

Backups

lwhsu (2019, CC-BY)

? (?-2018)

Outline

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

Key Concepts

- ❑ The backup that has never been verified is the same as no backup
- ❑ Types
 - Scope
 - Full
 - Incremental
 - Differential
 - Storage
 - Hot/Cold
 - Online/Offline
 - Remote

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**

- **Different “types”**

- **RAID**

- **Cold Archive**

- 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 特性代碼	8105
Drive 特性	
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

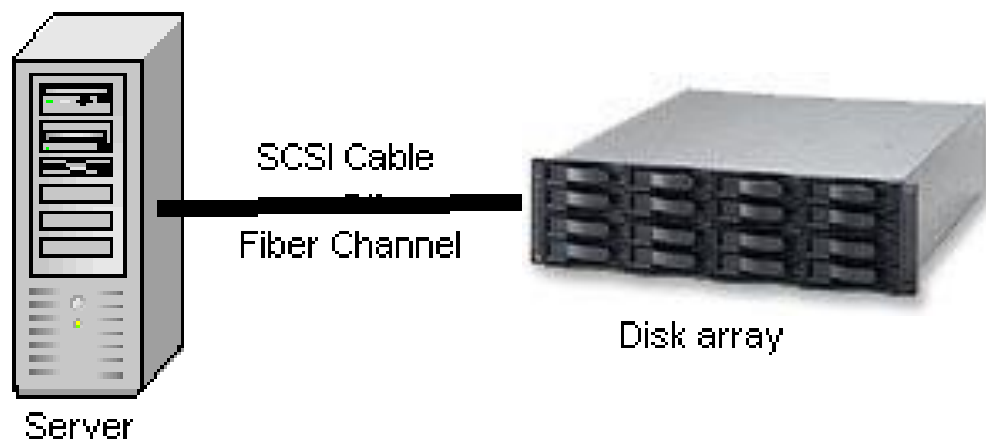
型號	L32-LTO 基本框架、D32-LTO 擴充架
特點	
磁帶機類型	IBM LTO Ultrium 2 或 1
框架數量	1 個基本框架與最多 15 個擴充架
磁帶機數量	最多 192 個：L32-1 到 12 LTO；D32-0 到 12 LTO
磁帶盒數量	最多 6,881 個：L32-87 至 281；D32-396 至 440
邏輯資料庫數量	最多 192 個：L32-最多至 12；D32-最多至 12
容量 ^{1,2}	2,752 TB 壓縮，使用 16 個框架配置與 4 台磁帶機 L32 (1-4 台磁帶機)-最多 112.4 TB/ 框架壓縮；56.2 TB 原生 D32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



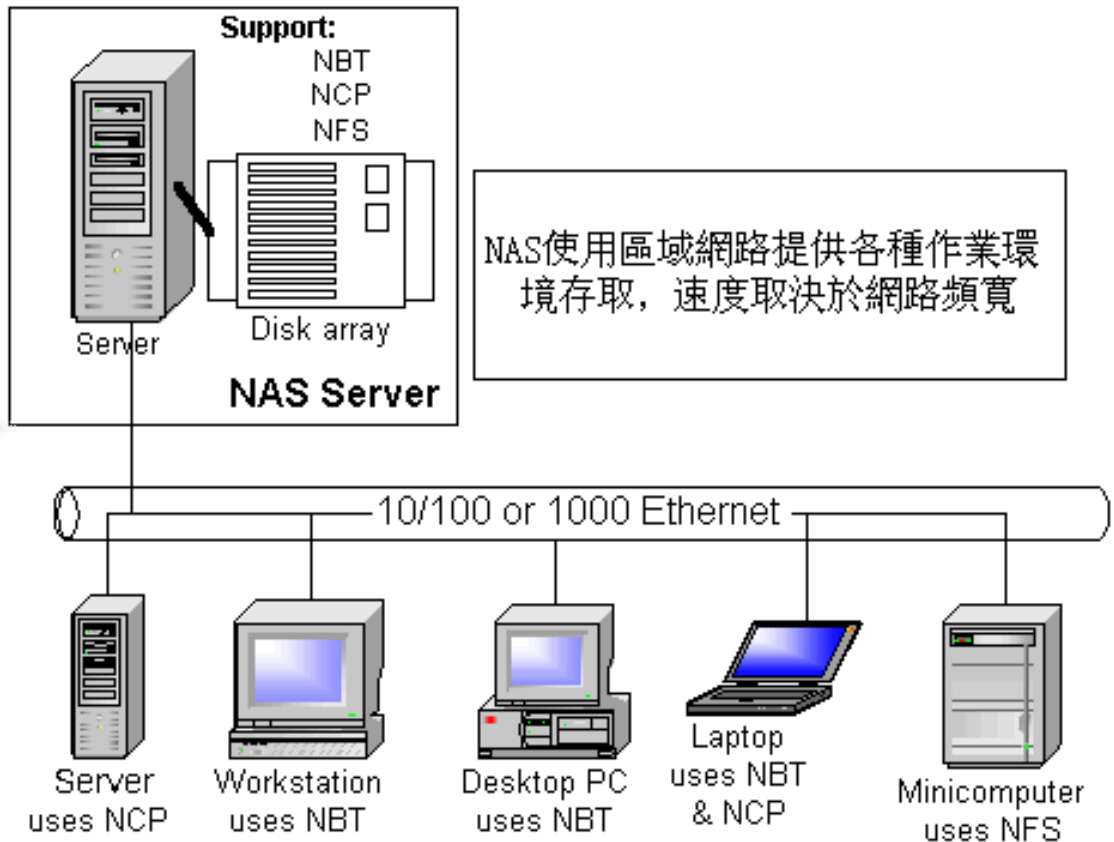
IBM TotalStorage DS6000 的目標：

- 以合理價格的儲存系統解決方案，為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 Media – Cloud

- ❑ Azure Backup
- ❑ AWS S3 Glacier / Deep Archive
- ❑ GCP Archival Cloud Storage



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 \leq 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

UFS 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
```