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COMP 225: Network and System Administration
Notes #4: Back up Data Files

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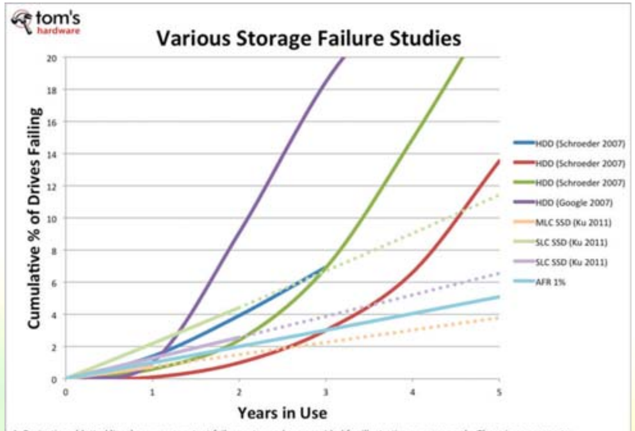
Topics

- System backup and restore considerations
- Types of backups, and their pros and cons
- Practicing backup and restore in Linux
  - Archival utility: tar
  - Task scheduler: crontab

Why Backing up Files?



1. Projections (dotted lines) assume constant failure rates and are provided for illustrative purposes only. There is no reason to believe that SSDs model a constant failure rate.
2. Data excludes write endurance related errors.
2. Each line represents one population of drives subjected to a particular workload

Why Backup?

- With "backup and restore" operations, can protect data from loss
- Backup offers more than one copy of system files
- The purpose of restore is to recover data that is temporarily unavailable due to some unexpected event

On File System Backup

- Therefore, backing up user and system files on a single-user Linux system is a good routine operation of an ordinary user
- For complex multiuser systems, it is ***a necessary procedure*** for anyone responsible for the administration of the system
- As a system administrator, an easy-to-remember set of considerations is in the form of *How*, *What*, *Why*, *When*, *Where*, and *Who*?

Questions on System Backup

- *"How"* – the commands, utilities, applications, or combination of hardware and software to accomplish the backup and archive; the strategies such as incrementally, in a rolling fashion, or across the entire file system structure totally, etc.
- *"What"* – the selected data for backup, such as user files, user account files, certain kinds of documents, the whole disk drive, multiple disk drives, subset or all of system files, etc.
- *"Why"* – the decisions on the relative importance of *"What"* for backing up

Questions on System Backup (cont'd)

- *"When"* – how often to backup, e.g., hourly, once a day, once a week, once a month, or at what time to save a particular file, etc.
- *"Where"* – the locations of the backup data, e.g., local disk, Cloud storage, a USB thumb drive, another computer or Network Attached Storage (NAS), etc. manually or automatically, etc.
- *"Who"* – the backup is carried out by a person, an automated software, or an automated process through the Cloud vendors, etc.

Good to Do Backup?

- Backup is not free
- No backup is risky
- Nowadays, in fact, cost of backing up is diminishing, value of data is growing

Proper Backup Procedure

- Choose your application
- Scheduling
- Implementation
- Inventory (content and media)
- Verify
- Automate
- Secure

Factors on Making Backups

- Determine which data is critical
  - Recovery point objective (RPO) – How much data can be lost? An hour, a week of data?
- Determine frequency and types of backups to be used
  - Recovery time objective (RTO) – How fast should data be recovered? Can we continue to operate without recovering data for a day, a week…?

Factors on Making Backups (cont'd)

- Among file's attributes (or metadata), there is one bit called "archive flag"
  - This flag informs the backup program about which files need backing up
  - 0 for has been backed up recently; 1 for needs to be backed up
- Types of backups*
  - Full – a full backup backs up all the files in the back up target
  - Differential – an incremental backup backs up all the files that have changed since the last *full backup*
  - Incremental – similar to "differential" but using ***any type of backup*** the last time
- Remark: full archival backup (or mirror image copy or raw device backup) – every single bit on a disk is duplicated, including empty space

*** The definitions of "differential" or "incremental" might be different for some other practitioners**

Factors on Making Backups (cont'd)

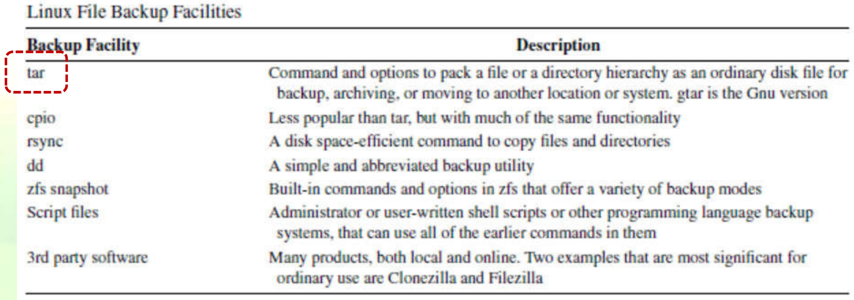
- Determine the categories of data, and you can schedule the backups accordingly
- Determine which data is static and which is dynamic.
  - Some OS installations are changed infrequently, i.e., few backups required
  - Some applications may require continuous backups, e.g., online market places
  - Understand the changing state of your client's data to determine an appropriate backup schedule

Factors on Making Backups (cont'd)

- Determine the appropriate media storage for your backups:
  - CD/DVD
  - Tape
  - Hard Disk
  - Online

Choose your Backup Tools: Examples

- Many commercial apps are available for different OSes
- MS Windows: "Backup and Restore" capability
- Linux/Unix



Linux File Backup Facilities

Backup Facility	Description
tar	Command and options to pack a file or a directory hierarchy as an ordinary disk file for backup, archiving, or moving to another location or system. gtar is the Gnu version
cpio	Less popular than tar, but with much of the same functionality
rsync	A disk space-efficient command to copy files and directories
dd	A simple and abbreviated backup utility
zfs snapshot	Built-in commands and options in zfs that offer a variety of backup modes
Script files	Administrator or user-written shell scripts or other programming language backup systems, that can use all of the earlier commands in them
3rd party software	Many products, both local and online. Two examples that are most significant for ordinary use are Clonezilla and Filezilla

Files and Times

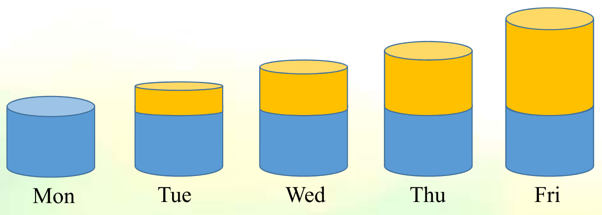
- Three different times for each file (in Linux)
  - *mtime* - modification time; this value is changed when the content of the file is changed
  - *atime* - access time; the value of this is changed when the file is accessed. The atime can change when a backup utility or script read the file as well as when a use reads the file
  - *ctime* - change time; the value is updated whenever the attributes of the file change. This can be ownership or permissions
- Note: file system backups change *atime* while raw device backups will not. If implementing incremental or differential backups, this is important

Full Backup

- Pros
  - Provides a complete copy of all files
  - Easy to manage
  - Done less frequently than other types of backups due to cost and resource requirements, e.g., monthly, quarterly, semi-annually, annually
- Cons
  - Usually requires more media space than either differential or incremental
  - Takes a long duration to recover the full backup to a new disk

Differential Backup

- Copy modified files since the last ***full backup***
- Differential backups grow with time, they can eventually grow larger than the last full backup
- Scheduled more frequently than a full backups: Weekly, monthly

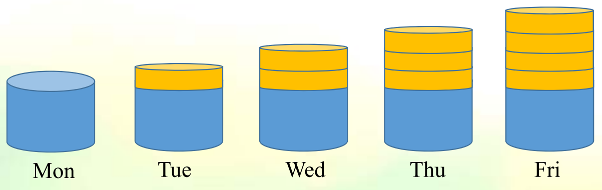


Differential Backup (cont'd)

- Pros
  - Redundancy
  - In general, takes up less time and space than a full backup
  - If the differential backup grows to the size of the last full backup, then schedule a new full backup
- Cons
  - Redundancy – potentially many unneeded copies of the same data
  - Subsequent differentials take longer and use more media space

Incremental Backups

- A backup of what has changed since using any type of backup the last time
- Frequency of incremental backups depends on the client needs: weekly, daily, hourly, continuously



Incremental Backups (cont'd)

- Pros
  - Keeps a revision history of actively changing files
  - Fastest backup type
  - Uses the least amount of media to complete a single backup
- Cons
  - Much more difficult to manage
  - Failure in the chain of backup?

Backup Considerations

- Backups slow down service
  - Files should be write-locked during backup
- Avoid doing backups during peak service hours. Schedule during early AM hours on the weekend and holidays

Example of Scheduling

- Full backup twice per year
- Differential each first Saturday morning of each month that is not scheduled for a full backup
- Incremental each Saturday morning that is not scheduled for a Full or Differential

Other Schedule Considerations

- Consider completing a backup in conjunction with and before any major system changes are scheduled

Backup Automation

- Automation reduces human errors
- Many pre-packaged applications include automatic scheduling
- Linux/Unix backup scripts can be submitted using the `cron` utility
- Logs can be kept in `/var/log`, and e-mail can be sent to the admin

Data Compression

- Risks – if the media is damaged, recovery may be difficult or impossible
- Lossy
  - Some data tolerates degradation (loss of information)
- No-loss
  - Some data should not be compressed. Know your data!

Restoration of Data

- Common reasons for restores
  - Accidental file deletion
  - Disk failure
  - Disaster recovery: fire, flood, earthquake, hacker attack, sabotage, terrorist attack, etc.

`tar` - Linux Backup Utility

- `tar` (tape archiver) is a powerful backup and restore utility
- Most Linux files are downloaded as compressed .tar files

Common Options for `tar`

Full optional operation name

`-c --create` is to create a new archive

`-v --verbose` is to list the files being processed

The short form

`--acls` is to enable POSIX ACLs that the directory has

`-x --extract` is to extract/restore the archived file

`-r --append` is to add the single file or directory to the archive

`-p –preserve-permissions` is to extract information about file permissions

`-f --file` is to specify the name of an archive file or a device location

Data Compression for `tar`

- There are different compression algorithms, the popular ones are
  - -z --gzip --gunzip : compress or decompress using gzip function
  - -j --bzip2 : compress or decompress using bzip2 function
  - -J --xz : compress or decompress using xz function

Examples

- The simplest command to create an archive file from a directory

```
$ tar --create --verbose --file archive_name.tar
directory_name
```

- Backup an entire computer

```
$ sudo tar -cvpzf backup.tar.gz --exclude=/mnt /
```

- Backup up content of a web site excluding the video files

```
$ sudo tar -cvpzf wwwbackup.tar.gz
--exclude=/var/www/video /var/www
```

- Restore files

```
$ sudo tar -xvpzf wwwbackup.tar.gz -C /recover
```

↑ Change to directory

Job scheduling with crontab

- Many administrative tasks must be done frequently and regularly
  - Rotating log files, backing up data
- In Linux, Running jobs at regular intervals is managed by the cron facility
  - consists of the crond daemon and a set of tables describing what work is to be done and with what frequency
  - The daemon wakes up every minute and checks the crontabs to determine what needs to be done
  - The crond daemon is usually started by the init process at system startup
- Use the crontab command

Job Scheduling

- How often to do a job?
- Many administrative tasks must be done frequently and regularly, e.g.,
  - Rotating log files, backing up data
- In Linux, running jobs at regular intervals can be managed with the `cron` (Ubuntu) or `crond` (Red Hat) facility
  - A `crond` daemon and a set of tables describing what work to do and its frequency
  - The daemon wakes up every minute and checks the `crontab`s to check what to do
  - The `crond` daemon starts when the system boots and runs as long as the system is up

Use the `crontab` Command

- A `cron` configuration file is "`crontab`" which we call it ***cron* table**
- Containing lists of command lines and times at which they are to be invoked
- `Crontab`s for individual users are stored under `/var/spool/cron` (Linux) or `/var/cron/tabs` (FreeBSD)
- There is at most one `crontab` file per user

Editing `crontab`

- To create or edit a `crontab`, use the `crontab` command with the option `-e` (for "edit")

```
$ sudo crontab -e
```

- We can select our editor of choice using the command

```
$ sudo select-editor
```

  Or it may ask you upon creating a `cron` table

- Each `crontab` entry contains six fields
  - Comments are introduced with a pound sign (#) in the first column of a line
  - Each non-comment line contains ***six fields*** and represents one command

minute hour dom month weekday command

The Fields

1. Minute of the hour (0-59)
2. Hour of the day (0-23)
3. Day of the month (dom) (1-31)
4. Month of the year (1-12)
5. Day of the week (0-6 for Sun, Mon, Tue, Wed, Thu, Fri, Sat)
6. String to be executed by bash

- For each time-related field
  - ***A star***, which matches everything
  - ***A single integer***, which matches exactly
  - ***Two integers separated by a dash***, matching a range of values
  - ***A range followed by a slash and a step value***, e.g., 1-10/2
  - ***A comma-separate list of integers or ranges***, matching any value

Examples

- `45  10  *  * 1-5  [a bash command]`
  - "10:45 a.m., Monday through Friday."
- `0,20,40 22-23 * 7 Fri-Sat /home/ian/mycrontest.sh`
  - Runs `mycrontest.sh` shell script at 10 pm, 10:20 pm, 10:40 pm, 11 pm, 11:20 pm, 11:40 pm, in July on Fridays and Saturdays

Automatic Backup

- Combining `crontab` and `tar` to make an automatic backup
- Back up www web site files every minute (crazy!)

```
* * * * * sudo tar -cvpzf /backupfolder/wwwbackup.tar.gz
/var/www
```

- Back up www web site files at 3 am on Tuesdays

```
0 3 * * 2 sudo tar -cvpzf /backupfolder/wwwbackup.tar.gz
/var/www
```

Remarks

- Discussed backup and crontab
- Questions?
- A lab practice will be available in a few days…