THE BASIC BACKUP GUIDE

TAPE BACKUP STRATEGIES FOR THE SMALL-TO-MEDIUM BUSINESS

EXABYTE ®

Contents

ABOUT THIS GUIDE

Suppose for a moment that a virus infects your entire computer network. The virus spreads through every employee's workstation, into every document and database file. All your work, all your data — it's all destroyed. How would your business recover?

Without an adequate backup and recovery plan, your business is at risk. Because your company relies on its data and mission-critical applications, the cost of downtime is exorbitant, potentially exceeding thousands of dollars per hour for such expenses as recovering data and system files, replacing equipment, losing productivity, and losing customers. According to a recent disaster recovery study, nearly half of the companies that are unable to fully restore their data after a disaster *will go out of business entirely.*

WHY TAPE IS IDEAL FOR BACKUP

Whether you are backing up an individual workstation or a small network, tape is an ideal storage medium because it is capable of storing high capacities of information for a relatively low cost. And, tape is perfect for archival because you can store cartridges off-site for enhanced data security.

TAPE AUTOMATION - NOW AVAILABLE FOR SMBS

Until recently, tape backup for the small-to-medium business meant manually inserting tape cartridges into individual tape drives. Tape automation has traditionally been the realm of big-budget IT departments. But now, affordable autoloaders and small tape libraries provide SMBs with the convenience and risk reduction previously available only to large businesses.

If you want to reduce the risk of human error in backups or just don't want to spend time manually inserting and removing tapes each time you back up, consider one of today's automated tape solutions. A ten-cartridge autoloader, such as Exabyte's VXA-2 PacketLoader 1x10 1u, can provide reliable, unattended backup for up to two weeks for little more than the price of a standalone tape drive.

WHO SHOULD READ THIS GUIDE

Read this guide if you are responsible for protecting data in a small or medium business. It provides information about how to use tape technology for backup and recovery and how to implement common backup strategies and tape rotations.

NOTE: Whether you already have a tape backup system in place or you are deciding to purchase a new tape backup system, you can find helpful advice in this guide.

1

ABOUT DATA BACKUP

This chapter addresses some common questions about data backup.

WHAT DOES IT MEAN TO BACK UP, RESTORE, AND ARCHIVE?

Data *backup* is the process of transferring data from your company's primary computer system to a separate storage device, such as a tape drive. If the original data is lost or damaged, you can *restore* the information from the device and resume normal business operations. An *archive* is a long-term, permanent data backup, which is kept off-site.

WHAT TYPES OF FILES SHOULD BE BACKED UP?

The most important files to back up are data files — the files that change on a frequent basis. Periodically, you should also back up the entire system in case of a catastrophic disaster. This periodic backup should include system files that contain specific user information for customized settings and passwords. You may also want to back up software files if you no longer have the original disks. Most backup software provides the option of backing up all files on the drive, the files that have changed since the last backup, or individually selected files.

HOW OFTEN SHOULD DATA BE BACKED UP?

Because data files change every time someone enters new information, many companies back up the data files every day (or only those files that have changed) and then perform a complete backup of the entire system on a weekly, bi-weekly, or monthly basis. For your own company, you can determine the necessary frequency of backups by asking yourself how often the data changes and how critical are the different types of data files. In other words, how much data can you afford to lose without causing your business undue hardship?

It may seem that you should back up your files almost continuously, but that isn't practical. The best strategy is to devise a schedule that works for the majority of your data files. For example, you can schedule a daily backup of new and modified data files and then a weekly backup of all files. If you have critical files that must be backed up more often, you can back up these files throughout the day.

File type	Back up daily	Back up weekly
Data files	✔	✔
Critical files (may be backed up several times a day)	✔	✔
All other files (includes system files and software files)		✔

WHEN SHOULD BACKUPS TAKE PLACE?

Ideally, you should back up data after regular business hours when employee demands on the network are at a minimum. This off-hours time frame is called the "backup window." Many small companies have an adequate backup window to perform backup jobs at night and on weekends.

However, if your business operates 24 hours a day, 7 days a week (24x7), or if you have employees working in different time zones, you may have little or no backup window. In this case, you must determine a time period when employees will be the least affected.

TIP: If your business operates 24x7, use backup software that has an open file option. This option allows you to perform a backup while the files are in use.

HOW LONG SHOULD DATA BE STORED?

How long you store data depends on the type of data and your business requirements.

▸ For data files that change frequently, you should keep only the most recent files. As the previous data becomes obsolete, you can overwrite and reuse the tapes.

▸ For the full set of files on your system, you should store the files in a secure, off-site location. By having this complete file set, you can recover the entire system in case a disaster destroys the originals.

▸ For certain types of data (tax records, contracts, personnel files, patient records, and so on), you may need to archive data for a specified time period to meet specific legal requirements. In court cases, courts will hold owners and company officers liable for data loss (despite the reason for the loss).

WHERE SHOULD BACKUP TAPES BE STORED?

You should store one full set of your company's data on-site for immediate recovery and another copy off-site at a secure location in case your business suffers a fire, theft, or other disaster. Many small companies choose to store backup tapes in a safe-deposit box at a local bank or even at the owner's home. To eliminate the hassle and worry, other companies prefer to contract with a vendor who specializes in archival and storage.

HOW OFTEN SHOULD TAPES BE RETIRED?

You should follow the tape manufacturer's guidelines for tape storage and replacement. Most manufacturers print these guidelines on the tape packaging. Also, most backup software tracks errors on a given tape, which alerts you that a tape should be retired.

TIP: If you still aren't sure when to retire tapes, a good rule of thumb is to retire tapes used for daily backups once a year.

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TYPES OF BACKUP

This chapter describes the different types of backup strategies, so you can decide which method is right for your business. Software applications include options for copying the full set of system files, for copying a partial set of new or modified files, and for copying selected, individual files. Most companies use a combination of full and partial backups by performing nightly backups on files that have changed throughout the day, then a full backup of all files on a weekend day.

FULL BACKUPS

A *full* backup copies all the files on the system – the system files, the software files, and the data files. You should perform a full backup on a weekly, bi-weekly, or monthly basis. With a full backup of your data set on tape, you can restore your entire system if a disaster destroys the original files.

TIP: If your data set is small, you could perform a full backup on a daily basis. However, you should *not* use the same tape every day. Continuously overwriting a section of tape could damage it over a long period of time. (See Chapter 3 for more information about effective tape rotation schemes.)

PARTIAL BACKUPS

A *partial* backup copies all files that have been added or changed since the last backup job. There are two main types of partial backups: *incremental* and *differential*, summarized in the table below.

Backup type	Files copied
Incremental	Files added or changed since the last *full or partial* backup.
Differential	Files added or changed since the last *full* backup.

TIP: For any crucial files that would be difficult to re-create, you can perform a *selective* backup at any time during the day. With this method, you don't need to wait until the next scheduled backup to copy the crucial files.

INCREMENTAL BACKUPS

If you need to save time and cost during regular backup jobs, choose a plan that includes full and incremental backups. In this strategy, you perform a regular backup of all files (weekly, bi-weekly, etc.), then a more frequent backup (daily) of only the files that have changed since the last backup session.

This full/incremental backup method means that fewer files need to be copied and less time is required for the backup procedure. However, this method can also make a complete system restore slower if you have created many different incremental backup tapes (one for each day of the week, for example), or if you need to restore only a particular file and must hunt through several different incremental backup tapes. (See "Which backup strategy is best?" on page 8 for more information.)

TIP: Because an incremental backup session may only use a small section of tape, you can conserve the required number of backup tapes by using the software's tape-append option. This option allows you to write additional backup sessions where the previous session left off and to make full use of a single tape. However, if you lose this one tape, you've lost data from several backup sessions.

DIFFERENTIAL BACKUPS

If you need to save on restore time and hassle in the event of a disaster, choose a plan that includes full and differential backups. In this strategy, you perform a regular backup of all files (weekly, bi-weekly, etc.), then a more frequent backup (daily) of all files that have changed since the last full backup session.

This full/differential backup method helps the restore process run more efficiently, because only one full backup tape and one differential backup tape are required for a complete restore of the system. However, this method is slower on the backup process because more files are copied daily. (See for more information.)

TIP: If a full data backup requires more than one tape, you might consider investing in a tape autoloader, which includes a tape drive and a robotic arm that automatically handles tape rotation. For a small price increase over a standalone tape drive, an autoloader eliminates the need for manually switching out tapes and eliminates the potential for human error.

WHICH BACKUP STRATEGY IS BEST?

Is it better to combine full backups with incremental or differential partial backups? The answer for your situation depends on what factors are most important to you. Do you want to save time and cost on the backup process? If so, you should choose incremental partial backups. Or, is it more important to make the restore process as quick and simple as possible in the event of a disaster? If so, you should choose differential partial backups.

TIP: Most companies perform full/differential backups, because the restore process only requires 2 tapes (or tape sets).

The table below highlights the main advantages and disadvantages of incremental versus differential backup strategies.

Backup type	Advantages	Disadvantages
Incremental (all new or modified files since last *full or partial* backup)	- Faster backup time because there are fewer files. - Reduced wear on backup device and tape. - Fewer tapes may be required.	- Slower restore times because there may be more than two tapes required (the full backup tape and each incremental backup tape). - Higher cost of downtime in a system disaster.
Differential (all new or modified files since last *full* backup)	- Faster restore times because there are only two tape sets required (the full and differential backup tapes). - Lower cost of downtime in a system disaster.	- Slower backup process because more files are copied. - Increased wear on backup device and tape. - More tapes may be required.

TIME AND TAPES REQUIRED FOR A BACKUP

The following examples show how a differential or incremental backup strategy affects the time and tapes required for backups.

Differential backup: time and tapes required[*]				
Day	**Type of backup**	**Size**	**Time**	**No. of tapes**
Friday	Full	160 GB	4 hours	3 tapes
Monday	Differential	45 GB	1.1 hours	1 tape
Tuesday	Differential	56 GB	1.4 hours	1 tape
Wednesday	Differential	67 GB	1.7 hours	2 tapes
Thursday	Differential	83 GB	2.1 hours	2 tapes
Total:		**411 GB**	**10.3 hours**	**9 tapes**

Incremental backup: time and tapes required[*]				
Day	**Type of backup**	**Size**	**Time**	**No. of tapes**
Friday	Full	160 GB	4 hours	3 tapes
Monday	Incremental	45 GB	1.1 hours	1 tape
Tuesday	Incremental	11 GB	.3 hours	1 tape
Wednesday	Incremental	11 GB	.3 hours	1 tape
Thursday	Incremental	16 GB	.4 hours	1 tape
Total:		**243 GB**	**6.1 hours**	**7 tapes**

[*] These examples are based on a weekly backup cycle with a tape drive that can transfer data at 40 gigabytes (GB) per hour on a 60-gigabyte capacity tape.

For differential backups, the amount of data and hours increase throughout the week, requiring two more tapes and almost twice the backup time than the incremental backup.

TAPES REQUIRED FOR THE RESTORE PROCESS

The following examples show how a differential or an incremental backup strategy affects the amount of tapes required for a restore process.

Differential backup: Tapes required for restore process		
Day	**Type of backup**	**Types of files copied**
Friday	Full	Tape 1, 2, 3
Monday	Differential	Tape 4
Tuesday	Differential	Tape 5
Wednesday	Differential	Tape 6, 7
Thursday	Differential	Tape 8, 9
Tapes required for complete system restore:		**Tapes 1, 2, 3, 8, 9**

Incremental backup: Tapes required for restore process		
Day	**Type of backup**	**Tapes required**
Friday	Full	Tape 1, 2, 3
Monday	Incremental	Tape 4
Tuesday	Incremental	Tape 5
Wednesday	Incremental	Tape 6
Thursday	Incremental	Tape 7
Tapes required for complete system restore:		**All 7 tapes**

For a full system restore, the differential backup strategy requires only Friday's full backup tape set and Thursday's differential backup tape set, while the incremental backup strategy requires all the backup tapes.

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TAPE ROTATION

This chapter describes some common methods for tape rotation, which determines when to reuse tapes during a backup cycle. A good rotation strategy protects data by ensuring adequate file versions are always available on tape and by protecting the tape from excessive wear and damage, which could lead to unrecoverable data.

Most small companies use one of these rotation schedules: six-tape rotation, Grandfather - Father - Son (GFS), or Tower of Hanoi, described in more detail in the following sections.

NOTE: This chapter provides some *suggestions* for how to implement these rotation strategies. You can modify the strategies in many different ways to fit your needs.

SIX-TAPE ROTATION

The six-tape rotation method is a simple and cost-effective "tape-a-day" scheme, which is ideal for a small business that does not need to back up high volumes of data. This rotation method involves rotating between two tapes for full backups on Fridays, and then using four tapes for either incremental or differential backups on Monday through Thursday.

TIP: If the full data capacity doesn't fit onto one tape, use "tape sets." Most software provides options for tracking and managing tape sets.

To perform a six-tape rotation method:

1. Purchase six tapes and label them:
   Tape 1: FRI1
   Tape 2: FRI2
   Tape 3: MON
   Tape 4: TUES
   Tape 5: WED
   Tape 6: THU

2. Beginning on a Friday, perform a full backup on the FRI1 tape. Store the FRI1 tape off site.

   TIP: For even greater data protection, create duplicate FRI1 tapes: one for on-site storage and one for off-site storage.

3. On Monday, Tuesday, Wednesday, and Thursday, perform an incremental or differential backup on the appropriately labeled tape. Store these tapes at your company site.

4. On the next Friday, perform a full backup on the FRI2 tape. Store this tape off site; and if desired, also retrieve the FRI1 tape for next Friday's full backup.

5. Repeat step 3, reusing the Monday through Thursday tapes.

6. On Fridays, perform full backups, alternating between the FRI1 and FRI2 tapes. Be sure to store at least one Friday tape off site.

The chart below shows how you might create a six-tape rotation schedule in a month.

MON	TUES	WED	THU	FRI
				FRI 1
MON	TUES	WED	THU	FRI 2
MON	TUES	WED	THU	FRI 1
MON	TUES	WED	THU	FRI 2
MON	TUES	WED	THU	FRI 1

Incremental or Differential — Full

Figure 3-1 Six-tape rotation method in a one-month period

TIP: For an even more efficient and cost-effective type of backup schedule, you can perform a three-tape rotation. First, perform a full backup on Tape 1, then alternate between Tape 2 and Tape 3 for nightly, differential backups. You can perform full backups every 2 weeks, or whenever you feel it's necessary. This three-tape rotation method is ideal if you have a small amount of data to back up and you need to save money on media costs. And, by performing differential backups, you only need two tapes for a full system restore.

GRANDFATHER - FATHER - SON (GFS)

The most commonly used tape rotation schedule is called Grandfather - Father - Son (GFS). This rotation scheme operates on the same five-day work week principle as the six-tape rotation method, except that you use more tapes (or tape sets) for backing up data daily (on the "son" tapes), weekly (on the "father" tapes), and monthly (on the "grandfather" tapes). The monthly tapes can be archived for permanent storage or recycled on a quarterly or yearly basis.

The following steps show how to perform a simple GFS rotation method using 20 tapes:

1. Obtain 20 tapes and label them as follows:

   ▸ 4 daily tapes (sons) labeled "MON" through "THURS"
   ▸ 4 weekly tapes (fathers) labeled "WEEK1" through "WEEK4"
   ▸ 12 monthly tapes (grandfathers) labeled with the month and year

   NOTE: If a full backup exceeds the capacity of one tape, create "tape sets."

2. Beginning on a Friday, perform a full backup on the "WEEK1" tape. Store the "Week" tapes either on site or off site.

3. Beginning on the following Monday, perform daily differential or incremental backups on the "MON" through "THURS" tapes. Store the MON through THURS tapes on site.

4. On Friday, perform another full backup on the "WEEK2" tape.

5. Continue with this rotation method until the last business day of the month. On the last business day (no matter what the day of the week it is), perform a full backup on the first monthly (grandfather) tape. Label the tape with the current date and store it off site.

The following chart shows how you might create a GFS rotation schedule.

MON	TUES	WED	THU	FRI
				WEEK 1
MON	TUES	WED	THU	WEEK 2
MON	TUES	WED	THU	WEEK 3
MON	TUES	WED	THU	WEEK 4
MON	TUES	WED	THU	MONTH 1

└── Incremental or Differential ──┘   Full

Figure 3-2 GFS rotation method in a one-month period

TOWER OF HANOI

The Tower of Hanoi schedule is a secure and cost-effective tape-rotation method, but it's also complex. In Tower of Hanoi, you perform a full backup on five tape sets: labeled A, B, C, D, E. Tape Set A is used every other backup session; Tape Set B is used every fourth backup session; Tape Set C is used every eight sessions; and so on. You could perform these backup sessions nightly, weekly, or at whatever intervals you determine.

The table below shows how the Tower of Hanoi rotation method alternates for each tape set:

Backup session	Tape set used
1	A
2	B
3	A
4	C
5	A
6	B
7	A
8	D
9	A
10	B
11	A
12	C
13	A
14	B
15	A
16	E

To perform a Tower of Hanoi tape rotation:

1. Label five tapes (or tape sets): A, B, C, D, E.

2. For the first backup session, perform a full backup on Tape Set A.

3. For the second backup session, perform a full backup on Tape Set B.

4. Continue alternating the tape sets as shown in the previous table.

5. Once you've reached Tape Set E on the sixteenth day, begin the pattern over again. Store Tape E off site.

TIP: For archival, you can periodically retire the Tape Set E backup.

The following chart shows a month of backups in the Tower of Hanoi rotation schedule.

MON	TUES	WED	THU	FRI
Tape A	Tape B	Tape A	Tape C	Tape A
Tape B	Tape A	Tape D	Tape A	Tape B
Tape A	Tape C	Tape A	Tape B	Tape A
Tape E	Tape A	Tape B	Tape A	Tape C
Tape A	Tape B	Tape A		

└─────── Full ───────┘

Figure 3-3 Tower of Hanoi method in a one-month period

WHICH ROTATION METHOD IS BEST?

Rotation method	Advantages	Disadvantages
Six-tape	Requires only a few tapes, which provides an easy and cheap rotation method. It's ideal for small data volumes (as much capacity as one tape can hold).	Keeps only a week's worth of data, unless you regularly archive the full-backup tapes.
Grandfather - Father - Son (GFS)	Provides the most secure data protection and implements monthly archival of tapes. It's also a simple method, which most software supports.	Requires more tapes, which can become expensive.
Tower of Hanoi	Allows for easy full-system restores (no shuffling through tapes with partial backups on them). This is ideal for small businesses that are concerned with being able to do full restores. Also, it's more cost effective than GFS (uses fewer tapes).	Requires a difficult rotation strategy, which is not as straight-forward to implement as the other rotation methods. Unless your backup software supports it, this method is too complex to track tape rotation manually. Also requires a time-consuming full backup every session.

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TAPE PLANNING

This chapter provides some considerations for planning the total number of tapes your backup strategy requires and the tape costs associated with that strategy.

DETERMINING THE NUMBER OF REQUIRED TAPES

To help determine how many tapes you need, consider the following:

▶ **Full backup size**. What is the size, in gigabytes, of a full system backup? This amount should include data files, system files, and software files. When you've determined the total capacity, divide that number by the total capacity of each cartridge. For example, if the total capacity of your system is 600 gigabytes, and each tape holds 60 gigabytes, you will need 10 tapes.

TIP: Most tape drives and software applications provide a data compression feature to reduce the size of files. By compressing data, you'll reduce the amount of tapes needed.

▶ **Partial backup size.** Estimate the size, in gigabytes, of an average partial (differential or incremental) backup. This amount includes the data files that change on a daily basis. For example, if an average incremental backup is 60 gigabytes, and each tape holds 30 gigabytes, you need two tapes for every incremental backup.

TIP: By using the software's tape-append feature, you can append incremental or differential backups sets at the end of a previous backup. This saves on tape usage.

▶ **Tape rotation method and frequency of backups**. What type of tape rotation method will you implement and how many tapes will it require? (See Chapter 3 for how tape rotation methods affect the number of tapes you need.) For example, in a GFS rotation scheme, if you need 1 tape for 4 partial backups a week (1x4=4 tapes), 3 tapes for 4 weekly full backups (3x4=12 tapes), and 3 tapes for 12 monthly full backups (3x12=36 tapes), you would need 52 tapes (4+12+36).

▶ **Tape archival.** How many tapes will you archive off-site on a yearly basis? Will you archive one full backup monthly or quarterly? For example, if a full backup requires 3 tapes and you plan to archive a copy of one full backup per month, you'll need to purchase 36 tapes a year for archival.

▶ **Tape retirement**. How often will you retire the tapes used for daily backups? You should determine a schedule for retirement, based on the tape's rated service live.

TIP: If your software tracks rewrite errors, you may want to monitor that number and discard any tape that shows a significant increase in errors. The cost of replacing a tape is much lower than the cost of losing data.

DETERMINING THE COST

You can purchase tapes in various lengths, which offer various data capacities. Prices for tape cartridges can range from $60 to $100 per tape, depending on the type of tape drive you have. You'll also need to purchase a few cleaning cartridges to ensure proper tape drive operation.

TIP: To help estimate your own tape requirements and cost, contact an Exabyte Sales representative.

Notes

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BACKUP TIPS

Finally, here are some additional tips for securing data:

✔ Perform backups without exception. If your employees are responsible for backing up their own data and you are concerned that backups don't always happen, centralize the backups across a network. To make backups easier, you can use backup software that performs the process automatically. You can also invest in a tape autoloader, which will eliminate the need for a person to insert and remove tapes.

✔ After performing a backup, use the backup software to verify that the backup completed successfully. If your software does not contain this feature, you can restore one or two unimportant files to be sure that the backup is valid.

✔ Rotate tapes to preserve multiple copies of data. Don't re-use the same tape for backup every day. If that tape is lost or destroyed, you must re-create the data file by file. Also, create alternate copies of your data in case a tape is damaged.

✔ Keep backup tapes both at your company site and at an alternate location. In the event of a day-to-day disaster (a file gets accidentally deleted or a local hard drive dies), keep a set of backup tapes on site for quick recovery. In the event of a major disaster that affects your company location (such as a fire or flood), keep a set of backup tapes off site in a secure location so you can restore your business to normal operations.

✔ Run a good antivirus software on your computer system to prevent viruses from being transferred onto your backup tapes.

✔ Clearly label tape cartridges so you can quickly identify the correct restore tape. Label each tape with the date of backup, type of drive used, and enough information to generally identify the contents. For example: "2/27/04 - Exabyte VXA - Weekly Fully Backup of Personnel Records."

✔ Take proper care of the tapes. Store tapes according to the recommendations listed on the tape packaging. Do not expose tapes to sources of contamination, like copiers and printers that emit toner and paper dust.

✔ Take proper care of the tape drive. Most drives require periodic cleaning with a separate cleaning cartridge. Follow the manufacturer's cleaning recommendations.

✔ Consider using an archive vendor for tape storage. An archive vendor can provide services ranging from secure facilities for tape storage to prepaid delivery of your tapes in the event of a disaster.

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Notes