WHITE PAPER

BACKUP STRATEGIES AND TAPE ROTATION

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Why backup?

Everybody is experiencing that ever-increasing amounts of electronic data is being handled, transmitted and stored. Computer data is "mission critical" and nobody should risk their business because they don't care about securing their data. A proper backup strategy is the most effective insurance against fire, theft, disk crash, natural disaster, human error, unhappy employees, Y2K problems and viruses. These events can all cause data loss and result in time consuming data recovery operations (happy ending) or lost customers and lost business (a sad story).

In addition to the backup function itself, a tape storage system can also be used for functions such as hierarchical data management, archiving and data distribution.

The cost of backup

When calculating the cost of a backup system many elements should be considered. Some are easy to identify and the cost is clear. Others are less obvious and will vary from installation to installation. In addition the requirements will vary, such as for capacity, performance and system up-time. Your system requirements and price constraints will limit your freedom of choice, but still there are enough options left.

✔ **Tape Drives** provide a wide variety of combinations of capacity, speed, functionality, cost and reliability. Tape drive technologies are defined according to proprietary or industrial standards.

✔ **Media**, or tape cartridges, is required with every drive. Several manufacturers (such as Imation, Sony, Verbatim) provide media for the various tape drive standards.

✔ **Software** to run the backup may be installed as a separate backup application or the backup function and tape drive support may be embedded within the Operating System. A rich variety of functionality is found in the market.

✔ **Installation** should be flawless, but may be a real pain. Compatibility issues and driver availability are the most common problems.

✔ **Operation and maintenance** is usually straightforward once the installation is complete. Although defining the backup scheme, regular head cleaning and performing day to day operations still takes some workload. Even single file restore operations may be time consuming if the backup routine is cumbersome.

✔ **Cartridge** replacements are necessary because of tape wear. Different technologies experience different tape wear and thus different media costAs a rule of thumb: If the cartridge is used frequently, then replace it once a year. Also, when cartridges are picked to be stored for long time archival of data, they must be replaced in the cartridge rotation scheme.

✔ **Cleaning cartridges** are needed to keep the tape head clean. Even so-called "self cleaning" solutions need maintenance.

✔ **Repair and warranty** should ideally not be a concern. But it happens that drives fail. Then rapid replacement and responsive support departments are often vital. The rate of Annual Field Returns is an important quality parameter in estimating this cost. The warranty

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period should also be taken into account.

✔ **Lifetime** is limited, also for tape drives. The more moving parts in the system, the shorter the lifetime. Or, system requirements may change making the tape drive obsolete or inadequate for the intended installation.

Total Cost of Ownership (TCO)

TCO evaluations must be carried out for a limited user segment to be relevant, or even per installation basis. If not, the huge variety of parameters will make pure number comparisons meaningless. Below a typical Small Office environment TCO calculation scheme is suggested. The major cost elements to include are drive purchase, initial media, media wear/replacement and backup application costs. To compare alternatives with different capacities, the cost pr. GB or speed requirements must be taken into account.

✔ **Input parameters:**
- Drive street price
- Media street price
- No. of cartridges used per year

Simplified TCO formula:

$$DriveCost + (NoOfCartr * CartrCost)$$

"Life Time" TCO Formula:

For a more complete calculation a few more cost elements should be included to visualize the annual backup cost. Still this equation does still not take into account manpower costs, reliability issues, warranty etc., all cost factors that will add to the formula below:

✔ **Assumption** (example in equation below):
- 10 % annual reduction of media price
- 11 % Net Present Value (NPV) Rate of return
- 3 year period

$$\frac{DriveCost + (NoOfCartr * CartrCost * 10\% \text{ price reduction per year} * 11\% \text{ NPV rate of return})}{NoOfYears * NoOfCartr * Capacity}$$

The cost of not backing up

The doomsday perspective: Disaster may strike! And it actually can. Although more often single files are lost rather than whole systems, the cost of recreating lost data can be significant. Lost files causes a vast amount of time to be expended and may lead to lost business and lost customers either in critical situations or if vital data can not be found when needed.

Most people know someone who has lost a file. Recently the ICH (Chernobyl) virus caused thousands of computers to fail and a lot of organizations lost valuable data. When you loose your data, some way or another, there is usually several ways to recreate it. Paper copies may be available so that it can be retyped, fragments of the information or un-compiled source data may be available elsewhere so that new versions can be created. Anyway, spending tens of thousands of $ recreating lost data is not very attractive.

There are also companies specializing in regenerating files and corrupted data from damaged storage media. This costs time and money, but fortunately the data may often be recovered. In many cases data are definitely lost, because no source or copy exists or the amount of data lost is too huge to be recovered in the time available. Then only imagination limits the consequences of a data loss.

Then there is the network itself. Corrupted files or hard disk crashes can effectively knock out a local network. Downtime may cost $10,000 or more pr. hour, and without proper backup and disaster recovery routines, the downtime can be painfully long.

What about RAID (Redundant Array of Inexpensive Disks)? Doesn't this protect the data? Yes, to a certain extent if a hard disk is failing, but only 20% of data losses are due to HD failures, the remaining 80% will not be protected in a RAID system without tape backup.

No company should risk running a critical database and not generate a regular backup. The value of off-site vaulting of disaster recovery media is a "bet your business" event. For example,

value of off-site vaulting of disaster recovery media is a "bet your business" event. For example, after the World Trade Center bombing in New York, more than 50 percent of the businesses that did not have off-site recovery media went out of business. Another event was the 1994 earthquake in Califirnia. Based on experience from this disaster, the California State University, Northridge (CSUN), has installed an off-site SLR50 based tape library for backup of CSUN's Workstations and Servers.

Basic principles of backup

The three main areas of tape storage are backup (short-term storage), archiving (long term storage) and disaster recovery. Between backup and archiving we find near-line storage, which is used amongst others in Storage Area Network (SAN) environments.

- ✔ **Backup** means making copies of files originally stored on hard disks. Backup is required to recreate lost or damaged files or to restore a system that is down. Files used for backup are redundant, they ar not used as "working copies".

- ✔ **Archiving** means copying one or more files onto a tape for long term storage. This may be for legal reasons or to free up hard disk space.

- ✔ **Disaster recovery** means recovering from a situation where the system is knocked out. Backups stored off-site may be required and large portions, if not all, of the system and system data may be reinstalled.

> *i* **Remember that data security is achieved only through media redundancy on reliable media.**

THREE GOLDEN RULES

- ✔ **Tape rotation** - Don't use the same cartridge two days in a row!
  If your system fails during backup you might loose both your hard disk data and the tape data.

- ✔ **Offsite copy** - Store a complete backup offsite!
  Always ensure that a backup, less than one week old, is kept at a different location.

- ✔ **Every day**
  A backup's validity has short duration. Much of the data quickly becomes obsolete.

BACKUP SCHEDULING

Full, differential or incremental backup
can be combined in several ways. A full backup should always be kept in a safe (off-site) location. In a full backup, all data is stored on the tape. In a differential backup, all data that are changed since the last full or incremental backup is stored. In an incremental backup, all data changed since the last full, differential or incremental backup is stored. Incremental backups save time, but restoring from a series of incremental backups will be slow.

Daily and weekly backup.
This is not a question of either-or; it's both! Some may find it very time consuming to perform a full backup every day. And it is often not necessary. If all changed data is backed up every day by performing incremental backups, then a weekly full backup may provide the security and convenience needed by most smaller systems.

Servers and WorkStations
require different approaches in backup administration. This is handled through the installed backup application SW. Where any Workstation takes care of itself, the server must take into account the activity on the connected devices and the network. This may mean different time slots and usage of several tapes and it will probably affect the performance requirements of the backup components.

Local or remote backup
is a relevant question in relation to servers only. (To do a remote backup on a Workstation it must be connected to a server). Usually one attempts to centralize backup operations as much as possible. This is obvious because of the cost of equipment, backup regularity and general system, operation and maintenance cost. Ideally, all backups should be stored on off-site media.

Backup strategies for the small office

Below are suggested various tape rotation schemes for small office backup. These schemes are showing backup strategies which are acceptable as an absolute minimum. In addition archiving requirements should be included and, dependant on the local conditions, disaster recovery precautions must be analyzed.

> *i* **Why not 2 or 3 cartridges?**
> Because you cannot keep a row of revisions available, the backup history will be lost. Good data may be overwritten by bad data before a problem is noticed.

Simple 5 day rotation, 5 cartridges
- ✔ Five cartridges, each assigned for different days of the week.
- ✔ Full back up each night. Always store the last completed backup off-site overnight.

Day:	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Cartridge:	1	2	3	4	5	-	-

Pro's: Simple

Con's: Too short backup story. A file version from the previous week may be needed. With this rotation scheme it may not be available.

7 (or 5) day/2 week rotation with off-site copy, 5 cartridges
- ✔ Two cartridges assigned for daily, incremental back up. **[1-2]**
- ✔ Two cartridges for full, weekly backup. Each cartridge used every 2nd week. **[3-4]**
- ✔ One cartridge for long-term (1-6 months), off-site storage. **[5]**

Day:	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Cartridge:	1	2	1	2	3	1	2
Cartridge:	1	2	1	2	4	1	2

Pro's: Simple. Some redundancy reduces the danger of not being able to recreate the history. Long term copy stored off-site.

Con's: The cartridges used for alternating daily backups gives to little redundancy. Still, the backup history beyond two weeks may be lost.

Recommended backup strategies

Below, some backup tape rotation schemes are suggested that are suited for forming the basis of backup routines of most offices. These schemes show basic priciples for recommended backup strategies. In addition, archiving requirements should be included and, dependant on local conditions, the disaster recovery precautions must be analyzed and prepared for.

5 day/4 week/3 month rotation, 11 cartridges
- ✔ Four cartridges are assigned for daily differential backups. **[1-4]**
- ✔ Three cartridges are assigned for weekly incremental backups. **[5-7]**
- ✔ Three cartridges are assigned for full monthly backups, the 4th Friday each month. **[8-10]**
- ✔ 1 other tape is used for an incremental backup if there is a 5th Friday in the month. [11]

Day:	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Cartridge:	1	2	3	4	5	-	-
Cartridge:	1	2	3	4	6	-	-
Cartridge:	1	2	3	4	7	-	-
Cartridge:	1	2	3	4	8-10	-	-

Cartridge:	1	2	3	4	11	-	-

> **Pro's:** Redundancy reduces the danger of not being able to recreate the history. History may be recovered at least four weeks back. Long term copy stored off-site through the "5th Friday" backup.
>
> **Con's:** As more tapes are involved, this increases the complexity and introduces requirements to human accuracy.

5 day/4 week/3 month rotation, 12 cartridges

✔ Son: Four cartridges are assigned for daily differential backups. **[1-4]**
✔ Father: Five cartridges are assigned for full weekly backups. **[5-9]**
✔ Grandfather: Three cartridges are assigned for full monthly backups. **[10-12]**

Day:	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Cartridge:	1	2	3	4	5	-	-
Cartridge:	1	2	3	4	6	-	-
Cartridge:	1	2	3	4	7	-	-
Cartridge:	1	2	3	4	8	-	-
Cartridge:	1	10-12[1]	-	-	9[2]	-	-

1. On the last business day of the month. 2. When there is a 5th Friday in the month.

> **Pro's:** Redundancy reduces the danger of not being able to recreate the history. History may be recovered at least four weeks back. Long term copy stored off-site through the monthly backups.
>
> **Con's:** As more tapes are involved, it increases the complexity and introduces requirements to human accuracy.

This is a commonly used scheme (Grandfather -Father - Son) that covers most backup, disaster recovery and archiving needs. For long term archiving, tapes can be pulled from the rotation and replaced.

Conclusion

SELECTING THE RIGHT STRATEGY FOR YOUR BACKUP:

✔ Verify that your backup data can be recovered.
✔ Create a version history.
✔ Store backup copies off-site.
✔ Have a storage management system in place.
✔ More tapes in the rotation scheme does not mean higher media wear.
Media wear is a function of the number of hours each tape is used.

> *i* Complete tape storage management solutions include drive, media for cartridge rotation, cleaning cartridge, SW and installation guide.
> **And it is not complete until properly implemented and maintained.**

SELECTING THE RIGHT SYSTEM:

✔ Don't buy something unreliable
It'll be repaired all the time and it won't be there when you really need it.

✔ Don't buy something too small
You'll get tired of managing the resource and regret not getting something larger. The amount of stored data will increase.

✔ Don't buy something too slow

- Don't buy something too slow
  You'll be frustrated and unhappy because you can't finish the job on time.

- Don't buy something too fast
  It's too expensive and you can't drive that fast anyway if the system cannot keep up. up to speed. Most often the system throughput is the bottle-neck.

- Keep it Simple
  You don't want to worry about it once it's installed

TANDBERG DATA

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