A UNIX tour

...looking a bit closer under the hood

Processes

- A running instance of a program is called a "process"
- Identified by a numeric process id (pid)
  - unique while process is running; will be re-used some time after it terminates
- Has its own private memory space
  - not accessible by other processes; not even other instances of the same program

What does UNIX give a process?

- A table of environment variables
  - just a bunch of *name=value* settings
  - kept in memory (process gets own private copy)
- A table of open files
  - 0: standard input
  - 1: standard output
  - 2: standard error
- A set of argument strings
  - e.g. what you put *after* the command name
- THAT'S ALL!!

The shell: a simple interface

- The shell lets you start processes
  - and waits for them to finish, unless you run them in the "background"
- The shell lets you set environment variables
- The shell lets you set up file descriptors
  - Normally stdin is connected to your keyboard and stdout/stderr to your screen, but you can override
- The shell lets you pass arguments

Shell expansion

- The shell performs processing on your command line *before* starting the program
- Splits line into words (cmd, arg1, arg2,...)
- Searches for cmd in PATH if required
- Performs various types of argument expansion
  - See exercise

The shell itself runs as a process

- A shell can start another shell
- A shell has its own environment
  - e.g. it uses the PATH setting to locate programs
  - it copies the environment to its children
- A shell has stdin/stdout/stderr
  - You can run a non-interactive shell, i.e. a script
  - Examples include periodic system tidying
    - log rotation
    - rebuilding of the locate database
    - rebuilding of the man page index

Once a process has started...

- It can make "system calls" to the Kernel as needed, e.g. to
  - read and write data
  - open and close files
  - start new child processes *(known as "fork") ...etc*
- Using its pid, you can send it a "signal", e.g.
  - Request to terminate
  - Request to suspend (stop temporarily) or restart
  - Certain system events also send signals
- When it ends, returns 'exit code' (0-127)
  - to parent (the process which started it)

Process control from the shell

- For a "foreground" process
  - Ctrl-C = terminate
  - Ctrl-Z = suspend **
- Show all processes
  - ps auxw
- Send a signal to any process
  - kill [-sig] pid
- More advanced job control
  - jobs = list all jobs (children) started by this shell
  - fg %n = resume in foreground **
  - bg %n = resume in background

Summary

- Processes identified by pid
- Each process at start gets 3 things:
  - Environment variables, e.g. HOME="/home/you"
  - Open files
  - Arguments
- You can send signals to a running process
- At end it returns a numeric exit code
- Shell gives you control of these things

Practical Exercise 1

Processes and security

- Each process runs with set privileges
  - effective uid
  - effective gid
  - supplementary groups
- Some operations are only available to root
  - e.g. bind socket to port below 1024
  - e.g. shut down system
- A process running as root (euid=0) can change to any other uid - but not back again
- Other processes cannot change uid at all!

How do users change passwords?

- Note that /etc/master.passwd is only readable and writable by root
- The 'passwd' program has special privileges, it is marked "setuid root"
- Whenever a user starts the 'passwd' program, kernel gives it euid=root
  - It can then change the user's password
- setuid programs must be written very carefully to avoid security holes
- Don't fiddle with setuid bits

Aside...

- It's really useful to think of commands in pairs
  - The command which *shows* a setting and the command which *changes* that setting
- Example:
  - *pwd* shows the current working directory
  - *cd* changes the current working directory
- Follow the 3-step system for changes
  - Check things are how you think they are
  - Make the change
  - Check things have changed as you expected

Commands for managing files

- Show which files exist: ls
- Show detail (long form): ls -l
- Manipulating files: cp, mv, rm
- Which editor to use?
  - vi
    - clunky but always available
  - ee
    - FreeBSD-specific
  - joe
    - has to be installed as a separate package

The Virtual Filesystem (VFS)

- All filesystems appear in a single tree
- Must have a root device - /
- Can attach other devices at other points
- At bootup, everything in /etc/fstab is mounted
  - except lines marked 'noauto'

Key VFS commands

- Show status
  - mount
  - df
- Attach device
  - mount -t cd9660 /dev/acd0 /cdrom
    - /cdrom is called the "mount point"
    - it's just an empty subdirectory
    - after mounting, the filesystem contents appear here
- Detach device
  - umount /cdrom

Other devices

- Formatting a floppy disk
  - fdformat /dev/fd0
  - newfs_msdos -L myfloppy /dev/fd0
- Mounting a floppy disk
  - mount -t msdos /dev/fd0 /mnt
- USB pen
  - mount -t msdos /dev/da0s1 /mnt
    - typical example
    - look in /var/log/messages to check device
    - use 'fdisk /dev/da0' to look at slices
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Filesystem safety

- DON'T remove any media until it has been unmounted
  - Otherwise, filesystem can be corrupted
- Kernel won't let you unmount a filesystem if it is in use
  - Use 'fstat' to find processes using it
- ALWAYS shut down properly
- Filesystem repair tool is called "fsck"