tar - archive/unarchive files and directories

Capture in a single file (archive) metadata and contents of files and directories, e.g.:

```
# capture files in sheeple directory tree
# -c create an archive
# -f archive filename
# -z compress with gzip
$ tar -zcf sheeple.tar.gz sheeple
$ cp sheeple.tar.gz /tmp
$ cd /tmp
# extract files from archive
# -x create an archive
# -v (verbose) - print filenames when extracting
# -f archive filename
$ tar -xvf sheeple.tar.gz
...
```

curl - interact with web-servers

curl lets you interact from command line with web and other servers

```
# fetch a file
$ curl -O https://cgi.cse.unsw.edu.au/~cs2041/examples.zip
# get other info
$ curl I https://unsw.edu.au
HTTP/1.1 200 OK
Server: Apache/2.4.34 (Red Hat) OpenSSL/1.0.1e-fips PHP/5.6.25
X-Powered-By: PHP/5.6.25
# send data to web server
$ curl -X PUT -H 'content-type: txt/plain' https://google.com
# send cookies to web server
$ curl -b 'id=42' https://google.com
....
```

many other options

ssh - encrypted remote login

- ssh was written by Finnish university student Tatu Ylönen
- quickly adopted as an internet standard

```
$ ssh-keygen
Generating public/private rsa key pair.
Enter file in which to save the key (/home/andrewt/.ssh/id_rsa):
# leaves private key in $HOME/.ssh/id_rsa
# leaves public key in $HOME/.ssh/id_rsa.pub
$ cat $HOME/.ssh/id_rsa.pub
ssh-rsa AAAAB3NzaC1yc2EAAAABIwAAAQEAxL+t ....
```

Add public key to `$HOME/.ssh/authorized_keys` to allow for access without password.

Can also run commands remotely:

```
$ ssh z1234567@login.cse.unsw.edu.au ls -las
```

rsync - efficiently copies files & directories

`rsync` efficiently copies files & directories locally or between machines (using ssh)

```
# mirror a directory tree in your CSE account
#    -a preserves metadata & copies recursively
#    -P shows progress
$ rsync -aP sheeple/ login.cse.unsw.edu.au:sheeple_backup/
```

If you run rsync command again it will only copy files which have changed.

If only a part of large file changed, will copy only the change (delta).

Many options, see `man rsync`

rsync

```
# create a 100mb file
$ dd if=/dev/random bs=1M count=100 of=100_mb_file
# takes 25 seconds to copy it to CSE (40Mbps NBN)
$ time rsync 100_mb_file login.cse.unsw.edu.au:100_mb_file
real    0m24.943s
# repeat the rsync without changing the file - very fast
$ time rsync 100_mb_file login.cse.unsw.edu.au:100_mb_file
real    0m0.782s
# change a few bytes of the file
$ echo hello andrew >>100_mb_file
# rsync still fast
$ time rsync 100_mb_file login.cse.unsw.edu.au:100_mb_file
real    0m0.846s
```

Tools for Managing Processes

Unix provides a range of tools for manipulating processes

Commands:

- `ps` ... show process information
- `top` ... show high-cpu-usage process information
- `kill` ... send a signal to a process
- `killall` ... send a signal to a process with particular names

Linux Filesystem Layout

`/home` - home directories for users on the system

`/bin` - important system programs (scripts and binaries)

`/usr/` - system programs and associated files

- `/usr/bin` system programs
- `/usr/local/bin` custom installed localp rograms
- `/usr/lib` - libraries (linked with programs)
- `/usr/include` - header files for C programs.

`/etc` - holds configuration for system programs

`/opt` - multi-operating system packages sometimes install here

`/var` - system files that regulary change, e.g.: log files, database files.

`/tmp` - directory for temporary files - removed on reboot

Linux Filesystem Layout

`/root` - home directory for root user

`/boot` - files need to boot operating system

`/dev` - pathnames for hardware devices.

`/media` - mount-point for removable device

`/proc` - special filesystem with information about processes

`/sys` - special filesystem with information about system

/dev - directory for devices

Devices manipulated by special files in `/dev` e.g a disk might appear as `/dev/sda`

```
$ ls -l /dev
...
brw-rw---- 1 root disk      8,   0 May 21 08:38 sda
brw-rw---- 1 root disk      8,   1 May 21 08:38 sda1
...
crw-rw-rw- 1 root root      1,   3 May 21 08:38 null
...
crw-rw-rw- 1 root root      1,   8 May 21 08:38 random
...
crw--w---- 1 root tty       4,   0 May 21 08:38 tty0
...
rw-rw-rw- 1 root root      1,   5 May 21 08:38 zero
```

fdisk - manipulate file-system partitions

Disks can be separated into separate regions called partitions.

This allows parts of disk to be used for different purposes

fdisk is a simple program to view or change partitions, see also gparted.

```
$ fdisk -l /dev/sdg
Disk /dev/sdg: 28.66 GiB, 30752636928 bytes, 60063744 sectors
Disk model: Ultra
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disklabel type: dos
Disk identifier: 0x00000000

Device     Boot Start      End  Sectors  Size Id Type
/dev/sdg1          32 60063743 60063712 28.7G  c W95 FAT32 (LBA)
```

Beware: dangerous operation - have backups!

File System Formats

- **ext4** - mostly widely used Linux file-system
- **ext2/ext3** - older versions of ext4 - limited with less features
- **brtfs** - copy-on-write filesystem with interesting features
- **zfs** - filesystem which can span disks with interesting features
- **ntfs** default Windows file-system - can be accessed from Linux
- **vfat** - older Windows filesystem - widely used for removable devices such as SD cards and USB keys

mkfs - create a filesystem on a disk

```
$ ls -l /dev/sdg*
brw-rw---- 1 root disk 8, 96 Aug  4 12:47 /dev/sdg
brw-rw---- 1 root disk 8, 97 Aug  4 12:47 /dev/sdg1
$ mkfs /dev/sdg1
mke2fs 1.45.6 (20-Mar-2020)
Discarding device blocks: done
Creating filesystem with 262144 4k blocks and 100096 inodes
Filesystem UUID: 66028671-cece-47ff-804c-4a3b7f9f0ea5
Superblock backups stored on blocks:
    32768, 98304, 163840, 229376

Allocating group tables: done
Writing inode tables: done
Creating journal (8192 blocks): done
Writing superblocks and filesystem accounting information: done
```

Beware: dangerous operation - have backups!

mount - mount a file-system

mount makes a file-system available from a point in the file-system

umount reverses this.

```
$ mkdir /tmp/g
$ sudo mount /dev/sdb1 /tmp/g
$ ls -l /tmp/g
..
$ umount /tmp/g
```

Distributions usually have a helper program to mount/unmount removable devices.

fsck - repair a file-system

Power failure or otehr unexpected events may leave a filesystem in inconsistent state.

`fsck` (file system check) checks and repairs a file-system.

```
$ sudo fsck /dev/sdg1
fsck from util-linux 2.34
fsck.fat 4.1 (2017-01-24)
/dev/sdg1: 5 files, 739/1876074 clusters
```

File system should not be in use (unmounted)

Beware: dangerous operation - have backups!

/etc/fstab - filesystem configuration

Configures file systems on device to be mounted when system starts.

```
$ cat /etc/fstab
# device   mount-point  fs-type  options
/dev/sda1      /          ext4    noatime,errors=remount-ro  1 1
/dev/sda2      none       swap    sw                         0 0
```

Must include a root file-system on /

Usually includes a swap device.

Often use a unique label for device because device names can change if hardware reconfigured, e.g. more disks added.

```
$ cat /etc/fstab
UUID=36bcedb9-de07-4de0-82c6-509000029f0e  /  ext4 defaults  1 1
```

fsck - repair an (unmounted) file system

fdisk - print change disk partition tables

mount - mount a file-system

/etc/passwd - user database

User information in **/etc/passwd**

Password hashes in **/etc/shadow**

Every user has unique number: **uid**

```
$ sed2q /etc/passwd
root:x:0:0:root:/root:/bin/bash
daemon:x:1:1:daemon:/usr/sbin:/usr/sbin/nologin
$ sudo sed2q /etc/passwd
root:$6$YiSiP7Pehz8aoe...../:18379:0:99999:7:::
daemon:*:18362:0:99999:7:::
```

Manage users with **adduser deluser**

/etc/group - group database

Group information in **/etc/group**

```
$ head /etc/group
root:x:0:
daemon:x:1:
bin:x:2:
sys:x:3:
adm:x:4:
tty:x:5:
```

Each group has unique number: **gid**

Do not edit /etc/group directly

Add users to groups with **adduser**

Also **addgroup delgroup**

root user

Many system actions require root (uid == 0)

su allows you to switch to root or other user.

sudo allows command to be run as root

Use cautiously - easy to damage system with comands run as root.

Edit sudo config file `/etc/sudoers` with **visudo**

```
# Adding user to sudo group should allow them to run sudo
$ adduser andrewt sudo
```

Linux Distributions

A distribution is a Linux kernel packaged together with other programs

Many linux distributions, popular with CSE students are: Debian, Ubuntu, Mint, Arch, Red Hat

Debian

One of the oldest Linux distribution (1993)

Widely used and available for many platforms.

Stable - new release every 2 yrs.

Linux Package

A packages contains files that make up an application

And build scripts to install/remove application.

May contain metadata for managing the package.

Used to install new applications onto a system

Debian uses the .deb format

apt

```
# update database of packaes available
$ apt update
# install a package + dependencies
$ apt install <packagename>
# uninstall package
$ apt remove <packagename>
# update all packages
$ apt dist-upgrade
# search for a package
$ apt search <packagename>
# install a downloaded package file
$ apt install ./package.deb
```