CSE 265:
System and Network Administration

- Controlling Processes
  - Components of a process
  - Life cycle of a process
  - Signals
  - Send signals using kill and killall
  - Process states
  - Influence scheduling priority with nice and renice
  - Monitoring processes with ps and top
  - Runaway processes
  - Periodic processes

Components of a process

- A process is the instantiation of a program
- From the kernel's perspective, a process is:
  - An address space (the set of memory pages with code, libraries, and data)
  - Set of data structures (within the kernel)
    - The process's address space map
    - Current status
    - Execution priority
    - Resources used
    - Signal mask (which signals are blocked)
    - The owner
    - Which instructions are currently being executed

Process attributes

- Process ID – PID
  - Unique identifier, wraps around
- Parent PID – PPID
  - When a process is cloned, there is a parent and a child
- Real and effective user ID – UID and EUID
  - EUID is used to determine what permissions the process has
  - Also records original EUID (saved UID)
    - Can be re-accessed later in program (even after changing EUID)
- Real and effective group ID – GID and EGID
- Niceness
  - The CPU time available depends on its scheduling priority
  - Users can make their processes 'nicer' to the rest of the system
- Control terminal – where stdin, stdout, stderr are attached

Process life cycle

- An existing process calls fork(2)
  - Parent is told PID of child
  - Child process is told 0
- Child can use exec (or similar) to start a new program
- When ready to die, process calls _exit(2) with exit code
  - Process becomes a zombie
- Parent must wait(2) to collect status of dead children
  - Resource usage, why killed
- Orphans are re-mapped to init

Signals

- Signals are process-level interrupt requests
- Uses
  - Inter-process communication
  - Terminal driver can kill, interrupt or suspend processes (Ctrl-C, Ctrl-Z)
  - Can be sent by admin (with kill) for various purposes
  - Can be sent by kernel when process breaks a rule
    - e.g., division by zero
  - Can be sent by kernel for i/o available, death of child

Handling signals

- Process can designate a signal handler for a particular signal
- If no handler, kernel takes some default action
- When handler is finished catching signal, execution continues where the signal was received
- Process can request that particular signals be ignored, or blocked
- If signal is received while blocked, one instance of that signal is buffered until it is unblocked

Important signals

#	Name	Description	Default	Catch?	Block?	Dump?
1	HUP	Hangup	Terminate	Yes	Yes	No
	Reset request; clean up process on terminal (modem hangup) **csh processes ignore HUP; bash users need **nohup** command*					
2	INT	Interrupt	Terminate	Yes	Yes	No
	Control-C, can catch and clean up before quiting.					
3	QUIT	Quit	Terminate	Yes	Yes	Yes
	Similar to TERM, but generates a core dump					
9	KILL	Kill	Terminate	No	No	No
	Never received by process; OS terminates process.					
*	BUS	Bus error	Terminate	Yes	Yes	Yes
	Error signal. Typically a memory alignment problem.					
11	SEGV	Segmentation Fault	Terminate	Yes	Yes	Yes
	Error signal. Typically a memory access to protected space.					

More signals

#	Name	Description	Default	Catch?	Block?	Dump?
15	TERM	Software termination	Terminate	Yes	Yes	No
	Request to terminate execution. Process can clean up, exit.					
*	STOP	Stop	Stop	No	No	No
	OS suspends execution of process until CONT received.					
*	TSTP	Keyboard stop	Stop	Yes	Yes	Yes
	Keyboard Ctrl-Z request to stop. Catchable.					
*	CONT	Continue after stop	Ignore	Yes	No	No
	Continue after STOP or TSTP.					
*	WINCH	Window changed	Ignore	Yes	Yes	No
	Sent by terminal emulator when config changes (resize)					
*	USR1	User-defined	Terminate	Yes	Yes	No
	User defined. Apache restarts gracefully.					
*	USR2	User-defined	Terminate	Yes	Yes	No

Scheduling priority

- “Niceness” is hint to kernel about how often to schedule the process
- Linux ranges from -20 (high priority, not nice) to +19 (low priority, very nice), 0 is default
- User/process can raise, but not lower niceness
  - Root can lower
- Examples

  % **nice +5 ~/bin/longtask**

  % **renice -5 8829**

  % **sudo renice 5 -u boggs**

Sending signals

# kill [-*signal*] ***pid***

# kill sends TERM signal by default

# kill -9 *pid*   === kill -KILL *pid*

- “Guarantees” that the process will die

# kill -USR1 910 3044

# sudo killall -USR1 httpd

- **killall** removes need for pid

Monitoring processes: ps

- /bin/ps primary tool
- Shows
  - PID, UID, priority, control terminal
  - Memory usage, CPU time, status
- Multiple variations of ps
  - **ps -aux** (BSD, Linux)
  - **ps -Af** (Solaris)

Process states

- Process exist in one of four states
  - **Runnable** – can be executed
  - **Sleeping** – waiting for some resources
    - Gets no CPU time until resource is available
  - **Zombie** – trying to die (parent hasn't waited)
  - **Stopped** – process is suspended (i.e., not permitted to run)
    - Like sleeping, but can't wake until CONT received

Sample top output

```
top - 20:30:57 up 1 day, 22:48, 15 users,  load average: 0.04, 0.07, 0.05
Tasks: 163 total,   1 running, 162 sleeping,   0 stopped,   0 zombie
Cpu(s):  4.7%us,  1.5%sy,  0.0%ni, 93.5%id,  0.0%wa,  0.2%hi,  0.2%si,  0.0%st
Mem:   2073964k total,  1525460k used,   548504k free,   200188k buffers
Swap:  4194296k total,        0k used,  4194296k free,   798200k cached

  PID USER      PR  NI  VIRT  RES  SHR S %CPU %MEM    TIME+  COMMAND
 5792 brian     15   0  362m 196m  27m S    5  9.7 172:39.93 firefox-bin
 5540 brian     15   0 17984 9112 6532 S    3  0.4   0:49.05 metacity
 5406 root      15   0  136m 107m  11m S    3  5.3  44:58.77 Xorg
10001 brian     15   0  104m  27m  15m S    0  1.4   0:52.50 rhythmbox
17511 brian     15   0  2168 1040  792 R    0  0.1   0:00.01 top
25759 root       5 -10  508m 158m 154m S    0  2.0  74:54.98 vmware-vmx
17124 hadoop    21   0 1207m  15m 2716 S    0  0.2   7:46.71 java
17231 hadoop    15   0 1204m  12m 1304 S    0  0.2   1:55.97 java
25370 root      15   0  382m 4976 2428 S    0  0.1   7:50.96 vmplayer
 2513 ntp       15   0 19116 4808 3716 S    0  0.1   0:04.37 ntpd
23138 root      15   0 84980 3184 2492 S    0  0.0   0:00.03 sshd
 3184 root      12  -3  120m 1764 1196 S    0  0.0   0:01.83 python
    1 root      15   0  2044  640  552 S    0  0.0   0:02.74 init
    2 root      RT   0     0    0    0 S    0  0.0   0:00.00 migration/0
    3 root      34  19     0    0    0 S    0  0.0   0:00.00 ksoftirqd/0
    4 root      RT   0     0    0    0 S    0  0.0   0:00.00 watchdog/0
    5 root      RT   0     0    0    0 S    0  0.0   0:00.00 migration/1
```

Example ps output

```
USER       PID %CPU %MEM   VSZ  RSS TTY      STAT START   TIME COMMAND
root         1  0.0  0.0  1364   64 ?        S    2003   3:03 init [5]   --init
root         2  0.0  0.0     0    0 ?        SW   2003   1:35 [keventd]
root         3  0.0  0.0     0    0 ?        SWN  2003   0:27 [ksoftirqd_CPU0]
root         5  0.1  0.0     0    0 ?        SW   2003 465:05 [kswapd]
root         6  3.0  0.0     0    0 ?        SW   2003 7754:49 [kscand]
root         7  0.0  0.0     0    0 ?        SW   2003   1:16 [bdflush]
root         8  0.0  0.0     0    0 ?        SW   2003   4:06 [kupdated]
root         9  0.0  0.0     0    0 ?        SW<  2003   0:00 [mdrecoveryd]
root        13  0.0  0.0     0    0 ?        SW   2003  16:12 [kjournald]
root        92  0.0  0.0     0    0 ?        SW   2003   0:00 [khubd]
root       589  0.0  0.0     0    0 ?        SW   2003   0:01 [eth0]
root       761  0.0  0.0  1424  340 ?        S    2003   0:48 syslogd -m 0
root       766  0.0  0.0  1364  244 ?        S    2003   0:00 klogd -x
rpc        786  0.0  0.0  1524  360 ?        S    2003   0:22 portmap
rpcuser    814  0.0  0.0  1660  484 ?        S    2003   1:27 rpc.statd
ntp        933  0.0  0.0  1884 1880 ?        SL   2003  11:18 ntpd -U ntp -g
root      1045  0.0  0.0  2140  164 ?        S    2003   0:00 xinetd -stayalive
root      1092  0.0  0.0  1796  176 ?        S    2003   0:00 rpc.rquotad
root      1097  0.1  0.0     0    0 ?        SW   2003 267:24 [nfsd]
root      1105  0.0  0.0     0    0 ?        SW   2003   0:05 [lockd]
root      1113  0.0  0.0  1960  608 ?        S    2003   0:02 rpc.mountd
root      1209  0.0  0.0  1560  288 ?        S    2003   1:14 crond
daemon    1383  0.0  0.0  1408  200 ?        S    2003   0:00 /usr/sbin/atd
root      1456  0.0  0.0  1348  116 tty2     S    2003   0:00 /sbin/mingetty tt
```

Runaway processes

- What can you do about processes using an unusual amount of resources (memory, CPU, disk space)?
  - Identify resource hogs using **top** and/or **ps**
  - Contact owner and ask about resource usage
  - Suspend using STOP signal (might break job)
    - Contact owner, restart or kill later
  - Renice CPU hog

Monitoring processes: top

- /usr/bin/top is optional in some OSes
- Shows top-n CPU-using processes
  - Plus other stats, like memory usage and availability, system load
  - Can renice within top
  - Automatically refreshes screen every 5 seconds
  - Can focus on a particular user

Creating periodic processes

- Automation, as you've heard, is key to efficiency
- Instead of manually performing tasks daily, weekly, or monthly, you can schedule them
  - cron
  - anacron
- Includes tasks like:
  - monitoring, log rotation, backups, file distribution

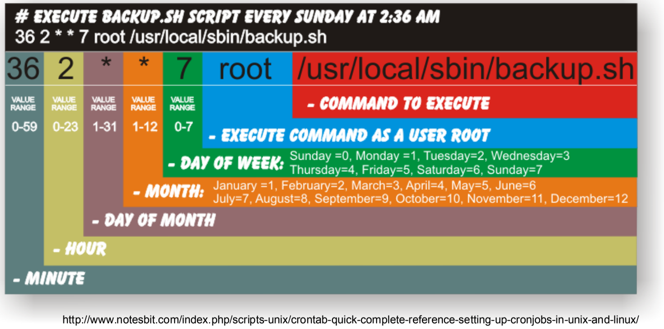
cron

- cron daemon performs tasks at scheduled times
- crontab files are examined by cron for schedule
  - /etc/crontab, /etc/cron.d/*, /var/spool/cron/*
- cron wakes up each minute and checks to see if anything needs to be executed
- cron is susceptible to changes in time
  - doesn't compensate for when machine is down, or time changes (clock adjustments or daylight savings time) that are sufficiently large (3 hours, at least for some implementations)
- anacron works daily
  - records when task last performed, and will catch up with missing time

crontab files

- Filename provides username in /var/spool/cron/
- Example crontab entries:

```
# run make at 2:30 each Monday morning
30 2 * * 1 (cd /home/joe4/project; make)
```



```
# EXECUTE BACKUP.SH SCRIPT EVERY SUNDAY AT 2:36 AM
36 2 * * 7 root /usr/local/sbin/backup.sh
```

36
2
*
*
7
root
/usr/local/sbin/backup.sh
VALUE RANGE 0-59
VALUE RANGE 0-23
VALUE RANGE 1-31
VALUE RANGE 1-12
VALUE RANGE 0-7
- COMMAND TO EXECUTE
- EXECUTE COMMAND AS A USER ROOT
- DAY OF WEEK: Sunday =0, Monday =1, Tuesday=2, Wednesday=3 Thursday=4, Friday=5, Saturday=6, Sunday=7
- MONTH: January =1, February=2, March=3, April=4, May=5, June=6 July=7, August=8, September=9, October=10, November=11, December=12
- DAY OF MONTH
- HOUR
- MINUTE

http://www.notesbit.com/index.php/scripts-unix/crontab-quick-complete-reference-setting-up-cronjobs-in-unix-and-linux/

Managing crontabs

- Use **crontab -e** to edit
  - Checks out a copy
  - Uses EDITOR environment variable
  - Resubmits it to the /var/spool/cron/ directory
- **crontab -l** will list the contents to stdout
- /etc/cron.allow and /etc/cron.deny can control access to cron facilities

Using cron

- Distributions set up crontab entries to automatically run scripts in
  - /etc/cron.monthly/
  - /etc/cron.weekly/
  - /etc/cron.daily/
  - /etc/cron.hourly/

- Typical tasks:
  - Cleaning the filesystem (editor files, core files) using find
  - Distributing files (mail aliases, sendmail config, etc.) using rsync, rdist, or expect
  - Log rotation