two to terminate the tape). As a consequence, you will need to take a lot of care in configuring them to make them work correctly with Bacula.

Supported Autochangers

For information on supported autochangers, please see the [Autochangers Known to Work with Bacula](#) section of the Autochangers chapter of this manual.

Up Front Decisions

- Before building Bacula you need to decide if you want to use SQLite, MySQL, or PostgreSQL. Unless you are already familiar with MySQL or PostgreSQL, we suggest that you start with the SQLite database as it is the simplest. If you need security or have a large operation, you should consider the MySQL or PostgreSQL databases because it provides all the Bacula features and is the best tested. MySQL and PostgreSQL are also much easier to upgrade than SQLite when new versions of Bacula require a database update.
- If you wish to use SQLite as the Bacula catalog, please see [Installing and Configuring SQLite](#) chapter of this manual.
- If you wish to use PostgreSQL as the Bacula catalog, please see the [Installing and Configuring PostgreSQL](#) chapter of this manual.
- If you wish to use MySQL as the Bacula catalog, please see the [Installing and Configuring MySQL](#) chapter of this manual.
- At this point, you should have Bacula built and installed. If not, please follow the instructions in the [Bacula Installation Chapter](#) of this manual.

Installing Bacula

Before setting up your configuration files, you will want to install Bacula in its final location. Simply enter:

```
make install
```

If you have previously installed Bacula, the old binaries will be overwritten, but the old configuration files will remain unchanged, and the "new" configuration files will be appended with a **.new**. Generally if you have previously installed and run Bacula you will want to discard or ignore the configuration files with the appended **.new**. For the details of doing the install, please see the [Installing Bacula](#) chapter of this manual.

Understanding Pools, Volumes and Labels

If you have been using a program such as **tar** to backup your system, Pools, Volumes, and labeling may be a bit confusing at first. A Volume is a single physical tape (or possibly a single file) on which Bacula will write your backup data. Pools group together Volumes so that a backup is not restricted to the length of a single Volume (tape). Consequently, rather than explicitly naming Volumes in your Job, you specify a Pool, and Bacula will select the next appendable Volume from the Pool and request you to mount it.

Although the basic Pool options are specified in the Director's Pool resource, the **real** Pool is maintained in the Bacula Catalog. It contains information taken from the Pool resource (bacula-dir.conf) as well as information on all the Volumes that have been added to the Pool. Adding Volumes to a Pool is usually done manually with the Console program using the **label**

command.

For each Volume, Bacula maintains a fair amount of catalog information such as the first write date/time, the last write date/time, the number of files on the Volume, the number of bytes on the Volume, the number of Mounts, etc.

Before Bacula will read or write a Volume, the physical Volume must have a Bacula software label so that Bacula can be sure the correct Volume is mounted. This is usually done using the **label** command in the Console program.

The steps for creating a Pool, adding Volumes to it, and writing software labels to the Volumes, may seem tedious at first, but in fact, they are quite simple to do, and they allow you to use multiple Volumes (rather than being limited to the size of a single tape). Pools also give you significant flexibility in your backup process. For example, you can have a "Daily" Pool of Volumes for Incremental backups and a "Weekly" Pool of Volumes for Full backups. By specifying the appropriate Pool in the daily and weekly backup Jobs, you thereby insure that no daily Job ever writes to a Volume in the Weekly Pool and vice versa, and Bacula will tell you what tape is needed and when.

For more on Pools, see the [Pool Resource](#) section of the Director Configuration chapter, or simply read on, and we will come back to this subject later.

Setting Up Bacula Configuration Files

After running the appropriate `./configure` command and doing a **make**, and a **make install**, if this is the first time you are running Bacula, you must create valid configuration files for the Director, the File daemon, the Storage daemon, and the Console programs. If you have followed our recommendations, default configuration files as well as the daemon binaries will be located in your installation directory. In any case, the binaries are found in the directory you specified on the `---sbindir` option to the `./configure` command, and the configuration files are found in the directory you specified on the `---sysconfdir` option.

When initially setting up Bacula you will need to invest a bit of time in modifying the default configuration files to suit your environment. This may entail starting and stopping Bacula a number of times until you get everything right. Please do not despair. Once you have created your configuration files, you will rarely need to change them nor will you stop and start Bacula very often. Most of the work will simply be in changing the tape when it is full.

[Configuring the Console Program](#)

The Console configuration file is found in the directory specified on the `---sysconfdir` option that you specified on the `./configure` command and by default is named **console.conf**. Normally, for first time users, no change is needed to this file. Reasonable defaults are set.

[Configuring the File daemon](#)

The File daemon configuration file is found in the directory specified on the `---sysconfdir` option that you specified on the `./configure` command. By default, the File daemon's configuration file is named **bacula-fd.conf**. Normally, for first time users, no change is needed to this file.

Reasonable defaults are set. However, if you are going to back up more than one machine, you

will need to install the File daemon with a unique configuration file on each machine to be backed up. The information about each File daemon must appear in the Director's configuration file.

Configuring the Director

The Director configuration file is found in the directory specified on the `--sysconfdir` option that you specified on the `./configure` command. Normally the Director's configuration file is named **bacula-dir.conf**.

In general, the only change you must make is modify the FileSet resource so that the **Include** configuration directive contains at least one line with a valid name of a directory (or file) to be saved.

If you do not have a DLT tape drive, you will probably want to edit the Storage resource to contain names that are more representative of your actual storage device. You can always use the existing names as you are free to arbitrarily assign them, but they must agree with the corresponding names in the Storage daemon's configuration file.

You may also want to change the email address for notification from the default **root** to your email address.

Finally, if you have multiple systems to be backed up, you will need a separate File daemon or Client specification for each system, specifying its name, address, and password. We have found that giving your daemons the same name as your system but post fixed with **-fd** helps a lot in debugging. That is, if your system name is **foobaz**, you would give the File daemon the name **foobaz-fd**. For the Director, you might use **foobaz-dir**, and for the storage daemon, you might use **foobaz-sd**.

Configuring the Storage daemon

The Storage daemon's configuration file is found in the directory specified on the `--sysconfdir` option that you specified on the `./configure` command. By default, the Storage daemon's file is named **bacula-sd.conf**. Edit this file to contain the correct Archive device names for any tape devices that you have. If the configuration process properly detected your system, they will already be correctly set. These Storage resource name and Media Type must be the same as the corresponding ones in the Director's configuration file **bacula-dir.conf**. If you want to backup to a file instead of a tape, the Archive device must point to a directory in which the Volumes will be created as files when you label the Volume.

Testing your Configuration Files

You can test if your configuration file is syntactically correct by running the appropriate daemon with the `-t` option. The daemon will process the configuration file and print any error messages then terminate. For example, assuming you have installed your binaries and configuration files in the same directory.

```
cd <installation-directory>
./bacula-dir -t -c bacula-dir.conf
./bacula-fd -t -c bacula-fd.conf
./bacula-sd -t -c bacula-sd.conf
```



```
./console -t -c console.conf
```

will test the configuration files of each of the main programs. If the configuration file is OK, the program will terminate without printing anything.

Testing Bacula Compatibility with Your Tape Drive

Before spending a lot of time on Bacula only to find that it doesn't work with your tape drive, please read the [btape — Testing Your Tape Drive](#) chapter of this manual. If you have a modern standard SCSI tape drive on a Linux or Solaris, most likely it will work, but better test than be sorry. For FreeBSD (and probably other xBSD flavors), reading the above mentioned tape testing chapter is a must. Also, for FreeBSD, please see [The FreeBSD Diary](#) for a detailed description on how to make Bacula work on your system. In addition, users of FreeBSD prior to 4.9-STABLE dated Mon Dec 29 15:18:01 2003 UTC who plan to use tape devices, please see the file **platforms/freebsd/pthreads-fix.txt** in the main Bacula directory concerning important information concerning compatibility of Bacula and your system.

Get Rid of the /lib/tls Directory

As noted above the new pthreads library **/lib/tls** installed by default on recent Red Hat systems running kernel 2.4.x is defective. You must remove it or rename it then reboot your system before running Bacula.

Running Bacula

Probably the most important part of running Bacula is being able to restore files. If you haven't tried recovering files at least once, when you actually have to do it, you will be under a lot more pressure (and prone to make errors) than if you had already tried it once.

To get a good idea how to use Bacula in a short time, we **strongly** recommend that you follow the example in [Running Bacula Chapter](#) of this manual where you will get detailed instructions on how to run Bacula.

Log Rotation

If you use the default **bacula-dir.conf** or some variation of it, you will note that it logs all the Bacula output to a file. To avoid that this file grows without limit, we recommend that you copy the file **logrotate** from the **scripts/logrotate** to **/etc/logrotate.d/bacula**. This will cause the log file to be rotated once a month and kept for a maximum of 5 months. You may want to edit this file to change the default log rotation preferences.

Disaster Recovery

If you intend to use Bacula as a disaster recovery tool rather than simply a program to restore lost or damaged files, you will want to read the [Disaster Recovery Using Bacula Chapter](#) of this manual.

In any case, you are strongly urged to carefully test restoring some files that you have saved rather than wait until disaster strikes. This way, you will be prepared.



The Current State of Bacula



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Installing Bacula

[Bacula 1.34 User's Guide](#)

The Network Backup Solution

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Getting Started



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General

In general, you will need the Bacula source release, and if you want to run a Windows client, you will need the Bacula Windows binary release. However, Bacula needs certain third party packages (such as **readline**, **SQLite**, **MySQL** to build properly depending on the options you specify. To simplify your task, we have combined a number of these packages into two **depkgs** releases (Dependency Packages). This can vastly simplify your life by providing you with all the necessary packages rather than requiring you to find them on the Web, load them, and install them.

Upgrading Bacula

If you are upgrading from one Bacula version to another, you should first carefully read all the ReleaseNotes of all versions between your current version and the version to which you are upgrading. If the Bacula catalog database has been upgraded, you will either need to reinitialize your database starting from scratch, or save an ASCII copy of your database then proceed to upgrade it. If there are several database upgrades between your version and the version to which you are upgrading, you will need to apply each database upgrade script. For your convenience, you can find all the old upgrade scripts in the **upgradedb** directory of the source code. You will need to edit the scripts to correspond to your system configuration. The final upgrade script, if any, will be in the **src/cats** directory as described in the ReleaseNotes.

If you are upgrading from one major version to another, you will need to replace all your components at the same time as generally the inter-daemon protocol will change. However, within any particular release (e.g. version 1.32.x) unless there is an oversight or bug, the daemon protocol will not change. If this is confusing, simply read the ReleaseNotes very carefully as they will note if all daemons must be upgraded at the same time.

Dependency Packages

As discussed above, we have combined a number of third party packages that Bacula might need into the **depkgs** and **depkgs1** releases. Typically, they will be named **depkgs-ddMMMy.tar.gz** and **depkgs1-ddMMMy.tar.gz** where **dd** is the day we release it, **MMM** is the abbreviated month (e.g. Jan), and **yy** is the year. An actual example is: **depkgs-07Apr02.tar.gz**. To install and build this package (if needed), you do the following:

1. Create a **bacula** directory, into which you will place both the Bacula source as well as the dependency package.
2. Detar the **depkg** into the **bacula** directory.
3. `cd bacula/depkgs`
4. `make`

Although the exact composition of the dependency packages may change from time to time, the current makeup is the following:

3rd Party Package	depkgs	depkgs1	depkgs-win32
-------------------	--------	---------	--------------

SQLite	X	–	–
mtx	X	–	–
readline	X	–	–
pthreads	–	–	X
zlib	–	–	X

Note, some of these packages are quite large, so that this part can be a bit time consuming. The above instructions will build all the packages contained in the directory. However, when building Bacula, it will take only those pieces that it actually needs.

Alternatively, you can make just the packages that are needed. For example,

```
cd bacula/depkgs
make sqlite
```

will configure and build only the SQLite package.

You should build the packages that you will require in **depkgs** and/or **depkgs1** prior to configuring and building Bacula, since Bacula will need them during the build process.

Even if you do not use SQLite, you might find it worth while to build **mtx** because the **tapeinfo** program that comes with it can often provide you with valuable information about your SCSI tape drive (e.g. compression, min/max block sizes, ...).

The **depkgs-win32** package contains the source code for the pthreads and zlib libraries used by the native Win32 client program. It will only be needed if you intend to build the Win32 client from source.

Supported Operating Systems

Please see the [Supported Operating Systems](#) section of the QuickStart chapter of this manual.

Building Bacula from Source

The basic installation is rather simple.

1. Install and build any **depkgs** as noted above.
2. Configure and install MySQL or PostgreSQL (if desired). [Installing and Configuring MySQL Phase I](#) or [Installing and Configuring PostgreSQL Phase I](#). If you are installing from rpms, and are using MySQL, please be sure to install **mysql-devel**, so that the MySQL header files are available while compiling Bacula. In addition, the MySQL client library **mysqlclient** requires the gzip compression library **libz.a** or **libz.so**. If you are using rpm packages, these libraries are in the **libz-devel** package. On Debian

systems, you will need to load the **zlib1g-dev** package. If you are not using rpms or debs, you will need to find the appropriate package for your system.

Note, if you already have a running MySQL or PostgreSQL on your system, you can skip this phase provided that you have built the thread safe libraries. And you have already installed the additional rpms noted above.

3. As an alternative to MySQL and PostgreSQL, configure and install SQLite, which is part of the **depkgs**. [Installing and Configuring SQLite](#).
4. Detar the Bacula source code preferably into the **bacula** directory discussed above.
5. **cd** to the directory containing the source code.
6. `./configure` (with appropriate options as described below)
7. Check the output of `./configure` very carefully, especially the Install binaries and Install config files directories. If they are not correct, please rerun `./configure` until they are. The output from `./configure` is stored in **config.out** and can be re-displayed at any time without rerunning the `./configure` by doing **cat config.out**.
8. If after running `./configure` once, you decide to change options and re-run it, that is perfectly fine, but before re-running it, you should run:

```
make distclean
```

so that you are sure to start from scratch and not have a mixture of the two options. This is because `./configure` caches much of the information. The **make distclean** is also critical if you move the source file from one machine to another. If the **make distclean** fails, just ignore it and continue on.

9. **make**

If you get errors while linking in the Storage daemon directory (`src/stored`), it is probably because you have not loaded the static libraries on your system. I noticed this problem on a Solaris system. To correct it, make sure that you have not added **--enable-static-tools** to the `./configure` command.

10. **make install**
11. If you are new to Bacula, we strongly recommend that you skip the next step and use the default configuration files, then run the example program in the next chapter, then come back and modify your configuration files to suit your particular needs.
12. Customize the configuration files for each of the three daemons (Directory, File, Storage) and for the Console program. For the details of how to do this, please see [Setting Up Bacula Configuration Files](#) in the Configuration chapter of this manual. We recommend that you start by modifying the default configuration files supplied, making the minimum changes necessary. Complete customization can be done after you have Bacula up and running. Please take care when modifying passwords, which were randomly generated, and the daemon **Name** values as the passwords and names must agree between the configuration files for security reasons.
13. Create the Bacula MySQL database and tables (if using MySQL) [Installing and Configuring MySQL Phase II](#) or create the Bacula PostgreSQL database and tables [Installing and Configuring PostgreSQL Phase II](#) or alternatively if you are using SQLite [Installing and Configuring SQLite Phase II](#).
14. Start Bacula (`./bacula start`) Note. the next chapter shows you how to do this in detail.
15. Interface with Bacula using the Console program
16. For the previous two items, please follow the instructions in the [Running Bacula](#) chapter of this manual, where you will run a simple backup and do a restore. Do this before you

make heavy modifications to the configuration files so that you are sure that Bacula works and are familiar with it. After that changing the conf files will be easier.

17. If after installing Bacula, you decide to "move it", that is to install it in a different set of directories, proceed as follows:

```
make uninstall
make distclean
./configure (your-new-options)
make
make install
```

If all goes well, the **./configure** will correctly determine which operating system you are running and configure the source code appropriately. Currently, FreeBSD, Linux (RedHat), and Solaris are supported. MacOS X 10.3 is reported to work with the Client only as long as readline support is disabled.

If you install Bacula on more than one system, and they are identical, you can simply transfer the source tree to that other system and do a "make install". However, if there are differences in the libraries or OS versions, or you wish to install on a different OS, you should start from the original compress tar file. If you do transfer the source tree, and you have previously done a **./configure** command, you **MUST** do:

```
make distclean
```

prior to doing your new **./configure**. This is because the GNU autoconf tools cache the configuration, and if you re-use a configuration for a Linux machine on a Solaris, you can be sure your build will fail. To avoid this, as mentioned above, either start from the tar file, or do a "make distclean".

In general, you will probably want to supply a more complicated **configure** statement to ensure that the modules you want are built and that everything is placed into the correct directories.

For example, on RedHat, one could use the following:

```
CFLAGS="-g -Wall" \
./configure \
  --sbindir=$HOME/bacula/bin \
  --sysconfdir=$HOME/bacula/bin \
  --with-pid-dir=$HOME/bacula/bin/working \
  --with-subsys-dir=$HOME/bacula/bin/working \
  --with-mysql=$HOME/mysql \
  --with-working-dir=$HOME/bacula/bin/working \
  --with-dump-email=$USER
```

Note, the advantage of using the above configuration to start is that everything will be put into a single directory, which you can later delete once you have run the examples in the next chapter and learned how Bacula works. In addition, the above can be installed and run as non-root.

For the developer's convenience, I have added a **defaultconfig** script to the **examples** directory. This script contains the statements that you would normally use, and each developer/user may modify them to suit his needs. You should find additional useful examples in this directory as well.

The **`--enable-conio`** or **`--enable-readline`** options are useful because they provide a command line history and editing capability for the Console program. If you have included either option in the build, either the **termcap** or the **ncurses** package will be needed to link. On some systems, such as SuSE, the termcap library is not in the standard library directory. As a consequence, the option may be disabled or you may get an error message such as:

```
/usr/lib/gcc-lib/i586-suse-linux/3.3.1/.../ld:  
cannot find -ltermcap  
collect2: ld returned 1 exit status
```

while building the Bacula Console. In that case, you will need to set the **LDFLAGS** environment variable prior to building.

```
export LDFLAGS="-L/usr/lib/termcap"
```

The same library requirements apply if you wish to use the readline subroutines for command line editing and history.

Please be aware that on some systems such as Mandrake, readline tends to gobble up prompts, which makes it totally useless. If this happens to you, use the disable option, or if you are using version 1.33 and above try using **`--enable-conio`** to use a built-in readline replacement. You will still need the either termcap or ncurses library, but it is unlikely that the **conio** package will gobble up prompts.

What Database to Use?

Before building Bacula you need to decide if you want to use SQLite or MySQL. If you are not already running MySQL, we recommend that you start by using SQLite. This will greatly simplify the setup for you.

If you wish to use MySQL as the Bacula catalog, please see the [Installing and Configuring MySQL](#) chapter of this manual. You will need to install MySQL prior to continuing with the configuration of Bacula.

If you wish to use PostgreSQL as the Bacula catalog, please see the [Installing and Configuring PostgreSQL](#) chapter of this manual. You will need to install PostgreSQL prior to continuing with the configuration of Bacula.

If you wish to use SQLite as the Bacula catalog, please see [Installing and Configuring SQLite](#) chapter of this manual.

Quick Start

There are a good number of options and important considerations given below that you can skip for the moment if you have not had any problems building Bacula with a simplified configuration as shown above.

If you want to dive right into it, we recommend you skip to the next chapter, and run the example program. It will teach you a lot about Bacula and as an example can be installed into a single directory (for easy removal) and run as non-root. If you have any problems or when you want to

do a real installation, come back to this chapter and read the details presented below.

Configure Options

The following command line options are available for **configure** to customize your installation.

--sysbindir=<binary-path>

Defines where the Bacula binary (executable) files will be placed during a **make install** command.

--sysconfdir=<config-path>

Defines where the Bacula configuration files should be placed during a **make install** command.

--enable-smartalloc

This enables the inclusion of the Smartalloc orphaned buffer detection code. This option is highly recommended. Because we never build without this option, you may experience problems if it is not enabled. This configuration parameter is used while building Bacula

--enable-gnome

If you have GNOME installed on your computer and you want to use the GNOME GUI Console interface to Bacula, you must specify this option. Doing so will build everything in the **src/gnome-console** directory.

--enable-static-tools

This option causes the linker to link the Storage daemon utility tools (**bls**, **bextract**, and **bscan**) statically. This permits using them without having the shared libraries loaded. If you have problems linking in the **src/stored** directory, make sure you have not enabled this option, or explicitly disable static linking by adding **--disable-static-tools**.

--enable-static-fd

This option causes the make process to build a **static-bacula-fd** in addition to the standard File daemon. This static version will include statically linked libraries and is required for the Bare Metal recovery. This option is largely superseded by using **make static-bacula-fd** from within the **src/forced** directory. Also, the **--enable-client-only** option described below is useful for just building a client so that all the other parts of the program are not compiled.

--enable-static-sd

This option causes the make process to build a **static-bacula-sd** in addition to the standard Storage daemon. This static version will include statically linked libraries and could be useful during a Bare Metal recovery.

--enable-static-dir

This option causes the make process to build a **static-bacula-dir** in addition to the standard Director. This static version will include statically linked libraries and could be useful during a Bare Metal recovery.

--enable-static-cons

This option causes the make process to build a **static-console** and a **static-gnome-console** in addition to the standard console. This static version will include statically linked libraries and could be useful during a Bare Metal recovery.

--enable-client-only

This option causes the make process to build only the File daemon and the libraries that it needs. None of the other daemons, storage tools, nor the console will be build.

Likewise a **make install** will then only install the File daemon. To cause all daemons to be built, you will need to do a configuration without this option. This option greatly facilitates building a Client on a client only machine.

`--enable-largefile`

This option (default) causes Bacula to be built with 64 bit file address support if it is available on your system. This permits Bacula to read and write files greater than 2 GBytes in size. You may disable this feature and revert to 32 bit file addresses by using `--disable-largefile`.

`--with-sqlite=<sqlite-path>`

This enables use of the SQLite database. The **sqlite-path** is not normally specified as Bacula looks for the necessary components in a standard location (**depkgs/sqlite**). See [Installing and Configuring MySQL](#) chapter of this manual for more details.

`--with-mysql=<mysql-path>`

This enables building of the Catalog services for Bacula. It assumes that MySQL is running on your system, and expects it to be installed in the **mysql-path** that you specify. If this option is not present, the build will automatically include the internal Bacula database code. We recommend that you use this option if possible. If you do use this option, please proceed to installing MySQL in the [Installing and Configuring MySQL](#) chapter before proceeding with the configuration.

`--with-postgresql=<path>`

This provides an explicit path to the PostgreSQL libraries if Bacula cannot find it by default.

`--enable-conio`

Tells Bacula to enable building the small, light weight readline replacement routine. It is generally much easier to configure than readline, although, like readline, it needs either the termcap or ncurses library.

`--with-readline=<readline-path>`

Tells Bacula where **readline** is installed. Normally, Bacula will find readline if it is in a standard library. If it is not found and no `--with-readline` is specified, readline will be disabled. This option affects the Bacula build. Readline provides the Console program with a command line history and editing capability.

`--enable-readline`

Tells Bacula to enable readline support. It is normally disabled due to the large number of configuration problems and the fact that the package seems to change in incompatible ways from version to version.

`--with-tcp-wrappers=<path>`

This specifies that you want TCP wrappers (man hosts_access(5)) compiled in. The path is optional since Bacula will normally find the libraries in the standard locations. This option affects the Bacula build. In specifying your restrictions in the **/etc/hosts.allow** or **/etc/hosts.deny** files, do not use the **twist** option (hosts_options(5)) or the Bacula process will be terminated.

For more information on configuring and testing TCP wrappers, please see the [Configuring and Testing TCP Wrappers](#) section in the Security Chapter.

`--with-working-dir=<working-directory-path>`

This option is mandatory and specifies a directory into which Bacula may safely place files that will remain between Bacula executions. For example, if the internal database is used, Bacula will keep those files in this directory. This option is only used to modify the daemon configuration files. You may also accomplish the same thing by directly editing them later.

`--with-base-port=<port=number>`

In order to run, Bacula needs three TCP/IP ports (one for the Bacula Console, one for the Storage daemon, and one for the File daemon). The `--with-baseport` option will automatically assign three ports beginning at the base port address specified. You may

also change the port number in the resulting configuration files. However, you need to take care that the numbers correspond correctly in each of the three daemon configuration files. The default base port is 9101, which assigns ports 9101 through 9103. These ports (9101, 9102, and 9103) have been officially assigned to Bacula by IANA. This option is only used to modify the daemon configuration files. You may also accomplish the same thing by directly editing them later.

--with-dump-email=<email-address>

This option specifies the email address where any core dumps should be set. This option is normally only used by developers.

--with-pid-dir=<PATH>

This specifies where Bacula should place the process id file during execution. The default is: **/var/run**.

--with-subsys-dir=<PATH>

This specifies where Bacula should place the subsystem lock file during execution. The default is **/var/run/subsys**. Please make sure that you do not specify the same directory for this directory and for the **sbindir** directory.

--with-dir-password=<Password>

This option allows you to specify the password used to access the Directory (normally from the Console program). If it is not specified, configure will automatically create a random password.

--with-fd-password=<Password>

This option allows you to specify the password used to access the File daemon (normally called from the Director). If it is not specified, configure will automatically create a random password.

--with-sd-password=<Password>

This option allows you to specify the password used to access the Directory (normally called from the Director). If it is not specified, configure will automatically create a random password.

--with-dir-user=<User>

This option allows you to specify the UserId used to run the Director. The Director must be started as root, but doesn't need to run as root, and after doing preliminary initializations, it can "drop" to the UserId specified on this option.

--with-dir-group=<Group>

This option allows you to specify the GroupId used to run the Director. The Director must be started as root, but doesn't need to run as root, and after doing preliminary initializations, it can "drop" to the GroupId specified on this option.

--with-sd-user=<User>

This option allows you to specify the UserId used to run the Storage daemon. The Storage daemon must be started as root, but doesn't need to run as root, and after doing preliminary initializations, it can "drop" to the UserId specified on this option. If you use this option, you will need to take care that the Storage daemon has access to all the devices (tape drives, ...) that it needs.

--with-sd-group=<Group>

This option allows you to specify the GroupId used to run the Storage daemon. The Storage daemon must be started as root, but doesn't need to run as root, and after doing preliminary initializations, it can "drop" to the GroupId specified on this option.

--with-fd-user=<User>

This option allows you to specify the UserId used to run the File daemon. The File daemon must be started as root, and in most cases, it needs to run as root, so this option is used only in very special cases, after doing preliminary initializations, it can "drop" to the UserId specified on this option.

`--with-fd-group=<Group>`

This option allows you to specify the GroupId used to run the File daemon. The File daemon must be started as root, and in most cases, it must be run as root, however, after doing preliminary initializations, it can "drop" to the GroupId specified on this option.

Note, many other options are presented when you do a `./configure --help`, but they are not implemented.

Recommended Options for most Systems

For most systems, we recommend starting with the following options:

```
./configure \
--enable-smartalloc \
--sbindir=$HOME/bacula/bin \
--sysconfdir=$HOME/bacula/bin \
--with-pid-dir=$HOME/bacula/bin/working \
--with-subsys-dir=$HOME/bacula/bin/working \
--with-mysql=$HOME/mysql \
--with-working-dir=$HOME/bacula/working
```

If you want to install Bacula in an installation directory rather than run it out of the build directory (as developers will do most of the time), you should also include the `--sbindir` and `--sysconfdir` options with appropriate paths. Neither are necessary if you do not use "make install" as is the case for most development work. See below for an example of how Kern does it.

RedHat

Using SQLite:

```
CFLAGS="-g -Wall" ./configure \
--sbindir=$HOME/bacula/bin \
--sysconfdir=$HOME/bacula/bin \
--enable-smartalloc \
--with-sqlite=$HOME/bacula/depkgs/sqlite \
--with-working-dir=$HOME/bacula/working \
--with-pid-dir=$HOME/bacula/bin/working \
--with-subsys-dir=$HOME/bacula/bin/working \
--enable-gnome \
--enable-conio
```

or

```
CFLAGS="-g -Wall" ./configure \
--sbindir=$HOME/bacula/bin \
--sysconfdir=$HOME/bacula/bin \
--enable-smartalloc \
--with-mysql=$HOME/mysql \
--with-working-dir=$HOME/bacula/working \
--with-pid-dir=$HOME/bacula/bin/working \
--with-subsys-dir=$HOME/bacula/bin/working \
--enable-gnome \
--enable-conio
```

Solaris

```
#!/bin/sh
CFLAGS="-g" ./configure \
  --sbindir=$HOME/bacula/bin \
  --sysconfdir=$HOME/bacula/bin \
  --with-mysql=$HOME/mysql \
  --enable-smartalloc \
  --with-pid-dir=$HOME/bacula/bin/working \
  --with-subsys-dir=$HOME/bacula/bin/working \
  --with-working-dir=$HOME/bacula/working
```

FreeBSD

Please see: [The FreeBSD Diary](#) for a detailed description on how to make Bacula work on your system. In addition, users of FreeBSD prior to 4.9–STABLE dated Mon Dec 29 15:18:01 2003 UTC who plan to use tape devices, please see the file **platforms/freebsd/threads-fix.txt** in the main Bacula directory concerning important information concerning compatibility of Bacula and your system.

Win32

To install the binary Win32 version of the File daemon please see the [Win32 Installation Chapter](#) in this document.

Windows Systems with CYGWIN Installed

If you wish to build from the source, you will need Microsoft C++ version 6.0 or greater. In Bacula prior to version 1.33, CYGWIN was used. However, the Cygwin version of the Bacula client has been dropped in version 1.33 and later in favor of a native Win32 client (File daemon).

Note, although most parts of Bacula build on Windows systems, the only part that we have tested and used is the File daemon.

Finally, you should follow the installation instructions in the [Win32 Installation](#) section of this document, skipping the part that describes unZipping the binary release.

Kern's Configure Script

The script that I use for building on my "production" Linux machines is:

```
#!/bin/sh
# This is Kern's configure script for Bacula
CFLAGS="-g -Wall" \
  ./configure \
  --sbindir=$HOME/bacula/bin \
  --sysconfdir=$HOME/bacula/bin \
  --enable-smartalloc \
  --enable-gnome \
  --with-pid-dir=$HOME/bacula/bin/working \
  --with-subsys-dir=$HOME/bacula/bin/working \
  --with-mysql=$HOME/mysql \
```

```
--with-working-dir=$HOME/bacula/bin/working \  
--with-dump-email=$USER \  
--with-smtp-host=mail.your-site.com \  
--with-baseport=9101  
exit 0
```

Note that I define the base port as 9101, which means that Bacula will use port 9101 for the Director console, port 9102 for the File daemons, and port 9103 for the Storage daemons. These ports should be available on all systems because they have been officially assigned to Bacula by IANA (Internet Assigned Numbers Authority). We strongly recommend that you use only these ports to prevent any conflicts with other programs. This is in fact the default if you do not specify a **--with-baseport** option.

You may also want to put the following entries in your **/etc/services** file as it will make viewing the connections made by Bacula easier to recognize (i.e. `netstat -a`):

```
bacula-dir      9101/tcp  
bacula-fd       9102/tcp  
bacula-sd       9103/tcp
```

Building a File Daemon or Client

If you run the Director and the Storage daemon on one machine and you wish to back up another machine, you must have a copy of the File daemon for that machine. If the machine and the Operating System are identical, you can simply copy the Bacula File daemon binary file **bacula-fd** as well as its configuration file **bacula-fd.conf** then modify the name and password in the conf file to be unique. Be sure to make corresponding additions to the Director's configuration file (**bacula-dir.conf**).

If the architecture or the O/S level are different, you will need to build a File daemon on the Client machine. To do so, you can use the same **./configure** command as you did for your main program, starting either from a fresh copy of the source tree, or using **make distclean** before the **./configure**.

Since the File daemon does not access the Catalog database, you can remove the **--with-mysql** or **--with-sqlite** options, then add **--enable-client-only**. This will compile only the necessary libraries and the client programs and thus avoids the necessity of installing one or another of those database programs to build the File daemon. With the above option, you simply enter **make** and just the client will be built.

Auto Starting the Daemons

If you wish the daemons to be automatically started and stopped when your system is booted (a good idea), one more step is necessary. First, the **./configure** process must recognize your system — that is it must be a supported platform and not **unknown**, then you must install the platform dependent files by doing:

```
(become root)  
make install-autostart
```

Please note, that the auto-start feature is implemented only on systems that we officially support

(currently, FreeBSD, RedHat Linux, and Solaris), and has only been fully tested on RedHat Linux.

The **make install-autostart** will cause the appropriate startup scripts to be installed with the necessary symbolic links. On RedHat Linux systems, these scripts reside in **/etc/rc.d/init.d/bacula-dir**, **/etc/rc.d/init.d/bacula-fd**, and **/etc/rc.d/init.d/bacula-sd**. However the exact location depends on what operating system you are using.

If you only wish to install the File daemon, you may do so with:

```
make install-autostart-fd
```

Other Make Notes

To simply build a new executable in any directory, enter:

```
make
```

To clean out all the objects and binaries (including the files named 1, 2, or 3, which Kern uses as temporary files), enter:

```
make clean
```

To really clean out everything for distribution, enter:

```
make distclean
```

note, this cleans out the Makefiles and is normally done from the top level directory to prepare for distribution of the source. To recover from this state, you must redo the **./configure** in the top level directory, since all the Makefiles will be deleted.

To add a new file in a subdirectory, edit the Makefile.in in that directory, then simply do a **make**. In most cases, the make will rebuild the Makefile from the new Makefile.in. In some case, you may need to issue the **make** a second time. In extreme cases, cd to the top level directory and enter: **make Makefiles**.

To add dependencies:

```
make depend
```

The **make depend** appends the header file dependencies for each of the object files to Makefile and Makefile.in. This command should be done in each directory where you change the dependencies. Normally, it only needs to be run when you add or delete source or header files. **make depend** is normally automatically invoked during the configuration process.

To install:

```
make install
```

This not normally done if you are developing Bacula, but is used if you are going to run it to backup your system.

Bacula Storage Management System

After doing a **make install** the following files will be installed on your system (more or less). The exact files and location (directory) for each file depends on your **./configure** command (e.g. `gnome-console` and `gnome-console.conf` are not installed if you do not configure GNOME. Also, if you are using SQLite instead of mysql, some of the files will be different).

```
bacula
bacula-dir
bacula-dir.conf
bacula-fd
bacula-fd.conf
bacula-sd
bacula-sd.conf
bextract
bls
bscan
btape
btraceback
btraceback.gdb
bconsole
bconsole.conf
create_mysql_database
dbcheck
delete_catalog_backup
drop_bacula_tables
drop_mysql_tables
fd
gnome-console
gnome-console.conf
make_bacula_tables
make_catalog_backup
make_mysql_tables
mtx-changer
query.sql
bsmtp
startmysql
stopmysql
```

Modifying the Bacula Configuration Files

See the chapter [Configuring Bacula](#) in this manual for instructions on how to set Bacula configuration files.



Getting Started



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The Network Backup Solution

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~~Bacula 1.34 User's Guide~~



Installing Bacula



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Bacula Configuration

Running Bacula

This chapter will guide you through running Bacula. To do so, we assume you have installed Bacula, possibly in a single file as shown in the previous chapter, in which case, you can run Bacula as non-root for these tests. However, we assume that you have not changed the .conf files. If you have modified the .conf files, please go back and uninstall Bacula, then reinstall it, but do not make any changes. The examples in this chapter use the default configuration files, and will write the volumes to disk in your **/tmp** directory, in addition, the data backed up will be the source directory where you built Bacula. As a consequence, you can run all the Bacula daemons for these tests as non-root. Please note, in production, your File daemon(s) must run as root. See the Security chapter for more information on this subject.

The general flow of running Bacula is:

1. `cd <install-directory>`
2. Start the Database (if using MySQL or PostgreSQL)
3. Start the Daemons with **./bacula start**
4. Start the Console program to interact with the Director
5. Run a job
6. When the Volume fills, unmount the Volume, if it is a tape, label a new one, and continue running. In this chapter, we will write only to disk files so you won't need to worry about tapes for the moment.
7. Test recovering some files from the Volume just written to ensure the backup is good and that you know how to recover. Better test before disaster strikes
8. Add a second client.

Each of these steps is described in more detail below.

Before Running Bacula

Before running Bacula for the first time in production, we recommend that you run the **test** command in the **btape** program as described in the [Utility Program Chapter](#) of this manual. This will help ensure that Bacula functions correctly with your tape drive. If you have a modern HP, Sony, or Quantum DDS or DLT tape drive running on Linux or Solaris, you can probably skip this test as Bacula is well tested with these drives and systems. For all other cases, you are **strongly** encouraged to run the test before continuing. **btape** also has a **fill** command that attempts to duplicate what Bacula does when filling a tape and writing on the next tape. You should consider trying this command as well, but be forewarned, it can take hours (about 4 hours on my drive) to fill a large capacity tape.

Starting the Database

If you are using MySQL or PostgreSQL as the Bacula database, you should start it before you attempt to run a job to avoid getting error messages from Bacula when it starts. The scripts **startmysql** and **stopmysql** are what I (Kern) use to start and stop my local MySQL. Note, if you are using SQLite, you will not want to use **startmysql** or **stopmysql**. If you are running this in production, you will probably want to find some way to automatically start MySQL or PostgreSQL after each system reboot.

If you are using SQLite (i.e. you specified the `--with-sqlite=xxx` option on the `./configure` command, you need do nothing. SQLite is automatically started by **Bacula**.

Starting the Daemons

To start the three daemons, from your installation directory, simply enter:

```
./bacula start
```

This script starts the Storage daemon, the File daemon, and the Director daemon, which all normally run as daemons in the background. If you are using the autostart feature of Bacula, your daemons will either be automatically started on reboot, or you can control them individually with the files **bacula-dir**, **bacula-fd**, and **bacula-sd**, which are usually located in `/etc/init.d`, though the actual location is system dependent.

Note, on Windows, currently only the File daemon is ported, and it must be started differently. Please see the [Windows Version of Bacula](#) Chapter of this manual.

The [installation chapter](#) of this manual explains how you can install scripts that will automatically restart the daemons when the system starts.

Interacting with the Director to Query or Start Jobs

To communicate with the director and to query the state of Bacula or run jobs, from the top level directory, simply enter:

```
./bconsole
```

Note, on 1.32 versions and lower, the command name is **console** rather than **bconsole**. Alternatively to running the command line console, if you have GNOME installed and used the `--enable-gnome` on the configure command, you may use the GNOME Console program:

```
./gnome-console
```

For simplicity, here we will describe only the `./console` program. Most of what is described here applies equally well to `./gnome-console`.

The `./bconsole` runs the Bacula Console program, which connects to the Director daemon. Since Bacula is a network program, you can run the Console program anywhere on your network. Most frequently, however, one runs it on the same machine as the Director. Normally, the Console program will print something similar to the following:

```
[kern@polymatou bin]$ ./bconsole
Connecting to Director lpmatou:9101
1000 OK: HeadMan Version: 1.30 (28 April 2003)
*
```

the asterisk is the console command prompt.

Type **help** to see a list of available commands:

```
*help
Command      Description
=====
add           add media to a pool
autodisplay  autodisplay [on/off] -- console messages
automount    automount [on/off] -- after label
cancel       cancel job=nnn -- cancel a job
create       create DB Pool from resource
delete       delete [pool=<pool-name> | media volume=<volume-name>]
estimate     performs FileSet estimate debug=1 give full listing
exit         exit = quit
help         print this command
label       label a tape
list         list [pools | jobs | jobtotals | media <pool> |
              files jobid=<nn>]; from catalog
llist       full or long list like list command
messages    messages
mount        mount <storage-name>
prune        prune expired records from catalog
purge        purge records from catalog
query        query catalog
quit         quit
relabel     relabel a tape
release      release <storage-name>
restore      restore files
run          run <job-name>
setdebug     sets debug level
show         show (resource records) [jobs | pools | ... | all]
sqlquery     use SQL to query catalog
status       status [storage | client]=<name>
time         print current time
unmount      unmount <storage-name>
update       update Volume or Pool
use          use catalog xxx
var          does variable expansion
version      print Director version
wait         wait until no jobs are running
*
```

Details of the console program's commands are explained in the [Console Chapter](#) of this manual.

Running a Job

At this point, we assume you have done the following:

- Configured Bacula with **./configure --your-options**
- Built Bacula using **make**
- Installed Bacula using **make install**
- Have created your database with, for example, **./create_sqlite_database**
- Have created the Bacula database tables with, **./make_bacula_tables**
- Have possibly edited your **bacula-dir.conf** file to personalize it a bit. BE CAREFUL! if you change the Director's name or password, you will need to make similar modifications in the other .conf files. For the moment it is probably better to make no changes.
- You have started Bacula with **./bacula start**
- You have invoked the Console program with **./bconsole**

Furthermore, we assume for the moment you are using the default configuration files.

At this point, enter the following command:

```
show filesets
```

and you should get something similar to:

```
FileSet: name=Full Set
        Inc: /home/kern/bacula/bacula-1.30
        Exc: /proc
        Exc: /tmp
        Exc: /.journal
        Exc: /.fsck
FileSet: name=Catalog
        Inc: /home/kern/bacula/testbin/working/bacula.sql
```

This is a pre-defined **FileSet** that will backup the Bacula source directory. The actual directory names printed should correspond to your configuration. For testing purposes, we have chosen a directory of moderate size (about 40 Megabytes) and complexity without being too big. The FileSet **Catalog** is used for backing up Bacula's catalog and is not of interest to us for the moment. The **Inc:** entries are the files or directories that will be included in the backup and the **Exc:** are those that will be excluded.

Now is the time to run your first backup job. We are going to backup your Bacula source directory to a File Volume in your **/tmp** directory just to show you how easy it is. Now enter:

```
status dir
```

and you should get the following output:

```
rufus-dir Version: 1.30 (28 April 2003)
Daemon started 28-Apr-2003 14:03, 0 Jobs run.
Console connected at 28-Apr-2003 14:03
No jobs are running.
Level          Type          Scheduled          Name
=====
Incremental    Backup    29-Apr-2003 01:05  Client1
Full          Backup    29-Apr-2003 01:10  BackupCatalog
=====
```

where the times and the Director's name will be different according to your setup. This shows that an Incremental job is scheduled to run for the Job **Client1** at 1:05am and that at 1:10, a **BackupCatalog** is scheduled to run. Note, you should probably change the name **Client1** to be the name of your machine, if not, when you add additional clients, it will be very confusing. For my real machine, I use **Rufus** rather than **Client1** as in this example.

Now enter:

```
status client
```

and you should get something like:

```
The defined Client resources are:
```

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```
1: rufus-fd
Item 1 selected automatically.
Connecting to Client rufus-fd at rufus:8102

rufus-fd Version: 1.30 (28 April 2003)
Daemon started 28-Apr-2003 14:03, 0 Jobs run.
Director connected at: 28-Apr-2003 14:14
No jobs running.
====
```

In this case, the client is named **rufus-fd** your name will be different, but the line beginning with **rufus-fd Version ...** is printed by your File daemon, so we are now sure it is up and running.

Finally do the same for your Storage daemon with:

```
status storage
```

and you should get:

```
The defined Storage resources are:
  1: File
Item 1 selected automatically.
Connecting to Storage daemon File at rufus:8103

rufus-sd Version: 1.30 (28 April 2003)
Daemon started 28-Apr-2003 14:03, 0 Jobs run.
Device /tmp is not open.
No jobs running.
====
```

You will notice that the default Storage daemon device is named **File** and that it will use device **/tmp**, which is not currently open.

Now, let's actually run a job with:

```
run
```

you should get the following output:

```
Using default Catalog name=MyCatalog DB=bacula
A job name must be specified.
The defined Job resources are:
  1: Client1
  2: BackupCatalog
  3: RestoreFiles
Select Job resource (1-3):
```

Here, Bacula has listed the three different Jobs that you can run, and you should choose number **1** and type enter, at which point you will get:

```
Run Backup job
JobName: Client1
FileSet: Full Set
Level: Incremental
Client: rufus-fd
Storage: File
Pool: Default
```

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When: 2003-04-28 14:18:57
OK to run? (yes/mod/no):

At this point, take some time to look carefully at what is printed and understand it. It is asking you if it is OK to run a job named **Client1** with FileSet **Full Set** (we listed above) as an Incremental job on your Client (your client name will be different), and to use Storage **File** and Pool **Default**, and finally, it wants to run it now (the current time should be displayed by your console).

Here we have the choice to run (**yes**), to modify one or more of the above parameters (**mod**), or to not run the job (**no**). Please enter **yes**, at which point you should immediately get the command prompt (an asterisk). If you wait a few seconds, then enter the command **messages** you will get back something like:

```
28-Apr-2003 14:22 rufus-dir: Last FULL backup time not found. Doing
                    FULL backup.
28-Apr-2003 14:22 rufus-dir: Start Backup JobId 1,
                    Job=Client1.2003-04-28_14.22.33
28-Apr-2003 14:22 rufus-sd: Job Client1.2003-04-28_14.22.33 waiting.
                    Cannot find any appendable volumes.
Please use the "label" command to create a new Volume for:
    Storage:      FileStorage
    Media type:   File
    Pool:         Default
```

The first message, indicates that no previous Full backup was done, so Bacula is upgrading our Incremental job to a Full backup (this is normal). The second message indicates that the job started with JobId 1., and the third message tells us that Bacula cannot find any Volumes in the Pool for writing the output. This is normal because we have not yet created (labeled) any Volumes. Bacula indicates to you all the details of the volume it needs.

At this point, the job is blocked waiting for a Volume. You can check this if you want by doing a **status dir**. In order to continue, we label a Volume with:

```
label
```

and Bacula will print:

```
The defined Storage resources are:
    1: File
Item 1 selected automatically.
Enter new Volume name:
```

at which point, you should enter some name beginning with a letter and containing only letters and numbers (period, hyphen, and underscore) are also permitted. For example, enter **TestVolume001**, and you should get back:

```
Defined Pools:
    1: Default
Item 1 selected automatically.
Connecting to Storage daemon File at rufus:8103 ...
Sending label command for Volume "TestVolume001" Slot 0 ...
3000 OK label. Volume=TestVolume001 Device=/tmp
Catalog record for Volume "TestVolume002", Slot 0 successfully created.
Requesting mount FileStorage ...
```

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3001 OK mount. Device=/tmp

Finally, enter **messages** and you should get something like:

```
28-Apr-2003 14:30 rufus-sd: Wrote label to prelabeled Volume
"TestVolume001" on device /tmp
28-Apr-2003 14:30 rufus-dir: Bacula 1.30 (28Apr03): 28-Apr-2003 14:30
JobId:                1
Job:                  Client1.2003-04-28_14.22.33
FileSet:              Full Set
Backup Level:         Full
Client:               rufus-fd
Start time:           28-Apr-2003 14:22
End time:             28-Apr-2003 14:30
Files Written:        1,444
Bytes Written:        38,988,877
Rate:                 81.2 KB/s
Software Compression: None
Volume names(s):      TestVolume001
Volume Session Id:    1
Volume Session Time:  1051531381
Last Volume Bytes:    39,072,359
FD termination status: OK
SD termination status: OK
Termination:          Backup OK

28-Apr-2003 14:30 rufus-dir: Begin pruning Jobs.
28-Apr-2003 14:30 rufus-dir: No Jobs found to prune.
28-Apr-2003 14:30 rufus-dir: Begin pruning Files.
28-Apr-2003 14:30 rufus-dir: No Files found to prune.
28-Apr-2003 14:30 rufus-dir: End auto prune.
```

If you don't see the output immediately, you can keep entering **messages** until the job terminates, or you can enter, **autodisplay on** and your messages will automatically be displayed as soon as they are ready.

If you do an **ls -l** of your **/tmp** directory, you will see that you have the following item:

```
-rw-r-----  1 kern      kern      39072153 Apr 28 14:30 TestVolume001
```

This is the file Volume that you just wrote and it contains all the data of the job just run. If you run additional jobs, they will be appended to this Volume unless you specify otherwise.

If you would like to stop here, you can simply enter **quit** in the Console program, and you can stop Bacula with **./bacula stop**. To clean up, simply delete the file **/tmp/TestVolume001**, and you should also re-initialize your database using:

```
./drop_bacula_tables
./make_bacula_tables
```

Please note that this will erase all information about the previous jobs that have run, and that you might want to do it now while testing but that normally you will not want to re-initialize your database.

If you would like to try restoring the files that you just backed up, read the following section.

Restoring Your Files

If you have run the default configuration and the save of the Bacula source code as demonstrated above, you can restore the backed up files in the Console program by entering:

```
restore all
```

where you will get:

First you select one or more JobIds that contain files to be restored. You will be presented several methods of specifying the JobIds. Then you will be allowed to select which files from those JobIds are to be restored.

To select the JobIds, you have the following choices:

- 1: List last 20 Jobs run
- 2: List Jobs where a given File is saved
- 3: Enter list of comma separated JobIds to select
- 4: Enter SQL list command
- 5: Select the most recent backup for a client
- 6: Select backup for a client before a specified time
- 7: Enter a list of files to restore
- 8: Enter a list of files to restore before a specified time
- 9: Cancel

Select item: (1-9):

As you can see, there are a number of options, but for the current demonstration, please enter **5** to do a restore of the last backup you did, and you will get the following output:

Defined Clients:

1: rufus-fd

Item 1 selected automatically.

The defined FileSet resources are:

1: 1 Full Set 49Eann5no/ZR7+/uW95U6D

Item 1 selected automatically.

JobId	Level	JobFiles	StartTime	VolumeName
1	F	1444	2003-04-28 14:22:33	TestVolume002

You have selected the following JobId: 1

Building directory tree for JobId 1 ...

1 Job inserted into the tree and marked for extraction.

The defined Storage resources are:

1: File

Item 1 selected automatically.

You are now entering file selection mode where you add and remove files to be restored. All files are initially added. Enter "done" to leave this mode.

```
cwd is: /
$
```

where I have truncated the listing on the right side to make it more readable. As you can see by starting at the top of the listing, Bacula knows what client you have, and since there was only

one, it selected it automatically, likewise for the FileSet. Then Bacula produced a listing containing all the jobs that form the current backup, in this case, there is only one, and the Storage daemon was also automatically chosen. Bacula then took all the files that were in Job number 1 and entered them into a **directory tree** (a sort of in memory representation of your filesystem). At this point, you can use the **cd** and **ls** or **dir** commands to walk up and down the directory tree and view what files will be restored. For example, if I enter **cd /home/kern/bacula/bacula-1.30** and then enter **dir** I will get a listing of all the files in the Bacula source directory. On your system, the path will be somewhat different. For more information on this, please refer to the [Restore Command Chapter](#) of this manual for more details.

To exit this mode, simply enter:

```
done
```

and you will get the following output:

```
Bootstrap records written to
/home/kern/bacula/testbin/working/restore.bsr
```

```
The restore job will require the following Volumes:
```

```
TestVolume001
```

```
1444 files selected to restore.
```

```
Run Restore job
JobName:      RestoreFiles
Bootstrap:    /home/kern/bacula/testbin/working/restore.bsr
Where:        /tmp/bacula-restores
Replace:      always
FileSet:      Full Set
Client:       rufus-fd
Storage:      File
JobId:        *None*
When:         2003-04-28 14:53:54
OK to run? (yes/mod/no):
```

If you answer **yes** your files will be restored to **/tmp/bacula-restores**. If you want to restore the files to their original locations, you must use the **mod** option and explicitly set **Where:** to nothing (or to /). We recommend you go ahead and answer **yes** and after a brief moment, enter **messages**, at which point you should get a listing of all the files that were restored as well as a summary of the job that looks similar to this:

```
28-Apr-2003 14:56 rufus-dir: Bacula 1.30 (28Apr03): 28-Apr-2003 14:56
JobId:           2
Job:             RestoreFiles.2003-04-28_14.56.06
Client:          rufus-fd
Start time:      28-Apr-2003 14:56
End time:        28-Apr-2003 14:56
Files Restored:  1,444
Bytes Restored:  38,816,381
Rate:           9704.1 KB/s
FD termination status: OK
Termination:     Restore OK
```

```
28-Apr-2003 14:56 rufus-dir: Begin pruning Jobs.
28-Apr-2003 14:56 rufus-dir: No Jobs found to prune.
28-Apr-2003 14:56 rufus-dir: Begin pruning Files.
28-Apr-2003 14:56 rufus-dir: No Files found to prune.
28-Apr-2003 14:56 rufus-dir: End auto prune.
```

After exiting the Console program, you can examine the files in **/tmp/bacula-restore**, which will contain a small directory tree with all the files. Be sure to clean up at the end with:

```
rm -rf /tmp/bacula-restore
```

Quitting the Console Program

Simply enter the command **quit**.

Adding a Second Client

If you have gotten the example shown above to work on your system, you may be ready to add a second Client (File daemon). That is you have a second machine that you would like backed up. The only part you need installed on the other machine is the binary **bacula-fd** (or **bacula-fd.exe** for Windows) and its configuration file **bacula-fd.conf**. You can start with the same **bacula-fd.conf** file that you are currently using and make one minor modification to it to create the conf file for your second client. Change the File daemon name from whatever was configured, **rufus-fd** in the example above, but your system will have a different name. The best is to change it to the name of your second machine. For example:

```
...
#
# "Global" File daemon configuration specifications
#
FileDaemon {                                # this is me
    Name = rufus-fd
    FDport = 9102                          # where we listen for the director
    WorkingDirectory = /home/kern/bacula/working
    Pid Directory = /var/run
}
...
```

would become:

```
...
#
# "Global" File daemon configuration specifications
#
FileDaemon {                                # this is me
    Name = matou-fd
    FDport = 9102                          # where we listen for the director
    WorkingDirectory = /home/kern/bacula/working
    Pid Directory = /var/run
}
...
```

where I show just a portion of the file and have changed **rufus-fd** to **matou-fd**. The names you use are your choice. For the moment, I recommend you change nothing else. Later, you will want

to change the password.

Now you should install that change on your second machine. Then you need to make some additions to your Director's configuration file to define the new File daemon or Client. Starting from our original example which should be installed on your system, you should add the following lines (essentially copies of the existing data but with the names changed) to your Director's configuration file **bacula-dir.conf**.

```
#
# Define the main nightly save backup job
# By default, this job will back up to disk in /tmp
Job {
    Name = "Matou"
    Type = Backup
    Client = matou-fd
    FileSet = "Full Set"
    Schedule = "WeeklyCycle"
    Storage = File
    Messages = Standard
    Pool = Default
    Write Bootstrap = "/home/kern/bacula/working/matou.bsr"
}
Client {
    Name = matou-fd
    Address = matou
    FdPort = 9102
    Catalog = MyCatalog
    Password = "xxxxx"           # password for
    File Retention = 30d         # 30 days
    Job Retention = 180d         # six months
    AutoPrune = yes             # Prune expired Jobs/Files
}
```

That is all that is necessary. I copied the existing resource to create a second Job (Matou) to backup the second client (matou-fd). It has the name **Matou**, the Client is named **matou-fd**, and the bootstrap file name is changed, but everything else is the same. This means that Matou will be backed up on the same schedule using the same set of tapes. You may want to change that later, but for now, let's keep it simple.

The second change was to add a new Client resource that defines **matou-fd** and has the correct address **matou**, but in real life, you may need a fully qualified machine address or an IP address. I also kept the password the same (shown as xxxxx for the example).

At this point, if you stop Bacula and restart it, and start the Client on the other machine, everything will be ready, and the prompts that you saw above will now include the second machine.

To make this a real production installation, you will possibly want to use different Pool, or a different schedule. It is up to you to customize. In any case, you should change the password in both the Director's file and the Client's file for additional security.

When The Tape Fills

If you have scheduled your job, typically nightly, there will come a time when the tape fills up

and **Bacula** cannot continue. In this case, Bacula will send you a message similar to the following:

```
rufus-sd: block.c:337 === Write error errno=28: ERR=No space left
on device
```

This indicates that Bacula got a write error because the tape is full. Bacula will then search the Pool specified for your Job looking for an appendable volume. In the best of all cases, you will have properly set your Retention Periods and you will have all your tapes marked to be Recycled, and **Bacula** will automatically recycle the tapes in your pool requesting and overwriting old Volumes. For more information on recycling, please see the [Recycling chapter](#) of this manual. If you find that your Volumes were not properly recycled (usually because of a configuration error), please see the [Manually Recycling Volumes](#) section of the Recycling chapter.

If like me, you have a very large set of Volumes and you label them with the date the Volume was first writing, or you have not set up your Retention periods, Bacula will not find a tape in the pool, and it will send you a message similar to the following:

```
rufus-sd: Job kernsave.2002-09-19.10:50:48 waiting. Cannot find any
appendable volumes.
Please use the "label" command to create a new Volume for:
Storage:      STD-10000
Media type:   DDS-4
Pool:        Default
```

Until you create a new Volume, this message will be repeated an hour later, then two hours later, and so on doubling the interval each time up to a maximum interval of 1 day.

The obvious question at this point is: What do I do now?

The answer is simple: first, using the Console program, release the tape using the **unmount** command. If you only have a single drive, it will be automatically selected, otherwise, make sure you release the one specified on the message (in this case **STD-10000**).

Next, you remove the tape from the drive and insert a new blank tape. Note, on some older tape drives, you may need to write an end of file mark (**mt -f /dev/nst0 weof**) to prevent the drive from running away when Bacula attempts to read the label.

Finally, you use the **label** command in the Console to write a label to the new Volume. The **label** command will contact the Storage daemon to write the software label, if it is successful, it will add the new Volume to the Pool, then issue a **mount** command to the Storage daemon. See the previous sections of this chapter for more details on labeling tapes.

The result is that Bacula will continue the previous Job writing the backup to the new Volume.

If you have a Pool of volumes and Bacula is cycling through them, instead of the above message "Cannot find any appendable volumes.", Bacula may ask you to mount a specific volume. In that case, you should attempt to do just that. If you do not have the volume any more (for any of a number of reasons), you can simply mount another volume from the same Pool, providing it is appendable, and Bacula will use it. You can use the **list volumes** command in the console program to determine which volumes are appendable and which are not.

If like me, you have your Volume retention periods set correctly, but you have no more free Volumes, you can relabel and reuse a Volume as follows:

- Do a **list volumes** in the Console and select the oldest Volume for relabeling.
- If you have setup your Retention periods correctly, the Volume should have VolStatus **Purged**.
- If the VolStatus is not set to Purged, you will need to purge the database of Jobs that are written on that Volume. Do so by using the command **purge jobs volume** in the Console. If you have multiple Pools, you will be prompted for the Pool then enter the VolumeName (or MediaId) when requested.
- Then simply use the **relabel** command to relabel the Volume.

To manually relabel the Volume use the following additional steps:

- To delete the Volume from the catalog use the **delete volume** command in the Console and select the VolumeName (or MediaId) to be deleted.
- Use the **unmount** command in the Console to unmount the old tape.
- Physically relabel the old Volume that you deleted so that it can be reused.
- Insert the old Volume in the tape drive.
- From a command line do: **mt -f /dev/st0 rewind** and **mt -f /dev/st0 weof**, where you need to use the proper tape drive name for your system in place of **/dev/st0**.
- Use the **label** command in the Console to write a new Bacula label on your tape.
- Use the **mount** command in the Console if it is not automatically done, so that Bacula starts using your newly labeled tape.

Other Useful Console Commands

status dir

Print a status of all running jobs and jobs scheduled in the next 24 hours.

status

The console program will prompt you to select a daemon type, then will request the daemon's status.

status jobid=nn

Print a status of JobId nn if it is running. The Storage daemon is contacted and requested to print a current status of the job as well.

list pools

List the pools defined in the Catalog (normally only Default is used).

list media

Lists all the media defined in the Catalog.

list jobs

Lists all jobs in the Catalog that have run.

list jobid=nn

Lists JobId nn from the Catalog.

list jobtotals

Lists totals for all jobs in the Catalog.

list files jobid=nn

List the files that were saved for JobId nn.

list jobmedia

List the media information for each Job run.

messages

Prints any messages that have been directed to the console.

unmount storage=storage-name

Unmounts the drive associated with the storage device with the name **storage-name** if the drive is not currently being used. This command is used if you wish Bacula to free the drive so that you can use it to label a tape.

mount storage=storage-name

Causes the drive associated with the storage device to be mounted again. When Bacula reaches the end of a volume and requests you to mount a new volume, you must issue this command after you have placed the new volume in the drive. In effect, it is the signal needed by Bacula to know to start reading or writing the new volume.

quit

Exit or quit the console program.

Most of the commands given above, with the exception of **list**, will prompt you for the necessary arguments if you simply enter the command name.

Debug Daemon Output

If you want debug output from the daemons as they are running, start the daemons from the install directory as follows:

```
./bacula start -d20
```

To stop the three daemons, enter the following from the install directory:

```
./bacula stop
```

The execution of **bacula stop** may complain about pids not found. This is OK, especially if one of the daemons has died, which is very rare.

To do a full system save, each File daemon must be running as root so that it will have permission to access all the files. None of the other daemons require root privileges. However, the Storage daemon must be able to open the tape drives. On many systems, only root can access the tape drives. Either run the Storage daemon as root, or change the permissions on the tape devices to permit non-root access. MySQL and PostgreSQL can be installed and run with any userid; root privilege is not necessary.

Have Patience When Starting the Daemons or Mounting Blank Tapes

When you start the Bacula daemons, the Storage daemon attempts to open all defined storage devices and verify the currently mounted Volume (if configured). Until all the storage devices are verified, the Storage daemon will not accept connections from the Console program. If a tape was previously used, it will be rewound, and on some devices this can take several minutes. As a consequence, you may need to have a bit of patience when first contacting the Storage daemon after starting the daemons. If you can see your tape drive, once the lights stop flashing, the drive will be ready to be used.

The same considerations apply if you have just mounted a blank tape in a drive such as an HP DLT. It can take a minute or two before the drive properly recognizes that the tape is blank. If

you attempt to **mount** the tape with the Console program during this recognition period, it is quite possible that you will hang your SCSI driver (at least on my RedHat Linux system). As a consequence, you are again urged to have patience when inserting blank tapes. Let the device settle down before attempting to access it.

Difficulties Connecting from the FD to the SD

If you are having difficulties getting one or more of your File daemons to connect to the Storage daemon, it is most likely because you have not used a fully qualified Internet address on the **Address** directive in the Director's Storage resource. That is the resolver on the File daemon's machine (not on the Director's) must be able to resolve the name you supply into an IP address. An example of an address that is guaranteed not to work: **localhost**. An example that may work: **megalon**. An example that is more likely to work: **magalon.mydomain.com**. On Win32 if you don't have a good resolver (often true on older Win98 systems), you might try using an IP address in place of a name.

If your address is correct, then make sure that no other program is using the port 9103 on the Storage daemon's machine. The Bacula port number are authorized by IANA, and should not be used by other programs, but apparently some HP printers do use these port numbers. A **netstat -a** on the Storage daemon's machine can determine who is using the 9103 port (used for FD to SD communications in Bacula).

Daemon Command Line Options

Each of the three daemons (Director, File, Storage) accepts a small set of options on the command line. In general, each of the daemons as well as the Console program accepts the following options:

- c <file>**
Define the file to use as a configuration file. The default is the daemon name followed by **.conf** i.e. **bacula-dir.conf** for the Director, **bacula-fd.conf** for the File daemon, and **bacula-sd** for the Storage daemon.
- d nn**
Set the debug level to **nn**. Higher levels of debug cause more information to displayed on STDOUT concerning what the daemon is doing.
- f**
Run the daemon in the foreground. This option is needed to run the daemon under the debugger.
- s**
Do not trap signals. This option is needed to run the daemon under the debugger.
- t**
Read the configuration file and print any error messages, then immediately exit. Useful for syntax testing of new configuration files.
- v**
Be more verbose or more complete in printing error and informational messages. Recommended.
- ?**
Print the version and list of options.

The Director has the following additional Director specific option:

`-r <job>`

Run the named job immediately. This is for debugging and should not be used.

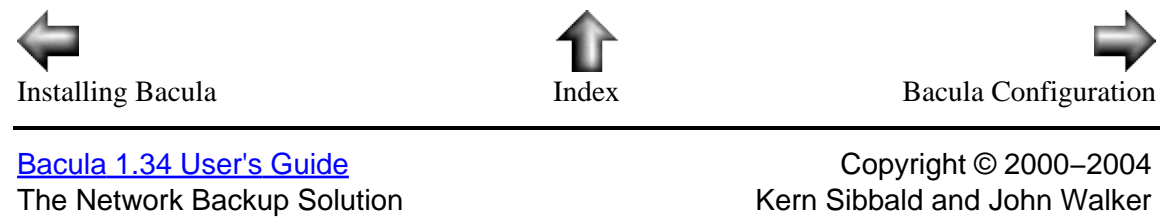
The File daemon has the following File daemon specific option:

`-i`

Assume that the daemon is called from **inetd** or **xinetd**. In this case, the daemon assumes that a connection has already been made and that it is passed as STDIN. After the connection terminates the daemon will exit.

The Storage daemon has no Storage daemon specific options.

The Console program has no console specific options.



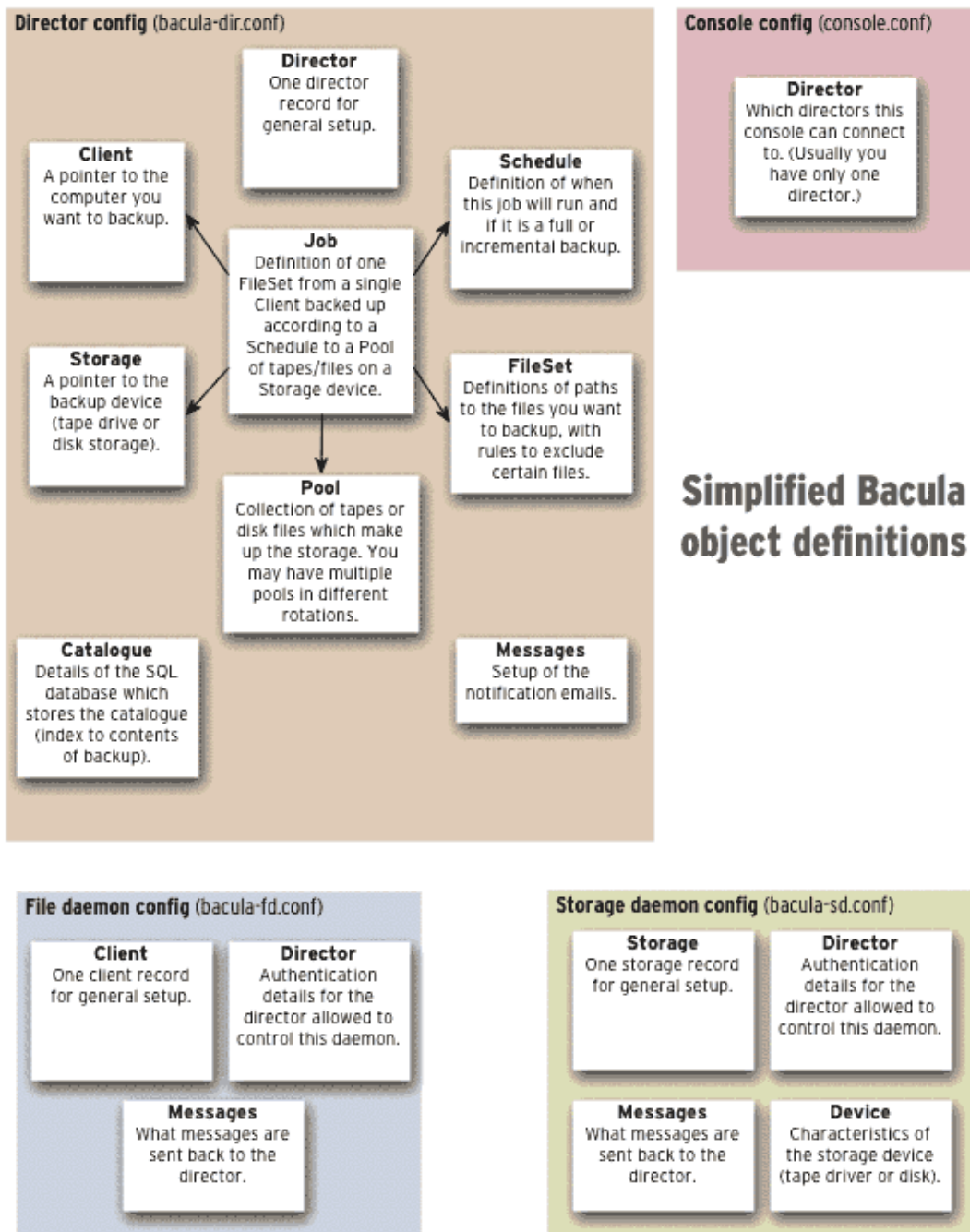
Customizing the Configuration Files

When each of the Bacula programs starts, it reads a configuration file specified on the command line or the default **bacula-dir.conf**, **bacula-fd.conf**, **bacula-sd.conf**, or **console.conf** for the Director daemon, the File daemon, the Storage daemon, and the Console program respectively.

Each service (Director, Client, Storage, Console) has its own configuration file containing a set of Resource Records. These resources are very similar from one service to another, but may contain different records depending on the service. For example, in the Director's resource file, the **Director** resource defines the name of the Director, a number of global Director parameters and his password. In the File daemon configuration file, the **Director** resource specifies which Directors are permitted to use the File daemon.

Before running Bacula for the first time, you must customize the configuration files for each daemon. Default configuration files will have been created by the installation process, but you will need to modify them to correspond to your system. An overall view of the resources can be seen in the following:

Bacula Storage Management System



(thanks to Aristedes Maniatis for the above graphic)

Resource Record Format

Although, you won't need to know the details of all the records, a basic knowledge of Bacula resource records is essential. Each record contained within the resource (within the braces) is composed of a keyword followed by an equal sign (=) followed by one or more values. The keywords must be one of the known Bacula resource record keywords, and it may be composed of upper or lower case characters and spaces.

Each resource definition **MUST** contain a Name record, and may optionally contain a Description record. The Name record is used to uniquely identify the resource. The Description record is (will be) used during display of the record to provide easier human recognition of the record. For example:

```
Director {  
    Name = "MyDir"  
    Description = "Main Bacula Director"  
    WorkingDirectory = "$HOME/bacula/bin/working"  
}
```

Defines the Director resource with the name "MyDir" and a working directory \$HOME/bacula/bin/working. In general, if you want spaces in a name to the right of the first equal sign (=), you must enclose that name within double quotes. Otherwise quotes are not generally necessary because once defined, quoted strings and unquoted strings are all equal.

Comments

When reading the configuration file, blank lines are ignored and everything after a hash sign (#) until the end of the line is taken to be a comment. A semicolon (;) is a logical end of line, and anything after the semicolon is considered as the next statement. If a statement appears on a line by itself, a semicolon is not necessary to terminate it, so generally in the examples in this manual, you will not see many semicolons.

Upper and Lower Case and Spaces

Case (upper/lower) and spaces are totally ignored in the resource record keywords (the part before the equal sign).

Within the keyword (i.e. before the equal sign), spaces are not significant. Thus the keywords: **name**, **Name**, and **N a m e** are all identical.

Spaces after the equal sign and before the first character of the value are ignored.

In general, spaces within a value are significant (not ignored), and if the value is a name, you must enclose the name in double quotes for the spaces to be accepted. Names may contain up to 127 characters. Currently, a name may contain any ASCII character. Within a quoted string, any character following a backslash (\) is taken as itself (handy for inserting backslashes and double quotes (")).

Please note, however, that Bacula resource names as well as certain other names (e.g. Volume names) will in the future be severely limited to permit only letters (including ISO accented letters), numbers, and a few special characters (space, underscore, ...). All other characters and punctuation will be illegal.

Recognized Primitive Data Types

When parsing the resource records, Bacula classifies the data according to the types listed below. The first time you read this, it may appear a bit overwhelming, but in reality, it is all pretty logical and straight forward.

name

A keyword or name consisting of alpha numeric characters, including the hyphen, underscore, and dollar characters. The first character of a **name** must be a letter. A name has a maximum length currently set to 127 bytes. Typically keywords appear on the left side of an equal (i.e. they are Bacula keywords). Keywords may not be quoted.

name-string

A name-string is similar to a name, except that the name may be quoted and can thus contain additional characters including spaces. Name strings are limited to 127 characters in length. Name strings are typically used on the right side of an equal (i.e. they are values to be associated with a keyword).

string

A quoted string containing virtually any character including spaces, or a non-quoted string. A string may be of any length. Strings are typically values that correspond to filenames, directories, or system command names. A backslash (\) turns the next character into itself, so to include a double quote in a string, you precede the double quote with a backslash. Likewise to include a backslash.

directory

A directory is either a quoted or non-quoted string. A directory will be passed to your standard shell for expansion when it is scanned. Thus constructs such as **\$HOME** are interpreted to be their correct values.

password

This is a Bacula password and it is stored internally in MD5 hashed format.

integer

A 32 bit integer value. It may be positive or negative.

positive integer

A 32 bit positive integer value.

long integer

A 64 bit integer value. Typically these are values such as bytes that can exceed 4 billion and thus require a 64 bit value.

yes/no

Either a **yes** or a **no**.

size

A size specified as bytes. Typically, this is a floating point scientific input format followed by an optional modifier. The floating point input is stored as a 64 bit integer value. If a modifier is present, it must immediately follow the value with no intervening spaces. The following modifiers are permitted:

k

1,024 (kilobytes)

kb

1,000 (kilobytes)

m

1,048,576 (megabytes)

mb

1,000,000 (megabytes)

g

1,073,741,824 (gigabytes)

gb

1,000,000,000 (gigabytes)

time

A time or duration specified in seconds. It is specified in two parts: a number part and a modifier part. The number can be an integer or a floating point number. The time is stored internally as a 64 bit integer value. The modifier is mandatory and follows the number part, either with or without intervening spaces. The following modifiers are permitted:

seconds
seconds
minutes
minutes (60 seconds)
hours
hours (3600 seconds)
days
days (3600*24 seconds)
weeks
weeks (3600*24*7 seconds)
months
months (3600*24*30 seconds)
quarters
quarters (3600*24*91 seconds)
years
years (3600*24*365 seconds)

Any abbreviation of these modifiers is also permitted (i.e. **seconds** may be specified as **sec** or **s**. A specification of **m** will be taken as months.

Note! in Bacula version 1.31 and below, the modifier was optional. It is now mandatory.

Resource Types

The following table lists all current Bacula resource types. It shows what resources must be defined for each service (daemon). The default configuration files will already contain at least one example of each permitted resource, so you need not worry about creating all these kinds of records from scratch.

Resource	Director	Client	Storage	Console
Catalog	Yes	No	No	No
Client	Yes	Yes	No	No
Console	Yes	No	No	Yes
Device	No	No	Yes	No
Director	Yes	Yes	Yes	Yes

FileSet	Yes	No	No	No
Job	Yes	No	No	No
JobDefs	Yes	No	No	No
Message	Yes	Yes	Yes	No
Pool	Yes	No	No	No
Schedule	Yes	No	No	No
Storage	Yes	No	Yes	No

The details of each Resource and the records permitted therein are described in the following chapters.

The following configuration files must be defined:

- [Console](#) — to define the resources for the Console program (user interface to the Director). It defines which Directors are available so that you may interact with them.
- [Director](#) — to define the resources necessary for the Director. You define all the Clients and Storage daemons that you use in this configuration file.
- [Client](#) — to define the resources for each client to be backed up. That is, you will have a separate Client resource file on each machine that runs a File daemon.
- [Storage](#) — to define the resources to be used by each Storage daemon. Normally, you will have a single Storage daemon that controls your tape drive or tape drives. However, if you have tape drives on several machines, you will have at least one Storage daemon per machine.



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The Network Backup Solution

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Bacula Configuration



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Client/File daemon Configuration

Configuring the Director

Of all the configuration files needed to run **Bacula**, the Director's is the most complicated, and the one that you will need to modify the most often as you add clients or modify the FileSets.

For a general discussion of configuration file and resources including the data types recognized by **Bacula**. Please see the [Configuration](#) chapter of this manual.

Director Resource Types

Director resource type may be one of the following:

Job, JobDefs, Client, Storage, Catalog, Schedule, FileSet, Pool, Director, or Messages.

We present them here in the most logical order for defining them:

- [Director](#) — to define the Director's name and its access password used for authenticating the Console program. Only a single Director resource definition may appear in the Director's configuration file. If you have either **/dev/random bc** on your machine, Bacula will generate a random password during the configuration process, otherwise it will be left blank.
- [Job](#) — to define the backup/restore Jobs and to tie together the Client, FileSet and Schedule resources to be used for each Job.
- [JobDefs](#) — optional resource for providing defaults for Job resources.
- [Schedule](#) — to define when a Job is to be automatically run by **Bacula's** internal scheduler.
- [FileSet](#) — to define the set of files to be backed up for each Client.
- [Client](#) — to define what Client is to be backed up.
- [Storage](#) — to define on what physical device the Volumes should be mounted.
- [Pool](#) — to define what the pool of Volumes that can be used for a particular Job.
- [Catalog](#) — to define in what database to keep the list of files and the Volume names where they are backed up.
- [Messages](#) — to define where error and information messages are to be sent or logged.

The Director Resource

The Director resource defines the attributes of the Directors running on the network. In the current implementation, there is only a single Director resource, but the final design will contain multiple Directors to maintain index and media database redundancy.

Director

Start of the Director records. One and only one director resource must be supplied.

Name = *<name>*

The director name used by the system administrator. This record is required.

Description = *<text>*

The text field contains a description of the Director that will be displayed in the graphical user interface. This record is optional.

Password = *<UA-password>*

Specifies the password that must be supplied for the default Bacula Console to be authorized. The same password must appear in the **Director** resource of the Console configuration file. For added security, the password is never actually passed across the network but rather a challenge response hash code created with the password. This record is required. If you have either **/dev/random** or **bc** on your machine, Bacula will generate a random password during the configuration process, otherwise it will be left blank and you must manually supply it.

Messages = *<Messages-resource-name>*

The messages resource specifies where to deliver Director messages that are not associated with a specific Job. Most messages are specific to a job and will be directed to the Messages resource specified by the job. However, there are a few messages that can occur when no job is running. This record is required.

Working Directory = *<Directory>*

This directive is mandatory and specifies a directory in which the Director may put its status files. This directory should be used only by Bacula but may be shared by other Bacula daemons. Standard shell expansion of the **Directory** is done when the configuration file is read so that values such as **\$HOME** will be properly expanded. This record is required.

Pid Directory = *<Directory>*

This directive is mandatory and specifies a directory in which the Director may put its process Id file files. The process Id file is used to shutdown Bacula and to prevent multiple copies of Bacula from running simultaneously. Standard shell expansion of the **Directory** is done when the configuration file is read so that values such as **\$HOME** will be properly expanded.

Typically on Linux systems, you will set this to: **/var/run**. If you are not installing Bacula in the system directories, you can use the **Working Directory** as defined above. This record is required.

QueryFile = *<Path>*

This directive is mandatory and specifies a directory and file in which the Director can find the canned SQL statements for the **Query** command of the Console. Standard shell expansion of the **Path** is done when the configuration file is read so that values such as **\$HOME** will be properly expanded. This record is required.

Maximum Concurrent Jobs = *<number>*

where *<number>* is the maximum number of total Director Jobs that should run concurrently. The default is set to 1, but you may set it to a larger number. Note

however, at this time (Bacula version 1.32f-3), multiple simultaneous jobs seem to work fine, but this feature has not been heavily tested in production.

Because this feature is not yet well tested, we recommend that you make careful tests to ensure that everything you want works. Please note that the Volume format becomes much more complicated with multiple simultaneous jobs, consequently, restores can take much longer if Bacula must sort through interleaved volume blocks from multiple simultaneous jobs. There may also still be some cases where directives such as **Maximum Volume Jobs** are not properly synchronized with multiple simultaneous jobs (subtle timing issues can arise).

At the current time, there is no configuration parameter set or limit the number console connections. A maximum of five simultaneous console connections are permitted.

Note that **Maximum Concurrent Jobs** is implemented in the Director, Job, Client, and Storage resources. Each one is independent of the others, and all limits from each of those resources must be met before a Job can run. There should be no problems increasing the **Maximum Concurrent Jobs** in the Director, Client, and Job resources.

FD Connect Timeout = <time>

where **time** is the time that the Director should continue attempting to contact the File daemon to start a job, and after which the Director will cancel the job. The default is 30 minutes.

SD Connect Timeout = <time>

where **time** is the time that the Director should continue attempting to contact the Storage daemon to start a job, and after which the Director will cancel the job. The default is 30 minutes.

DIRport = <port-number>

Specify the port (a positive integer) on which the Director daemon will listen for Bacula Console connections. This same port number must be specified in the Director resource of the Console configuration file. The default is 9101, so normally this record need not be specified.

DirAddress = <IP-Address>

This record is optional, but if it is specified, it will cause the Director server (for the Console program) to bind to the specified **IP-Address**, which is either a domain name or an IP address specified as a dotted quadruple in string or quoted string format. If this record is not specified, the Director will bind to any available address (the default).

The following is an example of a valid Director resource definition:

```
Director {
  Name = HeadMan
  WorkingDirectory = "$HOME/bacula/bin/working"
  Password = UA_password
  PidDirectory = "$HOME/bacula/bin/working"
  QueryFile = "$HOME/bacula/bin/query.sql"
  Messages = Standard
}
```

The Job Resource

The Job resource defines a Job (Backup, Restore, ...) that Bacula must perform. Each Job resource definition contains the names of the Clients and their FileSets to backup or restore, the Schedule for the Job, where the data are to be stored, and what media Pool can be used. In effect, each Job resource must specify What, Where, How, and When or FileSet, Storage, Backup/Restore/Level, and Schedule respectively.

Only a single type (**Backup**, **Restore**, ...) can be specified for any job. If you want to backup multiple FileSets on the same Client or multiple Clients, you must define a Job for each one.

Job

Start of the Job records. At least one Job resource is required.

Name = <name>

The Job name. This name can be specified on the **Run** command in the console program to start a job. If the name contains spaces, it must be specified between quotes. It is generally a good idea to give your job the same name as the Client that it will backup. This permits easy identification of jobs.

When the job actually runs, the unique Job Name will consist of the name you specify here followed by the date and time the job was scheduled for execution. This record is required.

Type = <job-type>

The **Type** record specifies the Job type, which may be one of the following: **Backup**, **Restore**, **Verify**, or **Admin**. This record is required. Within a particular Job Type, there are also Levels as discussed in the next item.

Backup

Run a backup Job. Normally you will have at least one Backup job for each client you want to save. Normally, unless you turn off cataloging, most all the important statistics and data concerning files backed up will be placed in the catalog.

Restore

Run a restore Job. Normally, you will specify only one Restore job which acts as a sort of prototype that you will modify using the console program in order to perform restores. Although certain basic information from a Restore job is saved in the catalog, it is very minimal compared to the information stored for a Backup job — for example, no File records are generated since no Files are saved.

Verify

Run a verify Job. In general, **verify** jobs permit you to compare the contents of the catalog to the file system, or to what was backed up. In addition, to verifying that a tape that was written can be read, you can also use **verify** as a sort of tripwire intrusion detection.

Admin

Run a admin Job. An **Admin** job can be used to periodically run catalog pruning, if you do not want to do it at the end of each **Backup** Job. Although an Admin job is recorded in the catalog, very little data is saved.

Level = <job-level>

The Level record specifies the default Job level to be run. Each different Job Type (Backup, Restore, ...) has a different set of Levels that can be specified. The Level is

normally overridden by a different value that is specified in the **Schedule** resource. This record is not required, but must be specified either by a **Level** record or as an override specified in the **Schedule** resource.

For a **Backup** Job, the Level may be one of the following:

Full

is all files in the FileSet whether or not they have changed.

Incremental

is all files that have changed since the last successful backup of the specified FileSet. If the Director cannot find a previous Full backup then the job will be upgraded into a Full backup. When the Director looks for a "suitable" backup record in the catalog database, it looks for a previous Job with:

- The same Job name.
- The same Client name.
- The same FileSet (any change to the definition of the FileSet such as adding or deleting a file in the Include or Exclude sections constitutes a different FileSet.
- The Job was a Full, Differential, or Incremental backup.
- The Job terminated normally (i.e. did not fail or was not canceled).

If all the above conditions do not hold, the Director will upgrade the Incremental to a Full save. Otherwise, the Incremental backup will be performed as requested.

The File daemon (Client) decides which files to backup for an Incremental backup by comparing start time of the prior Job (Full, Differential, or Incremental) against the time each file was last "modified" (st_mtime) and the time its attributes were last "changed" (st_ctime). If the file was modified or its attributes changed on or after this start time, it will then be backed up.

Please note that some virus scanning software may change st_ctime while doing the scan. For example, if the virus scanning program attempts to reset the access time (st_atime), which Bacula does not use, it will cause st_ctime to change and hence Bacula will backup the file during an Incremental or Differential backup. In the case of Sophos virus scanning, you can prevent it from resetting the access time (st_atime) and hence changing st_ctime by using the **--no-reset-atime** option. For other software, please see their manual.

Differential

is all files that have changed since the last successful Full backup of the specified FileSet. If the Director cannot find a previous Full backup or a suitable Full backup, then the Differential job will be upgraded into a Full backup. When the Director looks for a "suitable" Full backup record in the catalog database, it looks for a previous Job with:

- The same Job name.
- The same Client name.
- The same FileSet (any change to the definition of the FileSet such as adding or deleting a file in the Include or Exclude sections constitutes a different FileSet.
- The Job was a FULL backup.
- The Job terminated normally (i.e. did not fail or was not canceled).

If all the above conditions do not hold, the Director will upgrade the Differential to a Full save. Otherwise, the Differential backup will be performed as requested.

The File daemon (Client) decides which files to backup for a differential backup by comparing the start time of the prior Full backup Job against the time each file was last "modified" (st_mtime) and the time its attributes were last "changed"(st_ctime). If the file was modified or its attributes were changed on or after this start time, it will then be backed up. The start time used is displayed after the **Since** on the Job report. In rare cases, using the start time of the prior backup may cause some files to be backed up twice, but it ensures that no change is missed. As with the Incremental option, you should ensure that the clocks on your server and client are synchronized or as close as possible to avoid the possibility of a file being skipped. Note, on versions 1.33 or greater Bacula automatically makes the necessary adjustments to the time between the server and the client so that the times Bacula uses are synchronized.

For a **Restore** Job, no level need be specified.

For a **Verify** Job, the Level may be one of the following:

InitCatalog

does a scan of the specified **FileSet** and stores the file attributes in the Catalog database. Since no file data is saved, you might ask why you would want to do this. It turns out to be a very simple and easy way to have a **Tripwire** like feature using **Bacula**. In other words, it allows you to save the state of a set of files defined by the **FileSet** and later check to see if those files have been modified or deleted and if any new files have been added. This can be used to detect system intrusion. Typically you would specify a **FileSet** that contains the set of system files that should not change (e.g. /sbin, /boot, /lib, /bin, ...). Normally, you run the **InitCatalog** level verify one time when your system is first setup, and then once again after each modification (upgrade) to your system. Thereafter, when you want to check the state of your system files, you use a **Verify level = Catalog**. This compares the results of your **InitCatalog** with the current state of the files.

Catalog

Compares the current state of the files against the state previously saved during an **InitCatalog**. Any discrepancies are reported. The items reported are determined by the **verify** options specified on the **Include** directive in the specified **FileSet** (see the **FileSet** resource below for more details). Typically this command will be run once a day (or night) to check for any changes to your system files.

Please note! If you run two Verify Catalog jobs on the same client at the same time, the results will certainly be incorrect. This is because Verify Catalog modifies the Catalog database while running in order to track new files.

VolumeToCatalog

This level causes Bacula to read the file attribute data written to the Volume from the last Job. The file attribute data are compared to the values saved in the Catalog database and any differences are reported. This is similar to the **Catalog** level except that instead of comparing the disk file attributes to the catalog

database, the attribute data written to the Volume is read and compared to the catalog database. Although the attribute data including the signatures (MD5 or SHA1) are compared the actual file data is not compared (it is not in the catalog).

Please note! If you run two Verify VolumeToCatalog jobs on the same client at the same time, the results will certainly be incorrect. This is because the Verify VolumeToCatalog modifies the Catalog database while running.

DiskToCatalog

This level causes Bacula to read the files as they currently are on disk, and to compare the current file attributes with the attributes saved in the catalog from the last backup for the job specified on the **VerifyJob** record. This level differs from the **Catalog** level described above by the fact that it compare not against a previous Verify job but against a previous backup. When you run this level, you must supply the verify options on your Include statements. Those options determine what attribute fields are compared.

This command can be very useful if you have disk problems because it will compare the current state of your disk against the last successful backup, which may be several jobs.

Note, the current implementation (1.32c) does not identify files that have been deleted.

Verify Job = <Job-Resource-Name>

If you run a verify job without this record, the last job run will be compared with the catalog, which means that you must immediately follow a backup by a verify command. If you specify a **Verify Job** Bacula will find the last job with that name that ran. This permits you to run all your backups, then run Verify jobs on those that you wish to be verified (most often a **VolumeToCatalog**) so that the tape just written is re-read.

JobDefs = <JobDefs-Resource-Name>

If a JobDefs-Resource-Name is specified, all the values contained in the named JobDefs resource will be used as the defaults for the current Job. Any value that you explicitly define in the current Job resource, will override any defaults specified in the JobDefs resource. The use of this directive permits writing much more compact Job resources where the bulk of the directives are defined in one or more JobDefs. This is particularly useful if you have many similar Jobs but with minor variations such as different Clients.

Bootstrap = <bootstrap-file>

The Bootstrap record specifies a bootstrap file that, if provided, will be used during **Restore** Jobs and is ignored in other Job types. The **bootstrap** file contains the list of tapes to be used in a restore Job as well as which files are to be restored. Specification of this record is optional, and if specified, it is used only for a restore job. In addition, when running a Restore job from the console, this value can be changed.

If you use the **Restore** command in the Console program, to start a restore job, the **bootstrap** file will be created automatically from the files you select to be restored.

For additional details of the **bootstrap** file, please see [Restoring Files with the Bootstrap File](#) chapter of this manual.

Write Bootstrap = <bootstrap-file-specification>

The **writebootstrap** record specifies a file name where Bacula will write a **bootstrap** file for each Backup job run. Thus this record applies only to Backup Jobs. If the Backup

job is a Full save, Bacula will erase any current contents of the specified file before writing the bootstrap records. If the Job is an Incremental save, Bacula will append the current bootstrap record to the end of the file.

Using this feature, permits you to constantly have a bootstrap file that can recover the current state of your system. Normally, the file specified should be a mounted drive on another machine, so that if your hard disk is lost, you will immediately have a bootstrap record available.

If the **bootstrap-file-specification** begins with a vertical bar (|), Bacula will use the specification as the name of a program to which it will pipe the bootstrap record. It could for example be a shell script that emails you the bootstrap record.

For more details on using this file, please see the chapter entitled [The Bootstrap File](#) of this manual.

Client = <client-resource-name>

The Client record specifies the Client (File daemon) that will be used in the current Job. Only a single Client may be specified in any one Job. The Client runs on the machine to be backed up, and sends the requested files to the Storage daemon for backup, or receives them when restoring. For additional details, see the [Client Resource section](#) of this chapter. This record is required.

FileSet = <FileSet-resource-name>

The FileSet record specifies the FileSet that will be used in the current Job. The FileSet specifies which directories (or files) are to be backed up, and what options to use (e.g. compression, ...). Only a single FileSet resource may be specified in any one Job. For additional details, see the [FileSet Resource section](#) of this chapter. This record is required.

Messages = <messages-resource-name>

The Messages record defines what Messages resource should be used for this job, and thus how and where the various messages are to be delivered. For example, you can direct some messages to a log file, and others can be sent by email. For additional details, see the [Messages Resource](#) Chapter of this manual. This record is required.

Pool = <pool-resource-name>

The Pool record defines the pool of Volumes where your data can be backed up. Many Bacula installations will use only the **Default** pool. However, if you want to specify a different set of Volumes for different Clients or different Jobs, you will probably want to use Pools. For additional details, see the [Pool Resource section](#) of this chapter. This resource is required.

Full Backup Pool = <pool-resource-name>

The *Full Backup Pool* specifies a Pool to be used for Full backups. It will override any Pool specification during a Full backup. This resource is optional.

Differential Backup Pool = <pool-resource-name>

The *Differential Backup Pool* specifies a Pool to be used for Differential backups. It will override any Pool specification during a Differential backup. This resource is optional.

Incremental Backup Pool = <pool-resource-name>

The *Incremental Backup Pool* specifies a Pool to be used for Incremental backups. It will override any Pool specification during an Incremental backup. This resource is optional.

Schedule = <schedule-name>

The Schedule record defines what schedule is to be used for the Job. The schedule determines when the Job will be automatically started and what Job level (i.e. Full, Incremental, ...) is to be run. This record is optional, and if left out, the Job can only be

started manually. For additional details, see the [Schedule Resource Chapter](#) of this manual. If a Schedule resource is specified, the job will be run according to the schedule specified. If no Schedule resource is specified for the Job, the job must be manually started using the Console program. Although you may specify only a single Schedule resource for any one job, the Schedule resource may contain multiple **Run** records, which allow you to run the Job at many different times, and each **run** record permits overriding the default Job Level Pool, Storage, and Messages resources. This gives considerable flexibility in what can be done with a single Job.

Storage = <storage-resource-name>

The Storage record defines the name of the storage services where you want to backup the FileSet data. For additional details, see the [Storage Resource Chapter](#) of this manual. This record is required.

Max Start Delay = <time>

The time specifies maximum delay between the scheduled time and the actual start time for the Job. For example, a job can be scheduled to run at 1:00am, but because other jobs are running, it may wait to run. If the delay is set to 3600 (one hour) and the job has not begun to run by 2:00am, the job will be canceled. This can be useful, for example, to prevent jobs from running during day time hours. The default is 0 which indicates no limit.

Max Run Time = <time>

The time specifies maximum allowed time that a job may run, counted from the when the job starts (**not** necessarily the same as when the job was scheduled). This directive is implemented only in version 1.33 and later.

Max Wait Time = <time>

The time specifies maximum allowed time that a job may block waiting for a resource (such as waiting for a tape to be mounted, or waiting for the storage or file daemons to perform their duties), counted from the when the job starts (**not** necessarily the same as when the job was scheduled). This directive is implemented only in version 1.33 and later. Note, the implementation is not yet complete, so this directive does not yet work correctly.

Prune Jobs = <yes/no>

Normally, pruning of Jobs from the Catalog is specified on a Client by Client basis in the Client resource with the **AutoPrune** record. If this record is specified (not normally) and the value is **yes**, it will override the value specified in the Client resource. The default is **no**.

Prune Files = <yes/no>

Normally, pruning of Files from the Catalog is specified on a Client by Client basis in the Client resource with the **AutoPrune** record. If this record is specified (not normally) and the value is **yes**, it will override the value specified in the Client resource. The default is **no**.

Prune Volumes = <yes/no>

Normally, pruning of Volumes from the Catalog is specified on a Client by Client basis in the Client resource with the **AutoPrune** record. If this record is specified (not normally) and the value is **yes**, it will override the value specified in the Client resource. The default is **no**.

Run Before Job = <command>

The specified **command** is run as an external program prior to running the current Job. Any output sent by the job to standard output will be included in the Bacula job report. The command string must be a valid program name or name of a shell script. This record is not required, but if it is defined, and if the exit code of the program run is non-zero,

the current Bacula job will be canceled. In addition, the command string is parsed then feed to the `execvp()` function, which means that the path will be searched to execute your specified command, but there is no shell interpretation, as a consequence, if you complicated commands or want any shell features such as redirection or piping, you must call a shell script and do it inside that script.

Before submitting the specified command to the operating system, Bacula performs character substitution of the following characters:

```
%% = %  
%c = Client's name  
%d = Director's name  
%i = JobId  
%e = Job Exit Status  
%j = Unique Job name  
%l = Job Level  
%n = Job name  
%t = Job type  
%v = Volume name
```

As of version 1.30, Bacula checks the exit status of the `RunBeforeJob` program. If it is non-zero, the job will be error terminated. Lutz Kittler has pointed out that this can be a simple way to modify your schedules during a holiday. For example, suppose that you normally do Full backups on Fridays, but Thursday and Friday are holidays. To avoid having to change tapes between Thursday and Friday when no one is in the office, you can create a `RunBeforeJob` that returns a non-zero status on Thursday and zero on all other days. That way, the Thursday job will not run, and on Friday the tape you insert on Wednesday before leaving will be used.

Run After Job = <command>

The specified **command** is run as an external program after the current job terminates. This record is not required. The command string must be a valid program name or name of a shell script. If the exit code of the program run is non-zero, the current Bacula job will terminate in error. Before submitting the specified command to the operating system, Bacula performs character substitution as described above for the **Run Before Job** record.

An example of the use of this command is given in the [Tips Chapter](#) of this manual. As of version 1.30, Bacula checks the exit status of the `RunAfter` program. If it is non-zero, the job will be terminated in error.

Client Run Before Job = <command>

This command is the same as **Run Before Job** except that it is run on the client machine. The same restrictions apply to Unix systems as noted above for the **Run Before Job**. In addition, for a Windows client on version 1.33 and above, please take careful note that you must ensure a correct path to your script, and the script or program is expected to be a .bat file or a Windows program. Unix like commands will not work unless you have installed and properly configured Cygwin in addition to and separately from Bacula. Some Suggestions from Phil Stracchino for running on Win32 machines with the native Win32 File daemon:

1. The `ClientRunBeforeJob` directive should specify a .bat file which runs the actual client-side commands, rather than trying to run (for example) `regedit /e` directly.

2. The batch file should explicitly 'exit 0' on successful completion.
3. The path to the batch file should be specified in Unix form:

```
ClientRunBeforeJob = "c:/bacula/bin/systemstate.bat"
```

rather than DOS/Windows form:

```
ClientRunBeforeJob = "c:\bacula\bin\systemstate.bat" INCORRECT
```

Client Run After Job = <command>

This command is the same as **Run After Job** except that it is run on the client machine.

Note, please see the notes above in **Client Run Before Job** concerning Windows clients.

Spool Data = <yes/no>

If this directive is set to **yes** (default no), the Storage daemon will be requested to spool the data for this Job to disk rather than write it directly to tape. Once all the data arrives or the spool file maximum sizes are reached, the data will be despoiled and written to tape. When this directive is set to yes, the Spool Attributes is also automatically set to yes. Spooling data prevents tape shoe-shine (start and stop) during Incremental saves. This option should not be used if you are writing to a disk file.

Spool Attributes = <yes/no>

The default is set to **no**, which means that the File attributes are sent by the Storage daemon to the Director as they are stored on tape. However, if you want to avoid the possibility that database updates will slow down writing to the tape, you may want to set the value to **yes**, in which case the Storage daemon will buffer the File attributes and Storage coordinates to a temporary file in the Working Directory, then when writing the Job data to the tape is completed, the attributes and storage coordinates will be sent to the Director. The default is **no**.

Where = <directory>

This record applies only to a Restore job and specifies a prefix to the directory name of all files being restored. This permits files to be restored in a different location from which they were saved. If **Where** is not specified or is set to backslash (/), the files will be restored to their original location. By default, we have set **Where** in the example configuration files to be **/tmp/bacula-restore**. This is to prevent accidental overwriting of your files.

Replace = <replace-option>

This record applies only to a Restore job and specifies what happens when Bacula wants to restore a file or directory that already exists. You have the following options for **replace-option**:

replace-option:

always

when the file to be restored already exists, it is deleted then replaced by the copy backed up.

ifnewer

if the backed up file (on tape) is newer than the existing file, the existing file is deleted and replaced by the back up.

ifolder

if the backed up file (on tape) is older than the existing file, the existing file is deleted and replaced by the back up.

never

if the backed up file already exists, Bacula skips restoring this file.

Prefix Links=<yes/no>

If a **Where** path prefix is specified for a recovery job, apply it to absolute links as well. The default is **No**. When set to **Yes** then while restoring files to an alternate directory, any absolute soft links will also be modified to point to the new alternate directory. Normally this is what is desired — i.e. everything is self consistent. However, if you wish to later move the files to their original locations, all files linked with absolute names will be broken.

Maximum Concurrent Jobs = <number>

where <number> is the maximum number of Jobs from the current Job resource that can run concurrently. Note, this record limits only Jobs with the same name as the resource in which it appears. Any other restrictions on the maximum concurrent jobs such as in the Director, Client, or Storage resources will also apply in addition to the limit specified here. The default is set to 1, but you may set it to a larger number. We strongly recommend that you read the WARNING documented under [Maximum Concurrent Jobs](#) in the Director's resource.

Reschedule On Error = <yes/no>

If this record is enabled, and the job terminates in error, the job will be rescheduled as determined by the **Reschedule Interval** and **Reschedule Times** records. If you cancel the job, it will not be rescheduled. The default is **no** (i.e. the job will not be rescheduled). This specification can be useful for portables, laptops, or other machines that are not always connected to the network or switched on.

Reschedule Interval = <time-specification>

If you have specified **Reschedule On Error** = **yes** and the job terminates in error, it will be rescheduled after the interval of time specified by **time-specification**. See [the time specification formats](#) in the Configure chapter for details of time specifications. If no interval is specified, the job will not be rescheduled on error.

Reschedule Times = <count>

This record specifies the maximum number of times to reschedule the job. If it is set to zero (the default) the job will be rescheduled an indefinite number of times.

Priority = <number>

This record permits you to control the order in which your jobs run by specifying a positive non-zero number. The higher the number, the lower the job priority. Assuming you are not running concurrent jobs, all queued jobs of priority 1 will run before queued jobs of priority 2 and so on, regardless of the original scheduling order.

The priority only affects waiting jobs that are queued to run, not jobs that are already running. If one or more jobs of priority 2 are already running, and a new job is scheduled with priority 1, the currently running priority 2 jobs must complete before the priority 1 job is run.

The default priority is 10.

If you want to run concurrent jobs, which is not recommended, you should keep these points in mind:

- To run concurrent jobs, you must set Maximum Concurrent Jobs = 2 in 5 or 6 distinct places: in bacula-dir.conf in the Director, the Job, the Client, the Storage resources; in bacula-fd in the FileDaemon (or Client) resource, and in bacula-sd.conf in the Storage resource. If any one is missing, it will throttle the jobs to one at a time.
- Bacula concurrently runs jobs of only one priority at a time. It will not simultaneously run a priority 1 and a priority 2 job.
- If Bacula is running a priority 2 job and a new priority 1 job is scheduled, it will wait until the running priority 2 job terminates even if the Maximum Concurrent Jobs settings would otherwise allow two jobs to run simultaneously.

- Suppose that bacula is running a priority 2 job and new priority 1 job is scheduled and queued waiting for the running priority 2 job to terminate. If you then start a second priority 2 job, the waiting priority 1 job will prevent the new priority 2 job from running concurrently with the running priority 2 job. That is: as long as there is a higher priority job waiting to run, no new lower priority jobs will start even if the Maximum Concurrent Jobs settings would normally allow them to run. This ensures that higher priority jobs will be run as soon as possible.

If you have several jobs of different priority, it is best not to start them at exactly the same time, because Bacula must examine them one at a time. If by chance Bacula treats a lower priority first, then it will run before your high priority jobs. To avoid this, start any higher priority a few seconds before lower ones. This insures that Bacula will examine the jobs in the correct order, and that your priority scheme will be respected.

The following is an example of a valid Job resource definition:

```
Job {
    Name = "Minou"
    Type = Backup
    Level = Incremental                # default
    Client = Minou
    FileSet="Minou Full Set"
    Storage = DLTDDrive
    Pool = Default
    Schedule = "MinouWeeklyCycle"
    Messages = Standard
}
```

The JobDefs Resource

The JobDefs resource permits all the same directives that can appear in a Job resource. However, a JobDefs resource does not create a Job, rather it can be referenced within a Job to provide defaults for that Job. This permits you to concisely define several nearly identical Jobs, each one referencing a JobDefs resource which contains the defaults. Only the changes from the defaults need be mentioned in each Job.

The Schedule Resource

The Schedule resource provides a means of automatically scheduling a Job as well as the ability to override the default Level, Pool, Storage and Messages resources. If a Schedule resource is not referenced in a Job, the Job may only be run manually. In general, you specify an action to be taken and when.

Schedule

Start of the Schedule records. No **Schedule** resource is required, but you will need at least one if you want Jobs to be automatically started.

Name = <name>

The name of the schedule being defined. The name record is required.

Run = <Job-overrides> <Date-time-specification>

The Run record defines when a Job is to be run, and what overrides if any to apply. You may specify multiple **run** records within a **Schedule** resource. If you do, they will all be applied (i.e. multiple schedules). If you have two **Run** records that start at the same time, two Jobs will start at the same time (well, within one second of each other).

The **Job-overrides** permit overriding the Level, the Storage, the Messages, and the Pool specifications provided in the Job resource. In addition, the FullPool, the IncrementalPool, and the DifferentialPool specifications permit overriding the Pool specification according to what backup Job Level is in effect.

By the use of overrides, you may customize a particular Job. For example, you may specify a Messages override for your Incremental backups that outputs messages to a log file, but for your weekly or monthly Full backups, you may send the output by email by using a different Messages override.

Job-overrides are specified as: **keyword=value** where the keyword is Level, Storage, Messages, Pool, FullPool, DifferentialPool, or IncrementalPool, and the **value** is as defined on the respective record formats for the Job resource. You may specify multiple **Job-overrides** on one **Run** record by separating them with one or more spaces or by separating them with a trailing comma. For example:

Level=Full

is all files in the FileSet whether or not they have changed.

Level=Incremental

is all files that have changed since the last backup.

Pool=Weekly

specifies to use the Pool named **Weekly**.

Storage=DLT_Drive

specifies to use **DLT_Drive** for the storage device.

Messages=Verbose

specifies to use the **Verbose** message resource for the Job.

FullPool=Full

specifies to use the Pool named **Full** if the job is a full backup, or is upgraded from another type to a full backup.

DifferentialPool=Differential

specifies to use the Pool named **Differential** if the job is a differential backup.

IncrementalPool=Incremental

specifies to use the Pool named **Incremental** if the job is an incremental backup.

SpoolData=yes/no

tells Bacula to request the Storage daemon to spool data to a disk file before putting it on tape.

Date-time-specification determines when the Job is to be run. Any specification given is assumed to be repetitive in nature. By default, Bacula assumes that the job is to be run every hour of every day of every month. By using date specifications, you limit or fix the frequency of the repetition. This is done by using masks for the hour, day of the month, day of the week, week of the month, week of the year, and month. By specifying one or more of the above, you can define a schedule to repeat at almost any frequency you want.

Basically, you must supply a **month**, **day**, **hour**, and **minute** the Job is to be run. Of these four items to be specified, **day** is special in that you may either specify a day of the month such as 1, 2, ... 31, or you may specify a day of the week such as Monday, Tuesday, ... Sunday. Finally, you may also specify a week qualifier to restrict the schedule to the first, second, third, fourth, or fifth week of the month.

The Job will be run on either day that matches the current day (day of the week, or day of the month).

The default is that every hour of every day of every week of every month is set. As you specify the parts of the time, the default for that part of the time is cleared and the new value set. However, the other defaults are set until a limiting specification is given. For example, if you specify only a day of the week, such as **Tuesday** the Job will be run every hour of every Tuesday of every Month. That is the **month** and **hour** remain set to the defaults of every month and all hours.

The date/time to run the Job can be specified in the following way in pseudo-BNF:

```
<void-keyword>      = on
<at-keyword>        = at
<week-keyword>      = 1st | 2nd | 3rd | 4th | 5th | first |
                      second | third | forth | fifth
<wday-keyword>      = sun | mon | tue | wed | thu | fri | sat |
                      sunday | monday | tuesday | wednesday |
                      thursday | friday
<week-of-year-keyword> = w00 | w01 | ... w52 | w53
<month-keyword>     = jan | feb | mar | apr | may | jun | jul |
                      aug | sep | oct | nov | dec | january |
                      february | ... | december
<daily-keyword>     = daily
<weekly-keyword>    = weekly
<monthly-keyword>   = monthly
<hourly-keyword>    = hourly
<digit>             = 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0
<number>            = <digit> | <digit><number>
<l2hour>            = 0 | 1 | 2 | ... 12
<hour>              = 0 | 1 | 2 | ... 23
<minute>            = 0 | 1 | 2 | ... 59
<day>               = 1 | 2 | ... 31
<time>              = <hour>:<minute> |
                      <l2hour>:<minute>am |
                      <l2hour>:<minute>pm
<time-spec>         = <at-keyword> <time> |
                      <hourly-keyword>
<date-keyword>      = <void-keyword> <weekly-keyword>
```

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```
<day-range>      = <day>-<day>
<month-range>    = <month-keyword>-<month-keyword>
<wday-range>     = <wday-keyword>-<wday-keyword>
<range>          = <day-range> | <month-range> |
                  <wday-range>
<date>           = <date-keyword> | <day> | <range>
<date-spec>      = <date> | <date-spec>
<day-spec>       = <day> | <wday-keyword> |
                  <day-range> | <wday-range> |
                  <daily-keyword>
<day-spec>       = <day> | <wday-keyword> |
                  <week-keyword> <wday-keyword>
<month-spec>     = <month-keyword> | <month-range> |
                  <monthly-keyword>
<date-time-spec> = <month-spec> <day-spec> <time-spec>
```

Note, the Week of Year specification wnn follows the ISO standard definition of the week of the year, where Week 1 is the week in which the first Thursday of the year occurs, or alternatively, the week which contains the 4th of January. w00 for Bacula is the week that precedes that week (i.e. has the first few days of the year if any occur before Thursday).

An example schedule resource that is named **WeeklyCycle** and runs a job with level full each Sunday at 1:05am and an incremental job Monday through Saturday at 1:05am is:

```
Schedule {
    Name = "WeeklyCycle"
    Run = Level=Full sun at 1:05
    Run = Level=Incremental mon-sat at 1:05
}
```

An example of a possible monthly cycle is as follows:

```
Schedule {
    Name = "MonthlyCycle"
    Run = Level=Full Pool=Monthly 1st sun at 1:05
    Run = Level=Differential 2nd-5th sun at 1:05
    Run = Level=Incremental Pool=Daily mon-sat at 1:05
}
```

The first of every month:

```
Schedule {
    Name = "First"
    Run = Level=Full 1 at 1:05
    Run = Level=Incremental 2-31 at 1:05
}
```

The FileSet Resource

The FileSet resource defines what files are to be included in a backup job. At least one **FileSet** resource is required. It consists of a list of files or directories to be included, a list of files or directories to be excluded and the various backup options such as compression, encryption, and signatures that are to be applied to each file.

Any change to the list of the included files will cause Bacula to automatically create a new FileSet (defined by the name and an MD5 checksum of the Include contents). Each time a new FileSet is created, Bacula will ensure that the first backup is always a Full save.

FileSet

Start of the FileSet records. At least one **FileSet** resource must be defined.

Name = <name>

The name of the FileSet resource. This record is required.

Include = <processing-options>

{ <file-list> }

The Include resource specifies the list of files and/or directories to be included in the backup job. There can be any number of **Include file-list** specifications within the FileSet, each having its own set of **processing-options**. Normally, the **file-list** consists of one file or directory name per line. Directory names should be specified without a trailing slash. Wild-card (or glob matching) does not work when used in an Include list. It does work in an Exclude list though. Just the same, any asterisk (*), question mark (?), or left-bracket ([) must be preceded by a slash (\) if you want it to represent the literal character.

You should **always** specify a full path for every directory and file that you list in the FileSet. In addition, on Windows machines, you should **always** prefix the directory or filename with the drive specification (e.g. **c:/xxx**) using Unix directory name separators (forward slash). However, within an **Exclude** where for some reason the exclude will not work with a prefixed drive letter. If you want to specify a drive letter in exclusions on Win32 systems, you can do so by specifying:

```
Exclude = { /cygdrive/d/archive/Mulberry }
```

where in this case, the **/cygdrive/d** is Cygwin's way of referring to drives on Win32 (thanks to Mathieu Arnold for this tip).

Bacula's default for processing directories is to recursively descend in the directory saving all files and subdirectories. Bacula will not by default cross file systems (or mount points in Unix parlance). This means that if you specify the root partition (e.g. **/**), Bacula will save only the root partition and not any of the other mounted file systems. Similarly on Windows systems, you must explicitly specify each of the drives you want saved (e.g. **c:/** and **d:/** ...). In addition, at least for Windows systems, you will most likely want to enclose each specification within double quotes. The **df** command on Unix systems will show you which mount points you must specify to save everything. See below for an example.

Take special care not to include a directory twice or Bacula will backup the same files two times wasting a lot of space on your archive device. Including a directory twice is

very easy to do. For example:

```
Include = { /usr }
```

on a Unix system where /usr is a subdirectory (rather than a mounted filesystem) will cause /usr to be backed up twice. In this case, on Bacula versions prior to 1.32f-5-09Mar04 due to a bug, you will not be able to restore hard linked files that were backed up twice.

The **<processing-options>** is optional. If specified, it is a list of **keyword=value** options to be applied to the file-list. Multiple options may be specified by separating them with spaces. These options are used to modify the default processing behavior of the files included. Since there can be multiple **Include** sets, this permits effectively specifying the desired options (compression, encryption, ...) on a file by file basis. The options may be one of the following:

compression=GZIP

All files saved will be software compressed using the GNU ZIP compression format. The compression is done on a file by file basis by the File daemon. If there is a problem reading the tape in a single record of a file, it will at most affect that file and none of the other files on the tape. Normally this option is **not** needed if you have a modern tape drive as the drive will do its own compression. However, compression is very important if you are writing your Volumes to a file, and it can also be helpful if you have a fast computer but a slow network. Specifying **GZIP** uses the default compression level six (i.e. **GZIP** is identical to **GZIP6**). If you want a different compression level (1 through 9), you can specify it by appending the level number with no intervening spaces to **GZIP**. Thus **compression=GZIP1** would give minimum compression but the fastest algorithm, and **compression=GZIP9** would give the highest level of compression, but requires more computation. According to the GZIP documentation, compression levels greater than 6 generally give very little extra compression but are rather CPU intensive.

signature=MD5

An MD5 signature will be computed for all files saved. Adding this option generates about 5% extra overhead for each file saved. In addition to the additional CPU time, the MD5 signature adds 16 more bytes per file to your catalog. We strongly recommend that this option be specified as a default for all files.

signature=SHA1

An SHA1 signature will be computed for all The SHA1 algorithm is purported to be some what slower than the MD5 algorithm, but at the same time is significantly better from a cryptographic point of view (i.e. much fewer collisions, much lower probability of being hacked.) It adds four more bytes than the MD5 signature. We strongly recommend that either this option or MD5 be specified as a default for all files. Note, only one of the two options MD5 or SHA1 can be computed for any file.

**encryption=<algorithm>*

All files saved will be encrypted using one of the following algorithms (NOT YET IMPLEMENTED):

**AES*

verify=<options>

The options letters specified are used when running a **Verify Level=Catalog** job, and may be any combination of the following:

<i>i</i>	compare the inodes
<i>p</i>	compare the permission bits
<i>n</i>	compare the number of links
<i>u</i>	compare the user id
<i>g</i>	compare the group id
<i>s</i>	compare the size
<i>a</i>	compare the access time
<i>m</i>	compare the modification time (st_mtime)
<i>c</i>	compare the change time (st_ctime)
<i>S</i>	report file size decreases
<i>5</i>	compare the MD5 signature
<i>l</i>	compare the SHA1 signature

A useful set of general options on the **Level=Catalog** verify is **pins5** i.e. compare permission bits, inodes, number of links, size, and MD5 changes.

onefs=yes/no

If set to **yes** (the default), **Bacula** will remain on a single file system. That is it will not backup file systems that are mounted on a subdirectory. In this case, you must explicitly list each file system you want saved. If you set this option to **no**, Bacula will backup all mounted file systems (i.e. traverse mount points) that are found within the **FileSet**. Thus if you have NFS or Samba file systems mounted on a directory included in your FileSet, they will also be backed up. Normally, it is preferable to set **onefs=yes** and to explicitly name each file system you want backed up. See the example below for more details.

portable=yes/no

If set to **yes** (default is **no**), the Bacula File daemon will backup Win32 files in a portable format. By default, this option is set to **no**, which means that on Win32 systems, the data will be backed up using Windows API calls and on WinNT/2K/XP, the security and ownership data will be properly backed up (and restored), but the data format is not portable to other systems — e.g. Unix, Win95/98/Me. On Unix systems, this option is ignored, and unless you have a specific need to have portable backups, we recommend accept the default (**no**) so that the maximum information concerning your files is backed up.

recurse=yes/no

If set to **yes** (the default), Bacula will recurse (or descend) into all subdirectories found unless the directory is explicitly excluded using an **exclude** definition. If

you set **recurse=no**, Bacula will save the subdirectory entries, but not descend into the subdirectories, and thus will not save the contents of the subdirectories. Normally, you will want the default (**yes**).

sparse=yes/no

Enable special code that checks for sparse files such as created by ndbm. The default is **no**, so no checks are made for sparse files. You may specify **sparse=yes** even on files that are not sparse file. No harm will be done, but there will be a small additional overhead to check for buffers of all zero, and a small additional amount of space on the output archive will be used to save the seek address of each non-zero record read.

Restrictions: Bacula reads files in 32K buffers. If the whole buffer is zero, it will be treated as a sparse block and not written to tape. However, if any part of the buffer is non-zero, the whole buffer will be written to tape, possibly including some disk sectors (generally 4098 bytes) that are all zero. As a consequence, Bacula's detection of sparse blocks is in 32K increments rather than the system block size. If anyone considers this to be a real problem, please send in a request for change with the reason. The sparse code was first implemented in version 1.27.

If you are not familiar with sparse files, an example is say a file where you wrote 512 bytes at address zero, then 512 bytes at address 1 million. The operating system will allocate only two blocks, and the empty space or hole will have nothing allocated. However, when you read the sparse file and read the addresses where nothing was written, the OS will return all zeros as if the space were allocated, and if you backup such a file, a lot of space will be used to write zeros to the volume. Worse yet, when you restore the file, all the previously empty space will now be allocated using much more disk space. By turning on the **sparse** option, Bacula will specifically look for empty space in the file, and any empty space will not be written to the Volume, nor will it be restored. The price to pay for this is that Bacula must search each block it reads before writing it. On a slow system, this may be important. If you suspect you have sparse files, you should benchmark the difference or set sparse for only those files that are really sparse.

readfifo=yes/no

If enabled, tells the Client to read the data on a backup and write the data on a restore to any FIFO (pipe) that is explicitly mentioned in the FileSet. In this case, you must have a program already running that writes into the FIFO for a backup or reads from the FIFO on a restore. This can be accomplished with the **RunBeforeJob** record. If this is not the case, Bacula will hang indefinitely on reading/writing the FIFO. When this is not enabled (default), the Client simply saves the directory entry for the FIFO.

mtimeonly=yes/no

If enabled, tells the Client that the selection of files during Incremental and Differential backups should be based only on the `st_mtime` value in the `stat()` packet. The default is **no** which means that the selection of files to be backed up will be based on both the `st_mtime` and the `st_ctime` values. In general, it is not recommended to use this option.

keepatime=yes/no

The default is **no**. When enabled, Bacula will reset the `st_atime` (access time) field of files that it backs up to their value prior to the backup. This option is not

generally recommended as there are very few programs that use `st_atime`, and the backup overhead is increased because of the additional system call necessary to reset the times. (I'm not sure this works on Win32).

<file-list> is a space separated list of filenames and/or directory names. To include names containing spaces, enclose the name between double-quotes. The list may span multiple lines, in fact, normally it is good practice to specify each filename on a separate line.

There are a number of special cases when specifying files or directories in a **file-list**. They are:

- ◆ Any file-list item preceded by an at-sign (@) is assumed to be a filename containing a list of files, which is read when the configuration file is parsed during Director startup. Note, that the file is read on the Director's machine and not on the Client.
- ◆ Any file-list item beginning with a vertical bar (|) is assumed to be a program. This program will be executed on the Director's machine at the time the Job starts (not when the Director reads the configuration file), and any output from that program will be assumed to be a list of files or directories, one per line, to be included. This allows you to have a job that for example includes all the local partitions even if you change the partitioning by adding a disk. In general, you will need to prefix your command or commands with a **sh -c** so that they are invoked by a shell. This will not be the case if you are invoking a script as in the second example below. Also, you must take care to escape wild-cards and ensure that any spaces in your command are escaped as well. If you use a single quotes (') within a double quote ("), Bacula will treat everything between the single quotes as one field so it will not be necessary to escape the spaces. In general, getting all the quotes and escapes correct is a real pain as you can see by the next example. As a consequence, it is often easier to put everything in a file, and simply use the file name within Bacula. In that case the **sh -c** will not be necessary providing the first line of the file is `#!/bin/sh`.

As an example:

```
Include = signature=SHA1 {
    " | sh -c 'df -l | grep \"/dev/hd[ab]\" | grep -v \".*/tmp\" \" \"
      | awk \"{print \\$6}\\\" \" \"
}
```

will produce a list of all the local partitions on a RedHat Linux system. Note, the above line was split, but should normally be written on one line. Quoting is a real problem because you must quote for Bacula which consists of preceding every `\` and every `"` with a `\`, and you must also quote for the shell command. In the end, it is probably easier just to execute a small file with:

```
Include = signature=MD5 {
    " | my_partitions"
}
```

where `my_partitions` has:

```
#!/bin/sh
```

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```
df -l | grep "^/dev/hd[ab]" | grep -v ".*tmp" \
| awk "{print \$6}"
```

If the vertical bar (|) is preceded by a backslash as in `\|`, the program will be executed on the Client's machine instead of on the Director's machine — (this is implemented but not tested, and very likely will not work on Windows).

- ◆ Any file-list item preceded by a less-than sign (<) will be taken to be a file. This file will be read on the Director's machine at the time the Job starts, and the data will be assumed to be a list of directories or files, one per line, to be included. This feature allows you to modify the external file and change what will be saved without stopping and restarting Bacula as would be necessary if using the @ modifier noted above.

If you precede the less-than sign (<) with a backslash as in `\<`, the file-list will be read on the Client machine instead of on the Director's machine (implemented but not tested).

- ◆ If you explicitly specify a block device such as `/dev/hda1`, then Bacula (starting with version 1.28) will assume that this is a raw partition to be backed up. In this case, you are strongly urged to specify a **sparse=yes** include option, otherwise, you will save the whole partition rather than just the actual data that the partition contains. For example:

```
Include = signature=MD5 sparse=yes {
    /dev/hd6
}
```

will backup the data in device `/dev/hd6`.

Ludovic Strappazon has pointed out that this feature can be used to backup a full Microsoft Windows disk. Simply boot into the system using a Linux Rescue disk, then load a statically linked Bacula as described in the [Disaster Recovery Using Bacula](#) chapter of this manual. Then simply save the whole disk partition. In the case of a disaster, you can then restore the desired partition.

- ◆ If you explicitly specify a FIFO device name (created with `mkfifo`), and you add the option **readfifo=yes** as an option, Bacula will read the FIFO and back its data up to the Volume. For example:

```
Include = signature=SHA1 readfifo=yes {
    /home/abc/fifo
}
```

if `/home/abc/fifo` is a fifo device, Bacula will open the fifo, read it, and store all data thus obtained on the Volume. Please note, you must have a process on the system that is writing into the fifo, or Bacula will hang, and after one minute of waiting, it will go on to the next file. The data read can be anything since Bacula treats it as a stream.

This feature can be an excellent way to do a "hot" backup of a very large database. You can use the **RunBeforeJob** to create the fifo and to start a

program that dynamically reads your database and writes it to the fifo. Bacula will then write it to the Volume.

During the restore operation, the inverse is true, after Bacula creates the fifo if there was any data stored with it (no need to explicitly list it or add any options), that data will be written back to the fifo. As a consequence, if any such FIFOs exist in the fileset to be restored, you must ensure that there is a reader program or Bacula will block, and after one minute, Bacula will time out the write to the fifo and move on to the next file.

The Exclude Files specifies the list of files and/or directories to be excluded from the backup job. The **<file-list>** is a comma or space separated list of filenames and/or directory names. To exclude names containing spaces, enclose the name between double-quotes. Most often each filename is on a separate line.

For exclusions on Windows systems, do not include a leading drive letter such as **c:**. This does not work. Any filename preceded by an at-sign (@) is assumed to be a filename on the Director's machine containing a list of files.

The following is an example of a valid FileSet resource definition:

```
FileSet {
  Name = "Full Set"
  Include = compression=GZIP signature=SHA1 sparse=yes {
    @/etc/backup.list
  }
  Include = {
    /root/myfile
    /usr/lib/another_file
  }
  Exclude = { *.o }
}
```

Note, in the above example, all the files contained in /etc/backup.list will be compressed with GZIP compression, an SHA1 signature will be computed on the file's contents (its data), and sparse file handling will apply.

The two files /root/myfile and /usr/lib/another_file will also be saved but without any options. In addition, all files with the extension **.o** will be excluded from the file set (i.e. from the backup).

Suppose you want to save everything except **/tmp** on your system. Doing a **df** command, you get the following output:

```
[kern@rufus k]$ df
Filesystem      1k-blocks      Used Available Use% Mounted on
/dev/hda5        5044156      439232   4348692  10% /
/dev/hda1         62193        4935    54047    9% /boot
/dev/hda9       20161172   5524660  13612372  29% /home
/dev/hda2         62217        6843    52161   12% /rescue
/dev/hda8        5044156      42548   4745376   1% /tmp
/dev/hda6        5044156   2613132  2174792  55% /usr
none             127708         0    127708   0% /dev/shm
//minimatou/c$  14099200   9895424  4203776  71% /mnt/mmatou
lmatou:/         1554264     215884  1258056  15% /mnt/matou
lmatou:/home     2478140   1589952   760072  68% /mnt/matou/home
```

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lmatou:/usr	1981000	1199960	678628	64%	/mnt/matou/usr
lpmatou:/	995116	484112	459596	52%	/mnt/pmatou
lpmatou:/home	19222656	2787880	15458228	16%	/mnt/pmatou/home
lpmatou:/usr	2478140	2038764	311260	87%	/mnt/pmatou/usr
deuter:/	4806936	97684	4465064	3%	/mnt/deuter
deuter:/home	4806904	280100	4282620	7%	/mnt/deuter/home
deuter:/files	44133352	27652876	14238608	67%	/mnt/deuter/files

Now, if you specify only `/` in your Include list, Bacula will only save the Filesystem `/dev/hda5`. To save all file systems except `/tmp` with out including any of the Samba or NFS mounted systems, and explicitly excluding a `/tmp`, `/proc`, `.journal`, and `.autofsck`, which you will not want to be saved and restored, you can use the following:

```
FileSet {
    Name = Everything
    Include = {
        /
        /boot
        /home
        /rescue
        /usr
    }
    Exclude = {
        /proc
        /tmp
        .journal
        .autofsck
    }
}
```

Since `/tmp` is on its own filesystem and it was not explicitly named in the Include list, it is not really needed in the exclude list. It is better to list it in the Exclude list for clarity, and in case the disks are changed so that it is no longer in its own partition.

Please be aware that allowing Bacula to traverse or change file systems can be **very** dangerous. For example, with the following:

```
FileSet {
    Name = "Bad example"
    Include = oneofs=no {
        /mnt/matou
    }
}
```

you will be backing up an NFS mounted partition (`/mnt/matou`), and since `onefs` is set to `no`, Bacula will traverse file systems. However, if `/mnt/matou` has the current machine's file systems mounted, as is often the case, you will get yourself into a recursive loop and the backup will never end.

The following FileSet definition will backup a raw partition:

```
FileSet {
    Name = "RawPartition"
    Include = sparse=yes {
        /dev/hda2
    }
}
```

Note, in backing up and restoring a raw partition, you should ensure that no other process including the system is writing to that partition. As a precaution, you are strongly urged to ensure that the raw partition is not mounted or is mounted read-only. If necessary, this can be done using the **RunBeforeJob** record.

Additional Considerations for Using Excludes on Windows

For exclude lists to work correctly on Windows, you must observe the following rules:

- Filenames are case sensitive, so you must use the correct case.
- To exclude a directory, you must not have a trailing slash on the directory name.
- If you have spaces in your filename, you must enclose the entire name in double-quote characters ("). Trying to use a backslash before the space will not work.
- You must not precede the excluded file or directory with a drive letter (such as **c:**) otherwise it will not work.

Thanks to Thiago Lima for summarizing the above items for us. If you are having difficulties getting includes or excludes to work, you might want to try using the **estimate job=xxx listing** command documented in the [Console chapter](#) of this manual.

Windows Considerations for FileSets

If you are entering Windows file names, the directory path may be preceded by the drive and a colon (as in **c:**). However, the path separators must be specified in Unix convention (i.e. forward slash (/)). If you wish to include a quote in a file name, precede the quote with a backslash (\\). For example you might use the following for a Windows machine to backup the "My Documents" directory:

```
FileSet {
    Name = "Windows Set"
    Include = {
        "c:/My Documents"
    }
    Exclude = { *.obj *.exe }
}
```

When using exclusion on Windows, do not use a drive prefix (i.e. **c:**) as it will prevent the exclusion from working. However, if you need to specify a drive letter in exclusions on Win32 systems, you can do so by specifying:

```
Exclude = { /cygdrive/d/archive/Mulberry }
```

where in this case, the **/cygdrive/d** is Cygwin's way of referring to drive **d:** (thanks to Mathieu Arnold for this tip).

A Windows Example FileSet

The following example was contributed by Phil Stracchino:

```
This is my Windows 2000 fileset:
```



```
FileSet {
    Name = "Windows 2000 Full Set"
    Include = signature=MD5 {
        c:/
    }
    # Most of these files are excluded not because we don't want
    # them, but because Win2K won't allow them to be backed up
    # except via proprietary Win32 API calls.
    Exclude = {
        "/Documents and Settings/*/Application Data/*/Profiles/*/*/
        Cache/*"
        "/Documents and Settings/*/Local Settings/Application Data/
        Microsoft/Windows/[Uu][Ss][Rr][Cc][Ll][Aa][Ss][Ss].*"
        "/Documents and Settings/*/[Nn][Tt][Uu][Ss][Ee][Rr].*"
        "/Documents and Settings/*/Cookies/*"
        "/Documents and Settings/*/Local Settings/History/*"
        "/Documents and Settings/*/Local Settings/
        Temporary Internet Files/*"
        "/Documents and Settings/*/Local Settings/Temp/*"
        "/WINNT/CSC"
        "/WINNT/security/logs/scepol.log"
        "/WINNT/system32/config/*"
        "/WINNT/msdownld.tmp/*"
        "/WINNT/Internet Logs/*"
        "/WINNT/$Nt*Uninstall*"
        "/WINNT/Temp/*"
        "/temp/*"
        "/tmp/*"
        "/pagefile.sys"
    }
}
```

Note, the three line of the above Exclude were split to fit on the document page, they should be written on a single line in real use.

Testing Your FileSet

If you wish to get an idea of what your FileSet will really backup or if your exclusion rules will work correctly, you can test it by using the **estimate** command in the Console program. See the [estimate command](#) in the Console chapter of this manual.

Windows NTFS Naming Considerations

NTFS filenames containing Unicode characters (i.e. > 0xFF) cannot be explicitly named at the moment. You must include such names by naming a higher level directory or a drive letter that does not contain Unicode characters.

The Client Resource

The Client resource defines the attributes of the Clients that are served by this Director; that is the machines that are to be backed up. You will need one Client resource definition for each machine to be backed up.

Client (or FileDaemon)

Start of the Client records.

Name = <name>

The client name which will be used in the Job resource record or in the console run command. This record is required.

Address = <address>

Where the address is a host name, a fully qualified domain name, or a network address in dotted quad notation for a Bacula File server daemon. This record is required.

FD Port = <port-number>

Where the port is a port number at which the Bacula File server daemon can be contacted. The default is 9102.

Catalog = <Catalog-resource-name>

This specifies the name of the catalog resource to be used for this Client. This record is required.

Password = <password>

This is the password to be used when establishing a connection with the File services, so the Client configuration file on the machine to be backed up must have the same password defined for this Director. This record is required. If you have either **/dev/random** or **/dev/urandom** on your machine, Bacula will generate a random password during the configuration process, otherwise it will be left blank.

File Retention = <time-period-specification>

The File Retention record defines the length of time that Bacula will keep File records in the Catalog database. When this time period expires, and if **AutoPrune** is set to **yes** Bacula will prune (remove) File records that are older than the specified File Retention period. Note, this affects only records in the catalog database. It does not effect your archive backups.

File records may actually be retained for a shorter period than you specify on this record if you specify either a shorter **Job Retention** or shorter **Volume Retention** period. The shortest retention period of the three takes precedence. The time may be expressed in seconds, minutes, hours, days, weeks, months, quarters, or years. See the [Configuration chapter](#) of this manual for additional details of time specification.

The default is 60 days.

Job Retention = <time-period-specification>

The Job Retention record defines the length of time that Bacula will keep Job records in the Catalog database. When this time period expires, and if **AutoPrune** is set to **yes** Bacula will prune (remove) Job records that are older than the specified File Retention period. As with the other retention periods, this affects only records in the catalog and not data in your archive backup.

If a Job record is selected for pruning, all associated File and JobMedia records will also be pruned regardless of the File Retention period set. As a consequence, you normally will set the File retention period to be less than the Job retention period. The Job retention period can actually be less than the value you specify here if you set the

Volume Retention record in the Pool resource to a smaller duration. This is because the Job retention period and the Volume retention period are independently applied, so the smaller of the two takes precedence.

The Job retention period is specified as seconds, minutes, hours, days, weeks, months, quarters, or years. See the [Configuration chapter](#) of this manual for additional details of time specification.

The default is 180 days.

AutoPrune = <yes/no>

If AutoPrune is set to **yes** (default), Bacula (version 1.20 or greater) will automatically apply the File retention period and the Job retention period for the Client at the end of the Job. If you set **AutoPrune** = **no**, pruning will not be done, and your Catalog will grow in size each time you run a Job. Pruning affects only information in the catalog and not data stored in the backup archives (on Volumes).

Maximum Concurrent Jobs = <number>

where <number> is the maximum number of Jobs with the current Client that can run concurrently. Note, this record limits only Jobs for Clients with the same name as the resource in which it appears. Any other restrictions on the maximum concurrent jobs such as in the Director, Job, or Storage resources will also apply in addition to any limit specified here. The default is set to 1, but you may set it to a larger number. We strongly recommend that you read the WARNING documented under [Maximum Concurrent Jobs](#) in the Director's resource.

**Priority* = <number>

The number specifies the priority of this client relative to other clients that the Director is processing simultaneously. The priority can range from 1 to 1000. The clients are ordered such that the smaller number priorities are performed first (not currently implemented).

The following is an example of a valid Client resource definition:

```
Client {
  Name = Minimatou
  Address = minimatou
  Catalog = MySQL
  Password = very_good
}
```

The Storage Resource

The Storage resource defines which Storage daemons are available for use by the Director.

Storage

Start of the Storage records. At least one storage resource must be specified.

Name = <name>

The name of the storage resource. This name appears on the Storage record specified in the Job record and is required.

Address = <address>

Where the address is a host name, a **fully qualified domain name**, or an **IP address**. Please note that the <address> as specified here will be transmitted to the File daemon who will then use it to contact the Storage daemon. Hence, it is **not**, a good idea to use **localhost** as the name but rather a fully qualified machine name or an IP address. This record is required.

SD Port = <port>

Where port is the port to use to contact the storage daemon for information and to start jobs. This same port number must appear in the Storage resource of the Storage daemon's configuration file. The default is 9103.

Password = <password>

This is the password to be used when establishing a connection with the Storage services. This same password also must appear in the Director resource of the Storage daemon's configuration file. This record is required. If you have either **/dev/random** or **/dev/urandom** on your machine, Bacula will generate a random password during the configuration process, otherwise it will be left blank.

Device = <device-name>

This record specifies the name of the device to be used to for the storage. This name is not the physical device name, but the logical device name as defined on the **Name** record contained in the **Device** resource definition of the **Storage daemon** configuration file. You can specify any name you would like (even the device name if you prefer) up to a maximum of 127 characters in length. The physical device name associated with this device is specified in the **Storage daemon** configuration file (as **Archive Device**). Please take care not to define two different Storage resource records in the Director that point to the same Device in the Storage daemon. Doing so may cause the Storage daemon to block (or hang) attempting to open the same device that is already open. This record is required.

Media Type = <MediaType>

This record specifies the Media Type to be used to store the data. This is an arbitrary string of characters up to 127 maximum that you define. It can be anything you want. However, it is best to make it descriptive of the storage media (e.g. File, DAT, "HP DLT8000", 8mm, ...). In addition, it is essential that you make the **Media Type** specification unique for each storage media type. If you have two DDS-4 drives that have incompatible formats, or if you have a DDS-4 drive and a DDS-4 autochanger, you almost certainly should specify different **Media Types**. For the moment, this distinction is not very critical, but in a later version of Bacula, it will be able to mount any Volume with **Media Type DDS-4** on any drive that supports **DDS-4**. The **MediaType** specified here, **must** correspond to the **Media Type** specified in the **Device** resource of the **Storage daemon** configuration file. This record is required, and it is used by the Director and the Storage daemon to ensure that a Volume automatically selected from the Pool corresponds to the physical device. If a Storage daemon handles

multiple devices (e.g. will write to various file Volumes on different partitions), this record allows you to specify exactly which device.

As mentioned above, the value specified in the Director's Storage resource must agree with the value specified in the Device resource in the **Storage daemon's** configuration file. It is also an additional check so that you don't try to write data for a DLT onto an 8mm device.

Autochanger = <yes/no>

If you specify **yes** for this command (the default is **no**), when you use the **label** command or the **add** command to create a new Volume, **Bacula** will also request the Autochanger Slot number. This simplifies creating database entries for Volumes in an autochanger. If you forget to specify the Slot, the autochanger will not be used. However, you may modify the Slot associated with a Volume at any time by using the **update volume** command in the console program. When **autochanger** is enabled, the algorithm used by Bacula to search for available volumes will be modified to consider only Volumes that are known to be in the autochanger's magazine. If no **in changer** volume is found, Bacula will attempt recycling, pruning, ..., and if still no volume is found, Bacula will search for any volume whether or not in the magazine. By privileging in changer volumes, this procedure minimizes operator intervention. The default is **no**. For the autochanger to be used, you must also specify **Autochanger = yes** in the [Device Resource](#) in the Storage daemon's configuration file as well as other important Storage daemon configuration information. Please consult the [Using Autochangers](#) manual of this chapter for the details of using autochangers.

Maximum Concurrent Jobs = <number>

where <number> is the maximum number of Jobs with the current Storage resource that can run concurrently. Note, this record limits only Jobs for Jobs using this Storage daemon. Any other restrictions on the maximum concurrent jobs such as in the Director, Job, or Client resources will also apply in addition to any limit specified here. The default is set to 1, but you may set it to a larger number. We strongly recommend that you read the WARNING documented under [Maximum Concurrent Jobs](#) in the Director's resource.

While it is possible to set the Director's, Job's, or Client's maximum concurrent jobs greater than one, you should take great care in setting the Storage daemon's greater than one. By keeping this record set to one, you will avoid having two jobs simultaneously write to the same Volume. Although this is supported, it is not currently recommended.

The following is an example of a valid Storage resource definition:

```
# Definition of tape storage device
Storage {
    Name = DLTDrive
    Address = lpmatou
    Password = storage_password # password for Storage daemon
    Device = "HP DLT 80"        # same as Device in Storage daemon
    Media Type = DLT8000        # same as MediaType in Storage daemon
}
```

The Pool Resource

The Pool resource defines the set of storage Volumes (tapes or files) to be used by Bacula to write the data. By configuring different Pools, you can determine which set of Volumes (media) receives the backup data. This permits, for example, to store all full backup data on one set of Volumes and all incremental backups on another set of Volumes. Alternatively, you could assign a different set of Volumes to each machine that you backup. This is most easily done by defining multiple Pools.

Another important aspect of a Pool is that it contains the default attributes (Maximum Jobs, Retention Period, Recycle flag, ...) that will be given to a Volume when it is created. This avoids the need for you to answer a large number of questions when labeling a new Volume. Each of these attributes can later be changed on a Volume by Volume basis using the **update** command in the console program. Note that you must explicitly specify which Pool Bacula is to use with each Job. Bacula will not automatically search for the correct Pool.

Most often in Bacula installations all backups for all machines (Clients) go to a single set of Volumes. In this case, you will probably only use the **Default** Pool. If your backup strategy calls for you to mount a different tape each day, you will probably want to define a separate Pool for each day. For more information on this subject, please see the [Backup Strategies](#) chapter of this manual.

To use a Pool, there are three distinct steps. First the Pool must be defined in the Director's configuration file. Then the Pool must be written to the Catalog database. This is done automatically by the Director each time that it starts, or alternatively can be done using the **create** command in the console program. Finally, if you change the Pool definition in the Director's configuration file and restart Bacula, the pool will be updated alternatively you can use the **update pool** console command to refresh the database image. It is this database image rather than the Director's resource image that is used for the default Volume attributes. Note, for the pool to be automatically created or updated, it must be explicitly referenced by a Job resource.

Next the physical media must be labeled. The labeling can either be done with the **label** command in the **console** program or using the **btape** program. The preferred method is to use the **label** command in the **console** program.

Finally, you must add Volume names (and their attributes) to the Pool. For Volumes to be used by Bacula they must be of the same **Media Type** as the archive device specified for the job (i.e. if you are going to back up to a DLT device, the Pool must have DLT volumes defined since 8mm volumes cannot be mounted on a DLT drive). The **Media Type** has particular importance if you are backing up to files. When running a Job, you must explicitly specify which Pool to use. Bacula will then automatically select the next Volume to use from the Pool, but it will ensure that the **Media Type** of any Volume selected from the Pool is identical to that required by the Storage resource you have specified for the Job.

If you use the **label** command in the console program to label the Volumes, they will automatically be added to the Pool, so this last step is not normally required.

It is also possible to add Volumes to the database without explicitly labeling the physical volume. This is done with the **add** console command.

As previously mentioned, each time Bacula starts, it scans all the Pools associated with each Catalog, and if the database record does not already exist, it will be created from the Pool Resource definition. **Bacula** probably should do an **update pool** if you change the Pool definition, but currently, you must do this manually using the **update pool** command in the Console program.

The Pool Resource defined in the Director's configuration file (bacula-dir.conf) may contain the following records:

Pool

Start of the Pool records. There must be at least one Pool resource defined.

Name = <name>

The name of the pool. For most applications, you will use the default pool name **Default**. This record is required.

Number of Volumes = <number>

This record specifies the number of volumes (tapes or files) contained in the pool. Normally, it is defined and updated automatically by the Bacula catalog handling routines.

Maximum Volumes = <number>

This record specifies the maximum number of volumes (tapes or files) contained in the pool. This record is optional, if omitted or set to zero, any number of volumes will be permitted. In general, this record is useful for Autochangers where there is a fixed number of Volumes, or for File storage where you wish to ensure that the backups made to disk files do not become too numerous or consume too much space.

Pool Type = <type>

This record defines the pool type, which corresponds to the type of Job being run. It is required and may be one of the following:

- ◇ **Backup**
- ◇ ***Archive**
- ◇ ***Cloned**
- ◇ ***Migration**
- ◇ ***Copy**
- ◇ ***Save**

Use Volume Once = <yes/no>

This record if set to **yes** specifies that each volume is to be used only once. This is most useful when the Media is a file and you want a new file for each backup that is done. The default is **no** (i.e. use volume any number of times). This record will most likely be phased out (deprecated), so you are recommended to use **Maximum Volume Jobs = 1** instead.

Maximum Volume Jobs = <positive-integer>

This record specifies the maximum number of Jobs that can be written to the Volume. If you specify zero (the default), there is no limit. Otherwise, when the number of Jobs backed up to the Volume equals **positive-integer** the Volume will be marked **Used**. When the Volume is marked **Used** it can no longer be used for appending Jobs, much like the **Full** status but it can be recycled if recycling is enabled. By setting **MaximumVolumeJobs** to one, you get the same effect as setting **UseVolumeOnce = yes**.

Maximum Volume Files = <positive-integer>

This record specifies the maximum number of files that can be written to the Volume. If you specify zero (the default), there is no limit. Otherwise, when the number of files written to the Volume equals **positive-integer** the Volume will be marked **Used**. When

the Volume is marked **Used** it can no longer be used for appending Jobs, much like the **Full** status but it can be recycled if recycling is enabled. This value is checked and the **Used** status is set only at the end of a job that writes to the particular volume.

Maximum Volume Bytes = <size>

This record specifies the maximum number of bytes that can be written to the Volume. If you specify zero (the default), there is no limit except the physical size of the Volume. Otherwise, when the number of bytes written to the Volume equals **size** the Volume will be marked **Used**. When the Volume is marked **Used** it can no longer be used for appending Jobs, much like the **Full** status but it can be recycled if recycling is enabled. This value is checked and the **Used** status set while the job is writing to the particular volume.

Volume Use Duration = <time-period-specification>

The Volume Use Duration record defines the time period that the Volume can be written beginning from the time of first data write to the Volume. If the time-period specified is zero (the default), the Volume can be written indefinitely. Otherwise, when the time period from the first write to the volume (the first Job written) exceeds the time-period-specification, the Volume will be marked **Used**, which means that no more Jobs can be appended to the Volume, but it may be recycled if recycling is enabled. You might use this record, for example, if you have a Volume used for Incremental backups, and Volumes used for Weekly Full backups. Once the Full backup is done, you will want to use a different Incremental Volume. This can be accomplished by setting the Volume Use Duration for the Incremental Volume to six days. I.e. it will be used for the 6 days following a Full save, then a different Incremental volume will be used.

This value is checked and the **Used** status is set only at the end of a job that writes to the particular volume, which means that even though the use duration may have expired, the catalog entry will not be updated until the next job that uses this volume is run.

Catalog Files = <yes/no>

This record defines whether or not you want the names of the files that were saved to be put into the catalog. The default is **yes**. The advantage of specifying **Catalog Files = No** is that you will have a significantly smaller Catalog database. The disadvantage is that you will not be able to produce a Catalog listing of the files backed up for each Job (this is often called Browsing).

AutoPrune = <yes/no>

If AutoPrune is set to **yes** (default), Bacula (version 1.20 or greater) will automatically apply the Volume Retention period when new Volume is needed and no appendable Volumes exist in the Pool. Volume pruning causes expired Jobs (older than the **Volume Retention** period) to be deleted from the Catalog and permits possible recycling of the Volume.

Volume Retention = <time-period-specification>

The Volume Retention record defines the length of time that **Bacula** will keep Job records associated with the Volume in the Catalog database. When this time period expires, and if **AutoPrune** is set to **yes** Bacula will prune (remove) Job records that are older than the specified Volume Retention period. All File records associated with pruned Jobs are also pruned. The time may be specified as seconds, minutes, hours, days, weeks, months, quarters, or years. The **Volume Retention** applied independently to the **Job Retention** and the **File Retention** periods defined in the Client resource. This means that the shorter period is the one that applies. Note, that when the **Volume Retention** period has been reached, it will prune both the Job and the File records.

The default is 365 days. Note, this record sets the default value for each Volume entry in the Catalog when the Volume is created. The value in the catalog may be later individually changed for each Volume using the Console program.

By defining multiple Pools with different Volume Retention periods, you may effectively have a set of tapes that is recycled weekly, another Pool of tapes that is recycled monthly and so on. However, one must keep in mind that if your **Volume Retention** period is too short, it may prune the last valid Full backup, and hence until the next Full backup is done, you will not have a complete backup of your system, and in addition, the next Incremental or Differential backup will be promoted to a Full backup. As a consequence, the minimum **Volume Retention** period should be at twice the interval of your Full backups. This means that if you do a Full backup once a month, the minimum Volume retention period should be two months.

Recycle = <yes/no>

This record specifies the default for recycling Purged Volumes. If it is set to **yes** and Bacula needs a volume but finds none that are appendable, it will search for Purged Volumes (i.e. volumes with all the Jobs and Files expired and thus deleted from the Catalog). If the Volume is recycled, all previous data written to that Volume will be overwritten.

Recycle Oldest Volume = <yes/no>

This record instructs the Director to search for the oldest used Volume in the Pool when another Volume is requested by the Storage daemon and none are available. The catalog is then **pruned** respecting the retention periods of all Files and Jobs written to this Volume. If all Jobs are pruned (i.e. the volume is Purged), then the Volume is recycled and will be used as the next Volume to be written. This record respects any Job, File, or Volume retention periods that you may have specified, and as such it is **much** better to use this record than the Purge Oldest Volume.

This record can be useful if you have a fixed number of Volumes in the Pool and you want to cycle through them and you have specified the correct retention periods.

Recycle Current Volume = <yes/no>

If Bacula needs a new Volume, this record instructs Bacula to Prune the volume respecting the Job and File retention periods. If all Jobs are pruned (i.e. the volume is Purged), then the Volume is recycled and will be used as the next Volume to be written. This record respects any Job, File, or Volume retention periods that you may have specified, and thus it is **much** better to use it rather than the Purge Oldest Volume record. This record can be useful if you have: a fixed number of Volumes in the Pool, you want to cycle through them, and you have specified retention periods that prune Volumes before you have cycled through the Volume in the Pool.

Purge Oldest Volume = <yes/no>

This record instructs the Director to search for the oldest used Volume in the Pool when another Volume is requested by the Storage daemon and none are available. The catalog is then **purged** irrespective of retention periods of all Files and Jobs written to this Volume. The Volume is then recycled and will be used as the next Volume to be written. This record overrides any Job, File, or Volume retention periods that you may have specified.

This record can be useful if you have a fixed number of Volumes in the Pool and you want to cycle through them and when all Volumes are full, but you don't want to worry about setting proper retention periods. However, by using this option you risk losing

valuable data.

Please be aware that Purge Oldest Volume disregards all retention periods. If you have only a single Volume defined and you turn this variable on, that Volume will always be immediately overwritten when it fills! So at a minimum, ensure that you have a decent number of Volumes in your Pool before running any jobs. If you want retention periods to apply do not use this record. To specify a retention period, use the **Volume Retention** record (see above).

I highly recommend against using this record, because it is sure that some day, Bacula will recycle a Volume that contains current data.

Accept Any Volume = <yes/no>

This record specifies whether or not any volume from the Pool may be used for backup. The default is **yes** as of version 1.27 and later. If it is **no** then only the first writable volume in the Pool will be accepted for writing backup data, thus Bacula will fill each Volume sequentially in turn before using any other appendable volume in the Pool. If this is **no** and you mount a volume out of order, Bacula will not accept it. If this is **yes** any appendable volume from the pool mounted will be accepted.

If your tape backup procedure dictates that you manually mount the next volume, you will almost certainly want to be sure this record is turned on.

If you are going on vacation and you think the current volume may not have enough room on it, you can simply label a new tape and leave it in the drive, and assuming that **Accept Any Volume** is **yes** Bacula will begin writing on it. When you return from vacation, simply remount the last tape, and Bacula will continue writing on it until it is full. Then you can remount your vacation tape and Bacula will fill it in turn.

Cleaning Prefix = <string>

This record defines a prefix string, which if it matches the beginning of a Volume name during labeling of a Volume, the Volume will be defined with the VolStatus set to **Cleaning** and thus Bacula will never attempt to use this tape. This is primarily for use with autochangers that accept barcodes where the convention is that barcodes beginning with **CLN** are treated as cleaning tapes.

Label Format = <format>

This record specifies the format of the labels contained in this pool. The format record is used as a sort of template to create new Volume names during automatic Volume labeling.

The **format** should be specified in double quotes, and consists of letters, numbers and the special characters hyphen (-), underscore (_), colon (:), and period (.), which are the legal characters for a Volume name. The **format** should be enclosed in double quotes (").

In addition, the format may contain a number of variable expansion characters which will be expanded by a complex algorithm allowing you to create Volume names of many different formats. In all cases, the expansion process must resolve to the set of characters noted above that are legal Volume names. Generally, these variable expansion characters begin with a dollar sign (\$) or a left bracket ([). If you specify variable expansion characters, you should always enclose the format with double quote characters ("). For more details on variable expansion, please see the [Variable Expansion](#) Chapter of this manual.

If no variable expansion characters are found in the string, the Volume name will be formed from the **format** string appended with the number of volumes in the pool plus one, which will be edited as four digits with leading zeros. For example, with a **Label Format = "File–"**, the first volumes will be named **File–0001**, **File–0002**, ...

With the exception of Job specific variables, you can test your **LabelFormat** by using the [var command](#) the Console Chapter of this manual.

In almost all cases, you should enclose the format specification (part after the equal sign) in double quotes.

In order for a Pool to be used during a Backup Job, the Pool must have at least one Volume associated with it. Volumes are created for a Pool using the **label** or the **add** commands in the **Bacula Console**, program. In addition to adding Volumes to the Pool (i.e. putting the Volume names in the Catalog database), the physical Volume must be labeled with valid Bacula software volume label before **Bacula** will accept the Volume. This will be automatically done if you use the **label** command. Bacula can automatically label Volumes if instructed to do so, but this feature is not yet fully implemented.

The following is an example of a valid Pool resource definition:

```
Pool {  
    Name = Default  
    Pool Type = Backup  
}
```

The Catalog Resource

The Catalog Resource defines what catalog to use for the current job. Currently, Bacula can only handle a single database server (SQLite, MySQL, built-in) that is defined when configuring **Bacula**. However, there may be as many Catalogs (databases) defined as you wish. For example, you may want each Client to have its own Catalog database, or you may want backup jobs to use one database and verify or restore jobs to use another database.

Catalog

Start of the Catalog records. At least one Catalog resource must be defined.

Name = <name>

The name of the Catalog. No necessary relation to the database server name. This name will be specified in the Client resource record indicating that all catalog data for that Client is maintained in this Catalog. This record is required.

password = <password>

This specifies the password to use when logging into the database. This record is required.

DB Name = <name>

This specifies the name of the database. If you use multiple catalogs (databases), you specify which one here. If you are using an external database server rather than the internal one, you must specify a name that is known to the server (i.e. you explicitly created the Bacula tables using this name. This record is required.

user = <user>

This specifies what user name to use to log into the database. This record is required.

DB Socket = <socket-name>

This is the name of a socket to use on the local host to connect to the database. This record is used only by MySQL and is ignored by SQLite. Normally, if neither **DB Socket** or **DB Address** are specified, MySQL will use the default socket.

DB Address = <address>

This is the host address of the database server. Normally, you would specify this instead of **DB Socket** if the database server is on another machine. In that case, you will also specify **DB Port**. This record is used only by MySQL and is ignored by SQLite if provided. This record is optional.

DB Port = <port>

This defines the port to be used in conjunction with **DB Address** to access the database if it is on another machine. This record is used only by MySQL and is ignored by SQLite if provided. This record is optional.

The following is an example of a valid Catalog resource definition:

```
Catalog
{
    Name = SQLite
    dbname = bacula;
    user = bacula;
    password = ""                                # no password = no security
}
```

or for a Catalog on another machine:

```
Catalog
```

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```
{  
  Name = MySQL  
  dbname = bacula  
  user = bacula  
  password = ""  
  DB Address = remote.acme.com  
  DB Port = 1234  
}
```

The Messages Resource

For the details of the Messages Resource, please see the [Messages Resource Chapter](#) of this manual.

The Console Resource

As of Bacula version 1.33 and higher, there are three different kinds of consoles, which the administrator or user can use to interact with the Director. These three kinds of consoles comprise three different security levels.

- The first console type is an **anonymous** or **default** console, which has full privileges. There is no console resource necessary for this type since the password is specified in the Director's resource and consequently such consoles do not have an name as defined on a **Name =** directive. This is the kind of console that was initially implemented in versions prior to 1.33 and remains valid. Typically you would use it only for administrators.
- The second type of console, and new to version 1.33 and higher is a "named" console defined within a Console resource in both the Director's configuration file and in the Console's configuration file. Both the names and the passwords in these two entries must match much as is the case for Client programs.

This second type of console begins with absolutely no privileges except those explicitly specified in the Director's Console resource. Thus you can have multiple Consoles with different names and passwords, sort of like multiple users, each with different privileges. As a default, these consoles can do absolutely nothing — no commands what so ever. You give them privileges or rather access to commands and resources by specifying access control lists in the Director's Console resource. The ACLs are specified by a directive followed by a list of access names. Examples of this are shown below.

- The third type of console is similar to the above mentioned one in that it requires a Console resource definition in both the Director and the Console. In addition, if the console name, provided on the **Name =** directive, is the same as a Client name, that console is permitted to use the **SetIP** command to change the Address directive in the Director's client resource to the IP address of the Console. This permits portables or other machines using DHCP (non-fixed IP addresses) to "notify" the Director of their current IP address.

The Console resource is optional and need not be specified. The following directives are permitted within the Director's configuration resource:

Name = <name>

The name of the console. This name must match the name specified in the Console's configuration resource (much as is the case with Client definitions).

Password = <password>

Specifies the password that must be supplied for a named Bacula Console to be authorized. The same password must appear in the **Console** resource of the Console configuration file. For added security, the password is never actually passed across the network but rather a challenge response hash code created with the password. This record is required. If you have either **/dev/random** or **/dev/urandom** on your machine, Bacula will generate a random password during the configuration process, otherwise it will be left blank.

JobACL = <name-list>

This directive is used to specify a list of Job resource names that can be accessed by the console. Without this directive, the console cannot access any of the Director's Job resources. Multiple Job resource names may be specified by separating them with

commas, and/or by specifying multiple JobACL directives. For example, the directive may be specified as:

```
JobACL = kernsave, "Backup client 1", "Backup client 2"  
JobACL = "RestoreFiles"
```

With the above specification, the console can access the Director's resource records for the four jobs named on the JobACL directives.

ClientACL = <name-list>

This directive is used to specify a list of Client resource names that can be accessed by the console.

StorageACL = <name-list>

This directive is used to specify a list of Storage resource names that can be accessed by the console.

ScheduleACL = <name-list>

This directive is used to specify a list of Schedule resource names that can be accessed by the console.

PoolACL = <name-list>

This directive is used to specify a list of Pool resource names that can be accessed by the console.

FileSetACL = <name-list>

This directive is used to specify a list of FileSet resource names that can be accessed by the console.

CatalogACL = <name-list>

This directive is used to specify a list of Catalog resource names that can be accessed by the console.

CommandACL = <name-list>

This directive is used to specify a list of console commands that can be executed by the console.

Aside from Director resource names and console command names, the special keyword ***all*** can be specified in any of the above access control lists. When this keyword is present, any resource or command name (which ever is appropriate) will be accepted.

The Counter Resource

The Counter Resource defines a counter variable that can be accessed by variable expansion used for creating Volume labels with the **LabelFormat** record. See the [LabelFormat](#) record in this chapter for more details.

Counter

Start of the Counter record. Counter records are optional.

Name = *<name>*

The name of the Counter. This is the name you will use in the variable expansion to reference the counter value.

Minimum = *<integer>*

This specifies the minimum value that the counter can have. It also becomes the default. If not supplied, zero is assumed.

Maximum = *<integer>*

This is the maximum value value that the counter can have. If not specified or set to zero, the counter can have a maximum value of 2,147,483,648 (2 to the 31 power). When the counter is incremented past this value, it is reset to the Minimum.

**WrapCounter* = *<counter-name>*

If this value is specified, when the counter is incremented past the maximum and thus reset to the minimum, the counter specified on the **WrapCounter** is incremented. (This is not currently implemented).

Catalog = *<catalog-name>*

If this record is specified, the counter and its values will be saved in the specified catalog. If this record is not present, the counter will be redefined each time that Bacula is started.

A Complete Example Director Configuration File

An example Director configuration file might be the following:

```
#
# Default Bacula Director Configuration file
#
# The only thing that MUST be changed is to add one or more
# file or directory names in the Include directive of the
# FileSet resource.
#
# For Bacula release 1.15 (5 March 2002) -- redhat
#
# You might also want to change the default email address
# from root to your address. See the "mail" and "operator"
# directives in the Messages resource.
#

Director {                                \# define myself
    Name = rufus-dir
    QueryFile = "/home/kern/bacula/bin/query.sql"
    WorkingDirectory = "/home/kern/bacula/bin/working"
    PidDirectory = "/home/kern/bacula/bin/working"
    Password = "XkSfzu/Cf/wX4L8Zh4G4/yhCbPLcz3YVdmVoQvU3EyF/"
}

# Define the backup Job
Job {
    Name = "NightlySave"
    Type = Backup
    Level = Incremental                # default
    Client=rufus-fd
    FileSet="Full Set"
    Schedule = "WeeklyCycle"
    Storage = DLTDrive
    Messages = Standard
    Pool = Default
}

Job {
    Name = "Restore"
    Type = Restore
    Client=rufus-fd
    FileSet="Full Set"
    Where = /tmp/bacula-restores
    Storage = DLTDrive
    Messages = Standard
    Pool = Default
}

# List of files to be backed up
FileSet {
    Name = "Full Set"
    Include = signature=SHA1 {
#
# Put your list of files here, one per line or include an
```

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```
# external list with:
#
# @file-name
#
# Note: / backs up everything

/

}
Exclude = { }
}

# When to do the backups
Schedule {
    Name = "WeeklyCycle"
    Run = Full sun at 1:05
    Run = Incremental mon-sat at 1:05
}

# Client (File Services) to backup
Client {
    Name = rufus-fd
    Address = rufus
    Catalog = MyCatalog
    Password = "MQk6lVinz4GG2hdIZkldsKE/LxMZGo6znMHiD7t7vzF+"
    File Retention = 60d      # sixty day file retention
    Job Retention = 1y        # 1 year Job retention
    AutoPrune = yes          # Auto apply retention periods
}

# Definition of DLT tape storage device
Storage {
    Name = DLTDDrive
    Address = rufus
    Password = "jMeWZvfikUHvt3kzKVVPpQ0ccmV6emPnF2cPYFdhLApQ"
    Device = "HP DLT 80"      # same as Device in Storage daemon
    Media Type = DLT8000      # same as MediaType in Storage daemon
}

# Definition of DDS tape storage device
Storage {
    Name = SDT-10000
    Address = rufus
    Password = "jMeWZvfikUHvt3kzKVVPpQ0ccmV6emPnF2cPYFdhLApQ"
    Device = SDT-10000        # same as Device in Storage daemon
    Media Type = DDS-4        # same as MediaType in Storage daemon
}

# Definition of 8mm tape storage device
Storage {
    Name = "8mmDrive"
    Address = rufus
    Password = "jMeWZvfikUHvt3kzKVVPpQ0ccmV6emPnF2cPYFdhLApQ"
    Device = "Exabyte 8mm"
    MediaType = "8mm"
}

# Definition of file storage device
Storage {
    Name = File
```

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```
Address = rufus
Password = "jMeWZvfikUHvt3kzKVVPpQ0ccmV6emPnF2cPYFdhLApQ"
Device = FileStorage
Media Type = File
}

# Generic catalog service
Catalog {
    Name = MyCatalog
    dbname = bacula; user = bacula; password = ""
}

# Reasonable message delivery -- send most everything to
# the email address and to the console
Messages {
    Name = Standard
    mail = root@localhost = all, !skipped, !terminate
    operator = root@localhost = mount
    console = all, !skipped, !saved
}

# Default pool definition
Pool {
    Name = Default
    Pool Type = Backup
    AutoPrune = yes
    Recycle = yes
}
```



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General

The Client (or File Daemon) Configuration is one of the simpler ones to specify. Generally, other than changing the Client name so that error messages are easily identified, you will not need to modify the default Client configuration file.

For a general discussion of configuration file and resources including the data types recognized by **Bacula**, please see the [Configuration](#) chapter of this manual. The following Client Resource definitions must be defined:

- [Client](#) — to define what Clients are to be backed up.
- [Director](#) — to define the Director's name and its access password.
- [Messages](#) — to define where error and information messages are to be sent.

The Client Resource

The Client Resource (or FileDaemon) resource defines the name of the Client (as used by the Director) as well as the port on which the Client listens for Director connections.

Client (or FileDaemon)

Start of the Client records. There must be one and only one Client resource in the configuration file, since it defines the properties of the current client program.

Name = <name>

The client name that must be used by the Director when connecting. Generally, it is a good idea to use a name related to the machine so that error messages can be easily identified if you have multiple Clients. This record is required.

Working Directory = <Directory>

This directive is mandatory and specifies a directory in which the File daemon may put its status files. This directory should be used only by **Bacula**, but may be shared by other Bacula daemons. This record is required

Pid Directory = <Directory>

This directive is mandatory and specifies a directory in which the Director may put its process Id file files. The process Id file is used to shutdown Bacula and to prevent multiple copies of Bacula from running simultaneously. This record is required. Standard shell expansion of the **Directory** is done when the configuration file is read so that values such as **\$HOME** will be properly expanded.

Typically on Linux systems, you will set this to: **/var/run**. If you are not installing Bacula in the system directories, you can use the **Working Directory** as defined above.

Heartbeat Interval = <time-interval>

This record defines an interval of time. For each heartbeat that the File daemon receives from the Storage daemon, it will forward it to the Director. In addition, if no heartbeat has been received from the Storage daemon and thus forwarded the File daemon will send a heartbeat signal to the Director and to the Storage daemon to keep the channels active. The default interval is zero which disables the heartbeat. This feature is particularly useful if you have a router such as 3Com that does not follow Internet standards and times out an inactive connection after a short duration.

Maximum Concurrent Jobs = <number>

where <number> is the maximum number of Jobs that should run concurrently. The default is set to 2, but you may set it to a larger number. Each contact from the Director (e.g. status request, job start request) is considered as a Job, so if you want to be able to do a **status** request in the console at the same time as a Job is running, you will need to set this value greater than 1.

FDPort = <port-number>

This specifies the port number on which the Client listens for Director connections. It must agree with the FDPort specified in the Client resource of the Director's configuration file. The default is 9102.

FDAddress = <IP-Address>

This record is optional, and if it is specified, it will cause the File daemon server (for Director connections) to bind to the specified **IP-Address**, which is either a domain name or an IP address specified as a dotted quadruple. If this record is not specified, the File daemon will bind to any available address (the default).

SDConnectTimeout = <time-interval>

This record defines an interval of time that the File daemon will try to connect to the Storage daemon. The default is 30 minutes. If no connection is made in the specified time interval, the File daemon cancels the Job.

Maximum Network Buffer Size = <bytes>

where <bytes> specifies the initial network buffer size to use with the File daemon. This size will be adjusted down if it is too large until it is accepted by the OS. Please use care in setting this value since if it is too large, it will be trimmed by 512 bytes until the OS is happy, which may require a large number of system calls. The default value is 32,768 bytes.

The following is an example of a valid Client resource definition:

```
Client {                                # this is me
    Name = rufus-fd
    WorkingDirectory = $HOME/bacula/bin/working
    Pid Directory = $HOME/bacula/bin/working
}
```

The Director Resource

The Director resource defines the name and password of the Directors that are permitted to contact this Client.

Director

Start of the Director records. There may be any number of Director resources in the Client configuration file. Each one specifies a Director that is allowed to connect to this Client.

Name = <name>

The name of the Director that may contact this Client. This name must be the same as the name specified on the Director resource in the Director's configuration file. This record is required.

Password = <password>

Specifies the password that must be supplied for a Director to be authorized. This password must be the same as the password specified in the Client resource in the Director's configuration file. This record is required.

Thus multiple Directors may be authorized to use this Client's services. Each Director will have a different name, and normally a different password as well.

The following is an example of a valid Director resource definition:

```
#
# List Directors who are permitted to contact the File daemon
#
Director {
    Name = HeadMan
    Password = very_good          \# password HeadMan must supply
}

Director {
    Name = Worker
    Password = not_as_good
}
```


The Message Resource

Please see the [Messages Resource](#) Chapter of this manual for the details of the Messages Resource.

There must be at least one Message resource in the Client configuration file.

Example Client Configuration File

An example File Daemon configuration file might be the following:

```
#
# Default Bacula File Daemon Configuration file
#
# For Bacula release 1.15 (5 March 2002) -- redhat 7.1
#
# There is not much to change here except perhaps to
#   set the Director's name and File daemon's name
#   to something more appropriate for your site.
#

#
# List Directors who are permitted to contact this File daemon
#
Director {
    Name = rufus-dir
    Password = "/LqPRkX++saVyQE7w7mmiFg/qxYclkuFww6FEyY/47jU"
}

#
# "Global" File daemon configuration specifications
#
FileDaemon {                                \# this is me
    Name = rufus-fd
    WorkingDirectory = $HOME/bacula/bin/working
    Pid Directory = $HOME/bacula/bin/working
}

# Send all messages except skipped files back to Director
Messages {
    Name = Standard
    director = rufus-dir = all, !skipped
}
```



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Storage Daemon Configuration

General

The Storage Daemon configuration file has relatively few resource definitions. However, due to the great variation in backup media and system capabilities, the storage daemon must be highly configurable. As a consequence, there are quite a large number of record types in the Device Resource definition that allow you to define all the characteristics of your Storage device (normally a tape drive). Fortunately, with modern storage devices, very few records are actually needed.

Examples of **Device** resource records that are known to work for a number of common tape drives can be found in the `<bacula-src>/examples/devices` directory.

For a general discussion of configuration file and resources including the data types recognized by **Bacula**, please see the [Configuration](#) chapter of this manual. The following Storage Resource definitions must be defined:

- [Storage](#) — to define the name of the Storage daemon.
- [Director](#) — to define the Director's name and his access password.
- [Device](#) — to define the characteristics of your storage device (tape drive).
- [Messages](#) — to define where error and information messages are to be sent.

Storage Resource

In general, the properties specified under the Storage resource define global properties of the Storage daemon. Each Storage daemon configuration file must have one and only one Storage resource definition.

Name = `<Storage-Daemon-Name>`

Specifies the Name of the Storage daemon. This record is required.

Working Directory = `<Directory>`

This directive is mandatory and specifies a directory in which the Storage daemon may put its status files. This directory should be used only by **Bacula**, but may be shared by other Bacula daemons. This record is required

Pid Directory = `<Directory>`

This directive is mandatory and specifies a directory in which the Director may put its process Id file files. The process Id file is used to shutdown Bacula and to prevent multiple copies of Bacula from running simultaneously. This record is required. Standard shell expansion of the **Directory** is done when the configuration file is read so that values such as **\$HOME** will be properly expanded.

Typically on Linux systems, you will set this to: `/var/run`. If you are not installing Bacula in the system directories, you can use the **Working Directory** as defined above.

Heartbeat Interval = `<time-interval>`

This record defines an interval of time. When the Storage daemon is waiting for the operator to mount a tape, each time interval, it will send a heartbeat signal to the File daemon. The default interval is zero which disables the heartbeat. This feature is particularly useful if you have a router such as 3Com that does not follow Internet

standards and times out an inactive connection after a short duration.

Maximum Concurrent Jobs = *<number>*

where *<number>* is the maximum number of Jobs that should run concurrently. The default is set to 2, but you may set it to a larger number. Each contact from the Director (e.g. status request, job start request) is considered as a Job, so if you want to be able to do a **status** request in the console at the same time as a Job is running, you will need to set this value greater than 1.

SDPort = *<port-number>*

Specifies port number on which the Storage daemon listens for Director connections. The default is 9103.

SDAddress = *<IP-Address>*

This record is optional, and if it is specified, it will cause the Storage daemon server (for Director and File daemon connections) to bind to the specified **IP-Address**, which is either a domain name or an IP address specified as a dotted quadruple. If this record is not specified, the Storage daemon will bind to any available address (the default).

The following is a typical Storage daemon Storage definition.

```
#
# "Global" Storage daemon configuration specifications appear
# under the Storage resource.
#
Storage {
    Name = "Storage daemon"
    Address = localhost
    WorkingDirectory = "~/bacula/working"
    Pid    Directory = "~/bacula/working"
}
```

Director Resource

The Director resource specifies the Name of the Director which is permitted to use the services of the Storage daemon. There may be multiple Director resources. The Director Name and Password must match the corresponding values in the Director's configuration file.

Name = *<Director-Name>*

Specifies the Name of the Director allowed to connect to the Storage daemon. This record is required.

Password = *<Director-password>*

Specifies the password that must be supplied by the above named Director. This record is required.

The following is an example of a valid Director resource definition:

```
Director {
    Name = MainDirector
    Password = my_secret_password
}
```

Device Resource

The Device Resource specifies the details of each device (normally a tape drive) that can be used by the Storage daemon. There may be multiple Device resources for a single Storage daemon. In general, the properties specified within the Device resource are specific to the Device.

Name = Device-Name

Specifies the Name that the Director will use when asking to backup or restore to or from this device. This is the logical Device name, and may be any string up to 127 characters in length. It is generally a good idea to make it correspond to the English name of the backup device. The physical name of the device is specified on the **Archive Device** record described below. The name you specify here is also used in your Director's conf file on the [Device record](#) in its Storage resource.

Archive Device = name-string

The specified **name-string** gives the system file name of the storage device managed by this storage daemon. This will usually be the device file name of a removable storage device (tape drive), for example `"/dev/nst0"` or `"/dev/rmt/0mbn"`. It may also be a directory name if you are archiving to disk storage. When specifying a tape device, it is preferable that the "non-rewind" variant of the device file name be given. In addition, on systems such as Sun, which have modified the tape access methods, you must be sure to specify to use Berkeley I/O conventions with the device. The **b** in the Solaris (Sun) archive specification `/dev/rmt/0mbn` is what is needed in this case. Bacula does not support SysV tape drive behavior.

As noted above, normally the Archive Device is the name of a tape drive, but you may also specify a directory name. In that case, Bacula will write to file storage in the specified directory, and the filename used will be the Volume name as specified in the Catalog. If you want to write into more than one directory (i.e. to spread the load to different disk drives), you will need to define two Device resources, each containing an Archive Device with a different directory.

In addition to a tape device name or a directory name, Bacula will accept the name of a FIFO. A FIFO is a special kind of file that connects two programs via kernel memory. If a FIFO device is specified for a backup operation, you must have a program that reads what Bacula writes into the FIFO. When the Storage daemon starts the job, it will wait for **MaximumOpenWait** seconds for the read program to start reading, and then time it out and terminate the job. As a consequence, it is best to start the read program at the beginning of the job perhaps with the **RunBeforeJob** record. For this kind of device, you never want to specify **AlwaysOpen**, because you want the Storage daemon to open it only when a job starts, so you must explicitly set it to **No**. Since a FIFO is a one way device, Bacula will not attempt to read a label of a FIFO device, but will simply write on it. To create a FIFO Volume in the catalog, use the **add** command rather than the **label** command to avoid attempting to write a label.

During a restore operation, if the Archive Device is a FIFO, Bacula will attempt to read from the FIFO, so you must have an external program that writes into the FIFO. Bacula will wait **MaximumOpenWait** seconds for the program to begin writing and will then time it out and terminate the job. As noted above, you may use the **RunBeforeJob** to start the writer program at the beginning of the job.

The Archive Device record is required.

Media Type = name-string

The specified **name-string** names the type of media supported by this device, for example, "DLT7000". Media type names are arbitrary in that you set it to anything you want, but must be known to the volume database to keep track of which storage daemons can read which volumes. The same **name-string** must appear in the appropriate Storage resource definition in the Director's configuration file. Even though the names you assign are arbitrary (i.e. you choose the name you want), you should take care in specifying them because in a future version of Bacula, the Media Type can be used to determine which storage device Bacula should select. Thus you should probably use the same Media Type specification for all drives where the Media can be freely interchanged. You should also ensure to have unique Media Type names if the Media is not compatible between drives. This specification is required for all devices.

Autochanger = Yes/No

If **Yes**, this device is an automatic tape changer, and you should also specify a **Changer Device** as well as a **Changer Command**. If **No** (default), the volume must be manually changed. You might also want to add an identical record to the [Storage resource](#) in the Director's configuration file so that when labeling tapes you are prompted for the slot.

Changer Device = name-string

The specified **name-string** gives the system file name of the autochanger device name that corresponds to the **Archive Device** specified. This device name is specified only if you have an autochanger. Typically, you will want to specify the **generic scsi** device name. For example, on Linux systems, for archive device **/dev/nst0**. This record is optional. See the [Using Autochangers](#) chapter of this manual for more details of using this and the following autochanger records.

Changer Command = name-string

The **name-string** specifies an external program to be called that will automatically change volumes as required by **Bacula**. There are a number of substitution characters that may be specified to configure your autochanger. For additional details, please see the [Autochangers](#) chapter of this manual.

Drive Index = number

The **Drive Index** that you specify is passed to the **mtx-changer** script and is thus passed to the **mtx** program. By default, the Drive Index is zero, so if you have only one drive in your autochanger, everything will work normally. However, if you have multiple drives, you may specify two Bacula Device resources. The first will either set Drive Index to zero, or leave it unspecified, and the second Device Resource should contain a Drive Index set to 1. This will then permit you to use two or more drives in your autochanger. However, you must ensure that Bacula does not request the same Volume on both drives at the same time.

Maximum Changer Wait = time

This record specifies the maximum time for Bacula to wait for an autochanger to change the volume. If this time is exceeded, Bacula will invalidate the Volume slot number stored in the catalog and try again. If no additional changer volumes exist, Bacula will ask the operator to intervene. The default time out is 5 minutes.

Always Open = Yes/No

If **Yes** (default), Bacula will always keep the device open unless specifically **unmounted** by the Console program. This permits Bacula to ensure that the tape drive is always available. If you set **AlwaysOpen** to **no** Bacula will only open the drive when necessary, and at the end of the Job if no other Jobs are using the drive, it will be freed. To minimize unnecessary operator intervention, it is highly recommended that **Always Open = yes**. This also ensures that the drive is available when Bacula needs it. If you have **Always Open = yes** (recommended) and you want to use the drive for something else, simply use the **unmount** command in the Console program to release the drive. However, don't forget to remount the drive with **mount** when the drive is available or the next Bacula job will block.

For File storage, this record is ignored. For a FIFO storage device, you must set this to **No**.

Please note that if you set this directive to **No** Bacula will release the tape drive between each job, and thus the next job will rewind the tape and position it to the end of the data. This can be a very time consuming operation.

Volume Poll Interval = time

If a non-zero time interval is specified, Bacula will poll the device after asking the operator to mount a new volume to see if the new volume has been mounted. If the time interval is zero (the default), no polling will occur. This directive can be useful if you want to avoid operator intervention via the console. The operator can simply remove the old volume and insert the requested one, and Bacula will continue. Please be aware that if you set this interval to small, you may excessively wear your tape drive if the old tape remains in the drive since Bacula will read it on each poll. This could be avoided by using the **Offline On Unmount** and the **Close on Poll** directives.

Close on Poll= Yes/No

If **Yes**, Bacula close the device (equivalent to an unmount except no mount is required) and reopen it at each poll. Normally this is not too useful unless you have the **Offline on Unmount** directive set, in which case the drive will be taken offline preventing wear on the tape during any future polling. Once the operator inserts a new tape, Bacula will recognize the drive on the next poll and automatically continue with the backup.

Maximum Open Wait = time

This record specifies the maximum amount of time that Bacula will wait for a device that is busy. The default is 5 minutes. If the device cannot be obtained, the current Job will be terminated in error. Bacula will re-attempt to open the drive the next time a Job starts that needs the the drive.

Removable media = Yes/No

If **Yes**, this device supports removable media (for example, tapes or CDs). If **No**, media cannot be removed (for example, an intermediate backup area on a hard disk).

Random access = Yes/No

If **Yes**, the archive device is assumed to be a random access medium which supports the **lseek** (or **lseek64** if Largefile is enabled during configuration) facility.

Maximum block size = size-in-bytes

The Storage daemon will always attempt to write blocks of the specified **size-in-bytes** to the archive device. As a consequence, this statement specifies both the default block size and the maximum block size. The size written never exceed the given **size-in-bytes**. If

adding data to a block would cause it to exceed the given maximum size, the block will be written to the archive device, and the new data will begin a new block. If no value is specified or zero is specified, the Storage daemon will use a default block size of 64,512 bytes (126 * 512).

Minimum block size = size-in-bytes

This statement applies only to non-random access devices (e.g. tape drives). Blocks written by the storage daemon to a non-random archive device will never be smaller than the given **size-in-bytes**. The Storage daemon will attempt to efficiently fill blocks with data received from active sessions but will, if necessary, add padding to a block to achieve the required minimum size.

To force the block size to be fixed, as is normally the case for non-random access devices (tape drives), set the **Minimum block size** and the **Maximum block size** to the same value (zero included). The default is that both the minimum and maximum block size are zero and the default block size is 64,512 bytes. If you wish the block size to be fixed and different from the default, specify the same value for both **Minimum block size** and **Maximum block size**.

For example, suppose you want a fixed block size of 100K bytes, then you would specify:

```
Minimum block size = 100K
Maximum block size = 100K
```

If you want the block size to be variable but with a 64K minimum and 200K maximum (and default as well), you would specify:

```
Minimum block size = 64K
Maximum blocksize = 200K
```

Hardware End of Medium = Yes/No

If **No**, the archive device is not required to support end of medium ioctl request, and the storage daemon will use the forward space file function to find the end of the recorded data. If **Yes**, the archive device must support the `ioctl MTEOM` call, which will position the tape to the end of the recorded data. In addition, your SCSI driver must keep track of the file number on the tape and report it back correctly by the **MTIOCGET** ioctl. Note, some SCSI drivers will correctly forward space to the end of the recorded data, but they do not keep track of the file number. On Linux machines, the SCSI driver has a **fast-eod** option, which if set will cause the driver to lose track of the file number. You should ensure that this option is always turned off using the **mt** program.

Default setting for Hardware End of Medium is **Yes**. This function is used before appending to a tape to ensure that no previously written data is lost. We recommend if you have a non standard or unusual tape drive that you use the **btape** program to test your drive to see whether or not it supports this function. All modern (after 1998) tape drives support this feature.

If you set Hardware End of Medium = no, you should also set **Fast Forward Space File** = **no**. If you do not, Bacula will most likely be unable to correctly find the end of data on the tape.

Fast Forward Space File = Yes/No

If **No**, the archive device is not required to support keeping track of the file number (**MTIOCGET** ioctl) during forward space file. If **Yes**, the archive device must support the **ioctl** MTFSF call, which virtually all drivers support, but in addition, your SCSI driver must keep track of the file number on the tape and report it back correctly by the **MTIOCGET** ioctl. Note, some SCSI drivers will correctly forward space, but they do not keep track of the file number or more seriously, they do not report end of medium. Default setting for Fast Forward Space File is **Yes**. If you disable Hardware End of Medium, most likely you should also disable Fast Forward Space file. The **test** command in the program **btape** will test this feature and advise you if it should be turned off.

BSF at EOM = Yes/No

If **No**, the default, no special action is taken by Bacula with the End of Medium (end of tape) is reached because the tape will be positioned after the last EOF tape mark, and Bacula can append to the tape as desired. However, on some systems, such as FreeBSD, when Bacula reads the End of Medium (end of tape), the tape will be positioned after the second EOF tape mark (two successive EOF marks indicated End of Medium). If Bacula appends from that point, all the appended data will be lost. The solution for such systems is to specify **BSF at EOM** which causes Bacula to backspace over the second EOF mark. Determination of whether or not you need this record is done using the **test** command in the **btape** program.

TWO EOF = Yes/No

If **No**, Bacula will write two end of file marks when terminating a tape — i.e. after the last job or at the end of the medium. If **Yes**, the default, Bacula will only write one end of file to terminate the tape.

Backward Space Record = Yes/No

If **Yes**, the archive device supports the **MTBSR** **ioctl** to backspace records. If **No**, this call is not used and the device must be rewound and advanced forward to the desired position. Default is **Yes** for non random-access devices.

Backward Space File = Yes/No

If **Yes**, the archive device supports the **MTBSF** and **MTBSF** **ioctls** to backspace over an end of file mark and to the start of a file. If **No**, these calls are not used and the device must be rewound and advanced forward to the desired position. Default is **Yes** for non random-access devices.

Forward Space Record = Yes/No

If **Yes**, the archive device must support the **MTFSR** **ioctl** to forward space over records. If **No**, data must be read in order to advance the position on the device. Default is **Yes** for non random-access devices.

Forward Space File = Yes/No

If **Yes**, the archive device must support the **MTFSF** **ioctl** to forward space by file marks. If **No**, data must be read to advance the position on the device. Default is **Yes** for non random-access devices.

Offline On Unmount = Yes/No

The default for this record is **No**. If **Yes** the archive device must support the **MTOFFL** **ioctl** to rewind and take the volume offline. In this case, Bacula will issue the offline (eject) request before closing the device during the **unmount** command. If **No** Bacula

will not attempt to offline the device before unmounting it. After an offline is issued, the cassette will be ejected thus **requiring operator intervention** to continue, and on some systems require an explicit load command to be issued (**mt -f /dev/xxx load**) before the system will recognize the tape. If you are using an autochanger, some devices require an offline to be issued prior to changing the volume. However, most devices do not and may get very confused.

Maximum Volume Size = size

No more than **size** bytes will be written onto a given volume on the archive device. This record is used mainly in testing Bacula to simulate a small Volume. It can also be useful if you wish to limit the size of a File Volume to say less than 2GB of data. In some rare cases of really antiquated tape drives that do not properly indicate when the end of a tape is reached during writing (though I have read about such drives, I have never personally encountered one). Please note, this record is deprecated (being phased out) in favor of the **Maximum Volume Bytes** defined in the Director's configuration file.

Maximum File Size = size

No more than **size** bytes will be written into a given logical file on the volume. Once this size is reached, an end of file mark is written on the volume and subsequent data are written into the next file. Breaking long sequences of data blocks with file marks permits quicker positioning to the start of a given stream of data and can improve recovery from read errors on the volume. The default is one Gigabyte.

Maximum Network Buffer Size = bytes

where *bytes* specifies the initial network buffer size to use with the File daemon. This size will be adjusted down if it is too large until it is accepted by the OS. Please use care in setting this value since if it is too large, it will be trimmed by 512 bytes until the OS is happy, which may require a large number of system calls. The default value is 32,768 bytes.

Maximum Spool Size = bytes

where the bytes specify the maximum spool size for all jobs that are running. The default is no limit.

Maximum Job Spool Size = bytes

where the bytes specify the maximum spool size for any one job that is running. The default is no limit.

Spool Directory = directory/em>

specifies the name of the directory to be used to store the spool files for this device. The default is to use the working directory.

Parallelism

Maximum Concurrent Jobs = positive integer

The storage daemon will accept no more than the given **positive integer** of simultaneous connections. The default is 10. It is best to set this number fairly large (e.g. 10 or 20) and control how many Jobs are running with the **Maximum Concurrent Jobs** in the Storage resource in the Director's configuration file.

Capabilities

Label media = Yes/No

If **Yes**, permits this device to automatically label blank media without an explicit operator command. It does so by using an internal algorithm as defined on the [Label Format](#) record in each Pool resource. If this is **No** as by default, Bacula will label tapes only by specific operator command (**label** in the Console) or when the tape has been recycled. The automatic labeling feature is most useful when writing to disk rather than tape volumes.

Automatic mount = Yes/No

If **Yes** (the default), permits the daemon to examine the device to determine if it contains a Bacula labeled volume. This is done initially when the daemon is started, and then at the beginning of each job. This record is particularly important if you have set **Always Open = no** because it permits Bacula to attempt to read the device before asking the system operator to mount a tape.

Messages Resource

For a description of the Messages Resource, please see the [Messages Resource](#) Chapter of this manual.

Sample Storage Daemon Configuration File

A example Storage Daemon configuration file might be the following:

```
#
# Default Bacula Storage Daemon Configuration file
#
# For Bacula release 1.15 (5 March 2002) -- redhat 7.1
#
# You may need to change the name of your tape drive
# on the "Archive Device" directive in the Device
# resource. If you change the Name and/or the
# "Media Type" in the Device resource, please ensure
# that bacula-dir.conf has corresponding changes.
#

Storage {                                \# definition of myself
    Name = rufus-sd
    Address = rufus
    WorkingDirectory = "$HOME/bacula/bin/working"
    Pid Directory = "$HOME/bacula/bin/working"
}

#
# List Directors who are permitted to contact Storage daemon
#
Director {
    Name = rufus-dir
    Password = "ZF9Ctf5PQoWCPkmR3s4atCB0usUPg+vWWyIo2VS5ti6k"
}

#
```

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```
# Devices supported by this Storage daemon
# To connect, the Director's bacula-dir.conf must have the
# same Name and MediaType.
#
Device {
    Name = "HP DLT 80"
    Media Type = DLT8000
    Archive Device = /dev/nst0
    AutomaticMount = yes;                \# when device opened, read it
    AlwaysOpen = yes;
    RemovableMedia = yes;
}

#Device {
#   Name = SDT-7000                    #
#   Media Type = DDS-2
#   Archive Device = /dev/nst0
#   AutomaticMount = yes;              # when device opened, read it
#   AlwaysOpen = yes;
#   RemovableMedia = yes;
#}

#Device {
#   Name = Floppy
#   Media Type = Floppy
#   Archive Device = /mnt/floppy
#   RemovableMedia = yes;
#   Random Access = Yes;
#   AutomaticMount = yes;              # when device opened, read it
#   AlwaysOpen = no;
#}

#Device {
#   Name = FileStorage
#   Media Type = File
#   Archive Device = /tmp
#   LabelMedia = yes;                  # lets Bacula label unlabeled media
#   Random Access = Yes;
#   AutomaticMount = yes;              # when device opened, read it
#   RemovableMedia = no;
#   AlwaysOpen = no;
#}

#
# A very old Exabyte with no end of media detection
#
#Device {
#   Name = "Exabyte 8mm"
#   Media Type = "8mm"
#   Archive Device = /dev/nst0
#   Hardware end of medium = No;
#   AutomaticMount = yes;              # when device opened, read it
#   AlwaysOpen = Yes;
#   RemovableMedia = yes;
#}

#
# Send all messages to the Director,
# mount messages also are sent to the email address
#
Messages {
```

Bacula Storage Management System

```
Name = Standard
director = rufus-dir = all
operator = root = mount
}
```



Client/File daemon Configuration



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The Network Backup Solution

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Console Configuration

Messages Resource

The Messages Resource

The Messages resource defines how messages are to be handled and destinations to which they should be sent.

Even though each daemon has a full message handler, within the File daemon and the Storage daemon, you will normally choose to send all the appropriate messages back to the Director. This permits all the messages associated with a single Job to be combined in the Director and sent as a single email message to the user, or logged together in a single file.

Each message that Bacula generates (i.e. that each daemon generates) has an associated type such as INFO, WARNING, ERROR, etc. Using the message resource, you can specify which message types you wish to see and where they should be sent. In addition, a message may be sent to multiple destinations. For example, you may want all error messages both logged as well as sent to you in an email. By defining multiple messages resources, you can have different message handling for each type of Job (e.g. Full backups versus Incremental backups).

The records contained in a Messages resource consist of a **destination** specification followed by a list of **message-types** in the format:

destination = message-type1, message-type2, message-type3, ...
or for those destinations that need an address specification (e.g. email):

destination = address = message-type1, message-type2, message-type3, ...

Where **destination** is one of a predefined set of keywords that define where the message is to be sent (**stdout**, **file**, ...), **message-type** is one of a predefined set of keywords that define the type of message generated by **Bacula** (**ERROR**, **WARNING**, **FATAL**, ...), and **address** varies according to the **destination** keyword, but is typically an email address or a filename.

The following are the list of the possible record definitions that can be used in a message resource.

Messages

Start of the Messages records.

Name = <name>

The name of the Messages resource. The name you specify here will be used to tie this Messages resource to a Job and/or to the daemon.

MailCommand = <command>

In the absence of this resource, Bacula will send all mail using the following command:
mail -s "Bacula Message" <recipients>

In many cases, depending on your machine, this command may not work. Using the **MailCommand**, you can specify exactly how to send the mail. During the processing of the **command**, normally specified as a quoted string, the following substitutions will be used:

- %% = %

- %c = Client's name
- %d = Director's name
- %e = Job Exit code (OK, Error, ...)
- %i = Job Id
- %j = Unique Job name
- %l = Job level
- %n = Job name
- %r = Recipients
- %t = Job type (e.g. Backup, ...)

The following is the command I (Kern) use. Note, the whole command should appear on a single line in the configuration file rather than split as is done here for presentation:

```
mailcommand = "/home/kern/bacula/bin/bsmtp -h mail.whitehouse.com -f
\"\\(Bacula\\) %r\" -s \"Bacula: %t %e of %c %l\" %r"
```

Note, the **bsmtp** program is provided as part of **Bacula**. For additional details, please see the [bsmtp --- Customizing Your Email Messages](#) section of the Bacula Utility Programs chapter of this manual. Please test any **mailcommand** that you use to ensure that your bsmtp gateway accepts the addressing form that you use. Certain program such as Exim can be very selective as to what forms are permitted particularly in the from part.

OperatorCommand = <command>

This resource specification is similar to the **MailCommand** except that it is used for Operator messages. The substitutions performed for the **MailCommand** are also done for this command. Normally, you will set this command to the same value as specified for the **MailCommand**.

Debug = <debug-level>

This sets the debug message level to the debug level, which is an integer. Higher debug levels cause more debug information to be produced. You are requested not to use this record since it will be deprecated.

<destination> = <message-type1>, <message-type2>...

Where **destination** may be one of the following:

stdout

Send the message to standard output.

stderr

Send the message to standard error.

console

Send the message to the console (Bacula Console). These messages are held until the console program connects to the Director.

<destination> = <address> = <message-type1>, <message-type2>...

Where **address** depends on the **destination**, which may be one of the following:

director

Send the message to the Director whose name is given in the **address** field. Note, in the current implementation, the Director Name is ignored, and the message is sent to the Director that started the Job.

file

Send the message to the filename given in the **address** field. If the file already exists, it will be overwritten.

append

Append the message to the filename given in the **address** field. If the file already exists, it will be appended to. If the file does not exist, it will be created.

syslog

Send the message to the system log (syslog) using the facility specified in the **address** field. Note, for the moment, the **address** field is ignored and the message is always sent to the **LOG_ERR** facility.

mail

Send the message to the email addresses that are given as a comma separated list in the **address** field. Mail messages are grouped together during a job and then sent as a single email message when the job terminates. The advantage of this destination is that you are notified about every Job that runs. However, if you backup 5 or 10 machines every night, the volume of email messages can be important. Some users use filter programs such as **procmail** to automatically file this email based on the Job termination code (see **mailcommand**).

mail on error

Send the message to the email addresses that are given as a comma separated list in the **address** field if the Job terminates with an error condition. MailOnError messages are grouped together during a job and then sent as a single email message when the job terminates. This destination differs from the **mail** destination in that if the Job terminates normally, the message is totally discarded (for this destination). If the Job terminates in error, it is emailed. By using other destinations such as **append** you can ensure that even if the Job terminates normally, the output information is saved.

operator

Send the message to the email addresses that are specified as a comma separated list in the **address** field. This is similar to **mail** above, except that each message is sent as received. Thus there is one email per message. This is most useful for **mount** messages (see below).

For any destination, the **message-type** field is a comma separated list of the following types or classes of messages:

info

General information messages.

warning

Warning messages. Generally this is some unusual condition but not expected to be serious.

error

Non-fatal error messages. The job continues running. Any error message should be investigated as it means that something went wrong.

fatal

Fatal error messages. Fatal errors cause the job to terminate.

terminate

Message generated when the daemon shuts down.

saved

Files saved normally.

notsaved

Files not saved because of some error. Usually because the file cannot be accessed (i.e. it does not exist or is not mounted).

skipped

Files that were skipped because of a user supplied option such as an incremental backup or a file that matches an exclusion pattern. This is not considered an

error condition such as the files listed for the **notsaved** type because the configuration file explicitly requests these types of files to be skipped. For example, any unchanged file during an incremental backup, or any subdirectory if the no recursion option is specified.

mount

Volume mount or intervention requests from the Storage daemon. These requests require a specific operator intervention for the job to continue.

restored

The **ls** style listing generated for each file restored is sent to this message class.

all

All message types.

**security*

Security info/warning messages (not currently implemented).

The following is an example of a valid Messages resource definition, where all messages except files explicitly skipped or daemon termination messages are sent by email to enforcement@sec.com. In addition all mount messages are sent to the operator (i.e. emailed to enforcement@sec.com). Finally all messages other than explicitly skipped files and files saved are sent to the console:

```
Messages {
  Name = Standard
  mail = enforcement@sec.com = all, !skipped, !terminate
  operator = enforcement@sec.com = mount
  console = all, !skipped, !saved
}
```

With the exception of the email address (changed to avoid junk mail from robot's), Kern's Director's Messages resource is as follows. Note, the **mailcommand** and **operatorcommand** are on a single line — they had to be split for this manual:

```
Messages {
  Name = Standard
  mailcommand = "bacula/bin/bsmtp -h mail.whitehouse.com \
    -f \"\\(Bacula\\) %r\" -s \"Bacula: %t %e of %c %l\" %r"
  operatorcommand = "bacula/bin/bsmtp -h mail.whitehouse.com \
    -f \"\\(Bacula\\) %r\" -s \"Bacula: Intervention needed \
      for %j\" %r"
  MailOnError = security@whitehouse.com = all, !skipped, \
    !terminate
  append = "bacula/bin/log" = all, !skipped, !terminate
  operator = security@whitehouse.com = mount
  console = all, !skipped, !saved
}
```



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Variable Expansion

Console Configuration

General

The Console configuration file is the simplest of all the configuration files, and in general, you should not need to change it except for the password. It simply contains the information necessary to contact the Director or Directors.

For a general discussion of configuration file and resources including the data types recognized by **Bacula**, please see the [Configuration](#) chapter of this manual.

The following Console Resource definition must be defined:

- [Director](#) --- to define the Director's name and his access password. Note, you may define more than one Director resource in the Console configuration file. If you do so, the Console program will ask you which one you want to use.

The Director Resource

The Director resource defines the attributes of the Director running on the network. You may have multiple Director resource specifications in a single Console configuration file. If you have more than one, you will be prompted to choose one when you start the **Console** program.

Director

Start of the Director records.

Name = <name>

The director name used by the system administrator. This name must be identical to the **Name** specified in the **Director** resource of the [Director's configuration](#) file.

DIRPort = <port-number>

Specify the port to use to connect to the Director. This value will most likely already be set to the value you specified on the **--with-base-port** option of the **./configure** command. This port must be identical to the **DIRport** specified in the **Director** resource of the [Director's configuration](#) file. The default is 9101 so this record is not normally specified.

Address = <address>

Where the address is a host name, a fully qualified domain name, or a network address used to connect to the Director.

Password = <password>

Where the password is the password needed for the Director to accept the Console connection. This password must be identical to the **Password** specified in the **Director** resource of the [Director's configuration](#) file. This record is required.

An actual example might be:

```
Director {
  Name = HeadMan
  address = rufus.cats.com
  password = xyzlerploit
}
```

The ConsoleFont Resource

The ConsoleFont resource is available only in the GNOME version of the console. It permits you to define the font that you want used to display in the main listing window.

ConsoleFont

Start of the ConsoleFont records.

Name = <name>

The name of the font.

Font = <X-Window Font Specification>

The string value given here defines the desired font. It is specified in the standard cryptic X Window format. For example, the default specification is:

```
Font = "-misc-fixed-medium-r-normal-*-*-130-*-*-c-*-*iso8859-1"
```

Thanks to Phil Stracchino for providing the code for this feature.

An actual example might be:

```
ConsoleFont {
  Name = Default
  Font = "-misc-fixed-medium-r-normal-*-*-130-*-*-c-*-*iso8859-1"
}
```

Console Commands

For more details on running the console and its commands, please see the [Bacula Console](#) chapter of this manual.

Sample Console Configuration File

A example Console configuration file might be the following:

```
#
# Bacula Console Configuration File
#

Director {
  Name = HeadMan
  address = "my_machine.my_domain.com"
  Password = Console_password
}
```



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Variable Expansion

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Variable Expansion

Variable expansion is somewhat similar to Unix shell variable expansion. Currently (version 1.31), it is used only in format labels, but in the future, it will most likely be used in more places.

General Functionality

This is basically a string expansion capability that permits referencing variables, indexing arrays, conditional replacement of variables, case conversion, substring selection, regular expression matching and replacement, character class replacement, padding strings, repeated expansion in a user controlled loop, support of arithmetic expressions in the loop start, step and end conditions, and recursive expansion.

When using variable expansion characters in a Volume Label Format record, the format should always be enclosed in double quotes (").

For example, `${HOME}` will be replaced by your home directory as defined in the environment. If you have defined the variable `xxx` to be `Test`, then the reference `${xxx:p/7/Y/r}` will right pad the contents of `xxx` to a length of seven characters filling with the character `Y` giving `YYYTest`.

Bacula Variables

Within Bacula, there are three main classes of variables with some minor variations within the classes. The classes are:

Counters

Counters are defined by the **Counter** resources in the Director's conf file. The counter can either be a temporary counter that lasts for the duration of Bacula's execution, or it can be a variable that is stored in the catalog, and thus retains its value from one Bacula execution to another. Counter variables may be incremented by postfixing a plus sign (+ after the variable name).

Internal Variables

Internal variables are read-only, and may be related to the current job (i.e. Job name), or may be special variables such as the date and time. The following variables are available:

- ♦ **Year** — the full year
- ♦ **Month** — the current month 1–12
- ♦ **Day** — the day of the month 1–31
- ♦ **Hour** — the hour 0–24
- ♦ **Minute** — the current minute 0–59
- ♦ **Second** — the current second 0–59
- ♦ **WeekDay** — the current day of the week 0–6 with 0 being Sunday
- ♦ **Job** — the job name
- ♦ **Dir** — the Director's name
- ♦ **Level** — the Job Level
- ♦ **Type** — the Job type
- ♦ **JobId** — the JobId
- ♦ **JobName** — the unique job name composed of Job and date
- ♦ **Storage** — the Storage daemon's name

- ◆ **Client** — the Client's name
- ◆ **NumVols** — the current number of Volumes in the Pool
- ◆ **Pool** — the Pool name
- ◆ **Catalog** — the Catalog name
- ◆ **MediaType** — the Media Type

Environment Variables

Environment variables are read-only, and must be defined in the environment prior to executing Bacula. Environment variables may be either scalar or an array, where the elements of the array are referenced by subscripting the variable name (e.g. `${Months[3]}`). Environment variable arrays are defined by separating the elements with a vertical bar (`|`), thus `set Months="Jan|Feb|Mar|Apr|..."` defines an environment variable named **Month** that will be treated as an array, and the reference `${Months[3]}` will yield **Mar**. The elements of the array can have differing lengths.

Full Syntax

Since the syntax is quite extensive, below, you will find the pseudo BNF. The special characters have the following meaning:

```

::=      definition
( )      grouping if the parens are not quoted
|        separates alternatives
'/'      literal / (or any other character)
CAPS     a character or character sequence
*        preceding item can be repeated zero or more times
?        preceding item can appear zero or one time
+        preceding item must appear one or more times

```

And the pseudo BNF describing the syntax is:

```

input      ::= ( TEXT
                | variable
                | INDEX_OPEN input INDEX_CLOSE (loop_limits)?
                ) *

variable   ::= DELIM_INIT (name|expression)

name       ::= (NAME_CHARS)+

expression ::= DELIM_OPEN
                (name|variable)+
                (INDEX_OPEN num_exp INDEX_CLOSE)?
                (':' command)*
                DELIM_CLOSE

command    ::= '-' (TEXT_EXP|variable)+
                | '+' (TEXT_EXP|variable)+
                | 'o' NUMBER ('-'|',') (NUMBER)?
                | '#'
                | '*' (TEXT_EXP|variable)+
                | 's' '/' (TEXT_PATTERN)+
                |   '/' (variable|TEXT_SUBST)*
                |   '/' ('m'|'g'|'i'|'t')*
                | 'y' '/' (variable|TEXT_SUBST)+
                |   '/' (variable|TEXT_SUBST)*
                | '/'

```

```

| 'p' '/' NUMBER
| '/' (variable|TEXT_SUBST)*
| '/' ('r'|'l'|'c')
| '%' (name|variable)+
| '(' ('(TEXT_ARGS)? ')?
| 'l'
| 'u'

num_exp ::= operand
| operand ('+'|'-'|'*'|'/'|'%') num_exp

operand ::= ('+'|'-')? NUMBER
| INDEX_MARK
| '(' num_exp ')'
| variable

loop_limits ::= DELIM_OPEN
(num_exp)? ',' (num_exp)? (',' (num_exp))?.
DELIM_CLOSE

NUMBER ::= ('0'|...|'9')+

TEXT_PATTERN ::= (^('/'))+
TEXT_SUBST ::= (^(DELIM_INIT|'/'))+
TEXT_ARGS ::= (^(DELIM_INIT|''))+
TEXT_EXP ::= (^(DELIM_INIT|DELIM_CLOSE|':'|'+'))+
TEXT ::= (^(DELIM_INIT|INDEX_OPEN|INDEX_CLOSE))+

DELIM_INIT ::= '$'
DELIM_OPEN ::= '{'
DELIM_CLOSE ::= '}'
INDEX_OPEN ::= '['
INDEX_CLOSE ::= ']'
INDEX_MARK ::= '#'
NAME_CHARS ::= 'a'|...|'z'|'A'|...|'Z'|'0'|...|'9'

```

Semantics

The items listed in **command** above, which always follow a colon (:) have the following meanings:

- perform substitution if variable is empty
- + perform substitution if variable is not empty
- o cut out substring of the variable value
- # length of the variable value
- * substitute empty string if the variable value is not empty, otherwise substitute the trailing parameter
- s regular expression search and replace. The trailing options are: m = multiline, i = case insensitive, g = global, t = plain text (no regexp)
- y transpose characters from class A to class B
- p pad variable to l = left, r = right or c = center, with second value.
- % special function call (none implemented)
- l lower case the variable value
- u upper case the variable value

The **loop_limits** are start, step, and end values.

A counter variable name followed immediately by a plus (+) will cause the counter to be incremented by one.

Examples

To create an ISO date:

```
DLT-${Year}-${Month:p/2/0/r}-${Day:p/2/0/r}
```

on 20 June 2003 would give **DLT-2003-06-20**

If you set the environment variable **mon** to **January|February|March|April|May|...**

```
File-${mon[${Month}]}/${Day}/${Year}
```

on the first of March would give **File-March/1/2003**



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The Network Backup Solution

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The Console Restore Command

Bacula Console

General

The **Bacula Console** (sometimes called the User Agent) is a program that allows the user or the System Administrator, to interact with the Bacula Director daemon while the daemon is running.

The current Bacula Console comes in two versions: a shell interface (TTY style), and a GNOME GUI interface. Both permit the administrator or authorized users to interact with Bacula. You can determine the status of a particular job, examine the contents of the Catalog as well as perform certain tape manipulations with the Console program.

In addition, there is a wx-console built with wxWidgets that allows a graphic restore of files. As of version 1.34.1 it is in an early stage of development, but it quite useful.

Since the Console program interacts with the Director by the network, your Console and Director programs do not necessarily need to run on the same machine.

In fact, a certain minimal knowledge of the Console program is needed in order for Bacula to be able to write on more than one tape, because when Bacula requests a new tape, it waits until the user, via the Console program, indicates that the new tape is mounted.

Configuration

When the Console starts, it reads a standard Bacula configuration file named **bconsole.conf** or **gnome-console.conf** in the case of the GNOME Console version. This file allows default configuration of the Console, and at the current time, the only Resource Record defined is the Director resource, which gives the Console the name and address of the Director. For more information on configuration of the Console program, please see the [Console Configuration File](#) Chapter of this document.

Running the Console Program

After launching the Console program (bconsole), it will prompt you for the next command with an asterisk (*). (Note, in the GNOME version, the prompt is not present; you simply enter the commands you want in the command text box at the bottom of the screen.) Generally, for all commands, you can simply enter the command name and the Console program will prompt you for the necessary arguments. Alternatively, in most cases, you may enter the command followed by arguments. The general format is:

```
<command> <keyword1>[=<argument1>] <keyword2>[=<argument2>] ...
```

where **command** is one of the commands listed below; **keyword** is one of the keywords listed below (usually followed by an argument); and **argument** is the value.

For example:

```
list files jobId=23
```

will list all files saved for JobId 23. Or:

```
show pools
```

will display all the Pool resource records.

Stopping the Console Program

Normally, you simply enter **quit** or **exit** and the Console program will terminate. However, it waits until the Director acknowledges the command. If the Director is already doing a lengthy command (e.g. **prune**), it may take some time. If you want to immediately terminate the Console program, enter the **.quit** command.

There is currently no way to interrupt a Console command once issued (i.e. **ctl-C** does not work). However, if you are at a prompt that is asking you to select one of several possibilities and you would like to abort the command, you can enter a period (**.**), and in most cases, you will either be returned to the main command prompt or if appropriate the previous prompt (in the case of nested prompts). In a few places such as where it is asking for a Volume name, the period will be taken to be the Volume name. In that case, you will most likely be able to cancel at the next prompt.

Alphabetic List of Console Commands

The following commands are currently implemented:

add [pool=<pool-name> storage=<storage> jobid=<JobId>]

This command is used to add Volumes to an existing Pool. The Volume names entered are placed in the Catalog and thus become available for backup operations. Normally, the **label** command is used rather than this command because the **label** command labels the physical media (tape) and does the equivalent of the **add** command. This command affects only the Catalog and not the physical media (data on Volumes). The physical media must exist and be labeled before use (usually with the **label** command). This command can, however, be useful if you wish to add a number of Volumes to the Pool that will be physically labeled at a later time. It can also be useful if you are importing a tape from another site. Please see the **label** command below for the list of legal characters in a Volume name.

autodisplay on/off

This command accepts **on** or **off** as an argument, and turns auto-display of messages on or off respectively. The default for the console program is **off**, which means that you will be notified when there are console messages pending, but they will not automatically be displayed. The default for the gnome-console program is **on**, which means that messages will be displayed when they are received (usually within 5 seconds of them being generated).

When autodisplay is turned off, you must explicitly retrieve the messages with the **messages** command. When autodisplay is turned on, the messages will be displayed on the console as they are received.

automount on/off

This command accepts **on** or **off** as the argument, and turns auto-mounting of the tape after a **label** command on or off respectively. The default is **on**. If **automount** is turned

off, you must explicitly **mount** the tape after a label command to use it.

cancel [*jobid*=<number> *job*=<job-name>]

This command is used to cancel a job and accepts **jobid=nnn** or **job=xxx** as an argument where nnn is replaced by the JobId and xxx is replaced by the job name. If you do not specify a keyword, the Console program will prompt you with the names of all the active jobs allowing you to choose one.

Once a Job is marked to be canceled, it may take a bit of time (generally within a minute) before it actually terminates, depending on what operations it is doing.

create [*pool*=<pool-name>]

This command is used to create a Pool record in the database using the Pool resource record defined in the Director's configuration file. So in a sense, this command simply transfers the information from the Pool resource in the configuration file into the Catalog. Normally this command is done automatically for you when the Director starts providing the Pool is referenced within a Job resource. If you use this command on an existing Pool, it will automatically update the Catalog to have the same information as the Pool resource. After creating a Pool, you will most likely use the **label** command to label one or more volumes and add their names to the Media database.

When starting a Job, if Bacula determines that there is no Pool record in the database, but there is a Pool resource of the appropriate name, it will create it for you. If you want the Pool record to appear in the database immediately, simply use this command to force it to be created.

delete [*volume*=<vol-name> *pool*=<pool-name> *job* *jobid*=<id>]

The delete command is used to delete a Volume, Pool or Job record from the Catalog as well as all associated Volume records that were created. This command operates only on the Catalog database and has no effect on the actual data written to a Volume. This command can be dangerous and we strongly recommend that you do not use it unless you know what you are doing.

If the keyword **Volume** appears on the command line, the named Volume will be deleted from the catalog, if the keyword **Pool** appears on the command line, a Pool will be deleted, and if the keyword **Job** appears on the command line, a Job and all its associated records (File and JobMedia) will be deleted from the catalog. The full form of this command is:

delete pool=<pool-name>

or

delete volume=<volume-name> pool=<pool-name> or

delete JobId=<job-id> JobId=<job-id2> ...

The first form deletes a Pool record from the catalog database. The second form deletes a Volume record from the specified pool in the catalog database. The third form delete the specified Job record from the catalog database.

estimate

Using this command, you can get an idea how many files will be backed up, or if you are unsure about your Include statements in your FileSet, you can test them without doing an actual backup. A Job name must be specified and optionally a Client and FileSet. It then

contacts the client which computes the number of files and bytes that would be backed up. Optionally you may specify the keyword **listing** in which case, all the files to be backed up will be listed. Note, it could take quite some time to display them if the backup is large. The full form is:

```
estimate job=<job-name> listing client=<client-name> fileset=<fileset-name>
```

Specification of the **job** is sufficient, but you can also override the client and/or fileset defined in the Job record by specifying them on the estimate command line.

As an example, you might do:

```
@output /tmp/listing
estimate job=NightlySave listing
@output
```

which will do a full listing of all files to be backed up for the Job **NightlySave** and put it in the file **/tmp/listing**.

help

This command displays the list of commands available.

label

This command is used to label physical volumes. The full form of this command is:

```
label storage=<storage-name> volume=<volume-name> slot=<slot>
```

If you leave out any part, you will be prompted for it. The media type is automatically taken from the Storage resource definition that you supply. Once the necessary information is obtained, the Console program contacts the specified Storage daemon and requests that the tape be labeled. If the tape labeling is successful, the Console program will create a Volume record in the appropriate Pool.

The Volume name is restricted to letters, numbers, and the special characters hyphen (-), underscore (_), colon (:), and period (.). All other characters including a space are illegal. This restriction is to ensure good readability of Volume names to reduce operator errors.

Please note, when labeling a blank tape, Bacula will get read I/O error when it attempts to ensure that the tape is already labeled. If you wish to avoid getting these messages, please write an EOF mark on your tape before attempting to label it:

```
mt rewind
mt weof
```

The label command can fail for a number of reasons:

1. The Volume name you specify is already in the Volume database.
2. The Storage daemon has a tape already mounted on the device, in which case you must **unmount** the device, insert a blank tape, then do the **label** command.
3. The tape in the device is already a Bacula labeled tape. (Bacula will never relabel a Bacula labeled tape unless it is recycled and you use the **relabel** command).
4. There is no tape in the drive.

There are two ways to relabel a volume that already has a Bacula label. The brute force method is to write an end of file mark on the tape using the system **mt** program, something like the following:

```
mt -f /dev/st0 rewind
mt -f /dev/st0 weof
```

Then you use the **label** command to add a new label. However, this could leave traces of the old volume in the catalog.

The preferable method to relabel a tape is to first **purge** the volume, either automatically, or explicitly with the **purge** command, then use the **relabel** command described below.

If your autochanger has barcode labels, you can label all the Volumes in your autochanger one after another by using the **label barcodes** command. For each tape in the changer containing a barcode, Bacula will mount the tape and then label it with the same name as the barcode. An appropriate Media record will also be created in the catalog. Any barcode that begins with the same characters as specified on the "CleaningPrefix=xxx" command, will be treated as cleaning tapes, and will not be labeled. For example with:

```
Pool {
    Name ...
    Cleaning Prefix = "CLN"
}
```

Any slot containing a barcode of CLNxxxx will be treated as a cleaning tape and will not be mounted.

list

The list command lists the requested contents of the Catalog. The various fields of each record are listed on a single line. If there The various forms of the list command are:
list jobs

list jobid=<id>

list job=<job-name>

list jobmedia

list jobmedia jobid=<id>

list jobmedia job=<job-name>

list files jobid=<id>

list files job=<job-name>

list pools

list clients

list jobtotals

list volumes

list volumes jobid=<id>

list volumes pool=<pool-name>

list volumes job=<job-name>

list volume=<volume-name> list nextvolume job=<job-name>

list nextvol job=<job-name>

What most of the above commands do should be more or less obvious. In general if you do not specify all the command line arguments, the command will prompt you for what is needed.

The **list nextvol** command will print the Volume name to be used by the specified job. You should be aware that exactly what Volume will be used depends on a lot of factors including the time and what a prior job will do. It may fill a tape that is not full when you issue this command. As a consequence, this command will give you a good estimate of what Volume will be used but not a definitive answer. In addition, this command may have certain side effect because it runs through the same algorithm as a job, which means it may automatically purge or recycle a Volume.

If you wish to add specialized commands that list the contents of the catalog, you can do so by adding them to the **query.sql** file. However, this takes some knowledge of programming SQL. Please see the **query** command below for additional information. See below for listing the full contents of a catalog record with the **llist** command.

As an example, the command **list pools** might produce the following output:

PoId	Name	NumVols	MaxVols	PoolType	LabelFormat
1	Default	0	0	Backup	*
2	Recycle	0	8	Backup	File

As mentioned above, the **list** command lists what is in the database. Some things are put into the database immediately when Bacula starts up, but in general, most things are put in only when they are first used, which is the case for a Client as with Job records, etc.

Bacula should create a client record in the database the first time you run a job for that client. Doing a **status** will not cause a database record to be created. The client database record will be created whether or not job fails, but it must at least start. When the Client is actually contacted, additional info from the client will be added to the client record (a "uname -a" output).

If you want to see what Client resources you have available in your conf file, you use the Console command **show clients**.

*l*list

The *l*list or "long list" command takes all the same arguments that the *list* command described above does. The difference is that the *l*list command list the full contents of each database record selected. It does so by listing the various fields of the record vertically, with one field per line. It is possible to produce a very large number of output lines with this command.

If instead of the **list pools** as in the example above, you enter **l**list pools you might get the following output:

```

      PoolId: 1
      Name: Default
      NumVols: 0
      MaxVols: 0
      UseOnce: 0
      UseCatalog: 1
      AcceptAnyVolume: 1
      VolRetention: 1,296,000
      VolUseDuration: 86,400
      MaxVolJobs: 0
      MaxVolBytes: 0
      AutoPrune: 0
      Recycle: 1
      PoolType: Backup
      LabelFormat: *

      PoolId: 2
      Name: Recycle
      NumVols: 0
      MaxVols: 8
      UseOnce: 0
      UseCatalog: 1
      AcceptAnyVolume: 1
      VolRetention: 3,600
      VolUseDuration: 3,600
      MaxVolJobs: 1
      MaxVolBytes: 0
      AutoPrune: 0
      Recycle: 1
      PoolType: Backup
      LabelFormat: File

```

*m*essages

This command causes any pending console messages to be immediately displayed.

*m*ount

The *mount* command is used to mount a volume on a physical device. This command is used only if there is no Volume in a drive and Bacula requests a mount or when you have specifically unmounted a Volume with the **unmount** console command. The various forms of the *mount* command are:

```
mount storage=<storage-name>
```

```
mount [ jobid=<id> | job=<job-name> ]
```

If you have specified **Automatic Mount = yes** in the Storage daemon's Device resource, under most circumstances, Bacula will automatically access the Volume unless you have explicitly **unmounted** it in the Console program.

prune

The Prune command allows you to safely remove expired database records from Jobs and Volumes. This command works only on the Catalog database and does not affect data written to Volumes. In all cases, the Prune command applies a retention period to the specified records. You can Prune expired File entries from Job records; you can Prune expired Job records from the database, and you can Prune both expired Job and File records from specified Volumes.

prune files|jobs|volume client=<client-name> volume=<volume-name>

For a Volume to be pruned, the **VolStatus** must be Full, Used, or Append, otherwise the pruning will not take place.

purge

The Purge command will delete associated Catalog database records from Jobs and Volumes without considering the retention period. **Purge** works only on the Catalog database and does not affect data written to Volumes. This command can be dangerous because you can delete catalog records associated with current backups of files, and we recommend that you do not use it unless you know what you are doing. The permitted forms of **purge** are: purge files jobid=<jobid>|job=<job-name>|client=<client-name> purge jobs client=<client-name> (of all jobs)

purge volume|volume=<vol-name> (of all jobs)

For the **purge** command to work on Volume Catalog database records the **VolStatus** must be Append, Full, Used, or Error.

The actual data written to the Volume will be unaffected by this command.

relabel

This command is used to label physical volumes. The full form of this command is: relabel storage=<storage-name> volume=<newvolume-name> name=<old-volume-name>

If you leave out any part, you will be prompted for it. In order for the Volume (old-volume-name) to be relabeled, it must be in the catalog, and the volume status must be marked **Purged** or **Recycle**. This happens automatically as a result of applying retention periods, or you may explicitly purge the volume using the **purge** command.

Once the volume is physically relabeled, the old data written on the Volume is lost and cannot be recovered.

release

This command is used to cause the Storage daemon to rewind (release) the current tape in the drive, and to re-read the Volume label the next time the tape is used.

release storage=<storage-name>

After a release command, the device is still kept open by Bacula so it cannot be used by another program. However, the operator can remove the current tape and to insert a different one, and when the next Job starts, Bacula will know to re-read the tape label to find out what tape is mounted. If you want to be able to use the drive with another program (e.g. **mt**), you must use the **unmount** command to cause Bacula to completely

release (close) the device.

restore

The restore command allows you to select one or more Jobs (JobIds) to be restored using various methods. Once the JobIds are selected, the File records for those Jobs are placed in an internal Bacula directory tree, and the restore enters a file selection mode that allows you to interactively walk up and down the file tree selecting individual files to be restored. This mode is somewhat similar to the standard Unix **restore** program's interactive file selection mode.

```
restore storage=<storage-name> client=<client-name> where=<path>  
pool=<pool-name> fileset=<fileset-name> select current all done
```

Where **current**, if specified, tells the restore command to automatically select a restore to the most current backup. If not specified, you will be prompted. The **all** specification tells the restore command to restore all files. If it is not specified, you will be prompted for the files to restore. For details of the **restore** command, please see the [Restore Chapter](#) of this manual.

run

This command allows you to schedule jobs to be run immediately. The full form of the command is:

```
run job=<job-name> client=<client-name> fileset=<FileSet-name>  
level=<level-keyword> storage=<storage-name> where=<directory-prefix>  
when=<universal-time-specification> yes
```

Any information that is needed but not specified will be listed for selection, and before starting the job, you will be prompted to accept, reject, or modify the parameters of the job to be run, unless you have specified **yes**, in which case the job will be immediately sent to the scheduler.

On my system, when I enter a run command, I get the following prompt:

```
A job name must be specified.  
The defined Job resources are:  
  1: Matou  
  2: Polymatou  
  3: Rufus  
  4: Minimatou  
  5: Minou  
  6: PmatouVerify  
  7: MatouVerify  
  8: RufusVerify  
  9: Watchdog  
Select Job resource (1-9):
```

If I then select number 5, I am prompted with:

```
Run Backup job  
JobName:  Minou  
FileSet:  Minou Full Set  
Level:    Incremental  
Client:   Minou  
Storage:  DLTDDrive
```

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```
Pool:      Default
When:      2003-04-23 17:08:18
OK to run? (yes/mod/no):
```

If I now enter **yes**, the Job will be run. If I enter **mod**, I will be presented with the following prompt.

```
Parameters to modify:
  1: Level
  2: Storage
  3: Job
  4: FileSet
  5: Client
  6: When
  7: Pool
Select parameter to modify (1-7):
```

If you wish to start a job at a later time, you can do so by setting the **When** time. Use the **mod** option and select **When** (no. 6). Then enter the desired start time in YYYY-MM-DD HH:MM:SS format.

setdebug

This command is used to set the debug level in each daemon. The form of this command is:

```
setdebug level=nn [client=<client-name> | dir | director | storage=<storage-name> | all]
```

show

The show command will list the Director's resource records as defined in the Director's configuration file (normally **bacula-dir.conf**). This command is used mainly for debugging purposes by developers. The following keywords are accepted on the show command line: directors, clients, counters, jobs, storages, catalogs, schedules, filesets, groups, pools, messages, all, help. Please don't confuse this command with the **list**, which displays the contents of the catalog.

sqlquery

The sqlquery command puts the Console program into SQL query mode where each line you enter is concatenated to the previous line until a semicolon (;) is seen. The semicolon terminates the command, which is then passed directly to the SQL database engine.

When the output from the SQL engine is displayed, the formation of a new SQL command begins. To terminate SQL query mode and return to the Console command prompt, you enter a period (.) in column 1.

Using this command, you can query the SQL catalog database directly. Note you should really know what you are doing otherwise you could damage the catalog database. See the **query** command below for simpler and safer way of entering SQL queries.

Depending on what database engine you are using (MySQL or SQLite), you will have somewhat different SQL commands available. For more detailed information, please refer to the MySQL or SQLite documentation.

status

This command will display the status of the next jobs that are scheduled during the next twenty-four hours as well as the status of currently running jobs. The full form of this command is:

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```
status [all | dir=<dir-name> | director | client=<client-name> |  
storage=<storage-name>]
```

If you do a **status dir**, the console will list any currently running jobs, a summary of all jobs scheduled to be run in the next 24 hours, and a listing of the last 10 terminated jobs with their statuses. The scheduled jobs summary will include the Volume name to be used. You should be aware of two things: 1. to obtain the volume name, the code goes through the same code that will be used when the job runs, which means that it may prune or recycle a Volume; 2. The Volume listed is only a best guess. The Volume actually used may be different because of the time difference (more durations may expire when the job runs) and another job could completely fill the Volume requiring a new one.

In the Running Jobs listing, you may find the following types of information:

```
2507 Catalog MatouVerify.2004-03-13_05.05.02 is waiting execution  
5349 Full    CatalogBackup.2004-03-13_01.10.00 is waiting for higher  
           priority jobs to finish  
5348 Differe Minou.2004-03-13_01.05.09 is waiting on max Storage jobs  
5343 Full    Rufus.2004-03-13_01.05.04 is running
```

Looking at the above listing from bottom to top, obviously JobId 5343 (Rufus) is running. JobId 5348 (Minou) is waiting for JobId 5343 to finish because it is using the Storage resource, hence the "waiting on max Storage jobs". JobId 5349 has a lower priority than all the other jobs so it is waiting for higher priority jobs to finish, and finally, JobId 2508 (MatouVerify) is waiting because only one job can run at a time, hence it is simply "waiting execution"

unmount

This command causes the indicated Bacula Storage daemon to unmount the specified device. The forms of the command are the same as the mount command:

```
unmount storage=<storage-name>
```

```
unmount [ jobid=<id> | job=<job-name> ]
```

update

This command will update catalog for either a specific Pool record, a Volume record, or the Slots in an autochanger with barcode capability. In the case of updating a Pool record, the new information will be automatically taken from the corresponding Director's configuration resource record. It can be used to increase the maximum number of volumes permitted or to set a maximum number of volumes. The following main keywords may be specified:
media, volume, pool, slots

In the case of updating a Volume, you will be prompted for which value you wish to change. The following Volume parameters may be changed:

```
Volume Status  
Volume Retention Period  
Volume Use Duration  
Maximum Volume Jobs  
Maximum Volume Bytes  
Recycle Flag  
Slot
```

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InChanger Flag
Pool
Volume Files

For slots **update slots**, Bacula will obtain a list of slots and their barcodes from the Storage daemon, and for each barcode found, it will automatically update the slot in the catalog Media record to correspond to the new value. This is very useful if you have moved cassettes in the magazine, or if you have removed the magazine and inserted a different one. As the slot of each Volume is updated, the InChanger flag for that Volume will also be set, and any other Volumes in the Pool will have their InChanger flag turned off. This permits Bacula to know what magazine (tape holder) is currently in the autochanger.

If you do not have barcodes, you can accomplish the same thing in version 1.33 and later by using the **update slots scan** command. The **scan** keyword tells Bacula to physically mount each tape and to read its VolumeName.

For Pool **update pool**, Bacula will transfer the Volume record to the pool specified.

The full form of the update command with all command line arguments is:

```
update volume=xxx pool=yyy slots volstatus=xxx VolRetention=ddd  
VolUse=ddd MaxVolJobs=nnn MaxVolBytes=nnn Recycle=yes/no  
slot=nnn
```

use

This command allows you to specify which Catalog database to use. Normally, you will be using only one database so this will be done automatically. In the case that you are using more than one database, you can use this command to switch from one to another.
use <database-name>

var

This command takes a string or quoted string and does variable expansion on it the same way variable expansion is done on the **LabelFormat** string. Thus, for the most part, you can test your LabelFormat strings. The difference between the **var** command and the actual LabelFormat process is that during the var command, no job is running so "dummy" values are used in place of Job specific variables. Generally, however, you will get a good idea of what is going to happen in the real case.

version

The command prints the Director's version.

quit

This command terminates the console program. The console program sends the **quit** request to the Director and waits for acknowledgment. If the Director is busy doing a previous command for you that has not terminated, it may take some time. You may quit immediately by issuing the **.quit** command (i.e. quit preceded by a period).

query

This command reads a predefined SQL query from the query file (the name and location of the query file is defined with the QueryFile resource record in the Director's configuration file). You are prompted to select a query from the file, and possibly enter one or more parameters, then the command is submitted to the Catalog database SQL

engine.

The following queries are currently available (version 1.24):

```
Available queries:
1: List Job totals:
2: List where a file is saved:
3: List where the most recent copies of a file are saved:
4: List total files/bytes by Job:
5: List total files/bytes by Volume:
6: List last 20 Full Backups for a Client:
7: List Volumes used by selected JobId:
8: List Volumes to Restore All Files:
9: List where a File is saved:
Choose a query (1-9):
```

exit

This command terminates the console program.

wait

The wait command causes the Director to pause until there are no jobs running. This command is useful in a batch situation such as regression testing where you wish to start a job and wait until that job completes before continuing.

Special dot Commands

There is a list of commands that are prefixed with a period (.). These commands are intended to be used either by batch programs or graphical user interface front-ends. They are not normally used by interactive users. Once GUI development begins, this list will be considerably expanded. The following is the list of dot commands:

```
.die          cause the Director to segment fault (for debugging)
.jobs         list all job names
.filesets     list all fileset names
.clients      list all client names
.msgs         return any queued messages
.quit         quit
.exit         quit
```

Special At (@) Commands

Normally, all commands entered to the Console program are immediately forwarded to the Director, which may be on another machine, to be executed. However, there is a small list of **at** commands, all beginning with a at character (@), that will not be sent to the Director, but rather interpreted by the Console program directly. Note, these commands are implemented only in the tty console program and not in the GNOME Console. These commands are:

@input <filename>

Read and execute the commands contained in the file specified.

@output <filename> w/a

Send all following output to the filename specified either overwriting the file (w) or appending to the file (a). To redirect the output to the terminal, simply enter **@output**

without a filename specification. WARNING: be careful not to overwrite a valid file. A typical example during a regression test might be:

```
@output /dev/null
commands ...
@output
```

@tee <filename> w/a

Send all subsequent output to both the specified file and the terminal. It is turned off by specifying **@tee** or **@output** without a filename.

@sleep <seconds>

Sleep the specified number of seconds.

@time

Print the current time and date.

@version

Print the Console's version.

@quit

quit

@exit

quit

@# anything

Comment

Running the Console Program from a Shell Script

You can automate many Console tasks by running the console program from a shell script. For example, if you have created a file containing the following commands:

```
./bconsole -c ./bconsole.conf <<END_OF_DATA
unmount storage=DDS-4
quit
END_OF_DATA
```

when that file is executed, it will unmount the current DDS-4 storage device. You might want to run this command during a Job by using the **RunBeforeJob** or **RunAfterJob** records.

It is also possible to run the Console program from file input where the file contains the commands as follows:

```
./bconsole -c ./bconsole.conf <filename
```

where the file named **filename** contains any set of console commands.

As a real example, the following script is part of the Bacula regression tests. It labels a volume (a disk volume), runs a backup, then does a restore of the files saved.

```
bin/bconsole -c bin/bconsole.conf <<END_OF_DATA
@output /dev/null
messages
@output /tmp/log1.out
label volume=TestVolume001
run job=Client1 yes
```

```
wait
messages
@#
@# now do a restore
@#
@output /tmp/log2.out
restore current all
yes
wait
messages
@output
quit
END_OF_DATA
```

The output from the backup is directed to /tmp/log1.out and the output from the restore is directed to /tmp/log2.out. To ensure that the backup and restore ran correctly, the output files are checked with:

```
grep "^Termination: *Backup OK" /tmp/log1.out
backupstat=$?
grep "^Termination: *Restore OK" /tmp/log2.out
restorestat=$?
```

Adding Volumes to a Pool

If you have used the **label** command to label a Volume, it will be automatically added to the Pool, and you will not need to add any media to the pool.

Alternatively, you may choose to add a number of Volumes to the pool without labeling them. At a later time when the Volume is requested by **Bacula** you will need to label it.

Before adding a volume, you must know the following information:

1. The name of the Pool (normally "Default")
2. The Media Type as specified in the Storage Resource in the Director's configuration file (e.g. "DLT8000")
3. The number and names of the Volumes you wish to create.

For example, to add media to a Pool, you would issue the following commands to the console program:

```
*add
Enter name of Pool to add Volumes to: Default
Enter the Media Type: DLT8000
Enter number of Media volumes to create. Max=1000: 10
Enter base volume name: Save
Enter the starting number: 1
10 Volumes created in pool Default
*
```

To see what you have added, enter:

```
*list media pool=Default
+-----+-----+-----+-----+-----+-----+
| MedId | VolumeNa | MediaTyp | VolStat | Bytes | LastWritten |
+-----+-----+-----+-----+-----+-----+

```


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11	Save0001	DLT8000	Append	0	0000-00-00 00:00
12	Save0002	DLT8000	Append	0	0000-00-00 00:00
13	Save0003	DLT8000	Append	0	0000-00-00 00:00
14	Save0004	DLT8000	Append	0	0000-00-00 00:00
15	Save0005	DLT8000	Append	0	0000-00-00 00:00
16	Save0006	DLT8000	Append	0	0000-00-00 00:00
17	Save0007	DLT8000	Append	0	0000-00-00 00:00
18	Save0008	DLT8000	Append	0	0000-00-00 00:00
19	Save0009	DLT8000	Append	0	0000-00-00 00:00
20	Save0010	DLT8000	Append	0	0000-00-00 00:00

+

*

Notice that the console program automatically appended a number to the base Volume name that you specify (Save in this case). If you don't want it to append a number, you can simply answer 0 (zero) to the question "Enter number of Media volumes to create. Max=1000:", and in this case, it will create a single Volume with the exact name you specify.



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Maintaining Your Catalog

The Bacula Console Restore Command

General

Below, we will discuss restoring files with the Console **Restore** command, which is the recommended way of doing it. However, there is a standalone program named **bextract**, which also permits restoring files. For more information on this program, please see the [Bacula Utility Programs](#) chapter of this manual. You will also want to look at the **bls** program in the same chapter, which allows you to list the contents of your Volumes. Finally, if you have an old Volume that is no longer in the catalog, you can restore the catalog entries using the program named **bscan**, documented in the same [Bacula Utility Programs](#) chapter.

In general, to restore a file or a set of files, you must run a **restore** job. That is a job with **Type = Restore**. As a consequence, you will need a predefined **restore** job in your **bacula-dir.conf** (Director's config) file. The exact parameters (Client, FileSet, ...) that you define are not important as you can either modify them manually before running the job or if you use the **restore** command, explained below, they will be automatically set for you.

Since Bacula is a network backup program, you must be aware that when you restore files, it is up to you to ensure that you or Bacula have selected the correct Client and the correct hard disk location for restoring those files. **Bacula** will quite willingly backup client A, and restore it by sending the files to a different directory on client B. Normally, you will want to avoid this, but assuming the operating systems are not too different in their file structures, this should work perfectly well, if so desired.

The Restore Command

Since Bacula maintains a catalog of your files and on which Volumes (disk or tape), they are stored, it can do most of the bookkeeping work, allowing you simply to specify what kind of restore you want (current, before a particular date), and what files to restore. Bacula will then do the rest.

This is accomplished using the **restore** command in the Console. First you select the kind of restore you want, then Bacula. Once the JobIds are selected, the File records for those Jobs are placed in an internal Bacula directory tree, and the restore enters a file selection mode that allows you to interactively walk up and down the file tree selecting individual files to be restored. This mode is somewhat similar to the standard Unix **restore** program's interactive file selection mode.

Within the Console program, after entering the **restore** command, you are presented with the following selection prompt:

```
First you select one or more JobIds that contain files
to be restored. You will be presented several methods
of specifying the JobIds. Then you will be allowed to
select which files from those JobIds are to be restored.
```

To select the JobIds, you have the following choices:

- 1: List last 20 Jobs run
- 2: List Jobs where a given File is saved
- 3: Enter list of JobIds to select
- 4: Enter SQL list command

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```
5: Select the most recent backup for a client
6: Select backup for a client before a specified time
7: Enter a list of files to restore
8: Enter a list of files to restore before a specified time
9: Cancel
Select item: (1-9):
```

- Item 1 will list the last 20 jobs run. If you find the Job you want, you can then select item 3 and enter its JobId(s).
- Item 2 will list all the Jobs where a specified file is saved. If you find the Job you want, you can then select item 3 and enter the JobId.
- Item 3 allows you to enter a list of comma separated JobIds whose files will be put into the directory tree.
- Item 4 allows you to enter any arbitrary SQL command. This is probably the most primitive way of finding the desired JobIds, but at the same time, the most flexible. Once you have found the JobId(s), you can select item 3 and enter them.
- Item 5 will automatically select the most recent Full backup and all subsequent incremental and differential backups for a specified Client. These are the Jobs and Files which if reloaded will restore your system to the most current saved state. It automatically enters the JobIds found into the directory tree. This is probably the most convenient of all the above options to use if you wish to restore a selected Client to its most recent state.
- Item 6 allows you to specify a date and time then Bacula will automatically select the most recent Full backup and all subsequent incremental and differential backups that started before the specified date and time.
- Item 7 allows you to specify one or more filenames (complete path required) to be restored. Each filename is entered one at a time or if you prefix a filename with the less-than symbol (<) Bacula will read that file and assume it is a list of filenames to be restored. The filename entry mode is terminated by entering a blank line.
- Item 8 allows you to specify a date and time before entering the filenames. See Item 7 above for more details.
- Item 9 allows you to cancel the restore command.

As an example, suppose that we select item 5 (restore to most recent state). It will then ask for the desired Client, which on my system, will print all the Clients found in the database as follows:

```
Defined clients:
1: Rufus
2: Matou
3: Polymatou
4: Minimatou
5: Minou
6: MatouVerify
7: PmatouVerify
8: RufusVerify
9: Watchdog
Select Client (File daemon) resource (1-9):
```

You will probably have far fewer Clients than this example, and if you have only one Client, it will be automatically selected, but in this case, I enter **Rufus** to select the Client. Then Bacula needs to know what FileSet is to be restored, so it prompts with:

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```
The defined FileSet resources are:
  1: Full Set
  2: Kerns Files
Select FileSet resource (1-2):
```

I choose item 1, which is my full backup. Normally, you will only have a single FileSet for each Job, and if your machines are similar (all Linux) you may only have one FileSet for all your Clients.

At this point, **Bacula** has all the information it needs to find the most recent set of backups. It will then query the database, which may take a bit of time, and it will come up with something like the following. Note, some of the columns are truncated here for presentation:

JobId	Levl	JobFiles	StartTime	VolumeName	File	SesId	VolSesTime
1,792	F	128,374	08-03 01:58	DLT-19Jul02	67	18	1028042998
1,792	F	128,374	08-03 01:58	DLT-04Aug02	0	18	1028042998
1,797	I	254	08-04 13:53	DLT-04Aug02	5	23	1028042998
1,798	I	15	08-05 01:05	DLT-04Aug02	6	24	1028042998

```
You have selected the following JobId: 1792,1792,1797
Building directory tree for JobId 1792 ...
Building directory tree for JobId 1797 ...
Building directory tree for JobId 1798 ...
```

```
cwd is: /
$
```

Depending on the number of **JobFiles** for each JobId, the **Building directory tree ...**" can take a bit of time.

In our example, Bacula found four Jobs that comprise the most recent backup of the specified Client and FileSet. Two of the Jobs have the same JobId because that Job wrote on two different Volumes. The third Job was an incremental backup to the previous Full backup, and it only saved 254 Files compared to 128,374 for the Full backup. The fourth Job was also an incremental backup that saved 15 files.

Next Bacula entered those Jobs into the directory tree, marks all files to be restored as a default, tells you how many files are in the tree, and tells you what the current working directory (**cwd**) is /. Finally, Bacula prompts with the dollar sign (\$) to indicate that you may enter commands to move around the directory tree and to select files.

Instead of choosing item 5 on the first menu (Select the most recent backup for a client), if we had chosen item 3 (Enter list of JobIds to select) and we had entered the JobIds **1792,1797,1798** we would have arrived at the same point.

One point to note if you are manually entering JobIds is that you must enter them in the order they were run (generally in increasing JobId order). If you enter them out of order and the same file was saved in two or more of the Jobs, you may end up with an old version of that file (i.e. not the most recent).

While in file selection mode, you can enter **help** or a question mark (?) to produce a summary of

the available commands:

Command	Description
=====	=====
cd	change current directory
count	count marked files in and below the cd
dir	list current directory
done	leave file selection mode
estimate	estimate restore size
exit	exit = done
find	find files -- wildcards allowed
help	print help
ls	list current directory -- wildcards allowed
lsmark	list the marked files in and below the cd
mark	mark file to be restored
markdir	mark directory entry to be restored -- nonrecursive
pwd	print current working directory
unmark	unmark file to be restored
unmarkdir	unmark directory -- no recursion
quit	quit
?	print help

As a default Bacula no files have been selected for restore. If you want to restore everything, at this point, you should enter **mark ***, and then **done** and **Bacula** will write the bootstrap records to a file and request your approval to start a restore job.

If you do not enter the above mentioned **mark *** command, you will start with an empty slate. Now you can simply start looking at the tree and **mark** particular files or directories if you want restored. It is easy to make a mistake in specifying a file to mark or unmark, and Bacula's error handling is not perfect, so please check your work by using the **ls** or **dir** commands to see what files are actually selected. Any selected file has its name preceded by an asterisk.

To check what is marked or not marked, enter the **count** command, which displays:

```
128401 total files. 128401 marked to be restored.
```

Each of the above commands will be described in more detail in the next section. We continue with the above example, having accepted to restore all files as Bacula set by default. On entering the **done** command, Bacula prints:

```
Bootstrap records written to /home/kern/bacula/working/restore.bsr
```

The restore job will require the following Volumes:

```
DLT-19Jul02
DLT-04Aug02
```

```
128401 files selected to restore.
```

```
Run Restore job
JobName:      kernsrestore
Bootstrap:    /home/kern/bacula/working/restore.bsr
Where:        /tmp/bacula-restores
Replace:      always
FileSet:      Kerns Files
```

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```
Client:      Rufus
Storage:     SDT-10000
JobId:       *None*
OK to run? (yes/mod/no):
```

Please examine each of the items very carefully to make sure that they are correct. In particular, look at **Where**, which tells you where in the directory structure the files will be restored, and **Client**, which tells you which client will receive the files. These items will not always be completed with the correct values depending on which of the restore options you chose.

The above assumes that you have defined a **Restore Job** resource in your Director's configuration file. Normally, you will only need one Restore Job resource definition because by its nature, restoring is a manual operation, and using the Console interface, you will be able to modify the Restore Job to do what you want.

An example Restore Job resource definition is given below.

Returning to the above example, you should verify that the Client name is correct before running the Job. However, you may want to modify some of the parameters of the restore job. For example, in addition to checking the Client it is wise to check that the Storage device chosen by Bacula is indeed correct. Although the **FileSet** is shown, it will be ignored in restore. The restore will choose the files to be restored either by reading the **Bootstrap** file, or if not specified, it will restore all files associated with the specified backup **JobId** (i.e. the JobId of the Job that originally backed up the files).

Finally before running the job, please note that the default location for restoring files is **not** their original locations, rather the directory **/tmp/bacula-restore**s. You can change this default by modifying your **bacula-dir.conf** file, or you can modify it using the **mod** option. If you want to restore the files to their original location, you must have **Where** set to nothing or to the root, i.e. **/**.

If you now enter **yes**, Bacula will run the restore Job. The Storage daemon will first request Volume **DLT-19Jul02** and after the appropriate files have been restored from that volume, it will request Volume **DLT-04Aug02**.

Selecting Files by Filename

If you have a small number of files to restore, and you know the filenames, you can either put the list of filenames in a file to be read by Bacula, or you can enter the names one at a time. The filenames must include the full path and filename. No wild cards are used.

To enter the files, after the **restore**, you select item number 7 from the prompt list:

To select the JobIds, you have the following choices:

- 1: List last 20 Jobs run
- 2: List Jobs where a given File is saved
- 3: Enter list of JobIds to select
- 4: Enter SQL list command
- 5: Select the most recent backup for a client
- 6: Select backup for a client before a specified time
- 7: Enter a list of files to restore
- 8: Enter a list of files to restore before a specified time

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```
9: Cancel
Select item: (1-9): 7
```

which then prompts you with for the client name:

```
Defined Clients:
  1: Timmy
  2: Tibs
  3: Rufus
Select the Client (1-3): 3
```

Of course, your client list will be different, and if you have only one client, it will be automatically selected. And finally, Bacula requests you to enter a filename:

```
Enter filename:
```

At this point, you can enter the full path and filename

```
Enter filename: /home/kern/bacula/k/Makefile.in
Enter filename:
```

as you can see, it took the filename. If Bacula cannot find a copy of the file, it prints the following:

```
Enter filename: junk filename
No database record found for: junk filename
Enter filename:
```

If you want Bacula to read the filenames from a file, you simply precede the filename with a less-than symbol (<). When you have entered all the filenames, you enter a blank line, and Bacula will write the bootstrap file, tell you what tapes will be used, and propose a Restore job to be run:

```
Enter filename:
Automatically selected Storage: DDS-4
Bootstrap records written to /home/kern/bacula/working/restore.bsr
```

The restore job will require the following Volumes:

```
test1
```

```
1 file selected to restore.
```

```
Run Restore job
JobName:      kernsrestore
Bootstrap:    /home/kern/bacula/working/restore.bsr
Where:        /tmp/bacula-restores
Replace:      always
FileSet:      Kerns Files
Client:       Rufus
Storage:      DDS-4
When:         2003-09-11 10:20:53
Priority:     10
OK to run? (yes/mod/no):
```

It is possible to automate the selection by file by putting your list of files in say `/tmp/file-list`, then using the following command:

```
restore client=Rufus file=</tmp/file-list
```

If in modifying the parameters for the Run Restore job, you find that Bacula asks you to enter a Job number, this is because you have not yet specified either a Job number or a Bootstrap file. Simply entering zero will allow you to continue and to select another option to be modified.

Command Line Arguments

If all the above sounds complicated, you will probably agree that it really isn't after trying it a few times. It is possible to do everything that was shown above, with the exception of selecting the FileSet, by using command line arguments with a single command by entering:

```
restore client=Rufus select current all done yes
```

The **client=Rufus** specification will automatically select Rufus as the client, the **current** tells Bacula that you want to restore the system to the most current state possible, and the **yes** suppresses the final **yes/mod/no** prompt and simply runs the restore.

The full list of possible command line arguments are:

- **all** — select all Files to be restored.
- **select** — use the tree selection method.
- **done** — do not prompt the user in tree mode.
- **current** — automatically select the most current set of backups for the specified client.
- **client=xxxx** — select the specified client.
- **jobid=nnn** — specify a JobId or comma separated list of JobIds to be restored.
- **before=YYYY-MM-DD HH:MM:SS** — specify a date and time to which the system should be restored. Only Jobs started before the specified date/time will be selected, and as is the case for **current** Bacula will automatically find the most recent prior Full save and all Differential and Incremental saves run before the date you specify. Note, this command is not too user friendly in that you must specify the date/time exactly as shown.
- **file=filename** — specify a filename to be restored. You must specify the full path and filename. Prefixing the entry with a less-than sign (<) will cause Bacula to assume that the filename is on your system and contains a list of files to be restored. Bacula will thus read the list from that file. Multiple **file=xxx** specifications may be specified on the command line.
- **jobid=nnn** — specify a JobId to be restored.
- **pool=pool-name** — specify a Pool name to be used for selection of Volumes when specifying options 5 and 6 (restore current system, and restore current system before given date). This permits you to have several Pools, possibly one offsite, and to select the Pool to be used for restoring.
- **yes** — automatically run the restore without prompting for modifications (most useful in batch scripts).

Restoring on Windows

If you are restoring on WinNT/2K/XP systems, Bacula will restore the files with the original ownerships and permissions as would be expected. This is also true if you are restoring those files to an alternate directory (using the `Where` option in restore). However, if the alternate directory does not already exist, the Bacula File daemon (Client) will create it, and since the File daemon runs under the `SYSTEM` account, the directory will be created with `SYSTEM` ownership and permissions. In this case, you may have problems accessing the newly restored files.

To avoid this problem, you can create the alternate directory before doing the restore. Bacula will not change the ownership and permissions of the directory if it is already created as long as it is not one of the directories being restored (i.e. written to tape).

Restoring Files Can Be Slow

Restoring files is generally **much** slower than backing it up for several reasons. The first is that during a backup the tape is normally already positioned and Bacula need only write. On the other hand, because restoring files is done so rarely, Bacula keeps only the head start file and block on the tape for the whole job rather than on a file by file basis which would use quite a lot of space in the catalog.

Bacula versions 1.31a and older would seek to the first file on the first tape, then sequentially search the tape for the specified files. If you were doing a full restore, this is OK, but if you want to restore one or two files, the process could be quite long.

This deficiency has been corrected in version 1.32. The consequence is that Bacula will forward space to the correct file mark on the tape for the Job, then forward space to the correct block, and finally sequentially read each record until it gets to the correct one(s) for the file or files you want to restore. Once the desired files are restored, Bacula will stop reading the tape. For restoring a small number of files, version 1.32 and greater are hundreds of times faster than previous versions.

Finally, instead of just reading a file for backup, during the restore, Bacula must create the file, and the operating system must allocate disk space for the file as Bacula is restoring it.

For all the above reasons the restore process is generally much slower than backing up.

Example Restore Job Resource

```
Job {
    Name = "RestoreFiles"
    Type = Restore
    Client = Any-client
    FileSet = "Any-FileSet"
    Storage = Any-storage
    Where = /tmp/bacula-restores
    Messages = Standard
    Pool = Default
}
```

If **Where** is not specified, the default location for restoring files will be their original locations.

File Selection Commands

After you have selected the Jobs to be restored and Bacula has created the in-memory directory tree, you will enter file selection mode as indicated by the dollar sign (\$) prompt. While in this mode, you may use the commands listed above. The basic idea is to move up and down the in memory directory structure with the **cd** command much as you normally do on the system. Once you are in a directory, you may select the files that you want restored. As a default all files are marked to be restored. If you wish to start with no files, simply enter: **cd /** and **unmark ***, then proceed to select the files you wish to restore by marking them with the **mark** command. The available commands are:

cd

The **cd** command changes the current directory to the argument specified. It operates much like the Unix **cd** command. Wildcard specifications are not permitted.

dir

The **dir** command is similar to the **ls** command, except that it prints it in long format (all details). This command can be a bit slower than the **ls** command because it must access the catalog database for the detailed information for each file.

estimate

The **estimate** command prints a summary of the total files in the tree, how many are marked to be restored, and an estimate of the number of bytes to be restored. This can be useful if you are short on disk space on the machine where the files will be restored.

find

The **find** command accepts one or more arguments and displays all files in the tree that match that argument. The argument may have wildcards. It is somewhat similar to the Unix command **find / -name arg**.

ls

The **ls** command produces a listing of all the files contained in the current directory much like the Unix **ls** command. You may specify an argument containing wildcards, in which case only those files will be listed. Any file that is marked to be restored will have its name preceded by an asterisk (*). Directory names will be terminated with a forward slash (/) to distinguish them from filenames.

lsmark

The **lsmark** command is the same as the **ls** except that it will print only those files marked for extraction. The other distinction is that it will recursively descend into any directory selected.

mark

The **mark** command allows you to mark files to be restored. It takes a single argument which is the filename or directory name in the current directory to be marked for extraction. The argument may be a wildcard specification, in which case all files that match in the current directory are marked to be restored. If the argument matches a directory rather than a file, then the directory and all files contained in that directory (recursively) are marked to be restored. Any marked file will have its name preceded with an asterisk (*) in the output produced by the **ls** or **dir** commands. Note, supplying a full path on the mark command does not work as expected to select a file or directory in the current directory. Also, the **mark** command works on the current and lower directories but does not touch higher level directories.

After executing the **mark** command, it will print a brief summary:

```
No files marked.
```

If no files were marked, or:

```
nn files marked.
```

if some files are marked.

unmark

The **unmark** is identical to the **mark** command, except that it unmarks the specified file or files so that they will not be restored. Note: the **unmark** command works from the current directory, so it does not unmark any files at a higher level. First do a **cd /** before the **unmark *** command if you want to unmark everything.

pwd

The **pwd** command prints the current working directory. It accepts no arguments.

count

The **count** command prints the total files in the directory tree and the number of files marked to be restored.

done

This command terminates file selection mode.

exit

This command terminates file selection mode (the same as done).

quit

This command terminates the file selection and does not run the restore job.

help

This command prints a summary of the commands available.

?

This command is the same as the **help** command.



The Console Program



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Maintaining Your Catalog

[Bacula 1.34 User's Guide](#)

The Network Backup Solution

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Restoring Files



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Automatic Volume Recycling

Catalog Maintenance

Without proper setup and maintenance, your Catalog may continue to grow indefinitely as you run Jobs and backup Files. How fast the size of your Catalog grows depends on the number of Jobs you run and how many files they backup. By deleting records within the database, you can make space available for the new records that will be added during the next Job. By constantly deleting old expired records (dates older than the Retention period), your database size will remain constant.

If you started with the default configuration files, they already contain reasonable defaults for a small number of machines (less than 5), so if you fall into that case, catalog maintenance will not be urgent if you have a few hundred megabytes of disk space free. Whatever the case may be, some knowledge of retention periods will be useful.

Setting Retention Periods

Bacula uses three Retention periods: the **File Retention** period, the **Job Retention** period, and the **Volume Retention** period. Of these three, the File Retention period is by far the most important in determining how large your database will become.

The **File Retention** and the **Job Retention** are specified in each Client resource as is shown below. The **Volume Retention** period is specified in the Pool resource, and the details are given in the next chapter of this manual.

File Retention = <time-period-specification>

The File Retention record defines the length of time that Bacula will keep File records in the Catalog database. When this time period expires, and if **AutoPrune** is set to **yes**, Bacula will prune (remove) File records that are older than the specified File Retention period. The pruning will occur at the end of a backup Job for the given Client. Note that the Client database record contains a copy of the File and Job retention periods, but Bacula uses the current values found in the Director's Client resource to do the pruning. Retention periods are specified in seconds, but as a convenience, there are a number of modifiers that permit easy specification in terms of minutes, hours, days, weeks, months, quarters, or years on the record. See the [Configuration chapter](#) of this manual for additional details of modifier specification.

The default is 60 days.

Job Retention = <time-period-specification>

The Job Retention record defines the length of time that **Bacula** will keep Job records in the Catalog database. When this time period expires, and if **AutoPrune** is set to **yes** Bacula will prune (remove) Job records that are older than the specified File Retention period. Note, if a Job record is selected for pruning, all associated File and JobMedia records will also be pruned regardless of the File Retention period set. As a consequence, you normally will set the File retention period to be less than the Job retention period. The retention period is specified in seconds, but as a convenience, there are a number of modifiers that permit easy specification in terms of minutes, hours, days, weeks, months, quarters, or years. See the [Configuration chapter](#) of this manual for additional details of modifier specification.

The default is 180 days.

AutoPrune = <yes/no>

If AutoPrune is set to **yes** (default), Bacula will automatically apply the File retention period and the Job retention period for the Client at the end of the Job.

If you turn this off by setting it to **no**, your Catalog will grow each time you run a Job.

Compacting Your MySQL Database

Over time, as noted above, your database will tend to grow. I've noticed that even though Bacula regularly prunes files, **MySQL** does not effectively use the space, and instead continues growing. To avoid this, from time to time, you must compact your database. Normally, large commercial database such as Oracle have commands that will compact a database to reclaim wasted file space. MySQL has the **OPTIMIZE TABLE** command that you can use, and SQLite version 2.8.4 and greater has the **VACUUM** command. We leave it to you to explore the utility of the **OPTIMIZE TABLE** command in MySQL.

All database programs have some means of writing the database out in ASCII format and then reloading it. Doing so will re-create the database from scratch producing a compacted result, so below, we show you how you can do this for both MySQL and SQLite.

For a **MySQL** database, you could write the Bacula database as an ASCII file (bacula.sql) then reload it by doing the following:

```
mysqldump -f --opt bacula > bacula.sql
mysql bacula < bacula.sql
rm -f bacula.sql
```

Depending on the size of your database, this will take more or less time and a fair amount of disk space. For example, if I cd to the location of the MySQL Bacula database (typically /opt/mysql/var or something similar) and enter:

```
du bacula
```

I get **620,644** which means there are that many blocks containing 1024 bytes each or approximately 635 MB of data. After doing the **mysqldump**, I had a bacula.sql file that had **174,356** blocks, and after doing the **mysql** command to recreate the database, I ended up with a total of **210,464** blocks rather than the original **629,644**. In other words, the compressed version of the database took approximately one third of the space of the database that had been in use for about a year.

As a consequence, I suggest you monitor the size of your database and from time to time (once every 6 months or year), compress it.

Repairing Your MySQL Database

If you find that you are getting errors writing to your MySQL database, or Bacula hangs each time it tries to access the database, you should consider running MySQL's database check and repair routines. The program you need to run depends on the type of database indexing you are

using. If you are using the default, you will probably want to use **myisamchk**. For more details on how to do this, please consult the MySQL document at:
<http://www.mysql.com/doc/en/Repair.html>.

Compacting Your PostgreSQL Database

Over time, as noted above, your database will tend to grow. I've noticed that even though Bacula regularly prunes files, PostgreSQL has a **VACUUM** command that will compact your database for you. Alternatively you may want to use the **vacuumdb** command, which can be run from a cron job.

All database programs have some means of writing the database out in ASCII format and then reloading it. Doing so will re-create the database from scratch producing a compacted result, so below, we show you how you can do this for PostgreSQL.

For a **PostgreSQL** database, you could write the Bacula database as an ASCII file (bacula.sql) then reload it by doing the following:

```
pg_dump bacula > bacula.sql
cat bacula.sql | psql bacula
rm -f bacula.sql
```

Depending on the size of your database, this will take more or less time and a fair amount of disk space. For example, you can **cd** to the location of the Bacula database (typically /usr/local/pgsql/data or possible /var/lib/pgsql/data) and check the size.

Compacting Your SQLite Database

First please read the previous section that explains why it is necessary to compress a database. SQLite version 2.8.4 and greater have the **Vacuum** command for compacting the database.

```
cd working-directory
echo 'vacuum' | sqlite bacula.db
```

As an alternative, you can use the following commands, adapted to your system:

```
cd working-directory
echo '.dump' | sqlite bacula.db > bacula.sql
rm -f bacula.db
sqlite bacula.db < bacula.sql
rm -f bacula.sql
```

Where **working-directory** is the directory that you specified in the Director's configuration file. Note, in the case of SQLite, it is necessary to completely delete (rm) the old database before creating a new compressed version.

Migrating from SQLite to MySQL

You may begin using Bacula with SQLite then later find that you want to switch to MySQL for any of a number of reasons: SQLite tends to use more disk than MySQL, SQLite apparently does not handle database sizes greater than 2GBytes, ... Several users have done so by first producing

an ASCII "dump" of the SQLite database, then creating the MySQL tables with the **create_mysql_tables** script that comes with Bacula, and finally feeding the SQLite dump into MySQL using the **-f** command line option to continue past the errors that are generated by the DDL statements that SQLite's dump creates. Of course, you could edit the dump and remove the offending statements. Otherwise, MySQL accepts the SQL produced by SQLite.

Backing Up Your Bacula Database

If ever the machine on which you Bacula database crashes, and you need to restore from backup tapes, one of your first priorities will probably be to recover the database. Although Bacula will happily backup your catalog database if it is specified in the FileSet, this is not a very good way to do it because the database will be saved while Bacula is modifying it. Thus the database may be in an unstable state. Worse yet, you will backup the database before all the Bacula updates have been applied.

To resolve these problems, you need backup the database after all the backup jobs have been run. In addition, you will want to make a copy while Bacula is not modifying it. To do so, you can use two scripts provided in the release **make_catalog_backup** and **delete_catalog_backup**. These files will be automatically generated along with all the other Bacula scripts. The first script will make an ASCII copy of your Bacula database into **bacula.sql** in the working directory you specified on your configuration, and the second will delete the **bacula.sql** file.

The basic sequence of events to make this work correctly is as follows:

- Run all your nightly backups
- After running your nightly backups, run a Catalog backup Job
- The Catalog backup job must be scheduled after your last nightly backup
- You use **RunBeforeJob** to create the ASCII backup file and **RunAfterJob** to clean up

Assuming that you start all your nightly backup jobs at 1:05 am (and that they run one after another), you can do the catalog backup with the following additional Director configuration statements:

```
# Backup the catalog database (after the nightly save)
Job {
    Name = "BackupCatalog"
    Type = Backup
    Client=rufus-fd
    FileSet="Catalog"
    Schedule = "WeeklyCycleAfterBackup"
    Storage = DLTDrive
    Messages = Standard
    Pool = Default
    RunBeforeJob = "/home/kern/bacula/bin/make_catalog_backup"
    RunAfterJob = "/home/kern/bacula/bin/delete_catalog_backup"
}

# This schedule does the catalog. It starts after the WeeklyCycle
Schedule {
    Name = "WeeklyCycleAfterBackup"
    Run = Full sun-sat at 1:10
}

# This is the backup of the catalog
```

```
FileSet {
    Name = "Catalog"
    Include = signature=MD5 {
        @working_directory@/bacula.sql
    }
}
```

Backing Up Third Party Databases

If you are running a database in production mode on your machine, Bacula will happily backup the files, but if the database is in use while Bacula is reading it, you may back it up in an unstable state.

The best solution is to shutdown your database before backing it up, or use some tool specific to your database to make a valid live copy perhaps by dumping the database in ASCII format. I am not a database expert, so I cannot provide you advice on how to do this, but if you are unsure about how to backup your database, you might try visiting the Backup Central site, which has been renamed Storage Mountain (www.backupcentral.com). In particular, their [Free Backup and Recovery Software](#) page has links to scripts that show you how to shutdown and backup most major databases.

Database Size

As mentioned above, if you do not do automatic pruning, your Catalog will grow each time you run a Job. Normally, you should decide how long you want File records to be maintained in the Catalog and set the **File Retention** period to that time. Then you can either wait and see how big your Catalog gets or make a calculation assuming approximately 154 bytes for each File saved and knowing the number of Files that are saved during each backup and the number of Clients you backup.

For example, suppose you do a backup of two systems, each with 100,000 files. Suppose further that you do a Full backup weekly and an Incremental every day, and that the Incremental backup typically saves 4,000 files. The size of your database after a month can roughly be calculated as:

$$\text{Size} = 154 * \text{No. Systems} * (100,000 * 4 + 10,000 * 26)$$

where we have assumed 4 weeks in a month and 26 incremental backups per month. This would give the following:

$$\begin{aligned} \text{Size} &= 154 * 2 * (100,000 * 4 + 10,000 * 26) \\ \text{or} \\ \text{Size} &= 308 * (400,000 + 260,000) \\ \text{or} \\ \text{Size} &= 203,280,000 \text{ bytes} \end{aligned}$$

So for the above two systems, we should expect to have a database size of approximately 200 Megabytes. Of course, this will vary according to how many files are actually backed up.

Below are some statistics for a MySQL database containing Job records for five Clients beginning September 2001 through May 2002 (8.5 months) and File records for the last 80 days. (Older File records have been pruned). For these systems, only the user files and system files that

change are backed up. The core part of the system is assumed to be easily reloaded from the RedHat rpms.

In the list below, the files (corresponding to Bacula Tables) with the extension .MYD contain the data records whereas files with the extension .MYI contain indexes.

You will note that the File records (containing the file attributes) make up the large bulk of the number of records as well as the space used (459 Mega Bytes including the indexes). As a consequence, the most important Retention period will be the **File Retention** period. A quick calculation shows that for each File that is saved, the database grows by approximately 150 bytes.

Size in Bytes	Records	File
=====	=====	=====
168	5	Client.MYD
3,072		Client.MYI
344,394,684	3,080,191	File.MYD
115,280,896		File.MYI
2,590,316	106,902	Filename.MYD
3,026,944		Filename.MYI
184	4	FileSet.MYD
2,048		FileSet.MYI
49,062	1,326	JobMedia.MYD
30,720		JobMedia.MYI
141,752	1,378	Job.MYD
13,312		Job.MYI
1,004	11	Media.MYD
3,072		Media.MYI
1,299,512	22,233	Path.MYD
581,632		Path.MYI
36	1	Pool.MYD
3,072		Pool.MYI
5	1	Version.MYD
1,024		Version.MYI

This database has a total size of approximately 450 Megabytes.

If we were using SQLite, the determination of the total database size would be much easier since it is a single file, but we would have less insight to the size of the individual tables as we have in this case.

Note, SQLite databases may be as much as 50% larger than MySQL databases due to the fact that all data is stored as ASCII strings. That is even binary integers are stored as ASCII strings, and this seems to increase the space needed.



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Backing Up to Disk Volumes

Automatic Volume Recycling

Normally, Bacula will write on a volume, and once the tape is written, it can append to the volume, but it will never overwrite the data thus destroying it. When we speak of **recycling** volumes, we mean that **Bacula** can write over the previous contents of a volume. Thus all previous data will be lost.

If you are like me, you may not want Bacula to automatically recycle (reuse) tapes. This requires a large number of tapes, and when I need a tape, I manually recycle it. For more on manual recycling, see the section entitled [Manually Recycling Volumes](#) below in this chapter.

Most people prefer to have a Pool of tapes that are used for daily backups and recycled once a week, another Pool of tapes that are used for Full backups once a week and recycled monthly, and finally a Pool of tapes that are used once a month and recycled after a year or two. With a scheme like this, your pool of tapes remains constant.

By properly defining your Volume Pools with appropriate Retention periods, Bacula can manage the recycling (such as defined above) automatically.

Automatic recycling of Volumes is controlled by three records in the **Pool** resource definition in the Director's configuration file. These three records are:

- AutoPrune = yes
- VolumeRetention = <time>
- Recycle = yes

Automatic recycling of Volumes is performed by Bacula only when it wants a new Volume and no appendable Volumes are available in the Pool. It will then search the Pool for any Volumes with the **Recycle** flag set and whose Volume Status is **Full**. At that point, the recycling occurs in two steps. The first is that a Volume must be purged of all Jobs and Files, and the second step is the actual recycling of the Volume. The Volume will be purged if the VolumeRetention period has expired. If no volumes can be recycled for any of the reasons stated above, Bacula will request operator intervention (i.e. it will ask you to label a new volume).

A key point mentioned above that can be a source of frustration is that Bacula will only recycle purged Volumes if there is no other appendable Volume available. So, if you wish to "force" Bacula to use a purged Volume, you must first ensure that no other Volume in the Pool is marked **Append**. If necessary, you can manually set a volume to **Full**. The reason for this is that Bacula wants to preserve the data on your old tapes (even though purged from the catalog) as long as absolutely possible before overwriting it.

Automatic Pruning

By setting **AutoPrune** to **yes** you will permit **Bacula** to automatically prune all Volumes in the Pool when a Job needs another Volume. When a Job requests another volume and there are no Volumes with Volume Status **Append** available, Bacula will begin volume pruning. This means that all Jobs that are older than the **VolumeRetention** period will be pruned from every Volume that has Volume Status **Full** or **Used** and has Recycle set to **yes**. Pruning consists of deleting the corresponding Job, File, and JobMedia records from the catalog database. No change to the physical data on the Volume occurs during the pruning process. When all files are pruned from a

Volume (i.e. no records in the catalog), the Volume will be marked as **Purged** implying that no Jobs remain on the volume. The Pool records that control the pruning are described below.

AutoPrune = <yes/no>

If AutoPrune is set to **yes** (default), Bacula (version 1.20 or greater) will automatically apply the Volume retention period when running a Job and it needs a new Volume but no appendable volumes are available. At that point, Bacula will prune all Volumes that can be pruned (i.e. AutoPrune set) in an attempt to find a usable volume. If during the autopruning, all files are pruned from the Volume, it will be marked with VolStatus **Purged**. The default is **yes**.

Volume Retention = <time-period-specification>

The Volume Retention record defines the length of time that Bacula will guarantee that the Volume is not reused counting from the time the last job stored on the Volume terminated.

When this time period expires, and if **AutoPrune** is set to **yes**, and a new Volume is needed, but no appendable Volume is available, Bacula will prune (remove) Job records that are older than the specified Volume Retention period.

The Volume Retention period takes precedence over any Job Retention period you have specified in the Client resource. It should also be noted, that the Volume Retention period is obtained by reading the Catalog Database Media record rather than the Pool resource record. This means that if you change the VolumeRetention in the Pool resource record, you must ensure that the corresponding change is made in the catalog by using the **update pool** command. Doing so will insure that any new Volumes will be created with the changed Volume Retention period. Any existing Volumes will have their own copy of the Volume Retention period that can only be changed on a Volume by Volume basis using the **update volume** command.

When all file catalog entries are removed from the volume, its VolStatus is set to **Purged**. The files remain physically on the Volume until the volume is overwritten.

Retention periods are specified in seconds, minutes, hours, days, weeks, months, quarters, or years on the record. See the [Configuration chapter](#) of this manual for additional details of time specification.

The default is 1 year.

Recycle = <yes/no>

This statement tells Bacula whether or not the particular Volume can be recycled (i.e. rewritten). If Recycle is set to **no** (the default), then even if Bacula prunes all the Jobs on the volume and it is marked **Purged**, it will not consider the tape for recycling. If Recycle is set to **yes** and all Jobs have been pruned, the volume status will be set to **Purged** and the volume may then be reused when another volume is needed. If the volume is reused, it is relabeled with the same Volume Name, however all previous data will be lost.

Note, it is also possible to "force" pruning of all Volumes in the Pool associated with a Job by adding **Prune Files = yes** to the Job resource.

Recycling Algorithm

After all Volumes of a Pool have been pruned (as mentioned above, this happens when a Job needs a new Volume and no appendable Volumes are available), Bacula will look for the oldest Volume that is Purged (all Jobs and Files expired), and if the **Recycle** flag is on (Recycle=yes) for that Volume, Bacula will relabel it and write new data on it.

The full recycling algorithm that Bacula uses when it needs a new Volume is:

- Search the Pool for a Volume with VolStatus=Append (if there is more than one, the Volume with the oldest date last written is chosen. If two have the same date then the one with the lowest MediaId is chosen).
- Search the Pool for a Volume with VolStatus=Recycle (if there is more than one, the Volume with the oldest date last written is chosen. If two have the same date then the one with the lowest MediaId is chosen).
- Prune volumes applying Volume retention period (Volumes with VolStatus Full, Used, or Append are pruned).
- Search the Pool for a Volume with VolStatus=Purged
- Attempt to create a new Volume if automatic labeling enabled
- Prune the oldest Volume if RecycleOldestVolume=yes (the Volume with the oldest LastWritten date and VolStatus equal to Full, Recycle, Purged, Used, or Append is chosen). This record ensures that all retention periods are properly respected.
- Purge the oldest Volume if PurgeOldestVolume=yes (the Volume with the oldest LastWritten date and VolStatus equal to Full, Recycle, Purged, Used, or Append is chosen). We strongly recommend against the use of **PurgeOldestVolume** as it can quite easily lead to loss of current backup data.
- Give up and ask operator.

The above occurs when Bacula has finished writing a Volume or when no Volume is present in the drive.

On the other hand, if you have inserted a different Volume after the last job, and Bacula recognizes the Volume as valid, it will request authorization from the Director to use this Volume. In this case, if you have set **Recycle Current Volume = yes** and the Volume is marked as Used or Full, Bacula will prune the volume and if all jobs were removed during the pruning (respecting the retention periods), the Volume will be recycled and used. For this to work, you must have **Accept Any Volume = yes** in the Pool. The recycling algorithm in this case is:

- If the VolStatus is **Append** or **Recycle** and **Accept Any Volume** is set, the volume will be used.
- If **Recycle Current Volume** is set and the volume is marked **Full** or **Used**, Bacula will prune the volume (applying the retention period). If all Jobs are pruned from the volume, it will be recycled.

This permits users to manually change the Volume every day and load tapes in an order different from what is in the catalog, and if the volume does not contain a current copy of your backup data, it will be used.

Recycle Status

Each Volume inherits the Recycle status (yes or no) from the Pool resource record when the Media record is created (normally when the Volume is labeled). This Recycle status is stored in the Media record of the Catalog. Using the the Console program, you may subsequently change the Recycle status for each Volume. For example in the following output from **list volumes**:

VolumeNa	Media	VolSta	VolByte	LastWritte	VolRet	Rec
File0001	File	Full	4190055	2002-05-25	14400	1
File0002	File	Full	1896460	2002-05-26	14400	1
File0003	File	Full	1896460	2002-05-26	14400	1
File0004	File	Full	1896460	2002-05-26	14400	1
File0005	File	Full	1896460	2002-05-26	14400	1
File0006	File	Full	1896460	2002-05-26	14400	1
File0007	File	Purged	1896466	2002-05-26	14400	1

all the volumes are marked as recyclable, and the last Volume, **File0007** has been purged, so it may be immediately recycled. The other volumes are all marked recyclable and when their Volume Retention period (14400 seconds or 4 hours) expires, they will be eligible for pruning, and possible recycling. Even though Volume **File0007** has been purged, all the data on the Volume is still recoverable. A purged Volume simply means that there are no entries in the Catalog. Even if the Volume Status is changed to **Recycle**, the data on the Volume will be recoverable. The data is lost only when the Volume is re-labeled and re-written.

To modify Volume **File0001** so that it cannot be recycled, you use the **update volume pool=File** command in the console program, or simply **update** and Bacula will prompt you for the information.

VolumeNa	Media	VolSta	VolByte	LastWritten	VolRet	Rec
File0001	File	Full	4190055	2002-05-25	14400	0
File0002	File	Full	1897236	2002-05-26	14400	1
File0003	File	Full	1896460	2002-05-26	14400	1
File0004	File	Full	1896460	2002-05-26	14400	1
File0005	File	Full	1896460	2002-05-26	14400	1
File0006	File	Full	1896460	2002-05-26	14400	1
File0007	File	Purged	1896466	2002-05-26	14400	1

In this case, **File0001** will never be automatically recycled. The same effect can be achieved by setting the Volume Status to Read-Only.

Making Bacula Use a Single Tape

Most people will want Bacula to fill a tape and when it is full, a new tape will be mounted, and so on. However, as an extreme example, it is possible for Bacula to write on a single tape, and every night to rewrite it. To get this to work, you must do two things: first, set the VolumeRetention to less than your save period (one day), and the second item is to make Bacula mark the tape as full after using it once. This is done using **UseVolumeOnce = yes**. If this latter

record is not used and the tape is not full after the first time it is written, Bacula will simply append to the tape and eventually request another volume. Using the tape only once, forces the tape to be marked **Full** after each use, and the next time **Bacula** runs, it will recycle the tape.

An example Pool resource that does this is:

```
Pool {  
    Name = DDS-4  
    Use Volume Once = yes  
    Pool Type = Backup  
    AutoPrune = yes  
    VolumeRetention = 12h # expire after 12 hours  
    Recycle = yes  
}
```

A Daily, Weekly, Monthly Tape Usage Example

This example is meant to show you how one could define a fixed set of volumes that Bacula will rotate through on a regular schedule. There are an infinite number of such schemes, all of which have various advantages and disadvantages.

We start with the following assumptions:

- A single tape has more than enough capacity to do a full save.
- There are 10 tapes that are used on a daily basis for incremental backups. They are pre-labeled Daily1 ... Daily10.
- There are 4 tapes that are used on a weekly basis for full backups. They are labeled Week1 ... Week4.
- There are 12 tapes that are used on a monthly basis for full backups. They are numbered Month1 ... Month12
- A full backup is done every Saturday evening (tape inserted Friday evening before leaving work).
- No backups are done over the weekend (this is easy to change).
- The first Friday of each month, a Monthly tape is used for the Full backup.
- Incremental backups are done Monday – Friday (actually Tue–Fri mornings).

We start the system by doing a Full save to one of the weekly volumes or one of the monthly volumes. The next morning, we remove the tape and insert a Daily tape. Friday evening, we remove the Daily tape and insert the next tape in the Weekly series. Monday, we remove the Weekly tape and re-insert the Daily tape. On the first Friday of the next month, we insert the next Monthly tape in the series rather than a Weekly tape, then continue. When a Daily tape finally fills up, **Bacula** will request the next one in the series, and the next day when you notice the email message, you will mount it and **Bacula** will finish the unfinished incremental backup.

What does this give? Well, at any point, you will have a the last complete Full save plus several Incremental saves. For any given file your want to recover (or your whole system), you will have a copy of that file every day for at least the last 14 days. For older versions, you will have at least 3 and probably 4 Friday full saves of that file, and going back further, you will have a copy of that file made on the beginning of the month for at least a year.

So you have copies of any file (or your whole system) for at least a year, but as you go back in time, the time between copies increases from daily to weekly to monthly.

What would the Bacula configuration look like to implement such a scheme?

```
Schedule {
    Name = "NightlySave"
    Run = Level=Full Pool=Monthly 1st sat at 03:05
    Run = Level=Full Pool=Weekly 2nd-5th sat at 03:05
    Run = Level=Incremental Pool=Daily tue-fri at 03:05
}

Job {
    Name = "NightlySave"
    Type = Backup
    Level = Full
    Client = LocalMachine
    FileSet = "File Set"
    Messages = Standard
    Storage = DDS-4
    Pool = Daily
    Schedule = "NightlySave"
}

# Definition of file storage device
Storage {
    Name = DDS-4
    Address = localhost
    SDPort = 9103
    Password = XXXXXXXXXXXXXXXX
    Device = FileStorage
    Media Type = 8mm
}

FileSet {
    Name = "File Set"
    Include = signature=MD5 {
        ffffffffffffffffffff
    }
    Exclude = { *.o }
}

Pool {
    Name = Daily
    Pool Type = Backup
    AutoPrune = yes
    VolumeRetention = 10d # recycle in 10 days
    Maximum Volumes = 10
    Recycle = yes
}

Pool {
    Name = Weekly
    Use Volume Once = yes
    Pool Type = Backup
    AutoPrune = yes
    VolumeRetention = 30d # recycle in 30 days (default)
    Recycle = yes
}

Pool {
    Name = Monthly
    Use Volume Once = yes
    Pool Type = Backup
}
```



```

AutoPrune = yes
VolumeRetention = 365d # recycle in 1 year
Recycle = yes
}

```

Automatic Pruning and Recycling Example

Perhaps the best way to understand the various resource records that come into play during automatic pruning and recycling is to run a Job that goes through the whole cycle. If you add the following resources to your Director's configuration file:

```

Schedule {
    Name = "30 minute cycle"
    Run = Level=Full Pool=File Messages=Standard Storage=File
        hourly at 0:05
    Run = Level=Full Pool=File Messages=Standard Storage=File
        hourly at 0:35
}

Job {
    Name = "Filetest"
    Type = Backup
    Level = Full
    Client=XXXXXXXXXX
    FileSet="Test Files"
    Messages = Standard
    Storage = File
    Pool = File
    Schedule = "30 minute cycle"
}

# Definition of file storage device
Storage {
    Name = File
    Address = XXXXXXXXXXXX
    SDPort = 9103
    Password = XXXXXXXXXXXXXXXX
    Device = FileStorage
    Media Type = File
}

FileSet {
    Name = "Test Files"
    Include = signature=MD5 {
        ffffffffffffffffffff
    }
    Exclude = { *.o }
}

Pool {
    Name = File
    Use Volume Once = yes
    Pool Type = Backup
    LabelFormat = "File"
    AutoPrune = yes
    VolumeRetention = 4h
    Maximum Volumes = 12
    Recycle = yes
}

```

Where you will need to replace the **ffffff**'s by the appropriate files to be saved for your configuration. For the FileSet Include, choose a directory that has one or two megabytes maximum since there will probably be approximately 8 copies of the directory that **Bacula** will cycle through.

In addition, you will need to add the following to your Storage daemon's configuration file:

```
Device {  
    Name = FileStorage  
    Media Type = File  
    Archive Device = /tmp  
    LabelMedia = yes;  
    Random Access = Yes;  
    AutomaticMount = yes;  
    RemovableMedia = no;  
    AlwaysOpen = no;  
}
```

With the above resources, Bacula will start a Job every half hour that saves a copy of the directory you chose to /tmp/File0001 ... /tmp/File0012. After 4 hours, Bacula will start recycling the backup Volumes (/tmp/File0001 ...). You should see this happening in the output produced. Bacula will automatically create the Volumes (Files) the first time it uses them.

To turn it off, either delete all the resources you've added, or simply comment out the **Schedule** record in the **Job** resource.

Manually Recycling Volumes

Although automatic recycling of Volumes is implemented in version 1.20 and later (see the [Automatic Recycling of Volumes](#) chapter of this manual), you may want to manually force reuse (recycling) of a Volume.

Assuming that you want to keep the Volume name, but you simply want to write new data on the tape, the steps to take are:

- Use the **update volume** command in the Console to ensure that the **Recycle** field is set to **1**
- Use the **purge jobs volume** command in the Console to mark the Volume as **Purged**. Check by using **list volumes**.

Once the Volume is marked Purged, it will be recycled the next time a Volume is needed.

If you wish to reuse the tape by giving it a new name, follow the following steps:

- Use the **purge jobs volume** command in the Console to mark the Volume as **Purged**. Check by using **b>list volumes**.
- In Bacula version 1.30 or greater, use the Console **relabel** command to relabel the Volume.

Please note that the relabel command applies only to tape Volumes.

For Bacula versions prior to 1.30 or to manually relabel the Volume, use the instructions below:

- Use the **delete volume** command in the Console to delete the Volume from the Catalog.
- If the a different tape is mounted, use the **unmount** command, remove the tape, and insert the tape to be renamed.
- Write an EOF mark in the tape using the following commands:

```
mt -f /dev/nst0 rewind
mt -f /dev/nst0 weof
```

where you replace **/dev/nst0** with the appropriate device name on your system.

- Use the **label** command to write a new label to the tape and to enter it in the catalog.

Please be aware that the **delete** command can be dangerous. Once it is done, to recover the File records, you must either restore your database as it was before the **delete** command, or use the **bscan** utility program to scan the tape and recreate the database entries.



Catalog Maintenance



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Backing Up to Disk Volumes

[Bacula 1.34 User's Guide](#)

The Network Backup Solution

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Recycling Your Volumes



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Using Pools to Manage Disk Volumes

Backing Up to Disk Volumes

If you have a lot of hard disk storage or you absolutely must have your backups run within a small time window, you may want to direct Bacula to backup to disk Volumes rather than tape Volumes. This chapter is intended to give you some of the options that are available to you so that you can manage those disk volumes.

Key Concepts and Resource Records

Getting Bacula to write to disk rather than tape in the simplest case is rather easy. In the Storage daemon's configuration file, you simply define an **Archive Device** to be a directory. For example, if you want your disk backups to go into the directory `/home/bacula/backups`, you could use the following:

```
Device {
    Name = FileBackup
    Media Type = File
    Archive Device = /home/bacula/backups
    Random Access = Yes;
    AutomaticMount = yes;
    RemovableMedia = no;
    AlwaysOpen = no;
}
```

Assuming you have the appropriate **Storage** resource in your Director's configuration file that references the above Device resource,

```
Storage {
    Name = FileStorage
    Address = ...
    Password = ...
    Device = FileBackup
    Media Type = File
}
```

Bacula will then write the archive to the file `/home/bacula/backups/<volume-name>` where `<volume-name>` is the volume name of a Volume defined in the Pool. For example, if you have labeled a Volume named **Vol001**, Bacula will write to the file `/home/bacula/backups/Vol001`. Although you can later move the archive file to another directory, you should not rename it or it will become unreadable by Bacula. This is because each archive has the filename as part of the internal label, and the internal label must agree with the system filename before Bacula will use it.

Although this is quite simple, there are a number of problems, the first is that unless you specify otherwise, Bacula will always write to the same volume until you run out of disk space.

Pool Options to Limit the Volume Usage

Some of the options you have, all of which are specified in the Pool record, are:

- To write each Volume only once (i.e. one Job per Volume or file in this case), use:

UseVolumeOnce = yes.

- To write nnn Jobs to each Volume, use:

Maximum Volume Jobs = nnn.

- To limit the maximum size of each Volume, use:

Maximum Volume Bytes = mmmm.

- To limit the use time (i.e. write the Volume for a maximum of 5 days), use:

Volume Use Duration = ttt.

As mentioned above, each of those directives are specified in the Pool or Pools that you use for your Volumes. In the case of **Maximum Job Volumes**, **Maximum Volume Bytes**, and **Volume Use Duration**, you can actually specify the desired value on a Volume by Volume basis. The value specified in the Pool record becomes the default when labeling new Volumes. As an example of the use of one of the above, suppose your Pool resource contains:

```
Pool {
    Name = File
    Pool Type = Backup
    Volume Use Duration = 23h
}
```

then if you run a backup once a day (every 24 hours), Bacula will use a new Volume each backup because each Volume it writes can only be used for 23 hours after the first write.

Automatic Volume Labeling

Use of the above records brings up another problem — that of labeling your Volumes. For automated disk backup, you can either manually label each of your Volumes, or you can have Bacula automatically label new Volumes when they are needed. While, the automatic Volume labeling in version 1.30 and prior is a bit simplistic, but it does allow for automation, the features added in version 1.31 permit automatic creation of a wide variety of labels including information from environment variables and special Bacula Counter variables. Automatic Volume labeling is enabled by making a change to both the Pool resource (Director) and to the Device resource (Storage daemon) shown above. In the case of the Pool resource, you must provide Bacula with a label format that it will use to create new names. In the simplest form, the label format is simply the Volume name, to which Bacula will append a four digit number. This number starts at 0001 and is incremented for each Volume the pool contains. Thus if you modify your Pool resource to be:

```
Pool {
    Name = File
    Pool Type = Backup
    Volume Use Duration = 23h
    LabelFormat = "Vol"
}
```

Bacula will create Volume names Vol0001, Vol0002, and so on when new Volumes are needed.

Much more complex and elaborate labels can be created using variable expansion defined in the [Variable Expansion](#) chapter of this manual.

The second change that is necessary to make automatic labeling work is to give the Storage daemon permission to automatically label Volumes. Do so by adding **LabelMedia = yes** to the Device resource as follows:

```
Device {  
    Name = File  
    Media Type = File  
    Archive Device = /home/bacula/backups  
    Random Access = Yes;  
    AutomaticMount = yes;  
    RemovableMedia = no;  
    AlwaysOpen = no;  
    LabelMedia = yes  
}
```

You can find more details of the **Label Format** Pool record in [Label Format](#) description of the Pool resource records.

Restricting the Number of Volumes and Recycling

Automatic labeling discussed above brings up the problem of Volume management. With the above scheme, a new Volume will be created every day. If you have not specified Retention periods, your Catalog will continue to fill keeping track of all the files Bacula has backed up, and this procedure will create one new archive file (Volume) every day.

The tools Bacula gives you to help automatically manage these problems are the following:

1. Catalog file record retention periods, the [File Retention = ttt](#) record in the Client resource.
2. Catalog job record retention periods, the [Job Retention = ttt](#) record in the Client resource.
3. The [AutoPrune = yes](#) record in the Client resource to permit application of the above two retention periods.
4. The [Volume Retention = ttt](#) record in the Pool resource.
5. The [AutoPrune = yes](#) record in the Pool resource to permit application of the Volume retention period.
6. The [Recycle = yes](#) record in the Pool resource to permit automatic recycling of Volumes whose Volume retention period has expired.
7. The [Recycle Oldest Volume = yes](#) record in the Pool resource tells Bacula to Prune the oldest volume in the Pool, and if all files were pruned to recycle this volume and use it.
8. The [Recycle Current Volume = yes](#) record in the Pool resource tells Bacula to Prune the currently mounted volume in the Pool, and if all files were pruned to recycle this volume and use it.
9. The [Purge Oldest Volume = yes](#) record in the Pool resource permits a forced recycling of the oldest Volume when a new one is needed. **N.B. This record ignores retention periods! We highly recommend not to use this record, but instead use Recycle Oldest Volume**
10. The [Maximum Volumes = nnn](#) record in the Pool resource to limit the number of Volumes that can be created.

The first three records (File Retention, Job Retention, and AutoPrune) determine the amount of time that Job and File records will remain in your Catalog, and they are discussed in detail in the [Automatic Volume Recycling](#) chapter of this manual.

Volume Retention, AutoPrune, and Recycle determine how long Bacula will keep your Volumes before reusing them, and they are also discussed in detail in the [Automatic Volume Recycling](#) chapter of this manual.

The Maximum Volumes record can also be used in conjunction with the Volume Retention period to limit the total number of archive Volumes (files) that Bacula will create. By setting an appropriate Volume Retention period, a Volume will be purged just before it is needed and thus Bacula can cycle through a fixed set of Volumes. Cycling through a fixed set of Volumes can also be done by setting **Recycle Oldest Volume = yes** or **Recycle Current Volume = yes**. In this case, when Bacula needs a new Volume, it will prune the specified volume.

An Example

The following example is not very practical, but can be used to demonstrate the proof of concept in a relatively short period of time. The example consists of a single client that is backed up to a set of 12 archive files (Volumes). Each Volume is used (written) only once, and there are four Full saves done every hour (so the whole thing cycles around after three hours).

The Director's configuration file is as follows:

```
Director {
    Name = my-dir
    QueryFile = "~/bacula/bin/query.sql"
    PidDirectory = "~/bacula/working"
    WorkingDirectory = "~/bacula/working"
    Password = dir_password
}

Schedule {
    Name = "FourPerHour"
    Run = Level=Full Pool=Recycle Storage=File hourly at 0:05
    Run = Level=Full Pool=Recycle Storage=File hourly at 0:20
    Run = Level=Full Pool=Recycle Storage=File hourly at 0:35
    Run = Level=Full Pool=Recycle Storage=File hourly at 0:50
}

Job {
    Name = "RecycleExample"
    Type = Backup
    Level = Full
    Client = Rufus
    FileSet= "Example FileSet"
    Messages = Standard
    Storage = FileStorage
    Pool = Recycle
    Schedule = FourPerHour
}

FileSet {
    Name = "Example FileSet"
    Include = compression=GZIP signature=SHA1 {
        /home/kern/bacula/bin
```

```

    }
}

Client {
    Name = Rufus
    Address = rufus
    Catalog = BackupDB
    Password = client_password
}

Storage {
    Name = FileStorage
    Address = rufus
    Password = local_storage_password
    Device = RecycleDir
    Media Type = File
}

Catalog {
    Name = BackupDB
    dbname = bacula; user = bacula; password = ""
}

Messages {
    Name = Standard
    ...
}

Pool {
    Name = Recycle
    Use Volume Once = yes
    Pool Type = Backup
    LabelFormat = "Vol"
    AutoPrune = yes
    VolumeRetention = 2h
    Maximum Volumes = 12
    Recycle = yes
}

```

and the Storage daemon's configuration file is:

```

Storage {
    Name = my-sd
    WorkingDirectory = "~/bacula/working"
    Pid Directory = "~/bacula/working"
    MaximumConcurrentJobs = 10
}

Director {
    Name = my-dir
    Password = local_storage_password
}

Device {
    Name = RecycleDir
    Media Type = File
    Archive Device = /home/bacula/backups
    LabelMedia = yes;
    Random Access = Yes;
}

```



```

AutomaticMount = yes;
RemovableMedia = no;
AlwaysOpen = no;
}

Messages {
    Name = Standard
    director = my-dir = all
}

```

In this example, the Jobs will be backed up to directory **/home/bacula/backups** with Volume names Vol0001, Vol0002, ... Vol0012. Every backup Job will write a new volume cycling through the volume numbers, and two hours after a job has started, the volume will be pruned **Volume Retention = 2h**.

With a little bit of work, you can change the above example into a weekly or monthly cycle (take care about the amount of archive disk space used).

Backing up to Multiple Disks

Bacula can, of course, use multiple disks, but in general, each disk must be a separate Device specification in the Storage daemon's conf file, and you must then select what clients to backup to each disk.

The situation is a bit more complicated if you want to treat two disk drives logically as a single drive, which Bacula does not directly support. However, it is possible to back up your data to multiple disks as if they were a single drive by linking the Volumes from the first disk to the second disk.

For example, assume that you have two disks named **/disk1** and **/disk2**. If you then create a standard Storage daemon Device resource for backing up to the first disk, it will look like the following:

```

Device {
    Name = client1
    Media Type = File
    Archive Device = /disk1
    LabelMedia = yes;
    Random Access = Yes;
    AutomaticMount = yes;
    RemovableMedia = no;
    AlwaysOpen = no;
}

```

Since there is no way to get the above Device resource to reference both **/disk1** and **/disk2** we do it by pre-creating Volumes on **/disk2** with the following:

```

ln -s /disk2/Disk2-vol001 /disk1/Disk2-vol001
ln -s /disk2/Disk2-vol002 /disk1/Disk2-vol002
ln -s /disk2/Disk2-vol003 /disk1/Disk2-vol003
...

```

At this point, you can label the Volumes as Volume **Disk2-vol001**, **Disk2-vol002**, ... and Bacula will use them as if they were on **/disk1** but actually write the data to **/disk2**. The only minor

inconvenience with this method is that you must explicitly name the disks and cannot use automatic labeling unless you arrange to have the labels exactly match the links you have created.

Considerations for Multiple Clients

If we take the above example and add a second Client, here are a few considerations:

- Although the second client can write to the same set of Volumes, you will probably want to write to a different set.
- You can write to a different set of Volumes by defining a second Pool, which has a different name and a different **LabelFormat**.
- If you wish the Volumes for the second client to go into a different directory (perhaps even on a different filesystem to spread the load), you would do so by defining a second Device resource in the Storage daemon. The **Name** must be different, and the **Archive Device** could be different. To ensure that Volumes are never mixed from one pool to another, you might also define a different MediaType (e.g. **File1**).

In this example, we have two clients, each with a different Pool and a different number of archive files retained. They also write to different directories with different Volume labeling.

The Director's configuration file is as follows:

```
Director {
    Name = my-dir
    QueryFile = "~/bacula/bin/query.sql"
    PidDirectory = "~/bacula/working"
    WorkingDirectory = "~/bacula/working"
    Password = dir_password
}

# Basic weekly schedule
Schedule {
    Name = "WeeklySchedule"
    Run = Level=Full fri at 1:30
    Run = Level=Incremental sat-thu at 1:30
}

FileSet {
    Name = "Example FileSet"
    Include = compression=GZIP signature=SHA1 {
        /home/kern/bacula/bin
    }
}

Job {
    Name = "Backup-client1"
    Type = Backup
    Level = Full
    Client = client1
    FileSet= "Example FileSet"
    Messages = Standard
    Storage = File1
    Pool = client1
    Schedule = "WeeklySchedule"
}
```

```

Job {
    Name = "Backup-client2"
    Type = Backup
    Level = Full
    Client = client2
    FileSet= "Example FileSet"
    Messages = Standard
    Storage = File2
    Pool = client2
    Schedule = "WeeklySchedule"
}

Client {
    Name = client1
    Address = client1
    Catalog = BackupDB
    Password = client1_password
    File Retention = 7d
}

Client {
    Name = client2
    Address = client2
    Catalog = BackupDB
    Password = client2_password
}

# Two Storage definitions permits different directories
Storage {
    Name = File1
    Address = rufus
    Password = local_storage_password
    Device = client1
    Media Type = File
}

Storage {
    Name = File2
    Address = rufus
    Password = local_storage_password
    Device = client2
    Media Type = File
}

Catalog {
    Name = BackupDB
    dbname = bacula; user = bacula; password = ""
}

Messages {
    Name = Standard
    ...
}

# Two pools permits different cycling periods and Volume names
# Cycle through 15 Volumes (two weeks)
Pool {
    Name = client1
    Use Volume Once = yes
    Pool Type = Backup
}

```

```

LabelFormat = "Client1-"
AutoPrune = yes
VolumeRetention = 13d
Maximum Volumes = 15
Recycle = yes
}

# Cycle through 8 Volumes (1 week)
Pool {
    Name = client2
    Use Volume Once = yes
    Pool Type = Backup
    LabelFormat = "Client2-"
    AutoPrune = yes
    VolumeRetention = 6d
    Maximum Volumes = 8
    Recycle = yes
}

```

and the Storage daemon's configuration file is:

```

Storage {
    Name = my-sd
    WorkingDirectory = "~/bacula/working"
    Pid Directory = "~/bacula/working"
    MaximumConcurrentJobs = 10
}

Director {
    Name = my-dir
    Password = local_storage_password
}

# Archive directory for Client1
Device {
    Name = client1
    Media Type = File
    Archive Device = /home/bacula/client1
    LabelMedia = yes;
    Random Access = Yes;
    AutomaticMount = yes;
    RemovableMedia = no;
    AlwaysOpen = no;
}

# Archive directory for Client2
Device {
    Name = client2
    Media Type = File
    Archive Device = /home/bacula/client2
    LabelMedia = yes;
    Random Access = Yes;
    AutomaticMount = yes;
    RemovableMedia = no;
    AlwaysOpen = no;
}

Messages {
    Name = Standard
}

```

```
director = my-dir = all  
}
```



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Using Pools to Manage Disk Volumes

[Bacula 1.34 User's Guide](#)

The Network Backup Solution

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Backing Up to Disk Volumes



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Backup Strategies

Using Pools to Manage Disk Volumes

If you manage 5 or 10 machines and have a nice tape backup, you don't need Pools, and you may wonder what they are good for. In this chapter, you will see that Pools can help you optimize disk storage space. The same techniques can be applied to a shop that has multiple tape drives, or that wants to mount various different Volumes to meet their needs.

The Problem

A site that I administer (a charitable organization) had a tape DDS-3 tape drive that was failing. The exact reason for the failure is still unknown. Worse yet, their full backup size is about 15GB whereas the capacity of their broken DDS-3 was at best 8GB (rated 6/12). A new DDS-4 tape drive and the necessary cassettes was more expensive than their budget could handle.

The Solution

They want to maintain 6 months of backup data, and be able to access the old files on a daily basis for a week, a weekly basis for a month, then monthly for 6 months. In addition, and offsite capability was not needed (well perhaps it really is, but it was never used). Their daily changes amount to about 300MB on the average, or about 2GB per week.

As a consequence, the total volume of data they need to keep to meet their needs is about 100GB ($15\text{GB} \times 6 + 2\text{GB} \times 5 + 0.3 \times 7$) = 102.1GB.

The chosen solution was to buy a 120GB hard disk for next to nothing — far less than 1/10th the price of a tape drive and the cassettes to handle the same amount of data, and to have Bacula write to disk files.

The rest of this chapter will explain how to setup Bacula so that it would automatically manage a set of disk files with the minimum intervention on my part. The system has been running since 22 January 2004 until today (08 April 2004) with no intervention. Since we have not yet crossed the six month boundary, we still lack some data to be sure the system performs as desired.

Overall Design

Getting Bacula to write to disk rather than tape in the simplest case is rather easy, and is documented in the previous chapter. In addition, all the directives discussed here are explained in that chapter. We'll leave it to you to look at the details there. If you haven't read it and are not familiar with Pools, you probably should at least read it once quickly for the ideas before continuing here.

One needs to consider about what happens if we have only a single large Bacula Volume defined on our hard disk. Everything works fine until the Volume fills, then Bacula will ask you to mount a new Volume. Being a hard disk and the only one you have, this will be a bit of a problem. It should be obvious that it is better to use a number of smaller Volumes and arrange for Bacula to automatically recycle them so that the disk storage space can be reused. The other problem with a single Volume, is that at the current time (1.34.0) Bacula does not seek within a disk Volume, so restoring a single file can take more time than one would expect.

As mentioned, the solution is to have multiple Volumes, or files on the disk. To do so, we need to limit the use and thus the size of a single Volume, by time, by number of jobs, or by size. Any of these would work, but we chose to limit the use of a single Volume by putting a single job in each Volume with the exception of Volumes containing Incremental backup where there will be 6 jobs (a week's worth of data) per volume. The details of this will be discussed shortly.

The next problem to resolve is recycling of Volumes. As you noted from above, the requirements are to be able to restore monthly for 6 months, weekly for a month, and daily for a week. So to simplify things, why not do a Full save once a month, a Differential save once a week, and Incremental saves daily. Now since each of these different kinds of saves needs to remain valid for differing periods, the simplest way to do this (and possibly the only) is to have a separate Pool for each backup type.

The decision was to use three Pools: one for Full saves, one for Differential saves, and one for Incremental saves, and each would have a different number of volumes and a different Retention period to accomplish the requirements.

Full Pool

Putting a single Full backup on each Volume, will require six Full save Volumes, and a retention period of six months. The Pool needed to do that is:

```
Pool {  
    Name = Full-Pool  
    Pool Type = Backup  
    Recycle = yes  
    AutoPrune = yes  
    Volume Retention = 6 months  
    Accept Any Volume = yes  
    Maximum Volume Jobs = 1  
    Label Format = Full-  
    Maximum Volumes = 6  
}
```

Since these are disk Volumes, no space is lost by having separate Volumes for each backup (done once a month in this case). The items to note are the retention period of six months (i.e. they are recycled after 6 months), that there is one job per volume (Maximum Volume Jobs = 1), the volumes will be labeled Full-0001, ... Full-0006 automatically. One could have labeled these manual from the start, but why not use the features of Bacula.

Differential Pool

For the Differential backup Pool, we choose a retention period of a bit longer than a month and ensure that there is at least one Volume for each of the maximum of five weeks in a month. So the following works:

```
Pool {  
    Name = Diff-Pool  
    Pool Type = Backup  
    Recycle = yes  
    AutoPrune = yes  
    Volume Retention = 40 days  
    Accept Any Volume = yes
```

```
Maximum Volume Jobs = 1
Label Format = Diff-
Maximum Volumes = 6
}
```

As you can see, the Differential Pool can grow to a maximum of six volumes, and the Volumes are retained 40 days and there after can be recycled. Finally there is one job per volume. This, of course, could be tightened up a lot, but the expense here is a few GB which is not too serious.

Incremental Pool

Finally, here is the resource for the Incremental Pool:

```
Pool {
  Name = Inc-Pool
  Pool Type = Backup
  Recycle = yes
  AutoPrune = yes
  Volume Retention = 20 days
  Accept Any Volume = yes
  Maximum Volume Jobs = 6
  Label Format = Inc-
  Maximum Volumes = 5
}
```

We keep the data for 20 days rather than just a week as the needs require. To reduce the proliferation of volume names, we keep a week's worth of data (6 incremental backups) in each Volume. In practice, the retention period should be set to just a bit more than a week and keep only two or three volumes instead of five. Again, the lost is very little and as the system reaches the full steady state, we can adjust these values so that the total disk usage doesn't exceed the disk capacity.

The Actual Conf Files

The following example shows you the actual files used, with only a few minor modifications to simplify things.

The Director's configuration file is as follows:

```
Director {                                # define myself
  Name = bacula-dir
  DIRport = 9101
  QueryFile = "/home/bacula/bin/query.sql"
  WorkingDirectory = "/home/bacula/working"
  PidDirectory = "/home/bacula/working"
  Maximum Concurrent Jobs = 1
  Password = " "
  Messages = Standard
}

Job {
  Name = client
  Type = Backup
  Client = client-fd
}
```


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```
FileSet = "Full Set"
Schedule = "WeeklyCycle"
Storage = File
Messages = Standard
Pool = Default
Full Backup Pool = Full-Pool
Incremental Backup Pool = Inc-Pool
Differential Backup Pool = Diff-Pool
Write Bootstrap = "/home/bacula/working/client.bsr"
Priority = 10
}

FileSet {
    Name = "Full Set"
    Include = signature=SHA1 compression=GZIP9 {
        /
        /usr
        /home
    }
    Exclude = {
        /proc /tmp /.journal /.fsck
    }
}

Schedule {
    Name = "WeeklyCycle"
    Run = Full 1st sun at 1:05
    Run = Differential 2nd-5th sun at 1:05
    Run = Incremental mon-sat at 1:05
}

Client {
    Name = client-fd
    Address = client
    FDPort = 9102
    Catalog = MyCatalog
    Password = " "
    AutoPrune = yes          # Prune expired Jobs/Files
    Job Retention = 6 months
    File Retention = 60 days
}

Storage {
    Name = File
    Address = localhost
    SDPort = 9103
    Password = " "
    Device = FileStorage
    Media Type = File
}

Catalog {
    Name = MyCatalog
    dbname = bacula; user = bacula; password = " "
}

Pool {
    Name = Full-Pool
    Pool Type = Backup
    Recycle = yes           # automatically recycle Volumes
```

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```
AutoPrune = yes          # Prune expired volumes
Volume Retention = 6 months
Accept Any Volume = yes # write on any volume in the pool
Maximum Volume Jobs = 1
Label Format = Full-
Maximum Volumes = 6
}

Pool {
    Name = Inc-Pool
    Pool Type = Backup
    Recycle = yes          # automatically recycle Volumes
    AutoPrune = yes        # Prune expired volumes
    Volume Retention = 20 days
    Accept Any Volume = yes
    Maximum Volume Jobs = 6
    Label Format = Inc-
    Maximum Volumes = 5
}

Pool {
    Name = Diff-Pool
    Pool Type = Backup
    Recycle = yes
    AutoPrune = yes
    Volume Retention = 40 days
    Accept Any Volume = yes
    Maximum Volume Jobs = 1
    Label Format = Diff-
    Maximum Volumes = 6
}

Messages {
    Name = Standard
    mailcommand = "bsmtp -h mail.domain.com -f \"\\(Bacula\\) %r\"
                  -s \"Bacula: %t %e of %c %l\" %r"
    operatorcommand = "bsmtp -h mail.domain.com -f \"\\(Bacula\\) %r\"
                      -s \"Bacula: Intervention needed for %j\" %r"
    mail = root@domain.com = all, !skipped
    operator = root@domain.com = mount
    console = all, !skipped, !saved
    append = "/home/bacula/bin/log" = all, !skipped
}
```

and the Storage daemon's configuration file is:

```
Storage {                  # definition of myself
    Name = bacula-sd
    SDPort = 9103          # Director's port
    WorkingDirectory = "/home/bacula/working"
    Pid Directory = "/home/bacula/working"
}

Director {
    Name = bacula-dir
    Password = " "
}
```

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```
Device {  
    Name = FileStorage  
    Media Type = File  
    Archive Device = /files/bacula  
    LabelMedia = yes;      # lets Bacula label unlabeled media  
    Random Access = Yes;  
    AutomaticMount = yes;  # when device opened, read it  
    RemovableMedia = no;  
    AlwaysOpen = no;  
}  
  
Messages {  
    Name = Standard  
    director = bacula-dir = all  
}
```



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Using Autochangers

Backup Strategies

Although Recycling and Backing Up to Disk Volume have been discussed in previous chapters, this chapter is meant to give you an overall view of possible backup strategies and to explain their advantages and disadvantages.

Simple One Tape Backup

Probably the simplest strategy is to back everything up to a single tape and insert a new (or recycled) tape when it fills and Bacula requests a new one.

Advantages

- The operator intervenes only when a tape change is needed. (once a month at my site).
- There is little chance of operator error because the tape is not changed daily.
- A minimum number of tapes will be needed for a full restore. Typically the best case will be one tape and worst two.
- You can easily arrange for the Full backup to occur a different night of the month for each system, thus load balancing and shortening the backup time.

Disadvantages

- If your site burns down, you will lose your current backups, and in my case about a month of data.
- After a tape fills and you have put in a blank tape, the backup will continue, and this will generally happen during working hours.

Practical Details

This system is very simple. When the tape fills and Bacula requests a new tape, you **unmount** the tape from the Console program, insert a new tape and **label** it. In most cases after the label, Bacula will automatically mount the tape and resume the backup. Otherwise, you simply **mount** the tape.

Using this strategy, one typically does a Full backup once a week following by daily Incremental backups. To minimize the amount of data written to the tape, once can do (as I do) a Full backup once a month on the first Sunday of the month, a Differential backup on the 2nd–5th Sunday of the month, and incremental backups the rest of the week.

Manually Changing Tapes

If you use the strategy presented above, Bacula will ask you to change the tape, and you will **unmount** it and the remount it when you have inserted the new tape.

If you do not wish to interact with Bacula to change each tape, there are several ways to get Bacula to release the tape:

- In your Storage daemon's Device resource, set **AlwaysOpen = no**

In this case, Bacula will release the tape after every job. If you run several jobs, the tape will be rewound and repositioned to the end at the beginning of every job. This is not very efficient, but does let you change the tape whenever you want.

- Use a **RunAfterJob** statement to run a script after your last job. This could also be an **Admin** job that runs after all your backup jobs. The script could be something like:

```
#!/bin/sh
/full-path/console -c /full-path/console.conf <<END_OF_DATA
release storage=your-storage-name
END_OF_DATA
```

In this example, you would have **AlwaysOpen=yes**, but the **release** command would tell Bacula to rewind the tape and on the next job assume the tape has changed. This strategy may not work on some systems, or on autochangers because Bacula will still keep the drive open.

- The final strategy is the similar to the previous case except that you would use the **unmount** command to force Bacula to release the drive. Then you would eject the tape, and remount it as follows:

```
#!/bin/sh
/full-path/console -c /full-path/console.conf <          unmount storage=your-sto
END_OF_DATA
# the following is a shell command
mt eject
/full-path/console -c /full-path/console.conf <<END_OF_DATA
mount storage=your-storage-name
END_OF_DATA
```

Daily Tape Rotation

This scheme is quite different from the one mentioned above in that a Full backup is done to a different tape every day of the week. Generally, the backup will cycle continuously through 5 or 6 tapes each week. Variations are to use a different tape each Friday, and possibly at the beginning of the month. Thus if backups are done Monday through Friday only, you need only 5 tapes, and by having two Friday tapes, you need a total of 6 tapes. Many sites run this way, or using modifications of it based on two week cycles or longer.

Advantages

- All the data is stored on a single tape, so recoveries are simple and faster.
- Assuming the previous day's tape is taken offsite each day, a maximum of one days data will be lost if the site burns down.

Disadvantages

- The tape must be changed every day requiring a lot of operator intervention.
- More errors will occur because of human mistakes.
- If the wrong tape is inadvertently mounted, the Backup for that day will not occur exposing the system to data loss.

- There is much more movement of the tape each day (rewinds) leading to shorter tape drive life time.
- Initial setup of Bacula to run in this mode is more complicated than the Single tape system described above.
- Depending on the number of systems you have and their data capacity, it may not be possible to do a Full backup every night for time reasons or reasons of tape capacity.

Practical Details

The simplest way to "force" Bacula to use a different tape each day is to define a different Pool for each day of the the week a backup is done. In addition, you will need to specify appropriate Job and File retention periods so that Bacula will relabel and overwrite the tape each week rather than appending to it. Nic Bellamy has supplied an actual working model of this which we include here.

What is important is to create a different Pool for each day of the week, and on the **run** statement in the Schedule, to specify which Pool is to be used. He has one Schedule that accomplishes this, and a second Schedule that does the same thing for the Catalog backup run each day after the main backup (Priorities were not available when this script was written). In addition, he uses a **Max Start Delay** of 22 hours so that if the wrong tape is premounted by the operator, the job will be automatically canceled, and the backup cycle will re-synchronize the next day. He has named his Friday Pool **WeeklyPool** because in that Pool, he wishes to have several tapes to be able to restore to a time older than one week.

And finally, in his Storage daemon's Device resource, he has **Automatic Mount = yes** and **Always Open = No**. This is necessary for the tape ejection to work in his **end_of_backup.sh** script below.

For example, his bacula-dir.conf file looks like the following:

```
# /etc/bacula/bacula-dir.conf
#
# Bacula Director Configuration file
#

Director {
  Name = ServerName
  DIRport = 9101
  QueryFile = "/etc/bacula/query.sql"
  WorkingDirectory = "/var/lib/bacula"
  PidDirectory = "/var/run"
  SubSysDirectory = "/var/lock/subsys"
  Maximum Concurrent Jobs = 1
  Password = "console-pass"
  Messages = Standard
}

#
# Define the main nightly save backup job
#
Job {
  Name = "NightlySave"
  Type = Backup
  Client = ServerName
  FileSet = "Full Set"
```

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```
Schedule = "WeeklyCycle"
Storage = Tape
Messages = Standard
Pool = Default
Write Bootstrap = "/var/lib/bacula/NightlySave.bsr"
Max Start Delay = 22h
}

# Backup the catalog database (after the nightly save)
Job {
    Name = "BackupCatalog"
    Type = Backup
    Client = ServerName
    FileSet = "Catalog"
    Schedule = "WeeklyCycleAfterBackup"
    Storage = Tape
    Messages = Standard
    Pool = Default
    # This creates an ASCII copy of the catalog
    RunBeforeJob = "/usr/lib/bacula/make_catalog_backup -u bacula"
    # This deletes the copy of the catalog, and ejects the tape
    RunAfterJob = "/etc/bacula/end_of_backup.sh"
    Write Bootstrap = "/var/lib/bacula/BackupCatalog.bsr"
    Max Start Delay = 22h
}

# Standard Restore template, changed by Console program
Job {
    Name = "RestoreFiles"
    Type = Restore
    Client = ServerName
    FileSet = "Full Set"
    Storage = Tape
    Messages = Standard
    Pool = Default
    Where = /tmp/bacula-restores
}

# List of files to be backed up
FileSet {
    Name = "Full Set"
    Include = signature=MD5 {
        /
        /data
    }
    Exclude = { /proc /tmp /.journal }
}

#
# When to do the backups
#
Schedule {
    Name = "WeeklyCycle"
    Run = Level=Full Pool=MondayPool Monday at 8:00pm
    Run = Level=Full Pool=TuesdayPool Tuesday at 8:00pm
    Run = Level=Full Pool=WednesdayPool Wednesday at 8:00pm
    Run = Level=Full Pool=ThursdayPool Thursday at 8:00pm
    Run = Level=Full Pool=WeeklyPool Friday at 8:00pm
}
```

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```
# This does the catalog. It starts after the WeeklyCycle
Schedule {
    Name = "WeeklyCycleAfterBackup"
    Run = Level=Full Pool=MondayPool Monday at 8:15pm
    Run = Level=Full Pool=TuesdayPool Tuesday at 8:15pm
    Run = Level=Full Pool=WednesdayPool Wednesday at 8:15pm
    Run = Level=Full Pool=ThursdayPool Thursday at 8:15pm
    Run = Level=Full Pool=WeeklyPool Friday at 8:15pm
}

# This is the backup of the catalog
FileSet {
    Name = "Catalog"
    Include = signature=MD5 {
        /var/lib/bacula/bacula.sql
    }
}

# Client (File Services) to backup
Client {
    Name = ServerName
    Address = dionysus
    FDPort = 9102
    Catalog = MyCatalog
    Password = "client-pass"
    File Retention = 30d
    Job Retention = 30d
    AutoPrune = yes
}

# Definition of file storage device
Storage {
    Name = Tape
    Address = dionysus
    SDPort = 9103
    Password = "storage-pass"
    Device = Tandberg
    Media Type = MLR1
}

# Generic catalog service
Catalog {
    Name = MyCatalog
    dbname = bacula; user = bacula; password = ""
}

# Reasonable message delivery -- send almost all to email address
# and to the console
Messages {
    Name = Standard
    mailcommand = "/usr/sbin/bsmtp -h localhost -f \"\\(Bacula\\) %r\"
        -s \"Bacula: %t %e of %c %l\" %r"
    operatorcommand = "/usr/sbin/bsmtp -h localhost -f \"\\(Bacula\\) %r\"
        -s \"Bacula: Intervention needed for %j\" %r"
    mail = root@localhost = all, !skipped
    operator = root@localhost = mount
    console = all, !skipped, !saved
    append = "/var/lib/bacula/log" = all, !skipped
}

# Pool definitions
```


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```
#
# Default Pool for jobs, but will hold no actual volumes
Pool {
    Name = Default
    Pool Type = Backup
}

Pool {
    Name = MondayPool
    Pool Type = Backup
    Recycle = yes
    AutoPrune = yes
    Volume Retention = 6d
    Accept Any Volume = yes
    Maximum Volume Jobs = 2
}

Pool {
    Name = TuesdayPool
    Pool Type = Backup
    Recycle = yes
    AutoPrune = yes
    Volume Retention = 6d
    Accept Any Volume = yes
    Maximum Volume Jobs = 2
}

Pool {
    Name = WednesdayPool
    Pool Type = Backup
    Recycle = yes
    AutoPrune = yes
    Volume Retention = 6d
    Accept Any Volume = yes
    Maximum Volume Jobs = 2
}

Pool {
    Name = ThursdayPool
    Pool Type = Backup
    Recycle = yes
    AutoPrune = yes
    Volume Retention = 6d
    Accept Any Volume = yes
    Maximum Volume Jobs = 2
}

Pool {
    Name = WeeklyPool
    Pool Type = Backup
    Recycle = yes
    AutoPrune = yes
    Volume Retention = 12d
    Accept Any Volume = yes
    Maximum Volume Jobs = 2
}

# EOF
```

Note, the mailcommand and operatorcommand should be on a single line each. They were split

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to preserve the proper page width. In order to get Bacula to release the tape after the nightly backup, he uses a **RunAfterJob** script that deletes the ASCII copy of the database back and then rewinds and ejects the tape. The following is a copy of **end_of_backup.sh**

```
#!/bin/sh

/usr/lib/bacula/delete_catalog_backup

mt rewind
mt eject

exit 0
```

Finally, if you list his Volumes, you get something like the following:

```
*list media
Using default Catalog name=MyCatalog DB=bacula
Pool: WeeklyPool
+-----+-----+-----+-----+-----+-----+-----+
| MeId| VolumeName| MedTyp| VolStat| VolBytes | LastWritten | VolRet| Recyc|
+-----+-----+-----+-----+-----+-----+-----+
| 5 | Friday_1 | MLR1 | Used | 2157171998| 2003-07-11 20:20| 103680| 1 |
| 6 | Friday_2 | MLR1 | Append | 0 | 0 | 103680| 1 |
+-----+-----+-----+-----+-----+-----+-----+

Pool: MondayPool
+-----+-----+-----+-----+-----+-----+-----+
| MeId| VolumeName| MedTyp| VolStat| VolBytes | LastWritten | VolRet| Recyc|
+-----+-----+-----+-----+-----+-----+-----+
| 2 | Monday | MLR1 | Used | 2260942092| 2003-07-14 20:20| 518400| 1 |
+-----+-----+-----+-----+-----+-----+-----+

Pool: TuesdayPool
+-----+-----+-----+-----+-----+-----+-----+
| MeId| VolumeName| MedTyp| VolStat| VolBytes | LastWritten | VolRet| Recyc|
+-----+-----+-----+-----+-----+-----+-----+
| 3 | Tuesday | MLR1 | Used | 2268180300| 2003-07-15 20:20| 518400| 1 |
+-----+-----+-----+-----+-----+-----+-----+

Pool: WednesdayPool
+-----+-----+-----+-----+-----+-----+-----+
| MeId| VolumeName| MedTyp| VolStat| VolBytes | LastWritten | VolRet| Recyc|
+-----+-----+-----+-----+-----+-----+-----+
| 4 | Wednesday | MLR1 | Used | 2138871127| 2003-07-09 20:2 | 518400| 1 |
+-----+-----+-----+-----+-----+-----+-----+

Pool: ThursdayPool
+-----+-----+-----+-----+-----+-----+-----+
| MeId| VolumeName| MedTyp| VolStat| VolBytes | LastWritten | VolRet| Recyc|
+-----+-----+-----+-----+-----+-----+-----+
| 1 | Thursday | MLR1 | Used | 2146276461| 2003-07-10 20:50| 518400| 1 |
+-----+-----+-----+-----+-----+-----+-----+

Pool: Default
No results to list.
```

Note, I have truncated a number of the columns so that the information fits on the width of a page.

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Data Spooling

Data Spooling

Bacula allows you to specify that you want the Storage daemon to initially write your data to disk and then subsequently to tape. This serves several important purposes. First it can take a long time for data to come in from the File daemon during an Incremental backup. If it is directly written to tape, the tape will start and stop or shoe–shine as it is often called causing tape wear. By first writing the data to disk, then writing it to tape, the tape can be kept in continual motion. The second major purpose is that while the spooled data is being written to the tape, the despooling process has exclusive use of the tape. This means that you can spool multiple simultaneous jobs to disk, then have them very efficiently despoiled one at a time without having the data blocks from several jobs intermingled, thus substantially improving the time needed to restore files.

The remainder of this chapter explains the various directives that you can use in the spooling process.

Data Spooling Directives The following directives can be used to control data spooling.

- To turn on/off data spooling at the Job level in the Job resource in the Director's conf file (default **no**).

SpoolData = yes/no

- To override the Job specification in a Schedule Run directive in the Director's conf file.

SpoolData = yes/no

- To limit the maximum total size of the spooled data for a particular device. Specified in the Device resource of the Storage daemon's conf file (default unlimited).

Maximum Spool Size = size

Where size is a the maximum spool size for all jobs specified in bytes.

- To limit the maximum total size of the spooled data for a particular device for a single job. Specified in the Device Resource of the Storage daemon's conf file (default unlimited).

Maximum Job Spool Size = size

Where size is the maximum spool file size for a single job specified in bytes.

- To specify the spool directory for a particular device. Specified in the Device Resource of the Storage daemon's conf file (default, the working directory).

Spool Directory = directory

!!! MAJOR WARNING !!!

Please be very careful to exclude the spool directory from any backup, otherwise, your job will write enormous amounts of data to the Volume, and most probably terminate in error. This is simply because in attempting to backup the spool file, the backup data will be written a second time to the spool file, and so on ad infinitum.

Another advice is to always specify the maximum spool size so that your disk doesn't completely fill up. In principle, data spooling will properly detect a full disk, and despool data allowing the job to continue. However, attribute spooling is not so kind to the user. If the disk on which attributes are being spooled fills, the job will be canceled.

Other Points

- When data spooling is enabled, Bacula automatically turns on attribute spooling. In other words, it also spools the catalog entries to disk. This is done so that in case the job fails, there will be no catalog entries pointing to non-existent tape backups.
- Attribute spooling is done at the end of the job, as a consequence, after Bacula stops writing the data to the tape, there may be a pause while the attributes are sent to the Directory and entered into the catalog before the job terminates.
- Attribute spool files are always placed in the working directory.
- When Bacula begins despooling data spooled to disk, it takes exclusive use of the tape. This has the major advantage that in running multiple simultaneous jobs at the same time, the blocks of several jobs will not be intermingled.
- It probably does not make a lot of sense to enable data spooling if you are writing to disk files.



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Disaster Recovery Using Bacula

General

When disaster strikes, you must have a plan, and you must have prepared in advance otherwise the work of recovering your system and your files will be considerably greater. For example, if you have not previously saved the partitioning information for your hard disk, how can you properly rebuild it if the disk must be replaced?

Unfortunately, many of the steps one must take before and immediately after a disaster are very operating system dependent. As a consequence, this chapter will discuss in detail disaster recovery (also called Bare Metal Recovery) for **Linux** and **Solaris**. For Solaris, the procedures are still quite manual. For FreeBSD the same procedures may be used but they are not yet developed. For Win32, no luck. Apparently an "emergency boot" disk allowing access to the full system API without interference does not exist.

Important Considerations

Here are a few important considerations concerning disaster recovery that you should take into account before a disaster strikes.

- If the building which houses your computers burns down or is otherwise destroyed, do you have off-site backup data?
- Disaster recovery is much easier if you have several machines. If you have a single machine, how will you handle unforeseen events if your only machine is down?
- Do you want to protect your whole system and use Bacula to recover everything? or do you want to try to restore your system from the original installation disks and apply any other updates and only restore user files?

Bare Metal Recovery on Linux

The remainder of this section concerns recovering a **Linux** computer, and parts of it relate to the Red Hat version of Linux. The **Solaris** procedures can be found below.

A so called "Bare Metal" recovery is one where you start with an empty hard disk and you restore your machine. There are also cases where you may lose a file or a directory and want it restored. Please see the previous chapter for more details for those cases.

Bare Metal Recovery assumes that you have the following four items for your system:

- An emergency boot disk allowing you to boot without a hard disk
- A Bacula Rescue Disk containing your disk information and a number of helpful scripts (described below) including a statically linked version of the Bacula File daemon
- A full Bacula backup of your system possibly including Incremental or Differential backups since the last Full backup
- A second system running the Bacula Director, the Catalog, and the Storage daemon. (this is not an absolute requirement, but how to get around it is not yet documented here)

Restrictions

In addition, to the above assumptions, the following conditions or restrictions apply:

- Linux only — tested only on Red Hat, but should work on other Linuxes
- The scripts handle only SCSI and IDE disks
- All partitions will be recreated, but only **ext2**, **ext3**, and **swap** partitions will be reformatted. Any other partitions such as Windows FAT partitions will not be formatted by the scripts, but you can do it by hand
- You are using either **lilo** or **grub** as a boot loader, and you know which one (not automatically detected)
- The partitioning and reformatting scripts will not work with RAID devices, or other "complicated" disk partitioning/formatting schemes. Please check them carefully. You will probably need to edit them by hand.
- I have noticed that the partitioning and reformatting scripts no longer work with RedHat version 9 or greater. This is probably due to a change in output format of one of the utilities used or sfdisk. You will need to hand edit them.

Scripts

The scripts discussed below can be found in the **rescue/linux** subdirectory of the Bacula source code.

Preparation for a Bare Metal Recovery

There are two things you should do immediately on all (Linux) systems for which you wish to do a bare metal recovery:

1. Create a system emergency boot disk or alternatively a system installation boot floppy. This step can be skipped if you have an Installation CDROM and your machine will boot from CDROM (most modern computers will).
2. Create a Bacula Rescue disk, which captures the current working state of your computer and creates scripts to restore it. In addition, it creates a statically linked version of the Bacula File daemon (Client) program, which is key to successfully restoring from scratch.

Creating an Emergency Boot Disk

Here you have several choices:

- Create a tomsrtdisk disk (any Linux)
- Create an emergency boot disk (any Linux I think)
- Create a Red Hat Installation disk (Red Hat specific)
- Others

tomsrtdisk

My preference is to create and use a **tomsrtdisk** emergency boot disk because it gives you a very clean Linux environment (with a 2.2 kernel) and the most utilities. See <http://www.toms.net/rb/>

for more details on this. It is very easy to do and well worth the effort. However, I recommend that you create both especially if you have non-standard hardware. You may find that **tomsrtbt** will not work with your network driver (he surely has one, but you must explicitly put it on the disk), whereas the Linux rescue is more likely to work.

Emergency Boot Disk

To create a standard Linux emergency boot disk you must first know the name of the kernel, which you can find with:

```
ls -l /boot
```

and looking on the **vmlinux-...** line or alternative do an

```
uname -a
```

then become root and with a blank floppy in the drive, enter the following command:

```
mkbootdisk --device /dev/fd0 2.4.18-18
```

where you replace "2.4.18-18" by your system name.

This disk can then be booted and you will be in an environment with a number of important tools available. Some disadvantages of this environment as opposed to **tomsrtbt** are that you must enter **linux rescue** at the boot prompt or the boot will fail without a hard disk; it requires a disk boot image or a CDROM to be mounted, if the CDROM is released, you will loose a large number of the tools.

Red Hat Installation Disk

Specific to Red Hat Linux, is to create an Installation floppy, which can also be used as an emergency boot disk. The advantage of this method is that it works in conjunction with the installation CDROM and hence during the first part of restoring the system, you have a much larger number of tools available (on the CDROM). This can be extremely useful if you are not sure what really happened and you need to examine your system in detail.

To make a Red Hat Linux installation disk, do the following:

```
mount the Installation CDROM (/mnt/cdrom)
cd /mnt/cdrom/images
dd if=boot.img of=/dev/fd0 bs=1440k
```

Now that you have either an emergency boot disk or an installation floppy, you will be able to reboot your system in the absence of your hard disk or with a damaged hard disk. This method has the same disadvantages compared to **tomsrtbt** disk as mentioned above for the Emergency Boot Disk.

Creating a Bacula Rescue Disk

Simply having a boot disk is not sufficient to re-create things as they were. To solve this problem, we will create a Bacula Rescue disk. Everything that will be written to this disk will first be placed into the **<bacula-src>/rescue/linux** directory.

The first step is while your system is up and running normally, you use a Bacula script called **getdiskinfo** to capture certain important information about your hard disk configuration (partitioning, formatting, mount points, ...). **getdiskinfo** will also create a number of scripts using the information found that can be used in an emergency to repartition your disks, reformat them, and restore a statically linked version of the Bacula file daemon so that your disk can be restored from within a minimal boot environment.

The first step is to run **getdiskinfo** as follows:

```
su
cd <bacula-src>/rescue/linux
./getdiskinfo
```

getdiskinfo works for either IDE or SCSI drives and recognizes both ext2 and ext3 file systems. If you wish to restore other file systems, you will need to modify the code. This script can be run multiple times, but really only needs to be run once unless you change your hard disk configuration.

Assuming you have a single hard disk on device /dev/hda, **getdiskinfo** will create the following files:

partition.hda

This file contains the shell commands to repartition your hard disk drive /dev/hda to the current state. If you have additional drives (e.g. /dev/hdc), you will find one of these files for each drive. **DO NOT EXECUTE THIS SCRIPT UNLESS YOU WANT YOUR HARD DISK REPARTITIONED**

format.hda

This file contains the shell commands that will format each of the partitions on your hard drive. It knows about ext2, ext3, and swap partitions. All other partitions, you must manually format. It is recommended that any Microsoft partitions be partitioned with Microsoft's **format** command rather than using Unix tools. **DO NOT EXECUTE THIS SCRIPT UNLESS YOU WANT YOUR HARD DISK REFORMATTED**

mount_drives

This script will mount all ext2 and ext3 drives that were previously mounted. They will be mounted on /mnt/drive/. This is used just before running the statically linked Bacula so that it can access your drives for the restore.

restore_bacula

This script will restore the File daemon from the Bacula Rescue disk. Building the Bacula Rescue disk will be described later. This will provide your emergency boot environment with a Bacula file daemon. Note, this is a special statically linked version of the file daemon (i.e. it does not need or use shared libraries).

start_network

This script will start your network using the simplest possible commands. You will need to verify that the IP address used in this script is correct. In addition, if you have several ethernet cards, you may need to make other modifications to this script.

sfdisk

This is the program that will repartition your hard disk, and it is normally found in /sbin/sfdisk. It is placed in this directory so that it will be included on the rescue disk as it is not normally available with all emergency boot environments.

sfdisk.gz

This is the version of sfdisk that works with **tomsrtbt**. The standard sfdisk described above will not run under tomsrtbt.

The **getdiskinfo** program (actually a shell script) will also create a subdirectory named **diskinfo**, which contains the following files:

```
df.bsi
disks.bsi
fstab.bsi
ifconfig.bsi
mount.bsi
mount.ext2.bsi
mount.ext3.bsi
mtab.bsi
route.bsi
sfdisk.disks.bsi
sfdisk.hda.bsi
sfdisk.make.hda.bsi
```

Each of these files contains some important piece of information (sometimes redundant) about your hard disk setup or your network. Normally, you will not need this information, but it will be written to the Bacula Rescue disk just in case. Since it is normally not used, we will leave it to you to examine those files at your leisure.

Building a Static File Daemon

The second of the three steps in creating your Bacula Rescue disk is to build a static version of the File daemon. Do so by either configuring Bacula as follows or by allowing the **make_rescue_disk** script described below make it for you:

```
cd <bacula-src>
./configure <normal-options>
make
cd src/filed
make static-bacula-fd
strip static-bacula-fd
cp static-bacula-fd ../../rescue/linux/bacula-fd
cp bacula-fd.conf ../../rescue/linux
```

Note, above, we built **static-bacula-fd** and changed its name to **bacula-fd** when copying it to the rescue/linux directory.

Finally, in <bacula-src>/rescue/linux, ensure that the **WorkingDirectory** and **PIDDirectory** both point to reasonable locations on a stripped down system. If you are using **tomsrtbt** you will also want to replace machine names with IP addresses since there is no resolver running. With the Linux Rescue disk, network address mapping seems to work. Don't forget that at the time this version of the Bacula File daemon runs, your file system will not be restored. In my **bacula-fd.conf**, I use **/var/working**.

Writing the Bacula Rescue Floppy

When you have everything you need (output of `getdiskinfo`, Bacula File daemon, ...), you create your rescue floppy by putting a blank tape into your floppy disk drive and entering:

```
su
./make_rescue_disk
```

This script will reformat the floppy and write everything in the current directory and all files in the **diskinfo** directory to the floppy. If you supply the appropriate command line options, it will also build a static version of the Bacula file daemon and copy it along with the configuration file to the disk. Also using a command line option, you can make it write a compressed tar file containing all the files whose names are in **backup.etc.list** to the floppy. The list as provided contains names of files in **/etc** that you might need in a disaster situation. It is not needed, but in some cases such as a complex network setup, you may find it useful.

Options for `make_rescue_disk`

The following command line options are available for the `make_rescue_disk` script:

```
Usage: make_rescue_disk
      -h, --help           print this message
      --make-static-bacula make static File daemon and add to diskette
      --copy-static-bacula copy static File daemon to diskette
      --copy-etc-files     copy files in etc list to diskette
```

Briefly the options are:

--make-static-bacula

If this option is specified, the script will assume that you have already configured and built Bacula. It will then proceed to build a statically linked version and copy it along with `bacula-fd.conf` to the current directory, then write it to the rescue disk.

--copy-static-bacula,/dt>

If this option is given, the script will assume that you already have a copy of the statically linked Bacula in the current directory named **bacula-fd** as well as the configuration script. They will then be written to the rescue disk.

--copy-etc-files

If this option is specified, the script will tar the files in **backup.etc.list** and write them to the rescue disk.

Please examine the contents of the rescue floppy to ensure that it has everything you want and need. If not modify the scripts as necessary and re-run it until it is correct.

Now that you have both a system boot floppy and a Bacula Rescue floppy, assuming you have a full backup of your system made by Bacula, you are ready to handle nearly any kind of emergency restoration situation.

Restoring Your Linux System

Now, let's assume that your hard disk has just died and that you have replaced it with an new identical drive. In addition, we assume that you have:

1. A recent Bacula backup (Full plus Incrementals)
2. An emergency boot floppy (preferably **tomsrtbt**)
3. A Bacula Rescue Disk
4. Your Bacula Director, Catalog, and Storage daemon running on another machine on your local network.

This is a relatively simple case, and later in this chapter, as time permits, we will discuss how you might recover from a situation where the machine that crashes is your main Bacula server (i.e. has the Director, the Catalog, and the Storage daemon).

You will take the following steps to get your system back up and running:

1. Boot with your Emergency Floppy
2. Mount your Bacula Rescue floppy
3. Start the Network (local network)
4. Re-partition your hard disk(s) as it was before
5. Re-format your partitions
6. Restore the Bacula File daemon (static version)
7. Perform a Bacula restore of all your files
8. Re-install your boot loader
9. Reboot

Now for the details ...

Boot with your Emergency Floppy

First you will boot with your emergency floppy. If you use the Installation floppy described above, when you get to the boot prompt:

```
boot :
```

you enter **linux rescue**.

If you are booting from **tomsrtbt** simply enter the default responses.

When your machine finishes booting, you should be at the command prompt possibly with your hard disk mounted on **/mnt/sysimage** (Linux emergency only). To see what is actually mounted, use:

```
df
```

Mount your Bacula Rescue Floppy

Make sure that the mount point **/mnt/floppy** exists. If not, enter:

```
mkdir -p /mnt/floppy
```

then mount your **Bacula Rescue** disk and cd to it with:

```
mount /dev/fd0 /mnt/floppy
cd /mnt/floppy
```

To simplify running the scripts make sure the current directory is on your path by:

```
PATH=$PATH: .
```

Start the Network

At this point, you should bring up your network. Normally, this is quite simple and requires just a few commands. To simplify your task, we have created a script that should work in most cases by typing:

```
./start_network
```

You can test it by pinging another machine, or pinging your broken machine machine from another machine. Do not proceed until your network is up.

Unmount Your Hard Disk (if mounted)

When you are sure you want to repartition your disk, normally, if your disk was damaged or if you are using **tomsrtbt** your hard disk will not be mounted. However, if it is you must first unmount it so that it is not in use. Do so by entering **df** and then enter the correct commands to unmount the disks. For example:

```
umount /mnt/sysimage/boot
umount /mnt/sysimage/usr
umount /mnt/sysimage/proc
umount /mnt/sysimage/
```

where you explicitly unmount (**umount**) each sysimage partition and finally, the last one being the root. Do another **df** command to be sure you successfully unmount all the sysimage partitions.

This is necessary because **sfdisk** will refuse to partition a disk that is currently mounted. As mentioned, this should never be necessary with **tomsrtbt**.

Partition Your Hard Disk(s)

If you are using **tomsrtbt**, you will need to do the following steps to get the correct **sfdisk**:

```
rm -f sfdisk
bzip2 -d sfdisk.bz2
```

Do not do the above steps if you are using a standard Linux boot disk.

Then proceed with partitioning your hard disk by:

```
./partition.hda
```

If you have multiple disks, do the same for each of them. For SCSI disks, the repartition script will be named: **partition.sda**. If the script complains about the disk being in use, simply go back and redo the **df** command and **umount** commands until you no longer have your hard disk mounted. Note, in many cases, if your hard disk was seriously damaged or a new one installed, it will not automatically be mounted. If it is mounted, it is because the emergency kernel found one

or more possibly valid partitions.

If for some reason this procedure does not work, you can use the information in **partition.hda** to re-partition your disks by hand using **fdisk**.

Format Your Hard Disk(s)

After partitioning your disk, you must format it appropriately. The formatting script will put back swap partitions, normal Unix partitions (ext2) and journaled partitions (ext3). Do so by entering for each disk:

```
./format.hda
```

The format script will ask you if you want a block check done. We recommend to answer yes, but realize that for very large disks this can take hours.

Mount the Newly Formatted Disks

Once the disks are partitioned and formatted, you can remount them with the **mount_drives** script. All your drives must be mounted for Bacula to be able to access them. Run the script as follows:

```
./mount_drives  
df
```

The **df** will tell you if the drives are mounted. If not, re-run the script again. It isn't always easy to figure out and create the mount points and the mounts in the proper order, so repeating the **./mount_drives** command will not cause any harm and will most likely work the second time. If not, correct it by hand before continuing.

Unmount the CDROM

Next, if you are using the Red Hat installation disk, unmount the CDROM drive by doing:

```
umount /mnt/cdrom
```

This is not necessary if you are running **tomsrtbt**. In doing this, I find it is always busy, and I haven't figured out how to unmount it (Linux boot only).

Restore and Start the File Daemon

Now, change (cd) to some directory where you want to put the image of the Bacula File daemon. I use the tmp directory my hard disk (mounted as **/mnt/disk/tmp**) because it is easy. Then install into the current directory Bacula by running the **restore_bacula** script from the floppy drive. For example:

```
cd /mnt/disk  
mkdir -p /mnt/disk/tmp  
mkdir -p /mnt/disk/tmp/working  
/mnt/floppy/restore_bacula  
ls -l
```

Make sure **bacula-fd** and **bacula-fd.conf** are both there.

Edit the Bacula configuration file, create the `working/pid/subsys` directory if you haven't already done so above, and start Bacula by entering:

```
chroot /mnt/disk /tmp/bacula-fd -c /tmp/bacula-fd.conf
```

The above command starts the Bacula File daemon with your the proper root disk location (i.e. **/mnt/disk/tmp**). If Bacula does not start correct the problem and start it. You can check if it is running by entering:

```
ps fax
```

You can kill Bacula by entering:

```
kill -TERM <pid>
```

where **pid** is the first number printed in front of the first occurrence of **bacula-fd** in the **ps fax** command.

Now, you should be able to use another computer with Bacula installed to check the status by entering:

```
status client=xxxx
```

into the Console program, where `xxxx` is the name of the client you are restoring.

One common problem is that your **bacula-fd.conf** may contain machine addresses that are not properly resolved on this stripped down system because it is not running DNS. In that case, be prepared to edit **bacula-fd.conf** to replace the name of the Director's machine with its IP address. Or better yet, do this before building the Bacula rescue disk.

Restoring using the RedHat Installation Disk

Suppose your system was damaged for one reason or another, so that the hard disk and the partitioning and much of the filesystems are intact, but you want to do a full restore. If you have booted into your system with the RedHat Installation Disk by specifying **linux rescue** at the **boot:** prompt, you will find yourself in a shell command with your disks already mounted (if it was possible) in **/mnt/sysimage**. In this case, you can do much like you did above to restore your system:

```
cd /mnt/sysimage/tmp
mkdir -p /mnt/sysimage/tmp/working
/mnt/floppy/restore_bacula
ls -l
```

Make sure that **bacula-fd** and **bacula-fd.conf** are both in the current directory and that the directory names in the **bacula-fd.conf** correctly point to the appropriate directories. Then start Bacula with:

```
chroot /mnt/sysimage /tmp/bacula-fd -c /tmp/bacula-fd.conf
```

Restore Your Files

On the computer that is running the Director, you now run a **restore** command and select the files to be restored (normally everything), but before starting the restore, there is one final change you must make using the **mod** option. You must change the **Where** directory to be the root by using the **mod** option just before running the job and selecting **Where**. Set it to:

```
/
```

then run the restore.

You might be tempted to avoid using **chroot** and running Bacula directly and then using a **Where** to specify a destination of **/mnt/disk**. This is possible, however, the current version of Bacula always restores files to the new location, and thus any soft links that have been specified with absolute paths will end up with **/mnt/disk** prefixed to them. In general this is not fatal to getting your system running, but be aware that you will have to fix these links if you do not use **chroot**.

Final Step

At this point, the restore should have finished with no errors, and all your files will be restored. One last task remains and that is to write a new boot sector so that your machine will boot. For **lilo**, you enter the following command:

```
run_lilo
```

If you are using grub instead of lilo, you must enter the following:

```
run_grub
```

Note, I've had quite a number of problems with **grub** because it is rather complicated and not designed to install easily under a simplified system. So, if you experience errors or end up unexpectedly in a **chroot** shell, simply exit back to the normal shell and type in the appropriate commands from the **run_grub** script by hand until you get it to install.

Reboot

Reboot your machine by entering **exit** until you get to the main prompt then enter **ctl-d**.

If everything went well, you should now be back up and running. If not, re-insert the emergency boot floppy, boot, and figure out what is wrong.

At this point, you will probably want to remove the temporary copy of Bacula that you installed. Do so with:

```
rm -f /bacula-fd /bacula-fd.conf
rm -rf /working
```


Linux Problems or Bugs

Since every flavor and every release of Linux is different, there are likely to be some small difficulties with the scripts, so please be prepared to edit them in a minimal environment. A rudimentary knowledge of **vi** is very useful. Also, these scripts do not do everything. You will need to reformat Windows partitions by hand, for example.

Getting the boot loader back can be a problem if you are using **grub** because it is so complicated. If all else fails, reboot your system from your floppy but using the restored disk image, then proceed to a reinstallation of grub (looking at the run-grub script can help). By contrast, lilo is a piece of cake.

Bugs

When performing the bare metal recovery using the Red Hat emergency boot disk (actually the installation boot disk), I was never able to release the cdrom, and when the system came up **/mnt/cdrom** was soft linked to **/mnt/disk/dev/hdd**, which is not correct. I fixed this in each case by deleting and simply remaking it with **mkdir -p /mnt/cdrom**.

tomsrtbt

This is a single floppy (1.722Meg) that really has A LOT of software. For example, by default (version 2.0.103) you get:

```
AHA152X AHA1542 AIC7XXX BUSLOGIC DAC960 DEC_ELCP(TULIP) EATA
EEXPRESS/PRO/PRO100 EL2 EL3 EXT2 EXT3 FAT FD IDE-CD/DISK/TAPE IMM
INITRD ISO9660 JOLIET LOOP MATH_EMULATION MINIX MSDOS NCR53C8XX
NE2000 NFS NTFS PARPORT PCINE2K PCNET32 PLIP PPA RTL8139 SD
SERIAL/_CONSOLE SLIP SMC_ULTRA SR ST VFAT VID_SELECT VORTEX WD80x3
.exrc 3c589_cs agetty ash badblocks basename boot.b buildit.s busybox bz2bzImage bzip2
cardmgr cardmgr.pid cat chain.b chatr chgrp chmod chown chroot clear clone.s cmp common
config cp cpio cs cut date dd dd-lfs debugfs ddate df dhcpcd— dirname dmesg domainname ds
du dumpt2fs e2fsck echo egrep elvis ex false fdflush fdformat fdisk filesize find findsuper fmt
fstab grep group gunzip gzip halt head hexdump hexedit host.conf hostname hosts httpd i82365
ifconfig ile init inittab insmod install.s issue kernel key.lst kill killall killall5 ld ld-linux length
less libc libcom_err libe2p libext2fs libtermcap libuuid lilo lilo.conf ln loadkmap login ls lsattr
lsmod lua luasocket man map md5sum mitemrm mkdir mkdosfs mke2fs mkfifo mkfs.minix mknod
mkswap more more.help mount mt mtab mv nc netcat network networks nmclan_cs nslookup
passwd pax pcmcia_core pcnet_cs pidof ping poweroff printf profile protocols ps pwd rc.0 rc.S
rc.custom rc.custom.gz rc.pcmcia reboot rescuept reset resolv.conf rm rmdir rmmod route rsh
rshd script sed serial serial_cs services setserial settings.s sh shared slattach sleep sln sort split
stab strings swapoff swapon sync tail tar tcic tee telnet telnetd termcap test tomshexd
tomsrtbt.FAQ touch traceroute true tune2fs umount undeb— unpack.s unrpm— update utmp vi
vi.help view watch wc wget which xargs xirc2ps_cs yecho yes zcat
```

In addition, at [Tom's Web Site](#), you can find a lot of additional kernel drivers and other software (such as **sdisk**, which is used by Bacula).

Building his floppy is a piece of cake. Simply download his .tar.gz file then:

- detar the .tar.gz archive
- become root
- cd to the tomsrtbt-<version> directory
- load a blank floppy with no bad sectors
- ./install.s

FreeBSD Bare Metal Recovery

The same basic techniques described above also apply to FreeBSD. Although we don't yet have a fully automated procedure, Alex Torres Molina has provided us with the following instructions with a few additions from Jesse Guardiani and Dan Languille:

1. Boot with the FreeBSD installation disk
2. Go to Custom, Partition and create your slices and go to Label and create the partitions that you want. Apply changes.
3. Go to Fixit to start a emergency console.
4. Create devs ad0 if don't exist under /mnt2/dev (in my situation) with MAKEDEV.
The device or devices you create depend on what hard drives you have. ad0 is your first ATA drive. da0 would be your first SCSI drive. Under OS version 5 and greater, your device files are most likely automatically created for you.
5. mkdir /mnt/disk
this is the root of the new disk
6. mount /mnt2/dev/ad0s1a /mnt/disk
mount /mnt2/dev/ad0s1c /mnt/disk/var
mount /mnt2/dev/ad0s1d /mnt/disk/usr
.....
The same hard drive issues as above apply here too. Note, under OS version 5 or higher, your disk devices may be in /dev not /mnt2/dev.
7. Network configuraion (ifconfig x10 ip/mask + route add default ip-gateway)
8. mkdir /mnt/disk/tmp
9. cd /mnt/disk/tmp
10. Copy bacula-fd and bacula-fd.conf to this path
11. If you need to use sftp to copy files then you must do this:
ln -s /mnt2/usr/bin /usr/bin
12. chmod u+x bacula-fd
13. Modify bacula-fd.conf to fit this machine
14. Copy /bin/sh to /mnt/disk, necessary for chroot
15. Don't forget to put your bacula-dir's IP address and domain name in /mnt/disk/etc/hosts if it's not on a public net. Otherwise the FD on the machine you are restoring to won't be able to contact the SD and DIR on the remote machine.
16. mkdir -p /mnt/disk/var/db/bacula
17. chroot /mnt/disk /tmp/bacula-fd -c /tmp/bacula-fd.conf
to start bacula-fd
18. Now you can go to bacula-dir and restore the job with the entire contents of the broken server.
19. You must create /proc

Solaris Bare Metal Recovery

The same basic techniques described above apply to Solaris:

- the same restrictions as those given for Linux apply
- you will need to create a Bacula Rescue disk

However, during the recovery phase, the boot and disk preparation procedures are different:

- there is no need to create an emergency boot disk since it is an integrated part of the Solaris boot.
- you must partition and format your hard disk by hand following manual procedures as described in W. Curtis Preston's book "Unix Backup Recovery"

Once the disk is partitioned, formatted and mounted, you can continue with bringing up the network and reloading Bacula.

Preparing Solaris Before a Disaster

As mentioned above, before a disaster strikes, you should prepare the information needed in the case of problems. To do so, in the **rescue/solaris** subdirectory enter:

```
su
./getdiskinfo
./make_rescue_disk
```

The **getdiskinfo** script will, as in the case of Linux described above, create a subdirectory **diskinfo** containing the output from several system utilities. In addition, it will contain the output from the **SysAudit** program as described in Curtis Preston's book. This file **diskinfo/sysaudit.bsi** will contain the disk partitioning information that will allow you to manually follow the procedures in the "Unix Backup Recovery" book to repartition and format your hard disk. In addition, the **getdiskinfo** script will create a **start_network** script.

Once you have your your disks repartitioned and formatted, do the following:

- Start Your Network with the **start_network** script
- Restore the Bacula File daemon as documented above
- Perform a Bacula restore of all your files using the same commands as described above for Linux
- Re-install your boot loader using the instructions outlined in the "Unix Backup Recovery" book using **installboot**

Recovering a Server

Above, we considered how to recover a client machine where a valid Bacula server was running on another machine. However, what happens if your server goes down and you no longer have a running Director, Catalog, or Storage daemon? There are several solutions:

1. Bring up static versions of your Director, Catalog, and Storage daemon.

2. Move your server to another machine.

The first option, is very difficult because it requires you to have created a static version of the Director and the Storage daemon as well as the Catalog. If the Catalog uses MySQL or PostgreSQL, this may or may not be possible. In addition, to loading all these programs on a bare system (quite possible), you will need to make sure you have a valid driver for your tape drive.

The second suggestion is probably a much simpler solution, and one I have done myself. To do so, you might want to consider the following steps:

- If you are using MySQL or PostgreSQL, configure, build and install it from source (or user rpms) on your new system.
- Load the Bacula source code onto your new system, configure, install it, and create the Bacula database.
- If you have a valid saved Bootstrap file as created for your damaged machine with WriteBootstrap, use it to restore the files to the damaged machine, where you have loaded a static Bacula File daemon using the Bacula Rescue disk).
- If you have the Bootstrap file, you should now be back up and running, if you do not have a Bootstrap file, continue with the suggestions below.
- Using **bscan** scan the last set of backup tapes into your MySQL, PostgreSQL or SQLite database.
- Start Bacula, and using the Console **restore** command, restore the last valid copy of the Bacula database and the the Bacula configuration files.
- Move the database to the correct location.
- Start and restart Bacula, and with the full database using the Console **restore** command, restore all the files on the damaged machine, where you have loaded a Bacula File daemon using the Bacula Rescue disk.

Bugs and Other Considerations

Directory Modification and Access Times are Modified on pre-1.30 Baculas

When a pre-1.30 version of Bacula restores a directory, it first must create the directory, then it populates the directory with its files and subdirectories. The act of creating the files and subdirectories updates both the modification and access times associated with the directory itself. As a consequence, all modification and access times of all directories will be updated to the time of the restore.

This has been corrected in Bacula version 1.30 and later. The directory modification and access times is reset to the value saved in the backup after all the files and subdirectories have been restored. This has been tested and verified on normal restore operations, but not verified during a bare metal recovery.

Strange Bootstrap Files

If any of you look closely at the bootstrap file that is produced and used for the restore (I sure do), you will probably notice that the FileIndex item does not include all the files saved to the tape. This is because in some instances there are duplicates (especially in the case of an Incremental save), and in such circumstances, **Bacula** restores only the last of multiple copies of

a file or directory.

Disaster Recovery of Win32 Systems

Due to open system files, and registry problems, Bacula cannot save and restore a complete Win2K/XP/NT environment.

A suggestion by Damian Coutts using Microsoft's NTBackup utility in conjunction with Bacula should permit a Full bare metal restore of Win2K/XP (and possibly NT systems). His suggestion is to do an NTBackup of the critical system state prior to running a Bacula backup with the following command:

```
ntbackup backup systemstate /F c:\systemstate.bkf
```

The **backup** is the command, the **systemstate** says to backup only the system state and not all the user files, and the **/F c:\systemstate.bkf** specifies where to write the state file. this file must then be saved and restored by Bacula.

To restore the system state, you first reload a base operating system, then you would use Bacula to restore all the users files and to recover the **c:\systemstate.bkf** file, and finally, run **NTBackup** and **catalogue** the system statefile, and then select it for restore. The documentation says you can't run a command line restore of the systemstate.

To the best of my knowledge, this has not yet been tested. If you test it, please report your results to the Bacula email list.

Resetting Directory and File Ownership and Permissions on Win32 Systems

Bacula versions after 1.31 should properly restore ownership and permissions on all WinNT/XP/2K systems. If you do experience problems, generally in restores to alternate directories because higher level directories were not backed up by Bacula, you can correct any problems with the **SetACL** available under the GPL license at:
<http://sourceforge.net/projects/setacl/>.

Alternate Disaster Recovery Suggestion for Win32 Systems

Ludovic Strappazon has suggested an interesting way to backup and restore complete Win32 partitions. Simply boot your Win32 system with a Linux Rescue disk as described above for Linux, install a statically linked Bacula, and backup any of the raw partitions you want. Then to restore the system, you simply restore the raw partition or partitions. Here is the email that Ludovic recently sent on that subject:

```
I've just finished testing my brand new cd LFS/Bacula  
with a raw Bacula backup and restore of my portable.
```

```
I can't resist sending you the results: look at the rates !!!
```

```
hunt-dir: Start Backup JobId 100, Job=HuntBackup.2003-04-17_12.58.26
```

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```
hunt-dir: Bacula 1.30 (14Apr03): 17-Apr-2003 13:14
JobId:                100
Job:                  HuntBackup.2003-04-17_12.58.26
FileSet:              RawPartition
Backup Level:         Full
Client:               sauvegarde-fd
Start time:           17-Apr-2003 12:58
End time:             17-Apr-2003 13:14
Files Written:        1
Bytes Written:         10,058,586,272
Rate:                 10734.9 KB/s
Software Compression: None
Volume names(s):      000103
Volume Session Id:    2
Volume Session Time:  1050576790
Last Volume Bytes:    10,080,883,520
FD termination status: OK
SD termination status: OK
Termination:          Backup OK
```

```
hunt-dir: Begin pruning Jobs.
hunt-dir: No Jobs found to prune.
hunt-dir: Begin pruning Files.
hunt-dir: No Files found to prune.
hunt-dir: End auto prune.
```

```
hunt-dir: Start Restore Job RestoreFilesHunt.2003-04-17_13.21.44
hunt-sd: Forward spacing to file 1.
hunt-dir: Bacula 1.30 (14Apr03): 17-Apr-2003 13:54
JobId:                101
Job:                  RestoreFilesHunt.2003-04-17_13.21.44
Client:               sauvegarde-fd
Start time:           17-Apr-2003 13:21
End time:             17-Apr-2003 13:54
Files Restored:       1
Bytes Restored:        10,056,130,560
Rate:                 5073.7 KB/s
FD termination status: OK
Termination:          Restore OK
```

```
hunt-dir: Begin pruning Jobs.
hunt-dir: No Jobs found to prune.
hunt-dir: Begin pruning Files.
hunt-dir: No Files found to prune.
hunt-dir: End auto prune.
```

Restoring to a Running System

If for some reason you want to do a Full restore to a system that has a working kernel, you will need to take care not to overwrite the following files:

```
/etc/grub.conf
/etc/X11/Conf
/etc/fstab
/etc/mtab
/lib/modules
/usr/modules
```

/usr/X11R6
/etc/modules.conf

Additional Resources

Many thanks to Charles Curley who wrote [Linux Complete Backup and Recovery HOWTO](#) for the [The Linux Documentation Project](#). This is an excellent document on how to do Bare Metal Recovery on Linux systems, and it was this document that made me realize that Bacula could do the same thing.

You can find quite a few additional resources, both commercial and free at [Storage Mountain](#), formerly known as Backup Central.

And finally, the O'Reilly book, "Unix Backup Recovery" by W. Curtis Preston covers virtually every backup and recovery topic including bare metal recovery for a large range of Unix systems.



[Bacula 1.34 User's Guide](#)
The Network Backup Solution

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Kern Sibbald and John Walker



Autochangers -- General

Beginning with version 1.23, Bacula provides autochanger support for reading and writing tapes. In order to work with an autochanger, Bacula requires three things, each of which is explained in more detail after this list:

- A script that actually controls the autochanger according to commands sent by Bacula. We furnish such a script that works with **mtx** found in the **depkgs** distribution.
- That each Volume (tape) to be used must have a Slot number assigned to it so that Bacula knows where the Volume is in the autochanger. This is generally done with the **label** command. See below for more details.
- Modifications to your Storage daemon's Device configuration resource to identify that the device is a changer, as well as a few other parameters.
- Optionally, you can modify your Storage resource definition in the Director's configuration file so that you are automatically prompted for the Slot when labeling a Volume.

Bacula uses its own **mtx-changer** script to interface with a program that actually does the tape changing. Thus in principle, **mtx-changer** can be adapted to function with any autochanger program. The current version of **mtx-changer** works with the **mtx** program.

As of version 1.30, Bacula supports autochangers with barcode readers. This support includes two new Console commands: **label barcodes** and **update slots**. For more details on these commands, see the "Barcode Support" section below.

Current Bacula autochanger support does not include cleaning, stackers, or silos. However, under certain conditions, you may be able to make Bacula work with stackers (gravity feed and such). Bacula supports only single drive autochangers. If you have a multi-drive autochanger, it may work with Bacula if you use only one drive.

Autochangers Known to Work with Bacula

I hesitate to call these "supported" autochangers because the only autochanger that I have in my position and am able to test is the HP SureStore DAT40X6. All the other autochangers have been reported to work by Bacula users. Note, in the Capacity/Slot column below, I quote the Compressed capacity per tape (or Slot).

OS	Man.	Media	Model	Slots	Cap/Slot
Linux	Adic	LTO-2,LTO-, SDLT 320	Adic Scalar 24	24	100GB
Linux	Exabyte	VXA2	VXA PacketLoader 1x10 2U	10	80/160GB
Linux	HP	DDS-4	SureStore DAT-40X6	6	40GB
???	HP	DLT	A4853 DLT	30	40/70GB
Linux	HP (Compaq)	DLT VI	Compaq TL-895	96+4 import export	35/70GB
SuSE 9.0	IBM	LTO	IBM 3581 Ultrium Tape Loader	7	200/400GB
???	Overland	LTO	Overland LoaderXpress LTO	10-19	100GB
???	Overland	LTO	Overland Neo2000 LTO	26-30	100GB
FreeBSD 4.9	QUALSTAR	AIT1: 36GB,	QUALSTAR	12	AIT1:

	TLS-4210 (Qualstar)	AIT2: 50GB all uncomp	TLS-4210		36GB, AIT2: 50GB all uncomp
Linux	Skydata>	DLT	ATL-L200	8	40/80
???	Sony	DDS-4	TSL-11000	8	40GB
FreeBSD 4.9-STABLE	Sony	AIT-1	TSL-SA300C	4	45/70GB
???	Storagetek	DLT	Timberwolf DLT	6	40/70
Solaris	Sun	4mm DLT	Sun Desktop Archive Python 29279	4	20GB
Linux	Tandberg	DLT VI	VS 640	8?	35/70GB

In principle, if **mtx** will operate your changer correctly, then it is just a question of adapting the **mtx-changer** script (or selecting one already adapted) for proper interfacing. You can find a list of autochangers supported by **mtx** at the following link: <http://mtx.badtux.net/compatibility.php>. The home page for the **mtx** project can be found at: <http://mtx.badtux.net/>.

Knowing What SCSI Devices You Have

Under Linux, you can

```
cat /proc/scsi/scsi
```

to see what SCSI devices you have available. You can also:

```
cat /proc/scsi/sg/device_hdr /proc/scsi/sg/devices
```

to find out how to specify their control address (**/dev/sg0** for the first, **/dev/sg1** for the second, ...) on the **Changer Device** = Bacula directive.

Under FreeBSD, you can use:

```
camcontrol devlist
```

To list the SCSI devices as well as the **/dev/passn** that you will use on the Bacula **Changer Device** = directive.

Example Scripts

Please read the sections below so that you understand how autochangers work with Bacula. Although we supply a default **mtx-changer** script, your autochanger may require some additional changes. If you want to see examples of configuration files and scripts, please look in the **<bacula-src>/examples/devices** directory where you will find an example

HP-autoloader.conf Bacula Device resource, and several **mtx-changer** scripts that have been modified to work with different autochangers.

Slots

Some autochangers have more than one read/write device (drive). The current implementation, assumes the autochanger has only one device. To properly address autochangers, Bacula must know which Volume is in each **slot** of the autochanger. Slots are where the changer cartridges reside when not loaded into the drive. Bacula numbers these slots from one to the number of cartridges contained in the autochanger.

For each Volume in your changer, you will, using the Console program, assign a slot. This information is kept in **Bacula's** media database along with the other data for the volume. If no slot is given, or the slot is set to zero, Bacula will not attempt to use the autochanger even if all the necessary configuration records are present.

Device Configuration Records

Configuration of autochangers within Bacula is done in the Device resource of the Storage daemon. Four records: **Autochanger**, **Changer Device**, **Changer Command**, and **Maximum Changer Wait** control how Bacula uses the autochanger.

These four records, permitted in **Device** resources, are described in detail below:

Autochanger = Yes/No

The **Autochanger** record specifies that the current device is or is not an autochanger. The default is **no**.

Changer Device = <device-name>

In addition to the Archive Device name, you must specify a **Changer Device** name. This is because most autochangers are controlled through a different device than is used for reading and writing the cartridges. For example, on Linux, one normally uses the generic SCSI interface for controlling the autochanger, but the standard SCSI interface for reading and writing the tapes. On Linux, for the **Archive Device = /dev/nst0**, you would typically have **Changer Device = /dev/sg0**. Note, some of the more advanced autochangers will locate the changer device on **/dev/sg1**. Such devices typically have several drives and a large number of tapes.

On FreeBSD systems, the changer device will typically be on **/dev/pass0** through **/dev/passn**.

On Solaris, the changer device will typically be some file under **/dev/rdsk**.

Changer Command = <command>

This record is used to specify the external program to call and what arguments to pass to it. The command is assumed to be a standard program or shell script that can be executed by the operating system. This command is invoked each time that Bacula wishes to manipulate the autochanger. The following substitutions are made in the **command** before it is sent to the operating system for execution:

```
%% = %
%a = archive device name
%c = changer device name
```

```
%d = changer drive index base 0
%f = Client's name
%j = Job name
%o = command (loaded, load, or unload)
%s = Slot base 0
%S = Slot base 1
%v = Volume name
```

An actual example for using **mtx** with the **mtx-changer** script (part of the Bacula distribution) is:

```
Changer Command = "/etc/bacula/mtx-changer %c %o %S %a %d"
```

Where you will need to adapt the **/usr/bin** to be the actual path on your system. Details of the three commands currently used by Bacula (loaded, load, unload) as well as the output expected by Bacula are given in the **Bacula Autochanger Interface** section below.

Maximum Changer Wait = <time>

This record is used to define the maximum amount of time that Bacula will wait for an autoloader to respond to a command (e.g. load). The default is set to 120 seconds. If you have a slow autoloader you may want to set it longer.

If the autoloader program fails to respond in this time, it will be killed and Bacula will request operator intervention.

An Example Configuration File

The following **Device** resource implements an autochanger:

```
Device {
  Name = "Autochanger"
  Media Type = DDS-4
  Archive Device = /dev/nst0      # Normal archive device
  Changer Device = /dev/sg0      # Generic SCSI device name
  Changer Command = "/etc/bacula/mtx-changer %c %o %S %a %d"
  Autochanger = yes
  LabelMedia = no;
  AutomaticMount = yes;
  AlwaysOpen = yes;
  Mount Anonymous Volumes = no;
}
```

where you will adapt the **Archive Device**, the **Changer Device**, and the path to the **Changer Command** to correspond to the values used on your system.

The above **Device** resource will work equally well for any standard tape drive (with device name **/dev/nst0**) since the extra autochanger commands will not be used unless a **slot** has been specified in the catalog record for the Volume to be used. See below for more details on the **slot**.

Specifying Slots When Labeling

If you add an **Autochanger = yes** record to the Storage resource in your Director's configuration file, the Bacula Console will automatically prompt you for the slot number when you **add** or **label** tapes for that Storage device. You must also set **Autochanger = yes** in the Device resource

as we have described above in order for the autochanger to be used. Please see the [Storage Resource](#) in the Director's chapter and the [Device Resource](#) in the Storage daemon chapter for more details on these records.

Thus all stages of dealing with tapes can be totally automated. It is also possible to set or change the Slot using the **update** command in the Console and selecting **Volume Parameters** to update.

Even though all the above configuration statements are specified and correct, Bacula will attempt to access the autochanger only if a **slot** is non-zero in the catalog Volume record (with the Volume name).

FreeBSD Issues

If you are having problems on FreeBSD when Bacula tries to select a tape, and the message is **Device not configured**, this is because FreeBSD has made the tape device **/dev/nsa1** disappear when there is no tape mounted in the autochanger slot. As a consequence, Bacula is unable to open the device. The solution to the problem is to make sure that some tape is loaded into the tape drive before starting Bacula. This problem is correct in Bacula versions 1.32f-5 and later.

Please see the file **platforms/freebsd/pthreads-fix.txt** in the main Bacula directory concerning important information concerning compatibility of Bacula and your system.

Testing the Autochanger and Adapting Your mtx-changer Script

Before attempting to use the autochanger with Bacula, it is preferable to "hand-test" that the changer works. To do so, we suggest you do the following commands (assuming that the **mtx-changer** script is installed in **/usr/bin/bacula/mtx-changer**):

Make sure Bacula is not running.

```
/etc/bacula/mtx-changer /dev/sg0 list
```

This command should print:

```
1:
2:
3:
...
```

or one number per line for each slot that is occupied in your changer, and the number should be terminated by a colon (:). If your changer has barcodes, the barcode will follow the colon. If an error message is printed, you must resolve the problem (e.g. try a different SCSI control device name if **/dev/sg0** is incorrect. For example, on FreeBSD systems, the autochanger SCSI control device is generally **/dev/pass2**.

```
/etc/bacula/mtx-changer /dev/sg0 unload
```

If a tape is loaded, this should cause it to be unloaded.

```
/etc/bacula/mtx-changer /dev/sg0 load 3
```

Assuming you have a tape in slot 3, it will be loaded into the read slot (0).

```
/etc/bacula/mtx-changer /dev/sg0 loaded
```

It should print "3:"

```
/etc/bacula/mtx-changer /dev/sg0 unload
```

Once all the above commands work correctly, assuming that you have the right **Changer Command** in your configuration, Bacula should be able to operate the changer. The only remaining area of problems will be if your autoloader needs some time to get the tape loaded after issuing the command. After the **mtx-changer** script returns, Bacula will immediately rewind and read the tape. If Bacula gets rewind I/O errors after a tape change, you will probably need to insert a **sleep 20** after the **mtx** command, but be careful to exit the script with a zero status by adding **exit 0** after any additional commands you add to the script. This is because Bacula checks the return status of the script, which should be zero if all went well.

You can test whether or not you need a **sleep** by putting the following commands into a file and running it as a script:

```
#!/bin/sh
/etc/bacula/mtx-changer /dev/sg0 unload
/etc/bacula/mtx-changer /dev/sg0 load 3
mt -f /dev/st0 rewind
mt -f /dev/st0 weof
```

If the above script runs, you probably have no timing problems. If it does not run, start by putting a **sleep 30** or possibly a **sleep 60** in the script just after the **mtx-changer load** command. If that works, then you should move the sleep into the actual **mtx-changer** script so that it will be effective when Bacula runs.

A second problem that comes up with a small number of autochangers is that they need to have the cartridge ejected before it can be removed. If this is the case, the **load 3** will never succeed regardless of how long you wait. If this seems to be your problem, you can insert an eject just after the unload so that the script looks like:

```
#!/bin/sh
/etc/bacula/mtx-changer /dev/sg0 unload
mt -f /dev/st0 offline
/etc/bacula/mtx-changer /dev/sg0 load 3
mt -f /dev/st0 rewind
mt -f /dev/st0 weof
```

Obviously, if you need the **offline** command, you should move it into the **mtx-changer** script ensuring that you save the status of the **mtx** command or always force an **exit 0** from the script, because Bacula checks the return status of the script.

As noted earlier, there are several scripts in **<bacula-source>/examples/devices** that implement the above features, so they may be a help to you in getting your script to work.

If Bacula complains "Rewind error on /dev/nst0. ERR=Input/output error." you most likely need more sleep time in your **mtx-changer** before returning to Bacula after a load command has been completed.

Using the Autochanger

Let's assume that you have properly defined the necessary Storage daemon Device records, and you have added the **Autochanger = yes** record to the Storage resource in your Director's configuration file.

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Now you fill your autochanger with say six blank tapes.

What do you do to make Bacula access those tapes?

One strategy is to prelabel each of the tapes. Do so by starting Bacula, then with the Console program, enter the **label** command:

```
./console
Connecting to Director rufus:8101
1000 OK: rufus-dir Version: 1.26 (4 October 2002)
*label
```

it will then print something like:

```
Using default Catalog name=BackupDB DB=bacula
The defined Storage resources are:
    1: Autochanger
    2: File
Select Storage resource (1-2): 1
```

I select the autochanger (1), and it prints:

```
Enter new Volume name: TestVolume1
Enter slot (0 for none): 1
```

where I entered **TestVolume1** for the tape name, and slot **1** for the slot. It then asks:

```
Defined Pools:
    1: Default
    2: File
Select the Pool (1-2): 1
```

I select the Default pool. This will be automatically done if you only have a single pool, then Bacula will proceed to unload any loaded volume, load the volume in slot 1 and label it. In this example, nothing was in the drive, so it printed:

```
Connecting to Storage daemon Autochanger at localhost:9103 ...
Sending label command ...
3903 Issuing autochanger "load slot 1" command.
3000 OK label. Volume=TestVolume1 Device=/dev/nst0
Media record for Volume=TestVolume1 successfully created.
Requesting mount Autochanger ...
3001 Device /dev/nst0 is mounted with Volume TestVolume1
You have messages.
*
```

You may then proceed to label the other volumes. The messages will change slightly because Bacula will unload the volume (just labeled TestVolume1) before loading the next volume to be labeled.

Once all your Volumes are labeled, Bacula will automatically load them as they are needed.

To "see" how you have labeled your Volumes, simply enter the **list volumes** command from the Console program, which should print something like the following:

*list volumes

Using default Catalog name=BackupDB DB=bacula

Defined Pools:

1: Default

2: File

Select the Pool (1-2): 1

MedId	VolName	MedTyp	VolStat	Bites	LstWrt	VolReten	Recyc	Slot
1	TestVol1	DDS-4	Append	0	0	30672000	0	1
2	TestVol2	DDS-4	Append	0	0	30672000	0	2
3	TestVol3	DDS-4	Append	0	0	30672000	0	3
...								

Barcode Support

Bacula provides barcode support with two Console commands, **label barcodes** and **update slots**.

The **label barcodes** will cause Bacula to read the barcodes of all the cassettes that are currently installed in the magazine (cassette holder) using the **mtx-changer list** command. Each cassette is mounted in turn and labeled with the same Volume name as the barcode.

The **update slots** command will first obtain the list of cassettes and their barcodes from **mtx-changer**. Then it will find each volume in turn in the catalog database corresponding to the barcodes and set its Slot to correspond to the value just read. If the Volume is not in the catalog, then nothing will be done. This command is useful for synchronizing Bacula with the current magazine in case you have changed magazines or in case you have moved cassettes from one slot to another.

The **Cleaning Prefix** statement can be used in the Pool resource to define a Volume name prefix, which if it matches that of the Volume (barcode) will cause that Volume to be marked with a VolStatus of **Cleaning**. This will prevent Bacula from attempting to write on the Volume.

Bacula Autochanger Interface

Bacula calls the autochanger script that you specify on the **Changer Device** statement. Normally this script will be the **mtx-changer** script that we can provide, but it can in fact be any program. The only requirements are that the "commands" that Bacula uses are **loaded**, **load**, **unload** and **list** (slots may be used in the future). In addition, each of those commands must return the information in the precise format as specified below:

- Currently the changer commands used are:
 - loaded -- returns number of the slot that is loaded in the drive or 0 if the drive is empty.
 - load -- loads a specified slot (note, some autochangers require a 30 second pause after this command) into the drive.
 - unload -- unloads the device (returns cassette to its slot).
 - list -- returns one line for each cassette in the autochanger in the format <slot>:<barcode>. Where the **slot** is the non-zero integer representing

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the slot number, and **barcode** is the barcode associated with the cassette if it exists and if you autoloader supports barcodes. Otherwise the barcode field is blank.

- Other changer commands defined but not yet used:
 - slots -- returns total number of slots in the autochanger.

Bacula checks the exit status of the program called, and if it is zero, the data is accepted. If the exit status is non-zero, Bacula ignores any information returned and treats the drive as if it is not an autochanger.



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Examples

There are a number of example scripts for various things that can be found in the **example** subdirectory and its subdirectories of the Bacula source distribution.

Upgrading Bacula Versions

The first thing to do before upgrading from one version to another is to ensure that don't overwrite your production (current) version of Bacula until you have tested that the new version works.

If you have installed Bacula into a single directory, this is simple: simply make a copy of your Bacula directory.

If you have done a more typical Unix installation where the binaries are placed in one directory and the configuration files are placed in another, then the simplest way is to configure your new Bacula to go into a single file.

Whatever your situation may be (one of the two just described), you should probably start with the **defaultconf** script that can be found in the **examples** subdirectory. Copy this script to the main Bacula directory, modify it as necessary (there should not need to be many modifications), configure Bacula, build it, install it, then stop your production Bacula, copy all the ***.conf** files from your production Bacula directory to the test Bacula directory, start the test version, and run a few test backups. If all seems good, then you can proceed to install the new Bacula in place of or possibly over the old Bacula.

When installing a new Bacula you need not worry about losing the changes you made to your configuration files as the installation process will not overwrite them.

Getting Notified of Job Completion

One of the first things you should do is to ensure that you are being properly notified of the status of each Job run by Bacula, or at a minimum of each Job that terminates with an error.

Until you are completely comfortable with **Bacula**, we recommend that you send an email to yourself for each Job that is run. This is most easily accomplished by adding an email notification address in the **Messages** resource of your Director's configuration file. An email is automatically configured in the default configuration files, but you must ensure that the default **root** address is replaced by your email address.

For examples of how I (Kern) configure my system, please take a look at the **.conf** files found in the **examples** sub-directory. We recommend the following configuration (where you change the paths and email address to correspond to your setup). Note, the **mailcommand** and **operatorcommand** should be on a single line. They were split here for presentation:

```
Messages {  
    Name = Standard
```

```
mailcommand = "/home/bacula/bin/bsmtp -h localhost
               -f \"\\(Bacula\\) %r\"
               -s \"Bacula: %t %e of %c %l\" %r\"
operatorcommand = "/home/bacula/bin/bsmtp -h localhost
                  -f \"\\(Bacula\\) %r\"
                  -s \"Bacula: Intervention needed for %j\" %r\"
Mail = your-email-address = all, !skipped, !terminate
append = "/home/bacula/bin/log" = all, !skipped, !terminate
operator = your-email-address = mount
console = all, !skipped, !saved
}
```

You will need to ensure that the `/home/bacula/bin` path on the **mailcommand** and the **operatorcommand** lines points to your **Bacula** binary directory where the **bsmtp** program will be installed. You will also want to ensure that the **your-email-address** is replaced by your email address, and finally, you will also need to ensure that the `/home/bacula/bin/log` points to the file where you want to log all messages.

With the above Messages resource, you will be notified by email of every Job that ran, all the output will be appended to the **log** file you specify, all output will be directed to the console program, and all mount messages will be emailed to you. Note, some messages will be sent to multiple destinations.

The form of the mailcommand is a bit complicated, but it allows you to distinguish whether the Job terminated in error or terminated normally. Please see the [Mail Command](#) section of the Messages Resource chapter of this manual for the details of the substitution characters used above.

Once you are totally comfortable with Bacula as I am, or if you have a large number of nightly Jobs as I do (eight), you will probably want to change the **Mail** command to **Mail On Error** which will generate an email message only if the Job terminates in error. If the Job terminates normally, no email message will be sent, but the output will still be appended to the log file as well as sent to the Console program.

Getting Email Notification to Work

The section above describes how to get email notification of job status. Occasionally, however, users have problems receiving any email at all. In that case, the things to check are the following:

- Ensure that you have a valid email address specified on your **Mail** record in the Director's Messages resource. The email address should be fully qualified. Simply using **root** generally will not work, rather you should use **root@localhost** or better yet your full domain.
- Ensure that you do not have a **Mail** record in the Storage daemon's or File daemon's configuration files. The only record you should have is **director**:

```
director = director-name = all
```

- If all else fails, try replacing the **mailcommand** with

```
mailcommand = "mail -s test your@domain.com"
```

- Once the above is working, assuming you want to use **bsmtp**, submit the desired bsmtp command by hand and ensure that the email is delivered, then put that command into **Bacula**. Small differences in things such as the parenthesis around the word Bacula can make a big difference to some bsmtp programs. For example, you might start simply by using:

```
mailcommand = "/home/bacula/bin/bsmtp -f \"root@localhost\" %r"
```

Getting Notified that Bacula is Running

If like me, you have setup Bacula so that email is sent only when a Job has errors, as described in the previous section of this chapter, inevitably, one day, something will go wrong and **Bacula** can stall. This could be because Bacula crashes, which is vary rare, or more likely the network has caused **Bacula** to **hang** for some unknown reason.

To avoid this, you can use the **RunAfterJob** command in the Job resource to schedule a Job nightly, or weekly that simply emails you a message saying that Bacula is still running. For example, I have setup the following Job in my Director's configuration file:

```
Schedule {
    Name = "Watchdog"
    Run = Level=Full sun-sat at 6:05
}

Job {
    Name = "Watchdog"
    Type = Admin
    Client=Watchdog
    FileSet="Verify Set"
    Messages = Standard
    Storage = DLTDDrive
    Pool = Default
    Schedule = "Watchdog"
    RunAfterJob = "/home/kern/bacula/bin/watchdog %c %d"
}

Client {
    Name = Watchdog
    Address = rufus
    FDPort = 9102
    Catalog = Verify
    Password = ""
    File Retention = 1day
    Job Retention = 1 month
    AutoPrune = yes
}
```

Where I established a schedule to run the Job nightly. The Job itself is type **Admin** which means that it doesn't actually do anything, and I've defined a FileSet, Pool, Storage, and Client, all of which are not really used (and probably don't need to be specified). The key aspect of this Job is the command:

```
RunAfterJob = "/home/kern/bacula/bin/watchdog %c %d"
```

which runs my "watchdog" script. As an example, I have added the Job codes %c and %d which will cause the Client name and the Director's name to be passed to the script. For example, if the Client's name is **Watchdog** and the Director's name is **main-dir** then referencing \$1 in the script would get **Watchdog** and referencing \$2 would get **main-dir**. In this case, having the script know the Client and Director's name is not really useful, but in other situations it may be.

You can put anything in the watchdog scrip. In my case, I like to monitor the size of my catalog to be sure that **Bacula** is really pruning it. The following is my watchdog script:

```
#!/bin/sh
cd /home/kern/mysql/var/bacula
du . * |
/home/kern/bacula/bin/bsmtp \
    -f "\(Bacula\) abuse@whitehouse.com" -h mail.yyyy.com \
    -s "Bacula running" abuse@whitehouse.com
```

If you just wish to send yourself a message, you can do it with:

```
#!/bin/sh
cd /home/kern/mysql/var/bacula
/home/kern/bacula/bin/bsmtp \
    -f "\(Bacula\) abuse@whitehouse.com" -h mail.yyyy.com \
    -s "Bacula running" abuse@whitehouse.com <<END-OF-DATA
Bacula is still running!!!
END-OF-DATA
```

Maintaining a Valid Bootstrap File

By using a [WriteBootstrap](#) record in each of your Director's Job resources, you can constantly maintain a [bootstrap](#) file that will enable you to recover the state of your system as of the last backup without having the Bacula catalog. This permits you to more easily recover from a disaster that destroys your Bacula catalog.

When a Job resource has a **WriteBootstrap** record, Bacula will maintain the designated file (normally on another system but mounted by NSF) with up to date information necessary to restore your system. For example, in my Director's configuration file, I have the following record:

```
Write Bootstrap = "/mnt/deuter/files/backup/client-name.bsr"
```

where I replace **client-name** by the actual name of the client that is being backed up. Thus, Bacula automatically maintains one file for each of my clients. The necessary bootstrap information is appended to this file during each **Incremental** backup, and the file is totally rewritten during each **Full** backup.

Note, one major disadvantage of writing to an NFS mounted volume as I do is that if the other machine goes down, the OS will wait forever on the `fopen()` call that Bacula makes. As a consequence, Bacula will completely stall until the machine exporting the NSF mounts comes back up. The solution to this problem was provided by Andrew Hilborne, and consists of using the **soft** option instead of the **hard** option when mounting the NFS volume, which is typically done in `/etc/fstab/`. The NFS documentation explains these options in detail.

If you are starting off in the middle of a cycle (i.e. with Incremental backups) rather than at the beginning (with a Full backup), the **bootstrap** file will not be immediately valid as it must always have the information from a Full backup as the first record. If you wish to synchronize your bootstrap file immediately, you can do so by running a **restore** command for the client and selecting a full restore, but when the restore command asks for confirmation to run the restore Job, you simply reply no, then copy the bootstrap file that was written to the location specified on the **Write Bootstrap** record. The restore bootstrap file can be found in **restore.bsr** in the working directory that you defined. In the example given below for the client **rufus**, my input is shown in bold. Note, the JobId output has been partially truncated to fit on the page here:

```
(in the Console program)
*restore
First you select one or more JobIds that contain files
to be restored. You will then be presented several methods
of specifying the JobIds. Then you will be allowed to
select which files from those JobIds are to be restored.

To select the JobIds, you have the following choices:
    1: List last 20 Jobs run
    2: List Jobs where a given File is saved
    3: Enter list of JobIds to select
    4: Enter SQL list command
    5: Select the most recent backup for a client
    6: Cancel
Select item: (1-6): 5
The defined Client resources are:
    1: Minimatou
    2: Rufus
    3: Timmy
Select Client (File daemon) resource (1-3): 2
The defined FileSet resources are:
    1: Kerns Files
Item 1 selected automatically.

+-----+-----+-----+-----+-----+-----+-----+
| JobId | Levl | Files | StrtTim | VolName | File | SesId | VolSesTime |
+-----+-----+-----+-----+-----+-----+-----+
| 2     | F    | 84    | ...     | test1   | 0    | 1     | 1035645259 |
+-----+-----+-----+-----+-----+-----+-----+

You have selected the following JobId: 2
Building directory tree for JobId 2 ...

The defined Storage resources are:
    1: File
Item 1 selected automatically.

You are now entering file selection mode where you add and
remove files to be restored. All files are initially added.
Enter "done" to leave this mode.

cwd is: /
$ done

84 files selected to restore.

Run Restore job
JobName:     kernsrestore
Bootstrap:   /home/kern/bacula/working/restore.bsr
```

```
Where:      /tmp/bacula-restores
FileSet:    Kerns Files
Client:     Rufus
Storage:    File
JobId:      *None*
OK to run? (yes/mod/no): no
quit
```

```
(in a shell window)
cp ../working/restore.bsr /mnt/deuter/files/backup/rufus.bsr
```

Rejected Volumes After a Crash

Bacula keeps a count of the number of files on each Volume in its Catalog database so that before appending to a tape, it can verify that the number of files are correct, and thus prevent overwriting valid data. If the Director or the Storage daemon crashes before the job has completed, the tape will contain one more file than is noted in the Catalog, and the next time you attempt to use the same Volume, Bacula will reject it due to a mismatch between the physical tape (Volume) and the catalog.

The easiest solution to this problem is to label a new tape and start fresh. If you wish to continue appending to the current tape, you can do so by using the **update** command in the console program to change the **Volume Files** entry in the catalog. A typical sequence of events would go like the following:

- Bacula crashes
- You restart Bacula

Bacula then prints:

```
17-Jan-2003 16:45 rufus-dir: Start Backup JobId 13,
                  Job=kernsave.2003-01-17_16.45.46
17-Jan-2003 16:45 rufus-sd: Volume test01 previously written,
                  moving to end of data.
17-Jan-2003 16:46 rufus-sd: kernsave.2003-01-17_16.45.46 Error:
                  I cannot write on this volume because:
                  The number of files mismatch! Volume=11 Catalog=10
17-Jan-2003 16:46 rufus-sd: Job kernsave.2003-01-17_16.45.46 waiting.
                  Cannot find any appendable volumes.
Please use the "label" command to create a new Volume for:
Storage:      SDT-10000
Media type:   DDS-4
Pool:        Default
```

(note, lines wrapped for presentation)

The key here is the line that reads:

```
The number of files mismatch! Volume=11 Catalog=10
```

It says that Bacula found eleven files on the volume, but that the catalog says there should be ten. When you see this, you can be reasonably sure that the SD was interrupted while writing before it had a chance to update the catalog. As a consequence, you can just modify the catalog count to eleven, and even if the catalog contains references to files saved in file 11, everything will be OK and nothing will be lost. Note that if the SD had written several file marks to the volume, the difference between the Volume count and the Catalog count could be larger than one, but this is

unusual.

If on the other hand the catalog is marked as having more files than Bacula found on the tape, you need to consider the possible negative consequences of modifying the catalog. Please see below for a more complete discussion of this.

Continuing with the example of **Volume = 11 Catalog = 10**, to enable to Bacula to append to the tape, you do the following:

update

Update choice:

- 1: Volume parameters
- 2: Pool from resource
- 3: Slots from autochanger

Choose catalog item to update (1-3): **1**

Defined Pools:

- 1: Default
- 2: File

Select the Pool (1-2):

MedId	VolName	MedTyp	VolStat	VolBytes	Last	VolReten	Recy	SlT
1	test01	DDS-4	Error	352427156	...	31536000	1	0

Enter MediaId or Volume name: **1**

(note table output truncated for presentation) First, you chose to update the Volume parameters by entering a **1**. In the volume listing that follows, notice how the VolStatus is **Error**. We will correct that after changing the Volume Files. Continuing, you respond 1,

Updating Volume "test01"

Parameters to modify:

- 1: Volume Status
- 2: Volume Retention Period
- 3: Volume Use Duration
- 4: Maximum Volume Jobs
- 5: Maximum Volume Files
- 6: Maximum Volume Bytes
- 7: Recycle Flag
- 8: Slot
- 9: Volume Files
- 10: Pool
- 11: Done

Select parameter to modify (1-11): **9**

Warning changing Volume Files can result in loss of data on your Volume

Current Volume Files is: 10

Enter new number of Files for Volume: **11**

New Volume Files is: 11

Updating Volume "test01"

Parameters to modify:

- 1: Volume Status
- 2: Volume Retention Period
- 3: Volume Use Duration
- 4: Maximum Volume Jobs

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```
5: Maximum Volume Files
6: Maximum Volume Bytes
7: Recycle Flag
8: Slot
9: Volume Files
10: Pool
11: Done
Select parameter to modify (1-10): 1
```

Here, you have selected **9** in order to update the Volume Files, then you changed it from **10** to **11**, and you now answer **1** to change the Volume Status.

```
Current Volume status is: Error
Possible Values are:
1: Append
2: Archive
3: Disabled
4: Full
5: Used
6: Read-Only
Choose new Volume Status (1-6): 1
New Volume status is: Append
Updating Volume "test01"
Parameters to modify:
1: Volume Status
2: Volume Retention Period
3: Volume Use Duration
4: Maximum Volume Jobs
5: Maximum Volume Files
6: Maximum Volume Bytes
7: Recycle Flag
8: Slot
9: Volume Files
10: Pool
11: Done
Select parameter to modify (1-11): 11
Selection done.
```

At this point, you have changed the Volume Files from **10** to **11** to account for the last file that was written but not updated in the database, and you changed the Volume Status back to **Append**.

This was a lot of words to describe something quite simple.

The **Volume Files** option exists only in version 1.29 and later, and you should be careful using it. Generally, if you set the value to that which Bacula said is on the tape, you will be OK, especially if the value is one more than what is in the catalog.

Now lets consider the case:

```
The number of files mismatch! Volume=10 Catalog=12
```

Here the Bacula found fewer files on the volume than what is marked in the catalog. Now, in this case, you should hesitate lot before modifying the count in the catalog, because if you force the catalog from 12 to 10, Bacula will start writing after the file 10 on the tape, possibly overwriting valid data, and if you ever try to restore any of the files that the catalog has marked as saved on

Files 11 and 12, all chaos will break out. In this case, you will probably be better off using a new tape. In fact, you might want to see what files the catalog claims are actually stored on that Volume, and back them up to another tape and recycle this tape.

Security Considerations

Only the File daemon needs to run with root permission (so that it can access all files). As a consequence, you may run your Director, Storage daemon, and MySQL or PostgreSQL database server as non-root processes. Version 1.30 has the `-u` and the `-g` options that allow you to specify a userid and groupid on the command line to be used after Bacula starts.

As of version 1.33, thanks to Dan Langille, it is easier to configure the Bacula Director and Storage daemon to run as non-root.

You should protect the Bacula port addresses (normally 9101, 9102, and 9103) from outside access by a firewall or other means of protection to prevent unauthorized use of your daemons.

You should ensure that the configuration files are not world readable since they contain passwords that allow access to the daemons. Anyone who can access the Director using a console program can restore any file from a backup Volume.

You should protect your Catalog database. If you are using SQLite, make sure that the working directory is readable only by root (or your Bacula userid), and ensure that **bacula.db** has permissions `-rw-r--r--` (i.e. 640) or more strict. If you are using MySQL or PostgreSQL, please note that the Bacula setup procedure leaves the database open to anyone. At a minimum, you should assign the user **bacula** a userid and add it to your Director's configuration file in the appropriate Catalog resource.

Creating Holiday Schedules

If you normally change tapes every day or at least every Friday, but Thursday is a holiday, you can use a trick proposed by Lutz Kittler to ensure that no job runs on Thursday so that you can insert Friday's tape and be sure it will be used on Friday. To do so, define a **RunJobBefore** script that normally returns zero, so that the Bacula job will normally continue. You can then modify the script to return non-zero on any day when you do not want Bacula to run the job.

Automatic Labeling Using Your Autochanger

If you have an autochanger but it does not support barcodes, using a "trick" you can make Bacula automatically label all the volumes in your autochanger's magazine.

First create a file containing one line for each slot in your autochanger that has a tape to be labeled. The line will contain the slot number a colon (:) then the Volume name you want to use. For example, create a file named **volume-list**, which contains:

```
1:Volume001
2:TestVolume02
5:LastVolume
```

The records do not need to be in any order and you don't need to mention all the slots. Normally, you will have a consistent set of Volume names and a sequential set of numbers for each slot you want labeled. In the example above, I've left out slots 3 and 4 just as an example. Now, modify your **mtx-changer** script and comment out all the lines in the **list**) case by putting a # in column 1. Then add the following two lines:

```
cat <absolute-path>/volume-list
exit 0
```

so that the whole case looks like:

```
list)
#
# commented out lines
# cat <absolute-path>/volume-list
# exit 0
# ;
```

where you replace <absolute-path> with the full path to the volume-list file. Then using the console, you enter the following command:

```
label barcodes
```

and Bacula will proceed to mount the autochanger Volumes in the list and label them with the Volume names you have supplied. Bacula will think that the list was provided by the autochanger barcodes, but in reality, it was you who supplied the <barcodes>.

If it seems to work, when it finishes, enter:

```
list volumes
```

and you should see all the volumes nicely created.

Backing Up Portables Using DHCP

You may want to backup laptops or portables that are not always connected to the network. If you are using DHCP to assign an IP address to those machines when they connect, you will need to use the Dynamic Update capability of DNS to assign a name to those machines that can be used in the Address field of the Client resource in the Director's conf file.

Going on Vacation

At some point, you may want to be absent for a week or two and you want to make sure Bacula has enough tape left so that the backups will complete. You start by doing a **list volumes** in the Console program:

```
list volumes
```

```
Using default Catalog name=BackupDB DB=bacula
Pool: Default
```

MediaId	VolumeName	MediaType	VolStatus	VolBytes

23	DLT-30Nov02	DLT8000	Full	54,739,278,128
24	DLT-21Dec02	DLT8000	Full	56,331,524,629
25	DLT-11Jan03	DLT8000	Full	67,863,514,895
26	DLT-02Feb03	DLT8000	Full	63,439,314,216
27	DLT-03Mar03	DLT8000	Full	66,022,754,598
28	DLT-04Apr03	DLT8000	Full	60,792,559,924
29	DLT-28Apr03	DLT8000	Full	62,072,494,063
30	DLT-17May03	DLT8000	Full	65,901,767,839
31	DLT-07Jun03	DLT8000	Used	56,558,490,015
32	DLT-28Jun03	DLT8000	Full	64,274,871,265
33	DLT-19Jul03	DLT8000	Full	64,648,749,480
34	DLT-08Aug03	DLT8000	Full	64,293,941,255
35	DLT-24Aug03	DLT8000	Append	9,999,216,782

Note, I have truncated the output for presentation purposes. What is significant for is that I can see that my current tape has almost 10 Gbytes of data, and that the average amount of data I get on my tapes is about 60 Gbytes. So if I go on vacation now, I don't need to worry about tape capacity (at least not for short absences).

Equally significant is the fact that I did go on vacation the 28th of June 2003, and when I did the **list volumes** command, my current tape at that time, DLT-07Jun03 MediaId 31, had 56.5 Gbytes written. I could see that the tape would fill shortly. Consequently, I manually marked it as **Used** and replaced it with a fresh tape that I labeled as DLT-28Jun03, thus assuring myself that the backups would all complete without my intervention.

How to Exclude File on Windows Regardless of Case

This tip was submitted by Marc Brueckner who wasn't sure of the case of some of his files on Win32, which is case insensitive. The problem is that Bacula thinks that **/UNIMPORTANT FILES** is different from **/Unimportant Files**. Marc was aware that the file exclusion permits wild-cards. So, he specified:

```
"/[Uu][Nn][Ii][Mm][Pp][Oo][Rr][Tt][Aa][Nn][Tt] [Ff][Ii][Ll][Ee][Ss]"
```

As a consequence, the above exclude works for files of any case.

Please note that this works only in Bacula Exclude statement and not in Include.

Executing Scripts on a Remote Machine

This tip also comes from Marc Brueckner. (Note, this tip is probably outdated by the addition of **ClientRunBeforeJob** and **ClientRunAfterJob** Job records, but the technique still could be useful.) First I thought the "Run Before Job" statement in the Job-resource is for executing a script on the remote machine(the machine to be backed up). It could be usefull to execute scripts on the remote machine e.g. for stopping databases or other services while doing the backup. (Of cause I have to start the services again when the backup has finished) I found the following solution: Bacula could execute scrips on the remote machine by using ssh. The authentication is done automatically using a private key. First You have to generate a keypair. I ve done this by:

```
ssh-keygen -b 4096 -t dsa -f Bacula_key
```

This statement may take a little time to run. It creates a public/private key pair with no pass phrase. You could save the keys in /etc/bacula. Now you have two new files : Bacula_key which contains the private key and Bacula_key.pub which contains the public key.

Now you have to append the Bacula_key.pub file to the file authorized_keys in the \root\.ssh directory of the remote machine. Then you have to add (or uncomment) the line

```
AuthorizedKeysFile          %h/.ssh/authorized_keys
```

to the sshd_config file on the remote machine. Where the %h stands for the home-directory of the user (root in this case).

Assuming that your sshd is already running on the remote machine, you can now enter the folloing on the machine where Bacula runs:

```
ssh -i Bacula_key -l root "ls -la"
```

This should execute the "ls -la" command on the remote machine.

Now you could add lines like the following to your Director's conf file:

```
...
Run Before Job = ssh -i /etc/bacula/Bacula_key 192.168.1.1 \
                  "/etc/init.d/database stop"
Run After Job = ssh -i /etc/bacula/Bacula_key 192.168.1.1 \
                  "/etc/init.d/database start"
...
```

Even though Bacula version 1.32 has a ClientRunBeforeJob, the ssh method still could be useful for updating all the Bacula clients on several remote machines in a single script.

Recycling All Your Volumes

This tip comes from Phil Stracchino.

If you decide to blow away your catalog and start over, the simplest way to re-add all your prelabelled tapes with the minimum of fuss (provided you don't care about the data on the tapes) is to add the tape labels using the console **add** command, then go into the catalog and manually set the VolStatus of every tape to **Recycle**.

The SQL command to do this is very simple:

```
update Media set VolStatus = "Recycle";
```

Bacula will then ignore the data already stored on the tapes and just re-use each tape without further objection.

Backing up ACLs on ext3 or XFS filesystems

This tip comes from Volker Sauer.

Although the current implementation of Bacula (1.33) does not backup ACLs (access control lists) from ext3 or XFS filesystems, it is possible to do so using an external script. For example, you could dump the ACLs to a file with a script similar to the following:

```
#!/bin/sh
BACKUP_DIRS="/foo /bar"
STORE_ACL=/root/acl-backup
umask 077
for i in $BACKUP_DIRS; do
  cd $i /usr/bin/getfacl -R --skip-base .>$STORE_ACL/${i//\/_}
done
```

Then use Bacula to backup **/root/acl-backup**.

The ACLs could be restored using Bacula to the **/root/acl-backup** file, then restored to your system using:

```
setfacl --restore/root/acl-backup
```

Total Automation of Bacula Tape Handling

This tip was provided by Alexander Kuehn.

[Bacula](#) is a really nice backup program except that the manual tape changing requires user interaction with the bacula console.

Fortunately I can fix this.

Bacula supports a variety of tape changers through the use of mt-x-changer scripts/programs. This highly flexible approach allowed me to create [this shell script](#) which does the following: Whenever a new tape is required it sends a mail to the operator to insert the new tape. Then it wait's until a tape has been inserted, sends a mail again to say thank you and let's bacula continue it's backup.

So you can schedule and run backups without ever having to log on or see the console.

To make the whole thing work you need to create a Device resource which looks something like this ("Archive Device", "Maximum Changer Wait", "Media Type" and "Label media" may have different values):

```
Device {
  Name=DDS3
  Archive Device = # use yours not mine! ;)/dev/nsa0
  Changer Device = # not really required/dev/nsa0
  Changer Command = "# use this (maybe change the path)!
    /usr/local/bin/mtx-changer %o %a %S"
  Maximum Changer Wait = 3d           # 3 days in seconds
  AutomaticMount = yes;               # mount on start
  AlwaysOpen = yes;                  # keep device locked
  Media Type = DDS3                   # it's just a name
  RemovableMedia = yes;               #
  Offline On Unmount = Yes;           # keep this too
  Label media = Yes;                  #
}
```

As the script has to emulate the complete wisdom of a mt-x-changer it has an internal "database" where which tape is stored, you can see this at that line:

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```
labels="VOL-0001 VOL-0002 VOL-0003 VOL-0004 VOL-0005 VOL-0006  
VOL-0007 VOL-0008 VOL-0009 VOL-0010 VOL-0011 VOL-0012"
```

The above should be all on one line, and it effectively tells Bacula that volume "VOL-0001" is located in slot 1 (which is our lowest slot), that volume "VOL-0002" is located in slot 2 and so on..

The script also maintains a logfile (/var/log/mtx.log) where you can monitor its operation.



Using Autochangers



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Utility Programs

[Bacula 1.34 User's Guide](#)

The Network Backup Solution

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Kern Sibbald and John Walker

~~Bacula 1.34 User's Guide~~



Tips and Suggestions



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Tape Testing

Volume Utility Tools

This document describes the utility programs written to aid Bacula users and developers in dealing with Volumes external to Bacula.

Specifying the Configuration File

Starting with version 1.27, each of the following programs requires a valid Storage daemon configuration file (actually, the only part of the configuration file that these programs need is the **Device** resource definitions). This permits the programs to find the configuration parameters for your archive device (generally a tape drive). By default, they read **bacula-sd.conf** in the current directory, but you may specify a different configuration file using the **-c** option.

Specifying a Device Name For a Tape

Each of these programs require a **device-name** where the Volume can be found. In the case of a tape, this is the physical device name such as **/dev/nst0** or **/dev/rmt/0ubn** depending on your system. For the program to work, it must find the identical name in the Device resource of the configuration file. See below for specifying Volume names.

Specifying a Device Name For a File

If you are attempting to read or write an archive file rather than a tape, the **device-name** should be the full path to the archive location including the filename. The filename (last part of the specification) will be stripped and used as the Volume name, and the path (first part before the filename) must have the same entry in the configuration file. So, the path is equivalent to the archive device name, and the filename is equivalent to the volume name.

Specifying Volumes

In general, you must specify the Volume name to each of the programs below (with the exception of **btape**). The best method to do so is to specify a **bootstrap** file on the command line with the **-b** option. As part of the bootstrap file, you will then specify the Volume name or Volume names if more than one volume is needed. For example, suppose you want to read tapes **tape1** and **tape2**. First construct a **bootstrap** file named say, **list.bsr** which contains:

```
Volume=test1|test2
```

where each Volume is separated by a vertical bar. Then simply use:

```
./bls -b list.bsr /dev/nst0
```

In the case of Bacula Volumes that are on files, you may simply append volumes as follows:

```
./bls /tmp/test1\|test2
```

where the backslash (****) was necessary as a shell escape to permit entering the vertical bar (**|**).

And finally, if you feel that specifying a Volume name is a bit complicated with a bootstrap file, you can use the **-V** option (on all programs except **bcopy**) to specify one or more Volume names

separated by the vertical bar (|). For example,

```
./bls -V Vol1001 /dev/nst0
```

You may also specify an asterisk (*) to indicate that the program should accept any volume. For example:

```
./bls -V* /dev/nst0
```


bls

bls can be used to do an **ls** type listing of a **Bacula** tape or file. It is called:

```
Usage: bls [-d debug_level] <device-name>
        -b <file>          specify a bootstrap file
        -c <file>          specify a configuration file
        -d <level>         specify a debug level
        -e <file>          exclude list
        -i <file>          include list
        -j                 list jobs
        -k                 list blocks
        -L                 list tape label
        (none of above)    list saved files
        -t                 use default tape device
        -v                 be verbose
        -V                 specify Volume names (separated by |)
        -?                 print this message
```

For example, to list the contents of a tape:

```
./bls -V Volume-name /dev/nst0
```

Or to list the contents of a file:

```
./bls /tmp/Volume-name
or
./bls -V Volume-name /tmp
```

Note that, in the case of a file, the Volume name becomes the filename, so in the above example, you will replace the **xxx** with the name of the volume (file) you wrote.

Normally if no options are specified, **bls** will produce the equivalent output to the **ls -l** command for each file on the tape. Using other options listed above, it is possible to display only the Job records, only the tape blocks, etc. For example:

```
./bls /tmp/File002
bls: butil.c:148 Using device: /tmp
drwxrwxr-x  3 k k  4096 02-10-19 21:08 /home/kern/bacula/k/src/dird/
drwxrwxr-x  2 k k  4096 02-10-10 18:59 /home/kern/bacula/k/src/dird/CVS/
-rw-rw-r--  1 k k    54 02-07-06 18:02 /home/kern/bacula/k/src/dird/CVS/Root
-rw-rw-r--  1 k k    16 02-07-06 18:02 /home/kern/bacula/k/src/dird/CVS/Repository
-rw-rw-r--  1 k k  1783 02-10-10 18:59 /home/kern/bacula/k/src/dird/CVS/Entries
-rw-rw-r--  1 k k  97506 02-10-18 21:07 /home/kern/bacula/k/src/dird/Makefile
-rw-r--r--  1 k k  3513 02-10-18 21:02 /home/kern/bacula/k/src/dird/Makefile.in
-rw-rw-r--  1 k k  4669 02-07-06 18:02 /home/kern/bacula/k/src/dird/README-config
-rw-r--r--  1 k k  4391 02-09-14 16:51 /home/kern/bacula/k/src/dird/authenticate.c
-rw-r--r--  1 k k  3609 02-07-07 16:41 /home/kern/bacula/k/src/dird/autoprune.c
-rw-rw-r--  1 k k  4418 02-10-18 21:03 /home/kern/bacula/k/src/dird/bacula-dir.conf
...
-rw-rw-r--  1 k k    83 02-08-31 19:19 /home/kern/bacula/k/src/dird/.cvsignore
bls: Got EOF on device /tmp
84 files found.
```

Listing Bacula Jobs

If you are listing a Volume to determine what Jobs to restore, normally the `-j` option provides you with most of what you will need as long as you don't have multiple clients. For example,

```
./bls -j /tmp/test1
Volume Record: SessId=2 SessTime=1033762386 JobId=0 DataLen=144
Begin Session Record: SessId=2 SessTime=1033762386 JobId=1 Level=F Type=B
End Session Record: SessId=2 SessTime=1033762386 JobId=1 Level=F Type=B
Begin Session Record: SessId=3 SessTime=1033762386 JobId=2 Level=I Type=B
End Session Record: SessId=3 SessTime=1033762386 JobId=2 Level=I Type=B
Begin Session Record: SessId=4 SessTime=1033762386 JobId=3 Level=I Type=B
End Session Record: SessId=4 SessTime=1033762386 JobId=3 Level=I Type=B
bls: Got EOF on device /tmp
```

shows a full save followed by two incremental saves.

Adding the `-v` option will display virtually all information that is available for each record:

Listing Bacula Blocks

Normally, except for debugging purposes, you will not need to list Bacula blocks (the "primitive" unit of Bacula data on the Volume). However, you can do so with:

```
./bls -k /tmp/File002
bls: butil.c:148 Using device: /tmp
Block: 1 size=64512
Block: 2 size=64512
...
Block: 65 size=64512
Block: 66 size=19195
bls: Got EOF on device /tmp
End of File on device
```

By adding the `-v` option, you can get more information, which can be useful in knowing what sessions were written to the volume:

```
./bls -k -v /tmp/File002

Volume Label:
Id           : Bacula 0.9 mortal
VerNo        : 10
VolName      : File002
PrevVolName  :
VolFile      : 0
LabelType    : VOL_LABEL
LabelSize    : 147
PoolName     : Default
MediaType    : File
PoolType     : Backup
HostName     :
Date label written: 2002-10-19 at 21:16

Block: 1 blen=64512 First rec FI=VOL_LABEL SessId=1 SessTim=1035062102 Strm=0 rlen=147
Block: 2 blen=64512 First rec FI=6 SessId=1 SessTim=1035062102 Strm=DATA rlen=4087
Block: 3 blen=64512 First rec FI=12 SessId=1 SessTim=1035062102 Strm=DATA rlen=5902
Block: 4 blen=64512 First rec FI=19 SessId=1 SessTim=1035062102 Strm=DATA rlen=28382
```

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```
...
Block: 65 blen=64512 First rec FI=83 SessId=1 SessTim=1035062102 Strm=DATA rlen=1873
Block: 66 blen=19195 First rec FI=83 SessId=1 SessTim=1035062102 Strm=DATA rlen=2973
bls: Got EOF on device /tmp
End of File on device
```

Armed with the SessionId and the SessionTime, you can extract just about anything.

If you want to know even more, add a second **-v** to the command line to get a dump of every record in every block.

```
./bls -k -v -v /tmp/File002
bls: block.c:79 Dump block 80f8ad0: size=64512 BlkNum=1
      Hdrcksum=blbdfd6d cksum=blbdfd6d
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=VOL_LABEL Strm=0 len=147 p=80f8b40
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=SOS_LABEL Strm=-7 len=122 p=80f8be7
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=1 Strm=UATTR len=86 p=80f8c75
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=2 Strm=UATTR len=90 p=80f8cdf
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=3 Strm=UATTR len=92 p=80f8d4d
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=3 Strm=DATA len=54 p=80f8dbd
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=3 Strm=MD5 len=16 p=80f8e07
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=4 Strm=UATTR len=98 p=80f8e2b
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=4 Strm=DATA len=16 p=80f8eal
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=4 Strm=MD5 len=16 p=80f8ec5
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=5 Strm=UATTR len=96 p=80f8ee9
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=5 Strm=DATA len=1783 p=80f8f5d
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=5 Strm=MD5 len=16 p=80f9668
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=6 Strm=UATTR len=95 p=80f968c
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=6 Strm=DATA len=32768 p=80f96ff
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=6 Strm=DATA len=32768 p=8101713
bls: block.c:79 Dump block 80f8ad0: size=64512 BlkNum=2
      Hdrcksum=9accle7f cksum=9accle7f
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=6 Strm=contDATA len=4087 p=80f8b40
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=6 Strm=DATA len=31970 p=80f9b4b
bls: block.c:92 Rec: VId=1 VT=1035062102 FI=6 Strm=MD5 len=16 p=8101841
...
```

bextract

Normally, you will restore files by running a **Restore** Job from the **Console** program. However, **bextract** can be used to extract a single file or a list of files from a Bacula tape or file. In fact, **bextract** can be a useful tool to restore files to an empty system assuming you are able to boot, you have statically linked **bextract** and you have an appropriate **bootstrap** file.

It is called:

```
Usage: bextract [-d debug_level] <device-name> <directory-to-store-files>
        -b          specify a bootstrap file
        -dnn        set debug level to nn
        -e <file>    exclude list
        -i <file>    include list
        -V          specify Volume names (separated by |)
        -?          print this message
```

where **device-name** is the Archive Device (raw device name or full filename) of the device to be read, and **directory-to-store-files** is a path prefix to prepend to all the files restored.

NOTE: On Windows systems, if you specify a prefix of say `d:/tmp`, any file that would have been restored to **c:/My Documents** will be restored to **d:/tmp/My Documents**. That is, the original drive specification will be stripped. If no prefix is specified, the file will be restored to the original drive.

Extracting with Include or Exclude Lists

Using the **-e** option, you can specify a file containing a list of files to be excluded. Wildcards can be used in the exclusion list. This option will normally be used in conjunction with the **-i** option (see below). Both the **-e** and the **-i** options may be specified at the same time as the **-b** option. The bootstrap filters will be applied first, then the include list, then the exclude list.

Likewise, and probably more importantly, with the **-i** option, you can specify a file that contains a list (one file per line) of files and directories to include to be restored. The list must contain the full filename with the path. If you specify a path name only, all files and subdirectories of that path will be restored. If you specify a line containing only the filename (e.g. **my-file.txt**) it probably will not be extracted because you have not specified the full path.

For example, if the file **include-list** contains:

```
/home/kern/bacula
/usr/local/bin
```

Then the command:

```
./bextract -i include-list /dev/nst0 /tmp
```

will restore from the Bacula archive **/dev/nst0** all files and directories in the backup from **/home/kern/bacula** and from **/usr/local/bin**. The restored files will be placed in a file of the original name under the directory **/tmp** (i.e. `/tmp/home/kern/bacula/...` and `/tmp/usr/local/bin/...`).

Extracting With a Bootstrap File

The **-b** option is used to specify a **bootstrap** file containing the information needed to restore precisely the files you want. Specifying a **bootstrap** file is optional but recommended because it gives you the most control over which files will be restored. For more details on the **bootstrap** file, please see [Restoring Files with the Bootstrap File](#) chapter of this document. Note, you may also use a bootstrap file produced by the **restore** command. For example:

```
./bextract -b bootstrap-file /dev/nst0 /tmp
```

The bootstrap file allows detailed specification of what files you want restored (extracted). You may specify a bootstrap file and include and/or exclude files at the same time. The bootstrap conditions will first be applied, and then each file record seen will be compared to the include and exclude lists.

Extracting From Multiple Volumes

If you wish to extract files that span several Volumes, you can specify the Volume names in the bootstrap file or you may specify the Volume names on the command line by separating them with a vertical bar. See the section above under the **bls** program entitled **Listing Multiple Volumes** for more information. The same techniques apply equally well to the **bextract** program.

bscan

The **bscan** program can be used to re-create a database (catalog) from the backup information written to one or more Volumes. This is normally needed only if one or more Volumes have been pruned or purged from your catalog so that the records on the Volume are no longer in the catalog.

With some care, it can also be used to synchronize your existing catalog with a Volume. Since **bscan** modifies your catalog, we strongly recommend that you do a simple ASCII backup of your database before running **bscan** just to be sure. See [Compacting Your Database](#).

After the loss of a hard disk, if you do not have a valid **bootstrap** file for reloading your system, or if a Volume has been recycled but not overwritten, you can use **bscan** to re-create your database, which can then be used to **restore** your system or a file to its previous state.

It is called:

```
Usage: bscan [options] <bacula-archive>
  -b bootstrap      specify a bootstrap file
  -c <file>         specify configuration file
  -d <nn>           set debug level to nn
  -m               update media info in database
  -n <name>         specify the database name (default bacula)
  -u <user>         specify database user name (default bacula)
  -P <password>     specify database password (default none)
  -h <host>         specify database host (default NULL)
  -p               proceed inspite of I/O errors
  -r               list records
  -s               synchronize or store in database
  -v               verbose
  -V <Volumes>     specify Volume names (separated by |)
  -w <dir>         specify working directory (default from conf file)
  -?               print this message
```

If you are using MySQL or PostgreSQL, there is no need to supply a working directory since the database server knows where its databases are.

If you have provided security on your database, you may need to supply either the database name (**-b** option), the user name (**-u** option), and/or the password (**-p**) options.

As an example, let's suppose that you did a backup to Volume "Vol001" and that sometime later all record of that Volume was pruned or purged from the database. By using **bscan** you can recreate the catalog entries for that Volume and then use the **restore** command in the Console to restore whatever you want. A command something like:

```
bscan -c bacula-sd.conf -v -V Vol001 /dev/nst0
```

will give you a give you an idea of what is going to happen without changing your catalog. Of course, you may need to change the path to the Storage daemon's conf file, the Volume name, and your tape (or disk) device name. Note, if you are writing to a disk file, replace the device name with the path to the directory that contains the Volume. This must correspond to the Archive Device in the conf file.

Then to actually write or store the records in the catalog, add the `-s` option as follows:

```
bscan -s -c bacula-sd.conf -v -V Vol001 /dev/nst0
```

Using bscan to Compare a Volume to an existing Catalog

If you wish to compare the contents of a Volume to an existing catalog without changing the catalog, you can safely do so if and only if you do **not** specify either the `-m` or the `-s` options. However, at this time (Bacula version 1.26), the comparison routines are not as good or as thorough as they should be, so we don't particularly recommend this mode other than for testing.

Using bscan to Recreate a Catalog from a Volume

This is the mode for which **bscan** is most useful. You can either **bscan** into a freshly created catalog, or directly into your existing catalog (after having made an ASCII copy as described above). Normally, you should start with a freshly created catalog that contains no data.

Starting with a single Volume named **TestVolume1**, you run a command such as:

```
./bscan -V TestVolume1 -v -s -c bacula-sd.conf /dev/nst0
```

If there is more than one volume, simply append it to the first one separating it with a vertical bar. You may need to precede the vertical bar with a forward slash escape the shell — e.g. **TestVolume1|TestVolume2**. The `-v` option was added for verbose output (this can be omitted if desired). The `-s` option that tells **bscan** to store information in the database. The physical device name `/dev/nst0` is specified after all the options.

For example, after having done a full backup of a directory, then two incrementals, I reinitialized the SQLite database as described above, and using the bootstrap.bsr file noted above, I entered the following command:

```
./bscan -b bootstrap.bsr -v -s -c bacula-sd.conf /dev/nst0
```

which produced the following output:

```
bscan: bscan.c:182 Using Database: bacula, User: bacula
bscan: bscan.c:673 Created Pool record for Pool: Default
bscan: bscan.c:271 Pool type "Backup" is OK.
bscan: bscan.c:632 Created Media record for Volume: TestVolume1
bscan: bscan.c:298 Media type "DDS-4" is OK.
bscan: bscan.c:307 VOL_LABEL: OK for Volume: TestVolume1
bscan: bscan.c:693 Created Client record for Client: Rufus
bscan: bscan.c:769 Created new JobId=1 record for original JobId=2
bscan: bscan.c:717 Created FileSet record "Kerns Files"
bscan: bscan.c:819 Updated Job termination record for new JobId=1
bscan: bscan.c:905 Created JobMedia record JobId 1, MediaId 1
bscan: Got EOF on device /dev/nst0
bscan: bscan.c:693 Created Client record for Client: Rufus
bscan: bscan.c:769 Created new JobId=2 record for original JobId=3
bscan: bscan.c:708 Fileset "Kerns Files" already exists.
bscan: bscan.c:819 Updated Job termination record for new JobId=2
bscan: bscan.c:905 Created JobMedia record JobId 2, MediaId 1
bscan: Got EOF on device /dev/nst0
bscan: bscan.c:693 Created Client record for Client: Rufus
```

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```
bscan: bscan.c:769 Created new JobId=3 record for original JobId=4
bscan: bscan.c:708 Fileset "Kerns Files" already exists.
bscan: bscan.c:819 Updated Job termination record for new JobId=3
bscan: bscan.c:905 Created JobMedia record JobId 3, MediaId 1
bscan: Got EOF on device /dev/nst0
bscan: bscan.c:652 Updated Media record at end of Volume: TestVolume1
bscan: bscan.c:428 End of Volume. VolFiles=3 VolBlocks=57 VolBytes=10,027,437
```

The key points to note are that **bscan** prints a line when each major record is created. Due to the volume of output, it does not print a line for each file record unless you supply the **-v** option twice or more on the command line.

In the case of a Job record, the new JobId will not normally be the same as the original Jobid. For example, for the first JobId above, the new JobId is 1, but the original JobId is 2. This is nothing to be concerned about as it is the normal nature of databases. **bscan** will keep everything straight.

Although **bscan** claims that it created a Client record for Client: Rufus three times, it was actually only created the first time. This is normal.

You will also notice that it read an end of file after each Job (Got EOF on device ...). Finally the last line gives the total statistics for the bscan.

If you had added a second **-v** option to the command line, Bacula would have been even more verbose, dumping virtually all the details of each Job record it encountered.

Now if you start Bacula and enter a **list jobs** command to the console program, you will get:

JobId	Name	StartTime	Type	Lvl	JobFiles	JobBytes	JobStat
1	kernsave	2002-10-07 14:59	B	F	84	4180207	T
2	kernsave	2002-10-07 15:00	B	I	15	2170314	T
3	kernsave	2002-10-07 15:01	B	I	33	3662184	T

which corresponds virtually identically with what the database contained before it was re-initialized and restored with bscan. All the Jobs and Files found on the tape are restored including most of the Media record. The Volume (Media) records restored will be marked as **Full** so that they cannot be rewritten without operator intervention.

It should be noted that **bscan** cannot restore a database to the exact condition it was in previously because a lot of the less important information contained in the database is not saved to the tape. Nevertheless, the reconstruction is sufficiently complete, that you can run **restore** against it and get valid results.

Using bscan to Correct the Volume File Count

If the Storage daemon crashes during a backup Job, the catalog will no be properly updated for the Volume being used at the time of the crash. This means that the Storage daemon will have written say 20 files on the tape, but the catalog record for the Volume indicates only 19 files.

Bacula refuses to write on a tape that contains a different number of files from what is in the catalog. To correct this situation, you may run a **bscan** with the **-m** option (but **without** the **-s** option) to update only the final Media record for the Volumes read.

After bscan

If you use **bscan** to enter the contents of the Volume into an existing catalog, you should be aware that the records you entered may be pruned during the next job particularly if the Volume is very old or had been previously purged. To avoid this, after running **bscan**, you can manually set the volume status (VolStatus) to **Read-Only** by using the **update** command in the catalog. This will allow you to restore from the volume without having it immediately purged. When you have restored and backed up the data, you can reset the VolStatus to **Used** and the Volume will be purged from the catalog.

bcopy

The **bcopy** program can be used to copy one **Bacula** archive file to another. For example, you may copy a tape to a file, a file to a tape, a file to a file, or a tape to a tape. For tape to tape, you will need two tape drives. (a later version is planned that will buffer it to disk).

bcopy Command Options

```
Usage: bcopy [-d debug_level] <input-archive> <output-archive>
        -b bootstrap      specify a bootstrap file
        -c <file>         specify configuration file
        -dnn              set debug level to nn
        -i                specify input Volume names (separated by |)
        -o                specify output Volume names (separated by |)
        -v                verbose
        -w dir             specify working directory (default /tmp)
        -?                print this message
```

By using a **bootstrap** file, you can copy parts of a Bacula archive file to another archive.

One of the objectives of this program is to be able to recover as much data as possible from a damaged tape. However, the current version does not yet have this feature.

As this is a new program, any feedback on its use would be appreciated. In addition, I only have a single tape drive, so I have never been able to test this program with two tape drives.

btape

This program permits a number of elementary tape operations via a tty command interface. The **test** command, described below, can be very useful for testing older tape drive compatibility problems. Aside from initial testing of tape drive compatibility with **Bacula**, **btape** will be mostly used by developers writing new tape drivers.

btape can be dangerous to use with existing **Bacula** tapes because it will relabel a tape or write on the tape if so requested regardless that the tape may contain valuable data, so please be careful and use it only on blank tapes.

To work properly, **btape** needs to read the Storage daemon's configuration file. As a default, it will look for **bacula-sd.conf** in the current directory. If your configuration file is elsewhere, please use the **-c** option to specify where.

The physical device name must be specified on the command line, and that this same device name must be present in the Storage daemon's configuration file read by **btape**

```
Usage: btape [-c config_file] [-d debug_level] [device_name]
        -c <file>      set configuration file to file
        -dnn           set debug level to nn
        -s             turn off signals
        -t             open the default tape device
        -?             print this message.
```

Using btape to Verify your Tape Drive

An important reason for this program is to ensure that a Storage daemon configuration file is defined so that Bacula will correctly read and write tapes.

It is highly recommended that you run the **test** command before running your first Bacula job to ensure that the parameters you have defined for your storage device (tape drive) will permit **Bacula** to function properly. You only need to mount a blank tape, enter the command, and the output should be reasonably self explanatory. Please see the [Tape Testing](#) Chapter of this manual for the details.

btape Commands

The full list of commands are:

Command	Description
=====	=====
bsf	backspace file
bsr	backspace record
cap	list device capabilities
clear	clear tape errors
eod	go to end of Bacula data for append
test	General test Bacula tape functions
eom	go to the physical end of medium
fill	fill tape, write onto second volume
unfill	read filled tape
fsf	forward space a file
fsr	forward space a record

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help	print this command
label	write a Bacula label to the tape
load	load a tape
quit	quit btape
rd	read tape
readlabel	read and print the Bacula tape label
rectest	test record handling functions
rewind	rewind the tape
scan	read tape block by block to EOT and report
status	print tape status
test	test a tape for compatibility with Bacula
weof	write an EOF on the tape
wr	write a single record of 2048 bytes

The most useful commands are:

- test — test writing records and EOF marks and reading them back.
- fill — completely fill a volume with records, then write a few records on a second volume, and finally, both volumes will be read back. Please be aware that the data written will be quite similar every record, so you might want to turn compression off. One user found that the fill command wrote 750Gb to a tape that can hold 35Gb — so you can see that the hardware compression really worked well!
- readlabel — read and dump the label on a Bacula tape.
- cap — list the device capabilities as defined in the configuration file and as perceived by the Storage daemon.

The **readlabel** command can be used to display the details of a Bacula tape label. This can be useful if the physical tape label was lost or damaged.

In the event that you want to relabel a **Bacula**, you can simply use the **label** command which will write over any existing label. However, please note for labeling tapes, we recommend that you use the **label** command in the **Console** program since it will never overwrite a valid Bacula tape.

Other Programs

The following programs are general utility programs and in general do not need a configuration file nor a device name.

bsmtp

bsmtp is a simple mail transport program that permits more flexibility than the standard mail programs typically found on Unix systems. It can even be used on Windows machines.

It is called:

```
Usage: bsmtp [-f from] [-h mailhost] [-s subject] [-c copy] [recipient ...]
        -c          set the Cc: field
        -dnn        set debug level to nn
        -f          set the From: field
        -h          use mailhost:port as the bsmtp server
        -s          set the Subject: field
        -?          print this message.
```

If the **-f** option is not specified, **bsmtp** will use your userid. If the option is not specified **bsmtp** will use the value in the environment variable **bsmtpSERVER** or if there is none **localhost**. By default port 25 is used.

recipients is a space separated list of email recipients.

The body of the email message is read from standard input.

An example of the use of **bsmtp** would be to put the following statement in the **Messages** resource of your **bacula-dir.conf** file. Note, these commands should appear on a single line each.

```
mailcommand = "/home/bacula/bin/bsmtp -h mail.domain.com -f \"\\(Bacula\\) %r\"
               -s \"Bacula: %t %e of %c %l\" %r"
operatorcommand = "/home/bacula/bin/bsmtp -h mail.domain.com -f \"\\(Bacula\\) %r\"
                  -s \"Bacula: Intervention needed for %j\" %r"
```

Where you replace **/home/bacula/bin** with the path to your **Bacula** binary directory, and you replace **mail.domain.com** with the fully qualified name of your bsmtp (email) server, which normally listens on port 25. For more details on the substitution characters (e.g. %r) used in the above line, please see the documentation of the [MailCommand in the Messages Resource](#) chapter of this manual.

It is **HIGHLY** recommended that you test one or two cases by hand to make sure that the **mailhost** that you specified is correct and that it will accept your email requests. Since **bsmtp** always uses a TCP connection rather than writing in the spool file, you may find that your **from** address is being rejected because it does not contain a valid domain, or because your message is caught in your spam filtering rules. Generally, you should specify a fully qualified domain name in the **from** field, and depending on whether your bsmtp gateway is Exim or Sendmail, you may need to modify the syntax of the from part of the message. Please test.

dbcheck

dbcheck is a simple program that will search for inconsistencies in your database, and optionally fix them. The **dbcheck** program can be found in the **<bacula-source>/src/tools** directory of the source distribution. Though it is built with the make process, it is not normally "installed".

It is called:

```
Usage: dbcheck [-d debug_level] <working-directory>
          <bacula-database> <user> <password>
    -b                batch mode
    -dnn              set debug level to nn
    -f                fix inconsistencies
    -v                verbose
    -?                print this message
```

If the **-f** option is specified, **dbcheck** will repair (**fix**) the inconsistencies it finds. Otherwise, it will report only.

If the **-b** option is specified, **dbcheck** will run in batch mode, and it will proceed to examine and fix (if **-f** is set) all programmed inconsistency checks. If the **-b** option is not specified, **dbcheck** will enter interactive mode and prompt with the following:

```
Hello, this is the database check/correct program.
Please select the function you want to perform.
```

- 1) Toggle modify database flag
- 2) Toggle verbose flag
- 3) Eliminate duplicate Filename records
- 4) Eliminate duplicate Path records
- 5) Eliminate orphaned Jobmedia records
- 6) Eliminate orphaned File records
- 7) Eliminate orphaned Path records
- 8) Eliminate orphaned Filename records
- 9) Eliminate orphaned FileSet records
- 10) All (3-9)
- 11) Quit

```
Select function number:
```

By entering 1 or 2, you can toggle the modify database flag (**-f** option) and the verbose flag (**-v**). It can be helpful and reassuring to turn off the modify database flag, then select one or more of the consistency checks (items 3 through 9) to see what will be done, then toggle the modify flag on and re-run the check.

The inconsistencies examined are the following:

- Duplicate filename records. This can happen if you accidentally run two copies of Bacula at the same time, and they are both adding filenames simultaneously. It is a rare occurrence, but will create an inconsistent database. If this is the case, you will receive error messages during Jobs warning of duplicate database records. If you are not getting these error messages, there is no reason to run this check.
- Duplicate path records. This can happen if you accidentally run two copies of Bacula at the same time, and they are both adding filenames simultaneously. It is a rare occurrence, but will create an inconsistent database. See the item above for why this

occurs and how you know it is happening.

- Orphaned JobMedia records. This happens when a Job record is deleted (perhaps by a user issued SQL statement), but the corresponding JobMedia record (one for each Volume used in the Job) was not deleted. Normally, this should not happen, and even if it does, these records generally do not take much space in your database. However, by running this check, you can eliminate any such orphans.
- Orphaned File records. This happens when a Job record is deleted (perhaps by a user issued SQL statement), but the corresponding File record (one for each Volume used in the Job) was not deleted. Note, searching for these records can be **very** time consuming (i.e. it may take hours) for a large database. Normally this should not happen as Bacula takes care to prevent it. Just the same, this check can remove any orphaned File records. It is recommended that you run this once a year since orphaned File records can take a large amount of space in your database.
- Orphaned Path records. This condition happens any time a directory is deleted from your system and all associated Job records have been purged. During standard purging (or pruning) of Job records, Bacula does not check for orphaned Path records. As a consequence, over a period of time, old unused Path records will tend to accumulate and use space in your database. This check will eliminate them. It is strongly recommended that you run this check at least once a year.
- Orphaned Filename records. This condition happens any time a file is deleted from your system and all associated Job records have been purged. This can happen quite frequently as there are quite a large number of files that are created and then deleted. In addition, if you do a system update or delete an entire directory, there can be a very large number of Filename records that remain in the catalog but are no longer used.

During standard purging (or pruning) of Job records, Bacula does not check for orphaned Filename records. As a consequence, over a period of time, old unused Filename records will accumulate and use space in your database. This check will eliminate them. It is strongly recommended that you run this check at least once a year, and for large database (more than 200 Megabytes), it is probably better to run this once every 6 months.

testfind

testfind permits listing of files using the same search engine that is used for the **Include** resource in Job resources. Note, much of the functionality of this program (listing of files to be included) is present in the [estimate command](#) in the Console program.

The original use of testfind was to ensure that Bacula's file search engine was correct and to print some statistics on file name and path length. However, you may find it useful to see what bacula would do with a given **Include** resource. The **testfind** program can be found in the `<bacula-source>/src/tools` directory of the source distribution. Though it is built with the make process, it is not normally "installed".

It is called:

```
Usage: testfind [-d debug_level] [-] [pattern1 ...]
      -a          print extended attributes (Win32 debug)
      -dnn        set debug level to nn
      -           read pattern(s) from stdin
      -?          print this message.
```

```
Patterns are used for file inclusion -- normally directories.
Debug level>= 1 prints each file found.
Debug level>= 10 prints path/file for catalog.
Errors are always printed.
Files/paths truncated is a number with len> 255.
Truncation is only in the catalog.
```

Where a pattern is any filename specification that is valid within an **Include** resource definition. If none is specified, / (the root directory) is assumed. For example:

```
./testfind /bin
```

Would print the following:

```
Dir: /bin
Reg: /bin/bash
Lnk: /bin/bash2 -> bash
Lnk: /bin/sh -> bash
Reg: /bin/cpio
Reg: /bin/ed
Lnk: /bin/red -> ed
Reg: /bin/chgrp
...
Reg: /bin/ipcalc
Reg: /bin/usleep
Reg: /bin/aumix-minimal
Reg: /bin/mt
Lnka: /bin/gawk-3.1.0 -> /bin/gawk
Reg: /bin/pgawk
Total files      : 85
Max file length: 13
Max path length: 5
Files truncated: 0
Paths truncated: 0
```

Even though **testfind** uses the same search engine as **Bacula**, each directory to be listed, must be entered as a separate command line entry or entered one line at a time to standard input if the `-` option was specified.

Specifying a debug level of one (i.e. `-d1`) on the command line will cause **testfind** to print the raw filenames without showing the Bacula internal file type, or the link (if any). Debug levels of 10 or greater cause the filename and the path to be separated using the same algorithm that is used when putting filenames into the Catalog database.



Tips and Suggestions



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The Network Backup Solution

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Utility Programs



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When Bacula crashes (Kaboom)

Testing Your Tape Drive With Bacula

This chapter is concerned with testing and configuring your tape drive to make sure that it will work properly with Bacula using the **btape** program.

Specifying the Configuration File

Starting with version 1.27, each of the tape utility programs including the **btape** program requires a valid Storage daemon configuration file (actually, the only part of the configuration file that **btape** needs is the **Device** resource definitions). This permits **btape** to find the configuration parameters for your archive device (generally a tape drive). Without those parameters, the testing and utility programs do not know how to properly read and write your drive. By default, they use **bacula-sd.conf** in the current directory, but you may specify a different configuration file using the **-c** option.

Specifying a Device Name For a Tape

btape device-name where the Volume can be found. In the case of a tape, this is the physical device name such as **/dev/nst0** or **/dev/rmt/0ubn** depending on your system that you specify on the Archive Device directive. For the program to work, it must find the identical name in the Device resource of the configuration file. If the name is not found, the utility program will compare the name you entered to the Device names (rather than the Archive device names). See below for specifying Volume names.

Specifying a Device Name For a File

If you are attempting to read or write an archive file rather than a tape, the **device-name** should be the full path to the archive location including the filename. The filename (last part of the specification) will be stripped and used as the Volume name, and the path (first part before the filename) must have the same entry in the configuration file. So, the path is equivalent to the archive device name, and the filename is equivalent to the volume name.

btape

This program permits a number of elementary tape operations via a tty command interface. The **test** command, described below, can be very useful for testing tape drive compatibility problems. Aside from initial testing of tape drive compatibility with **Bacula**, **btape** will be mostly used by developers writing new tape drivers.

btape can be dangerous to use with existing **Bacula** tapes because it will relabel a tape or write on the tape if so requested regardless of whether or not the tape contains valuable data, so please be careful and use it only on blank tapes.

To work properly, **btape** needs to read the Storage daemon's configuration file. As a default, it will look for **bacula-sd.conf** in the current directory. If your configuration file is elsewhere, please use the **-c** option to specify where.

The physical device name or the Device resource name must be specified on the command line, and that this same device name must be present in the Storage daemon's configuration file read by **btape**

```
Usage: btape [options] device_name
       -b <file>    specify bootstrap file
       -c <file>    set configuration file to file
       -d <nn>      set debug level to nn
       -s           turn off signals
       -v           be verbose
       -?           print this message.
```

Using btape to Verify your Tape Drive

An important reason for this program is to ensure that a Storage daemon configuration file is defined so that Bacula will correctly read and write tapes.

It is highly recommended that you run the **test** command before running your first Bacula job to ensure that the parameters you have defined for your storage device (tape drive) will permit **Bacula** to function properly. You only need to mount a blank tape, enter the command, and the output should be reasonably self explanatory. For example:

```
(ensure that Bacula is not running)
./btape -c /usr/bin/bacula/bacula-sd.conf /dev/nst0
```

The output will be:

```
Tape block granularity is 1024 bytes.
btape: btape.c:376 Using device: /dev/nst0
*
```

Enter the test command:

```
test
```

The output produced should be something similar to the following:

Bacula Storage Management System

=== Append files test ===

This test is essential to Bacula.

I'm going to write one record in file 0,
two records in file 1,
and three records in file 2

```
btape: btape.c:387 Rewound /dev/nst0
btape: btape.c:855 Wrote one record of 64412 bytes.
btape: btape.c:857 Wrote block to device.
btape: btape.c:410 Wrote EOF to /dev/nst0
btape: btape.c:855 Wrote one record of 64412 bytes.
btape: btape.c:857 Wrote block to device.
btape: btape.c:855 Wrote one record of 64412 bytes.
btape: btape.c:857 Wrote block to device.
btape: btape.c:410 Wrote EOF to /dev/nst0
btape: btape.c:855 Wrote one record of 64412 bytes.
btape: btape.c:857 Wrote block to device.
btape: btape.c:855 Wrote one record of 64412 bytes.
btape: btape.c:857 Wrote block to device.
btape: btape.c:855 Wrote one record of 64412 bytes.
btape: btape.c:857 Wrote block to device.
btape: btape.c:410 Wrote EOF to /dev/nst0
btape: btape.c:387 Rewound /dev/nst0
btape: btape.c:693 Now moving to end of media.
btape: btape.c:427 Moved to end of media
We should be in file 3. I am at file 3. This is correct!
```

Now the important part, I am going to attempt to append to the tape.

```
btape: btape.c:855 Wrote one record of 64412 bytes.
btape: btape.c:857 Wrote block to device.
btape: btape.c:410 Wrote EOF to /dev/nst0
btape: btape.c:387 Rewound /dev/nst0
Done appending, there should be no I/O errors
```

```
Doing Bacula scan of blocks:
1 block of 64448 bytes in file 1
End of File mark.
2 blocks of 64448 bytes in file 2
End of File mark.
3 blocks of 64448 bytes in file 3
End of File mark.
1 block of 64448 bytes in file 4
End of File mark.
Total files=4, blocks=7, bytes = 451136
End scanning the tape.
We should be in file 4. I am at file 4. This is correct!
```

The above Bacula scan should have output identical to what follows.
Please double check it ...

```
=== Sample correct output ===
1 block of 64448 bytes in file 1
End of File mark.
2 blocks of 64448 bytes in file 2
End of File mark.
3 blocks of 64448 bytes in file 3
End of File mark.
1 block of 64448 bytes in file 4
```

Bacula Storage Management System

```
End of File mark.
Total files=4, blocks=7, bytes = 451136
=== End sample correct output ===
```

If the above scan output is not identical to the sample output, you **MUST** correct the problem or Bacula will not be able to write multiple Jobs to the tape.

```
=== Write, backup, and re-read test ===
```

I'm going to write three records and two eof's then backup over the eof's and re-read the last record. Bacula does this after writing the last block on the tape to verify that the block was written correctly. It is not an **essential** feature ...

```
btape: btape.c:387 Rewound /dev/nst0
btape: btape.c:597 Wrote first record of 64412 bytes.
btape: btape.c:608 Wrote second record of 64412 bytes.
btape: btape.c:619 Wrote third record of 64412 bytes.
btape: btape.c:410 Wrote EOF to /dev/nst0
btape: btape.c:410 Wrote EOF to /dev/nst0
btape: btape.c:631 Backspaced over two EOFs OK.
btape: btape.c:636 Backspace record OK.
btape: btape.c:658
Block re-read correct. Test succeeded!
=== End Write, backup, and re-read test ===
```

```
=== End Append files test ===
```

If you do not successfully complete the above test, please resolve the problem(s) before attempting to use **Bacula**. Depending on your tape drive, the test may recommend that you add certain records to your configuration. We strongly recommend that you do so and then re-run the above test to insure it works the first time.

Linux SCSI Tricks

You can find out what SCSI devices you have by doing:

```
cat /proc/scsi/scsi
```

For example, I get the following:

```
Attached devices:
Host: scsi2 Channel: 00 Id: 01 Lun: 00
  Vendor: HP          Model: C5713A          Rev: H107
  Type:   Sequential-Access          ANSI SCSI revision: 02
Host: scsi2 Channel: 00 Id: 04 Lun: 00
  Vendor: SONY        Model: SDT-10000       Rev: 0110
  Type:   Sequential-Access          ANSI SCSI revision: 02
```

If you want to remove the SDT-10000 device, you can do so as root with:

```
echo "scsi remove-single-device 2 0 4 0">/proc/scsi/scsi
```

and you can put add it back with:

```
echo "scsi add-single-device 2 0 4 0">/proc/scsi/scsi
```

where the 2 0 4 0 are the Host, Channel, Id, and Lun as seen on the output from **cat /proc/scsi/scsi**. Note, the Channel must be specified as numeric.

Tips for Resolving Problems

Bacula Cannot Open the Device

If you get an error message such as:

```
dev open failed: dev.c:265 stored: unable to open
device /dev/nst0:> ERR=No such device or address
```

the first time you run a job, it is most likely due to the fact that you specified the incorrect device name on your **Archive Device**.

If Bacula works fine with your drive, then all off a sudden you get error messages similar to the one shown above, it is quite possible that your driver module is being removed because the kernel deems it idle. This is done via **crontab** with the use of **rmmod -a**. To fix the problem, you can remove this entry from **crontab**, or you can manually **modprob** your driver module (or add it to the local startup script). Thanks to Alan Brown for this tip.

Incorrect File Number

When Bacula moves to the end of the medium, it normally uses the **ioctl(MTEOM)** function. Then Bacula uses the **ioctl(MTIOCGET)** function to retrieve the current file position from the **mt_fileno** field. Some SCSI tape drivers will use a fast means of seeking to the end of the medium and in doing so, they will not know the current file position and hence return a **-1**. As a consequence, if you get **"This is NOT correct!"** in the positioning tests, this may be the cause. You must correct this condition in order for Bacula to work.

There are two possible solutions to the above problem of incorrect file number:

- Figure out how to configure your SCSI driver to keep track of the file position during the MTEOM request. This is the preferred solution.
- Modify the **Device** resource of your **bacula-sd.conf** file to include:

```
Hardware End of File = no
```

This will cause Bacula to use the MTFSSF request to seek to the end of the medium, and Bacula will keep track of the file number itself.

Incorrect Number of Blocks

Bacula's preferred method of working with tape drives (sequential devices) is to run in variable block mode. All modern tape drives support this mode, but some older drives (in particular the

QIC drives) as well as the ATAPI ide–scsi driver run only in fixed block mode.

Even in variable block mode, with the exception of the first record on the second or subsequent volume of a multi–volume backup, Bacula will write blocks of a fixed size. However, in reading a tape, Bacula will assume that for each read request, exactly one block from the tape will be transferred. This the most common way that tape drives work and is well supported by **Bacula**.

Drives that run in fixed block mode can cause serious problems for Bacula if the drive's block size does not correspond exactly to **Bacula's** block size. In fixed block size mode, drivers may transmit a partial block or multiple blocks for a single read request. From **Bacula's** point of view, this destroys the concept of tape blocks. In order for Bacula to run in fixed block mode, you must include the following records in the Storage daemon's Device resource definition:

```
Minimum Block Size = nnn  
Maximum Block Size = nnn
```

where **nnn** must be the same for both records and must be identical to the driver's fixed block size.

We recommend that you avoid this configuration if at all possible. In any case, as of version 1.27, it is not at all clear that Bacula's handling of these fixed block drivers really works.

If you must run with fixed size blocks, make sure they are not 512 bytes. This is too small and the overhead that Bacula has with each record will become excessive. If at all possible set any fixed block size to something like 64,512 bytes.

Ensuring that the Tape Modes Are Properly Set -- Linux Only

If you have a modern SCSI tape drive and you are having problems with the **test** command as noted above, it may be that some program has set one or more of the your SCSI driver's options to non–default values. For example, if your driver is set to work in SysV manner, Bacula will not work correctly because it expects BSD behavior. To reset your tape drive to the default values, you can try the following, but **ONLY** if you have a SCSI tape drive on a **Linux** system:

```
become super user  
mt -f /dev/nst0 rewind  
mt -f /dev/nst0 stoptions buffer-writes async-writes read-ahead
```

The above commands will clear all options and then set those specified. None of the specified options are required by Bacula, but a number of other options such as SysV behavior must not be set. On systems other than Linux, you will need to consult your **mt** man pages or documentation to figure out how to do the same thing. This should not really be necessary though -- for example, on both Linux and Solaris systems, the default tape driver options are compatible with Bacula.

You may also want to ensure that no prior program has set the default block size, as happened to one user, by explicitly turning it off with:

```
mt -f /dev/nst0 defblksize 0
```

If you would like to know what stoptions you have set before making any of the changes noted above, you can now view them on Linux systems, thanks to a tip provided by Willem Riede. Do

the following:

```
become super user
mt -f /dev/nst0 stsetoptions 0
grep st0 /var/log/messages
```

and you will get output that looks something like the following:

```
kernel: st0: Mode 0 options: buffer writes: 1, async writes: 1, read ahead: 1
kernel: st0:      can bsr: 0, two FMs: 0, fast mteom: 0, auto lock: 0,
kernel: st0:      defs for wr: 0, no block limits: 0, partitions: 0, s2 log: 0
kernel: st0:      sysv: 0 nowait: 0
```

Note, I have chopped off the beginning of the line with the date and machine name for presentation purposes.

Checking and Setting Tape Hardware Compression

As far as I can tell, there is no way with the **mt** program to check if your tape hardware compression is turned on or off. You can, however, turn it on by using (on Linux):

```
become super user
mt -f /dev/nst0 defcompression 1
```

and of course, if you use a zero instead of the one at the end, you will turn it off.

You may also want to ensure that no prior program has set the default block size, as happened to one user, by explicitly turning it off with:

```
mt -f /dev/nst0 defblksize 0
```

If you have built the **mtx** program in the **depkgs** package, you can use **tapeinfo** to get quite a bit of information about your tape drive even if it is not an autochanger. For example on my DDS-4 drive, I get the following:

```
./tapeinfo -f /dev/sg0
Product Type: Tape Drive
Vendor ID: 'HP'
Product ID: 'C5713A'
Revision: 'H107'
Attached Changer: No
MinBlock:1
MaxBlock:16777215
SCSI ID: 5
SCSI LUN: 0
Ready: yes
BufferedMode: yes
Medium Type: Not Loaded
Density Code: 0x26
BlockSize: 0 <==== check this
DataCompEnabled: yes <==== check this
DataCompCapable: yes
DataDeCompEnabled: yes <==== check this
CompType: 0x20
DeCompType: 0x0
Block Position: 1141
```

where the **DataCompEnabled: yes** means that tape hardware compression is turned on. You can see it turn on and off (yes/no) by using the **mt** commands given above. Also, this output will tell you if the **BlockSize** is non-zero and hence set for a particular block size. Bacula is not likely to work in such a situation because it will normally attempt to write blocks of 64,512 bytes, except the last block of the job which will generally be shorter. The first thing to try is setting the default block size to zero using the **mt -f /dev/nst0 defblksize 0** command as shown above.

If your tape drive requires fixed block sizes (very unusual), you can use the following records:

```
Minimum Block Size = nnn
Maximum Block Size = nnn
```

in your Storage daemon's Device resource to force Bacula to write fixed size blocks (where you sent nnn to be the same for both of the above records). This should be done only if your drive does not support variable block sizes, or you have some other strong reasons for using fixed block sizes. As mentioned above, a small fixed block size of 512 or 1024 bytes will be very inefficient. Try to set any fixed block size to something like 64,512 bytes or larger if your drive will support it.

Also, note that the **Medium Type** field of the output of **tapeinfo** reports **Not Loaded**, which is not correct. As a consequence, you should ignore that field as well as the **Attached Changer** field.

Tape Modes on FreeBSD

Normally Bacula should run with: **mt -f /dev/rsa0 seteotmodel 2**, and then according to what the **btape test** command returns, you will probably need to set the following:

```
Hardware End of Medium = no
BSF at EOM = yes
```

but you should start the **test** command without these records and then add them if it requests you to do so. Normally, you will also want **mt -f /dev/rsa0 comp on** to be set.

Please see the file **platforms/freebsd/threads-fix.txt** in the main Bacula directory concerning important information concerning compatibility of Bacula and your system.

Determining What Tape Drives and Autochangers You Have on FreeBSD

On FreeBSD, you can do a **camcontrol devlist** as root to determine what drives and autochangers you have. For example,

```
undef# camcontrol devlist
  at scbus0 target 2 lun 0 (pass0,sa0)
  at scbus0 target 4 lun 0 (pass1,sa1)
  at scbus0 target 4 lun 1 (pass2)
```

from the above, you can determine that there is a tape drive on **/dev/rsa0** and another on **/dev/rsa1** in addition since there is a second line for the drive on **/dev/rsa1**, you know can assume that it is the control device for the autochanger (i.e. **/dev/pass2**).

Using the OnStream driver on Linux Systems

Bacula version 1.33 (not 1.32x) is now working and ready for testing with the OnStream kernel osst driver version 0.9.14 or above. Osst is available from: <http://sourceforge.net/projects/osst/>.

To make Bacula work you must first load the new driver then, as root, do:

```
mt -f /dev/nosst0 defblksize 32768
```

Also you must add the following to your Device resource in your Storage daemon's conf file:

```
Minimum Block Size = 32768
Maximum Block Size = 32768
```

Here is a Device specification provided by Michel Meyers that is known to work:

```
Device {
  Name = "Onstream DI-30"
  Media Type = "ADR-30"
  Archive Device = /dev/nosst0
  Minimum Block Size = 32768
  Maximum Block Size = 32768
  Hardware End of Medium = yes
  BSF at EOM = no
  Backward Space File = yes
  Fast Forward Space File = yes
  Two EOF = no
  AutomaticMount = yes
  AlwaysOpen = yes
  Removable Media = yes
}
```

Using btape to Simulate Bacula Filling a Tape

Because there are often problems with certain tape drives or systems when end of tape conditions occur, **btape** has a special command **fill** that causes it to write random data to a tape until the tape fills. It then writes at least one more Bacula block to a second tape. Finally, it reads back both tapes to ensure that the data has been written in a way that Bacula can recover it. Note, there is also a single tape option as noted below, which you should use rather than the two tape test. See below for more details.

This can be an extremely time consuming process (here is is about 6 hours), and you must have two blank tapes available. As this command is completely new, it is not well tested, and has considerable room for improvement, especially during the error checking in the read-back phase.

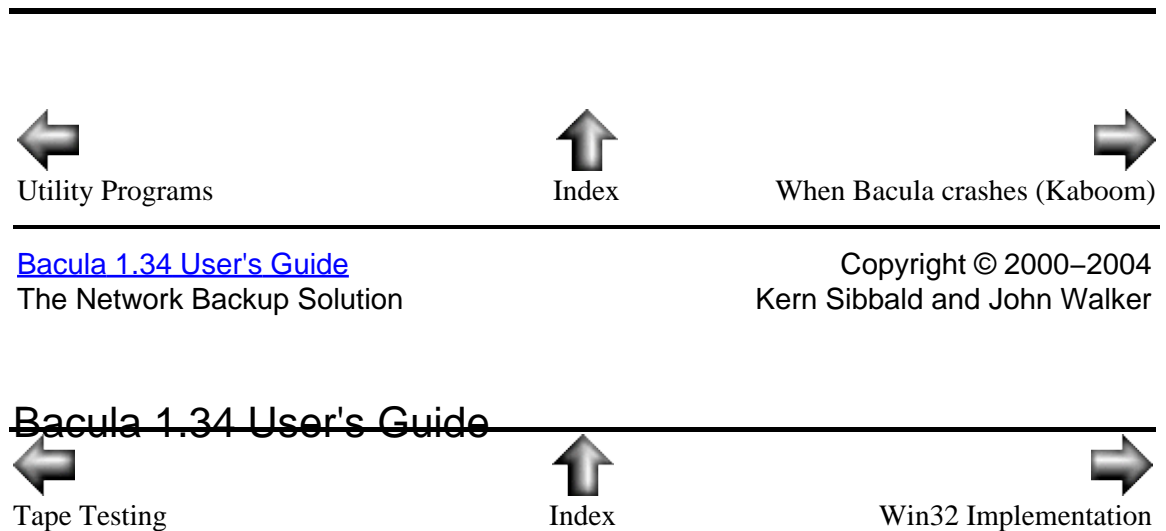
To begin this test, you enter the **fill** command and follow the instructions. There are two options: the simple single tape option and the multiple tape option. Please use only the simple single tape option because the multiple tape option still doesn't work totally correctly. If the single tape option does not succeed, you should correct the problem before using Bacula.

Tape Blocking Modes

SCSI tapes may either be written in **variable** or **fixed** block sizes. Newer drives support both modes, but some drives such as the QIC devices always use fixed block sizes. Bacula attempts to fill and write complete blocks (default 65K), so that in normal mode (variable block size), Bacula will always write blocks of the same size except the last block of a Job. If Bacula is configured to write fixed block sizes, it will pad the last block of the Job to the correct size. Bacula expects variable tape block size drives to behave as follows: Each write to the drive results in a single record being written to the tape. Each read returns a single record. If you request less byte than are in the record, only those number of bytes will be returned, but the entire logical record will have been read (the next read will retrieve the next record). Thus data from a single write is always returned in a single read, and sequentially written records are returned by sequential reads.

Bacula expects fixed block size tape drives to behave as follows: If a write length is greater than the physical block size of the drive, the write will be written as two blocks each of the fixed physical size. This a single write may become multiple physical records on the tape. (This is not a good situation). According to the documentation, one may never write an amount of data that is not the exact multiple of the blocksize (it is not specified if an error occurs or if the the last record is padded). When reading, it is my understanding that each read request reads one physical record from the tape. Due to the complications of fixed block size tape drives, you should avoid them if possible with Bacula, or you must be **ABSOLUTELY** certain that you use fixed block sizes within Bacula that correspond to the physical block size of the tape drive. This will ensure that Bacula has a one to one correspondence between what it writes and the physical record on the tape.

Please note that Bacula will not function correctly if it writes a block and that block is split into two or more physical records on the tape. Bacula assumes that each write causes a single record to be written, and that it can sequentially recover each of the blocks it has written by using the same number of sequential reads as it had written.



What To Do When Bacula Crashes (Kaboom)

If you are running on a Linux system, and you have a set of working configuration files, it is very unlikely that **Bacula** will crash. As with all software, however, it is inevitable that someday, it may crash, particularly if you are running on another operating system or using a new or unusual feature.

This chapter explains what you should do if one of the three **Bacula** daemons (Director, File, Storage) crashes.

Traceback

Each of the three Bacula daemons has a built-in exception handler which, in case of an error, will attempt to produce a traceback. If successful the traceback will be emailed to you.

For this to work, you need to ensure that a few things are setup correctly on your system:

1. You must have an installed copy of **gdb** (the GNU debugger), and it must be on **Bacula's** path.
2. The Bacula installed script file **btraceback** must be in the same directory as the daemon which dies, and it must be marked as executable.
3. The script file **btraceback.gdb** must have the correct path to it specified in the **btraceback** file.
4. You must have a **mail** program which is on **Bacula's** path.

If all the above conditions are met, the daemon that crashes will produce a traceback report and email it to you. If the above conditions are not true, you may be able to correct them by editing the **btraceback** file. In doing so, you can add a correct path to the **gdb** program, correct the path to the **btraceback.gdb** file, change the **mail** program or its path, or change your email address. The key line in the **btraceback** file is:

```
gdb -quiet -batch -x /home/kern/bacula/bin/btraceback.gdb \  
$1 $2 2>1| mail -s "Bacula traceback" your-address@xxx.com
```

Since each daemon has the same traceback code, a single **btraceback** file is sufficient if you are running more than one daemon on a machine.

Testing The Traceback

To "manually" test the traceback feature, you simply start **Bacula** then obtain the **PID** of the main daemon thread (there are multiple threads). Unfortunately, the output had to be split to fit on this page:

```
[kern@rufus kern]$ ps fax --columns 132 | grep bacula-dir  
2103 ?          S          0:00 /home/kern/bacula/k/src/dird/bacula-dir -c  
                               /home/kern/bacula/k/src/dird/dird.conf  
2104 ?          S          0:00 \_ /home/kern/bacula/k/src/dird/bacula-dir -c  
                               /home/kern/bacula/k/src/dird/dird.conf  
2106 ?          S          0:00 \_ /home/kern/bacula/k/src/dird/bacula-dir -c  
                               /home/kern/bacula/k/src/dird/dird.conf  
2105 ?          S          0:00 \_ /home/kern/bacula/k/src/dird/bacula-dir -c
```

```
/home/kern/bacula/k/src/dird/dird.conf
```

which in this case is 2103. Then while Bacula is running, you call the program giving it the path to the Bacula executable and the **PID**. In this case, it is:

```
./btraceback /home/kern/bacula/k/src/dird 2103
```

It should produce an email showing you the current state of the daemon (in this case the Director), and then exit leaving **Bacula** running as if nothing happened. If this is not the case, you will need to correct the problem by modifying the **btraceback** script.

Typical problems might be that **gdb** is not on the default path. Fix this by specifying the full path to it in the **btraceback** file. Another common problem is that the **mail** program doesn't work or is not on the default path. On some systems, it is preferable to use **Mail** rather than **mail**.

Getting A Traceback On Other Systems

It should be possible to produce a similar traceback on systems other than Linux, either using **gdb** or some other debugger. Solaris with **gdb** loaded works quite fine. On other systems, you will need to modify the **btraceback** program to invoke the correct debugger, and possibly correct the **btraceback.gdb** script to have appropriate commands for your debugger. If anyone succeeds in making this work with another debugger, please send us a copy of what you modified.

Manually Running Bacula Under The Debugger

If for some reason you cannot get the automatic traceback, or if you want to interactively examine the variable contents after a crash, you can run Bacula under the debugger. Assuming you want to run the Storage daemon under the debugger, you would do the following:

1. Start the Director and the File daemon. If the Storage daemon also starts, you will need to find its PID as shown above (`ps fax | grep bacula-sd`) and kill it with a command like the following:

```
kill -15 PID
```

where you replace **PID** by the actual value.

2. At this point, the Director and the File daemon should be running but the Storage daemon should not.
3. `cd` to the directory containing the Storage daemon
4. Start the Storage daemon under the debugger:

```
gdb ./bacula-sd
```

5. Run the Storage daemon:

```
run -s -f -c ./bacula-sd.conf
```

You may replace the **./bacula-sd.conf** with the full path to the Storage daemon's configuration file.

6. At this point, Bacula will be fully operational.
7. In another shell command window, start the Console program and do what is necessary to cause Bacula to die.
8. When Bacula crashes, the **gdb** shell window will become active and **gdb** will show you the error that occurred.
9. To get a general traceback of all threads, issue the following command:

```
thread apply all bt
```

After that you can issue any debugging command.



Tape Testing



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Win32 Implementation

[Bacula 1.34 User's Guide](#)

The Network Backup Solution

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What to do when Bacula crashes
(Kaboom)



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Disaster Recovery Using Bacula

The Windows Version of Bacula

General

At the current time only the File daemon or Client program has been tested on Windows. As a consequence, when we speak of the Windows version of Bacula below, we are referring to the File daemon only.

The Windows version of the Bacula File daemon has been tested on Win98, WinMe, WinNT, and Win2000 systems. We have coded to support Win95, but no longer have a system for testing. The Windows version of Bacula is a native Win32 port, but there are very few source code changes, which means that the Windows version is for the most part running code that has long proved stable on Unix systems. When running, it is perfectly integrated with Windows and displays its icon in the system icon tray, and provides a system tray menu to obtain additional information on how Bacula is running (status and events dialog boxes). If so desired, it can also be stopped by using the system tray menu, though this should normally never be necessary.

Once installed Bacula normally runs as a system service. This means that it is immediately started by the operating system when the system is booted, and runs in the background even if there is no user logged into the system.

Installation

Normally, you will install the Windows version of Bacula from the binaries. This install is standard Windows .exe that runs an install wizard using the NSIS Free Software installer, so if you have already installed Windows software, it should be very familiar to you.

If you have a previous version Cygwin of Bacula (1.32 or lower) installed, you should stop the service, uninstall it, and remove the directory possibly saving your bacula-fd.conf file for use with the new version you will install. The new native version of Bacula has far fewer files than the old Cygwin version.

Finally, proceed with the installation.

- Simply double click on the **winbacula-1.xx.0.exe** NSIS install icon. The actual name of the icon will vary from one release version to another.

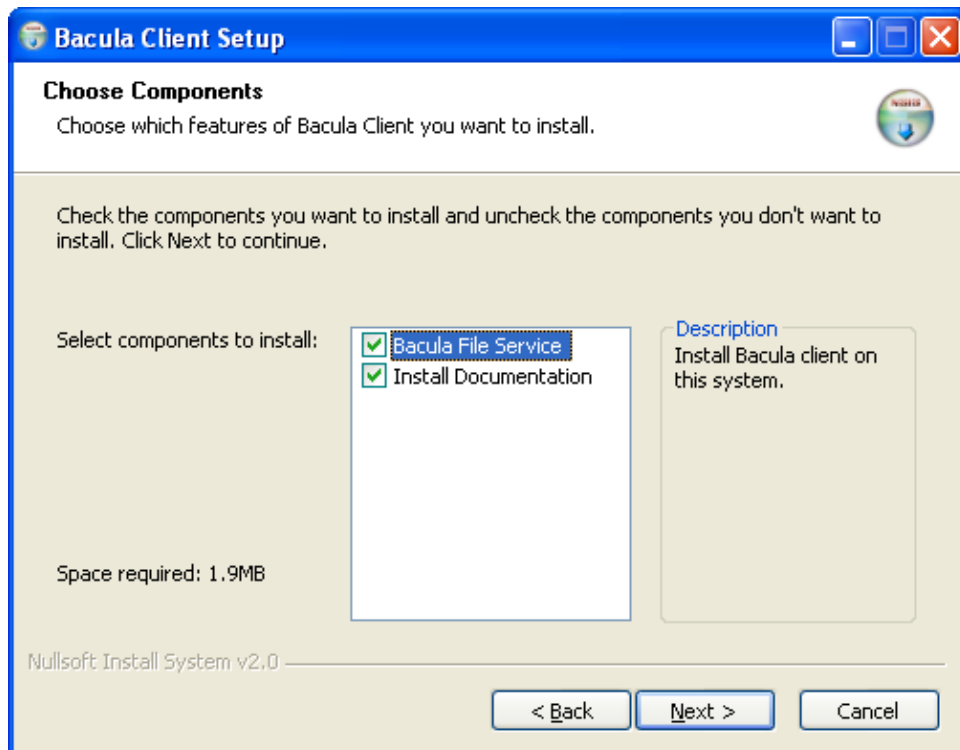


winbacula-1.xx.0.exe

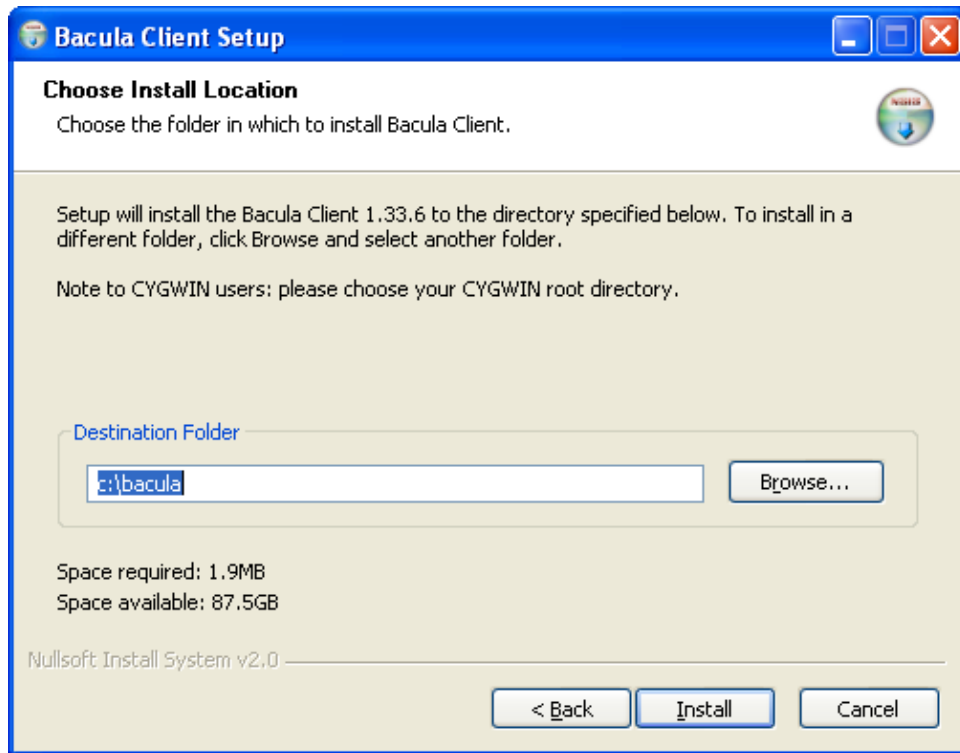
- Once launched, the installer wizard will ask you if you want to install Bacula.



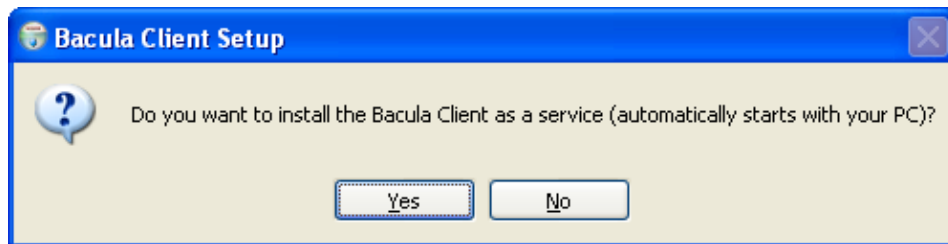
- If you proceed, you will be asked to select the components to be installed. You may install the Bacula program (Bacula File Service) and or the documentation. Both will be installed in sub-directories of the install location that you choose later. The components dialog looks like the following:



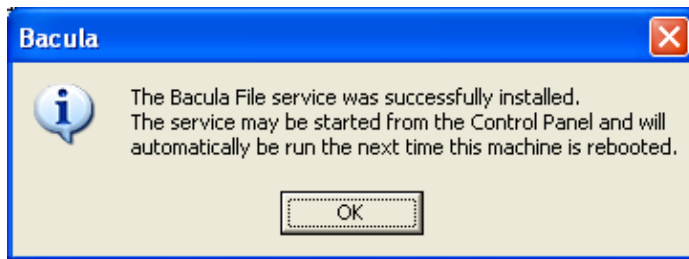
- Next you will be asked to select an installation directory.



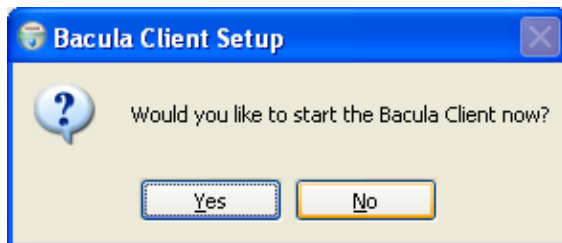
- If you are installing for the first time, you will be asked if you want to edit the bacula-fd.conf file, and if you respond with yes, it will be opened in notepad.
- Then the installer will ask if wish to install Bacula as a service. You should always choose to do so:



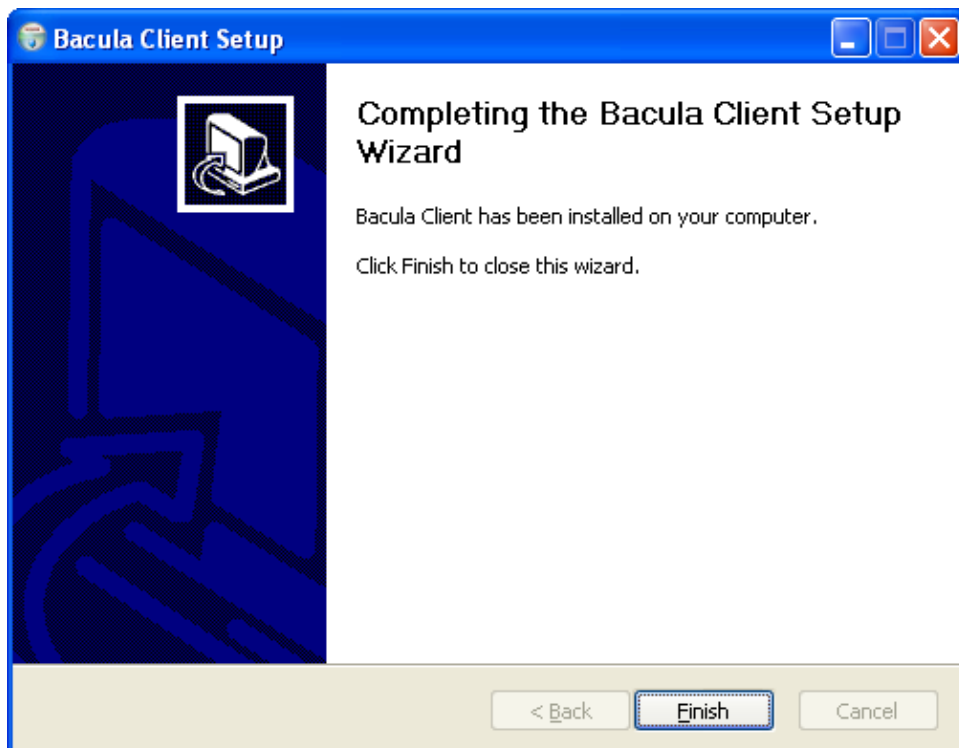
- If everything goes well, you will receive the following confirmation:


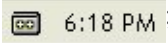


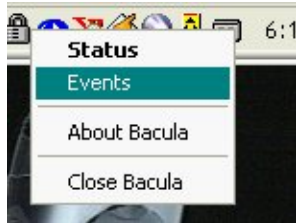
- Then you will be asked if you wish to start the service. If you respond with yes, any running Bacula will be shutdown and the new one started. You may see a DOS box momentarily appear on the screen as the service is started. It should disappear in a second or two:





- Finally, the finish dialog will appear:



That should complete the installation process. When the Bacula File Server is ready to serve files, an icon  representing a cassette (or tape) will appear in the system tray ; right click on it and a menu will appear.



The **Events** item is currently unimplemented, by selecting the **Status** item, you can verify whether any jobs are running or not.

When the Bacula File Server begins saving files, the color of the holes in the cassette icon will change from white to green , and if there is an error, the holes in the cassette icon will change to red .

If you are using remote desktop connections between your windows boxes, be warned that that tray icon does not always appear. It will always be visible when you log into the console, but the remote desktop may not display it.

Post Installation

After installing Bacula and before running it, you should check the contents of `c:\bacula\bin\bacula-fd.conf` to ensure that it corresponds to your configuration.

Uninstalling Bacula

Once Bacula has been installed, it can be uninstalled using the standard Windows Add/Remove Programs dialog found on the Control panel.

Dealing with Problems

The most likely source of problems is authentication when the Director attempts to connect to the File daemon that you installed. This can occur if the names and the passwords defined in the File daemon's configuration file `c:\bacula\bin\bacula-fd.conf` on the Windows machine do not match with the names and the passwords in the Director's configuration file `bacula-dir.conf` located on your Unix/Linux server.

More specifically, the password found in the **Client** resource in the Director's configuration file must be the same as the password in the **Director** resource of the File daemon's configuration file. In addition, the name of the **Director** resource in the File daemon's configuration file must be the same as the name in the **Director** resource of the Director's configuration file.

It is a bit hard to explain in words, but if you understand that a Director normally has multiple Clients and a Client (or File daemon) may permit access by multiple Directors, you can see that

the names and the passwords on both sides must match for proper authentication.

One user had serious problems with the configuration file until he realized that the Unix end of line conventions were used and Bacula wanted them in Windows format. This has not been confirmed though.

If there are other programs like Bacula on your system that use Cygwin, such as **VCD-Easy**, you may not be able to run the two programs at the same time because they are using different versions of Cygwin. As a consequence, if Bacula just won't start, see what other programs are running on your system.

Running Unix like programs on Windows machines is a bit frustrating because the Windows command line shell (DOS Window) is rather primitive. As a consequence, it is not generally possible to see the debug information and certain error messages that Bacula prints. With a bit of work, however, it is possible. When everything else fails and you want to **see** what is going on, try the following:

```
Start a DOS shell Window.
```

```
cd c:\bacula\bin
bacula-fd -t >out
type out
```

The **-t** option will cause Bacula to read the configuration file, print any error messages and then exit. the **>** redirects the output to the file named **out**, which you can list with the **type** command.

If something is going wrong later, or you want to run **Bacula** with a debug option, you might try starting it as:

```
bacula-fd -d 100 >out
```

In this case, Bacula will run until you explicitly stop it, which will give you a chance to connect to it from your Unix/Linux server.

In addition, you should look in the System Applications log on the Control Panel to find any Windows errors that Bacula got during the startup process.

Windows Compatibility Considerations

If any applications are running during the backup and they have open files, Bacula will not be able to backup those files, so be sure you close your applications (or tell your users to close their applications) before the backup.

Bacula doesn't know about the system registry, so you will either need to write it out to an ASCII file using **regedit /e** or use a program specifically designed to make a copy or backup the registry.

In Bacula versions 1.30 and earlier, we used the Cygwin emulation of Unix `open()`, `read()`, `write()`, ... calls to access files. This worked pretty well for Win95, Win98, and WinMe systems, but not very well for the other systems (NT/2K/XP) because those systems have special security and ownership information that was not saved. In addition on the NT/2K/XP systems, older versions of Bacula were not always able to access all files due to system permissions restrictions.

As a consequence, in Bacula version 1.31 and later, we use Windows backup API calls by default. Typical of Windows, programming these special BackupRead and BackupWrite calls is a real nightmare of complications. The end result gives some distinct advantages and some disadvantages.

First, the advantages are that on WinNT/2K/XP systems, the security and ownership information is now backed up. In addition, with the exception of files in use by another program (a major disaster for backup programs on Windows), Bacula can now access all system files. This means that when you restore files, the security and ownership information will be restored on WinNT/2K/XP along with the data.

The disadvantage of the Windows backup API calls is that it produces non-portable backups. That is files and their data that are backed up on WinNT using the native API calls (BackupRead/BackupWrite) cannot be restored on Win95/98/Me or Unix systems. In principle, a file backed up on WinNT can be restored on WinXP, but this remains to be seen in practice (not yet tested). In addition, the stand-alone tools such as **bls** and **bextract** cannot be used to retrieve the data for those files because those tools are not available on Windows. All restores must use the Bacula **restore** command. This restriction is mentioned for completeness, but in practice should not create any problems.

As a default, Bacula backs up Windows systems using the Windows API calls. If you want to backup data on a WinNT/2K/XP system and restore it on a Unix/Win95/98/Me system, we have provided a special **portable** option that backups the data in a portable fashion by using portable API calls. See the [portable option](#) on the Include statement in a FileSet resource in the Director's configuration chapter for the details on setting this option. However, using the portable option means you may have permissions problems accessing files, and none of the security and ownership information will be backed up or restored. The file data can, however, be restored on any system.

You should always be able to restore any file backed up on Unix or Win95/98/Me to any other system. On some systems, such as WinNT/2K/XP, you may have to reset the ownership of such restored files. Any file backed up on WinNT/2K/XP should in principle be able to be restored to a similar system (i.e. WinNT/2K/XP), however, I am unsure of the consequences if the owner information and accounts are not identical on both systems. Bacula will not let you restore files backed up on WinNT/2K/XP to any other system (i.e. Unix Win95/98/Me) if you have used the defaults.

Finally, if you specify the **portable=yes** option on the files you back up. Bacula will be able to restore them on any other system. However, any WinNT/2K/XP specific security and ownership information will be lost.

The following matrix will give you an idea of what you can expect. Thanks to Marc Brueckner for doing the tests:

Backup OS	Restore OS	Results
WinMe	WinMe	Works
WinMe	WinNT	Works (SYSTEM permissions)

WinMe	WinXP	Works (SYSTEM permissions)
WinMe	Linux	Works (SYSTEM permissions)
WinXP	WinXP	Works
WinXP	WinNT	Works (all files OK, but got "The data is invalid" message)
WinXP	WinMe	Error: Win32 data stream not supported.
WinXP	WinMe	Works if Portable=yes specified during backup.
WinXP	Linux	Error: Win32 data stream not supported.
WinXP	Linux	Works if Portable=yes specified during backup.
WinNT	WinNT	Works
WinNT	WinXP	Works
WinNT	WinMe	Error: Win32 data stream not supported.
WinNT	WinMe	Works if Portable=yes specified during backup.
WinNT	Linux	Error: Win32 data stream not supported.
WinNT	Linux	Works if Portable=yes specified during backup.
Linux	Linux	Works
Linux	WinNT	Works (SYSTEM permissions)
Linux	WinMe	Works
Linux	WinXP	Works (SYSTEM permissions)

Windows Disaster Recovery

We don't currently have a good solution for disaster recovery on Windows as we do on Linux. The main piece lacking is a Windows boot floppy or a Windows boot CD. Microsoft releases a Windows Pre-installation Environment (**WinPE**) that could possibly work, but we have not investigated it. This means that until someone figures out the correct procedure, you must restore the OS from the installation disks, then you can load a Bacula client and restore files. Please don't count on using **bextract** to extract files from your backup tapes during a disaster recovery unless you have backed up those files using the **portable** option. **bextract** does not run on Windows, and the normal way Bacula saves files using the Windows API prevents the files from

being restored on a Unix machine. Once you have an operational Windows OS loaded, you can run the File daemon and restore your user files.

Please see [Disaster Recovery of Win32 Systems](#) for the latest suggestion, which looks very promising.

It looks like Bart PE Builder, which creates a Windows PE (Pre-installation Environment) Boot-CD, may be just what is needed to build a complete disaster recovery system for Win32. This distribution can be found at <http://www.nu2.nu/pebuilder/>.

Windows Ownership and Permissions Problems

If you restore files backed up from WinNT/XP/2K to an alternate directory, Bacula may need to create some higher level directories that were not saved (or restored). In this case, the File daemon will create them under the SYSTEM account because that is the account that Bacula runs under as a service. As of version 1.32f-3, Bacula creates these files with full access permission. However, there may be cases where you have problems accessing those files even if you run as administrator. In principle, Microsoft supplies you with the way to cease the ownership of those files and thus change the permissions. However, a much better solution to working with and changing Win32 permissions is the program **SetACL**, which can be found at <http://setacl.sourceforge.net/>.

Manually resetting the Permissions

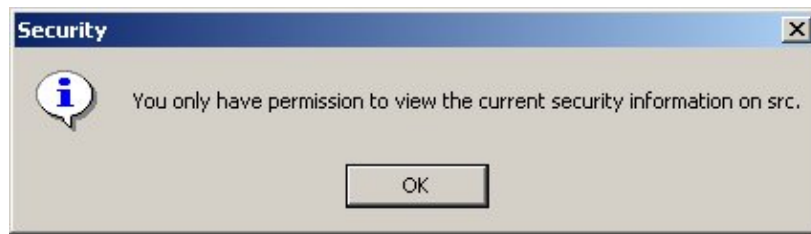
The following solution was provided by Dan Langille <dan at langille in the dot org domain>. The steps are performed using Windows 2000 Server but they should apply to most Win32 platforms. The procedure outlines how to deal with a problem which arises when a restore creates a top-level new directory. In this example, "top-level" means something like **c:\src**, not **c:\tmp\src** where **c:\tmp** already exists. If a restore job specifies / as the **Where:** value, this problem will arise.

The problem appears as a directory which cannot be browsed with Windows Explorer. The symptoms include the following message when you try to click on that directory:

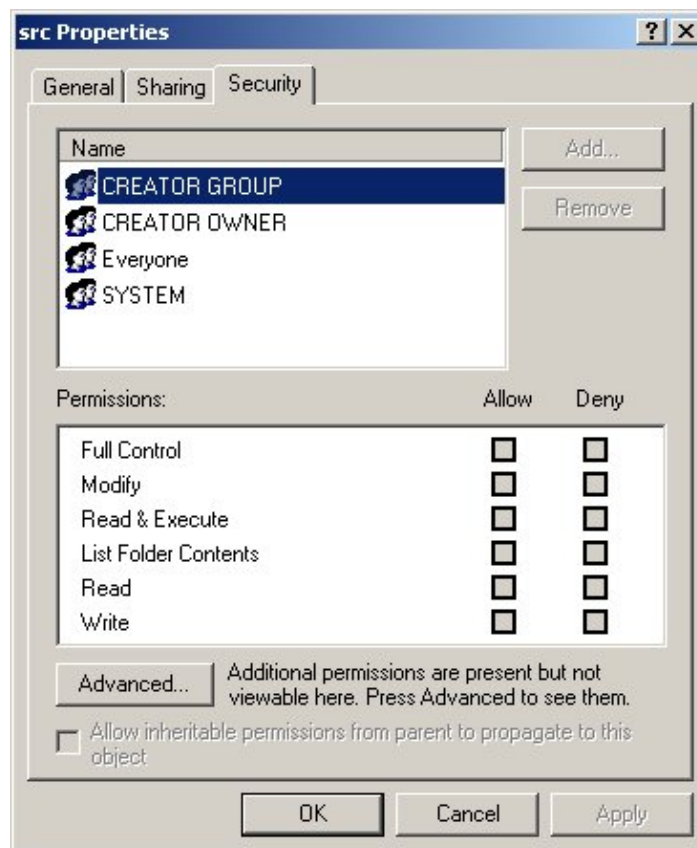


If you encounter this message, the following steps will change the permissions to allow full access.

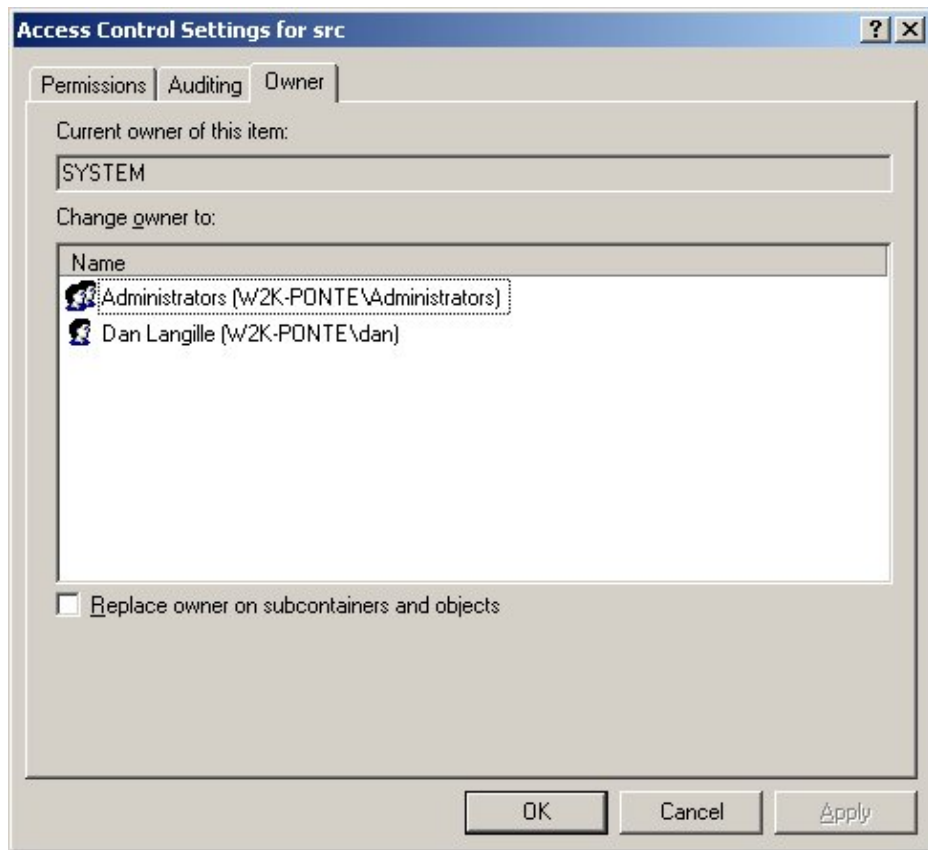
1. right click on the top level directory (in this example, **c:/src**) and select **Properties**.
2. click on the Security tab.
3. If the following message appears, you can ignore it, and click on **OK**.



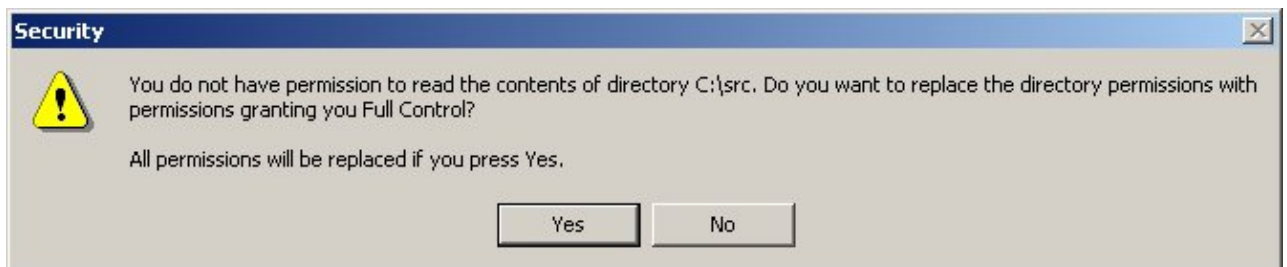
You should see something like this:



4. click on Advanced
5. click on the Owner tab
6. Change the owner to something other than the current owner (which is **SYSTEM** in this example as shown below).



7. ensure the "Replace owner on subcontainers and objects" box is checked
8. click on OK
9. When the message "You do not have permission to read the contents of directory "c:\src\basis. Do you wish to replace the directory permissions with permissions granting you Full Control?", click on Yes.



10. Click on OK to close the Properties tab

With the above procedure, you should now have full control over your restored directory.

Backing Up the WinNT/XP/2K System State

A suggestion by Damian Coutts using Microsoft's NTBackup utility in conjunction with Bacula should permit a full restore of any damaged system files on Win2K/XP. His suggestion is to do an NTBackup of the critical system state prior to running a Bacula backup with the following command:

```
ntbackup backup systemstate /F c:\systemstate.bkf
```

The **backup** is the command, the **systemstate** says to backup only the system state and not all the user files, and the **/F c:\systemstate.bkf** specifies where to write the state file. this file must then be saved and restored by Bacula.

To restore the system state, you first reload a base operating system if the OS is damaged, otherwise, this is not necessary, then you would use Bacula to restore all the damaged or lost user's files and to recover the **c:\systemstate.bkf** file. Finally if there are any damaged or missing system files or registry problems, you run **NTBackup** and **catalogue** the system statefile, and then select it for restore. The documentation says you can't run a command line restore of the systemstate.

To the best of my knowledge, this has not yet been tested. If you test it, please report your results to the Bacula email list.

Windows Considerations for Filename Specifications

Please see the [Director's Configuration chapter](#) of this manual for important considerations on how to specify Windows paths in Bacula FileSet Include and Exclude directives.

Command Line Options Specific to the Bacula Windows File Daemon (Client)

These options are not normally seen or used by the user, and are documented here only for information purposes. At the current time, to change the default options, you must either manually run **Bacula** or you must manually edit the system registry and modify the appropriate entries.

In order to avoid option clashes between the options necessary for **Bacula** to run on Windows and the standard Bacula options, all Windows specific options are signaled with a forward slash (/), while as usual, the standard Bacula options are signaled with a minus (-), or a minus minus (--). All the standard Bacula options can be used on the Windows version. In addition, the following Windows only options are implemented:

/servicehelper

Run the service helper application (don't use this it is deprecated.).

/service

Start Bacula as a service

/run

Run the Bacula application

/install

Install Bacula as a service in the system registry

/remove

Uninstall Bacula from the system registry

/about

Show the Bacula about dialogue box

/status

Show the Bacula status dialogue box

/events

Bacula Storage Management System

Show the Bacula events dialogue box (not yet implemented)

/kill

Stop any running **Bacula**

/help

Show the Bacula help dialogue box

It is important to note that under normal circumstances the user should never need to use these options as they are normally handled by the system automatically once Bacula is installed. However, you may note these options in some of the .bat files that have been created for your use.



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The Network Backup Solution

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~~Bacula 1.34 User's Guide~~



The Windows Version of Bacula



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Disaster Recovery Using Bacula

General

When disaster strikes, you must have a plan, and you must have prepared in advance otherwise the work of recovering your system and your files will be considerably greater. For example, if you have not previously saved the partitioning information for your hard disk, how can you properly rebuild it if the disk must be replaced?

Unfortunately, many of the steps one must take before and immediately after a disaster are very operating system dependent. As a consequence, this chapter will discuss in detail disaster recovery (also called Bare Metal Recovery) for **Linux** and **Solaris**. For Solaris, the procedures are still quite manual. For FreeBSD the same procedures may be used but they are not yet developed. For Win32, no luck. Apparently an "emergency boot" disk allowing access to the full system API without interference does not exist.

Important Considerations

Here are a few important considerations concerning disaster recovery that you should take into account before a disaster strikes.

- If the building which houses your computers burns down or is otherwise destroyed, do you have off-site backup data?
- Disaster recovery is much easier if you have several machines. If you have a single machine, how will you handle unforeseen events if your only machine is down?
- Do you want to protect your whole system and use Bacula to recover everything? or do you want to try to restore your system from the original installation disks and apply any other updates and only restore user files?

Bare Metal Recovery on Linux

The remainder of this section concerns recovering a **Linux** computer, and parts of it relate to the Red Hat version of Linux. The **Solaris** procedures can be found below.

A so called "Bare Metal" recovery is one where you start with an empty hard disk and you restore your machine. There are also cases where you may lose a file or a directory and want it restored. Please see the previous chapter for more details for those cases.

Bare Metal Recovery assumes that you have the following four items for your system:

- An emergency boot disk allowing you to boot without a hard disk
- A Bacula Rescue Disk containing your disk information and a number of helpful scripts (described below) including a statically linked version of the Bacula File daemon
- A full Bacula backup of your system possibly including Incremental or Differential backups since the last Full backup
- A second system running the Bacula Director, the Catalog, and the Storage daemon. (this is not an absolute requirement, but how to get around it is not yet documented here)

Restrictions

In addition, to the above assumptions, the following conditions or restrictions apply:

- Linux only — tested only on Red Hat, but should work on other Linuxes
- The scripts handle only SCSI and IDE disks
- All partitions will be recreated, but only **ext2**, **ext3**, and **swap** partitions will be reformatted. Any other partitions such as Windows FAT partitions will not be formatted by the scripts, but you can do it by hand
- You are using either **lilo** or **grub** as a boot loader, and you know which one (not automatically detected)
- The partitioning and reformatting scripts will not work with RAID devices, or other "complicated" disk partitioning/formatting schemes. Please check them carefully. You will probably need to edit them by hand.
- I have noticed that the partitioning and reformatting scripts no longer work with RedHat version 9 or greater. This is probably due to a change in output format of one of the utilities used or sfdisk. You will need to hand edit them.

Scripts

The scripts discussed below can be found in the **rescue/linux** subdirectory of the Bacula source code.

Preparation for a Bare Metal Recovery

There are two things you should do immediately on all (Linux) systems for which you wish to do a bare metal recovery:

1. Create a system emergency boot disk or alternatively a system installation boot floppy. This step can be skipped if you have an Installation CDROM and your machine will boot from CDROM (most modern computers will).
2. Create a Bacula Rescue disk, which captures the current working state of your computer and creates scripts to restore it. In addition, it creates a statically linked version of the Bacula File daemon (Client) program, which is key to successfully restoring from scratch.

Creating an Emergency Boot Disk

Here you have several choices:

- Create a tomsrtdisk disk (any Linux)
- Create an emergency boot disk (any Linux I think)
- Create a Red Hat Installation disk (Red Hat specific)
- Others

tomsrtdisk

My preference is to create and use a **tomsrtdisk** emergency boot disk because it gives you a very clean Linux environment (with a 2.2 kernel) and the most utilities. See <http://www.toms.net/rb/>

for more details on this. It is very easy to do and well worth the effort. However, I recommend that you create both especially if you have non-standard hardware. You may find that **tomsrtbt** will not work with your network driver (he surely has one, but you must explicitly put it on the disk), whereas the Linux rescue is more likely to work.

Emergency Boot Disk

To create a standard Linux emergency boot disk you must first know the name of the kernel, which you can find with:

```
ls -l /boot
```

and looking on the **vmlinux-...** line or alternative do an

```
uname -a
```

then become root and with a blank floppy in the drive, enter the following command:

```
mkbootdisk --device /dev/fd0 2.4.18-18
```

where you replace "2.4.18-18" by your system name.

This disk can then be booted and you will be in an environment with a number of important tools available. Some disadvantages of this environment as opposed to **tomsrtbt** are that you must enter **linux rescue** at the boot prompt or the boot will fail without a hard disk; it requires a disk boot image or a CDROM to be mounted, if the CDROM is released, you will loose a large number of the tools.

Red Hat Installation Disk

Specific to Red Hat Linux, is to create an Installation floppy, which can also be used as an emergency boot disk. The advantage of this method is that it works in conjunction with the installation CDROM and hence during the first part of restoring the system, you have a much larger number of tools available (on the CDROM). This can be extremely useful if you are not sure what really happened and you need to examine your system in detail.

To make a Red Hat Linux installation disk, do the following:

```
mount the Installation CDROM (/mnt/cdrom)
cd /mnt/cdrom/images
dd if=boot.img of=/dev/fd0 bs=1440k
```

Now that you have either an emergency boot disk or an installation floppy, you will be able to reboot your system in the absence of your hard disk or with a damaged hard disk. This method has the same disadvantages compared to **tomsrtbt** disk as mentioned above for the Emergency Boot Disk.

Creating a Bacula Rescue Disk

Simply having a boot disk is not sufficient to re-create things as they were. To solve this problem, we will create a Bacula Rescue disk. Everything that will be written to this disk will first be placed into the **<bacula-src>/rescue/linux** directory.

The first step is while your system is up and running normally, you use a Bacula script called **getdiskinfo** to capture certain important information about your hard disk configuration (partitioning, formatting, mount points, ...). **getdiskinfo** will also create a number of scripts using the information found that can be used in an emergency to repartition your disks, reformat them, and restore a statically linked version of the Bacula file daemon so that your disk can be restored from within a minimal boot environment.

The first step is to run **getdiskinfo** as follows:

```
su
cd <bacula-src>/rescue/linux
./getdiskinfo
```

getdiskinfo works for either IDE or SCSI drives and recognizes both ext2 and ext3 file systems. If you wish to restore other file systems, you will need to modify the code. This script can be run multiple times, but really only needs to be run once unless you change your hard disk configuration.

Assuming you have a single hard disk on device /dev/hda, **getdiskinfo** will create the following files:

partition.hda

This file contains the shell commands to repartition your hard disk drive /dev/hda to the current state. If you have additional drives (e.g. /dev/hdc), you will find one of these files for each drive. **DO NOT EXECUTE THIS SCRIPT UNLESS YOU WANT YOUR HARD DISK REPARTITIONED**

format.hda

This file contains the shell commands that will format each of the partitions on your hard drive. It knows about ext2, ext3, and swap partitions. All other partitions, you must manually format. It is recommended that any Microsoft partitions be partitioned with Microsoft's **format** command rather than using Unix tools. **DO NOT EXECUTE THIS SCRIPT UNLESS YOU WANT YOUR HARD DISK REFORMATTED**

mount_drives

This script will mount all ext2 and ext3 drives that were previously mounted. They will be mounted on /mnt/drive/. This is used just before running the statically linked Bacula so that it can access your drives for the restore.

restore_bacula

This script will restore the File daemon from the Bacula Rescue disk. Building the Bacula Rescue disk will be described later. This will provide your emergency boot environment with a Bacula file daemon. Note, this is a special statically linked version of the file daemon (i.e. it does not need or use shared libraries).

start_network

This script will start your network using the simplest possible commands. You will need to verify that the IP address used in this script is correct. In addition, if you have several ethernet cards, you may need to make other modifications to this script.

sfdisk

This is the program that will repartition your hard disk, and it is normally found in /sbin/sfdisk. It is placed in this directory so that it will be included on the rescue disk as it is not normally available with all emergency boot environments.

sfdisk.gz

This is the version of sfdisk that works with **tomsrtbt**. The standard sfdisk described above will not run under tomsrtbt.

The **getdiskinfo** program (actually a shell script) will also create a subdirectory named **diskinfo**, which contains the following files:

```
df.bsi
disks.bsi
fstab.bsi
ifconfig.bsi
mount.bsi
mount.ext2.bsi
mount.ext3.bsi
mtab.bsi
route.bsi
sfdisk.disks.bsi
sfdisk.hda.bsi
sfdisk.make.hda.bsi
```

Each of these files contains some important piece of information (sometimes redundant) about your hard disk setup or your network. Normally, you will not need this information, but it will be written to the Bacula Rescue disk just in case. Since it is normally not used, we will leave it to you to examine those files at your leisure.

Building a Static File Daemon

The second of the three steps in creating your Bacula Rescue disk is to build a static version of the File daemon. Do so by either configuring Bacula as follows or by allowing the **make_rescue_disk** script described below make it for you:

```
cd <bacula-src>
./configure <normal-options>
make
cd src/filed
make static-bacula-fd
strip static-bacula-fd
cp static-bacula-fd ../../rescue/linux/bacula-fd
cp bacula-fd.conf ../../rescue/linux
```

Note, above, we built **static-bacula-fd** and changed its name to **bacula-fd** when copying it to the rescue/linux directory.

Finally, in <bacula-src>/rescue/linux, ensure that the **WorkingDirectory** and **PIDDirectory** both point to reasonable locations on a stripped down system. If you are using **tomsrtbt** you will also want to replace machine names with IP addresses since there is no resolver running. With the Linux Rescue disk, network address mapping seems to work. Don't forget that at the time this version of the Bacula File daemon runs, your file system will not be restored. In my **bacula-fd.conf**, I use **/var/working**.

Writing the Bacula Rescue Floppy

When you have everything you need (output of `getdiskinfo`, Bacula File daemon, ...), you create your rescue floppy by putting a blank tape into your floppy disk drive and entering:

```
su
./make_rescue_disk
```

This script will reformat the floppy and write everything in the current directory and all files in the **diskinfo** directory to the floppy. If you supply the appropriate command line options, it will also build a static version of the Bacula file daemon and copy it along with the configuration file to the disk. Also using a command line option, you can make it write a compressed tar file containing all the files whose names are in **backup.etc.list** to the floppy. The list as provided contains names of files in **/etc** that you might need in a disaster situation. It is not needed, but in some cases such as a complex network setup, you may find it useful.

Options for `make_rescue_disk`

The following command line options are available for the `make_rescue_disk` script:

```
Usage: make_rescue_disk
      -h, --help           print this message
      --make-static-bacula make static File daemon and add to diskette
      --copy-static-bacula copy static File daemon to diskette
      --copy-etc-files     copy files in etc list to diskette
```

Briefly the options are:

--make-static-bacula

If this option is specified, the script will assume that you have already configured and built Bacula. It will then proceed to build a statically linked version and copy it along with `bacula-fd.conf` to the current directory, then write it to the rescue disk.

--copy-static-bacula,/dt>

If this option is given, the script will assume that you already have a copy of the statically linked Bacula in the current directory named **bacula-fd** as well as the configuration script. They will then be written to the rescue disk.

--copy-etc-files

If this option is specified, the script will tar the files in **backup.etc.list** and write them to the rescue disk.

Please examine the contents of the rescue floppy to ensure that it has everything you want and need. If not modify the scripts as necessary and re-run it until it is correct.

Now that you have both a system boot floppy and a Bacula Rescue floppy, assuming you have a full backup of your system made by Bacula, you are ready to handle nearly any kind of emergency restoration situation.

Restoring Your Linux System

Now, let's assume that your hard disk has just died and that you have replaced it with an new identical drive. In addition, we assume that you have:

1. A recent Bacula backup (Full plus Incrementals)
2. An emergency boot floppy (preferably **tomsrtbt**)
3. A Bacula Rescue Disk
4. Your Bacula Director, Catalog, and Storage daemon running on another machine on your local network.

This is a relatively simple case, and later in this chapter, as time permits, we will discuss how you might recover from a situation where the machine that crashes is your main Bacula server (i.e. has the Director, the Catalog, and the Storage daemon).

You will take the following steps to get your system back up and running:

1. Boot with your Emergency Floppy
2. Mount your Bacula Rescue floppy
3. Start the Network (local network)
4. Re-partition your hard disk(s) as it was before
5. Re-format your partitions
6. Restore the Bacula File daemon (static version)
7. Perform a Bacula restore of all your files
8. Re-install your boot loader
9. Reboot

Now for the details ...

Boot with your Emergency Floppy

First you will boot with your emergency floppy. If you use the Installation floppy described above, when you get to the boot prompt:

```
boot :
```

you enter **linux rescue**.

If you are booting from **tomsrtbt** simply enter the default responses.

When your machine finishes booting, you should be at the command prompt possibly with your hard disk mounted on **/mnt/sysimage** (Linux emergency only). To see what is actually mounted, use:

```
df
```

Mount your Bacula Rescue Floppy

Make sure that the mount point **/mnt/floppy** exists. If not, enter:

```
mkdir -p /mnt/floppy
```

then mount your **Bacula Rescue** disk and cd to it with:

```
mount /dev/fd0 /mnt/floppy
cd /mnt/floppy
```

To simplify running the scripts make sure the current directory is on your path by:

```
PATH=$PATH:.
```

Start the Network

At this point, you should bring up your network. Normally, this is quite simple and requires just a few commands. To simplify your task, we have created a script that should work in most cases by typing:

```
./start_network
```

You can test it by pinging another machine, or pinging your broken machine machine from another machine. Do not proceed until your network is up.

Unmount Your Hard Disk (if mounted)

When you are sure you want to repartition your disk, normally, if your disk was damaged or if you are using **tomsrtbt** your hard disk will not be mounted. However, if it is you must first unmount it so that it is not in use. Do so by entering **df** and then enter the correct commands to unmount the disks. For example:

```
umount /mnt/sysimage/boot
umount /mnt/sysimage/usr
umount /mnt/sysimage/proc
umount /mnt/sysimage/
```

where you explicitly unmount (**umount**) each sysimage partition and finally, the last one being the root. Do another **df** command to be sure you successfully unmount all the sysimage partitions.

This is necessary because **sfdisk** will refuse to partition a disk that is currently mounted. As mentioned, this should never be necessary with **tomsrtbt**.

Partition Your Hard Disk(s)

If you are using **tomsrtbt**, you will need to do the following steps to get the correct **sfdisk**:

```
rm -f sfdisk
bzip2 -d sfdisk.bz2
```

Do not do the above steps if you are using a standard Linux boot disk.

Then proceed with partitioning your hard disk by:

```
./partition.hda
```

If you have multiple disks, do the same for each of them. For SCSI disks, the repartition script will be named: **partition.sda**. If the script complains about the disk being in use, simply go back and redo the **df** command and **umount** commands until you no longer have your hard disk mounted. Note, in many cases, if your hard disk was seriously damaged or a new one installed, it will not automatically be mounted. If it is mounted, it is because the emergency kernel found one

or more possibly valid partitions.

If for some reason this procedure does not work, you can use the information in **partition.hda** to re-partition your disks by hand using **fdisk**.

Format Your Hard Disk(s)

After partitioning your disk, you must format it appropriately. The formatting script will put back swap partitions, normal Unix partitions (ext2) and journaled partitions (ext3). Do so by entering for each disk:

```
./format.hda
```

The format script will ask you if you want a block check done. We recommend to answer yes, but realize that for very large disks this can take hours.

Mount the Newly Formatted Disks

Once the disks are partitioned and formatted, you can remount them with the **mount_drives** script. All your drives must be mounted for Bacula to be able to access them. Run the script as follows:

```
./mount_drives  
df
```

The **df** will tell you if the drives are mounted. If not, re-run the script again. It isn't always easy to figure out and create the mount points and the mounts in the proper order, so repeating the **./mount_drives** command will not cause any harm and will most likely work the second time. If not, correct it by hand before continuing.

Unmount the CDROM

Next, if you are using the Red Hat installation disk, unmount the CDROM drive by doing:

```
umount /mnt/cdrom
```

This is not necessary if you are running **tomsrtbt**. In doing this, I find it is always busy, and I haven't figured out how to unmount it (Linux boot only).

Restore and Start the File Daemon

Now, change (cd) to some directory where you want to put the image of the Bacula File daemon. I use the tmp directory my hard disk (mounted as **/mnt/disk/tmp**) because it is easy. Then install into the current directory Bacula by running the **restore_bacula** script from the floppy drive. For example:

```
cd /mnt/disk  
mkdir -p /mnt/disk/tmp  
mkdir -p /mnt/disk/tmp/working  
/mnt/floppy/restore_bacula  
ls -l
```

Make sure **bacula-fd** and **bacula-fd.conf** are both there.

Edit the Bacula configuration file, create the `working/pid/subsys` directory if you haven't already done so above, and start Bacula by entering:

```
chroot /mnt/disk /tmp/bacula-fd -c /tmp/bacula-fd.conf
```

The above command starts the Bacula File daemon with your the proper root disk location (i.e. **/mnt/disk/tmp**). If Bacula does not start correct the problem and start it. You can check if it is running by entering:

```
ps fax
```

You can kill Bacula by entering:

```
kill -TERM <pid>
```

where **pid** is the first number printed in front of the first occurrence of **bacula-fd** in the **ps fax** command.

Now, you should be able to use another computer with Bacula installed to check the status by entering:

```
status client=xxxx
```

into the Console program, where `xxxx` is the name of the client you are restoring.

One common problem is that your **bacula-fd.conf** may contain machine addresses that are not properly resolved on this stripped down system because it is not running DNS. In that case, be prepared to edit **bacula-fd.conf** to replace the name of the Director's machine with its IP address. Or better yet, do this before building the Bacula rescue disk.

Restoring using the RedHat Installation Disk

Suppose your system was damaged for one reason or another, so that the hard disk and the partitioning and much of the filesystems are intact, but you want to do a full restore. If you have booted into your system with the RedHat Installation Disk by specifying **linux rescue** at the **boot:** prompt, you will find yourself in a shell command with your disks already mounted (if it was possible) in **/mnt/sysimage**. In this case, you can do much like you did above to restore your system:

```
cd /mnt/sysimage/tmp
mkdir -p /mnt/sysimage/tmp/working
/mnt/floppy/restore_bacula
ls -l
```

Make sure that **bacula-fd** and **bacula-fd.conf** are both in the current directory and that the directory names in the **bacula-fd.conf** correctly point to the appropriate directories. Then start Bacula with:

```
chroot /mnt/sysimage /tmp/bacula-fd -c /tmp/bacula-fd.conf
```

Restore Your Files

On the computer that is running the Director, you now run a **restore** command and select the files to be restored (normally everything), but before starting the restore, there is one final change you must make using the **mod** option. You must change the **Where** directory to be the root by using the **mod** option just before running the job and selecting **Where**. Set it to:

```
/
```

then run the restore.

You might be tempted to avoid using **chroot** and running Bacula directly and then using a **Where** to specify a destination of **/mnt/disk**. This is possible, however, the current version of Bacula always restores files to the new location, and thus any soft links that have been specified with absolute paths will end up with **/mnt/disk** prefixed to them. In general this is not fatal to getting your system running, but be aware that you will have to fix these links if you do not use **chroot**.

Final Step

At this point, the restore should have finished with no errors, and all your files will be restored. One last task remains and that is to write a new boot sector so that your machine will boot. For **lilo**, you enter the following command:

```
run_lilo
```

If you are using grub instead of lilo, you must enter the following:

```
run_grub
```

Note, I've had quite a number of problems with **grub** because it is rather complicated and not designed to install easily under a simplified system. So, if you experience errors or end up unexpectedly in a **chroot** shell, simply exit back to the normal shell and type in the appropriate commands from the **run_grub** script by hand until you get it to install.

Reboot

Reboot your machine by entering **exit** until you get to the main prompt then enter **ctl-d**.

If everything went well, you should now be back up and running. If not, re-insert the emergency boot floppy, boot, and figure out what is wrong.

At this point, you will probably want to remove the temporary copy of Bacula that you installed. Do so with:

```
rm -f /bacula-fd /bacula-fd.conf  
rm -rf /working
```

Linux Problems or Bugs

Since every flavor and every release of Linux is different, there are likely to be some small difficulties with the scripts, so please be prepared to edit them in a minimal environment. A rudimentary knowledge of **vi** is very useful. Also, these scripts do not do everything. You will need to reformat Windows partitions by hand, for example.

Getting the boot loader back can be a problem if you are using **grub** because it is so complicated. If all else fails, reboot your system from your floppy but using the restored disk image, then proceed to a reinstallation of grub (looking at the `run-grub` script can help). By contrast, lilo is a piece of cake.

Bugs

When performing the bare metal recovery using the Red Hat emergency boot disk (actually the installation boot disk), I was never able to release the cdrom, and when the system came up `/mnt/cdrom` was soft linked to `/mnt/disk/dev/hdd`, which is not correct. I fixed this in each case by deleting and simply remaking it with **mkdir -p /mnt/cdrom**.

tomsrtbt

This is a single floppy (1.722Meg) that really has A LOT of software. For example, by default (version 2.0.103) you get:

```
AHA152X AHA1542 AIC7XXX BUSLOGIC DAC960 DEC_ELCP(TULIP) EATA
EEXPRESS/PRO/PRO100 EL2 EL3 EXT2 EXT3 FAT FD IDE-CD/DISK/TAPE IMM
INITRD ISO9660 JOLIET LOOP MATH_EMULATION MINIX MSDOS NCR53C8XX
NE2000 NFS NTFS PARPORT PCINE2K PCNET32 PLIP PPA RTL8139 SD
SERIAL/_CONSOLE SLIP SMC_ULTRA SR ST VFAT VID_SELECT VORTEX WD80x3
.exrc 3c589_cs agetty ash badblocks basename boot.b buildit.s busybox bz2bzImage bzip2
cardmgr cardmgr.pid cat chain.b chatr chgrp chmod chown chroot clear clone.s cmp common
config cp cpio cs cut date dd dd-lfs debugfs ddate df dhcpcd— dirname dmesg domainname ds
du dumpt2fs e2fsck echo egrep elvis ex false fdflush fdformat fdisk filesize find findsuper fmt
fstab grep group gunzip gzip halt head hexdump hexedit host.conf hostname hosts httpd i82365
ifconfig ile init inittab insmod install.s issue kernel key.lst kill killall killall5 ld ld-linux length
less libc libcom_err libe2p libext2fs libtermcap libuuid lilo lilo.conf ln loadkmap login ls lsattr
lsmod lua luasocket man map md5sum mitemr mkdir mkdosfs mke2fs mkfifo mkfs.minix mknod
mkswap more more.help mount mt mtab mv nc netcat network networks nmclan_cs nslookup
passwd pax pcmcia_core pcnet_cs pidof ping poweroff printf profile protocols ps pwd rc.0 rc.S
rc.custom rc.custom.gz rc.pcmcia reboot rescuept reset resolv.conf rm rmdir rmmod route rsh
rshd script sed serial serial_cs services setserial settings.s sh shared slattach sleep sln sort split
stab strings swapoff swapon sync tail tar tcic tee telnet telnetd termcap test tomshexd
tomsrtbt.FAQ touch traceroute true tune2fs umount undeb— unpack.s unrpm— update utmp vi
vi.help view watch wc wget which xargs xirc2ps_cs yecho yes zcat
```

In addition, at [Tom's Web Site](#), you can find a lot of additional kernel drivers and other software (such as **sdisk**, which is used by Bacula).

Building his floppy is a piece of cake. Simply download his .tar.gz file then:

- detar the .tar.gz archive
- become root
- cd to the tomsrtbt-<version> directory
- load a blank floppy with no bad sectors
- ./install.s

FreeBSD Bare Metal Recovery

The same basic techniques described above also apply to FreeBSD. Although we don't yet have a fully automated procedure, Alex Torres Molina has provided us with the following instructions with a few additions from Jesse Guardiani and Dan Languille:

1. Boot with the FreeBSD installation disk
2. Go to Custom, Partition and create your slices and go to Label and create the partitions that you want. Apply changes.
3. Go to Fixit to start a emergency console.
4. Create devs ad0 if don't exist under /mnt2/dev (in my situation) with MAKEDEV.
The device or devices you create depend on what hard drives you have. ad0 is your first ATA drive. da0 would be your first SCSI drive. Under OS version 5 and greater, your device files are most likely automatically created for you.
5. mkdir /mnt/disk
this is the root of the new disk
6. mount /mnt2/dev/ad0s1a /mnt/disk
mount /mnt2/dev/ad0s1c /mnt/disk/var
mount /mnt2/dev/ad0s1d /mnt/disk/usr
.....
The same hard drive issues as above apply here too. Note, under OS version 5 or higher, your disk devices may be in /dev not /mnt2/dev.
7. Network configuraion (ifconfig x10 ip/mask + route add default ip-gateway)
8. mkdir /mnt/disk/tmp
9. cd /mnt/disk/tmp
10. Copy bacula-fd and bacula-fd.conf to this path
11. If you need to use sftp to copy files then you must do this:
ln -s /mnt2/usr/bin /usr/bin
12. chmod u+x bacula-fd
13. Modify bacula-fd.conf to fit this machine
14. Copy /bin/sh to /mnt/disk, necessary for chroot
15. Don't forget to put your bacula-dir's IP address and domain name in /mnt/disk/etc/hosts if it's not on a public net. Otherwise the FD on the machine you are restoring to won't be able to contact the SD and DIR on the remote machine.
16. mkdir -p /mnt/disk/var/db/bacula
17. chroot /mnt/disk /tmp/bacula-fd -c /tmp/bacula-fd.conf
to start bacula-fd
18. Now you can go to bacula-dir and restore the job with the entire contents of the broken server.
19. You must create /proc

Solaris Bare Metal Recovery

The same basic techniques described above apply to Solaris:

- the same restrictions as those given for Linux apply
- you will need to create a Bacula Rescue disk

However, during the recovery phase, the boot and disk preparation procedures are different:

- there is no need to create an emergency boot disk since it is an integrated part of the Solaris boot.
- you must partition and format your hard disk by hand following manual procedures as described in W. Curtis Preston's book "Unix Backup Recovery"

Once the disk is partitioned, formatted and mounted, you can continue with bringing up the network and reloading Bacula.

Preparing Solaris Before a Disaster

As mentioned above, before a disaster strikes, you should prepare the information needed in the case of problems. To do so, in the **rescue/solaris** subdirectory enter:

```
su
./getdiskinfo
./make_rescue_disk
```

The **getdiskinfo** script will, as in the case of Linux described above, create a subdirectory **diskinfo** containing the output from several system utilities. In addition, it will contain the output from the **SysAudit** program as described in Curtis Preston's book. This file **diskinfo/sysaudit.bsi** will contain the disk partitioning information that will allow you to manually follow the procedures in the "Unix Backup Recovery" book to repartition and format your hard disk. In addition, the **getdiskinfo** script will create a **start_network** script.

Once you have your your disks repartitioned and formatted, do the following:

- Start Your Network with the **start_network** script
- Restore the Bacula File daemon as documented above
- Perform a Bacula restore of all your files using the same commands as described above for Linux
- Re-install your boot loader using the instructions outlined in the "Unix Backup Recovery" book using **installboot**

Recovering a Server

Above, we considered how to recover a client machine where a valid Bacula server was running on another machine. However, what happens if your server goes down and you no longer have a running Director, Catalog, or Storage daemon? There are several solutions:

1. Bring up static versions of your Director, Catalog, and Storage daemon.

2. Move your server to another machine.

The first option, is very difficult because it requires you to have created a static version of the Director and the Storage daemon as well as the Catalog. If the Catalog uses MySQL or PostgreSQL, this may or may not be possible. In addition, to loading all these programs on a bare system (quite possible), you will need to make sure you have a valid driver for your tape drive.

The second suggestion is probably a much simpler solution, and one I have done myself. To do so, you might want to consider the following steps:

- If you are using MySQL or PostgreSQL, configure, build and install it from source (or user rpms) on your new system.
- Load the Bacula source code onto your new system, configure, install it, and create the Bacula database.
- If you have a valid saved Bootstrap file as created for your damaged machine with WriteBootstrap, use it to restore the files to the damaged machine, where you have loaded a static Bacula File daemon using the Bacula Rescue disk).
- If you have the Bootstrap file, you should now be back up and running, if you do not have a Bootstrap file, continue with the suggestions below.
- Using **bscan** scan the last set of backup tapes into your MySQL, PostgreSQL or SQLite database.
- Start Bacula, and using the Console **restore** command, restore the last valid copy of the Bacula database and the the Bacula configuration files.
- Move the database to the correct location.
- Start and restart Bacula, and with the full database using the Console **restore** command, restore all the files on the damaged machine, where you have loaded a Bacula File daemon using the Bacula Rescue disk.

Bugs and Other Considerations

Directory Modification and Access Times are Modified on pre-1.30 Baculas

When a pre-1.30 version of Bacula restores a directory, it first must create the directory, then it populates the directory with its files and subdirectories. The act of creating the files and subdirectories updates both the modification and access times associated with the directory itself. As a consequence, all modification and access times of all directories will be updated to the time of the restore.

This has been corrected in Bacula version 1.30 and later. The directory modification and access times is reset to the value saved in the backup after all the files and subdirectories have been restored. This has been tested and verified on normal restore operations, but not verified during a bare metal recovery.

Strange Bootstrap Files

If any of you look closely at the bootstrap file that is produced and used for the restore (I sure do), you will probably notice that the FileIndex item does not include all the files saved to the tape. This is because in some instances there are duplicates (especially in the case of an Incremental save), and in such circumstances, **Bacula** restores only the last of multiple copies of

a file or directory.

Disaster Recovery of Win32 Systems

Due to open system files, and registry problems, Bacula cannot save and restore a complete Win2K/XP/NT environment.

A suggestion by Damian Coutts using Microsoft's NTBackup utility in conjunction with Bacula should permit a Full bare metal restore of Win2K/XP (and possibly NT systems). His suggestion is to do an NTBackup of the critical system state prior to running a Bacula backup with the following command:

```
ntbackup backup systemstate /F c:\systemstate.bkf
```

The **backup** is the command, the **systemstate** says to backup only the system state and not all the user files, and the **/F c:\systemstate.bkf** specifies where to write the state file. this file must then be saved and restored by Bacula.

To restore the system state, you first reload a base operating system, then you would use Bacula to restore all the users files and to recover the **c:\systemstate.bkf** file, and finally, run **NTBackup** and **catalogue** the system statefile, and then select it for restore. The documentation says you can't run a command line restore of the systemstate.

To the best of my knowledge, this has not yet been tested. If you test it, please report your results to the Bacula email list.

Resetting Directory and File Ownership and Permissions on Win32 Systems

Bacula versions after 1.31 should properly restore ownership and permissions on all WinNT/XP/2K systems. If you do experience problems, generally in restores to alternate directories because higher level directories were not backed up by Bacula, you can correct any problems with the **SetACL** available under the GPL license at:
<http://sourceforge.net/projects/setacl/>.

Alternate Disaster Recovery Suggestion for Win32 Systems

Ludovic Strappazon has suggested an interesting way to backup and restore complete Win32 partitions. Simply boot your Win32 system with a Linux Rescue disk as described above for Linux, install a statically linked Bacula, and backup any of the raw partitions you want. Then to restore the system, you simply restore the raw partition or partitions. Here is the email that Ludovic recently sent on that subject:

```
I've just finished testing my brand new cd LFS/Bacula  
with a raw Bacula backup and restore of my portable.
```

```
I can't resist sending you the results: look at the rates !!!
```

```
hunt-dir: Start Backup JobId 100, Job=HuntBackup.2003-04-17_12.58.26
```

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```
hunt-dir: Bacula 1.30 (14Apr03): 17-Apr-2003 13:14
JobId:                100
Job:                  HuntBackup.2003-04-17_12.58.26
FileSet:              RawPartition
Backup Level:         Full
Client:               sauvegarde-fd
Start time:           17-Apr-2003 12:58
End time:             17-Apr-2003 13:14
Files Written:        1
Bytes Written:         10,058,586,272
Rate:                 10734.9 KB/s
Software Compression: None
Volume names(s):      000103
Volume Session Id:    2
Volume Session Time:  1050576790
Last Volume Bytes:    10,080,883,520
FD termination status: OK
SD termination status: OK
Termination:          Backup OK
```

```
hunt-dir: Begin pruning Jobs.
hunt-dir: No Jobs found to prune.
hunt-dir: Begin pruning Files.
hunt-dir: No Files found to prune.
hunt-dir: End auto prune.
```

```
hunt-dir: Start Restore Job RestoreFilesHunt.2003-04-17_13.21.44
hunt-sd: Forward spacing to file 1.
hunt-dir: Bacula 1.30 (14Apr03): 17-Apr-2003 13:54
JobId:                101
Job:                  RestoreFilesHunt.2003-04-17_13.21.44
Client:               sauvegarde-fd
Start time:           17-Apr-2003 13:21
End time:             17-Apr-2003 13:54
Files Restored:       1
Bytes Restored:        10,056,130,560
Rate:                 5073.7 KB/s
FD termination status: OK
Termination:          Restore OK
```

```
hunt-dir: Begin pruning Jobs.
hunt-dir: No Jobs found to prune.
hunt-dir: Begin pruning Files.
hunt-dir: No Files found to prune.
hunt-dir: End auto prune.
```

Restoring to a Running System

If for some reason you want to do a Full restore to a system that has a working kernel, you will need to take care not to overwrite the following files:

```
/etc/grub.conf
/etc/X11/Conf
/etc/fstab
/etc/mtab
/lib/modules
/usr/modules
```

/usr/X11R6
/etc/modules.conf

Additional Resources

Many thanks to Charles Curley who wrote [Linux Complete Backup and Recovery HOWTO](#) for the [The Linux Documentation Project](#). This is an excellent document on how to do Bare Metal Recovery on Linux systems, and it was this document that made me realize that Bacula could do the same thing.

You can find quite a few additional resources, both commercial and free at [Storage Mountain](#), formerly known as Backup Central.

And finally, the O'Reilly book, "Unix Backup Recovery" by W. Curtis Preston covers virtually every backup and recovery topic including bare metal recovery for a large range of Unix systems.



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Disaster Recovery Using Bacula



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Using Bacula to Improve Computer
Security

Using Bacula to Encrypt Communications to Clients

At the current time, Bacula does not have built-in communications encryption. However, without too much effort, it is possible to encrypt the communications between any of the daemons. This chapter will show you how to use **stunnel** to encrypt communications to your client programs. We assume the Director and the Storage daemon are running on one machine that will be called **server** and the Client or File daemon is running on a different machine called **client**. Although the details may be slightly different, the same principles apply whether you are encrypting between Unix, Linux, or Win32 machines. This example was developed between two Linux machines running stunnel version 4.04-4 on a Red Hat Enterprise 3.0 system.

Communications Ports Used

First, you must know that with the standard Bacula configuration, the Director will contact the File daemon on port 9102. The File daemon then contacts the Storage daemon using the address and port parameters supplied by the Director. The standard port used will be 9103. This in the typical server/client view of the world, the File daemon is a server to the Director (i.e. listens for the Director to contact it), and the Storage daemon is a server to the File daemon.

Encryption

The encryption is accomplished between the Director and the File daemon by using an stunnel on the Director's machine (server) to encrypt the data and to contact a stunnel on the File daemon's machine (client), which decrypts the data and passes it to the client.

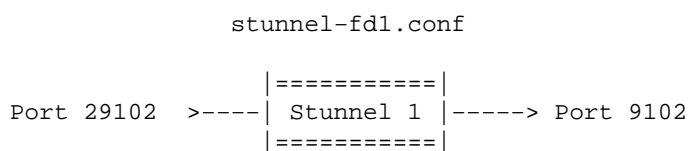
Between the File daemon and the Storage daemon, we use an stunnel on the File daemon's machine to encrypt the data and another stunnel on the Storage daemon's machine to decrypt the data.

As a consequence, there are actually four copies of stunnel running, two on server and two on client. This may sound a bit complicated, but it really isn't. To accomplish this, we will need to construct four separate conf files for stunnel, and we will need to make some minor modifications to the Director's conf file. None of the other conf files need to be changed.

A Picture

Since pictures usually help a lot, here is an overview of what we will be doing. Don't worry about all the details of the port numbers and such for the moment.

File daemon (client):



```

Port 9103  >-----|=====|-----> server:29103
                  | Stunnel 2 |
                  |=====|

```

Director (server):

stunnel-dir.conf

```

Port 29102  >-----|=====|-----> client:29102
                  | Stunnel 3 |
                  |=====|

```

stunnel-sd.conf

```

Port 29103  >-----|=====|-----> 9103
                  | Stunnel 4 |
                  |=====|

```

Certificates

In order for stunnel to function as a server, which it does in our diagram for Stunnel 1 and Stunnel 4, you must have a certificate and the key. It is possible to keep the two in separate files, but normally, you keep them in one single .pem file. You may create this certificate yourself in which case, it will be self-signed, or you may have it signed by a CA.

If you want your clients to verify that the server is in fact valid (Stunnel 2 and Stunnel 3), you will need to have the server certificates signed by a CA (Certificate Authority), and you will need to have the CA's public certificate (contains the CA's public key).

Having a CA signed certificate is **highly** recommended if you are using your client across the Internet, otherwise you are exposed to the man in the middle attack and hence loss of your data.

See below for how to create a self-signed certificate.

Securing the Data Channel

To simplify things a bit, let's for the moment consider only the data channel. That is the connection between the File daemon and the Storage daemon, which takes place on port 9103. In fact, in a minimalist solution, this is the only connection needs to be encrypted, because it is the one that transports your data. The connection between the Director and the File daemon is simply a control channel used to start the job and get the job status.

Normally the File daemon will contact the Storage daemon on port 9103 (supplied by the Director), so we need a stunnel that listens on port 9103 on the File daemon's machine, encrypts the data and sends it to the Storage daemon. This is depicted by Stunnel 2 above. Note that this stunnel is listening on port 9103 and sending to server:29103. We use port 29103 on the server because if we sent the data to port 9103, it would go directly to the Storage daemon, which doesn't understand encrypted data. On the server machine, we run Stunnel 4, which listens on port 29103, decrypts the data and sends it to the Storage daemon, which is listening on port 9103.

Modification of bacula-dir.conf for the Data Channel

The Storage resource of the bacula-dir.conf normally looks something like the following:

```
Storage {
    Name = File
    Address = server
    SDPort = 9103
    Password = storage_password
    Device = File
    Media Type = File
}
```

Notice that this is running on the server machine, and it points the File daemon back to server:9103, which is where our Storage daemon is listening. We modify this to be:

```
Storage {
    Name = File
    Address = localhost
    SDPort = 9103
    Password = storage_password
    Device = File
    Media Type = File
}
```

This causes the File daemon to send the data to the stunnel running on localhost (the client machine). We could have used client as the address as well.

config Files for stunnel to Encrypt the Data Channel

In the diagram above, we see above Stunnel 2 that we stunnel-fd2.conf on client. A pretty much minimal config file would look like the following:

```
client = yes
[29103]
accept = localhost:9103
connect = server:29103
```

The above config file does encrypt the data but it does not require a certificate, so it is subject to the man in the middle attack. The file I actually used, stunnel-fd2.conf, looked like this:

```
#
# Stunnel conf for Bacula client -> SD
#

pid = /home/kern/bacula/bin/working/stunnel.pid

#
# A cert is not mandatory here. If verify=2, a
# cert signed by a CA must be specified, and
# either CAfile or CPath must point to the CA's
# cert
#
cert = /home/kern/stunnel/stunnel.pem
CAfile = /home/kern/ssl/cacert.pem
verify = 2
```

```
client = yes

# debug = 7
# foreground = yes

[29103]
accept = localhost:9103
connect = server:29103
```

You will notice that I specified a pid file location because I ran stunnel under my own userid so I could not use the default, which requires root permission. I also specified a certificate that I have as well as verify level 2 so that the certificate is required and verified, and I must supply the location of the CA (Certificate Authority) certificate so that the stunnel certificate can be verified. Finally, you will see that there are two lines commented out, which when enabled, produce a lot of nice debug info in the command window.

If you do not have a signed certificate (stunnel.pem), you need to delete the cert, CAfile, and verify lines.

Note that the stunnel.pem, is actually a private key and a certificate in a single file. These two can be kept and specified individually, but keeping them in one file is more convenient.

The config file, stunnel-sd.conf, needed for Stunnel 4 on the server machine is:

```
#
# Bacula stunnel conf for Storage daemon
#

pid = /home/kern/bacula/bin/working/stunnel.pid

#
# A cert is mandatory here, it may be self signed
# If it is self signed, the client may not use
# verify
#
cert = /home/kern/stunnel/stunnel.pem

client = no

# debug = 7
# foreground = yes

[29103]
accept = 29103
connect = 9103
```

Starting and Testing the Data Encryption

It will most likely be the simplest to implement the Data Channel encryption in the following order:

- Setup and run Bacula backing up some data on your client machine without encryption.
- Stop Bacula.
- Modify the Storage resource in the Director's conf file.

- Start Bacula
- Start stunnel on the server with:

```
stunnel stunnel-sd.conf
```

- Start stunnel on the client with:

```
stunnel stunnel-fd2.conf
```

- Run a job.
- If it doesn't work, turn debug on in both stunnel conf files, restart the stunnels, rerun the job, repeat until it works.

Encrypting the Control Channel

The Job control channel is between the Director and the File daemon, and as mentioned above, it is not really necessary to encrypt, but it is good practice to encrypt it as well. The two stunnels that are used in this case will be Stunnel 1 and Stunnel 3 in the diagram above. Stunnel 3 on the server might normally listen on port 9102, but if you have a local File daemon, this will not work, so we make it listen on port 29102. It then sends the data to client:29102. Again we use port 29102 so that the stunnel on the client machine can decrypt the data before passing it on to port 9102 where the File daemon is listening.

Modification of bacula-dir.conf for the Control Channel

We need to modify the standard Client resource, which would normally look something like:

```
Client {
  Name = client-fd
  Address = client
  FDPort = 9102
  Catalog = BackupDB
  Password = "xxx"
}
```

to be:

```
Client {
  Name = client-fd
  Address = localhost
  FDPort = 29102
  Catalog = BackupDB
  Password = "xxx"
}
```

This will cause the Director to send the control information to localhost:29102 instead of directly to the client.

config Files for stunnel to Encrypt the Control Channel

The stunnel config file, `stunnel-dir.conf`, for the Director's machine would look like the following:

```
#
# Bacula stunnel conf for the Directory to contact a client
#

pid = /home/kern/bacula/bin/working/stunnel.pid

#
# A cert is not mandatory here. If verify=2, a
# cert signed by a CA must be specified, and
# either CAfile or CApath must point to the CA's
# cert
#
cert    = /home/kern/stunnel/stunnel.pem
CAfile  = /home/kern/ssl/cacert.pem
verify  = 2

client  = yes

# debug = 7
# foreground = yes

[29102]
accept  = localhost:29102
connect = client:29102
```

and the config file, `stunnel-fd1.conf`, needed to run stunnel on the Client would be:

```
#
# Bacula stunnel conf for the Directory to contact a client
#

pid = /home/kern/bacula/bin/working/stunnel.pid

#
# A cert is not mandatory here. If verify=2, a
# cert signed by a CA must be specified, and
# either CAfile or CApath must point to the CA's
# cert
#
cert    = /home/kern/stunnel/stunnel.pem
CAfile  = /home/kern/ssl/cacert.pem
verify  = 2

client  = yes

# debug = 7
# foreground = yes

[29102]
accept  = localhost:29102
connect = client:29102
```

Starting and Testing the Control Channel

It will most likely be the simplest to implement the Control Channel encryption in the following order:

- Stop Bacula.
- Modify the Client resource in the Director's conf file.
- Start Bacula
- Start stunnel on the server with:

```
stunnel stunnel-dir.conf
```

- Start stunnel on the client with:

```
stunnel stunnel-fdl.conf
```

- Run a job.
- If it doesn't work, turn debug on in both stunnel conf files, restart the stunnels, rerun the job, repeat until it works.

Using stunnel to Encrypt to a Second Client

On the client machine, you can just duplicate the setup that you have on the first client file for file and it should work fine.

In the bacula-dir.conf file, you will want to create a second client pretty much identical to how you did for the first one, but the port number must be unique. We previously used:

```
Client {
  Name = client-fd
  Address = localhost
  FdPort = 29102
  Catalog = BackupDB
  Password = "xxx"
}
```

so for the second client, we will, of course, have a different name, and we will also need a different port. Remember that we used port 29103 for the Storage daemon, so for the second client, we can use port 29104, and the Client resource would look like:

```
Client {
  Name = client2-fd
  Address = localhost
  FdPort = 29104
  Catalog = BackupDB
  Password = "yyy"
}
```

Now, fortunately, we do not need a third stunnel to on the Director's machine, we can just add the new port to the config file, stunnel-dir.conf, to make:

Bacula Storage Management System

```
#
# Bacula stunnel conf for the Directory to contact a client
#

pid = /home/kern/bacula/bin/working/stunnel.pid

#
# A cert is not mandatory here. If verify=2, a
# cert signed by a CA must be specified, and
# either CAfile or CApath must point to the CA's
# cert
#
cert = /home/kern/stunnel/stunnel.pem
CAfile = /home/kern/ssl/cacert.pem
verify = 2

client = yes

# debug = 7
# foreground = yes

[29102]
accept = localhost:29102
connect = client:29102

[29104]
accept = localhost:29102
connect = client2:29102
```

There are no changes necessary to the Storage daemon or the other stunnel so that this new client can talk to our Storage daemon.

Creating a Self-signed Certificate

You may create a self-signed certificate for use with stunnel that will permit you to make it function, but will now allow certificate validation. The .pem file containing both the certificate and the key can be made with the following, which I put in a file named **makepem**:

```
#!/bin/sh
#
# Simple shell script to make a .pem file that can be used
# with stunnel and Bacula
#
OPENSSL=openssl
umask 77
PEM1=`/bin/mktemp openssl.XXXXXX`
PEM2=`/bin/mktemp openssl.XXXXXX`
${OPENSSL} req -newkey rsa:1024 -keyout $PEM1 -nodes \
    -x509 -days 365 -out $PEM2
cat $PEM1 > stunnel.pem
echo "" >>stunnel.pem
cat $PEM2 >>stunnel.pem
rm $PEM1 $PEM2
```

The above script will ask you a number of questions. You may simply answer each of them by entering a return, or if you wish you may enter your own data.

Getting a CA Signed Certificate

The process of getting a certificate that is signed by a CA is quite a bit more complicated. You can purchase one from quite a number of PKI vendors, but that is not at all necessary for use with Bacula. To get a CA signed certificate, you will either need to find a friend that has setup his own CA or to become a CA yourself, and thus you can sign all your own certificates. The book *OpenSSL* by John Viega, Matt Mesier Pravar Chandra from O'Reilly explains how to do it, or you can read the documentation provided in the Open-source PKI Book project at Source Forge: <http://ospkibook.sourceforge.net/docs/OSPki-2.4.7/OSPki-html/ospki-book.htm>. Note, this link may change.



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The Bootstrap File

Using Bacula to Improve Computer Security

Since Bacula maintains a catalog of files, their attributes, and either SHA1 or MD5 signatures, it can be an ideal tool for improving computer security. This is done by making a snapshot of your system files with a **Verify Job** and then checking the current state of your system against the snapshot, on a regular basis (e.g. nightly).

The first step is to set up a **Verify Job** and to run it with:

```
Level = InitCatalog
```

The **InitCatalog** level tells **Bacula** simply get the information on the specified files and to put it into the catalog. That is your database is initialized and no comparison is done. The **InitCatalog** is normally run one time manually.

Thereafter, you will run a **Verify Job** on a daily (or whatever) basis with:

```
Level = Catalog
```

The **Level = Catalog** level tells Bacula to compare the current state of the files on the Client to the last **InitCatalog** that is stored in the catalog and to report any differences. See the example below for the format of the output.

You decide what files you want to form your "snapshot" by specifying them in a **FileSet** resource, and normally, they will be system files that do not change, or that only certain features change.

Then you decide what attributes of each file you want compared by specifying comparison options on the **Include** statements that you use in the **FileSet** resource of your **Catalog Jobs**.

The Details

In the discussion that follows, we will make reference to the **Verify Configuration Example** that is included below in the **A Verify Configuration Example** section. You might want to look it over now to get an idea of what it does.

The main elements consist of adding a schedule, which will normally be run daily, or perhaps more often. This is provided by the **VerifyCycle** Schedule, which runs at 5:05 in the morning every day.

Then you must define a Job, much as is done below. We recommend that the Job name contain the name of your machine as well as the word **Verify** or **Check**. In our example, we named it **MatouVerify**. This will permit you to easily identify your job when running it from the Console.

You will notice that most records of the Job are quite standard, but that the **FileSet** resource contains **verify=pins1** option in addition to the standard **signature=SHA1** option. If you don't want SHA1 signature comparison, and we cannot imagine why not, you can drop the **signature=SHA1** and none will be computed nor stored in the catalog. Or alternatively, you can use **verify=pins5** and **signature=MD5**, which will use the MD5 hash algorithm. The MD5 hash computes faster than SHA1, but is cryptographically less secure.

The **verify=pins1** is ignored during the **InitCatalog** Job, but is used during the subsequent **Catalog** Jobs to specify what attributes of the files should be compared to those found in the catalog. **pins1** is a reasonable set to begin with, but you may want to look at the details these and other options. They can be found in the [FileSet Resource](#) section of this manual. Briefly, however, the **p** of the **pins1** tells Verify to compare the permissions bits, the **i** is to compare inodes, the **n** causes comparison of the number of links, the **s** compares the file size, and the **1** compares the SHA1 checksums (this requires the **signature=SHA1** option to have been set also).

You must also specify the **Client** and the **Catalog** resources for your Verify job, but you probably already have them created for your client and do not need to recreate them, they are included in the example below for completeness.

As mentioned above, you will need to have a **FileSet** resource for the Verify job, which will have the additional **verify=pins1** option. You will want to take some care in defining the list of files to be included in your **FileSet**. Basically, you will want to include all system (or other) files that should not change on your system. If you select files, such as log files or mail files, which are constantly changing, your automatic Verify job will be constantly finding differences. The objective in forming the FileSet is to choose all unchanging important system files. Then if any of those files has changed, you will be notified, and you can determine if it changed because you loaded a new package, or because someone has broken into your computer and modified your files. The example below shows a list of files that I use on my RedHat 7.3 system. Since I didn't spend a lot of time working on it, it probably is missing a few important files (if you find one, please send it to me). On the other hand, as long as I don't load any new packages, none of these files change during normal operation of the system.

Running the Verify

The first thing you will want to do is to run an **InitCatalog** level Verify Job. This will initialize the catalog to contain the file information that will later be used as a basis for comparisons with the actual file system, thus allowing you to detect any changes (and possible intrusions into your system).

The easiest way to run the **InitCatalog** is manually with the console program by simply entering **run**. You will be presented with a list of Jobs that can be run, and you will choose the one that corresponds to your Verify Job, **MatouVerify** in this example.

```
The defined Job resources are:
  1: MatouVerify
  2: kernsrestore
  3: Filetest
  4: kernsave
Select Job resource (1-4): 1
```

Next, the console program will show you the basic parameters of the Job and ask you:

```
Run Verify job
JobName:  MatouVerify
FileSet:  Verify Set
Level:    Catalog
Client:   MatouVerify
Storage:  DLTDrive
OK to run? (yes/mod/no): mod
```

Here, you want to respond **mod** to modify the parameters because the Level is by default set to **Catalog** and we want to run an **InitCatalog** Job. After responding **mod**, the console will ask:

```
Parameters to modify:
  1: Job
  2: Level
  3: FileSet
  4: Client
  5: Storage
Select parameter to modify (1-5): 2
```

you should select number 2 to modify the **Level**, and it will display:

```
Levels:
  1: Initialize Catalog
  2: Verify from Catalog
  3: Verify Volume
  4: Verify Volume Data
Select level (1-4): 1
```

Choose item 1, and you will see the final display:

```
Run Verify job
JobName:  MatouVerify
FileSet:  Verify Set
Level:    Initcatalog
Client:   MatouVerify
Storage:  DLTDDrive
OK to run? (yes/mod/no): yes
```

at which point you respond **yes**, and the Job will begin.

There after the Job will automatically start according to the schedule you have defined. If you wish to immediately verify it, you can simply run a Verify **Catalog** which will be the default. No differences should be found.

What To Do When Differences Are Found

If you have setup your messages correctly, you should be notified if there are any differences and exactly what they are. For example, below is the email received after doing an update of OpenSSH:

```
HeadMan: Start Verify JobId 83 Job=RufusVerify.2002-06-25.21:41:05
HeadMan: Verifying against Init JobId 70 run 2002-06-21 18:58:51
HeadMan: File: /etc/pam.d/sshd
HeadMan:      st_ino   differ. Cat: 4674b File: 46765
HeadMan: File: /etc/rc.d/init.d/sshd
HeadMan:      st_ino   differ. Cat: 56230 File: 56231
HeadMan: File: /etc/ssh/ssh_config
HeadMan:      st_ino   differ. Cat: 81317 File: 8131b
HeadMan:      st_size  differ. Cat: 1202 File: 1297
HeadMan:      SHA1 differs.
HeadMan: File: /etc/ssh/sshd_config
HeadMan:      st_ino   differ. Cat: 81398 File: 81325
HeadMan:      st_size  differ. Cat: 1182 File: 1579
HeadMan:      SHA1 differs.
```

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```
HeadMan: File: /etc/ssh/ssh_config.rpmnew
HeadMan:      st_ino   differ. Cat: 812dd File: 812b3
HeadMan:      st_size  differ. Cat: 1167 File: 1114
HeadMan:      SHA1 differs.
HeadMan: File: /etc/ssh/sshd_config.rpmnew
HeadMan:      st_ino   differ. Cat: 81397 File: 812dd
HeadMan:      st_size  differ. Cat: 2528 File: 2407
HeadMan:      SHA1 differs.
HeadMan: File: /etc/ssh/moduli
HeadMan:      st_ino   differ. Cat: 812b3 File: 812ab
HeadMan: File: /usr/bin/scp
HeadMan:      st_ino   differ. Cat: 5e07e File: 5e343
HeadMan:      st_size  differ. Cat: 26728 File: 26952
HeadMan:      SHA1 differs.
HeadMan: File: /usr/bin/ssh-keygen
HeadMan:      st_ino   differ. Cat: 5df1d File: 5e07e
HeadMan:      st_size  differ. Cat: 80488 File: 84648
HeadMan:      SHA1 differs.
HeadMan: File: /usr/bin/sftp
HeadMan:      st_ino   differ. Cat: 5e2e8 File: 5df1d
HeadMan:      st_size  differ. Cat: 46952 File: 46984
HeadMan:      SHA1 differs.
HeadMan: File: /usr/bin/slogin
HeadMan:      st_ino   differ. Cat: 5e359 File: 5e2e8
HeadMan: File: /usr/bin/ssh
HeadMan:      st_mode  differ. Cat: 89ed File: 81ed
HeadMan:      st_ino   differ. Cat: 5e35a File: 5e359
HeadMan:      st_size  differ. Cat: 219932 File: 234440
HeadMan:      SHA1 differs.
HeadMan: File: /usr/bin/ssh-add
HeadMan:      st_ino   differ. Cat: 5e35b File: 5e35a
HeadMan:      st_size  differ. Cat: 76328 File: 81448
HeadMan:      SHA1 differs.
HeadMan: File: /usr/bin/ssh-agent
HeadMan:      st_ino   differ. Cat: 5e35c File: 5e35b
HeadMan:      st_size  differ. Cat: 43208 File: 47368
HeadMan:      SHA1 differs.
HeadMan: File: /usr/bin/ssh-keyscan
HeadMan:      st_ino   differ. Cat: 5e35d File: 5e96a
HeadMan:      st_size  differ. Cat: 139272 File: 151560
HeadMan:      SHA1 differs.
HeadMan: 25-Jun-2002 21:41
JobId:      83
Job:        RufusVerify.2002-06-25.21:41:05
FileSet:    Verify Set
Verify Level: Catalog
Client:     RufusVerify
Start time: 25-Jun-2002 21:41
End time:   25-Jun-2002 21:41
Files Examined: 4,258
Termination: Verify Differences
```

At this point, it was obvious that these files were modified during installation of the RPMs. If you want to be super safe, you should run a **Verify Level=Catalog** immediately before installing new software to verify that there are no differences, then run a **Verify Level=InitCatalog** immediately after the installation.

To keep the above email from being sent every night when the Verify Job runs, we simply re-run the Verify Job setting the level to **InitCatalog** (as we did above in the very beginning). This will

re-establish the current state of the system as your new basis for future comparisons. Take care that you don't do an **InitCatalog** after someone has placed a Trojan horse on your system!

If you have included in your **FileSet** a file that is changed by the normal operation of your system, you will get false matches, and you will need to modify the **FileSet** to exclude that file (or not to Include it), and then re-run the **InitCatalog**.

The FileSet that is show below is what I use on my RedHat 7.3 system. With a bit more thought, you can probably add quite a number of additional files that should be monitored.

A Verify Configuration Example

```
Schedule {
    Name = "VerifyCycle"
    Run = Level=Catalog sun-sat at 5:05
}

Job {
    Name = "MatouVerify"
    Type = Verify
    Level = Catalog # default level
    Client = MatouVerify
    FileSet = "Verify Set"
    Messages = Standard
    Storage = DLTDDrive
    Pool = Default
    Schedule = "VerifyCycle"
}

#
# The list of files in this FileSet should be carefully
# chosen. This is a good starting point.
#
FileSet {
    Name = "Verify Set"
    Include = verify=pins1 signature=SHA1 {
        /boot
        /bin
        /sbin
        /usr/bin
        /lib
        /root/.ssh
        /home/kern/.ssh
        /var/named
        /etc/sysconfig
        /etc/ssh
        /etc/security
        /etc/exports
        /etc/rc.d/init.d
        /etc/sendmail.cf
        /etc/sysctl.conf
        /etc/services
        /etc/xinetd.d
        /etc/hosts.allow
        /etc/hosts.deny
        /etc/hosts
        /etc/modules.conf
        /etc/named.conf
        /etc/pam.d
```

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```
    /etc/resolv.conf
}
Exclude = { }
}

Client {
    Name = MatouVerify
    Address = lmatou
    Catalog = Bacula
    Password = ""
    File Retention = 80d           # 80 days
    Job Retention = 1y            # one year
    AutoPrune = yes               # Prune expired Jobs/Files
}

Catalog {
    Name = Bacula
    dbname = verify; user = bacula; password = ""
}
```



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Restoring Files with a Bootstrap File

Bacula® – RPM Packaging FAQ

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Answers

1. How do I build Bacula for platform xxx?

The bacula spec file contains defines to build for several platforms: RedHat 7.x (rh7), RedHat 8.0 (rh8), RedHat 9 (rh9), Fedora Core 1 (fc1), and Whitebox Enterprise Linux 3.0 (wb3). The package build is controlled by a define set at the beginning of the file. These defines basically just control the dependancy information that gets coded into the finished rpm package. So while you could technically build a package without defining a platform, or with an incorrect platform, and have it install and run it would not contain correct dependancy information for the rpm database.

The platform define may be edited in the spec file directly (by default all defines are set to 0 or "not set"). For example, to build the RedHat 7.x package find the line in the spec file which reads

```
%define rh7 0
```

and edit it to read

```
%define rh7 1
```

Alternately you may pass the define on the command line when calling rpmbuild:

```
rpmbuild -ba --define "build_rh7 1" bacula.spec  
rpmbuild --rebuild --define build_rh7 1" bacula-x.x.x-x.src.rpm
```

2. How do I control which database support gets built?

By default sqlite support will be compiled statically from the depkgs and the bacula-sqlite package will be produced. To get the MySQL package and support either set the

```
%define mysql 0
```

to

```
%define mysql 1
```

in the spec file directly or pass it to rpmbuild on the command line:

```
rpmbuild -ba --define "build_rh7 1" --define "build_mysql 1" bacula.spec
```

3. What other defines are used?

Two other building defines of note are the `depkgs_version` and `tomsrtbt` identifiers. These two defines are set with each release and must match the version of those sources that are being used to build the packages. You would not ordinarily need to edit these.

4. I'm getting errors about not having permission when I try to build the packages. Do I need to be root?

No, you do not need to be root and, in fact, it is better practice to build rpm packages as a non-root user. Bacula packages are designed to be built by a regular user but you must make a few changes on your system to do this. If you are building on your own system then the simplest method is to add write permissions for all to the build directory (`/usr/src/redhat/`). To accomplish this execute the following command as root:

```
chmod -R 777 /usr/src/redhat
```

If you are working on a shared system where you can not use the method above then you need to recreate the `/usr/src/redhat` directory tree with all of it's subdirectories inside your home directory. Then create a file named `.rpmmacros` in your home directory (or edit the file if it already exists) and add the following line:

```
%_topdir /home/myuser/redhat
```

5. I'm building my own rpms but on all platforms and compiles I get an unresolved dependency for something called `/usr/afsws/bin/pagsh`.

This is a shell from the OpenAFS (Andrew File System). If you are seeing this then you chose to include the `docs/examples` directory in your package. One of the example scripts in this directory is a `pagsh` script. `Rpmbuild`, when scanning for dependencies, looks at the shebang line of all packaged scripts in addition to checking shared libraries. To avoid this do not package the `examples` directory.



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Installing and Configuring MySQL

The Bootstrap File

The information in this chapter is provided so that you may either create your own bootstrap files, or so that you can edit a bootstrap file produced by **Bacula**. However, normally the bootstrap file will be automatically created for you during the [restore](#) command in the Console program, or by using a [Write Bootstrap](#) record in your Backup Jobs, and thus you will never need to know the details of this file.

The **bootstrap** file contains ASCII information that permits precise specification of what files should be restored. It is a relatively compact form of specifying the information, is human readable, and can be edited with any text editor.

File Format

The general format of a **bootstrap** file is:

<keyword>= <value>

Where each **keyword** and the **value** specify which files to restore. More precisely the **keyword** and their **values** serve to limit which files will be restored and thus act as a filter. The absence of a keyword means that all records will be accepted.

Blank lines and lines beginning with a pound sign (#) in the bootstrap file are ignored.

There are keywords which permit filtering by Volume, Client, Job, FileIndex, Session Id, Session Time, ...

The more keywords that are specified, the more selective the specification of which files to restore will be. In fact, each keyword is **ANDed** with other keywords that may be present.

For example,

```
Volume = Test-001
VolSessionId = 1
VolSessionTime = 108927638
```

directs the Storage daemon (or the **bextract** program) to restore only those files on Volume Test-001 **AND** having VolumeSessionId equal to one **AND** having VolumeSession time equal to 108927638.

The full set of permitted keywords presented in the order in which they are matched against the Volume records are:

Volume

The value field specifies what Volume the following commands apply to. Each Volume specification becomes the current Volume, to which all the following commands apply until a new current Volume (if any) is specified. If the Volume name contains spaces, it should be enclosed in quotes.

Count

The value is the total number of files that will be restored for this Volume. This allows the Storage daemon to know when to stop reading the Volume.

VolFile

The value is a file number, a list of file numbers, or a range of file numbers numbers to match on the current Volume. The file number represents the physical file on the Volume where the data is stored. For a tape volume, this record is used to position to the correct starting file, and once the tape is past the last specified file, reading will stop.

VolBlock

The value is a block number, a list of block numbers, or a range of block numbers numbers to match on the current Volume. The block number represents the physical block on the Volume where the data is stored. This record is currently not used.

VolSessionTime

The value specifies a Volume Session Time to be matched from the current volume.

VolSessionId

The value specifies a VolSessionId, a list of volume session ids, or a range of volume session ids to be matched from the current Volume. Each VolSessionId and VolSessionTime pair corresponds to a unique Job that is backed up on the Volume.

**JobId*

The value specifies a JobId, list of JobIds, or range of JobIds to be selected from the current Volume. Note, the JobId may not be unique if you have multiple Directors, or if you have reinitialized your database. The JobId filter works only if you do not run multiple simultaneous jobs.

**Job*

The value specifies a Job name or list of Job names to be matched on the current Volume. The Job corresponds to a unique VolSessionId and VolSessionTime pair. However, the Job is perhaps a bit more readable by humans. Standard regular expressions (wildcards) may be used to match Job names. The Job filter works only if you do not run multiple simultaneous jobs.

**Client*

The value specifies a Client name or list of Clients to will be matched on the current Volume. Standard regular expressions (wildcards) may be used to match Client names. The Client filter works only if you do not run multiple simultaneous jobs.

FileIndex

The value specifies a FileIndex, list of FileIndexes, or range of FileIndexes to be selected from the current Volume. Each file (data) stored on a Volume within a Session has a unique FileIndex. For each Session, the first file written is assigned FileIndex equal to one and incremented for each file backed up.

This for a given Volume, the triple VolSessionId, VolSessionTime, and FileIndex uniquely identifies a file stored on the Volume. Multiple copies of the same file may be stored on the same Volume, but for each file, the triple VolSessionId, VolSessionTime, and FileIndex will be unique. This triple is stored in the Catalog database for each file.

Slot

The value specifies the autochanger slot. There may be only a single **Slot** specification for each Volume.

Stream

The value specifies a Stream, a list of Streams, or a range of Streams to be selected from the current Volume. Unless you really know what you are doing (the internals of **Bacula**, you should avoid this specification.

**JobType*

Not yet implemented.

**JobLevel*

Not yet implemented.

The **Volume** record is a bit special in that it must be the first record. The other keyword records may appear in any order and any number following a Volume record.

Multiple Volume records may be specified in the same bootstrap file, but each one starts a new set of filter criteria for the Volume.

In processing the bootstrap file within the current Volume, each filter specified by a keyword is **ANDed** with the next. Thus,

```
Volume = Test-01
Client = "My machine"
FileIndex = 1
```

will match records on Volume **Test-01 AND** Client records for **My machine AND** FileIndex equal to **one**.

Multiple occurrences of the same record are **ORed** together. Thus,

```
Volume = Test-01
Client = "My machine"
Client = "Backup machine"
FileIndex = 1
```

will match records on Volume **Test-01 AND** (Client records for **My machine OR Backup machine**) **AND** FileIndex equal to **one**.

For integer values, you may supply a range or a list, and for all other values except Volumes, you may specify a list. A list is equivalent to multiple records of the same keyword. For example,

```
Volume = Test-01
Client = "My machine", "Backup machine"
FileIndex = 1-20, 35
```

will match records on Volume **Test-01 AND** (Client records for **My machine OR Backup machine**) **AND** (FileIndex 1 **OR** 2 **OR** 3 ... **OR** 20 **OR** 35).

As previously mentioned above, there may be multiple Volume records in the same bootstrap file. Each new Volume definition begins a new set of filter conditions that apply to that Volume and will be **ORed** with any other Volume definitions.

As an example, suppose we query for the current set of tapes to restore all files on Client **Rufus** using the **query** command in the console program:

```
Using default Catalog name=MySQL DB=bacula
*query
Available queries:
  1: List Job totals:
  2: List where a file is saved:
  3: List where the most recent copies of a file are saved:
  4: List total files/bytes by Job:
  5: List total files/bytes by Volume:
```

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6: List last 10 Full Backups for a Client:
7: List Volumes used by selected JobId:
8: List Volumes to Restore All Files:
Choose a query (1-8): 8

Enter Client Name: Rufus

JobId	StartTime	VolumeName	StartFile	VolSesId	VolSesTime
154	2002-05-30 12:08	test-02	0	1	1022753312
202	2002-06-15 10:16	test-02	0	2	1024128917
203	2002-06-15 11:12	test-02	3	1	1024132350
204	2002-06-18 08:11	test-02	4	1	1024380678

The output shows us that there are four Jobs that must be restored. The first one is a Full backup, and the following three are all Incremental backups.

The following bootstrap file will restore those files:

```
Volume=test-02
VolSessionId=1
VolSessionTime=1022753312
Volume=test-02
VolSessionId=2
VolSessionTime=1024128917
Volume=test-02
VolSessionId=1
VolSessionTime=1024132350
Volume=test-02
VolSessionId=1
VolSessionTime=1024380678
```

As a final example, assume that the initial Full save spanned two Volumes. The output from **query** might look like:

JobId	StartTime	VolumeName	StartFile	VolSesId	VolSesTime
242	2002-06-25 16:50	File0003	0	1	1025016612
242	2002-06-25 16:50	File0004	0	1	1025016612
243	2002-06-25 16:52	File0005	0	2	1025016612
246	2002-06-25 19:19	File0006	0	2	1025025494

and the following bootstrap file would restore those files:

```
Volume=File0003
VolSessionId=1
VolSessionTime=1025016612
Volume=File0004
VolSessionId=1
VolSessionTime=1025016612
Volume=File0005
VolSessionId=2
VolSessionTime=1025016612
Volume=File0006
VolSessionId=2
```

VolSessionTime=1025025494

Automatic Generation of Bootstrap Files

One thing that is probably worth knowing: the bootstrap files that are generated automatically at the end of the job are not as optimized as those generated by the restore command. This is because the ones created at the end of the file, contain all files written to the Volume for that job. As a consequence, all the files saved to an Incremental or Differential job will be restored first by the Full save, then by any Incremental or Differential saves.

When the bootstrap file is generated for the restore command, only one copy (the most recent) of each file is restored.

So if you have spare cycles on your machine, you could optimize the bootstrap files by doing the following:

```
./console
restore client=xxx select all
no
quit

Backup bootstrap file.
```

The above will not work if you have multiple FileSets because that will be an extra prompt. However, the **restore client=xxx select all** builds the in-memory tree, selecting everything and creates the bootstrap file.

The **no** answers the **Do you want to run this (yes/mod/no)** question.

A Final Example

If you want to extract or copy a single Job, you can do it by selecting by JobId (code not tested) or better yet, if you know the VolSessionTime and the VolSessionId (printed on Job report and in Catalog), specifying this is by far the best. Using the VolSessionTime and VolSessionId is the way Bacula does restores. A bsr file might look like the following:

```
Volume="Vol1001"
VolSessionId=10
VolSessionTime=1080847820
```

If you know how many files are backed up (on the job report), you can enormously speed up the selection by adding (let's assume there are 157 files):

```
FileIndex=1-157
Count=157
```

Finally, if you know the File number where the Job starts, you can also cause bcopy to forward space to the right file without reading every record:

```
VolFile=20
```

There is nothing magic or complicated about a BSR file. Parsing it and properly applying it within Bacula **is** magic, but you don't need to worry about that.

If you want to see a **real** bsr file, simply fire up the **restore** command in the console program, select something, then answer no when it prompts to run the job. Then look at the file **restore.bsr** in your working directory.



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Installing and Configuring PostgreSQL

Installing and Configuring MySQL

Installing and Configuring MySQL -- Phase I

If you use the `./configure --with-mysql=mysql-directory` statement for configuring **Bacula**, you will need MySQL version 3.23.33 or later installed in the **mysql-directory** (we are currently using 3.23.56). If MySQL is installed in the standard system location, you need only enter `--with-mysql` since the configure program will search all the standard locations. If you install MySQL in your home directory or some other non-standard directory, you will need to provide the full path to it.

Installing and Configuring MySQL is not difficult but can be confusing the first time. As a consequence, below, we list the steps that we used to install it on our machines. Please note that our configuration leaves MySQL without any user passwords. This may be an undesirable situation if you have other users on your system.

Please note that as of Bacula version 1.31, the thread safe version of the MySQL client library is used, and hence you must add the `--enable-thread-safe-client` option to the `./configure` as shown below:

1. Download MySQL source code from www.mysql.com/downloads

2. Detar it with something like:

```
tar xvfz mysql-filename
```

Note, the above command requires GNU tar. If you do not have GNU tar, a command such as:

```
zcat mysql-filename | tar xvf -
```

will probably accomplish the same thing.

3. `cd mysql-source-directory`

where you replace **mysql-source-directory** with the directory name where you put the MySQL source code.

4. `./configure --enable-thread-safe-client --prefix=mysql-directory`

where you replace **mysql-directory** with the directory name where you want to install mysql. Normally for system wide use this is `/usr/local/mysql`. In my case, I use `~kern/mysql`.

5. `make`

This takes a bit of time.

6. `make install`

This will put all the necessary binaries, libraries and support files into the **mysql-directory** that you specified above.

7. ./scripts/mysql_install_db

This will create the necessary MySQL databases for controlling user access. Note, this script can also be found in the **bin** directory in the installation directory

The MySQL client library **mysqlclient** requires the gzip compression library **libz.a** or **libz.so**. If you are using rpm packages, these libraries are in the **libz-devel** package. On Debian systems, you will need to load the **zlib1g-dev** package. If you are not using rpms or debs, you will need to find the appropriate package for your system.

At this point, you should return to completing the installation of **Bacula**. Later after Bacula is installed, come back to this chapter to complete the installation. Please note, the installation files used in the second phase of the MySQL installation are created during the Bacula Installation.

Installing and Configuring MySQL -- Phase II

At this point, you should have built and installed MySQL, or already have a running MySQL, and you should have configured, built and installed **Bacula**. If not, please complete these items before proceeding.

Please note that the **./configure** used to build **Bacula** will need to include **--with-mysql=mysql-directory**, where **mysql-directory** is the directory name that you specified on the **./configure** command for configuring MySQL. This is needed so that Bacula can find the necessary include headers and library files for interfacing to MySQL.

Bacula will install scripts for manipulating the database (create, delete, make tables etc) into the main installation directory. These files will be of the form ***_bacula_*** (e.g. **create_bacula_database**). These files are also available in the **<bacula-src>/src/cats** directory after running **./configure**. If you inspect **create_bacula_database**, you will see that it calls **create_mysql_database**. The ***_bacula_*** files are provided for convenience. It doesn't matter what database you have chosen; **create_bacula_database** will always create your database.

Now you will create the Bacula MySQL database and the tables that Bacula uses.

1. Start **mysql**. You might want to use the **startmysql** script provided in the Bacula release.
2. **cd <install-directory>**

This directory contains the Bacula catalog interface routines.

3. ./grant_mysql_privileges

This script creates unrestricted access rights for **kern**, **kelvin**, and **bacula**. You may want to modify it to suit your situation. Please note that none of these userids including root are password protected.

4. ./create_mysql_database

This script creates the MySQL **bacula** database. The databases you create as well as the access databases will be located in `<install-dir>/var/` in a subdirectory with the name of the database, where `<install-dir>` is the directory name that you specified on the `--prefix` option. This can be important to know if you want to make a special backup of the Bacula database or to check its size.

5. `./make_mysql_tables`

This script creates the MySQL tables used by **Bacula**.

Each of the three scripts (`grant_mysql_privileges`, `create_mysql_database` and `make_mysql_tables`) allows the addition of a command line argument. This can be useful for specifying the user and or password. For example, you might need to add `-u root` to the command line to have sufficient privilege to create the Bacula tables.

To take a closer look at the access privileges that you have setup with the above, you can do:

```
mysql-directory/bin/mysql -u root mysql  
  
select * from user;
```

Re-initializing the Catalog Database

After you have done some initial testing with **Bacula**, you will probably want to re-initialize the catalog database and throw away all the test Jobs that you ran. To do so, you can do the following:

```
cd <install-directory>  
./drop_mysql_tables  
./make_mysql_tables
```

Please note that all information in the database will be lost and you will be starting from scratch. If you have written on any Volumes, you must write an end of file mark on the volume so that Bacula can reuse it. Do so with:

```
(stop Bacula or unmount the drive)  
mt -f /dev/nst0 rewind  
mt -f /dev/nst0 wEOF
```

Where you should replace `/dev/nst0` with the appropriate tape drive device name for your machine.

Linking Bacula with MySQL

After configuring Bacula with

```
./configure --enable-thread-safe-client --prefix=<mysql-directory>
```

where `<mysql-directory>` is in my case `/home/kern/mysql`, you may have to configure the loader so that it can find the MySQL shared libraries. If you have previously followed this procedure and later add the `--enable-thread-safe-client` options, you will need to rerun the

ldconfig program shown below. If you put MySQL in a standard place such as **/usr/lib** or **/usr/local/lib** this will not be necessary, but in my case it is. The description that follows is Linux specific. For other operating systems, please consult your manuals on how to do the same thing:

First edit: **/etc/ld.so.conf** and add a new line to the end of the file with the name of the **mysql-directory**. In my case, it is:

```
/home/kern/mysql/lib/mysql
```

then rebuild the loader's cache with:

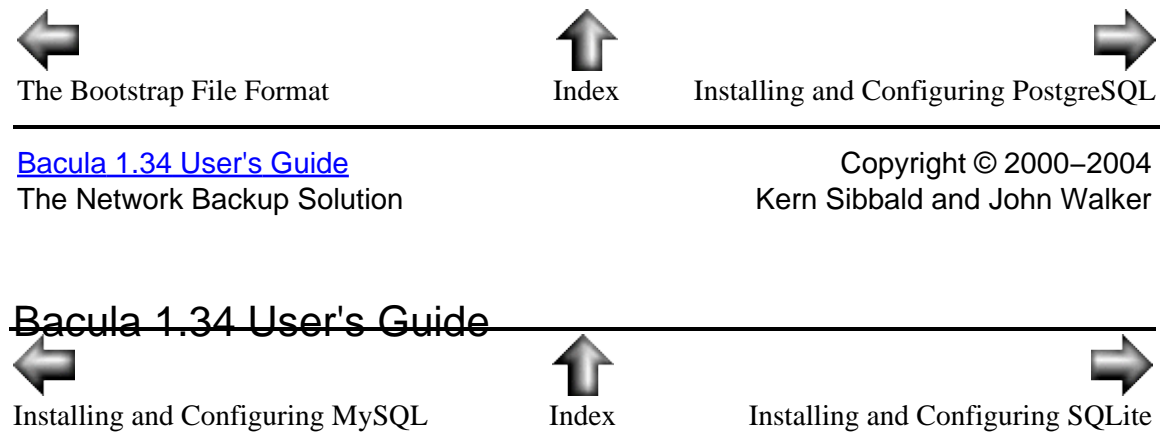
```
/sbin/ldconfig
```

If you upgrade to a new version of **MySQL**, the shared library names will probably changes, and you must re-run the **/sbin/ldconfig** command so that the runtime loader can find them.

Alternatively, your system may have a loader environment variable that can be set. For example, on a Solaris system where I do not have root permission, I use:

```
LD_LIBRARY_PATH=/home/kern/mysql/lib/mysql
```

Finally, if you have encryption enabled in MySQL, you may need to explicitly edit the Makefile in several of the directories to add **-lssl -lcrypto** to the link.



Installing and Configuring PostgreSQL

Installing and Configuring PostgreSQL -- Phase I

If you use the `./configure --with-postgresql=PostgreSQL-Directory` statement for configuring **Bacula**, you will need PostgreSQL version 7 or later installed (we are currently using 7.3.3, but earlier and later versions should work). If PostgreSQL is installed in the standard system location, you need only enter `--with-postgresql` since the configure program will search all the standard locations. If you install PostgreSQL in your home directory or some other non-standard directory, you will need to provide the full path with the `--with-postgresql` option.

Installing and configuring PostgreSQL is not difficult but can be confusing the first time. If you prefer, you may want to use a package provided by your chosen operating system. Binary packages are available on most PostgreSQL mirrors.

If you prefer to install from source, we recommend following the instructions found in the [PostgreSQL documentation](#).

If you are using FreeBSD, [this FreeBSD Diary article](#) will be useful. Even if you are not using FreeBSD, the article will contain useful configuration and setup information.

After installing PostgreSQL, you should return to completing the installation of **Bacula**. Later, after Bacula is installed, come back to this chapter to complete the installation. Please note, the installation files used in the second phase of the PostgreSQL installation are created during the Bacula Installation.

Installing and Configuring PostgreSQL -- Phase II

At this point, you should have built and installed PostgreSQL, or already have a running PostgreSQL, and you should have configured, built and installed **Bacula**. If not, please complete these items before proceeding.

Please note that the `./configure` used to build **Bacula** will need to include `--with-postgresql=PostgreSQL-directory`, where **PostgreSQL-directory** is the directory name that you specified on the `./configure` command for configuring PostgreSQL (if you didn't specify a directory or PostgreSQL is installed in a default location, you do not need to specify the directory). This is needed so that Bacula can find the necessary include headers and library files for interfacing to PostgreSQL.

Bacula will install scripts for manipulating the database (create, delete, make tables etc) into the main installation directory. These files will be of the form `*_bacula_*` (e.g. `create_bacula_database`). These files are also available in the `<bacula-src>/src/cats` directory after running `./configure`. If you inspect `create_bacula_database`, you will see that it calls `create_postgresql_database`. The `*_bacula_*` files are provided for convenience. It doesn't matter what database you have chosen; `create_bacula_database` will always create your database.

Now you will create the Bacula PostgreSQL database and the tables that Bacula uses. These instructions assume that you already have PostgreSQL running. You will need to perform these

steps as a user that is able to create new databases. This can be the PostgreSQL user (on most systems, this is the `pgsql` user).

1. `cd <install-directory>`

This directory contains the Bacula catalog interface routines.

2. `./create_bacula_database`

This script creates the PostgreSQL **bacula** database.

3. `./make_bacula_tables`

This script creates the PostgreSQL tables used by **Bacula**.

4. `./grant_bacula_privileges`

This script creates the database user **bacula** with restricted access rights. You may want to modify it to suit your situation. Please note that this database is not password protected.

Each of the three scripts (`create_bacula_database`, `make_bacula_tables`, and `grant_bacula_privileges`) allows the addition of a command line argument. This can be useful for specifying the user name. For example, you might need to add **-h hostname** to the command line to specify a remote database server.

To take a closer look at the access privileges that you have setup with the above, you can do:

```
PostgreSQL-directory/bin/psql --command \dp bacula
```

Re-initializing the Catalog Database

After you have done some initial testing with **Bacula**, you will probably want to re-initialize the catalog database and throw away all the test Jobs that you ran. To do so, you can do the following:

```
cd <install-directory>
./drop_bacula_tables
./make_bacula_tables
./grant_bacula_privileges
```

Please note that all information in the database will be lost and you will be starting from scratch. If you have written on any Volumes, you must write an end of file mark on the volume so that Bacula can reuse it. Do so with:

```
(stop Bacula or unmount the drive)
mt -f /dev/nst0 rewind
mt -f /dev/nst0 weof
```

Where you should replace **/dev/nst0** with the appropriate tape drive device name for your machine.

Credits

Many thanks to Dan Languille for writing the PostgreSQL driver. This will surely become the most popular database that Bacula supports.



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Internal Bacula Database

Installing and Configuring SQLite

Installing and Configuring SQLite -- Phase I

If you use the `./configure --with-sqlite` statement for configuring **Bacula**, you will need SQLite version 2.2.3 or later installed. Our standard location (for the moment) for SQLite is in the dependency package **depkgs/sqlite-2.2.3**. Please note that the version will be updated as new versions are available and tested.

Installing and Configuring is quite easy.

1. Download the Bacula dependency packages
2. Detar it with something like:

```
tar xvfz depkgs.tar.gz
```

Note, the above command requires GNU tar. If you do not have GNU tar, a command such as:

```
zcat depkgs.tar.gz | tar xvf -
```

will probably accomplish the same thing.

3. **cd depkgs**
4. **make sqlite**

At this point, you should return to completing the installation of **Bacula**.

Please note that the `./configure` used to build **Bacula** will need to include `--with-sqlite`.

Installing and Configuring SQLite -- Phase II

This phase is done **after** you have run the `./configure` command to configure **Bacula**.

Bacula will install scripts for manipulating the database (create, delete, make tables etc) into the main installation directory. These files will be of the form `*_bacula_*` (e.g. `create_bacula_database`). These files are also available in the `<bacula-src>/src/cats` directory after running `./configure`. If you inspect `create_bacula_database`, you will see that it calls `create_sqlite_database`. The `*_bacula_*` files are provided for convenience. It doesn't matter what database you have chosen; `create_bacula_database` will always create your database.

At this point, you can create the SQLite database and tables:

1. `cd <install-directory>`

This directory contains the Bacula catalog interface routines.

2. `./make_sqlite_tables`

This script creates the SQLite database as well as the tables used by **Bacula**. This script will be automatically setup by the `./configure` program to create a database named **bacula.db** in **Bacula's** working directory.

Linking Bacula with SQLite

If you have followed the above steps, this will all happen automatically and the SQLite libraries will be linked into **Bacula**.

Testing SQLite

As of this date (20 March 2002), we have much less "production" experience using SQLite than using MySQL. That said, we should note that SQLite has performed flawlessly for us in all our testing.

Re-initializing the Catalog Database

After you have done some initial testing with **Bacula**, you will probably want to re-initialize the catalog database and throw away all the test Jobs that you ran. To do so, you can do the following:

```
cd <install-directory>
./drop_sqlite_tables
./make_sqlite_tables
```

Please note that all information in the database will be lost and you will be starting from scratch. If you have written on any Volumes, you must write an end of file mark on the volume so that Bacula can reuse it. Do so with:

```
(stop Bacula or unmount the drive)
mt -f /dev/nst0 rewind
mt -f /dev/nst0 weof
```

Where you should replace **/dev/nst0** with the appropriate tape drive device name for your machine.



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Installing and Configuring SQLite



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The Bacula internal database is no longer supported, please do not use it.

Internal Bacula Database

Previously it was intended to be used primarily by Bacula developers for testing; although SQLite is also a good choice for this. We do not recommend its use in general.

This database is simplistic in that it consists entirely of Bacula's internal structures appended sequentially to a file. Consequently, it is in most cases inappropriate for sites with many clients or systems with large numbers of files, or long-term production environments.

Below, you will find a table comparing the features available with SQLite and MySQL and with the internal Bacula database. At the current time, you cannot dynamically switch from one to the other, but must rebuild the Bacula source code. If you wish to experiment with both, it is possible to build both versions of Bacula and install them into separate directories.

Feature	SQLite or MySQL	Bacula
Job Record	Yes	Yes
Media Record	Yes	Yes
FileName Record	Yes	No
File Record	Yes	No
FileSet Record	Yes	Yes
Pool Record	Yes	Yes
Client Record	Yes	Yes
JobMedia Record	Yes	Yes
List Job Records	Yes	Yes
List Media Records	Yes	Yes
List Pool Records	Yes	Yes
List JobMedia Records	Yes	Yes
Delete Pool Record	Yes	Yes
Delete Media Record	Yes	Yes
Update Pool Record	Yes	Yes

Bacula Storage Management System

Implement Verify	Yes	No
MD5 Signatures	Yes	No

In addition, since there is no SQL available, the Console commands: **sqlquery**, **query**, **retention**, and any other command that directly uses SQL are not available with the Internal database.



Installing and Configuring SQLite



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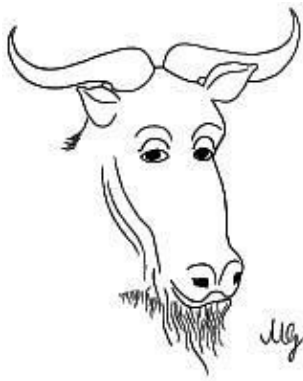


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```
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Gnomovision comes with ABSOLUTELY NO WARRANTY; for details
type `show w'. This is free software, and you are welcome
to redistribute it under certain conditions; type `show c'
for details.
```

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Bacula Storage Management System

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Bacula Licenses



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The Network Backup Solution

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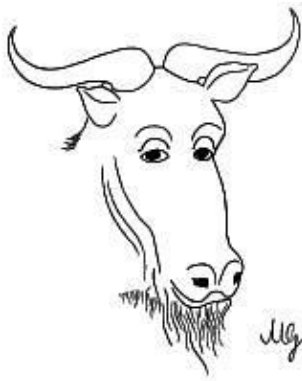


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FAQ

GNU Lesser General Public License



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Bacula Storage Management System

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Security Issues

Bacula Frequently Asked Questions

See [the bugs section](#) of this document for a list of known bugs and solutions.

*What is **Bacula**?*

Bacula is a network backup and restore program.

Does Bacula support Windows?

Yes, Bacula compiles and runs on Windows machines (Win98, WinMe, WinXP, WinNT, and Win2000). We provide a binary version of the Client (bacula-fd), but have not tested the Director nor the Storage daemon. Note, Win95 is no longer supported because it doesn't have the GetFileAttributesExA API call.

What language is Bacula written in?

It is written in C++, but it is mostly C code using only a limited set of the C++ extensions over C. Thus Bacula is completely compiled using the C++ compiler. There are several modules, including the Win32 interface that are written using the object oriented C++ features. Over time, we are slowly adding a larger subset of C++.

On what machines does Bacula run?

Bacula builds and executes on RedHat Linux (versions 7.1, 7.2, and 7.3), FreeBSD, Solaris, and Win32. On Win32 systems (Win95/98/Me/XP/NT/2000), only the client program (File daemon) has been tested.

Bacula has been my only backup tool for over three years backing up 5 machines nightly (3 Linux boxes running RedHat, a Win98 machine, and a WinNT machine).

Is Bacula stable?

Yes, it is remarkably stable, but remember, there are still a lot of unimplemented or partially implemented features. With a program of this size (70,000+ lines of C code not including the SQL programs) there are bound to be bugs. The current test environment (a twisted pair local network and a HP DLT backup tape) is rather ideal, so additional testing on other sites is necessary. The File daemon has never crashed — running months at a time with no intervention. The Storage daemon is remarkably stable with most of the problems arising during labeling or switching tapes. Storage daemon crashes are rare. The Director, given the multitude of functions it fulfills is also relatively stable. In a production environment, it rarely if ever crashes. Of the three daemons, the Director is the most prone to having problems. It frequently runs several months with no problems.

There are a number of reasons for this stability. 1. The program was largely written by one person to date (Kern). 2. The program constantly is checking the chain of allocated memory buffers to ensure that no overruns have occurred. 3. All memory leaks (orphaned buffers) are reported each time the program terminates. 4. Any signal (segmentation fault, ...) generates a traceback that is emailed to the developer. This permits quick resolution of bugs even if they only show up rarely in a production system.

I'm Getting Authorization Errors. What is Going On?

For security reasons, Bacula requires that both the File daemon and the Storage daemon know the name of the Director as well as his password. As a consequence, if you change the Director's name or password, you must make the corresponding change in the Storage daemon and in the File daemon configuration files.

During the authorization process, the Storage daemon and File daemon also require that the Director authenticate himself, so both ends require the other to have the correct name and password.

If you have edited the conf files and modified any name or any password, then your best bet is to go back to the original conf files generated by the Bacula installation process. Make only the absolutely necessary modifications to these files — e.g. add the correct email address. Then follow the instructions in the [Running Bacula](#) chapter of this manual. You will run a backup to disk and a restore. Only when that works, should you begin customization of the conf files.

Bacula Runs Fine but Cannot Access a Client on a Different Machine. Why?

There are several reasons why Bacula could not contact a client on a different machine. They are:

- ◊ It is a Windows Client, and the client died because of an improper configuration file. Check that the Bacula icon is in the system tray and the menu items work. If the client has died, the icon will disappear only when you move the mouse over the icon.
- ◊ The Client address or port is incorrect or not resolved by DNS. See if you can ping the client machine using the same address as in the Client record.
- ◊ You have a firewall, and it is blocking traffic on port 9102 between the Director's machine and the Clients machine (or on port 9103 between the Client and the Storage daemon machines).
- ◊ Your password or names are not correct in both the Director and the Client machine. Try configuring everything identical to how you run the client on the same machine as the Director, but just change the Address. If that works, make the other changes one step at a time until it works.

My Catalog is Full of Test Runs, How Can I Start Over?

If you are using MySQL do the following:

```
cd <bacula-source>/src/cats
./drop_mysql_tables
./make_mysql_tables
```

If you are using SQLite, do the following:

```
Delete bacula.db from your working directory.
cd <bacula-source>/src/cats
./drop_sqlite_tables
./make_sqlite_tables
```

Then write an EOF on each tape you used with **Bacula**

I Run a Restore Job and Bacula Hangs. What do I do?

On Bacula version 1.25 and prior, it expects you to have the correct tape mounted prior to a restore. On Bacula version 1.26 and higher, it will ask you for the tape, and if the wrong one it mounted, it will inform you.

If you have previously done an **unmount** command, all Storage daemon sessions (jobs) will be completely blocked from using the drive unmounted, so be sure to do a **mount** after your unmount. If in doubt, do a second **mount**, it won't cause any harm.

I Cannot Get My Windows Client to Start Automatically?

You are probably having one of two problems: either the Client is dying due to an incorrect configuration file, or you didn't do the Installation commands necessary to install it as a Windows Service.

For the first problem, see the next FAQ question. For the second problem, please review the [Windows Installation instructions](#) in this manual.

My Windows Client Immediately Dies When I Start It

The most common problem is either that the configuration file is not where it expects it to be, or that there is an error in the configuration file. You must have the configuration file in **c:\bacula\bin\bacula-fd.conf**.

To **see** what is going on when the File daemon starts on Windows, do the following:

```
Start a DOS shell Window.  
cd c:\bacula\bin  
bacula-fd -t >out  
type out
```

Calling **bacula-fd** with redirection (>) will write the diagnostic output to the file **out** which you can then list. The **-t** option tells Bacula to read the configuration file and then exit.

When I Start the Console, the Error Messages Fly By. How can I see them?

Either use a shell window with a scroll bar, or use the **gnome-console**. In any case, you probably should be logging all output to a file, and then you can simply view the file using an editor or the **less** program. To log all output, I have the following in my Director's Message resource definition:

```
append = "/home/kern/bacula/bin/log" = all, !skipped
```

Obviously you will want to change the filename to be appropriate for your system.

I didn't realize that the backups were not working on my Windows Client. What should I do?

You should be sending yourself an email message for each job. This will avoid the possibility of not knowing about a failed backup. To do so put something like:

```
Mail = yourname@yourdomain = all, !skipped
```


in your Director's message resource. You should then receive one email for each Job that ran. When you are comfortable with what is going on (it took me 9 months), you might change that to:

```
MailOnError = yourname@yourdomain = all, !skipped
```

then you only get email messages when a Job errors as is the case for your Windows machine.

You should also be logging the Director's messages, please see the previous FAQ for how to do so.

All my Jobs are scheduled for the same time. Will this cause problems?

No, not at all. Bacula will schedule all the Jobs at the same time, but will run them one after another unless you have increased the number of simultaneous jobs in the configuration files for the Director, the File daemon, and the Storage daemon. The appropriate configuration record is **Maximum Concurrent Jobs = nn**. At the current time, we recommend that you leave this set to **1** for the Director.

Can Bacula Backup My System To Files instead of Tape?

Yes, in principle, Bacula can backup to any storage medium as long as you have correctly defined that medium in the Storage daemon's Device resource. For an example of how to backup to files, please see the [Pruning Example](#) in the Recycling chapter of this manual. Also, there is a whole chapter devoted to [Backing Up to Disk](#).

Can Bacula Backup and Restore Files Greater than 2 Giga Bytes in Size?

If your operating system permits it, and you are running Bacula version 1.26 or later, the answer is yes. Unfortunately, large files are not supported by **cygwin** which Bacula uses for the Windows client. However, the native Windows APIs are used in Bacula version 1.31 and later on Windows systems, so in principal any 2 Giga Byte problems should disappear.

*I Started A Job then Decided I Really Did Not Want to Run It. Is there a better way than **./bacula stop** to stop it?*

Yes, you normally should use the Console command **cancel** to cancel a Job that is either scheduled or running. If the Job is scheduled, it will be marked for cancellation and will be canceled when it is scheduled to start. If it is running, it will normally terminate after a few minutes. If the Job is waiting on a tape mount, you may need to do a **mount** command before it will be canceled.

Why have You Trademarked the Name Bacula[®] ?

We have trademarked the name Bacula to ensure that all media written by any program named Bacula will always be compatible. Anyone may use the name Bacula, even in a

derivative product as long as it remains totally compatible in all respects with the program defined here.

Why is Your Online Document for Version 1.27 of Bacula when the Currently Release Version is 1.26?

As Bacula is being developed, the document is also being enhanced, more often than not it has clarifications of existing features that can be very useful to our users, so we publish the very latest document. Fortunately it is rare that there are confusions with new features.

If you want to read a document that pertains only to a specific version, please use the one distributed in the source code.

How Can You Be Sure that Bacula Really Saves and Restores All Files?

It is really quite simple, but took me awhile to figure out how to "prove" it. First make a Bacula Rescue disk, see the [Disaster Recovery Using Bacula](#) of this manual. Second, you run a full backup of all your files on all partitions. Third, you run an Verify InitCatalog Job on the same FileSet, which effectively makes a record of all the files on your system. Fourth, you run a Verify Catalog job and assure yourself that nothing has changed (well, between an InitCatalog and Catalog one doesn't expect anything). Then do the unthinkable, write zeros on your MBR (master boot record) wiping out your hard disk. Now, restore your whole system using your Bacula Rescue disk and the Full backup you made, and finally re-run the Verify Catalog job. You will see that with the exception of the directory modification and access dates and the files changed during the boot, your system is identical to what it was before you wiped your hard disk.

I did a Full backup last week, but now in running an Incremental, Bacula says it did not find a FULL backup time, so it did a FULL backup. Why?

Before doing an Incremental or a Differential backup, Bacula checks to see if there was a prior Full backup of the same Job that terminated successfully. If so, it uses the date that full backup started as the time for comparing if files have changed. If Bacula does not find a successfully full backup, it proceeds to do one. Perhaps you canceled the full backup, or it terminated in error. In such cases, the full backup will not be successful. You can check by entering **list jobs** and look to see if there is a prior Job with the same Name that has Level F and JobStatus T (normal termination).

Another reason why Bacula may not find a suitable Full backup is that every time you change the FileSet, Bacula will require a new Full backup. This is necessary to ensure that all files are properly backed up in the case where you have added more files to the FileSet. Beginning with version 1.31, the FileSets are also dated when they are created, and this date is displayed with the name when you are listing or selecting a FileSet. For more on backup levels see below.

How Can You Claim to Handle Unlimited Path and Filename Lengths when All Other Programs Have Fixed Limits?

Most of those other programs have been around for a long time, in fact since the beginning of Unix, which means that they were designed for rather small fixed length path and filename lengths. Over the years, these restrictions have been relaxed allowing longer names. Bacula on the other hand was designed in 2000, and so from the start, Path

and Filenames have been kept in buffers that start at 256 bytes in length but can grow as needed to handle any length. Most of the work is carried out by lower level routines making the coding rather easy.

What Is the Really Unique Feature of Bacula?

Well, it is hard to come up with unique features when backup programs for Unix machines have been around since the 1960s. That said, I believe that Bacula is the first and only program to use a standard SQL interface to its catalog database. Although this adds a bit of complexity and possibly overhead, it provides an amazingly rich set of features that are easy to program and enhance. The current code has barely scratched the surface in this regard (version 1.31).

The second feature, which gives a lot of power and flexibility to Bacula is the Bootstrap record definition.

The third unique feature, which is currently (1.30) unimplemented, and thus can be called vaporware :-), is Base level saves. When implemented, this will enormously reduce tape usage.

Since Bacula is Multithreaded, Why Do You Recommend Not Running Multiple Simultaneous Jobs?

Bacula can run multiple simultaneous jobs, but being very conservative, I do not recommend doing so at the current time for two reasons: 1. I'm not sure that two jobs accessing the same Volume won't have catalog conflicts. 2. Doing a restore from a Volume with records from two jobs intermingled is complicated.

I expect to have definitive solutions to both of those problems in a later version. In the mean time, I recommend running one Job at a time. If you want to experiment with this as several large shops are doing, ensure that each job is writing to a different Volume (i.e. has a different Storage resource). This will avoid the two problems mentioned above. Just the same, there may be other race conditions in the Director that cause problems. Be forewarned.

If I Do Run Multiple Simultaneous Jobs, How Can I Force One Particular Job to Run After Another Job?

Yes, you can set Priorities on your jobs so that they run in the order you specify. Please see: [the Priority record](#) in the Job resource.

I Am Not Getting Email Notification, What Can I Do?

The most common problem is that you have not specified a fully qualified email address and your bsmtplib server is rejecting the mail. The next most common problem is that your bsmtplib server doesn't like the syntax on the From part of the message. For more details on this and other problems, please see the [Getting Email Notification to Work](#) section of the Tips chapter of this manual. The section [Getting Notified of Job Completion](#) of the Tips chapter may also be useful. For more information on the **bsmtplib** mail program, please see [bsmtplib in the Volume Utility Tools chapter](#) of this manual.

I Change Recycling, Retention Periods, or File Sizes in my Pool Resource and they Still Don't Work.

The different variables associated with a Pool are defined in the Pool Resource, but are actually read by Bacula from the Catalog database. On Bacula versions prior to 1.30, after changing your Pool Resource, you must manually update the corresponding values in the Catalog by using the **update pool** command in the Console program. In Bacula version 1.30, Bacula does this for you automatically every time it starts.

When Bacula creates a Media record (Volume), it uses many default values from the Pool record. If you subsequently change the Pool record, the new values will be used as a default for the next Volume that is created, but if you want the new values to apply to existing Volumes, you must manually update the Volume Catalog entry using the **update volume** command in the Console program.

I Have Configured Compression On, But None of My Files Are Compressed. Why?

There are two kinds of compression. One is tape compression. This is done by the tape drive hardware, and you either enable or disable it with system tools such as **mt**. This compression works independently of Bacula.

Bacula also has compression code, which is normally used only when backing up to file Volumes. There are two conditions for this "software" to be enabled.

1. You must have the zip development libraries loaded on your system when building Bacula and Bacula must find this library, normally **/usr/lib/libz.a**. On RedHat systems, this library is provided by the **zlib-devel** rpm.

If the library is found by Bacula during the **./configure** it will be indicated on the **config.out** line by:

```
ZLIB support:  yes
```

2. You must add the **compression=gzip** option on your Include statement in the Director's configuration file.

Bacula is Asking for a New Tape After 2 GB of Data but My Tape holds 33 GB. Why?

There are several reasons why Bacula will request a new tape.

- ◇ There is an I/O error on the tape. Bacula prints an error message and requests a new tape. Bacula does not attempt to continue writing after an I/O error.
- ◇ Bacula encounters end of medium on the tape. This is not always distinguishable from an I/O error.
- ◇ You have specifically set some size limitation on the tape. For example the **Maximum Volume Bytes** or **Maximum Volume Files** in the Director's Pool resource, or **Maximum Volume Size** in the Storage daemon's Device resource.

Bacula is Not Doing the Right Thing When I Request an Incremental Backup. Why?

As explained in one of the previous questions, Bacula will automatically upgrade an Incremental or Differential job to a Full backup if it cannot find a prior Full backup or a suitable Full backup. For the gory details on how/when Bacula decides to upgrade levels please see the [Level record](#) in the Director's configuration chapter of this manual.

If after reading the above mentioned section, you believe that Bacula is not correctly handling the level (Differential/Incremental), please send us the following information for analysis:

- ◆ Your Director's configuration file.
- ◆ The output from **list jobs** covering the period where you are having the problem.
- ◆ The Job report output from the prior Full save (not critical).
- ◆ An **llist jobid=nnn** where nnn is the JobId of the prior Full save.
- ◆ The Job report output from the save that is doing the wrong thing (not critical).
- ◆ An **llist jobid=nnn** where nnn is the JobId of the job that was not correct.
- ◆ An explanation of what job went wrong and why you think it did.

The above information can allow us to analyze what happened, without it, there is not much we can do.

I am Backing Up an Offsite Machine with an Unreliable Connection. The Director Waits Forever for the Client to Contact the SD. What Can I Do.

Bacula was written on the assumption that it will have a good TCP/IP connection between all the daemons. As a consequence, the current Bacula doesn't deal with faulty connection very well. This situation is slowly being corrected over time. There are several things you can do to improve the situation.

- ◆ Upgrade to version 1.32 and use the new `SDConnectTimeout` record. For example, set:

```
SD Connect Timeout = 5 min
```

in the `FileDaemon` resource.

- ◆ Run these kinds of jobs after all other jobs.

When I ssh into a machine and start Bacula then attempt to exit, ssh hangs forever.

This happens because Bacula leaves `stdin`, `stdout`, and `stderr` open for debug purposes. To avoid it, the simplest thing to do is to redirect the output of those files to `/dev/null` or another file in your startup script (the RedHat autostart scripts do this automatically). For example, you start the Director with:

```
bacula-dir -c bacula-dir.conf ... 0>&1 2>&1 >/dev/null
```

and likewise for the other daemons.

I'm confused by the different Retention periods: File Retention, Job Retention, Volume Retention. Why are there so many?

Yes, this certainly can be confusing. The basic reason for so many is to allow flexibility. The File records take quite a lot of space in the catalog, so they are typically records you want to remove rather quickly. The Job records, take very little space, and they can be useful even without the File records to see what Jobs actually ran and when. One must understand that if the File records are removed from the catalog, you cannot use the

restore command to restore an individual file since Bacula no longer knows where it is. However, as long as the Volume Retention period has not expired, the data will still be on the tape, and can be recovered from the tape.

For example, I keep a 30 day retention period for my Files to keep my catalog from getting too big, but I keep my tapes for a minimum of one year, just in case.



LGPL



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The Network Backup Solution

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Bacula Security Issues

- The Clients (**bacula-fd**) must run as root to be able to access all the system files.
- It is not necessary to run the Director as root.
- It is not necessary to run the Storage daemon as root, but you must ensure that it can open the tape drives, which are often restricted to root access by default.
- You should restrict access to the Bacula configuration files, so that the passwords are not world-readable. The **Bacula** daemons are password protected using CRAM-MD5 (i.e. the password is not sent across the network). This will ensure that not everyone can access the daemons. It is a reasonably good protection, but can be cracked by experts.
- If you are using the recommended ports 9101, 9102, and 9103, you will probably want to protect these ports from external access using a firewall and/or using tcp wrappers (**/etc/hosts.allow**).
- Currently all data that is sent across the network is unencrypted. As a consequence, unless you use **ssh** or **stunnel** for port forwarding, it is not recommended to do a backup across an insecure network (e.g. the Internet). In a future version, we plan to have **ssl** encryption built-in.
- You should ensure that the Bacula working directories are readable and writable only by the Bacula daemons.
- If you are using **MySQL** it is not necessary for it to run with **root** permission.
- The default Bacula **grant-mysql-permissions** script grants all permissions to use the MySQL database without a password. If you want security, please tighten this up!
- Don't forget that Bacula is a network program, so anyone anywhere on the network with the console program and the Director's password can access Bacula and the backed up data.
- You can restrict what IP addresses Bacula will bind to by using the appropriate **DirAddress**, **FDAddress**, or **SDAddress** records in the respective daemon configuration files.

Configuring and Testing TCP Wrappers with Bacula

TCP Wrappers are implemented if you turn them on when configuring (**./configure --with-libwrap**). With this code enabled, you may control who may access your daemons. This control is done by modifying the file: **/etc/hosts.allow**. The program name that **Bacula** uses when applying these access restrictions is the name you specify in the daemon configuration file. You must not use the **twist** option in your **/etc/hosts.allow** or it will terminate the Bacula daemon when a connection is refused.

Dan Languille has provided the following information on configuring and testing TCP wrappers with Bacula.

If you read `hosts_options(5)`, you will see an option called `twist`. This option replaces the current process by an instance of the specified shell command. Typically, something like this is used:

```
ALL : ALL \
: severity auth.info \
: twist /bin/echo "You are not welcome to use %d from %h."
```

The libwrap code tries to avoid **twist** if it runs in a resident process, but that test will not protect the first `hosts_access()` call. This will result in the process (e.g. `bacula-fd`, `bacula-sd`, `bacula-dir`) being terminated if the first connection to their port results in the twist option being invoked. The potential, and I stree potential, exists for an attacker to prevent the daemons from running. This situation is eliminated if your `/etc/hosts.allow` file contains an appropriate ruleset. The following example is sufficient:

```
undef-fd : localhost : allow
undef-sd : localhost : allow
undef-dir : localhost : allow
```

```
undef-fd : ALL : deny
undef-sd : ALL : deny
undef-dir : ALL : deny
```

You must adjust the daemon names to those found in the respective daemon configuration files. In these examples, the Director is `undef-dir`, the Storage Daemon is `undef-sd`, and the File Daemon is `undef-fd`. Adjust to suit your situation. The above example rules assume that the SD, FD, and DIR all reside on the same box. If you have a remote FD client, then the following ruleset on the remote client will suffice:

```
undef-fd : director.example.org : allow
undef-fd : ALL : deny
```

where `director.example.org` is the host which will be contacting the client (ie. the box on which the Bacula Director daemon runs). The use of "ALL : deny" ensures that the twist option (if present) is not invoked. To properly test your configuration, start the daemon(s), then attempt to connect from an IP address which should be able to connect. You should see something like this:

```
$ telnet undef 9103
Trying 192.168.0.56...
Connected to undef.example.org.
Escape character is '^]'.
Connection closed by foreign host.
$
```

This is the correct response. If you see this:

```
$ telnet undef 9103
Trying 192.168.0.56...
Connected to undef.example.org.
Escape character is '^]'.
You are not welcome to use undef-sd from xeon.example.org.
Connection closed by foreign host.
$
```

then twist has been invoked and your configuration is not correct and you need to add the deny statement. It is important to note that your testing must include restarting the daemons after each connection attempt. You can also `tcpdchk(8)` and `tcpdmatch(8)` to validate your `/etc/hosts.allow` rules. Here is a simple test using `tcpdmatch`:

```
$ tcpdmatch undef-dir xeon.example.org
warning: undef-dir: no such process name in /etc/inetd.conf
client: hostname xeon.example.org
client: address 192.168.0.18
```



```
server: process undef-dir
matched: /etc/hosts.allow line 40
option: allow
access: granted
```

If you are running Bacula as a standalone daemon, the warning above can be safely ignored. Here is an example which indicates that your rules are missing a deny statement and the twist option has been invoked.

```
$ tcpdmatch undef-dir 10.0.0.1
warning: undef-dir: no such process name in /etc/inetd.conf
client: address 10.0.0.1
server: process undef-dir
matched: /etc/hosts.allow line 91
option: severity auth.info
option: twist /bin/echo "You are not welcome to use
      undef-dir from 10.0.0.1."
access: delegated
```

Running as non-root

Security advice from Dan Languille:

It is a good idea to run daemons with the lowest possible privileges. In other words, if you can, don't run applications as root which do not have to be root. The Storage Daemon and the Director Daemon do not need to be root. The File Daemon needs to be root in order to access all files on your system. In order to run as non-root, you need to create a user and a group. Choosing bacula as both the user name and the group name sounds like a good idea to me.

The FreeBSD port creates this user and group for you (actually, as I write this, the port doesn't do that, but it soon will). Here is what those entries looked like on my FreeBSD laptop:

```
bacula:*:1002:1002::0:0:Bacul Daemon:/var/db/bacula:/sbin/nologin
```

I used vipw to create this entry. I selected a User ID and Group ID of 1002 as they were unused on my system.

I also created a group in /etc/group:

```
bacula:*:1002:
```

The bacula user (as opposed to the Bacula daemon) will have a home directory of /var/db/bacula which is the default location for the Bacula database.

Now that you have both a bacula user and a bacula group, you can secure the bacula home directory by issuing this command:

```
chown -R bacula:bacula /var/db/bacula/
```

This ensures that only the bacula user can access this directory. It also means that if we run the Director and the Storage daemon as bacula, those daemons also have restricted access. This would not be the case if they were running as root.

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It is important to note that the storage daemon actually needs to be in the operator group for normal access to tape drives etc (at least on a FreeBSD system, that's how things are set up by default) Such devices are normally chown root:operator. It is easier and less error prone to make Bacula a member of that group than it is to play around with system permissions.

Starting the Bacula daemons

To start the bacula daemons on a FreeBSD system, issue the following command:

```
/usr/local/etc/rc.d/bacula.sh start
```

To confirm they are all running:

```
$ ps auwx | grep bacula
```

```
root 63416 0.0 0.3 2040 1172 ?? Ss 4:09PM 0:00.01
      /usr/local/sbin/bacula-sd -v -c /usr/local/etc/bacula-sd.conf
```

```
root 63418 0.0 0.3 1856 1036 ?? Ss 4:09PM 0:00.00
      /usr/local/sbin/bacula-fd -v -c /usr/local/etc/bacula-fd.conf
```

```
root 63422 0.0 0.4 2360 1440 ?? Ss 4:09PM 0:00.00
      /usr/local/sbin/bacula-dir -v -c /usr/local/etc/bacula-dir.conf
```



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[Bacula 1.34 User's Guide](#)

The Network Backup Solution

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Bacula Projects

Dealing with Firewalls

If you have a firewall or a DMZ installed on your computer, you may experience difficulties contacting one or more of the Clients to back them up. This is especially true if you are trying to backup a Client across the Internet.

Technical Details

If you are attempting to do this, the sequence of network events in Bacula to do a backup are the following:

```
Console -> DIR:9101
DIR      -> SD:9103
DIR      -> FD:9102
FD       -> SD:9103
```

Where it should be obvious that DIR represents the Director, FD the File daemon or client, and SD the Storage daemon. The numbers that follow those names are the standard ports used by Bacula, and the `->` represents the left side making a connection to the right side (i.e. the right side is the "server" or is listening on the specified port), and the left side is the "client" who initiates the conversation.

Note, port 9103 serves both the Director and the File daemon, each having its own independent connection.

If you are running **iptables**, you might add something like:

```
-A FW-1-INPUT -m state --state NEW -m tcp -p tcp --dport 9101:9103 -j ACCEPT
```

on your server, and

```
-A FW-1-INPUT -m state --state NEW -m tcp -p tcp --dport 9102 -j ACCEPT
```

on your client. In both cases, I assume that the machine is allowed to initiate connections on any port. If not, you will need to allow outgoing connections on ports 9102 and 9103 on your server and 9103 on your client. Thanks to Raymond Norton for this tip.

A Concrete Example

Jesse Guardiani's solution for his network for this problem, in his own words, is:

My bacula server is on the 192.168.1.0/24 network at IP address 192.168.1.52. For the sake of discussion we will refer to this network as the 'internal' network because it connects to the internet through a NAT'd firewall. We will call the network on the public (internet) side of the NAT'd firewall the 'external' network. Also, for the sake of discussion we will call my bacula server:

```
server.int.mydomain.tld
```

when a fully qualified domain name is required, or simply:

Bacula Storage Management System

server

if a hostname is adequate. We will call the various bacula daemons running on the server.int.mydomain.tld machine:

```
server-fd
server-sd
server-dir
```

In addition, I have two clients that I want to back up with Bacula. The first client is on the internal network. Its fully qualified domain name is:

private1.int.mydomain.tld

And its hostname is:

private1

This machine is a client and therefore runs just one bacula daemon:

private1-fd

The second client is on the external network. Its fully qualified domain name is:

public1.mydomain.tld

And its hostname is:

public1

This machine also runs just one bacula daemon:

public1-fd

Finally, I have a NAT firewall/gateway with two network interfaces. The first interface is on the internal network and serves as a gateway to the internet for all the machines attached to the internal network (For example, server.int.mydomain.tld and private1.int.mydomain.tld). The second interface is on the external (internet) network. The external interface has been assigned the name:

firewall.mydomain.tld

Remember:

```
*.int.mydomain.tld = internal network
*.mydomain.tld = external network
```

The Bacula Configuration Files for the Above

server-sd manages a 4 tape AIT autoloader. All of my backups are written to server-sd. I have just *one* Device resource in my server-sd.conf file:

```
Device {
```

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```
Name = "autochanger1";
Media Type = AIT-1;
Archive Device = /dev/nrsal;
Changer Device = /dev/ch0;
Changer Command = "/usr/local/sbin/chio-bacula %c %o %S %a";
Label Media = yes;
AutoChanger = yes;
AutomaticMount = yes;                # when device opened, read it
AlwaysOpen = yes;
    Hardware End of Medium = No
    Fast Forward Space File = No
    BSF at EOM = yes
}
```

However, I have **two** Storage resources in my server-dir.conf file:

```
Storage {
    Name = "autochanger1-int"        # Storage device for backing up
    Address = server.int.mydomain.tld
    SDPort = 9103
    Password = "mysecretpassword"
    Device = "autochanger1"
    Media Type = AIT-1
    Autochanger = yes
}
Storage {
    Name = "autochanger1-ext"        # Storage device for backing up
    Address = firewall.mydomain.tld
    SDPort = 9103
    Password = "mysecretpassword"
    Device = "autochanger1"
    Media Type = AIT-1
    Autochanger = yes
}
```

Note that BOTH of the above server-dir.conf Storage resources use the same 'autochanger1' Device resource from server-sd.conf.

My backup jobs run consecutively, one after the other, so only one of the above Storage resources is being used by Bacula file daemons at any given time. I don't know if this would cause problems at a site that runs more than one backup in parallel to a single tape device.

In addition to the above, I have two Client resources defined in server-dir.conf:

```
Client {
    Name = privatel-fd
    Address = privatel.int.mydomain.tld
    FDPort = 9102
    Catalog = MyCatalog
    Password = "mysecretpassword"    # password for FileDaemon
}
Client {
    Name = public1-fd
    Address = public1.mydomain.tld
    FDPort = 9102
    Catalog = MyCatalog
    Password = "mysecretpassword"    # password for FileDaemon
}
```

And finally, to tie it all together, I have two Job resources defined in `server-dir.conf`:

```
Job {
    Name = "Private1-Backup"
    Type = Backup
    Client = private1-fd
    FileSet = "Private1"
    Schedule = "WeeklyCycle"
    Storage = "autochanger1-int"
    Messages = Standard
    Pool = "Weekly"
    Write Bootstrap = "/var/db/bacula/Private1-Backup.bsr"
    Priority = 12
}
Job {
    Name = "Public1-Backup"
    Type = Backup
    Client = public1-fd
    FileSet = "Public1"
    Schedule = "WeeklyCycle"
    Storage = "autochanger1-ext"
    Messages = Standard
    Pool = "Weekly"
    Write Bootstrap = "/var/db/bacula/Public1-Backup.bsr"
    Priority = 13
}
```

It is important to notice that because the 'Private1-Backup' Job is intended to back up a machine on the internal network it uses the 'autochanger1-int' Storage resource. On the other hand, the 'Public1-Backup' Job is intended to back up a machine on the external network, so it uses the 'autochanger1-ext' Storage resource.

I have left the Pool, Catalog, Messages, FileSet, Schedule, and Director resources out of the above `server-dir.conf` examples because they are not pertinent to the discussion.

How Does It Work?

If I want to run a backup of `private1.int.mydomain.tld` and store that backup using `server-sd` then my understanding of the order of events is this:

1. I execute my Bacula 'console' command on `server.int.mydomain.tld`.
2. console connects to `server-dir`.
3. I tell console to 'run' backup Job 'Private1-Backup'.
4. console relays this command to `server-dir`.
5. `server-dir` connects to `private1-fd` at `private1.int.mydomain.tld:9102`
6. `server-dir` tells `private1-fd` to start sending the files defined in the 'Private1-Backup' Job's FileSet resource to the Storage resource 'autochanger1-int', which we have defined in `server-dir.conf` as having the address:port of `server.int.mydomain.tld:9103`.
7. `private1-fd` connects to `server.int.mydomain.tld:9103` and begins sending files.

Alternatively, if I want to run a backup of `public1.mydomain.tld` and store that backup using `server-sd` then my understanding of the order of events is this:

1. I execute my Bacula 'console' command on `server.int.mydomain.tld`.
2. console connects to `server-dir`.

3. I tell console to 'run' backup Job 'Public1-Backup'.
4. console relays this command to server-dir.
5. server-dir connects, through the NAT'd firewall, to public1-fd at public1.mydomain.tld:9102
6. server-dir tells public1-fd to start sending the files defined in the 'Public1-Backup' Job's FileSet resource to the Storage resource 'autochanger1-ext', which we have defined in server-dir.conf as having the address:port of firewall.mydomain.tld:9103.
7. public1-fd connects to firewall.mydomain.tld:9103 and begins sending files.

Important Note

In order for the above 'Public1-Backup' Job to succeed, firewall.mydomain.tld:9103 **MUST** be forwarded using the firewall's configuration software to server.int.mydomain.tld:9103. Some firewalls call this 'Server Publication'. Others may call it 'Port Forwarding'.



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Bacula Projects

Projects

- Test as many features of Bacula as possible. This is happening a bit with every release.
- Ensure that the documentation is complete and clear.
- Implement the Bacula Roadmap as defined below.
- Enhance the file restore code to restore according to a large number of criteria (include list, exclude list, state of system as of date xxx, ...) (assigned to Kern)
- Define and write a regression script.
- Implement verification of tape data — compared to what is on disk.
- Performance tuning.
- Implement a scripting language for running Jobs.
- Implement GNOME Bacula applet.
- Implement new serial code for daemon—daemon comm and replace all sscanf's.
- Complete review of SQL database usage, indexes, and table design.

Raw Todo List

Please see the file **kernstodo** in the main **Bacula** directory for the raw todo list.

Bacula Projects Roadmap

Projects:

Bacula Projects Roadmap
13 April 2004

Item 1: Implement Base jobs.

What: A base job is sort of like a Full save except that you will want the FileSet to contain only files that are unlikely to change in the future (i.e. a snapshot of most of your system after installing it). After the base job has been run, when you are doing a Full save, you specify one or more Base jobs to be used. All files that have been backed up in the Base job/jobs but not modified will then be excluded from the backup. During a restore, the Base jobs will be automatically pulled in where necessary.

Why: This is something none of the competition does, as far as we know (except BackupPC, which is a Perl program that saves to disk only). It is big win for the user, it makes Bacula stand out as offering a unique optimization that immediately saves time and money. Basically, imagine that you have 100 nearly identical Windows or Linux machine containing the OS and user files. Now for the OS part, a Base job will be backed up once, and rather than making 100 copies of the OS, there will be only one. If one or more of the systems have some files updated, no problem, they will be automatically restored.

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- Notes: Huge savings in tape usage even for a single machine. Will require more resources because the DIR must send FD a list of files/attrs, and the FD must search the list and compare it for each file to be saved.
- Item 2: Add Regular Expression Matching and Plug-ins to the FileSet Include statements.
- What: Allow users to specify wild-card and/or regular expressions to be matched in both the Include and Exclude directives in a FileSet. At the same time, allow users to define plug-ins to be called (based on regular expression/wild-card matching).
- Why: This would give the users the ultimate ability to control how files are backed up/restored. A user could write a plug-in knows how to backup his Oracle database without stopping/starting it, for example.
- Item 3: Implement a Migration job type that will move the job data from one device to another.
- What: The ability to copy, move, or archive data that is on a device to another device is very important.
- Why: An ISP might want to backup to disk, but after 30 days migrate the data to tape backup and delete it from disk. Bacula should be able to handle this automatically. It needs to know what was put where, and when, and what to migrate -- it is a bit like retention periods. Doing so would allow space to be freed up for current backups while maintaining older data on tape drives.
- Notes: Migration could be triggered by:
- Number of Jobs
 - Number of Volumes
 - Age of Jobs
 - Highwater size (keep total size)
 - Lowwater mark
- Item 4: Embedded Perl Scripting (precursor to 5).
- What: On a configuration parameter, embed the Perl language in Bacula.
- Why: The embedded Perl scripting can be called to implement Events such as "Volume Name needed", "End of Tape", "Tape at x% of rated capacity", "Job started", "Job Ended", "Job error", ...
- Notes: This needs Events.
- Item 5: Implement Events
- What: When a particular user defined Event occurs, call the embedded Perl interpreter.
- Why: This will provide the ultimate in user customization for

Bacula Storage Management System

Bacula. Almost anything imaginable can be done if Events are called at the appropriate place.

Notes: There is a certain amount of work to be done on how the user defines or "registers" events.

Item 6: Multiple Storage Devices for a Single Job

What: Allow any Job to use more than one Storage device.

Why: With two devices, for example, the second device could have the next backup tape pre-mounted reducing operator intervention in the middle of the night.

Item 7: Backup a Single Job Simultaneously to Multiple Storage Devices

What: Make two copies of the backup data at the same time.

Why: Large shops typically do this and then take one set of backups off-site. Some design work is needed in how to specify the type of backup (backup, archive, ...) for each Device.

Item 8: Break the one-to-one Relationship between a Job and a Specific Storage Device (or Devices if #10 is implemented).

What: Allow a Job to simply specify one or more MediaType, and the Storage daemon will select a device for it. In fact, the user should be able to specify one or more MediaType, Storage daemon, and/or device to be used.

Why: To allow more flexibility in large shops that have multiple drives and/or multiple drives of different types.

Item 9: Implement data encryption (as opposed to communications encryption)

What: Currently the data that is stored on the Volume is not encrypted. For confidentiality, encryption of data at the File daemon level is essential. Note, communications encryption encrypts the data when leaving the File daemon, then decrypts the data on entry to the Storage daemon. Data encryption encrypts the data in the File daemon and decrypts the data in the File daemon during a restore.

Why: Large sites require this.

Notes: The only algorithm that is needed is AES.
<http://csrc.nist.gov/CryptoToolkit/aes/>

Item 10: New daemon communication protocol.

What: The current daemon to daemon protocol is basically an ASCII printf() and sending the buffer. On the receiving end, the

Bacula Storage Management System

buffer is sscanf()ed to unpack it. The new scheme would retain the current ASCII sending, but would add an argc, argv like table driven scanner to replace sscanf.

Why: Named fields will permit error checking to ensure that what is sent is what the receiver really wants. The fields can be in any order and additional fields can be ignored allowing better upward compatibility. Much better checking of the types and values passed can be done.

Notes: These are internal improvements in the interest of the long-term stability and evolution of the program. On the one hand, the sooner they're done, the less code we have to rip up when the time comes to install them. On the other hand, they don't bring an immediately perceptible benefit to potential users.

Completed items from last year's list:

- Item 1: Multiple simultaneous Jobs. (done)
- Item 3: Write the bscan program -- also write a bcopy program (done).
- Item 5: Implement Label templates (done).
- Item 6: Write a regression script (done)
- Item 9: Add SSL to daemon communications (For now, implement with stunnel)
- Item 10: Define definitive tape format (done)
- Item 3: GUI for interactive restore. Partially Implemented in 1.34
Note, there is now a complete Webmin plugin, a partial GNOME console, and a partial wxWidgets console.
- Item 4: GUI for interactive backup
- Item 2: Job Data Spooling.



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Thanks

Special thanks to D. Scott Barninger for writing the bacula RPM spec file, building all the RPM files and loading them onto Source Forge.

Thanks to Richard Stallman for starting the Free Software movement and for bringing us gcc and all the other GNU tools.

Thanks to Linus Torvolds for bring us Linux.

Thanks to all the Free Software programmers. Without being able to peek at your code, and in some cases, take parts of it, this project would have been much more difficult.

Thanks to John Walker for suggesting this project, giving it a name, contributing software he has written, and for his programming efforts on Bacula as well as having acted as a constant sounding board and source of ideas.

Thanks to the apcupsd project where I started my Free Software efforts, and from which I was able to borrow some ideas and code that I had written.

Thanks to Scott Barninger for his tireless efforts to package and improve the rpms for Bacula on several platforms.

Thanks to Dan Langille for the **incredible** amount of testing he did on FreeBSD. His perseverance is truly remarkable. Thanks also for the many contributions he has made to improve Bacula (pthreads patch for FreeBSD, improved start/stop script and addition of Bacula userid and group, stunnel, ...), as well as his continuing support of Bacula users.

Thanks to Phil Stracchino for writing the gnome-console **ConsoleFont** configuration command, all the suggestions he has made, and his continuing support of Bacula users.

Thanks to multiple other Bacula Packagers who make and release packages for different platforms for Bacula.

Thanks to Christopher Hull for developing the native Win32 Bacula emulation code and for contributing it to the Bacula project.

Thanks to Nic Bellamy for providing the bacula-dir.conf file that he uses to implement daily tape rotation using multiple Pools.

Thanks to Johan Decock for providing numerous corrections to the manual.

Thanks to all the Bacula users, especially those of you who have contributed ideas, bug reports, patches, and new features.

The original variable expansion code used in the LabelFormat comes from the Open Source Software Project (www.ossproject.org). It has been adapted and extended for use in Bacula.

For all those who I have left out, please send me a reminder, and in any case, thanks for your contribution.

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Bacula Bugs

Well there certainly are bugs, and one day when additional man/woman power exists on the Bacula project, they will be reported here, but for the moment, you can view bugs submitted by users on the [Bacula Source Forge bug list](#), and any serious bugs of which we are aware, we personally post to the Source Forge bug list.

All we can say is that **Bacula** is amazing robust considering the amount of code and complexity of its tasks.

A "raw" list of the current known issues can be found in **kernstodo** in the main Bacula source directory.



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Director Services Daemon

General

This chapter is intended to be a technical discussion of the Director services and as such is not targeted at end users but rather at developers and system administrators that want or need to know more of the working details of **Bacula**.

The **Bacula Director** services consist of the program that supervises all the backup and restore operations.

To be written ...



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Bacula File Services

Storage Daemon Design

General

This chapter is intended to be a technical discussion of the Storage daemon services and as such is not targeted at end users but rather at developers and system administrators that want or need to know more of the working details of **Bacula**.

Introduction

The Bacula Storage daemon provides storage resources to a Bacula installation. An individual Storage daemon is associated with a physical permanent storage device (for example, a tape drive, CD writer, tape changer or jukebox, etc.), and may employ auxiliary storage resources (such as space on a hard disk file system) to increase performance and/or optimize use of the permanent storage medium.

Any number of storage daemons may be run on a given machine; each associated with an individual storage device connected to it, and BACULA operations may employ storage daemons on any number of hosts connected by a network, local or remote. The ability to employ remote storage daemons (with appropriate security measures) permits automatic off-site backup, possibly to publicly available backup repositories.

Development Outline

In order to provide a high performance backup and restore solution that scales to very large capacity devices and networks, the storage daemon must be able to extract as much performance from the storage device and network with which it interacts. In order to accomplish this, storage daemons will eventually have to sacrifice simplicity and painless portability in favor of techniques which improve performance. My goal in designing the storage daemon protocol and developing the initial prototype storage daemon is to provide for these additions in the future, while implementing an initial storage daemon which is very simple and portable to almost any POSIX-like environment. This original storage daemon (and its evolved descendants) can serve as a portable solution for non-demanding backup requirements (such as single servers of modest size, individual machines, or small local networks), while serving as the starting point for development of higher performance configurable derivatives which use techniques such as POSIX threads, shared memory, asynchronous I/O, buffering to high-speed intermediate media, and support for tape changers and jukeboxes.

Connections and Sessions

A client connects to a storage server by initiating a conventional TCP connection. The storage server accepts the connection unless its maximum number of connections has been reached or the specified host is not granted access to the storage server. Once a connection has been opened, the client may make any number of Query requests, and/or initiate (if permitted), one or more Append sessions (which transmit data to be stored by the storage daemon) and/or Read sessions (which retrieve data from the storage daemon).

Most requests and replies sent across the connection are simple ASCII strings, with status replies

prefixed by a four digit status code for easier parsing. Binary data appear in blocks stored and retrieved from the storage. Any request may result in a single-line status reply of "3201 Notification pending", which indicates the client must send a "Query notification" request to retrieve one or more notifications posted to it. Once the notifications have been returned, the client may then resubmit the request which resulted in the 3201 status.

The following descriptions omit common error codes, yet to be defined, which can occur from most or many requests due to events like media errors, restarting of the storage daemon, etc. These details will be filled in, along with a comprehensive list of status codes along with which requests can produce them in an update to this document.

Append Requests

append open session = <JobId> [<Password>]

A data append session is opened with the Job ID given by *JobId* with client password (if required) given by *Password*. If the session is successfully opened, a status of 3000 OK is returned with a "ticket = number" reply used to identify subsequent messages in the session. If too many sessions are open, or a conflicting session (for example, a read in progress when simultaneous read and append sessions are not permitted), a status of "3502 Volume busy" is returned. If no volume is mounted, or the volume mounted cannot be appended to, a status of "3503 Volume not mounted" is returned.

append data = <ticket-number>

If the append data is accepted, a status of 3000 OK data address = <IPaddress> port = <port> is returned, where the IPaddress and port specify the IP address and port number of the data channel. Error status codes are 3504 Invalid ticket number and 3505 Session aborted, the latter of which indicates the entire append session has failed due to a daemon or media error. Once the File daemon has established the connection to the data channel opened by the Storage daemon, it will transfer a header packet followed by any number of data packets. The header packet is of the form:

```
<file-index> <stream-id> <info>
```

The details are specified in the [Daemon Protocol](#) section of this document.

**append abort session* = <ticket-number>

The open append session with ticket *ticket-number* is aborted; any blocks not yet written to permanent media are discarded. Subsequent attempts to append data to the session will receive an error status of 3505 Session aborted.

append end session = <ticket-number>

The open append session with ticket *ticket-number* is marked complete; no further blocks may be appended. The storage daemon will give priority to saving any buffered blocks from this session to permanent media as soon as possible.

append close session = <ticket-number>

The append session with ticket *ticket* is closed. This message does not receive an 3000 OK reply until all of the content of the session are stored on permanent media, at which time said reply is given, followed by a list of volumes, from first to last, which contain blocks from the session, along with the first and last file and block on each

containing session data and the volume session key identifying data from that session in lines with the following format:

Volume = <Volume-id> <start-file> <start-block> <end-file>
<end-block> <volume-session-id> where *Volume-id* is the volume label, *start-file* and *start-block* are the file and block containing the first data from that session on the volume, *end-file* and *end-block* are the file and block with the last data from the session on the volume and *volume-session-id* is the volume session ID for blocks from the session stored on that volume.

Read Requests

Read open session = <JobId> <Volume-id> <start-file> <start-block> <end-file>
<end-block> <volume-session-id> <password>

where *Volume-id* is the volume label, *start-file* and *start-block* are the file and block containing the first data from that session on the volume, *end-file* and *end-block* are the file and block with the last data from the session on the volume and *volume-session-id* is the volume session ID for blocks from the session stored on that volume.

If the session is successfully opened, a status of

3100 OK Ticket = *number*"

is returned with a reply used to identify subsequent messages in the session. If too many sessions are open, or a conflicting session (for example, an append in progress when simultaneous read and append sessions are not permitted), a status of "3502 Volume busy" is returned. If no volume is mounted, or the volume mounted cannot be appended to, a status of "3503 Volume not mounted" is returned. If no block with the given volume session ID and the correct client ID number appears in the given first file and block for the volume, a status of "3505 Session not found" is returned.

Read data = <Ticket> > <Block>

The specified Block of data from open read session with the specified Ticket number is returned, with a status of 3000 OK followed by a "Length = *size*" line giving the length in bytes of the block data which immediately follows. Blocks must be retrieved in ascending order, but blocks may be skipped. If a block number greater than the largest stored on the volume is requested, a status of "3201 End of volume" is returned. If a block number greater than the largest in the file is requested, a status of "3401 End of file" is returned.

Read close session = <Ticket>

The read session with Ticket number is closed. A read session may be closed at any time; you needn't read all its blocks before closing it.

by [John Walker](#)

January 30th, MM



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Bacula Catalog Services

File Services Daemon

General

Please note, this section is somewhat out of date as the code has evolved significantly. The basic idea has not changed though.

This chapter is intended to be a technical discussion of the File daemon services and as such is not targeted at end users but rather at developers and system administrators that want or need to know more of the working details of **Bacula**.

The **Bacula File Services** consist of the programs that run on the system to be backed up and provide the interface between the Host File system and Bacula — in particular, the Director and the Storage services.

When time comes for a backup, the Director gets in touch with the File daemon on the client machine and hands it a set of "marching orders" which, if written in English, might be something like the following:

OK, **File daemon**, it's time for your daily incremental backup. I want you to get in touch with the Storage daemon on host archive.mysite.com and perform the following save operations with the designated options. You'll note that I've attached include and exclude lists and patterns you should apply when backing up the file system. As this is an incremental backup, you should save only files modified since the time you started your last backup which, as you may recall, was 2000-11-19-06:43:38. Please let me know when you're done and how it went. Thank you.

So, having been handed everything it needs to decide what to dump and where to store it, the File daemon doesn't need to have any further contact with the Director until the backup is complete providing there are no errors. If there are errors, the error messages will be delivered immediately to the Director. While the backup is proceeding, the File daemon will send the file coordinates and data for each file being backed up to the Storage daemon, which will in turn pass the file coordinates to the Director to put in the catalog.

During a **Verify** of the catalog, the situation is different, since the File daemon will have an exchange with the Director for each file, and will not contact the Storage daemon.

A **Restore** operation will be very similar to the **Backup** except that during the **Restore** the Storage daemon will not send storage coordinates to the Director since the Director presumably already has them. On the other hand, any error messages from either the Storage daemon or File daemon will normally be sent directly to the Directory (this, of course, depends on how the Message resource is defined).

Commands Received from the Director for a Backup

To be written ...

Commands Received from the Director for a Restore

To be written ...



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Internal Component Designs

Catalog Services

General

This chapter is intended to be a technical discussion of the Catalog services and as such is not targeted at end users but rather at developers and system administrators that want or need to know more of the working details of **Bacula**.

The **Bacula Catalog** services consist of the programs that provide the SQL database engine for storage and retrieval of all information concerning files that were backed up and their locations on the storage media.

We have investigated the possibility of using the following SQL engines for Bacula: Beagle, mSQL, GNU SQL, PostgreSQL, SQLite, Oracle, and MySQL. Each presents certain problems with either licensing or maturity. At present, we have chosen for development purposes to use MySQL, PostgreSQL and SQLite. MySQL was chosen because it is fast, proven to be reliable, widely used, and actively being developed. MySQL is released under the GNU GPL license. PostgreSQL was chosen because it is a full-featured, very mature database, and because Dan Langille did the Bacula driver for it. PostgreSQL is distributed under the BSD license. SQLite was chosen because it is small, efficient, and can be directly embedded in **Bacula** thus requiring much less effort from the system administrator or person building **Bacula**. In our testing SQLite has performed very well, and for the functions that we use, it has never encountered any errors except that it does not appear to handle databases larger than 2GBytes.

The Bacula SQL code has been written in a manner that will allow it to be easily modified to support any of the current SQL database systems on the market (for example: mSQL, iODBC, unixODBC, Solid, OpenLink ODBC, EasySoft ODBC, InterBase, Oracle8, Oracle7, and DB2).

If you do not specify either `--with-mysql` or `--with-postgresql` or `--with-sqlite` on the `./configure` line, Bacula will use its minimalist internal database. This database is kept for build reasons but is no longer supported. Bacula **requires** one of the three databases (MySQL, PostgreSQL, or SQLite) to run.

Filenames and Maximum Filename Length

In general, either MySQL, PostgreSQL or SQLite permit storing arbitrary long path names and file names in the catalog database. In practice, there still may be one or two places in the Catalog interface code that restrict the maximum path length to 512 characters and the maximum file name length to 512 characters. These restrictions are believed to have been removed. Please note, these restrictions apply only to the Catalog database and thus to your ability to list online the files saved during any job. All information received and stored by the Storage daemon (normally on tape) allows and handles arbitrarily long path and filenames.

Installing and Configuring MySQL

For the details of installing and configuring MySQL, please see the [Installing and Configuring MySQL](#) chapter of this manual.

Installing and Configuring PostgreSQL

For the details of installing and configuring PostgreSQL, please see the [Installing and Configuring PostgreSQL](#) chapter of this manual.

Installing and Configuring SQLite

For the details of installing and configuring SQLite, please see the [Installing and Configuring SQLite](#) chapter of this manual.

Internal Bacula Catalog

Please see the [Internal Bacula Database](#) chapter of this manual for more details.

Database Table Design

All discussions that follow pertain to the MySQL database. The details for the PostgreSQL and SQLite databases are essentially identical except for that all fields in the SQLite database are stored as ASCII text and some of the database creation statements are a bit different. The details of the internal Bacula catalog are not discussed here.

Because the Catalog database may contain very large amounts of data for large sites, we have made a modest attempt to normalize the data tables to reduce redundant information. While reducing the size of the database significantly, it does, unfortunately, add some complications to the structures.

In simple terms, the Catalog database must contain a record of all Jobs run by Bacula, and for each Job, it must maintain a list of all files saved, with their File Attributes (permissions, create date, ...), and the location and Media on which the file is stored. This is seemingly a simple task, but it represents a huge amount interlinked data. Note: the list of files and their attributes is not maintained when using the internal Bacula database. The data stored in the File records, which allows the user or administrator to obtain a list of all files backed up during a job, is by far the largest volume of information put into the Catalog database.

Although the Catalog database has been designed to handle backup data for multiple clients, some users may want to maintain multiple databases, one for each machine to be backed up. This reduces the risk of confusion of accidental restoring a file to the wrong machine as well as reducing the amount of data in a single database, thus increasing efficiency and reducing the impact of a lost or damaged database.

Sequence of Creation of Records for a Save Job

Start with StartDate, ClientName, Filename, Path, Attributes, MediaName, MediaCoordinates. (PartNumber, NumParts). In the steps below, "Create new" means to create a new record whether or not it is unique. "Create unique" means each record in the database should be unique. Thus, one must first search to see if the record exists, and only if not should a new one be created, otherwise the existing RecordId should be used.

1. Create new Job record with StartDate; save JobId

2. Create unique Media record; save MediaId
3. Create unique Client record; save ClientId
4. Create unique Filename record; save FilenameId
5. Create unique Path record; save PathId
6. Create unique Attribute record; save AttributeId
store ClientId, FilenameId, PathId, and Attributes
7. Create new File record
store JobId, AttributeId, MediaCoordinates, etc
8. Repeat steps 4 through 8 for each file
9. Create a JobMedia record; save MediaId
10. Update Job record filling in EndDate and other Job statistics

Database Tables

Filename		
Column Name	Data Type	Remark
FilenameId	integer	Primary Key
Name	Blob	Filename

The **Filename** table shown above contains the name of each file backed up with the path removed. If different directories or machines contain the same filename, only one copy will be saved in this table.

Path		
Column Name	Data Type	Remark
PathId	integer	Primary Key
Path	Blob	Full Path

The **Path** table contains shown above the path or directory names of all directories on the system or systems. The filename and any MSDOS disk name are stripped off. As with the filename, only one copy of each directory name is kept regardless of how many machines or drives have the same directory. These path names should be stored in Unix path name format.

Some simple testing on a Linux file system indicates that separating the filename and the path may be more complication than is warranted by the space savings. For example, this system has a total of 89,097 files, 60,467 of which have unique filenames, and there are 4,374 unique paths.

Finding all those files and doing two stats() per file takes an average wall clock time of 1 min 35 seconds on a 400MHz machine running RedHat 6.1 Linux.

Finding all those files and putting them directly into a MySQL database with the path and filename defined as TEXT, which is variable length up to 65,535 characters takes 19 mins 31 seconds and creates a 27.6 MByte database.

Doing the same thing, but inserting them into Blob fields with the filename indexed on the first 30 characters and the path name indexed on the 255 (max) characters takes 5 mins 18 seconds and creates a 5.24 MB database. Rerunning the job (with the database already created) takes about 2 mins 50 seconds.

Running the same as the last one (Path and Filename Blob), but Filename indexed on the first 30 characters and the Path on the first 50 characters (linear search done there after) takes 5 mins on the average and creates a 3.4 MB database. Rerunning with the data already in the DB takes 3 mins 35 seconds.

Finally, saving only the full path name rather than splitting the path and the file, and indexing it on the first 50 characters takes 6 mins 43 seconds and creates a 7.35 MB database.

File		
Column Name	Data Type	Remark
FileId	integer	Primary Key
FileIndex	integer	The sequential file number in the Job
JobId	integer	Link to Job Record
PathId	integer	Link to Path Record
FilenameId	integer	Link to Filename Record
MarkId	integer	Used to mark files during Verify Jobs
LStat	tinyblob	File attributes in base64 encoding
MD5	tinyblob	MD5 signature in base64 encoding

The **File** table shown above contains one entry for each file backed up by Bacula. Thus a file that is backed up multiple times (as is normal) will have multiple entries in the File table. This will probably be the table with the most number of records. Consequently, it is essential to keep the size of this record to an absolute minimum. At the same time, this table must contain all the information (or pointers to the information) about the file and where it is backed up. Since a file may be backed up many times without having changed, the path and filename are stored in separate tables.

This table contains by far the largest amount of information in the Catalog database, both from the stand point of number of records, and the stand point of total database size. As a consequence, the user must take care to periodically reduce the number of File records using the **retention** command in the Console program.

Job

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Column Name	Data Type	Remark
JobId	integer	Primary Key
Job	tinyblob	Unique Job Name
Name	tinyblob	Job Name
PurgedFiles	tinyint	Used by Bacula for purging/retention periods
Type	binary(1)	Job Type: Backup, Copy, Clone, Archive, Migration
Level	binary(1)	Job Level
ClientId	integer	Client index
JobStatus	binary(1)	Job Termination Status
SchedTime	datetime	Time/date when Job scheduled
StartTime	datetime	Time/date when Job started
EndTime	datetime	Time/date when Job ended
JobTDate	bigint	Start day in Unix format but 64 bits; used for Retention period.
VolSessionId	integer	Unique Volume Session ID
VolSessionTime	integer	Unique Volume Session Time
JobFiles	integer	Number of files saved in Job
JobBytes	bigint	Number of bytes saved in Job
JobErrors	integer	Number of errors during Job
JobMissingFiles	integer	Number of files not saved (not yet used)
PoolId	integer	Link to Pool Record
FileSetId	integer	Link to FileSet Record
PurgedFiles	tiny integer	Set when all File records purged
HasBase	tiny integer	Set when Base Job run

The **Job** table contains one record for each Job run by Bacula. Thus normally, there will be one per day per machine added to the database. Note, the JobId is used to index Job records in the database, and it often is shown to the user in the Console program. However, care must be taken with its use as it is not unique from database to database. For example, the user may have a database for Client data saved on machine Rufus and another database for Client data saved on machine Roxie. In this case, the two database will each have JobIds that match those in another

database. For a unique reference to a Job, see Job below.

The Name field of the Job record corresponds to the Name resource record given in the Director's configuration file. Thus it is a generic name, and it will be normal to find many Jobs (or even all Jobs) with the same Name.

The Job field contains a combination of the Name and the schedule time of the Job by the Director. Thus for a given Director, even with multiple Catalog databases, the Job will contain a unique name that represents the Job.

For a given Storage daemon, the VolSessionId and VolSessionTime form a unique identification of the Job. This will be the case even if multiple Directors are using the same Storage daemon.

The Job Type (or simply Type) can have one of the following values:

Value	Meaning
B	Backup Job
V	Verify Job
R	Restore Job
C	Console program (not in database)
D	Admin Job
A	Archive Job (not implemented)

The JobStatus field specifies how the job terminated, and can be one of the following:

Value	Meaning
C	Created but not yet running
R	Running
B	Blocked
T	Terminated normally
E	Terminated in Error
e	Non-fatal error
f	Fatal error
D	Verify Differences
A	Canceled by the user

F	Waiting on the File daemon
S	Waiting on the Storage daemon
m	Waiting for a new Volume to be mounted
M	Waiting for a Mount
s	Waiting for Storage resource
j	Waiting for Job resource
c	Waiting for Client resource
d	Waiting for Maximum jobs
t	Waiting for Start Time
p	Waiting for higher priority job to finish

FileSet		
Column Name	Data Type	Remark
FileSetId	integer	Primary Key
FileSet	tinyblob	FileSet name
MD5	tinyblob	MD5 checksum of FileSet
CreateTime	datetime	Time and date Fileset created

The **FileSet** table contains one entry for each FileSet that is used. The MD5 signature is kept to ensure that if the user changes anything inside the FileSet, it will be detected and the new FileSet will be used. This is particularly important when doing an incremental update. If the user deletes a file or adds a file, we need to ensure that a Full backup is done prior to the next incremental.

JobMedia		
Column Name	Data Type	Remark
JobMediaId	integer	Primary Key
JobId	integer	Link to Job Record
MediaId	integer	Link to Media Record
FirstIndex	integer	

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		The index (sequence number) of the first file written for this Job to the Media
LastIndex	integer	The index of the last file written for this Job to the Media
StartFile	integer	The physical media (tape) file number of the first block written for this Job
EndFile	integer	The physical media (tape) file number of the last block written for this Job
StartBlock	integer	The number of the first block written for this Job
EndBlock	integer	The number of the last block written for this Job
VolIndex	integer	The Volume use sequence number within the Job

The **JobMedia** table contains one entry for each volume written for the current Job. If the Job spans 3 tapes, there will be three JobMedia records, each containing the information to find all the files for the given JobId on the tape.

Media		
Column Name	Data Type	Remark
MediaId	integer	Primary Key
VolumeName	tinyblob	Volume name
Slot	integer	Autochanger Slot number or zero
PoolId	integer	Link to Pool Record
MediaType	tinyblob	The MediaType supplied by the user
FirstWritten	datetime	Time/date when first written
LastWritten	datetime	Time/date when last written
LabelDate	datetime	Time/date when tape labeled
VolJobs	integer	Number of jobs written to this media
VolFiles	integer	Number of files written to this media
VolBlocks	integer	Number of blocks written to this media
VolMounts	integer	Number of time media mounted
VolBytes	bigint	Number of bytes saved in Job

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VolErrors	integer	Number of errors during Job
VolWrites	integer	Number of writes to media
MaxVolBytes	bigint	Maximum bytes to put on this media
VolCapacityBytes	bigint	Capacity estimate for this volume
VolStatus	enum	Status of media: Full, Archive, Append, Recycle, Read-Only, Disabled, Error, Busy
Recycle	tinyint	Whether or not Bacula can recycle the Volumes: Yes, No
VolRetention	bigint	64 bit seconds until expiration
VolUseDuration	bigint	64 bit seconds volume can be used
MaxVolJobs	integer	maximum jobs to put on Volume
MaxVolFiles	integer	maximume EOF marks to put on Volume

The **Volume** table (internally referred to as the Media table) contains one entry for each volume, that is each tape, cassette (8mm, DLT, DAT, ...), or file on which information is or was backed up. There is one Volume record created for each of the NumVols specified in the Pool resource record.

Pool		
Column Name	Data Type	Remark
PoolId	integer	Primary Key
Name	Tinyblob	Pool Name
NumVols	Integer	Number of Volumes in the Pool
MaxVols	Integer	Maximum Volumes in the Pool
UseOnce	tinyint	Use volume once
UseCatalog	tinyint	Set to use catalog
AcceptAnyVolume	tinyint	Accept any volume from Pool
VolRetention	bigint	64 bit seconds to retain volume
VolUseDuration	bigint	64 bit seconds volume can be used
MaxVolJobs	integer	max jobs on volume

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MaxVolFiles	integer	max EOF marks to put on Volume
MaxVolBytes	bigint	max bytes to write on Volume
AutoPrune	tinyint	Yes/no for autopruning
Recycle	tinyint	Yes/no for allowing auto recycling of Volume
PoolType	enum	Backup, Copy, Cloned, Archive, Migration
LabelFormat	Tinyblob	Label format

The **Pool** table contains one entry for each media pool controlled by Bacula in this database. One media record exists for each of the NumVols contained in the Pool. The PoolType is a Bacula defined keyword. The MediaType is defined by the administrator, and corresponds to the MediaType specified in the Director's Storage definition record. The CurrentVol is the sequence number of the Media record for the current volume.

Client		
Column Name	Data Type	Remark
ClientId	integer	Primary Key
Name	TinyBlob	File Services Name
UName	TinyBlob	uname –a from Client (not yet used)
AutoPrune	tinyint	Yes/no for autopruning
FileRetention	bigint	64 bit seconds to retain Files
JobRetention	bigint	64 bit seconds to retain Job

The **Client** table contains one entry for each machine backed up by Bacula in this database. Normally the Name is a fully qualified domain name.

UnsavedFiles		
Column Name	Data Type	Remark
UnsavedId	integer	Primary Key
JobId	integer	JobId corresponding to this record
PathId	integer	Id of path
FilenameId	integer	Id of filename

The **UnsavedFiles** table contains one entry for each file that was not saved. Note! This record is not yet implemented.

Counter		
Column Name	Data Type	Remark
Counter	tinyblob	Counter name
MinValue	integer	Start/Min value for counter
MaxValue	integer	Max value for counter
CurrentValue	integer	Current counter value
WrapCounter	tinyblob	Name of another counter

The **Counter** table contains one entry for each permanent counter defined by the user.

Version		
Column Name	Data Type	Remark
VersionId	integer	Primary Key

The **Version** table defines the Bacula database version number. Bacula checks this number before reading the database to ensure that it is compatible with the Bacula binary file.

BaseFiles		
Column Name	Data Type	Remark
BaseId	integer	Primary Key
BaseJobId	integer	JobId of Base Job
JobId	integer	Reference to Job
FileId	integer	Reference to File
FileIndex	integer	File Index number

The **BaseFiles** table contains all the File references for a particular JobId that point to a Base file — i.e. they were previously saved and hence were not saved in the current JobId but in BaseJobId under FileId. FileIndex is the index of the file, and is used for optimization of Restore jobs to prevent the need to read the FileId record when creating the in memory tree. This record

is not yet implemented.

MySQL Table Definition

The commands used to create the MySQL tables are as follows:

```
USE bacula;
CREATE TABLE Filename (
  FilenameId INTEGER UNSIGNED NOT NULL AUTO_INCREMENT,
  Name BLOB NOT NULL,
  PRIMARY KEY(FilenameId),
  INDEX (Name(30))
);

CREATE TABLE Path (
  PathId INTEGER UNSIGNED NOT NULL AUTO_INCREMENT,
  Path BLOB NOT NULL,
  PRIMARY KEY(PathId),
  INDEX (Path(50))
);

CREATE TABLE File (
  FileId INTEGER UNSIGNED NOT NULL AUTO_INCREMENT,
  FileIndex INTEGER UNSIGNED NOT NULL DEFAULT 0,
  JobId INTEGER UNSIGNED NOT NULL REFERENCES Job,
  PathId INTEGER UNSIGNED NOT NULL REFERENCES Path,
  FilenameId INTEGER UNSIGNED NOT NULL REFERENCES Filename,
  MarkId INTEGER UNSIGNED NOT NULL DEFAULT 0,
  LStat TINYBLOB NOT NULL,
  MD5 TINYBLOB NOT NULL,
  PRIMARY KEY(FileId),
  INDEX (JobId),
  INDEX (PathId),
  INDEX (FilenameId)
);

CREATE TABLE Job (
  JobId INTEGER UNSIGNED NOT NULL AUTO_INCREMENT,
  Job TINYBLOB NOT NULL,
  Name TINYBLOB NOT NULL,
  Type BINARY(1) NOT NULL,
  Level BINARY(1) NOT NULL,
  ClientId INTEGER NOT NULL REFERENCES Client,
  JobStatus BINARY(1) NOT NULL,
  SchedTime DATETIME NOT NULL,
  StartTime DATETIME NOT NULL,
  EndTime DATETIME NOT NULL,
  JobTDate BIGINT UNSIGNED NOT NULL,
  VolSessionId INTEGER UNSIGNED NOT NULL DEFAULT 0,
  VolSessionTime INTEGER UNSIGNED NOT NULL DEFAULT 0,
  JobFiles INTEGER UNSIGNED NOT NULL DEFAULT 0,
  JobBytes BIGINT UNSIGNED NOT NULL,
  JobErrors INTEGER UNSIGNED NOT NULL DEFAULT 0,
  JobMissingFiles INTEGER UNSIGNED NOT NULL DEFAULT 0,
  PoolId INTEGER UNSIGNED NOT NULL REFERENCES Pool,
```

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```
FileSetId INTEGER UNSIGNED NOT NULL REFERENCES FileSet,
PurgedFiles TINYINT NOT NULL DEFAULT 0,
HasBase TINYINT NOT NULL DEFAULT 0,
PRIMARY KEY(JobId),
INDEX (Name(128))
);

CREATE TABLE FileSet (
  FileSetId INTEGER UNSIGNED NOT NULL AUTO_INCREMENT,
  FileSet TINYBLOB NOT NULL,
  MD5 TINYBLOB NOT NULL,
  CreateTime DATETIME NOT NULL,
  PRIMARY KEY(FileSetId)
);

CREATE TABLE JobMedia (
  JobMediaId INTEGER UNSIGNED NOT NULL AUTO_INCREMENT,
  JobId INTEGER UNSIGNED NOT NULL REFERENCES Job,
  MediaId INTEGER UNSIGNED NOT NULL REFERENCES Media,
  FirstIndex INTEGER UNSIGNED NOT NULL DEFAULT 0,
  LastIndex INTEGER UNSIGNED NOT NULL DEFAULT 0,
  StartFile INTEGER UNSIGNED NOT NULL DEFAULT 0,
  EndFile INTEGER UNSIGNED NOT NULL DEFAULT 0,
  StartBlock INTEGER UNSIGNED NOT NULL DEFAULT 0,
  EndBlock INTEGER UNSIGNED NOT NULL DEFAULT 0,
  VolIndex INTEGER UNSIGNED NOT NULL DEFAULT 0,
  PRIMARY KEY(JobMediaId),
  INDEX (JobId, MediaId)
);

CREATE TABLE Media (
  MediaId INTEGER UNSIGNED NOT NULL AUTO_INCREMENT,
  VolumeName TINYBLOB NOT NULL,
  Slot INTEGER NOT NULL DEFAULT 0,
  PoolId INTEGER UNSIGNED NOT NULL REFERENCES Pool,
  MediaType TINYBLOB NOT NULL,
  FirstWritten DATETIME NOT NULL,
  LastWritten DATETIME NOT NULL,
  LabelDate DATETIME NOT NULL,
  VolJobs INTEGER UNSIGNED NOT NULL DEFAULT 0,
  VolFiles INTEGER UNSIGNED NOT NULL DEFAULT 0,
  VolBlocks INTEGER UNSIGNED NOT NULL DEFAULT 0,
  VolMounts INTEGER UNSIGNED NOT NULL DEFAULT 0,
  VolBytes BIGINT UNSIGNED NOT NULL DEFAULT 0,
  VolErrors INTEGER UNSIGNED NOT NULL DEFAULT 0,
  VolWrites INTEGER UNSIGNED NOT NULL DEFAULT 0,
  VolCapacityBytes BIGINT UNSIGNED NOT NULL,
  VolStatus ENUM('Full', 'Archive', 'Append', 'Recycle', 'Purged',
    'Read-Only', 'Disabled', 'Error', 'Busy', 'Used', 'Cleaning') NOT NULL,
  Recycle TINYINT NOT NULL DEFAULT 0,
  VolRetention BIGINT UNSIGNED NOT NULL DEFAULT 0,
  VolUseDuration BIGINT UNSIGNED NOT NULL DEFAULT 0,
  MaxVolJobs INTEGER UNSIGNED NOT NULL DEFAULT 0,
  MaxVolFiles INTEGER UNSIGNED NOT NULL DEFAULT 0,
  MaxVolBytes BIGINT UNSIGNED NOT NULL DEFAULT 0,
  InChanger TINYINT NOT NULL DEFAULT 0,
  MediaAddressing TINYINT NOT NULL DEFAULT 0,
  VolReadTime BIGINT UNSIGNED NOT NULL DEFAULT 0,
  VolWriteTime BIGINT UNSIGNED NOT NULL DEFAULT 0,
  PRIMARY KEY(MediaId),
```

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```
INDEX (PoolId)
);

CREATE TABLE Pool (
  PoolId INTEGER UNSIGNED NOT NULL AUTO_INCREMENT,
  Name TINYBLOB NOT NULL,
  NumVols INTEGER UNSIGNED NOT NULL DEFAULT 0,
  MaxVols INTEGER UNSIGNED NOT NULL DEFAULT 0,
  UseOnce TINYINT NOT NULL,
  UseCatalog TINYINT NOT NULL,
  AcceptAnyVolume TINYINT DEFAULT 0,
  VolRetention BIGINT UNSIGNED NOT NULL,
  VolUseDuration BIGINT UNSIGNED NOT NULL,
  MaxVolJobs INTEGER UNSIGNED NOT NULL DEFAULT 0,
  MaxVolFiles INTEGER UNSIGNED NOT NULL DEFAULT 0,
  MaxVolBytes BIGINT UNSIGNED NOT NULL,
  AutoPrune TINYINT DEFAULT 0,
  Recycle TINYINT DEFAULT 0,
  PoolType ENUM('Backup', 'Copy', 'Cloned', 'Archive', 'Migration', 'Scratch') NOT NULL,
  LabelFormat TINYBLOB,
  Enabled TINYINT DEFAULT 1,
  ScratchPoolId INTEGER UNSIGNED DEFAULT 0 REFERENCES Pool,
  RecyclePoolId INTEGER UNSIGNED DEFAULT 0 REFERENCES Pool,
  UNIQUE (Name(128)),
  PRIMARY KEY (PoolId)
);

CREATE TABLE Client (
  ClientId INTEGER UNSIGNED NOT NULL AUTO_INCREMENT,
  Name TINYBLOB NOT NULL,
  Uname TINYBLOB NOT NULL,          /* full uname -a of client */
  AutoPrune TINYINT DEFAULT 0,
  FileRetention BIGINT UNSIGNED NOT NULL,
  JobRetention BIGINT UNSIGNED NOT NULL,
  UNIQUE (Name(128)),
  PRIMARY KEY (ClientId)
);

CREATE TABLE BaseFiles (
  BaseId INTEGER UNSIGNED AUTO_INCREMENT,
  BaseJobId INTEGER UNSIGNED NOT NULL REFERENCES Job,
  JobId INTEGER UNSIGNED NOT NULL REFERENCES Job,
  FileId INTEGER UNSIGNED NOT NULL REFERENCES File,
  FileIndex INTEGER UNSIGNED,
  PRIMARY KEY (BaseId)
);

CREATE TABLE UnsavedFiles (
  UnsavedId INTEGER UNSIGNED AUTO_INCREMENT,
  JobId INTEGER UNSIGNED NOT NULL REFERENCES Job,
  PathId INTEGER UNSIGNED NOT NULL REFERENCES Path,
  FilenameId INTEGER UNSIGNED NOT NULL REFERENCES Filename,
  PRIMARY KEY (UnsavedId)
);

CREATE TABLE Version (
  VersionId INTEGER UNSIGNED NOT NULL
);
```

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```
-- Initialize Version
INSERT INTO Version (VersionId) VALUES (7);

CREATE TABLE Counters (
  Counter TINYBLOB NOT NULL,
  MinValue INTEGER,
  MaxValue INTEGER,
  CurrentValue INTEGER,
  WrapCounter TINYBLOB NOT NULL,
  PRIMARY KEY (Counter(128))
);
```



Bacula File Services



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Internal Component Designs

[Bacula 1.34 User's Guide](#)
The Network Backup Solution

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Bacula Developer Notes

Bacula Internal Component Designs

Please note that some of this documents might be more or less out of date. Although these documents will give you a good idea of the code base, for any specific information, please refer to the source code.

Bacula Internal Component Design Documents

- [Developer Notes](#)
- [Porting Notes](#)
- [Regression Testing](#)
- [Bacula GUI Interface](#)
- [Intra-daemon Protocols](#)
- [Storage Media Format](#)
- [Memory Management Design](#)
- [Bacula Network Protocol](#)
- [Our MD5 Algorithm](#)
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[Bacula 1.34 User's Guide](#)

The Network Backup Solution

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Kern Sibbald and John Walker

Bacula 1.34 User's Guide



Internal Component Designs



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Porting Notes

Bacula Developer Notes

General

This document is intended mostly for developers and describes the the general framework of making Bacula source changes.

Contributions

Contributions from other programmers will be broken into two groups. The first are contributions that are aids and not essential to Bacula. In general, these will be scripts or will go into and examples or contributions directory.

The second class of contributions are those which will be integrated with Bacula and become an essential part. Within this class of contributions, there are two hurdles to surmount. One is getting your patch accepted, and two is dealing with copyright issues. The rest of this document describes some of the requirements for such code.

Patches

Subject to the copyright hurdle described below, your patches should be sent in **diff -u** format, which is the easiest for me to understand. If you plan on doing significant development work over a period of time, after having your first patch reviewed and approved, you will be eligible for having CVS access so that you can submit your changes directly to the CVS repository.

Copyrights

To avoid future problems concerning changing licensing or copyrights, all code contributions more than a hand full of lines must be in the Public Domain or have the copyright assigned to Kern Sibbald and John Walker as in the current code. This double copyright ownership ensures that no single person controls the software. The author of the code should be clearly indicated, and you must be extremely careful not to violate any copyrights or use other people's code without acknowledging it. The purpose of this requirement is to avoid future problems copyright problems. To understand on possible source of future problems, please examine the difficulties Mozilla is having finding previous contributors at <http://www.mozilla.org/MPL/missing.html>. The other important issue is to avoid copyright, patent, or intellectual property violations as are currently (May 2003) being claimed by SCO against IBM.

Although the copyright will be held by Kern and John, each developer is expected to indicate that he wrote and/or modified a particular module (or file) and any other sources.

Although we have absolutely no plans for any commercial venture, it would be ashame to totally rule it out. Our desire is that if one day something commercial is developed around Bacula (as is the case with MySQL, RedHat, Ximian, and other organizations), each developer will have an opportunity to participate, at a minimum, proportional to his prior contributions. Again, we have no current plans for creating any such commercial enterprise.

If you have any doubts about this, please don't hesitate to ask. Our (John and mine) track records with Autodesk are easily available; early programmers/founders/contributors and later employees

had substantial shares of the company, and no one founder had a controlling part of the company. Even though Microsoft created many millionaires among early employees, the politics of Autodesk (during our time at the helm) is in stark contrast to Microsoft where the majority of the company is still tightly held among a few.

Items not needing a copyright assignment are: most small changes, enhancements, or bug fixes of 5–10 lines of code, and documentation.

Copyright Assignment

Since this is not a commercial enterprise, and I prefer to believe in everyone's good faith, developers can assign the copyright by explicitly acknowledging that they do so in their first submission.

Developing Bacula

Typically the simplest way to develop Bacula is to open one xterm window pointing to the source directory you wish to update; a second xterm window at the top source directory level, and a third xterm window at the bacula directory <top>/src/bacula. After making source changes in one of the directories, in the top source directory xterm, build the source, and start the daemons by entering:

```
make
```

```
and
```

```
./startit
```

```
then in the enter:
```

```
./console
```

```
or
```

```
./gnome-console
```

to start the Console program. Enter any commands for testing. For example: run kernsverify full.

Note, the instructions here to use **./startit** are different from using a production system where the administrator starts Bacula by entering **./bacula start**. This difference allows a development version of **Bacula** to be run on a computer at the same time that a production system is running. The **./startit** strip starts **Bacula** using a different set of configuration files, and thus permits avoiding conflicts with any production system.

To make additional source changes, exit from the Console program, and in the top source directory, stop the daemons by entering:

```
./stopit
```

then repeat the process.

Debugging

Probably the first thing to do is to turn on debug output.

A good place to start is with a debug level of 20 as in `./startit -d20`. The `startit` command starts all the daemons with the same debug level. Alternatively, you can start the appropriate daemon with the debug level you want. If you really need more info, a debug level of 60 is not bad, and for just about everything a level of 200.

Using a Debugger

If you have a serious problem such as a segmentation fault, it can usually be found quickly using a good multiple thread debugger such as **`gdb`**. For example, suppose you get a segmentation violation in **`bacula-dir`**. You might use the following to find the problem:

```
<start the Storage and File daemons>
cd dird
gdb ./bacula-dir
run -f -s -c ./dird.conf
<it dies with a segmentation fault>
where
```

The **`-f`** option is specified on the **`run`** command to inhibit **`dird`** from going into the background. You may also want to add the **`-s`** option to the `run` command to disable signals which can potentially interfere with the debugging.

As an alternative to using the debugger, each **Bacula** daemon has a built in back trace feature when a serious error is encountered. It calls the debugger on itself, produces a back trace, and emails the report to the developer. For more details on this, please see the chapter in this manual entitled [What To Do When Bacula Crashes \(Kaboom\)](#).

Memory Leaks

Because Bacula runs routinely and unattended on client and server machines, it may run for a long time. As a consequence, from the very beginning, Bacula uses SmartAlloc to ensure that there are no memory leaks. To make detection of memory leaks effective, all Bacula code that dynamically allocates memory **MUST** have a way to release it. In general when the memory is no longer needed, it should be immediately released, but in some cases, the memory will be held during the entire time that Bacula is executing. In that case, there **MUST** be a routine that can be called at termination time that releases the memory. In this way, we will be able to detect memory leaks. Be sure to immediately correct any and all memory leaks that are printed at the termination of the daemons.

Special Files

Kern uses files named 1, 2, ... 9 with any extension as scratch files. Thus any files with these names are subject to being rudely deleted at any time.

When Implementing Incomplete Code

Please identify all incomplete code with a comment that contains *****FIXME*****, where there are three asterisks (*) before and after the word **FIXME** (in capitals) and no intervening spaces. This is important as it allows new programmers to easily recognize where things are partially implemented.

Bacula Source File Structure

The distribution generally comes as a tar file of the form **bacula.x.y.z.tar.gz** where x, y, and z are the version, release, and update numbers respectively.

Once you detar this file, you will have a directory structure as follows:

```
|
|- depkgs
|   |- mtx                (autochanger control program + tape drive info)
|   |- sqlite             (SQLite database program)
|- depkgs-win32
|   |- pthreads           (Native win32 pthreads library -- dll)
|   |- zlib               (Native win32 zlib library)
|- bacula                 (main source directory containing configuration
|                           and installation files)
|   |- autoconf           (automatic configuration files, not normally used
|                           by users)
|   |- doc                (documentation directory)
|       |- home-page      (Bacula's home page source)
|       |- html-manual    (html document directory)
|       |- techlogs       (Technical development notes);
|- intl                  (programs used to translate)
|- platforms             (OS specific installation files)
|   |- redhat             (Red Hat installation)
|   |- solaris            (Sun installation)
|   |- freebsd            (FreeBSD installation)
|   |- irix               (Irix installation -- not tested)
|   |- unknown            (Default if system not identified)
|- po                    (translations of source strings)
|- src                   (source directory; contains global header files)
|   |- cats               (SQL catalog database interface directory)
|   |- console            (bacula user agent directory)
|   |- dird               (Director daemon)
|   |- filed              (Unix File daemon)
|       |- win32          (Win32 files to make bacula-fd be a service)

|- findlib               (Unix file find library for File daemon)
|- gnome-console          (GNOME version of console program)
|- lib                   (General Bacula library)
|- stored                 (Storage daemon)
|- tconsole               (Tcl/tk console program -- not yet working)
|- testprogs              (test programs -- normally only in Kern's tree)
|- tools                  (Various tool programs)
|- win32                  (Native Win32 File daemon)
|   |- baculafd           (Visual Studio project file)
|   |- compat             (compatibility interface library)
|   |- filed              (links to src/filed)
|   |- findlib            (links to src/findlib)
|   |- lib                (links to src/lib)
|   |- console            (beginning of native console program)
```

```
| - wx-console      (wxWidgets console program)

| - regress        (Regression scripts)
|   | - bin         (temporary directory to hold Bacula installed binaries)
|   | - build       (temporary directory to hold Bacula source)
|   | - scripts     (scripts and .conf files)
|   | - tests       (test scripts)
|   | - tmp         (temporary directory for temp files)
```

Header Files

Please carefully follow the scheme defined below as it permits in general only two header file includes per C file, and thus vastly simplifies programming. With a large complex project like Bacula, it isn't always easy to ensure that the right headers are invoked in the right order (there are a few kludges to make this happen — i.e. in a few include files because of the chicken and egg problem, certain references to typedefs had to be replaced with **void**).

Every file should include **bacula.h**. It pulls in just about everything, with very few exceptions. If you have system dependent ifdefing, please do it in **baconfig.h**. The version number and date are kept in **version.h**.

Each of the subdirectories (console, cats, dird, filed, findlib, lib, stored, ...) contains a single directory dependent include file generally the name of the directory, which should be included just after the include of **bacula.h**. This file (for example, for the dird directory, it is **dird.h**) contains either definitions of things generally needed in this directory, or it includes the appropriate header files. It always includes **protos.h**. See below.

Each subdirectory contains a header file named **protos.h**, which contains the prototypes for subroutines exported by files in that directory. **protos.h** is always included by the main directory dependent include file.

Programming Standards

For the most part, all code should be written in C unless there is a burning reason to use C++, and then only the simplest C++ constructs will be used. Note, Bacula is slowly evolving to use more and more C++.

Code should have some documentation — not a lot, but enough so that I can understand it. Look at the current code, and you will see that I document more than most, but am definitely not a fanatic.

I prefer simple linear code where possible. Gotos are strongly discouraged except for handling an error to either bail out or to retry some code, and such use of gotos can vastly simplify the program.

Indenting Standards

I cannot stand code indented 8 columns at a time. This makes the code unreadable. Even 4 at a time uses a lot of space, so I have adopted indenting 3 spaces at every level. Note, indentation is the visual appearance of the source on the page, while tabbing is replacing a series of 8 spaces with a tab character.

Braces are required in all if statements (missing in some very old code). To avoid generating too many lines, the first brace appears on the first line (e.g. of an if), and the closing brace is on a line by itself. E.g.

```
if (abc) {
    some_code;
}
```

Just follow the convention in the code. Originally I indented case clauses under a switch(), but now I prefer non-indented cases.

```
switch (code) {
case 'A':
    do something
    break;
case 'B':
    again();
    break;
default:
    break;
}
```

Avoid using // style comments except for temporary code or turning off debug code. Standard C comments are preferred (this also keeps the code closer to C).

Attempt to keep all lines less than 85 characters long so that the whole line of code is readable at one time. This is not a rigid requirement.

Always put a brief description at the top of any new file created describing what it does and including your name and the date it was first written. Please don't forget any Copyrights and acknowledgements if it isn't 100% your code. Also, include the Bacula copyright notice that is in **src/c**.

In general you should have two includes at the top of the file. One is **#include "bacula.h"** and the second is an include for the particular directory the code is in, for example, **#include "dird.h"**. Sometimes additional includes are needed, but this should be rare.

In general (except for self-contained packages), prototypes should all be put in **protos.h** in each directory.

Always put space around assignment and comparison operators.

```
a = 1;
if (b>= 2) {
    cleanup();
}
```

but you can compress things in a **for** statement:

```
for (i=0; i <del.num_ids; i++) {
    ...
}
```

Don't overuse the inline if (?:). A full **if** is preferred, except in a print statement, e.g.:

```
if (ua->verbose &del.num_del != 0) {
    bsendmsg(ua, _("Pruned %d %s on Volume %s from catalog.\n"), del.num_del,
        del.num_del == 1 ? "Job" : "Jobs", mr->VolumeName);
}
```

Leave a certain amount of debug code (Dmsg) in code you submit, so that future problems can be identified. This is particularly true for complicated code likely to break. However, try to keep the debug code to a minimum to avoid bloating the program and above all to keep the code readable.

Please keep the same style in all new code you develop. If you include code previously written, you have the option of leaving it with the old indenting or re-indenting it. If the old code is indented with 8 spaces, then please re-indent it to Bacula standards.

If you are using **vim**, simply set your tabstop to 8 and your shiftwidth to 3.

Tabbing

Tabbing (inserting the tab character in place of spaces) is as normal on all Unix systems — a tab is converted into 8 spaces. My editor converts strings of spaces to tabs automatically — this results in significant compression of the files. Thus, you can remove tabs by replacing them with spaces if you wish. Please don't confuse tabbing (use of tab characters) with indenting (visual alignment of the code).

Don'ts

Please don't use:

```
strcpy()
strcat()
sprintf()
snprintf()
```

These should be replaced by the Bacula safe equivalents:

```
char *bstrncpy(char *dest, char *source, int dest_size);
char *bstrncat(char *dest, char *source, int dest_size);
int bsnprintf(char *buf, int32_t buf_len, const char *fmt, ...);
int bvsprintf(char *str, int32_t size, const char *format, va_list ap);
```

See `src/lib/bsys.c` for more details on these routines.

Don't use the **%lld** or the **%q** printf format editing types to edit 64 bit integers — they are not portable. Instead, use **%s** with **edit_uint64()**. For example:

```
char buf[100];
uint64_t num = something;
char ed1[50];

bsnprintf(buf, sizeof(buf), "Num=%s\n", edit_uint64(num, ed1));
```

The edit buffer **ed1** must be at least 27 bytes long to avoid overflow. See `src/lib/edit.c` for more details. If you look at the code, don't start screaming that I use **lld**. I actually use subtle trick taught to me by John Walker. The **lld** that appears in the editing routine is actually **#define** to a

what is needed on your OS (usually "lld" or "q") and is defined in `autoconf/configure.in` for each OS. C string concatenation causes the appropriate string to be concatenated to the "%".

Message Classes

Currently, there are four classes of messages: Debug, Error, Job, and Memory.

Debug Messages

Debug messages are designed to be turned on at a specified debug level and are always sent to STDOUT. There are designed to only be used in the development debug process. They are coded as:

```
DmsgN(level, message, arg1, ...)
```

where the N is a number indicating how many arguments are to be substituted into the message (i.e. it is a count of the number arguments you have in your message — generally the number of percent signs (%)). **level** is the debug level at which you wish the message to be printed. **message** is the debug message to be printed, and **arg1, ...** are the arguments to be substituted. Since not all compilers support `#defines` with `varargs`, you must explicitly specify how many arguments you have.

When the debug message is printed, it will automatically be prefixed by the name of the daemon which is running, the filename where the `Dmsg` is, and the line number within the file.

Some actual examples are:

```
Dmsg2(20, "MD5len=%d MD5=%s\n", strlen(buf), buf);
```

```
Dmsg1(9, "Created client %s record\n", client->hdr.name);
```

Error Messages

Error messages are messages that are related to the daemon as a whole rather than a particular job. For example, an out of memory condition may generate an error message. They are coded as:

```
EmsgN(error-code, level, message, arg1, ...)
```

As with debug messages, you must explicitly code the of arguments to be substituted in the message. **error-code** indicates the severity or class of error, and it may be one of the following:

M_ABORT	Causes the daemon to immediately abort. This should be used only in extreme cases. It attempts to produce a traceback.
M_ERROR_TERM	Causes the daemon to immediately terminate. This should be used only in extreme cases. It does not produce a traceback.
M_FATAL	Causes the daemon to terminate the current job, but the daemon keeps running

M_ERROR	Reports the error. The daemon and the job continue running
M_WARNING	Reports an warning message. The daemon and the job continue running
M_INFO	Reports an informational message.

There are other error message classes, but they are in a state of being redesigned or deprecated, so please do not use them. Some actual examples are:

```
Emsg1(M_ABORT, 0, "Cannot create message thread: %s\n", strerror(status));
```

```
Emsg3(M_WARNING, 0, "Connect to File daemon %s at %s:%d failed. Retrying ...\n",  
client->hdr.name, client->address, client->port);
```

```
Emsg3(M_FATAL, 0, "bdir<filed: bad response from Filed to %s command: %d %s\n", cmd, n,  
strerror(errno));
```

Job Messages

Job messages are messages that pertain to a particular job such as a file that could not be saved, or the number of files and bytes that were saved.

Memory Messages

Memory messages are messages that are edited into a memory buffer. Generally they are used in low level routines such as the low level device file dev.c in the Storage daemon or in the low level Catalog routines. These routines do not generally have access to the Job Control Record and so they return error messages reformatted in a memory buffer. Mmsg() is the way to do this.



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Bacula Regression Testing

Bacula Porting Notes

General

This document is intended mostly for developers who wish to port Bacula to a system that is not **officially** supported.

It is hoped that Bacula clients will eventually run on every imaginable system that needs backing up (perhaps even a Palm). It is also hoped that the Bacula Directory and Storage daemons will run on every system capable of supporting them.

Requirements

In General, the following holds true:

- **Bacula** has been compiled and run on Linux RedHat, FreeBSD, and Solaris systems.
- In addition, clients exist on Win32 (Cygwin), and Irix
- It requires GNU C++ to compile. You can try with other compilers, but you are on your own. The Irix client is built with the Irix compiler, but, in general, you will need GNU.
- Your compiler must provide support for 64 bit signed and unsigned integers.
- You will need a recent copy of the **autoconf** tools loaded on your system (version 2.13 or later). The **autoconf** tools are used to build the configuration program, but are not part of the Bacula source distribution.
- There are certain third party packages that Bacula needs. Except for MySQL, they can all be found in the **depkgs** and **depkgs1** releases.
- If you want to build the Win32 binaries, you will need the full Cygwin 1.5.5 release. Although all components build (console has some warnings), only the File daemon has been tested. Please note that if you attempt to build Bacula on any other version of Cygwin, particularly previous versions, you will be on your own.
- **Bacula** requires a good implementation of pthreads to work.
- The source code has been written with portability in mind and is mostly POSIX compatible. Thus porting to any POSIX compatible operating system should be relatively easy.

Steps to Take

- The first step is to ensure that you have version 2.13 or later of the **autoconf** tools loaded. You can skip this step, but making changes to the configuration program will be difficult or impossible.
- The run a **./configure** command in the main source directory and examine the output. It should look something like the following:

Configuration on Mon Oct 28 11:42:27 CET 2002:

```
Host:                                i686-pc-linux-gnu -- redhat 7.3
Bacula version:                      1.27 (26 October 2002)
Source code location:                .
Install binaries:                    /sbin
Install config files:                 /etc/bacula
C Compiler:                          gcc
```

Bacula Storage Management System

```
C++ Compiler:          c++
Compiler flags:        -g -O2
Linker flags:
Libraries:             -lpthread
Statically Linked Tools: no
Database found:        no
Database type:         Internal
Database lib:

Job Output Email:      root@localhost
Traceback Email:       root@localhost
SMTP Host Address:     localhost
Director Port:         9101
File daemon Port:      9102
Storage daemon Port:   9103
Working directory:     /etc/bacula/working
SQL binaries Directory

Large file support:    yes
readline support:      yes
cweb support:          yes /home/kern/bacula/depkgs/cweb
TCP Wrappers support:  no
ZLIB support:          yes
enable-smartalloc:     yes
enable-gnome:          no
gmp support:           yes
```

The details depend on your system. The first thing to check is that it properly identified your host on the **Host:** line. The first part (added in version 1.27) is the GNU four part identification of your system. The part after the `--` is your system and the system version. Generally, if your system is not yet supported, you must correct these.

- If the `./configure` does not function properly, you must determine the cause and fix it. Generally, it will be because some required system routine is not available on your machine.
- To correct problems with detection of your system type or with routines and libraries, you must edit the file `<bacula-src>/autoconf/configure.in`. This is the "source" from which `configure` is built. In general, most of the changes for your system will be made in `autoconf/aclocal.m4` in the routine `BA_CHECK_OPSYS` or in the routine `BA_CHECK_OPSYS_DISTNAME`. I have already added the necessary code for most systems, but if yours shows up as **unknown** you will need to make changes. Then as mentioned above, you will need to set a number of system dependent items in `configure.in` in the `case` statement at approximately line 1050 (depending on the Bacula release).
- The items to in the case statement that corresponds to your system are the following:
 - ♦ `DISTVER` — set to the version of your operating system. Typically some form of `uname` obtains it.
 - ♦ `TAPEDRIVE` — the default tape drive. Not too important as the user can set it as an option.
 - ♦ `PSCMD` — set to the `ps` command that will provide the PID in the first field and the program name in the second field. If this is not set properly, the **bacula stop** script will most likely not be able to stop Bacula in all cases.
 - ♦ `hostname` — command to return the base host name (non-qualified) of your system. This is generally the machine name. Not too important as the user can correct this in his configuration file.

- ◆ CFLAGS — set any special compiler flags needed. Many systems need a special flag to make pthreads work. See cygwin for an example.
- ◆ LDFLAGS — set any special loader flags. See cygwin for an example.
- ◆ PTHREAD_LIB — set for any special pthreads flags needed during linking. See freebsd as an example.
- ◆ lld — set so that a "long long int" will be properly edited in a printf() call.
- ◆ llu — set so that a "long long unsigned" will be properly edited in a printf() call.
- ◆ PFILES — set to add any files that you may define in your platform subdirectory. These files are used for installation of automatic system startup of Bacula daemons.
- To rebuild a new version of **configure** from a changed **autoconf/configure.in** you enter **make configure** in the top level Bacula source directory. You must have done a **./configure** prior to trying to rebuild the configure script or it will get into an infinite loop.
- If the **make configure** gets into an infinite loop, **ctl-c** it, then do **./configure** (no options are necessary) and retry the **make configure**, which should now work.
- To rebuild **configure** you will need to have **autoconf** version 2.57-3 or higher loaded. Older versions of autoconf will complain about unknown or bad options, and won't work.
- After you have a working **configure** script, you may need to make a few system dependent changes to the way Bacula works. Generally, these are done in **src/baconfig.h**. You can find a few examples of system dependent changes toward the end of this file. For example, on Irix systems, there is no definition for **socklen_t**, so it is made in this file. If your system has structure alignment requirements, check the definition of **BALIGN** in this file. Currently, all Bacula allocated memory is aligned on a **double** boundary.
- If you are having problems with Bacula's type definitions, you might look at **src/bc_types.h** where all the types such as **uint32_t**, **uint64_t**, etc. that Bacula uses are defined.



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Porting Bacula



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Implementing a GUI

Bacula Regression Testing

General

This document is intended mostly for developers who wish to ensure that their changes to Bacula don't introduce bugs in the base code.

You can find the existing regression script in the Bacula CVS on the SourceForge CVS in the project tree named **regress**.

There are two different aspects of regression testing that this document will discuss: 1. Running the Regression Script, 2. Writing a Regression test.

Running the Regression Script

There are a number of different tests that may be run, such as: the standard set that uses disk Volumes and runs under any userid; a small set of tests that write to tape; another set of tests where you must be root to run them. To date, each subset of tests runs no more than about 15 minutes.

Setting the Configuration Parameters

Once you have the regression directory loaded, you will first need to create a custom xxx.conf file for your system. You can either edit **prototype.conf** directly or copy it to a new file and edit it. To see a real example of a configuration file, look at **kern.conf**. The variables you need to modify are:

```
# Where to get the source to be tested
BACULA_SOURCE="${HOME}/bacula/k"

# Where to send email    !!!! Change me !!!!!!!
EMAIL=your-email@domain.com

# Full path where to find sqlite
DEPKGS="${HOME}/bacula/depkgs/sqlite"

TAPE_DRIVE="/dev/nst0"

# if you don't have an autochanger set
#   AUTOCHANGER to /dev/null
AUTOCHANGER="/dev/sg0"

# This must be the path to the autochanger
#   including its name
AUTOCHANGER_PATH="/bin/mtx"
```

- **BACULA_SOURCE** should be the full path to the Bacula source code that you wish to test.
- **EMAIL** should be your email address. Please remember to change this or I will get a flood of unwanted messages. You may or may not want to see these emails. In my case, I

don't need them so I direct it to the bit bucket.

- **SQLITE_DIR** should be the full path to the sqlite package, must be build before running a Bacula regression, if you are using SQLite. This variable is ignored if you are using MySQL or PostgreSQL.
- **TAPE_DRIVE** is the full path to your tape drive. The base set of regression tests do not use a tape, so this is only important if you want to run the full tests.
- **AUTOCHANGER** is the name of your autochanger device. Set this to /dev/null if you do not have one.
- **AUTOCHANGER_PATH** is the full path including the program name for your autochanger program (normally **mtx**). Leave the default value if you do not have one.

Building the Test Bacula

Once the above variables are set, you can build Bacula by entering:

```
./config xxx.conf
make setup
```

Where xxx.conf is the name of the conf file containing your system parameters. This will build a Makefile from Makefile.in, then copy the source code within the regression tree (in directory regress/build), configure it, and build it. There should be no errors. If there are, please correct them before continuing.

Running the Disk Only Regression

Once Bacula is built, you can run the basic disk only non-root regression test by entering:

```
make test
```

This will run the base set of tests using disk Volumes, currently (19 Dec 2003), there are current 18 separate tests that run. If you are testing on a non-Linux machine two of the tests will not be run. In any case, as we add new tests, the number will vary. It will take about 5 or 10 minutes if you have a fast (2 GHz) machine, and you don't need to be root to run these tests (I run under my regular userid). The result should be something similar to:

Test results

```
===== Backup Bacula Test OK =====
===== Verify Volume Test OK =====
===== sparse-test OK =====
===== compressed-test OK =====
===== sparse-compressed-test OK =====
===== Weird files test OK =====
===== two-jobs-test OK =====
===== two-vol-test OK =====
===== six-vol-test OK =====
===== bscan-test OK =====
===== Weird files2 test OK =====
===== concurrent-jobs-test OK =====
===== four-concurrent-jobs-test OK =====
===== bsr-opt-test OK =====
===== bextract-test OK =====
===== recycle-test OK =====
===== span-vol-test OK =====
```

```
===== restore-by-file-test OK =====
===== restore2-by-file-test OK =====
===== four-jobs-test OK =====
===== incremental-test OK =====
```

and the working tape tests are:

Test results

```
===== Bacula tape test OK =====
===== Small File Size test OK =====
===== restore-by-file-tape test OK =====
===== incremental-tape test OK =====
===== four-concurrent-jobs-tape OK =====
===== four-jobs-tape OK =====
```

Each separate test is self contained in that it initializes to run Bacula from scratch (i.e. newly created database). It will also kill any Bacula session that is currently running. In addition, it uses ports 8101, 8102, and 8103 so that it does not interfere with a production system.

Other Tests

There are a number of other tests that can be run as well. All the tests are a simply shell script keep in the regress directory. For example the "make test" simply executes **./all-non-root-tests**. The other tests are:

all_non-root-tests

All non-tape tests not requiring root. This is the standard set of tests, that in general, backup some data, then restore it, and finally compares the restored data with the original data.

all-root-tests

All non-tape tests requiring root permission. These are a relatively small number of tests that require running as root. The amount of data backed up can be quite large. For example, one test backs up /usr, another backs up /etc. One or more of these tests reports an error -- I'll fix it one day.

all-non-root-tape-tests

All tape test not requiring root. There are currently three tests, all run without being root, and backup to a tape. The first two tests use one volume, and the third test requires an autochanger, and uses two volumes. If you don't have an autochanger, then this script will probably produce an error.

all-tape-and-file-tests

All tape and file tests not requiring root. This includes just about everything, and I don't run it very often.

If a Test Fails

If you one or more tests fail, the line output will be similar to:

```
!!!! concurrent-jobs-test failed!!! !!!!!
```

If you want to determine why the test failed, you will need to modify the script so that it prints. Do so by finding the file in **regress/tests** that corresponds to the name printed. For example, the

script for the above error message is in: **regress/tests/concurrent-jobs-test**.

In order to see the output produced by Bacula, you need only change the lines that start with **@output** to **@tee**, then rerun the test by hand. it is very important to start the test from the **regress** directory.

To modify the test mentioned above so that you can see the output, change every occurrence of **@output** to **@tee** in the file. In rare cases you might need to remove the **2>&1 >/dev/null** from the end of the **bacula**, **bconsole**, or **diff** lines, but this is rare.

Writing a Regression Test

Any developer, who implements a major new feature, should write a regression test that exercises and validates the new feature. Each regression test is a complete test by itself. It terminates any running Bacula, initializes the database, starts Bacula, then runs the test by using the console program.

Running the Tests by Hand

You can run any individual test by hand by cd'ing to the **regress** directory and entering:

```
tests/<test-name>
```

Directory Structure

The directory structure of the regression tests is:

```
regress          - Makefile, scripts to start tests
|----- scripts - Scripts and conf files
|-----tests    - All test scripts are here
|
|-----         -- All directories below this point are used
|                for testing, but are created from the
|                above directories and are removed with
|                "make distclean"
|
|----- bin      - This is the install directory for
|                Bacula to be used testing
|----- build    - Where the Bacula source build tree is
|----- tmp      - Most temp files go here
|----- working  - Bacula working directory
|----- weird-files - Weird files used in two of the tests.
```

Adding a New Test

If you want to write a new regression test, it is best to start with one of the existing test scripts, and modify it to do the new test.

When adding a new test, be extremely careful about adding anything to any of the daemons' configuration files. The reason is that it may change the prompts that are sent to the console. For example, adding a Pool means that the current scripts, which assume that Bacula automatically selects a Pool, will now be presented with a new prompt, so the test will fail. If you need to

enhance the configuration files, consider making your own versions.



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Implementing a Bacula GUI Interface

General

This document is intended mostly for developers who wish to develop a new GUI interface to Bacula.

Minimal Code in Console Program

Until now, I have kept all the Catalog code in the Directory (with the exception of dbcheck and bscan). This is because at some point I would like to add user level security and access. If we have code spread everywhere such as in a GUI this will be more difficult. The other advantage is that any code you add to the Director is automatically available to both the tty console program and the GNOME program. The major disadvantage is it increases the size of the code — however, compared to Networker the Bacula Director is really tiny.

GUI Interface is Difficult

Interfacing to an interactive program such as Bacula can be very difficult because the interfacing program must interpret all the prompts that may come. This can be next to impossible. There are a number of ways that Bacula is designed to facilitate this:

- The Bacula network protocol is packet based, and thus pieces of information sent can be ASCII or binary.
- The packet interface permits knowing where the end of a list is.
- The packet interface permits special "signals" to be passed rather than data.
- The Director has a number of commands that are non-interactive. They all begin with a period, and provide things such as the list of all Jobs, list of all Clients, list of all Pools, list of all Storage, ... Thus the GUI interface can get to virtually all information that the Director has in a deterministic way. See <bacula-source>/src/dird/ua_dotcmds.c for more details on this.
- Most console commands allow all the arguments to be specified on the command line: e.g. **run job=NightlyBackup level=Full**

One of the first things to overcome is to be able to establish a conversation with the Director. Although you can write all your own code, it is probably easier to use the Bacula subroutines. The following code is used by the Console program to begin a conversation.

```
#include "bacula.h"
static BSOCK *UA_sock = NULL;
static JCR *jcr;
...
read-your-config-getting-address-and-pasword;

UA_sock = bnet_connect(NULL, 5, 15, "Director daemon", dir->address,
                      NULL, dir->DIRport, 0);

if (UA_sock == NULL) {
    terminate_console(0);
    return 1;
}
jcr.dir_bsock = UA_sock;
```

```
if (!authenticate_director(dir)) {  
    fprintf(stderr, "ERR=%s", UA_sock->msg);  
    terminate_console(0);  
    return 1;  
}  
read_and_process_input(stdin, UA_sock);  
if (UA_sock) {  
    bnet_sig(UA_sock, BNET_TERMINATE); /* send EOF */  
    bnet_close(UA_sock);  
}  
exit 0;
```

Then the `read_and_process_input` routine looks like the following:

```
get-input-to-send-to-the-Director;  
bnet_fsend(UA_sock, "%s", input);  
stat = bnet_recv(UA_sock);  
process-output-from-the-Director;
```

For a GUI program things will be a bit more complicated. Basically in the very inner loop, you will need to check and see if any output is available on the `UA_sock`. For an example, please take a look at the GNOME GUI interface code in: `<bacula-sourcesole/console.c`



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Storage Media Output Format

Daemon Protocol

General

This document describes the protocols used between the various daemons. As Bacula has developed, it has become quite out of date. The general idea still holds true, but the details of the fields for each command, and indeed the commands themselves have changed considerably.

It is intended to be a technical discussion of the general daemon protocols and as such is not targeted at end users but rather at developers and system administrators that want or need to know more of the working details of **Bacula**.

Low Level Network Protocol

At the lowest level, the network protocol is handled by **BSOCK** packets which contain a lot of information about the status of the network connection: who is at the other end, etc. Each basic **Bacula** network read or write actually consists of two low level network read/writes. The first write always sends four bytes of data in machine independent byte order. If data is to follow, the first four bytes are a positive non-zero integer indicating the length of the data that follow in the subsequent write. If the four byte integer is zero or negative, it indicates a special request, a sort of network signaling capability. In this case, no data packet will follow. The low level BSOCK routines expect that only a single thread is accessing the socket at a time. It is advised that multiple threads do not read/write the same socket. If you must do this, you must provide some sort of locking mechanism. I would not be appropriate for efficiency reasons to make every call to the BSOCK routines lock and unlock the packet.

General Daemon Protocol

In general, all the daemons follow the following global rules. There may be exceptions depending on the specific case. Normally, one daemon will be sending commands to another daemon (specifically, the Director to the Storage daemon and the Director to the File daemon).

- Commands are always ASCII commands that are upper/lower case dependent as well as space sensitive.
- All binary data is converted into ASCII (either with printf statements or using base64 encoding).
- All responses to commands sent are always prefixed with a return numeric code where codes in the 1000's are reserved for the Director, the 2000's are reserved for the File daemon, and the 3000's are reserved for the Storage daemon.
- Any response that is not prefixed with a numeric code is a command (or subcommand if you like) coming from the other end. For example, while the Director is corresponding with the Storage daemon, the Storage daemon can request Catalog services from the Director. This convention permits each side to send commands to the other daemon while simultaneously responding to commands.
- Any response that is of zero length, depending on the context, either terminates the data stream being sent or terminates command mode prior to closing the connection.
- Any response that is of negative length is a special sign that normally requires a response. For example, during data transfer from the File daemon to the Storage daemon, normally the File daemon sends continuously without intervening reads. However,

periodically, the File daemon will send a packet of length `-1` indicating that the current data stream is complete and that the Storage daemon should respond to the packet with an OK, ABORT JOB, PAUSE, etc. This permits the File daemon to efficiently send data while at the same time occasionally "polling" the Storage daemon for his status or any special requests.

Currently, these negative lengths are specific to the daemon, but shortly, the range 0 to `-999` will be standard daemon wide signals, while `-1000` to `-1999` will be for Director user, `-2000` to `-2999` for the File daemon, and `-3000` to `-3999` for the Storage daemon.

The Protocol Used Between the Director and the Storage Daemon

Before sending commands to the File daemon, the Director opens a Message channel with the Storage daemon, identifies itself and presents its password. If the password check is OK, the Storage daemon accepts the Director. The Director then passes the Storage daemon, the JobId to be run as well as the File daemon authorization (append, read all, or read for a specific session). The Storage daemon will then pass back to the Director a enabling key for this JobId that must be presented by the File daemon when opening the job. Until this process is complete, the Storage daemon is not available for use by File daemons.

```
SD: listens
DR: makes connection
DR: Hello <Director-name> calling <password>
SD: 3000 OK Hello
DR: JobId=nnn Allow=(append, read) Session=(*, SessionId)
    (Session not implemented yet)
SD: 3000 OK Job Authorization=<password>
DR: use device=<device-name> media_type=<media-type>          pool_name=<pool-name> pool_type=<pool-type>
SD: 3000 OK use device
```

For the Director to be authorized, the `<Director-name>` and the `<password>` must match the values in one of the Storage daemon's Director resources (there may be several Directors that can access a single Storage daemon).

The Protocol Used Between the Director and the File Daemon

A typical conversation might look like the following:

```
FD: listens
DR: makes connection
DR: Hello <Director-name> calling <password>
FD: 2000 OK Hello
DR: JobId=nnn Authorization=<password>
FD: 2000 OK Job
DR: storage address = <Storage daemon address> port = <port-number>
    name = <DeviceName> mediatype = <MediaType>
FD: 2000 OK storage
DR: include
DR: <directory1>
DR: <directory2>
...
```

```
DR: Null packet
FD: 2000 OK include
DR: exclude
DR: <directory1>
DR: <directory2>
...
DR: Null packet
FD: 2000 OK exclude
DR: full
FD: 2000 OK full
DR: save
FD: 2000 OK save
FD: Attribute record for each file as sent to the
    Storage daemon (described above).
FD: Null packet
FD: <append close responses from Storage daemon>
    e.g.
    3000 OK Volumes = <number of volumes>
    3001 Volume = <volume-id> <start file> <start block>
                <end file> <end block> <volume session-id>
    3002 Volume data = <date/time of last write> <Number bytes written>
                <number errors>
    ... additional Volume / Volume data pairs for volumes 2 .. n
FD: Null packet

FD: close socket
```

The Save Protocol Between the File Daemon and the Storage Daemon

Once the Storage daemon has issued the **save** command, the File daemon will contact the Storage daemon to begin the save.

In what follows: FD: refers to information set via the network from the File daemon to the Storage daemon, and SD: refers to information set from the Storage daemon to the File daemon.

Command and Control Information

Command and control information is exchanged in human readable ASCII commands.

```
FD: listens
SD: makes connection
FD: append open session = <JobId> [<password>]
SD: 3000 OK ticket = <number>
FD: append data <ticket-number>
SD: 3000 OK data address = <IPaddress> port = <port>
```

Data Information

The Data information consists of the file attributes and data to the Storage daemon. For the most part, the data information is sent one way: from the File daemon to the Storage daemon. This allows the File daemon to transfer information as fast as possible without a lot of handshaking and network overhead.

However, from time to time, the File daemon needs to do a sort of checkpoint of the situation to ensure that everything is going well with the Storage daemon. To do so, the File daemon sends a packet with a negative length indicating that he wishes the Storage daemon to respond by sending a packet of information to the File daemon. The File daemon then waits to receive a packet from the Storage daemon before continuing.

All data sent are in binary format except for the header packet, which is in ASCII. There are two packet types used data transfer mode: a header packet, the contents of which are known to the Storage daemon, and a data packet, the contents of which are never examined by the Storage daemon.

The first data packet to the Storage daemon will be an ASCII header packet consisting of the following data.

<File-Index> <Stream-Id> <Info>

where <File-Index> is a sequential number beginning from one that increments with each file (or directory) sent.

where <Stream-Id> will be 1 for the Attributes record and 2 for uncompressed File data. 3 is reserved for the MD5 signature for the file.

where <Info> transmit information about the Stream to the Storage Daemon. It is a character string field where each character has a meaning. The only character currently defined is 0 (zero), which is simply a place holder (a no op). In the future, there will be codes indicating compressed data, encrypted data, etc.

Immediately following the header packet, the Storage daemon will expect any number of data packets. The series of data packets is terminated by a zero length packet, which indicates to the Storage daemon that the next packet will be another header packet. As previously mentioned, a negative length packet is a request for the Storage daemon to temporarily enter command mode and send a reply to the File daemon. Thus an actual conversation might contain the following exchanges:

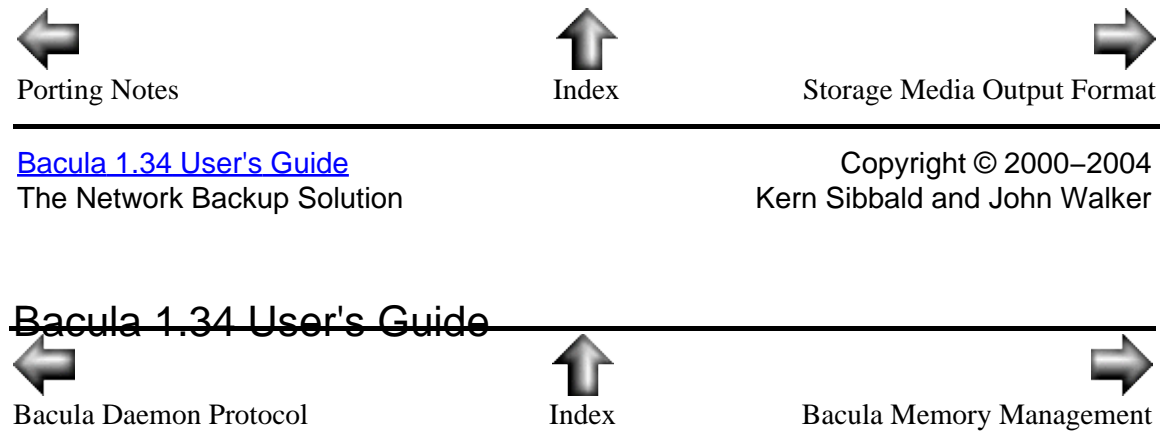
```
FD: <1 1 0> (header packet)
FD: <data packet containing file-attributes>
FD: Null packet
FD: <1 2 0>
FD: <multiple data packets containing the file data>
FD: Packet length = -1
SD: 3000 OK
FD: <2 1 0>
FD: <data packet containing file-attributes>
FD: Null packet
FD: <2 2 0>
FD: <multiple data packets containing the file data>
FD: Null packet
FD: Null packet
```

```
FD: append end session <ticket-number>
SD: 3000 OK end
FD: append close session <ticket-number>
SD: 3000 OK Volumes = <number of volumes>
```

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```
SD: 3001 Volume = <volumeid> <start file> <start block>
      <end file> <end block> <volume session-id>
SD: 3002 Volume data = <date/time of last write> <Number bytes written>
      <number errors>
SD: ... additional Volume / Volume data pairs for
      volumes 2 .. n
FD: close socket
```

The information returned to the File daemon by the Storage daemon in response to the **append** **close session** is transmit in turn to the Director.



Storage Media Output Format

General

This document describes the media format written by the Storage daemon. The Storage daemon reads and writes in units of blocks. Blocks contain records. Each block has a block header followed by records, and each record has a record header followed by record data.

This chapter is intended to be a technical discussion of the Media Format and as such is not targeted at end users but rather at developers and system administrators that want or need to know more of the working details of **Bacula**.

Definitions

Block

A block represents the primitive unit of information that the Storage daemon reads and writes to a physical device. Normally, for a tape device, it will be the same as a tape block. The Storage daemon always reads and writes blocks. A block consists of block header information followed by records. Clients of the Storage daemon (the File daemon) normally never see blocks. However, some of the Storage tools (bls, bscan, bextract, ...) may use block header information. In older Bacula tape versions, a block could contain records (see record definition below) from multiple jobs. However, all blocks currently written by Bacula are block level BB02, and a given block contains records for only a single job. Different jobs simply have their own private blocks that are intermingled with the other blocks from other jobs on the Volume (previously the records were intermingled within the blocks). Having only records from a single job in any give block permitted moving the VolumeSessionId and VolumeSessionTime (see below) from each record heading to the Block header. This has two advantages: 1. a block can be quickly rejected based on the contents of the header without reading all the records. 2. because there is on the average more than one record per block, less data is written to the Volume for each job.

Record

A record consists of a Record Header, which is managed by the Storage daemon and Record Data, which is the data received from the Client. A record is the primitive unit of information sent to and from the Storage daemon by the Client (File daemon) programs. The details are described below.

JobId

A number assigned by the Director daemon for a particular job. This number will be unique for that particular Director (Catalog). The daemons use this number to keep track of individual jobs. Within the Storage daemon, the JobId may not be unique if several Directors are accessing the Storage daemon simultaneously.

Session

A Session is a concept used in the Storage daemon corresponds one to one to a Job with the exception that each session is uniquely identified within the Storage daemon by a unique SessionId/SessionTime pair (see below).

VolSessionId

A unique number assigned by the Storage daemon to a particular session (Job) it is having with a File daemon. This number by itself is not unique to the given Volume, but with the VolSessionTime, it is unique.

VolSessionTime

A unique number assigned by the Storage daemon to a particular Storage daemon execution. It is actually the Unix time_t value of when the Storage daemon began execution cast to a 32 bit unsigned integer. The combination of the **VolSessionId** and the **VolSessionTime** for a given Storage daemon is guaranteed to be unique for each Job (or session).

FileIndex

A sequential number beginning at one assigned by the File daemon to the files within a job that are sent to the Storage daemon for backup. The Storage daemon ensures that this number is greater than zero and sequential. Note, the Storage daemon uses negative FileIndexes to flag Session Start and End Labels as well as End of Volume Labels. Thus, the combination of VolSessionId, VolSessionTime, and FileIndex uniquely identifies the records for a single file written to a Volume.

Stream

While writing the information for any particular file to the Volume, there can be any number of distinct pieces of information about that file, e.g. the attributes, the file data, ... The Stream indicates what piece of data it is, and it is an arbitrary number assigned by the File daemon to the parts (Unix attributes, Win32 attributes, data, compressed data, ...) of a file that are sent to the Storage daemon. The Storage daemon has no knowledge of the details of a Stream; it simply represents a numbered stream of bytes. The data for a given stream may be passed to the Storage daemon in single record, or in multiple records.

Block Header

A block header consists of a block identification ("BB02"), a block length in bytes (typically 64,512) a checksum, and sequential block number. Each block starts with a Block Header and is followed by Records. Current block headers also contain the VolSessionId and VolSessionTime for the records written to that block.

Record Header

A record header contains the Volume Session Id, the Volume Session Time, the FileIndex, the Stream, and the size of the data record which follows. The Record Header is always immediately followed by a Data Record if the size given in the Header is greater than zero. Note, for Block headers of level BB02 (version 1.27 and later), the Record header as written to tape does not contain the Volume Session Id and the Volume Session Time as these two fields are stored in the BB02 Block header. The in-memory record header does have those fields for convenience.

Data Record

A data record consists of a binary stream of bytes and is always preceded by a Record Header. The details of the meaning of the binary stream of bytes are unknown to the Storage daemon, but the Client programs (File daemon) defines and thus knows the details of each record type.

Volume Label

A label placed by the Storage daemon at the beginning of each storage volume. It contains general information about the volume. It is written in Record format. The Storage daemon manages Volume Labels, and if the client wants, he may also read them.

Begin Session Label

The Begin Session Label is a special record placed by the Storage daemon on the storage medium as the first record of an append session job with a File daemon. This record is useful for finding the beginning of a particular session (Job), since no records with the same VolSessionId and VolSessionTime will precede this record. This record is not normally visible outside of the Storage daemon. The Begin Session Label is similar to the Volume Label except that it contains additional information pertaining to the

Session.

End Session Label

The End Session Label is a special record placed by the Storage daemon on the storage medium as the last record of an append session job with a File daemon. The End Session Record is distinguished by a FileIndex with a value of minus two (−2). This record is useful for detecting the end of a particular session since no records with the same VolSessionId and VolSessionTime will follow this record. This record is not normally visible outside of the Storage daemon. The End Session Label is similar to the Volume Label except that it contains additional information pertaining to the Session.

Storage Daemon File Output Format

The file storage and tape storage formats are identical except that tape records are by default blocked into blocks of 64,512 bytes, except for the last block, which is the actual number of bytes written rounded up to a multiple of 1024 whereas the last record of file storage is not rounded up. The default block size of 64,512 bytes may be overridden by the user (some older tape drives only support block sizes of 32K). Each Session written to tape is terminated with an End of File mark (this will be removed later). Sessions written to file are simply appended to the end of the file.

Overall Format

A Bacula output file consists of Blocks of data. Each block contains a block header followed by records. Each record consists of a record header followed by the record data. The first record on a tape will always be the Volume Label Record.

No Record Header will be split across Bacula blocks. However, Record Data may be split across any number of Bacula blocks. Obviously this will not be the case for the Volume Label which will always be smaller than the Bacula Block size.

To simplify reading tapes, the Start of Session (SOS) and End of Session (EOS) records are never split across blocks. If this is about to happen, Bacula will write a short block before writing the session record (actually, the SOS record should always be the first record in a block, excepting perhaps the Volume label).

Due to hardware limitations, the last block written to the tape may not be fully written. If your drive permits backspace record, Bacula will backup over the last record written on the tape, re-read it and verify that it was correctly written.

When a new tape is mounted Bacula will write the full contents of the partially written block to the new tape ensuring that there is no loss of data. When reading a tape, Bacula will discard any block that is not totally written, thus ensuring that there is no duplication of data. In addition, since Bacula blocks are sequentially numbered within a Job, it is easy to ensure that no block is missing or duplicated.

Serialization

All Block Headers, Record Headers, and Label Records are written using Bacula's serialization routines. These routines guarantee that the data is written to the output volume in a machine

independent format.

Block Header

The format of the Block Header (version 1.27 and later) is:

```
uint32_t CheckSum;           /* Block check sum */
uint32_t BlockSize;          /* Block byte size including the header */
uint32_t BlockNumber;        /* Block number */
char ID[4] = "BB02";         /* Identification and block level */
uint32_t VolSessionId;       /* Session Id for Job */
uint32_t VolSessionTime;     /* Session Time for Job */
```

The Block header is a fixed length and fixed format and is followed by Record Headers and Record Data. The CheckSum field is a 32 bit checksum of the block data and the block header but not including the CheckSum field. The Block Header is always immediately followed by a Record Header. If the tape is damaged, a Bacula utility will be able to recover as much information as possible from the tape by recovering blocks which are valid. The Block header is written using the Bacula serialization routines and thus is guaranteed to be in machine independent format. See below for version 2 of the block header.

Record Header

Each binary data record is preceded by a Record Header. The Record Header is fixed length and fixed format, whereas the binary data record is of variable length. The Record Header is written using the Bacula serialization routines and thus is guaranteed to be in machine independent format.

The format of the Record Header (version 1.27 or later) is:

```
int32_t FileIndex;          /* File index supplied by File daemon */
int32_t Stream;             /* Stream number supplied by File daemon */
uint32_t DataSize;          /* size of following data record in bytes */
```

This record is followed by the binary Stream data of DataSize bytes, followed by another Record Header record and the binary stream data. For the definitive definition of this record, see record.h in the src/stored directory.

Additional notes on the above:

The VolSessionId

is a unique sequential number that is assigned by the Storage Daemon to a particular Job. This number is sequential since the start of execution of the daemon.

The VolSessionTime

is the time/date that the current execution of the Storage Daemon started. It assures that the combination of VolSessionId and VolSessionTime is unique for every jobs written to the tape, even if there was a machine crash between two writes.

The FileIndex

is a sequential file number within a job. The Storage daemon requires this index to be greater than zero and sequential. Note, however, that the File daemon may send multiple Streams for the same FileIndex. In addition, the Storage daemon uses negative

FileIndices to hold the Begin Session Label, the End Session Label, and the End of Volume Label.

The Stream

is defined by the File daemon and is used to identify separate parts of the data saved for each file (Unix attributes, Win32 attributes, file data, compressed file data, sparse file data, ...). The Storage Daemon has no idea of what a Stream is or what it contains except that the Stream is required to be a positive integer. Negative Stream numbers are used internally by the Storage daemon to indicate that the record is a continuation of the previous record (the previous record would not entirely fit in the block).

For Start Session and End Session Labels (where the FileIndex is negative), the Storage daemon uses the Stream field to contain the JobId. The current stream definitions are:

```
STREAM_UNIX_ATTRIBUTES      1      /* Generic Unix attributes */
STREAM_FILE_DATA            2      /* Standard uncompressed data */
STREAM_MD5_SIGNATURE        3      /* MD5 signature for the file */
STREAM_GZIP_DATA            4      /* GZip compressed file data */
STREAM_WIN32_ATTRIBUTES    5      /* Windows attributes (superset of Unix) */
STREAM_SPARSE_DATA          6      /* Sparse data stream */
STREAM_SPARSE_GZIP_DATA     7      /* Sparse data stream compressed by GZIP */
STREAM_PROGRAM_NAMES        8      /* program names for program data */
STREAM_PROGRAM_DATA         9      /* Data needing program */
STREAM_SHA1_SIGNATURE       10     /* SHA1 signature for the file */
STREAM_WIN32_DATA           11     /* Win32 BackupRead data */
STREAM_WIN32_GZIP_DATA      12     /* Gzipped Win32 BackupRead data */
```

The DataSize

is the size in bytes of the binary data record that follows the Session Record header. The Storage Daemon has no idea of the actual contents of the binary data record. For standard Unix files, the data record typically contains the file attributes or the file data. For a sparse file the first 64 bits of the file data contains the storage address for the data block.

The Record Header is never split across two blocks. If there is not enough room in a block for the full Record Header, the block is padded to the end with zeros and the Record Header begins in the next block. The data record, on the other hand, may be split across multiple blocks and even multiple physical volumes. When a data record is split, the second (and possibly subsequent) piece of the data is preceded by a new Record Header. Thus each piece of data is always immediately preceded by a Record Header. When reading a record, if Bacula finds only part of the data in the first record, it will automatically read the next record and concatenate the data record to form a full data record.

Records no longer used:

The format of the Block Header (version 1.26 and earlier) is:

```
uint32_t CheckSum;          /* Block check sum */
uint32_t BlockSize;         /* Block byte size including the header */
uint32_t BlockNumber;       /* Block number */
char ID[4] = "BB01";        /* Identification and block level */
```

The format of the Record Header (version 1.26 or earlier) is:

```
uint32_t VolSessionId;      /* Unique ID for this session */
```

```
uint32_t VolSessionTime; /* Start time/date of session */
int32_t FileIndex;      /* File index supplied by File daemon */
int32_t Stream;         /* Stream number supplied by File daemon */
uint32_t DataSize;      /* size of following data record in bytes */
```

Version BB02 Block Header

The original block header BB01 was designed to hold records from multiple sessions. However, it is simpler (and probably more efficient) for each session (Job) to have its own private block. As a consequence, the SessionId and SessionTime can be written once in each Block Header and not in the Record Header. So, the second and current version of the Block Header is:

```
uint32_t CheckSum;      /* Block check sum */
uint32_t BlockSize;     /* Block byte size including the header */
uint32_t BlockNumber;   /* Block number */
char ID[4] = "BB02";    /* Identification and block level */
uint32_t VolSessionId;  /* Applies to all records */
uint32_t VolSessionTime; /* contained in this block */
```

As with the previous version, the BB02 Block header is a fixed length and fixed format and is followed by Record Headers and Record Data. The CheckSum field is a 32 bit CRC checksum of the block data and the block header but not including the CheckSum field. The Block Header is always immediately followed by a Record Header. If the tape is damaged, a Bacula utility will be able to recover as much information as possible from the tape by recovering blocks which are valid. The Block header is written using the Bacula serialization routines and thus is guaranteed to be in machine independent format.

Version 2 Record Header

Version 2 Record Header is written to the medium when using Version BB02 Block Headers. The memory representation of the record is identical to the old BB01 Record Header, but on the storage medium, the first two fields, namely VolSessionId and VolSessionTime are not written. The Block Header is filled with these values when the First user record is written (i.e. non label record) so that when the block is written, it will have the current and unique VolSessionId and VolSessionTime. On reading each record from the Block, the VolSessionId and VolSessionTime is filled in the Record Header from the Block Header.

Volume Label Format

Tape volume labels are created by the Storage daemon in response to a **label** command given to the Console program, or alternatively by the **btape** program. created. Each volume is labeled with the following information using the Bacula serialization routines, which guarantee machine byte order independence.

For Bacula versions 1.27 and later, the Volume Label Format is:

```
char Id[32];            /* Bacula 1.0 Immortal\n */
uint32_t VerNum;        /* Label version number */

/* VerNum 11 and greater Bacula 1.27 and later */
btime_t label_btime;    /* Time/date tape labeled */
btime_t write_btime;    /* Time/date tape first written */
```

```

/* The following are 0 in VerNum 11 and greater */
float64_t write_date;      /* Date this label written */
float64_t write_time;     /* Time this label written */

char VolName[128];        /* Volume name */
char PrevVolName[128];    /* Previous Volume Name */
char PoolName[128];       /* Pool name */
char PoolType[128];       /* Pool type */
char MediaType[128];      /* Type of this media */

char HostName[128];       /* Host name of writing computer */
char LabelProg[32];       /* Label program name */
char ProgVersion[32];     /* Program version */
char ProgDate[32];       /* Program build date/time */

```

The following is no longer used, but Bacula can still read it. For Bacula versions 1.26 and earlier, the Volume Label is:

```

char Id[32];              /* Bacula 0.9 mortal\n */
uint32_t VerNum;          /* Label version number */

float64_t label_date;     /* Date tape labeled */
float64_t label_time;     /* Time tape labeled */

float64_t write_date;     /* Date this label written */
float64_t write_time;     /* Time this label written */

char VolName[128];        /* Volume name */
char PrevVolName[128];    /* Previous Volume Name */
char PoolName[128];       /* Pool name */
char PoolType[128];       /* Pool type */
char MediaType[128];      /* Type of this media */

char HostName[128];       /* Host name of writing computer */
char LabelProg[32];       /* Label program name */
char ProgVersion[32];     /* Program version */
char ProgDate[32];       /* Program build date/time */

```

Note, the LabelType (Volume Label, Volume PreLabel, Session Start Label, ...) is stored in the record FileIndex field of the Record Header and does not appear in the data part of the record.

Session Label

The Session Label is written at the beginning and end of each session as well as the last record on the physical medium. It has the following binary format:

```

char Id[32];              /* Bacula Immortal ... */
uint32_t VerNum;          /* Label version number */

uint32_t JobId;           /* Job id */
uint32_t VolumeIndex;     /* sequence no of vol */

/* Prior to VerNum 11 */
float64_t write_date;     /* Date this label written */

/* VerNum 11 and greater */
btime_t   write_btime;    /* time/date record written */

```

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```
/* The following is zero VerNum 11 and greater */
float64_t write_time;      /* Time this label written */

char PoolName[128];        /* Pool name */
char PoolType[128];        /* Pool type */
char JobName[128];         /* base Job name */
char ClientName[128];
/* Added in VerNum 10 */
char Job[128];             /* Unique Job name */
char FileSetName[128];     /* FileSet name */
uint32_t JobType;
uint32_t JobLevel;
```

In addition, the EOS label contains:

```
/* The remainder are part of EOS label only */
uint32_t JobFiles;
uint64_t JobBytes;
uint32_t start_block;
uint32_t end_block;
uint32_t start_file;
uint32_t end_file;
uint32_t JobErrors;
```

In addition, for VerNum greater than 10, the EOS label contains (in addition to the above):

```
uint32_t JobStatus          /* Job termination code */
```

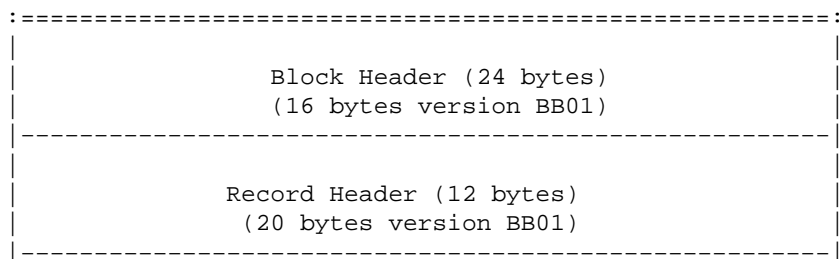
: Note, the LabelType (Volume Label, Volume PreLabel, Session Start Label, ...) is stored in the record FileIndex field and does not appear in the data part of the record. Also, the Stream field of the Record Header contains the JobId. This permits quick filtering without actually reading all the session data in many cases.

Overall Storage Format

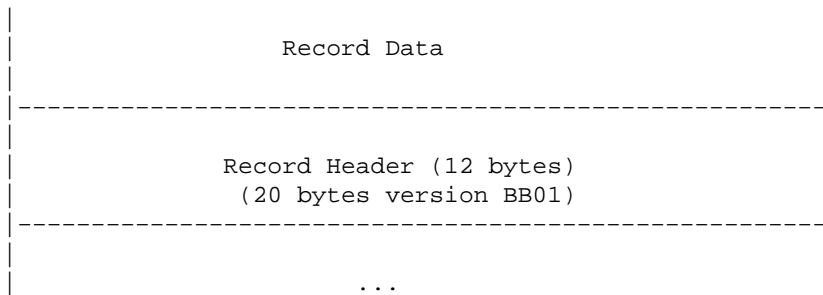
Current Bacula Tape Format
6 June 2001

Version BB02 added 28 September 2002
Version BB01 is the old deprecated format.

A Bacula tape is composed of tape Blocks. Each block has a Block header followed by the block data. Block Data consists of Records. Records consist of Record Headers followed by Record Data.



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Block Header: the first item in each block. The format is shown below.

Partial Data block: occurs if the data from a previous block spills over to this block (the normal case except for the first block on a tape). However, this partial data block is always preceded by a record header.

Record Header: identifies the Volume Session, the Stream and the following Record Data size. See below for format.

Record data: arbitrary binary data.

Block Header Format BB02	
Checksum	(uint32_t)
BlockSize	(uint32_t)
BlockNumber	(uint32_t)
"BB02"	(char [4])
VolSessionId	(uint32_t)
VolSessionTime	(uint32_t)

BB02: Serves to identify the block as a Bacula block and also serves as a block format identifier should we ever need to change the format.

Block Header Format BB01 (deprecated)	
Checksum	(uint32_t)
BlockSize	(uint32_t)
BlockNumber	(uint32_t)
"BB01"	(char [4])

BB01: Serves to identify the block as a Bacula block and also serves as a block format identifier should we ever need to change the format.

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BlockSize: is the size in bytes of the block. When reading back a block, if the BlockSize does not agree with the actual size read, Bacula discards the block.

Checksum: a checksum for the Block.

BlockNumber: is the sequential block number on the tape.

VolSessionId: a unique sequential number that is assigned by the Storage Daemon to a particular Job. This number is sequential since the start of execution of the daemon.

VolSessionTime: the time/date that the current execution of the Storage Daemon started. It assures that the combination of VolSessionId and VolSessionTime is unique for all jobs written to the tape, even if there was a machine crash between two writes.

Record Header Format BB02

FileIndex	(int32_t)
Stream	(int32_t)
DataSize	(uint32_t)

Record Header Format BB01 (deprecated)

VolSessionId	(uint32_t)
VolSessionTime	(uint32_t)
FileIndex	(int32_t)
Stream	(int32_t)
DataSize	(uint32_t)

VolSessionId: a unique sequential number that is assigned by the Storage Daemon to a particular Job. This number is sequential since the start of execution of the daemon.

VolSessionTime: the time/date that the current execution of the Storage Daemon started. It assures that the combination of VolSessionId and VolSessionTime is unique for all jobs written to the tape, even if there was a machine crash between two writes.

FileIndex: a sequential file number within a job. The Storage daemon enforces this index to be greater than zero and sequential. Note, however, that the File daemon may send multiple Streams for the same FileIndex.

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The Storage Daemon uses negative FileIndices to identify Session Start and End labels as well as the End of Volume labels.

Stream: defined by the File daemon and is intended to be used to identify separate parts of the data saved for each file (attributes, file data, ...). The Storage Daemon has no idea of what a Stream is or what it contains.

DataSize: the size in bytes of the binary data record that follows the Session Record header. The Storage Daemon has no idea of the actual contents of the binary data record. For standard Unix files, the data record typically contains the file attributes or the file data. For a sparse file the first 64 bits of the data contains the storage address for the data block.

Volume Label

:=====:	
Id	(32 bytes)

VerNum	(uint32_t)

label_date	(float64_t)
label_btime	(btime_t VerNum 11)

label_time	(float64_t)
write_btime	(btime_t VerNum 11)

write_date	(float64_t)
0	(float64_t) VerNum 11

write_time	(float64_t)
0	(float64_t) VerNum 11

VolName	(128 bytes)

PrevVolName	(128 bytes)

PoolName	(128 bytes)

PoolType	(128 bytes)

MediaType	(128 bytes)

HostName	(128 bytes)

LabelProg	(32 bytes)

ProgVersion	(32 bytes)

ProgDate	(32 bytes)

:=====:	

Id: 32 byte Bacula identifier "Bacula 1.0 immortal\n"

Bacula Storage Management System

(old version also recognized:)

Id: 32 byte Bacula identifier "Bacula 0.9 mortal\n"

LabelType (Saved in the FileIndex of the Header record).

PRE_LABEL	-1	Volume label on unwritten tape
VOL_LABEL	-2	Volume label after tape written
EOM_LABEL	-3	Label at EOM (not currently implemented)
SOS_LABEL	-4	Start of Session label (format given below)
EOS_LABEL	-5	End of Session label (format given below)

VerNum: 11

label_date: Julian day tape labeled

label_time: Julian time tape labeled

write_date: Julian date tape first used (data written)

write_time: Julian time tape first used (data written)

VolName: "Physical" Volume name

PrevVolName: The VolName of the previous tape (if this tape is
a continuation of the previous one).

PoolName: Pool Name

PoolType: Pool Type

MediaType: Media Type

HostName: Name of host that is first writing the tape

LabelProg: Name of the program that labeled the tape

ProgVersion: Version of the label program

ProgDate: Date Label program built

Session Label

Id		(32 bytes)	

VerNum		(uint32_t)	

JobId		(uint32_t)	

write_btime		(btime_t)	VerNum 11
*write_date		(float64_t)	VerNum 10

0		(float64_t)	VerNum 11
*write_time		(float64_t)	VerNum 10

PoolName		(128 bytes)	

PoolType		(128 bytes)	

JobName		(128 bytes)	

ClientName		(128 bytes)	

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Job	(128 bytes)	
FileSetName	(128 bytes)	
JobType	(uint32_t)	
JobLevel	(uint32_t)	
FileSetMD5	(50 bytes)	VerNum 11

Additional fields in End Of Session Label

JobFiles	(uint32_t)	
JobBytes	(uint32_t)	
start_block	(uint32_t)	
end_block	(uint32_t)	
start_file	(uint32_t)	
end_file	(uint32_t)	
JobErrors	(uint32_t)	
JobStatus	(uint32_t)	VerNum 11

:=====:

* => fields deprecated

Id: 32 byte Bacula Identifier "Bacula 1.0 immortal\n"

LabelType (in FileIndex field of Header):

```

EOM_LABEL -3      Label at EOM
SOS_LABEL -4      Start of Session label
EOS_LABEL -5      End of Session label

```

VerNum: 11

JobId: JobId

write_btime: Bacula time/date this tape record written

write_date: Julian date tape this record written - deprecated

write_time: Julian time tape this record written - deprecated.

PoolName: Pool Name

PoolType: Pool Type

MediaType: Media Type

ClientName: Name of File daemon or Client writing this session
Not used for EOM_LABEL.

Unix File Attributes

The Unix File Attributes packet consists of the following:

<File-Index> <Type> <Filename>@<File-Attributes>@<Link> @<Extended-Attributes@>

where

@

represents a byte containing a binary zero.

FileIndex

is the sequential file index starting from one assigned by the File daemon.

Type

is one of the following:

```
#define FT_LNKSAVED 1 /* hard link to file already saved */
#define FT_REGE 2 /* Regular file but empty */
#define FT_REG 3 /* Regular file */
#define FT_LNK 4 /* Soft Link */
#define FT_DIR 5 /* Directory */
#define FT_SPEC 6 /* Special file -- chr, blk, fifo, sock */
#define FT_NOACCESS 7 /* Not able to access */
#define FT_NOFOLLOW 8 /* Could not follow link */
#define FT_NOSTAT 9 /* Could not stat file */
#define FT_NOCHG 10 /* Incremental option, file not changed */
#define FT_DIRNOCHG 11 /* Incremental option, directory not changed */
#define FT_ISARCH 12 /* Trying to save archive file */
#define FT_NORECURSE 13 /* No recursion into directory */
#define FT_NOFSCHG 14 /* Different file system, prohibited */
#define FT_NOOPEN 15 /* Could not open directory */
#define FT_RAW 16 /* Raw block device */
#define FT_FIFO 17 /* Raw fifo device */
```

Filename

is the fully qualified filename.

File-Attributes

consists of the 13 fields of the stat() buffer in ASCII base64 format separated by spaces. These fields and their meanings are shown below. This stat() packet is in Unix format, and MUST be provided (constructed) for ALL systems.

Link

when the FT code is FT_LNK or FT_LNKSAVED, the item in question is a Unix link, and this field contains the fully qualified link name. When the FT code is not FT_LNK or FT_LNKSAVED, this field is null.

Extended-Attributes

The exact format of this field is operating system dependent. It contains additional or extended attributes of a system dependent nature. Currently, this field is used only on WIN32 systems where it contains a ASCII base64 representation of the WIN32_FILE_ATTRIBUTE_DATA structure as defined by Windows. The fields in the base64 representation of this structure are like the File-Attributes separated by spaces.

The File-attributes consist of the following:

Field No.	Stat Name	Unix	Win98/NT	MacOS
-----------	-----------	------	----------	-------

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1	st_dev	Device number of filesystem	Drive number	vRefNum
2	st_ino	Inode number	Always 0	fileID/dirID
3	st_mode	File mode	File mode	777 dirs/apps; 666 docs; 444 locked docs
4	st_nlink	Number of links to the file	Number of link (only on NTFS)	Always 1
5	st_uid	Owner ID	Always 0	Always 0
6	st_gid	Group ID	Always 0	Always 0
7	st_rdev	Device ID for special files	Drive No.	Always 0
8	st_size	File size in bytes	File size in bytes	Data fork file size in bytes
9	st_blksize	Preferred block size	Always 0	Preferred block size
10	st_blocks	Number of blocks allocated	Always 0	Number of blocks allocated
11	st_atime	Last access time since epoch	Last access time since epoch	Last access time –66 years
12	st_mtime	Last modify time since epoch	Last modify time since epoch	Last access time –66 years
13	st_ctime	Inode change time since epoch	File create time since epoch	File create time –66 years



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Bacula Memory Management

General

This document describes the memory management routines that are used in Bacula and is meant to be a technical discussion for developers rather than part of the user manual.

Since Bacula may be called upon to handle filenames of varying and more or less arbitrary length, special attention needs to be used in the code to ensure that memory buffers are sufficiently large. There are four possibilities for memory usage within **Bacula**. Each will be described in turn. They are:

- Statically allocated memory.
- Dynamically allocated memory using `malloc()` and `free()`.
- Non-pooled memory.
- Pooled memory.

Statically Allocated Memory

Statically allocated memory is of the form:

```
char buffer[MAXSTRING];
```

The use of this kind of memory is discouraged except when you are 100% sure that the strings to be used will be of a fixed length. One example of where this is appropriate is for **Bacula** resource names, which are currently limited to 127 characters (`MAX_NAME_LENGTH`). Although this maximum size may change, particularly to accommodate Unicode, it will remain a relatively small value.

Dynamically Allocated Memory

Dynamically allocated memory is obtained using the standard `malloc()` routines. As in:

```
char *buf;  
buf = malloc(256);
```

This kind of memory can be released with:

```
free(buf);
```

It is recommended to use this kind of memory only when you are sure that you know the memory size needed and the memory will be used for short periods of time — that is it would not be appropriate to use statically allocated memory. An example might be to obtain a large memory buffer for reading and writing files. When **SmartAlloc** is enabled, the memory obtained by `malloc()` will automatically be checked for buffer overwrite (overflow) during the `free()` call, and all `malloc`'ed memory that is not released prior to termination of the program will be reported as Orphaned memory.

Pooled and Non-pooled Memory

In order to facility the handling of arbitrary length filenames and to efficiently handle a high volume of dynamic memory usage, we have implemented routines between the C code and the malloc routines. The first is called "Pooled" memory, and is memory, which once allocated and then released, is not returned to the system memory pool, but rather retained in a Bacula memory pool. The next request to acquire pooled memory will return any free memory block. In addition, each memory block has its current size associated with the block allowing for easy checking if the buffer is of sufficient size. This kind of memory would normally be used in high volume situations (lots of malloc()s and free()s) where the buffer length may have to frequently change to adapt to varying filename lengths.

The non-pooled memory is handled by routines similar to those used for pooled memory, allowing for easy size checking. However, non-pooled memory is returned to the system rather than being saved in the Bacula pool. This kind of memory would normally be used in low volume situations (few malloc()s and free()s), but where the size of the buffer might have to be adjusted frequently.

Types of Memory Pool

Currently there are three memory pool types:

- PM_NOPOOL --- non-pooled memory.
- PM_FNAME --- a filename pool.
- PM_MESSAGE --- a message buffer pool.
- PM_EMSG --- error message buffer pool.

Getting Memory

To get memory, one uses:

```
void *get_pool_memory(pool);
```

where **pool** is one of the above mentioned pool names. The size of the memory returned will be determined by the system to be most appropriate for the application.

If you wish non-pooled memory, you may alternatively call:

```
void *get_memory(size_t size);
```

The buffer length will be set to the size specified, and it will be assigned to the PM_NOPOOL pool (no pooling).

Releasing Memory

To free memory acquired by either of the above two calls, use:

```
void free_pool_memory(void *buffer);
```

where **buffer** is the memory buffer returned when the memory was acquired. If the memory was originally allocated as type PM_NOPOOL, it will be released to the system, otherwise, it will be

placed on the appropriate Bacula memory pool free chain to be used in a subsequent call for memory from that pool.

Determining the Memory Size

To determine the memory buffer size, use:

```
size_t sizeof_pool_memory(void *buffer);
```

Resizing Pool Memory

To resize pool memory, use:

```
void *realloc_pool_memory(void *buffer);
```

The buffer will be reallocated, and the contents of the original buffer will be preserved, but the address of the buffer may change.

Automatic Size Adjustment

To have the system check and if necessary adjust the size of your pooled memory buffer, use:

```
void *check_pool_memory_size(void *buffer, size_t new-size);
```

where **new-size** is the buffer length needed. Note, if the buffer is already equal to or larger than **new-size** no buffer size change will occur. However, if a buffer size change is needed, the original contents of the buffer will be preserved, but the buffer address may change. Many of the low level Bacula subroutines expect to be passed a pool memory buffer and use this call to ensure the buffer they use is sufficiently large.

Releasing All Pooled Memory

In order to avoid orphaned buffer error messages when terminating the program, use:

```
void close_memory_pool();
```

to free all unused memory retained in the Bacula memory pool. Note, any memory not returned to the pool via `free_pool_memory()` will not be released by this call.

Pooled Memory Statistics

For debugging purposes and performance tuning, the following call will print the current memory pool statistics:

```
void print_memory_pool_stats();
```

an example output is:

Pool	Maxsize	Maxused	Inuse
0	256	0	0
1	256	1	0
2	256	1	0



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TCP/IP Network Protocol

General

This document describes the TCP/IP protocol used by Bacula to communicate between the various daemons and services. The definitive definition of the protocol can be found in `src/lib/bsock.h`, `src/lib/bnet.c` and `src/lib/bnet_server.c`.

Bacula's network protocol is basically a "packet oriented" protocol built on a standard TCP/IP streams. At the lowest level all packet transfers are done with `read()` and `write()` requests on system sockets. Pipes are not used as they are considered unreliable for large serial data transfers between various hosts.

Using the routines described below (`bnet_open`, `bnet_write`, `bnet_recv`, and `bnet_close`) guarantees that the number of bytes you write into the socket will be received as a single record on the other end regardless of how many low level `write()` and `read()` calls are needed. All data transferred are considered to be binary data.

bnet and Threads

These `bnet` routines work fine in a threaded environment. However, they assume that there is only one reader or writer on the socket at any time. It is highly recommended that only a single thread access any BSOCK packet. The exception to this rule is when the socket is first opened and it is waiting for a job to start. The wait in the Storage daemon is done in one thread and then passed to another thread for subsequent handling.

If you envision having two threads using the same BSOCK, think twice, then you must implement some locking mechanism. However, it probably would not be appropriate to put locks inside the `bnet` subroutines for efficiency reasons.

bnet_open

To establish a connection to a server, use the subroutine:

```
BSOCK *bnet_open(void *jcr, char *host, char *service, int port, int *fatal)
```

`bnet_open()`, if successful, returns the Bacula sock descriptor pointer to be used in subsequent `bnet_send()` and `bnet_read()` requests. If not successful, `bnet_open()` returns a NULL. If `fatal` is set on return, it means that a fatal error occurred and that you should not repeatedly call `bnet_open()`. Any error message will generally be sent to the JCR.

bnet_send

To send a packet, one uses the subroutine:

```
int bnet_send(BSOCK *sock)
```

This routine is equivalent to a `write()` except that it handles the low level details. The data to be sent is expected to be in `sock->msg` and be `sock->msglen` bytes. To send a packet, `bnet_send()`

first writes four bytes in network byte order than indicate the size of the following data packet. It returns:

```
Returns 0 on failure
Returns 1 on success
```

In the case of a failure, an error message will be sent to the JCR contained within the bsock packet.

bnet_fsend

This form uses:

```
int bnet_fsend(BSOCK *sock, char *format, ...)
```

and it allows you to send a formatted messages somewhat like `fprintf()`. The return status is the same as `bnet_send`.

Additional Error information

For additional error information, you can call **`is_bnet_error(BSOCK *bsock)`** which will return 0 if there is no error or non-zero if there is an error on the last transmission. The **`is_bnet_stop(BSOCK *bsock)`** function will return 0 if there no errors and you can continue sending. It will return non-zero if there are errors or the line is closed (no more transmissions should be sent).

bnet_recv

To read a packet, one uses the subroutine:

```
int bnet_recv(BSOCK *sock)
```

This routine is similar to a `read()` except that it handles the low level details. `bnet_read()` first reads packet length that follows as four bytes in network byte order. The data is read into `sock->msg` and is `sock->msglen` bytes. If the `sock->msg` is not large enough, `bnet_recv()` `realloc()` the buffer. It will return an error (-2) if `maxbytes` is less than the record size sent. It returns:

```
* Returns number of bytes read
* Returns 0 on end of file
* Returns -1 on hard end of file (i.e. network connection close)
* Returns -2 on error
```

It should be noted that `bnet_recv()` is a blocking read.

bnet_sig

To send a "signal" from one daemon to another, one uses the subroutine:

```
int bnet_sig(BSOCK *sock, SIGNAL)
```

where SIGNAL is one of the following:

1. BNET_EOF – deprecated use BNET_EOD
2. BNET_EOD – End of data stream, new data may follow
3. BNET_EOD_POLL – End of data and poll all in one
4. BNET_STATUS – Request full status
5. BNET_TERMINATE – Conversation terminated, doing close()
6. BNET_POLL – Poll request, I'm hanging on a read
7. BNET_HEARTBEAT – Heartbeat Response requested
8. BNET_HB_RESPONSE – Only response permitted to HB
9. BNET_PROMPT – Prompt for UA

bnet_strerror

Returns a formatted string corresponding to the last error that occurred.

bnet_close

The connection with the server remains open until closed by the subroutine:

```
void bnet_close(BSOCK *sock)
```

Becoming a Server

The `bnet_open()` and `bnet_close()` routines described above are used on the client side to establish a connection and terminate a connection with the server. To become a server (i.e. wait for a connection from a client), use the routine **`bnet_thread_server`**. The calling sequence is a bit complicated, please refer to the code in `bnet_server.c` and the code at the beginning of each daemon as examples of how to call it.

Higher Level Conventions

Within Bacula, we have established the convention that any time a single record is passed, it is sent with `bnet_send()` and read with `bnet_rcv()`. Thus the normal exchange between the server (S) and the client (C) are:

S: wait for connection	C: attempt connection
S: accept connection	C: <code>bnet_send()</code> send request
S: <code>bnet_rcv()</code> wait for request	
S: act on request	
S: <code>bnet_send()</code> send ack	C: <code>bnet_rcv()</code> wait for ack

Thus a single command is sent, acted upon by the server, and then acknowledged.

In certain cases, such as the transfer of the data for a file, all the information or data cannot be sent in a single packet. In this case, the convention is that the client will send a command to the server, who knows that more than one packet will be returned. In this case, the server will enter a loop:

```
while ((n=bnet_rcv(bsock)) > 0) {  
    act on request
```

```
}  
if (n < 0)  
    error
```

The client will perform the following:

```
bnet_send(bsock);  
bnet_send(bsock);  
...  
bnet_sig(bsock, BNET_EOD);
```

Thus the client will send multiple packets and signal to the server when all the packets have been sent by sending a zero length record.



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Smart Memory Allocation



Command Line Message Digest Utility

This page describes **md5**, a command line utility usable on either Unix or MS-DOS/Windows, which generates and verifies message digests (digital signatures) using the MD5 algorithm. This program can be useful when developing shell scripts or Perl programs for software installation, file comparison, and detection of file corruption and tampering.

NAME

md5 – generate / check MD5 message digest

SYNOPSIS

md5 [*-csignature*] [*-u*] [*-dinput_text | infile*] [*outfile*]

DESCRIPTION

A *message digest* is a compact digital signature for an arbitrarily long stream of binary data. An ideal message digest algorithm would never generate the same signature for two different sets of input, but achieving such theoretical perfection would require a message digest as long as the input file. Practical message digest algorithms compromise in favour of a digital signature of modest size created with an algorithm designed to make preparation of input text with a given signature computationally infeasible. Message digest algorithms have much in common with techniques used in encryption, but to a different end; verification that data have not been altered since the signature was published.

Many older programs requiring digital signatures employed 16 or 32 bit *cyclical redundancy codes* (CRC) originally developed to verify correct transmission in data communication protocols, but these short codes, while adequate to detect the kind of transmission errors for which they were intended, are insufficiently secure for applications such as electronic commerce and verification of security related software distributions.

The most commonly used present-day message digest algorithm is the 128 bit MD5 algorithm, developed by Ron Rivest of the [MIT Laboratory for Computer Science](#) and [RSA Data Security, Inc.](#) The algorithm, with a reference implementation, was published as Internet [RFC 1321](#) in April 1992, and was placed into the public domain at that time. Message digest algorithms such as MD5 are not deemed "encryption technology" and are not subject to the export controls some governments impose on other data security products. (Obviously, the responsibility for obeying the laws in the jurisdiction in which you reside is entirely your own, but many common Web and Mail utilities use MD5, and I am unaware of any restrictions on their distribution and use.)

The MD5 algorithm has been implemented in numerous computer languages including C, [Perl](#), and [Java](#); if you're writing a program in such a language, track down a suitable subroutine and incorporate it into your program. The program described on this page is a *command line* implementation of MD5, intended for use in shell scripts and Perl programs (it is much faster than computing an MD5 signature directly in Perl). This **md5** program was originally developed as part of a suite of tools intended to monitor large collections of files (for

example, the contents of a Web site) to detect corruption of files and inadvertent (or perhaps malicious) changes. That task is now best accomplished with more comprehensive packages such as [Tripwire](#), but the command line **md5** component continues to prove useful for verifying correct delivery and installation of software packages, comparing the contents of two different systems, and checking for changes in specific files.

OPTIONS

-c*signature*

Computes the signature of the specified *infile* or the string supplied by the **-d** option and compares it against the specified *signature*. If the two signatures match, the exit status will be zero, otherwise the exit status will be 1. No signature is written to *outfile* or standard output; only the exit status is set. The signature to be checked must be specified as 32 hexadecimal digits.

-d*input_text*

A signature is computed for the given *input_text* (which must be quoted if it contains white space characters) instead of input from *infile* or standard input. If input is specified with the **-d** option, no *infile* should be specified.

-u

Print how-to-call information.

FILES

If no *infile* or **-d** option is specified or *infile* is a single "-", **md5** reads from standard input; if no *outfile* is given, or *outfile* is a single "-", output is sent to standard output. Input and output are processed strictly serially; consequently **md5** may be used in pipelines.

BUGS

The mechanism used to set standard input to binary mode may be specific to Microsoft C; if you rebuild the DOS/Windows version of the program from source using another compiler, be sure to verify binary files work properly when read via redirection or a pipe.

This program has not been tested on a machine on which `int` and/or `long` are longer than 32 bits.



[Download md5.zip](#) (Zipped archive)

The program is provided as [md5.zip](#), a [Zipped](#) archive containing an ready-to-run Win32 command-line executable program, `md5.exe` (compiled using Microsoft Visual C++ 5.0), and in source code form along with a `Makefile` to build the program under Unix.

SEE ALSO

`sum(1)`

EXIT STATUS

md5 returns status 0 if processing was completed without errors, 1 if the **-c** option was specified and the given signature does not match that of the input, and 2 if processing could not be performed at all due, for example, to a nonexistent input file.

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ACKNOWLEDGEMENTS

The MD5 algorithm was developed by Ron Rivest. The public domain C language implementation used in this program was written by Colin Plumb in 1993.

[by John Walker](#)
January 6th, MIM



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MD5 Algorithm



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Smartalloc

Smart Memory Allocation With Orphaned Buffer Detection

Few things are as embarrassing as a program that leaks, yet few errors are so easy to commit or as difficult to track down in a large, complicated program as failure to release allocated memory. SMARTALLOC replaces the standard C library memory allocation functions with versions which keep track of buffer allocations and releases and report all orphaned buffers at the end of program execution. By including this package in your program during development and testing, you can identify code that loses buffers right when it's added and most easily fixed, rather than as part of a crisis debugging push when the problem is identified much later in the testing cycle (or even worse, when the code is in the hands of a customer). When program testing is complete, simply recompiling with different flags removes SMARTALLOC from your program, permitting it to run without speed or storage penalties.

In addition to detecting orphaned buffers, SMARTALLOC also helps to find other common problems in management of dynamic storage including storing before the start or beyond the end of an allocated buffer, referencing data through a pointer to a previously released buffer, attempting to release a buffer twice or releasing storage not obtained from the allocator, and assuming the initial contents of storage allocated by functions that do not guarantee a known value. SMARTALLOC's checking does not usually add a large amount of overhead to a program (except for programs which use `realloc()` extensively; see below). SMARTALLOC focuses on proper storage management rather than internal consistency of the heap as checked by the `malloc_debug` facility available on some systems. SMARTALLOC does not conflict with `malloc_debug` and both may be used together, if you wish. SMARTALLOC makes no assumptions regarding the internal structure of the heap and thus should be compatible with any C language implementation of the standard memory allocation functions.

Installing SMARTALLOC

SMARTALLOC is provided as a Zipped archive, [smartall.zip](#); see the download instructions below.

To install SMARTALLOC in your program, simply add the statement:

```
#include "smartall.h"
```

to every C program file which calls any of the memory allocation functions (`malloc`, `calloc`, `free`, etc.). SMARTALLOC must be used for all memory allocation with a program, so it's best to add the `#include` of "smartall.h" to the omnibus include file for your entire program, if you have such a thing. Next, define the symbol SMARTALLOC in the compilation before the inclusion of smartall.h. I usually do this by having my Makefile add the `"-DSMARTALLOC"` option to the C compiler for non-production builds. You can define the symbol manually, if you prefer, by adding the statement:

```
#define SMARTALLOC
```


before the `#include` of "smartall.h".

At the point where your program is all done and ready to relinquish control to the operating system, add the call:

```
sm_dump( datadump );
```

where *datadump* specifies whether the contents of orphaned buffers are to be dumped in addition printing to their size and place of allocation. The data are dumped only if *datadump* is nonzero, so most programs will normally use `sm_dump(0);`. If a mysterious orphaned buffer appears that can't be identified from the information this prints about it, replace the statement with `sm_dump(1);`. Usually the dump of the buffer's data will furnish the additional clues you need to excavate and extirpate the elusive error that left the buffer allocated.

Finally, add the files "smartall.h" and "smartall.c" from this release to your source directory, make dependencies, and linker input. You needn't make inclusion of smartall.c in your link optional; if compiled with SMARTALLOC not defined it generates no code, so you may always include it knowing it will waste no storage in production builds. Now when you run your program, if it leaves any buffers around when it's done, each will be reported by `sm_dump()` on stderr as follows:

```
Orphaned buffer:      120 bytes allocated at line 50 of gutshot.c
```

Squelching a SMARTALLOC

Usually, when you first install SMARTALLOC in an existing program you'll find it nattering about lots of orphaned buffers. Some of these turn out to be legitimate errors, but some are storage allocated during program initialisation that, while dynamically allocated, is logically static storage not intended to be released. Of course, you can get rid of the complaints about these buffers by adding code to release them, but by doing so you're adding unnecessary complexity and code size to your program just to silence the nattering of a SMARTALLOC, so an escape hatch is provided to eliminate the need to release these buffers.

Normally all storage allocated with the functions `malloc()`, `calloc()`, and `realloc()` is monitored by SMARTALLOC. If you make the function call:

```
sm_static(1);
```

you declare that subsequent storage allocated by `malloc()`, `calloc()`, and `realloc()` should not be considered orphaned if found to be allocated when `sm_dump()` is called. I use a call on `sm_static(1);` before I allocate things like program configuration tables so I don't have to add code to release them at end of program time. After allocating unmonitored data this way, be sure to add a call to:

```
sm_static(0);
```

to resume normal monitoring of buffer allocations. Buffers allocated while `sm_static(1)` is in effect are not checked for having been orphaned but all the other safeguards provided by SMARTALLOC remain in effect. You may release such buffers, if you like; but you don't have to.

Living with Libraries

Some library functions for which source code is unavailable may gratuitously allocate and return buffers that contain their results, or require you to pass them buffers which they subsequently release. If you have source code for the library, by far the best approach is to simply install SMARTALLOC in it, particularly since this kind of ill-structured dynamic storage management is the source of so many storage leaks. Without source code, however, there's no option but to provide a way to bypass SMARTALLOC for the buffers the library allocates and/or releases with the standard system functions.

For each function *xxx* redefined by SMARTALLOC, a corresponding routine named "actuallyxxx" is furnished which provides direct access to the underlying system function, as follows:

Standard function	Direct access function
<code>malloc(<i>size</i>)</code>	<code>actuallymalloc(<i>size</i>)</code>
<code>calloc(<i>nelem</i>, <i>elsize</i>)</code>	<code>actuallycalloc(<i>nelem</i>, <i>elsize</i>)</code>
<code>realloc(<i>ptr</i>, <i>size</i>)</code>	<code>actuallyrealloc(<i>ptr</i>, <i>size</i>)</code>
<code>free(<i>ptr</i>)</code>	<code>actuallyfree(<i>ptr</i>)</code>

For example, suppose there exists a system library function named "getimage()" which reads a raster image file and returns the address of a buffer containing it. Since the library routine allocates the image directly with `malloc()`, you can't use SMARTALLOC's `free()`, as that call expects information placed in the buffer by SMARTALLOC's special version of `malloc()`, and hence would report an error. To release the buffer you should call `actuallyfree()`, as in this code fragment:

```
struct image *ibuf = getimage("ratpack.img");
display_on_screen(ibuf);
actuallyfree(ibuf);
```

Conversely, suppose we are to call a library function, "putimage()", which writes an image buffer into a file and then releases the buffer with `free()`. Since the system `free()` is being called, we can't pass a buffer allocated by SMARTALLOC's allocation routines, as it contains special information that the system `free()` doesn't expect to be there. The following code uses `actuallymalloc()` to obtain the buffer passed to such a routine.

```
struct image *obuf =
    (struct image *) actuallymalloc(sizeof(struct image));
dump_screen_to_image(obuf);
putimage("scrdump.img", obuf); /* putimage() releases obuf */
```

It's unlikely you'll need any of the "actually" calls except under very odd circumstances (in four products and three years, I've only needed them once), but they're there for the rare occasions that demand them. Don't use them to subvert the error checking of SMARTALLOC; if you want to disable orphaned buffer detection, use the `sm_static(1)` mechanism described above. That way you don't forfeit all the other advantages of SMARTALLOC as you do when using `actuallymalloc()` and `actuallyfree()`.

SMARTALLOC Details

When you include "smartall.h" and define SMARTALLOC, the following standard system library functions are redefined with the #define mechanism to call corresponding functions within smartall.c instead. (For details of the redefinitions, please refer to smartall.h.)

```
void *malloc(size_t size)
void *calloc(size_t nelem, size_t elsize)
void *realloc(void *ptr, size_t size)
void free(void *ptr)
void cfree(void *ptr)
```

`cfree()` is a historical artifact identical to `free()`.

In addition to allocating storage in the same way as the standard library functions, the SMARTALLOC versions expand the buffers they allocate to include information that identifies where each buffer was allocated and to chain all allocated buffers together. When a buffer is released, it is removed from the allocated buffer chain. A call on `sm_dump()` is able, by scanning the chain of allocated buffers, to find all orphaned buffers. Buffers allocated while `sm_static(1)` is in effect are specially flagged so that, despite appearing on the allocated buffer chain, `sm_dump()` will not deem them orphans.

When a buffer is allocated by `malloc()` or expanded with `realloc()`, all bytes of newly allocated storage are set to the hexadecimal value 0x55 (alternating one and zero bits). Note that for `realloc()` this applies only to the bytes added at the end of buffer; the original contents of the buffer are not modified. Initializing allocated storage to a distinctive nonzero pattern is intended to catch code that erroneously assumes newly allocated buffers are cleared to zero; in fact their contents are random. The `calloc()` function, defined as returning a buffer cleared to zero, continues to zero its buffers under SMARTALLOC.

Buffers obtained with the SMARTALLOC functions contain a special sentinel byte at the end of the user data area. This byte is set to a special key value based upon the buffer's memory address. When the buffer is released, the key is tested and if it has been overwritten an assertion in the `free` function will fail. This catches incorrect program code that stores beyond the storage allocated for the buffer. At `free()` time the queue links are also validated and an assertion failure will occur if the program has destroyed them by storing before the start of the allocated storage.

In addition, when a buffer is released with `free()`, its contents are immediately destroyed by overwriting them with the hexadecimal pattern 0xAA (alternating bits, the one's complement of the initial value pattern). This will usually trip up code that keeps a pointer to a buffer that's been freed and later attempts to reference data within the released buffer. Incredibly, this is *legal* in the standard Unix memory allocation package, which permits programs to `free()` buffers, then raise them from the grave with `realloc()`. Such program "logic" should be fixed, not accommodated, and SMARTALLOC brooks no such Lazarus buffer" nonsense.

Some C libraries allow a zero size argument in calls to `malloc()`. Since this is far more likely to indicate a program error than a defensible programming stratagem, SMARTALLOC disallows it with an assertion.

When the standard library `realloc()` function is called to expand a buffer, it attempts to

expand the buffer in place if possible, moving it only if necessary. Because SMARTALLOC must place its own private storage in the buffer and also to aid in error detection, its version of `realloc()` always moves and copies the buffer except in the trivial case where the size of the buffer is not being changed. By forcing the buffer to move on every call and destroying the contents of the old buffer when it is released, SMARTALLOC traps programs which keep pointers into a buffer across a call on `realloc()` which may move it. This strategy may prove very costly to programs which make extensive use of `realloc()`. If this proves to be a problem, such programs may wish to use `actuallymalloc()`, `actuallyrealloc()`, and `actuallyfree()` for such frequently-adjusted buffers, trading error detection for performance. Although not specified in the System V Interface Definition, many C library implementations of `realloc()` permit an old buffer argument of `NULL`, causing `realloc()` to allocate a new buffer. The SMARTALLOC version permits this.

When SMARTALLOC is Disabled

When SMARTALLOC is disabled by compiling a program with the symbol SMARTALLOC not defined, calls on the functions otherwise redefined by SMARTALLOC go directly to the system functions. In addition, compile-time definitions translate calls on the "actually..." functions into the corresponding library calls; "actuallymalloc(100)", for example, compiles into "malloc(100)". The two special SMARTALLOC functions, `sm_dump()` and `sm_static()`, are defined to generate no code (hence the null statement). Finally, if SMARTALLOC is not defined, compilation of the file `smartall.c` generates no code or data at all, effectively removing it from the program even if named in the link instructions.

Thus, except for unusual circumstances, a program that works with SMARTALLOC defined for testing should require no changes when built without it for production release.

The `alloc()` Function

Many programs I've worked on use very few direct calls to `malloc()`, using the identically declared `alloc()` function instead. Alloc detects out-of-memory conditions and aborts, removing the need for error checking on every call of `malloc()` (and the temptation to skip checking for out-of-memory).

As a convenience, SMARTALLOC supplies a compatible version of `alloc()` in the file `alloc.c`, with its definition in the file `alloc.h`. This version of `alloc()` is sensitive to the definition of SMARTALLOC and cooperates with SMARTALLOC's orphaned buffer detection. In addition, when SMARTALLOC is defined and `alloc()` detects an out of memory condition, it takes advantage of the SMARTALLOC diagnostic information to identify the file and line number of the call on `alloc()` that failed.

Overlays and Underhandedness

String constants in the C language are considered to be static arrays of characters accessed through a pointer constant. The arrays are potentially writable even though their pointer is a constant. SMARTALLOC uses the compile-time definition `./smartall.wml` to obtain the name of the file in which a call on buffer allocation was performed. Rather than reserve space in a buffer to save this information, SMARTALLOC simply stores the pointer to the compiled-in text of the file name. This works fine as long as the program does not overlay its data among modules. If data are overlaid, the area of memory which contained the file name at the time it

was saved in the buffer may contain something else entirely when `sm_dump ()` gets around to using the pointer to edit the file name which allocated the buffer.

If you want to use SMARTALLOC in a program with overlayed data, you'll have to modify `smartall.c` to either copy the file name to a fixed-length field added to the `abufhead` structure, or else allocate storage with `malloc ()`, copy the file name there, and set the `abfname` pointer to that buffer, then remember to release the buffer in `sm_free`. Either of these approaches are wasteful of storage and time, and should be considered only if there is no alternative. Since most initial debugging is done in non-overlayed environments, the restrictions on SMARTALLOC with data overlaying may never prove a problem. Note that conventional overlaying of code, by far the most common form of overlaying, poses no problems for SMARTALLOC; you need only be concerned if you're using exotic tools for data overlaying on MS-DOS or other address-space-challenged systems.

Since a C language "constant" string can actually be written into, most C compilers generate a unique copy of each string used in a module, even if the same constant string appears many times. In modules that contain many calls on allocation functions, this results in substantial wasted storage for the strings that identify the file name. If your compiler permits optimization of multiple occurrences of constant strings, enabling this mode will eliminate the overhead for these strings. Of course, it's up to you to make sure choosing this compiler mode won't wreak havoc on some other part of your program.

Test and Demonstration Program

A test and demonstration program, `smtest.c`, is supplied with SMARTALLOC. You can build this program with the Makefile included. Please refer to the comments in `smtest.c` and the Makefile for information on this program. If you're attempting to use SMARTALLOC on a new machine or with a new compiler or operating system, it's a wise first step to check it out with `smtest` first.

Invitation to the Hack

SMARTALLOC is not intended to be a panacea for storage management problems, nor is it universally applicable or effective; it's another weapon in the arsenal of the defensive professional programmer attempting to create reliable products. It represents the current state of evolution of expedient debug code which has been used in several commercial software products which have, collectively, sold more than third of a million copies in the retail market, and can be expected to continue to develop through time as it is applied to ever more demanding projects.

The version of SMARTALLOC here has been tested on a Sun SPARCStation, Silicon Graphics Indigo², and on MS-DOS using both Borland and Microsoft C. Moving from compiler to compiler requires the usual small changes to resolve disputes about prototyping of functions, whether the type returned by buffer allocation is `char *` or `void *`, and so forth, but following those changes it works in a variety of environments. I hope you'll find SMARTALLOC as useful for your projects as I've found it in mine.



[Download smartall.zip](#) (Zipped archive)

SMARTALLOC is provided as [smartall.zip](#), a [Zipped](#) archive containing source code, documentation, and a `Makefile` to build the software under Unix.

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