Backups

Outline

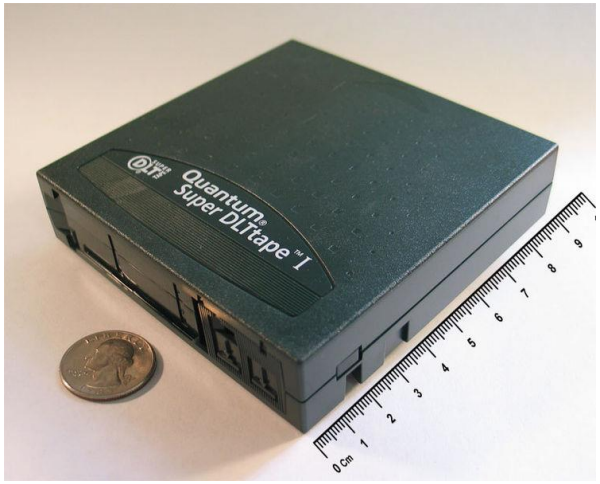
- Backup devices and media
- Backup philosophy
- Unix backup and archiving commands

Backup Media – By Storage (1)

- By Storage category
  - Hard disk
    - **SATA / SAS / SSD**
      - **120 ~ 450 MB /s**
    - **1 TB SATA3: NT 1,500**
    - **2 TB SATA3: NT 2,000**
    - **4 TB SAS: NT 9,000**
    - **256 G SSD: NT 2,500**
  - CD/DVD R RW
    - **CD**
      - **6 ~ 8 MB/s**
    - **DVD**
      - **8 ~ 15 MB/s**
    - **CD-R 0.7G: NT 6**
    - **DVD-R 4.7G: NT 9**
    - **DVD DL 8.5GB: NT 35**
    - **BD**
      - **4x 18 MB/s, 12x 64 MB/x**
      - **6x double-layer BD-R 50GB：NT 60**

Backup Media – By Storage (2)

- Tape
  - **DAT (Digital Audio Tape) 4mm tapes**
    - **DDS (Digital Data Storage), Minimal Error Rate, Higher Efficiency**
    - **DDS-4 (often used)**
      - **20/40GB(compressed), about NT 400.**
      - **1.0~3.0MB/s**
  - **Travan tapes**
    - **High Transfer Rate**
    - **Travan 40 (often used)**
      - **20/40GB(compressed), about NT 2000.**
      - **Up to 8.0MB/s**
  - **DLT (Digital Linear Tape)**
    - **High Capacity, Solid Reliability**
    - **Media**
      - **Max 800 GB, about NT 4000.**
      - **Speed: Up to 60 MB/s**



  - **LTO Ultrium**
    - **Fast Transfer Rate, High Performance, and High Storage Capacity**
    - **LTO Ultrium 3 (often used)**
      - **Max 1600 GB, about NT 5000.**
      - **Speed: up to 80 MB/s**
      - **Tape Drive is much more expensive……**

Backup Media – By Storage (3.1)

- Backup media compare

Medium	Capacity[a]	Speed[a]	Drive	Media	Cost/GB[a]	Reuse?	Random?[b]
CD-R	700MB	7MB/s	$15	15¢	21¢	No	Yes
CD-RW	700MB	4MB/s	$20	30¢	42¢	Yes	Yes
DVD±R	4.7GB	30MB/s	$30	30¢	6¢	No	Yes
DVD+R DL[c]	8.5GB	30MB/s	$30	$1	12¢	No	Yes
DVD±RW	4.7GB	10MB/s	$30	40¢	9¢	Yes	Yes
Blu-ray	25GB	30MB/s	$100	$3	12¢	No	Yes
DDS-4 (4mm)	20GB	30MB/s	$100	$5	25¢	Yes	No
DLT/S-DLT	160GB	16MB/s	$500	$10	6¢	Yes	No
DLT-S4	800GB	60MB/s	$2,500	$100	13¢	Yes	No
AIT-4 (8mm)	200GB	24MB/s	$1,200	$40	20¢	Yes	No
AIT-5	400GB	24MB/s	$2,500	$50	13¢	Yes	No
VXA-320	160GB	12MB/s	$800	$60	38¢	Yes	No
LTO-3	400GB	80MB/s	$200	$25	6¢	Yes	No
LTO-4	800GB	120MB/s	$1,600	$40	5¢	Yes	No

Backup Media – By Storage (3.2)

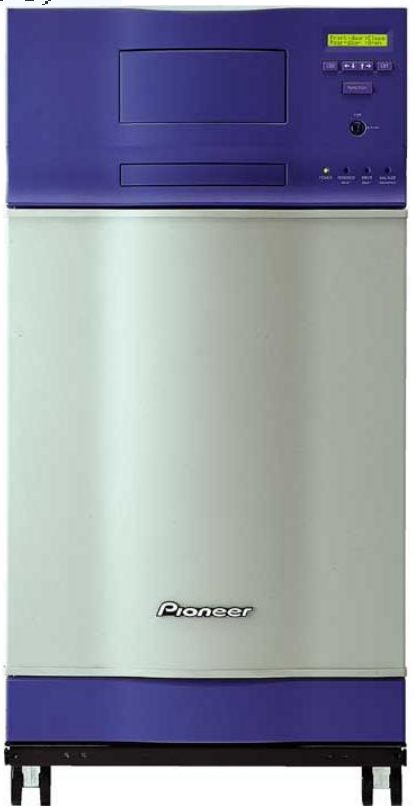
- **MO (Magneto-Optical)**
  - **MO 540M, 640M, 1.3G, 2.3G**
- **Removable Media**
  - **Floppy, ZIP, LS-120**
- **Jukebox**
  - **Automatically change removable media**
    - **DAT, DLT, CD, …**
- **Tape Library**
  - **Hardware backup solution for large data set**

Backup Media – By Storage (4)

- Jukebox
  - Automatically change removable media
  - Available for several types of media
    - DAT, DLT, CD

Specifications

Number of Magazines (50-disc Magazine)	Max. 6 units (front: max. 3, rear: max. 3)
Number of Magazines (20-disc)	1
Number of Drives	Max. 8 drives
Disc Change Time	Max. 8 seconds



Backup Media – By Storage (5)

Tape Library

IBM TotalStorage Ultrium Scalable Tape Library 3583 規格一覽表	
型號	L18 (18 個磁帶)；L36 (36 個磁帶)；L72 (72 個磁帶)
機架特性代碼	8006 機架套件
Native Fibre Channel Drive 特性	特性代碼 8105
Ultrium Scalable Tape Library 屬於客戶自行安裝的產品，如需 IBM 安裝則需酌收部分費用。	
特色	
磁帶機類型	IBM LTO Ultrium 2 或 1
磁帶機數目	最多 6 個
磁帶數目	18、36、54 或 72
每個磁帶的容量[1]	壓縮時每個磁帶容量可達 400GB；原始容量為 200GB 壓縮時每個磁帶庫容量可達 28.8TB；原始容量為 14.4TB
持續的資料傳輸速率[1]	壓縮時可達 70MB/ 秒；原始為 35MB/ 秒

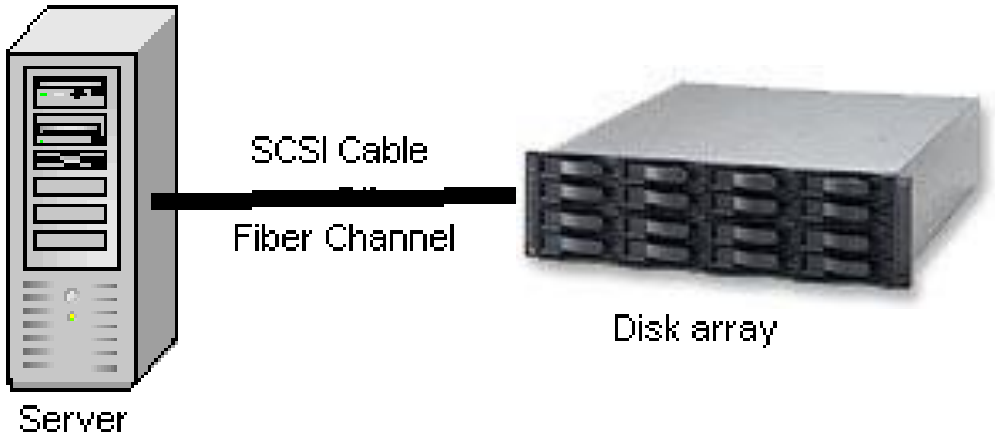
IBM TotalStorage UltraScalable Tape Library 3584 規格一覽表	
型號	L32-LTO 基本框架、D32-LTO 擴充架
特點	
磁帶機類型	IBM LTO Ultrium 2 或 1
框架數量	1 個基本框架與最多 15 個擴充架
磁帶機數量	最多 192 個：L32-1 到 12 LTO；D32-0 到 12 LTO
磁帶盒數量	最多 6,881 個：L32-87 至 281；D32-396 至 440
邏輯資料庫數量	最多 192 個：L32- 最多至 12; D32- 最多至 12
容量[1,2]	2,752 TB 壓縮，使用 16 個框架配置與 4 台磁帶機 L32 (1-4台磁帶機)- 最多112.4 TB/框架壓縮；56.2 TB原生 D32 (0 台磁帶機)- 最多 176 TB/ 框架壓縮；88.0 TB 原生

Backup Media – By Availability

- Off-line Storage
  - CD、DVD、MO
    - Adv:
      - Low cost, high reliability
    - Disadv:
      - Not-convenient, low speed
- Near-line Storage
  - JukeBox、Tape Library
    - Adv:
      - High capacity, high reliability
    - Disadv:
      - High malfunction rate, Not-convenient
- On-line Storage
  - Disk Array (RAID)
    - Adv:
      - Fast and high availability
    - Disadv:
      - High cost

Backup Media – By Enterprise Product (1)

- RAID architecture



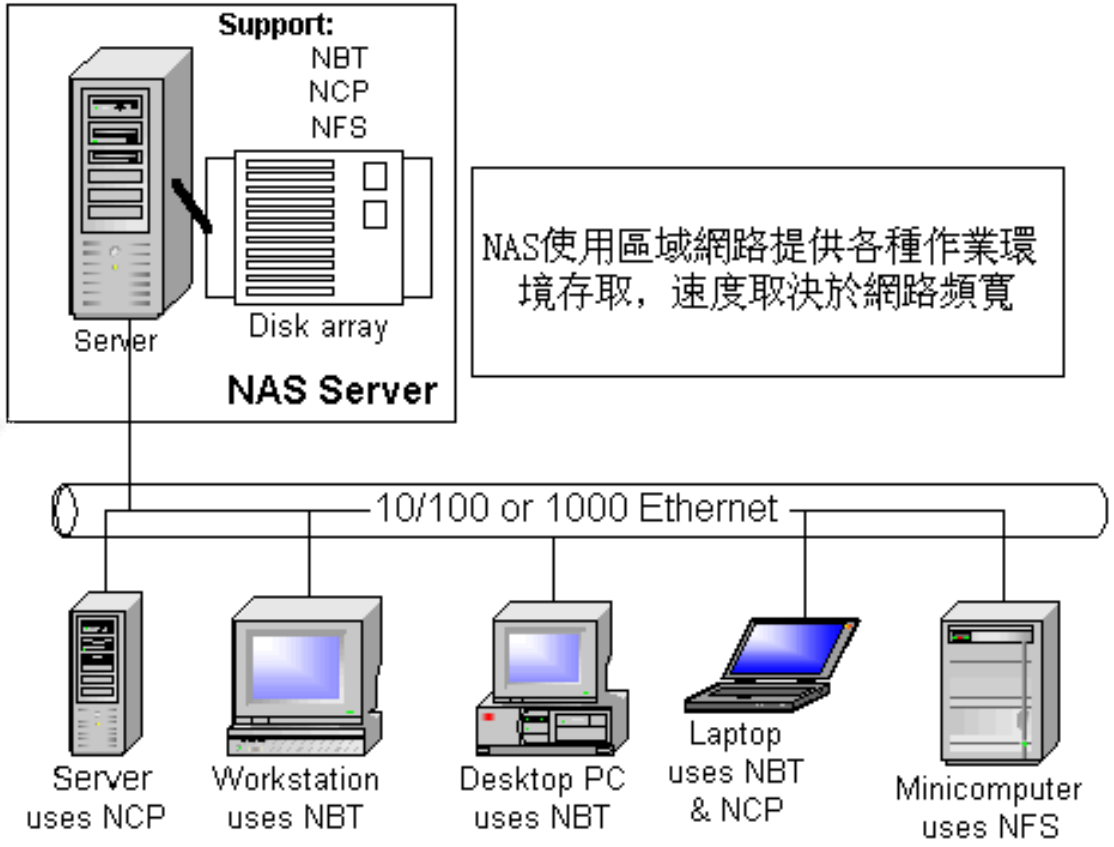
IBM TotalStorage DS6000 的目標：

- 以合理價格的儲存系統解決方案，爲大中型企業提供高可用性
- 具有企業級功能、模組化、可擴充特性，能支援開放性平台與大型主機
- 提供進階複製服務，與 IBM TotalStorage DS8000 系列及 IBM TotalStorage Enterprise Storage Server® (ESS) 800 和 750 系統互通
- 提供 GUI 介面與「快捷組態 (Express Configuration)」精靈，透過隨附的 IBM TotalStorage DS Storage Manager 來簡化系統配置與管理
- 採用模組化、3U、16 個磁碟機、機架式，隨儲存需求而擴增，最高可達 67.2TB 的實體容量

Backup Media – By Enterprise Product (2)

- NAS (Network Attached Storage)
  - Storage + Server + Cross-platform access OS + network access protocol

IBM NAS 300G
Supported Protocol:
NFS, HTTP, FTP, CIFS
Netware



Backup Philosophy

- Perform all dumps from one machine
- Label your taps
- Pick a reasonable backup interval
- Choose filesystems carefully
- Make daily dumps fit on one tape
- Make filesystems smaller than your dump device
- Keep Tapes off-site
- Protect your backups
- Limit activity during dumps
- Check your tapes
- Develop a tape life cycle
- Design your data for backups
- Prepare for the worst

Dumping filesystems – dump command (1)

- Used to backup filesystem into a large file to archive to an external device
- Advantages:
  - Backups can span multiple output media
  - Files of any type can be backed up and restored
  - Permissions, ownerships, and modification times are preserved
  - Files with holes are handled correctly
  - Backups can be performed incrementally
- Limitations:
  - Each filesystems must be dumped individually
  - Only filesystems on the local machine can be dumped
    - NFS filesystem is not allowed

Dumping filesystems – dump command (2)

- Backup level
  - 0 ~ 9
    - **Level 0 ➔ full backup**
    - **Level N ➔ incremental backup of Level ≦ N-1 for N = 1 ~ 9**
- dump command format
  - % dump [arguments] file-system
- dump command arguments
  - **u: update the /etc/dumpdates file after dump**
  - **f: the output backup file**
    - **Special device file, like /dev/nrsa0**
    - **Ordinary file**
    - **'-' to standard out**
    - **"user@host:file"**
  - **d: tape density in bytes per inch**
  - **s: tape length in feet**
  - **a: auto-size, bypass all tape length considerations (default d = 1600, s = 2300)**

Dumping filesystems – dump command (3)

- Example: Full backup

```
zfs[/mnt] -chiahung- ls -lh
drwxr-xr-x   3 root  wheel      512B Nov 22 15:34 ./
drwxr-xr-x  20 root  wheel       25B Nov 18 20:02 ../
-rw-r--r--   1 root  wheel      512M Nov 21 22:20 haha
zfs[/mnt] -chiahung- cat /etc/dumpdates
zfs[/mnt] -chiahung- df -h
Filesystem     Size    Used   Avail Capacity  Mounted on
zfs            15G    4.1G     11G    27%    /
devfs         1.0K    1.0K      0B   100%    /dev
/dev/da0s1a    8.7G    512M    7.5G     6%    /mnt
zfs[/mnt] -chiahung- sudo dump 0uLf - /dev/da0s1a > ~/dump.0
  DUMP: Date of this level 0 dump: Sun Nov 22 15:37:44 2009
  DUMP: Date of last level 0 dump: the epoch
  DUMP: Dumping snapshot of /dev/da0s1a to standard output
  DUMP: mapping (Pass I) [regular files]
  DUMP: mapping (Pass II) [directories]
  DUMP: estimated 525772 tape blocks.
  DUMP: dumping (Pass III) [directories]
  DUMP: dumping (Pass IV) [regular files]
  DUMP: DUMP: 525625 tape blocks
  DUMP: finished in 36 seconds, throughput 14600 KBytes/sec
  DUMP: level 0 dump on Sun Nov 22 15:37:44 2009
  DUMP: DUMP IS DONE
zfs[/mnt] -chiahung- cat /etc/dumpdates
/dev/da0s1a                 0 Sun Nov 22 15:37:44 2009
```

Dumping filesystems – dump command (4)

- Example: Incremental backup

```
zfs[/mnt] -chiahung- sudo cp -Rp /etc /mnt/
zfs[/mnt] -chiahung- ls -lh
drwxr-xr-x   4 root  wheel      512B Nov 22 15:48 ./
drwxr-xr-x  20 root  wheel       25B Nov 18 20:02 ../
drwxr-xr-x  20 root  wheel      2.0K Nov 22 15:35 etc/
-rw-r--r--   1 root  wheel      512M Nov 21 22:20 haha
zfs[/mnt] -chiahung- sudo dump 2uLf - /dev/da0s1a > ~/dump.2
  DUMP: Date of this level 2 dump: Sun Nov 22 15:49:04 2009
  DUMP: Date of last level 0 dump: Sun Nov 22 15:37:44 2009
  DUMP: Dumping snapshot of /dev/da0s1a to standard output
  DUMP: mapping (Pass I) [regular files]
  DUMP: mapping (Pass II) [directories]
  DUMP: estimated 2267 tape blocks.
  DUMP: dumping (Pass III) [directories]
  DUMP: dumping (Pass IV) [regular files]
  DUMP: DUMP: 2124 tape blocks
  DUMP: finished in less than a second
  DUMP: level 2 dump on Sun Nov 22 15:49:04 2009
  DUMP: DUMP IS DONE
zfs[/mnt] -chiahung- cat /etc/dumpdates
/dev/da0s1a                 0 Sun Nov 22 15:37:44 2009
/dev/da0s1a                 2 Sun Nov 22 15:49:04 2009
zfs[/mnt] -chiahung- ls -lh ~/dump*
-rw-rw-r--  1 chiahung  user   513M Nov 22 15:38 /home/chiahung/dump.0
-rw-rw-r--  1 chiahung  user   2.1M Nov 22 15:49 /home/chiahung/dump.2
```

Restoring from dumps – restore command (1)

- Restore can do
  - Restoring individual files
  - Restoring entire filesystem
- Options of restore command
  - i: interactive restore
  - r: restore an entire filesystem
  - f: the backup file that restore is going to use

Restoring from dumps – restore command (2)

- Restore individual file interactively

```
zfs[/tmp] -chiahung- cat ~/dump.2 | restore if -
restore > ?
Available commands are:
        ls [arg] - list directory
        cd arg - change directory
        pwd - print current directory
        add [arg] - add `arg' to list of files to be extracted
        delete [arg] - delete `arg' from list of files to be extracted
        extract - extract requested files
        setmodes - set modes of requested directories
        quit - immediately exit program
        what - list dump header information
        verbose - toggle verbose flag (useful with ``ls'')
        help or `?' - print this list
If no `arg' is supplied, the current directory is used
```

Restoring from dumps – restore command (4)

- Restore individual file interactively (cont.)

```
zfs[/tmp] -chiahung- cat ~/dump.2 | restore if -
restore > ls
.:
.snap/ etc/

restore > cd etc
restore > add make.conf
restore > extract
set owner/mode for '.'? [yn] n
restore > quit
zfs[/tmp] -chiahung- ls -ld etc
drwxr-xr-x  2 chiahung  wheel  3 Nov 22 15:35 etc/
zfs[/tmp] -chiahung- ls -l etc
total 6
drwxr-xr-x   2 chiahung  wheel    3 Nov 22 15:35 ./
drwxrwxrwt  10 root      wheel   42 Nov 22 15:58 ../
-rw-r--r--   1 chiahung  wheel  590 Nov 19 23:04 make.conf
```

Restoring from dumps – restore command (5)

- Restore entire filesystem
  - % restore -rf /home/temp/root.0
  - Steps
    - Restore level 0 first
    - Restore incremental dumps
      - 0 0 0 0 **0**
      - **0** 5 5 5 **5**
      - **0** 3 **2** 5 **4** **5**
      - **0** 9 9 5 9 9 **3** 9 9 **5** 9 **9**
      - **0** 3 5 9 **3** **5** **9**

Other archiving programs

- tar command
  - Read multiple files and packages them into one file
  - Example

    % tar czvf etc.tar.gz /etc/

    % tar xzvf etc.tar.gz

    % tar cf - fromdir | tar xfp - -C todir
- dd command
  - Copy filesystems between partitions of exactly the same size
  - Example

    % dd if=/dev/rst0 of=/dev/rst1

    % dd if=/tmp/kern.flp of=/dev/fd0

    % dd if=/dev/da1 of=/dev/da2 bs=1048576

CS home backup

- Using rsync
  - % rsync -a --delete
    - **-a: archive mode**
      - Recursive and preserve everything
    - **--delete:**
      - Delete any file that are not in the sending side

```
0 4 * * 1 (cd /raid;/usr/local/bin/rsync -aH --delete cs      /backup/user/)
0 4 * * 2 (cd /raid;/usr/local/bin/rsync -aH --delete gcs     /backup/user/)
0 4 * * 3 (cd /raid;/usr/local/bin/rsync -aH --delete dcs     /backup/user/)
0 4 * * 4 (cd /raid;/usr/local/bin/rsync -aH --delete alumni  /backup/user/)
```

CS home backup

❑ Snapshot

- CS home snapshot

```
wangth@csduty.cs.nctu.edu.tw[/u/gcs][20:14]$ ls -a
.         01        103       109       91        95        99
..        100       104       193       92        96
.snap     101       105       199       93        97
.snapshot 102       106       90        94        98
wangth@csduty.cs.nctu.edu.tw[/u/gcs/.snapshot][20:14]$ cd .snapshot/
wangth@csduty.cs.nctu.edu.tw[/u/gcs/.snapshot][20:14]$ ls
4hour.2018-01-02_0000  4hour.2018-01-02_2000  daily.2018-01-01_0010
4hour.2018-01-02_0400  daily.2017-12-28_0010  daily.2018-01-02_0010
4hour.2018-01-02_0800  daily.2017-12-29_0010  weekly.2017-12-17_0015
4hour.2018-01-02_1200  daily.2017-12-30_0010  weekly.2017-12-24_0015
4hour.2018-01-02_1600  daily.2017-12-31_0010  weekly.2017-12-31_0015
```

- HOWTO - 工作站取回備份
  - https://help.cs.nctu.edu.tw/help/index.php/HOWTO_-_工作站取回備份

Snapshot

```
derek[/] -chiahung- df -h
Filesystem     Size    Used   Avail Capacity  Mounted on
/dev/ad4s1a     70G     16G     48G    25%    /
devfs          1.0K    1.0K      0B   100%    /dev
derek[/] -chiahung- sudo mount -u -o snapshot /.snap/snapshot /
derek[/] -chiahung- df -h
Filesystem     Size    Used   Avail Capacity  Mounted on
/dev/ad4s1a     70G     16G     48G    25%    /
devfs          1.0K    1.0K      0B   100%    /dev
derek[~] -chiahung- sudo mdconfig -a -t vnode -f /.snap/snapshot -u 1
WARNING: opening backing store: /.snap/snapshot readonly
derek[~] -chiahung- sudo mount -r /dev/md1 /mnt
derek[~] -chiahung- ls /mnt/
./         COPYRIGHT  compat@    ftp/       mnt/       sys@
../        bin/       dev/       home/      proc/      tmp/
.cshrc     boot/      dist/      lib/       rescue/    usr/
.profile   cdrom/     entropy    libexec/   root/      var/
.snap/     cdrom1/    etc/       media/     sbin/
derek[~] -chiahung- sudo umount /mnt
derek[~] -chiahung- sudo mdconfig -d -u 1
```