Backup

- Why backup?
  - The choice of goals.
- Where?
  - The choice of medias.
- What?
  - The choice of contents.
- When?
  - The choice of schedules.
- How?
  - The choice of procedures of operations.

Backups

- Unattended backups - Avoid manually switch the tapes for one backup if possible
  - Buy a higher-capacity tape device
  - By a stacker or library and feed multiple pieces of media to one device
  - Change you dump sequence
  - Write a smarter script
  - Use multiple backup devices
- Protect your backups
  - Keep tapes off-site
  - Secure store Location
  - Write-locked
- Limit activity during dumps
Backups

- Verify your backup tapes
  - List the contents
  - Restore to another server
- Develop a tape life cycle
- Label your tapes
  - Uniquely identify their contents
  - Format, exact syntax of the dump command
  - Get a label machine
- Pick a reasonable backup interval
- Design your data for backups
- Choose file systems carefully
- Prepare for the worst
- Perform centralized backup

Backup Strategies

- Full backup
  - Copy all the files on a system to a backup device
  - Time consuming
- Incremental backups
  - Copy only those files that have been changed since some previous backup
  - Fast
  - Need previous backup for a complete restore
- Backup level
  - Each backup type has a level number assigned to it.
  - Full backup is 0
  - Backing up the system at level N means saving all the files that have changed since the very last backup at the level less than N
Backup Strategies

- Combination of using multiple levels:
  - Example 1:
    - Backup schedule:
      - Monday: level 0 backup
      - Tuesday: level 1 backup
      - Wednesday: level 1 backup
      - Thursday: level 1 backup
      - Friday: level 1 backup
    - How many tapes are needed to restore the complete filesystem?

Backup Strategies

- Example 2:
  - Backup schedule:
    - First Monday of month: level 0 full
    - All other Mondays: level 1 weekly incremental to 0
    - Tuesday: level 2 daily incremental to 1
    - Wednesday: level 2 daily incremental to 1
    - Thursday: level 2 daily incremental to 1
    - Friday: level 2 backup
  - How many tapes are needed for a complete restore?
Backup Strategies

- **Consider:**
  - Use different schedule for different filesystems
  - Make a full backup whenever you make significant change
    - A new kernel
    - OS upgrade
    - New application package installation

Backup Devices and Media

- Use removable media
- For media using magnetic particles, avoid
  - Audio speaker
  - Transformers and power supplies
  - Monitors use transformers and high voltages.
  - Prolonged exposure to the earth’s background radiation
- Floppy disks
  - Cheap and short life
  - Small capacity and slow
  - Drive comes with the system
Backup Devices and Media

- Super floppies
  - Zip drive
    - More capacity (> 128MB)
    - High media cost
    - Available with parallel, serial, SCSI and USB connectors.
- CD-R and CD-RW
  - More capacity, 650MB
  - Available with SCSI, IDE, parallel, USB, etc.
  - Are written with a laser through a photochemical process
    - Longer shelf life than magnetic media
    - Have you heard of CD-eating fungus?
- DVD writer
  - High capacity

Backup Devices and Media

- Removable hard disks
  - Orb drive from Castlewood Industries, 2.2G
  - Jaz from Iomega, 2G
  - Speed is attractive, comparable to normal disk drives
  - Small system and home machine backup
- DDS(4mm) cartridge tapes
  - Digital Data Storage
  - Use same principle as home video recorders - more reliable, lower error rate than DAT (Digital Audio Tape)
  - Can hold up to 20G
Backup Devices and Media

- DLT (Digital Linear Tapes)
  - Popular backup device
  - Quantum
  - Hold large amounts of data: DLT4 80G
  - Fast transfer rate: 6MB/s
  - Pricey media

- AIT (Advanced Intelligent Tape)
  - 6MB/s
  - 50G

- Mammoth
  - Exabyte's
  - 12MB/s native transfer rate

Backup Devices and Media

- Jukeboxes, stackers and tape libraries
  - A stackers is a simple tape changer that is used with a standard tape drive
  - A jukebox is a hardware device that can automatically change removable media in a limited number of drives
  - Tape libraries are a hardware backup solution for large data sets.

- Hard disks
  - Backup over network

- What to buy?
  - Budget
  - requirement
Native Backup & Recovery Utilities

- Backing up with the dump utility
- Restoring with the restore utility
- Backing up and restoring with the cpio utility
- Backing up and restoring with tar utility
- Backing up and restoring with dd utility
- Device-level tape manipulation with mt

Dump and restore

- the most common way to create and restore from backups
- The underlying commands used by automated backup software

Advantages:
- Backup can span multiple tapes
  - It detects the end of tape (EOT) and ask for a new tape
- Files of any type (even devices) can be backup and restored
- Permissions, ownerships and modification times are preserved.
- Files with holes are handled correctly
- Backup can be performed incrementally
- Read the inode table, so very efficient.
- Long names are handled correctly.
Dump and restore

- Limitations
  - Every filesystems must be dumped individually
  - Only filesystems on the local machine can be dumped.

- Incremental backup
  - File /etc/dumpdates to determine how far back an incremental dump must go
  - Flag u causes dump to automatically update /etc/dumpdates
  - /etc/dumpdates must be created manually first time
  - Dump sends output to some default device unless flag f is used
    - Use nonrewinding tape when put multiple dumps on a single tape.

Dump and restore

- Dump’s most important options
  - 0-9 The first argument of dump is the incremental dump level.
  - u Update /etc/dumpdates upon successful backup
  - s The size of the backup tape in feet
  - d density of the backup tape in bytes per inch (bpi)

- Example:
  - $ dump 3u /chem
Dump and restore

- **Restore's most important options**
  - `r` Read and restore the entire tape
  - `x` extract all files and directories listed and restore them in the current directory
  - `t` type the name of the listed files and directories on the terminal. Can be used to verify the tape is readable.
  - `f` name of the file or device holding the dump
  - `s` the corresponding argument indicates which file on tape is to be used for the restore.
  - `i` interactive mode. Most useful to restore a small group of files.

Dump and restore

- **Restore a entire filesystem**
  - Step1: restore the most recent level 0 dump
  - Step2: restore the recent next level
  - Step3: continue the procedure step2 until the last dump
  - **Example:**
    - Some dump sequences. Red number are the ones need to restore.
      - 000000
      - 032545
## Dump and restore

- **A complete example:**
  
  ```bash
  #/etc/mount /dev/dsk/c201d6s0/home
  #cd /home
  Mount first tape of level 0. Use mt to position to the right
  spot and then
  #restore r
  Mount the next level tape. Use mt to position to the right
  spot and then
  #restore r
  ```

## Dump and restore

- Again, exact command name, options, syntax varies from platform to platform
  - Example, On Solaris
    - dump has nothing to do with backup
    - The dump command is ufsdump
    - The restore command is ufsrestore
  - Check the OS specific document before you type the command
**tar**

- An archiving program for store and extract files from an archive file known as tarfile.

- **Features:**
  - create (-c), extract(-x) or view (-t) a tape file
  - Tarfile can be on tape file or a normal file (-f).
  - Recursive to directory
  - preserves ownership information (-p option)
  - Follow symbolic link (-h option)
  - Blocking factor may yield better performance (-b)
  - Use relative path (-C)

- **Drawbacks of some version of tars**
  - May not allow multiple tape volumes
  - Pathname may be limited to 100
  - File size maybe limited to 2G

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**tar**

- **Format:**
  - %tar options list_of_files

- **Examples:**
  - Save all files under /home to the default tape drive.
    
    `$tar -c /home`
  
  - Copy directory tree fromdir to todir
    
    `$tar cf - fromdir | (cd todir; tar xfp - )`
  
  - Save all the files under the directories /home, /home2 and /chem/public
    
    `* $tar -cf /dev/rmt1 /home /home2 /chem/public`
  
  - Perform a backup of files has been changed within a day
    
    `* $ tar c `find /home -mtime -1 ! -name "*.o" ! -type d -print`
**cpio**

- *Copy files to and from archives*

- **Advantages**
  - It is designed to easily backup completed arbitrary sets of files; tar is easiest to use with directory subtrees.
    - Work with find together.
  - It packs data on tape much more efficiently than tar.
  - On restore, it skips over bad spots on the tape while tar just dies.
  - It can span tapes.

- **Three operating modes**
  - **Copy-out mode** (-o)
    - Read a list of filenames, one per line, on the standard input, and write the archive onto the standard output.
    - Example:
      ```sh
cpio -o > /dev/rmt0
      ```
  - **Copy-in mode**
    - Copy files out of an archive or lists the archive contents
  - **Copy-pass mode**
    - Copy files from one directory tree to another, without using an archive.
      ```sh
cpio -pdm todir
      ```
  - **Perform an incremental backup using cpio**
    - Touch /backup/home_full
    - Find /home -print | cpio -o > /dev/rmt0
    - A day later ...
    - Touch /backup/home_incr_1
    - Find /home -newer /backup/home_full -print | cpio -o > /dev/rmt0
**dd**

- **A file copying and conversion program**
  - Transfer raw data between devices

- **Example:**
  - **Make a copy of magnetic tape**
    
    ```bash
    $dd if=/dev/rmt8 of=/dev/rmt9 cbs=16b
    ```

    If there is only one tape:
    ```bash
    $dd if=/dev/rmt8 of=tfile cbs=16b
    $dd if=tfile of=/dev/rmt8 cbs=16b
    ```

  - **Convert the byte order, a usage to read on a SUN machine a tar tape written on an SGI machine:**
    ```bash
    $ dd if=/dev/rst8 conv=swab | tar xf -
    ```

**mt**

- **Direct manipulation of tapes**
- **Format:** `mt [-f tapename] command [count]`
- **Commonly used function**
  - Remind (rew)
  - Check status (status)
  - Puts the tape off-line (offl)
  - Position a tape at a particular fileset (fsf [count], bsf [count])
    - Can be confusing
    - Quite useful sometime

- **Example**
  - Find what’s on a tape with no labels
Commercial Backup utilities

- **Consideration**
  - Full support of your platforms - heterogenous
  - Backup of raw partitions
  - Multiplexing
    - Simultaneous backup of many clients to one drive
    - Simultaneous backup of one client to many drives
  - Storage management features
  - Reduction in Network traffic
  - Support of a standard or custom backup format
  - Ease of administration
  - Ease of recovery
  - Protection of the backup index
  - Automation
  - Cost
  - Vendor

- Some packages with Unix vendor with extra payment

- Enterprise level backup solution examples
  - Commercial software
    - Veritas Netbackup
    - HP Openview OmniBack
  - Free software
    - Bacula
    - Amanda
Backing Up and Restoring the System
Filesystems

- Backup/restore the modified configuration
- When system filesystems need to be completely restored:
  - Reinstall OS and restore the files that you have modified
    - How many files have been customized
    - How widely they are spread
    - How much device and other reconfiguration needs to be redone
  - Booting from alternate media and then restoring the filesystems from full backup.
    - Basic steps
      - Boot off media
      - Prepare the filesystems
      - Restore
    - DOCUMENT and TEST the procedure
      - Emergency boot tapes only has limited number of normal system commands

Backing Up and Restoring the System
Filesystems

- Bootable backup tapes on some Unix versions
  - Created from live system
  - Self-restoring
  - Examples:
    - AIX’s mksysb utilities
      - It saves all of the filesystems in the root volume group (/, /usr, /var, /home, /tmp, etc)
        - `# mksysb -i /dev/rmt0`
      - To restore, boot from mksysb tape
    - HP-UX recovery tape
      - Run the command `mk_recovery`
Tape Special Files

- Tape drives often have names of
  - /dev/rmtN or /dev/rmt/N
    - Where N indicates the drive number
  - Include other characters as suffixes or prefixed to indicate
    - The density setting
    - Hardware compression setting
    - Rewinding setting
    - For example:
      - /dev/rmt/0mn

Moving data between systems

- In general, tar, cpio and dump archives are readable on many systems. But,
  - Block size difference
  - Archive format incompatibilities
  - Byte order difference
  - Compressed archives
Remote backup and restores

- Why remote?
  - No local tape drive
  - Faster tape drive on another system

- Command rdump and rrestore
  - The device name is
    - Host:local_device
    - #rdump Of anchor:/dev/nst0 /spare
  - Permission control
    - .rhosts

Database Backup & Recovery

- Database can be build on
  - Raw device
  - Unix files

- Database backup can be
  - Offline
    - No access to database at all.
    - Regular raw device/unix file backup can be applied
  - Online
    - Database is available to end users
      - On going transactions
      - modification to multiple devices/files with one transaction
    - Data integrity
      - Transaction log
      - Special backup commands/configuration
Database Backup & Recovery

- Example:
  - Sybase
    - Transaction log
    - Dump tape definition (size, device filename) inside the db
    - Dump command
      - Support multiple volume
      - Has to wait until tape is ready
      - Use non rewinding tape for multiple database.
    - Recovery is straightforward

- Example:
  - Oracle
    - Cold backup - shutting database down.
      - Incremental at filesystem level does not work
      - Recovery is ready.
    - Hot backup - turn on Archive mode
      - Archive log/undo log/redo log
        - Recover up to the point of failure
      - Backup mode
        - File system backup
      - RMAN (Support incremental)
      - Hot backup Recovery is a headache
Summary

- Backup is important, don’t neglect it
  - Strategy
  - Monitor
  - Test