06 - Processes and Jobs

CS 2043: Unix Tools and Scripting, Spring 2016 [1]

Stephen McDowell

February 10th, 2016

Cornell University

Table of contents

1. Processes Overview
2. Modifying Processes
3. Jobs
4. More on Git

Some Logistics

- HW1 due Friday, 2/12/2016 at 5pm

Some Logistics

- HW1 due Friday, 2/12/2016 at 5pm
- Drop deadline is today.

Some Logistics

- HW1 due Friday, 2/12/2016 at 5pm
- Drop deadline is today.
- Lecture-demo solutions...thanks Joe!

Some Logistics

- HW1 due Friday, 2/12/2016 at 5pm
- Drop deadline is today.
- Lecture-demo solutions...thanks Joe!
- The nature of the material in this topic basically dictates not covering OSX. They may exist, they may not.

Some Logistics

- HW1 due Friday, 2/12/2016 at 5pm
- Drop deadline is today.
- Lecture-demo solutions...thanks Joe!
- The nature of the material in this topic basically dictates not covering OSX. They may exist, they may not.
    - They may also give very different results.

Processes Overview

What is a Process?

- A process is just an instance of a running program.

What is a Process?

- A process is just an instance of a running program.
- Not just a "program" - it is being *executed*.

What is a Process?

- A process is just an instance of a running program.
- Not just a "program" - it is being *executed*.
- Not just a "running program", as you can execute the same program multiple times.

What is a Process?

- A process is just an instance of a running program.
- Not just a "program" - it is being *executed*.
- Not just a "running program", as you can execute the same program multiple times.
    - These would be multiple processes running an instance of the same program.

What is a Process?

- A process is just an instance of a running program.
- Not just a "program" - it is being *executed*.
- Not just a "running program", as you can execute the same program multiple times.
  - These would be multiple processes running an instance of the same program.
- Example: if you open more than one terminal (windows or tabs), you are running multiple processes of your shell.

Identification

- Processes have a unique "Process ID" (PID) when created.

Identification

- Processes have a unique "Process ID" (PID) when created.
- The PID allows you to distinguish between multiple instances of the same program.

Identification

- Processes have a unique "Process ID" (PID) when created.
- The PID allows you to distinguish between multiple instances of the same program.
- There are countless ways to discover the PID, as well as what processes are running.

Identification

- Processes have a unique "Process ID" (PID) when created.
- The PID allows you to distinguish between multiple instances of the same program.
- There are countless ways to discover the PID, as well as what processes are running.
- These methods often depend on how much information you want, as well as what your user priviliges are.

Identification: `ps`

Process Snapshot

`ps [options]`

- Reports a snapshot of the current running processes, including PIDs.
- By default, only the processes started by the user.
- `-e`: lists every process currently running on the system
- `-ely`: Gives more information than you can handle.
- `-u <username>`: lists all processes for user `username`.
- Note: very different for BSD/OSX, read the man page...

- To see more information about a process, pipe through `grep`.

Identification: `ps`

Process Snapshot

`ps [options]`

- Reports a snapshot of the current running processes, including PIDs.
- By default, only the processes started by the user.
- `-e`: lists every process currently running on the system
- `-ely`: Gives more information than you can handle.
- `-u <username>`: lists all processes for user `username`.
- Note: very different for BSD/OSX, read the man page...

- To see more information about a process, pipe through `grep`.
- For example: `ps -e | grep firefox` shows us the results about `firefox` processes.

Identification: `lsof`

List of Open Files

`lsof [options]`

- Very similar to `ps`, with more information by default.
- Frequently used for monitoring port connections...
- `-i`: lists IP sockets
  - `lsof -i tcp:843` shows all tcp processes on port `843`
- Many options...read the man page if you are intrigued.

- As with `ps`, often best served with a side of `grep`.

Identification: `lsof`

List of Open Files

`lsof [options]`

- Very similar to `ps`, with more information by default.
- Frequently used for monitoring port connections...
- `-i`: lists IP sockets
  - `lsof -i tcp:843` shows all tcp processes on port `843`
- Many options...read the man page if you are intrigued.

- As with `ps`, often best served with a side of `grep`.
- More useful for administration, especially when managing a networked environment.

Resource Usage

Display and Update top CPU Processes

`top [options]`

- Displays the amount of resources in percentages each process is using.
- `-d <seconds>`: control update frequency
  - The act of monitoring is an expensive process...
- `-u <user>`: only show processes owned by `user`
- `-p <PID>`: show statistics on process with id `PID` only.

- When used in conjunction with `ps` or `lsof`, can be a very powerful analysis tool.

Display and Update top CPU Processes

`top [options]`

- Displays the amount of resources in percentages each process is using.
- `-d <seconds>`: control update frequency
  - The act of monitoring is an expensive process...
- `-u <user>`: only show processes owned by `user`
- `-p <PID>`: show statistics on process with id `PID` only.

- When used in conjunction with `ps` or `lsof`, can be a very powerful analysis tool.
- Example sequence on the next page.

Example: Resource Monitoring

```
> ps -e | grep firefox
12975 ?        00:01:45 firefox
> top -p 12795
top - 09:37:56 up 1 day, 13:52,  5 users,  load average: 0.19, 0.20, 0.19
Tasks:   1 total,   0 running,   1 sleeping,   0 stopped,   0 zombie
%Cpu(s):  1.1 us,  0.5 sy,  0.0 ni, 98.4 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
KiB Mem : 16386660 total,  5990760 free,  3562320 used,  6833580 buff/cache
KiB Swap:  4194300 total,  4194300 free,        0 used. 12551476 avail Mem
  PID USER      PR  NI    VIRT    RES    SHR S  %CPU %MEM     TIME+ COMMAND
12975 sven      20   0 1437888 396868 105116 S   1.7  2.4   1:46.39 firefox
```

- You'll be best off reading through the man page to understand everything going on here.

Example: Resource Monitoring

```
> ps -e | grep firefox
12975 ?        00:01:45 firefox
> top -p 12795
top - 09:37:56 up 1 day, 13:52,  5 users,  load average: 0.19, 0.20, 0.19
Tasks:   1 total,   0 running,   1 sleeping,   0 stopped,   0 zombie
%Cpu(s):  1.1 us,  0.5 sy,  0.0 ni, 98.4 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
KiB Mem : 16386660 total,  5990760 free,  3562320 used,  6833580 buff/cache
KiB Swap:  4194300 total,  4194300 free,        0 used. 12551476 avail Mem
  PID USER      PR  NI    VIRT    RES    SHR S  %CPU %MEM     TIME+ COMMAND
12975 sven      20   0 1437888 396868 105116 S   1.7  2.4   1:46.39 firefox
```

- You'll be best off reading through the man page to understand everything going on here.
- Some great examples in [3].

Example: Resource Monitoring

```
> ps -e | grep firefox
12975 ?        00:01:45 firefox
> top -p 12795
top - 09:37:56 up 1 day, 13:52,  5 users,  load average: 0.19, 0.20, 0.19
Tasks:   1 total,   0 running,   1 sleeping,   0 stopped,   0 zombie
%Cpu(s):  1.1 us,  0.5 sy,  0.0 ni, 98.4 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
KiB Mem : 16386660 total,  5990760 free,  3562320 used,  6833580 buff/cache
KiB Swap:  4194300 total,  4194300 free,        0 used. 12551476 avail Mem
  PID USER      PR  NI    VIRT    RES    SHR S  %CPU %MEM     TIME+ COMMAND
12975 sven      20   0 1437888 396868 105116 S   1.7  2.4   1:46.39 firefox
```

- You'll be best off reading through the man page to understand everything going on here.
- Some great examples in [3].
  - I've found myself on that website *many* times, he has a lot of excellent examples about a large quantity of topics.

Example: Resource Monitoring

- Now I have opened about thirty tabs in firefox, and we get much different results:

Example: Resource Monitoring

- Now I have opened about thirty tabs in firefox, and we get much different results:
- Look at the cpu usage

Example: Resource Monitoring

- Now I have opened about thirty tabs in firefox, and we get much different results:
- Look at the cpu usage

```
> top -p 12795
top - 09:43:09 up 1 day, 13:57,  5 users,  load average: 1.33, 0.75, 0.41
Tasks:   1 total,   1 running,   0 sleeping,   0 stopped,   0 zombie
%Cpu(s): 13.4 us,  3.3 sy,  0.0 ni, 83.2 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
KiB Mem : 16386660 total,  3622768 free,  5679500 used,  7084392 buff/cache
KiB Swap:  4194300 total,  4194300 free,        0 used. 10300816 avail Mem
  PID USER      PR  NI    VIRT    RES    SHR S  %CPU %MEM     TIME+ COMMAND
12975 sven      20   0 3451396 1.372g 133688 R  75.7  8.8   5:00.96 firefox
```

Example: Resource Monitoring

- Now I have opened about thirty tabs in firefox, and we get much different results:
- Look at the cpu usage

```
> top -p 12795
top - 09:43:09 up 1 day, 13:57,  5 users,  load average: 1.33, 0.75, 0.41
Tasks:   1 total,   1 running,   0 sleeping,   0 stopped,   0 zombie
%Cpu(s): 13.4 us,  3.3 sy,  0.0 ni, 83.2 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
KiB Mem : 16386660 total,  3622768 free,  5679500 used,  7084392 buff/cache
KiB Swap:  4194300 total,  4194300 free,        0 used. 10300816 avail Mem
  PID USER      PR  NI    VIRT    RES    SHR S  %CPU %MEM     TIME+ COMMAND
12975 sven      20   0 3451396 1.372g 133688 R  75.7  8.8   5:00.96 firefox
```

- 75.7%?!!! Pretty common actually, this is why I always tell you to use your browser inside your Virtual Machine...

Modifying Processes

Priority

- Suppose you want to run some long calculation that might take days, but would consume 100% of your CPU.

Priority

- Suppose you want to run some long calculation that might take days, but would consume 100% of your CPU.
- Can we tell the server to give your process less priority in terms of CPU time?

Priority

- Suppose you want to run some long calculation that might take days, but would consume 100% of your CPU.
- Can we tell the server to give your process less priority in terms of CPU time?
- Recall that although Unix seems to run tens or hundreds of processes at once, one CPE can only run one process at a time*.

Priority

- Suppose you want to run some long calculation that might take days, but would consume 100% of your CPU.
- Can we tell the server to give your process less priority in terms of CPU time?
- Recall that although Unix seems to run tens or hundreds of processes at once, one CPE can only run one process at a time*.
- Quick switching back and forth between processes makes it seem as though they are all running simultaneously.

Priority

- Suppose you want to run some long calculation that might take days, but would consume 100% of your CPU.
- Can we tell the server to give your process less priority in terms of CPU time?
- Recall that although Unix seems to run tens or hundreds of processes at once, one CPE can only run one process at a time*.
- Quick switching back and forth between processes makes it seem as though they are all running simultaneously.
- The Unix masters anticipated this need, and each process was given a `priority` when it starts.

Initial Priority

Start a process with a non-default priority:

The nice command

`nice [options] command`

- Runs `command` with a specified *"niceness"* value (default: 10)
- *Niceness* values range from `-20` (highest priority) to `19` (lowest priority)
- Only `root` can give a process a *negative niceness* value
- Commands run without `nice` have priority `0`.

Example

```
nice -n 10 deluge
```

- Keeps torrents from hogging the CPU.

Adjusting Priority

The renice command

`renice <priority> -p <PID>`

- Changes the *niceness* of the process with id `PID` to `<priority>`
- Remember: only `root` can assign *negative* values.
- You can only `renice` a process you started.

Some Examples

`renice 5 -p 10275`

- Set the *niceness* of the process with `PID 10275` to `5`
  - Slightly lower than normal *niceness*

`renice 19 -u sven`

- Set the *niceness* of all my processes to 19

Ending Processes: I

Sometimes you need to end a process.

kill

`kill [-signal] <PID>`

- Sends the specified **`signal`** to the process with id **`PID`**
- By default, it terminates execution

killall

`killall [-signal] <name>`

- Kills processes by name.
- E.g. **`killall firefox`**

Note: These are dangerous commands, and should generally be last resorts.

Useful Kill Signals

- Kill signals can be used by number or name.

Useful Kill Signals

- Kill signals can be used by number or name.
- `TERM` or `15`: terminates execution (default).

Useful Kill Signals

- Kill signals can be used by number or name.
- `TERM` or `15`: terminates execution (default).
- `HUP` or `1`: hang-up (restarts the program)

Useful Kill Signals

- Kill signals can be used by number or name.
- `TERM` or `15`: terminates execution (default).
- `HUP` or `1`: hang-up (restarts the program)
- `KILL` or `9`: like bleach, can kill anything.

Useful Kill Signals

- Kill signals can be used by number or name.
- `TERM` or `15`: terminates execution (default).
- `HUP` or `1`: hang-up (restarts the program)
- `KILL` or `9`: like bleach, can kill anything.
- Some examples:

Useful Kill Signals

- Kill signals can be used by number or name.
- `TERM` or `15`: terminates execution (default).
- `HUP` or `1`: hang-up (restarts the program)
- `KILL` or `9`: like bleach, can kill anything.
- Some examples:

Killing 101

Useful Kill Signals

- Kill signals can be used by number or name.
- `TERM` or `15`: terminates execution (default).
- `HUP` or `1`: hang-up (restarts the program)
- `KILL` or `9`: like bleach, can kill anything.
- Some examples:

Killing 101

- `kill 9009`: terminates process with `PID 9009`

Useful Kill Signals

- Kill signals can be used by number or name.
- `TERM` or `15`: terminates execution (default).
- `HUP` or `1`: hang-up (restarts the program)
- `KILL` or `9`: like bleach, can kill anything.
- Some examples:

Killing 101

- `kill 9009`: terminates process with `PID 9009`
- `kill -9 3223`: REALLY kills the process with `PID 3223`

Useful Kill Signals

- Kill signals can be used by number or name.
- `TERM` or `15`: terminates execution (default).
- `HUP` or `1`: hang-up (restarts the program)
- `KILL` or `9`: like bleach, can kill anything.
- Some examples:

Killing 101

- `kill 9009`: terminates process with `PID 9009`
- `kill -9 3223`: REALLY kills the process with `PID 3223`
- `kill -HUP 12221`: restarts the process with `PID 12221`

Useful Kill Signals

- Kill signals can be used by number or name.
- `TERM` or `15`: terminates execution (default).
- `HUP` or `1`: hang-up (restarts the program)
- `KILL` or `9`: like bleach, can kill anything.
- Some examples:

Killing 101

- `kill 9009`: terminates process with `PID 9009`
- `kill -9 3223`: REALLY kills the process with `PID 3223`
- `kill -HUP 12221`: restarts the process with `PID 12221`
  - very useful for servers and daemon processes

Useful Kill Signals

- Kill signals can be used by number or name.
- `TERM` or `15`: terminates execution (default).
- `HUP` or `1`: hang-up (restarts the program)
- `KILL` or `9`: like bleach, can kill anything.
- Some examples:

Killing 101

- `kill 9009`: terminates process with `PID 9009`
- `kill -9 3223`: REALLY kills the process with `PID 3223`
- `kill -HUP 12221`: restarts the process with `PID 12221`
  - very useful for servers and daemon processes

- Remember `top`? You can both *renice* and *kill* processes from within it!

Jobs

What are Jobs?

Jobs

A job is a process running *under the influence* of a job control facility.

- Job control is a built-in feature of most shells, allowing the user to pause and resume tasks.
- The user can also run them in the background.
- Not covered here: `crontab`. For the future sys admins, read the article in [2]

Why do you want this?

Let's use `ping` as an example.

Ping

`ping <server>`

- Measures network response time (latency) to a remote server.
- Sends short bursts to the server, then measures time until they return.

Example:

`ping google.com`

- Remember, `ctrl+c` kills the process.

Why we Need Job Control

As long as `ping` runs, we lose control of our shell. This happens with many other applications.

- Moving large quantities of files

Why we Need Job Control

As long as `ping` runs, we lose control of our shell. This happens with many other applications.

- Moving large quantities of files
- Compiling source code

Why we Need Job Control

As long as `ping` runs, we lose control of our shell. This happens with many other applications.

- Moving large quantities of files
- Compiling source code
- Playing multimedia

Why we Need Job Control

As long as `ping` runs, we lose control of our shell. This happens with many other applications.

- Moving large quantities of files
- Compiling source code
- Playing multimedia
- Scientific computing

Why we Need Job Control

As long as `ping` runs, we lose control of our shell. This happens with many other applications.

- Moving large quantities of files
- Compiling source code
- Playing multimedia
- Scientific computing
- etc

Why we Need Job Control

As long as `ping` runs, we lose control of our shell. This happens with many other applications.

- Moving large quantities of files
- Compiling source code
- Playing multimedia
- Scientific computing
- etc

Example:

```
vlc
```

Starting a Job in the Background

To run a job in the background, we will use a new operator:

&

```
<command> [arguments] &
```

- Runs the specified command as a background job.
- Unless told otherwise, will send output to the terminal!
- But at least we can type in our terminal again.

Example:

```
vlc best_song_ever.flac &
```

Sending a Job to the Background

If you already started the job, but don't want to wait any more:

Pausing a Job

Press `ctrl+z` to pause a running process!

- Note this is still `ctrl` even on Mac...just like `ctrl+c`

Sending a Job to the Background

If you already started the job, but don't want to wait any more:

Pausing a Job

Press `ctrl+z` to pause a running process!

- Note this is still `ctrl` even on Mac...just like `ctrl+c`
- The shell will pause the jobs `JOB ID` (similar to `PID`)

Sending a Job to the Background

If you already started the job, but don't want to wait any more:

Pausing a Job

Press `ctrl+z` to pause a running process!

- Note this is still `ctrl` even on Mac...just like `ctrl+c`
- The shell will pause the jobs `JOB ID` (similar to `PID`)
- We can bring it back.

Revivals

Background

`bg <JOB ID>`

- Resumes the job with id `JOB ID` in the *background*
- Without `JOB ID`, resumes last job placed in background.

Foreground

`fg <JOB ID>`

- Resumes the job with id `JOB ID` in the *foreground*.
- Without `JOB ID`, resumes last job placed in background.

Discovering your jobs

`jobs`

- Prints the running, paused, or recently stopped jobs.
- Prints jobs with their `JOB ID`s.

Dealing with Excess Output

- Many programs output continuously as they run. Try `vlc`. Pretty, but also annoying.

Dealing with Excess Output

- Many programs output continuously as they run. Try `vlc`. Pretty, but also annoying.
- Redirect the output!

Dealing with Excess Output

- Many programs output continuously as they run. Try `vlc`. Pretty, but also annoying.
- Redirect the output!
- Saving the output:

Dealing with Excess Output

- Many programs output continuously as they run. Try `vlc`. Pretty, but also annoying.
- Redirect the output!
- Saving the output:

Save `ping` results

```
ping google.com > testping.log &
```

Dealing with Excess Output

- Many programs output continuously as they run. Try `vlc`. Pretty, but also annoying.
- Redirect the output!
- Saving the output:

Save `ping` results

```
ping google.com > testping.log &
```

- A `.log` file is common.

Dealing with Excess Output

- Many programs output continuously as they run. Try `vlc`. Pretty, but also annoying.
- Redirect the output!
- Saving the output:

Save `ping` results

```
ping google.com > testping.log &
```

- A `.log` file is common.
- Note you need to eventually end this `ping`!

Dealing with Excess Output

- Many programs output continuously as they run. Try `vlc`. Pretty, but also annoying.
- Redirect the output!
- Saving the output:

Save `ping` results

```
ping google.com > testping.log &
```

- A `.log` file is common.
- Note you need to eventually end this `ping`!

- Ignoring the output:

Dealing with Excess Output

- Many programs output continuously as they run. Try `vlc`. Pretty, but also annoying.
- Redirect the output!
- Saving the output:

Save `ping` results

```
ping google.com > testping.log &
```

- A `.log` file is common.
- Note you need to eventually end this `ping`!

- Ignoring the output:

Ignoring it all

```
vlc best_song_ever.flac -- &> /dev/null &
```

More on Git

Recap on Forks, Diff

- Word explanation of forks.

Recap on Forks, Diff

- Word explanation of forks.
- The magic of `git difftool`.

References I

[1] B. Abrahao, H. Abu-Libdeh, N. Savva, D. Slater, and others over the years.
Previous cornell cs 2043 course slides.

[2] C. Hope.
Linux and unix crontab command help and examples.
http://www.computerhope.com/unix/ucrontab.htm.

[3] R. Natarajan.
Can you top this? 15 practical linux top command examples.
http://www.thegeekstuff.com/2010/01/15-practical-unix-linux-top-command-examples/.

References II