

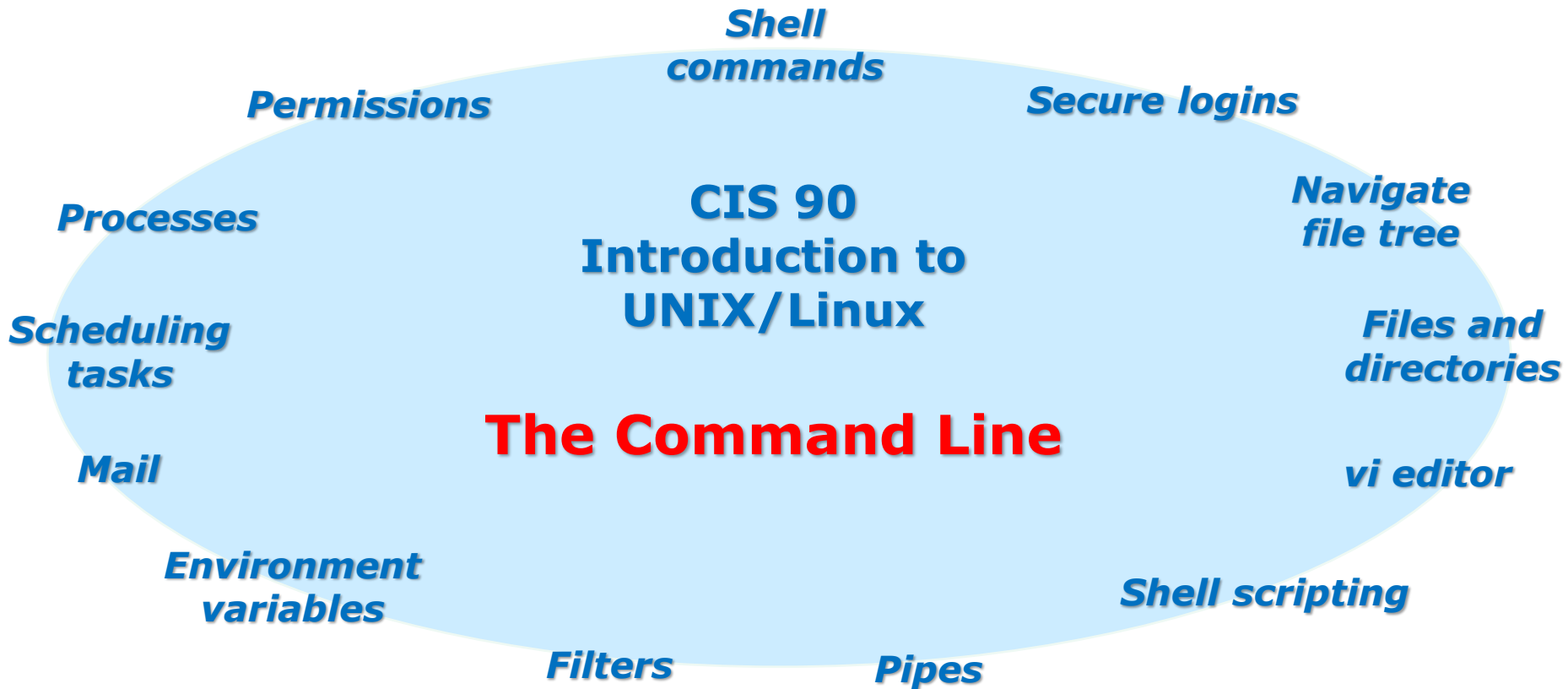


Rich's lesson module checklist

Last updated 4/9/2018

- ☐ Zoom recording named and published for previous lesson
- ☐ Slides and lab posted
- ☐ Print out agenda slide and annotate page numbers
- ☐ Flash cards
- ☐ 1st minute quiz
- ☐ Calendar page updated
- ☐ Lab 8 tested and published
- ☐ Real test published and scheduled on Canvas
- ☐ Real test servers startup and shutdown configured
- ☐ Real test accommodations (length and due time) made
- ☐ Practice test scheduled to prior to real test start
- ☐ Practice test servers scheduled to shutdown prior to real test
- ☐ 9V backup battery for microphone
- ☐ Backup slides, CCC info, handouts on flash drive
- ☐ Key card for door

- ☐ <https://zoom.us>
- ☐ Putty + Slides + Chrome
- ☐ Enable/Disable attendee sharing
 - ^ > Advanced Sharing Options > Only Host
- ☐ Enable/Disable attended annotations
 - Share > More > Disable Attendee Sharing



Student Learner Outcomes

1. Navigate and manage the UNIX/Linux file system by viewing, copying, moving, renaming, creating, and removing files and directories.
2. Use the UNIX features of file redirection and pipelines to control the flow of data to and from various commands.
3. With the aid of online manual pages, execute UNIX system commands from either a keyboard or a shell script using correct command syntax.

Introductions and Credits



Jim Griffin

- Created this Linux course
- Created Opus and the CIS VLab
- Jim's site: <http://cabrillo.edu/~jgriffin/>



Rich Simms

- HP Alumnus
- Started teaching this course in 2008 when Jim went on sabbatical
- Rich's site: <http://simms-teach.com>

And thanks to:

- John Govsky for many teaching best practices: e.g. the First Minute quizzes, the online forum, and the point grading system (<http://teacherjohn.com/>)



Student checklist - Before class starts

The screenshot shows a web browser window with the URL simms-teach.com/cis90calendar.php. The page title is "Rich's Cabrillo College CIS Classes CIS 90 Calendar". On the left sidebar, there are links for "CIS 90", "CIS 90A", "CIS 90B", "CIS 90C", "CIS 90D", "CIS 90E", "CIS 90F", "CIS 90G", "CIS 90H", "CIS 90I", "CIS 90J", "CIS 90K", "CIS 90L", "CIS 90M", "CIS 90N", "CIS 90O", "CIS 90P", "CIS 90Q", "CIS 90R", "CIS 90S", "CIS 90T", "CIS 90U", "CIS 90V", "CIS 90W", "CIS 90X", "CIS 90Y", "CIS 90Z". The main content area shows the "CIS 90 (Fall 2014) Calendar" with a table of lessons. The table has columns for "Lesson", "Date", "Topics", and "Link". The first lesson is "Lesson 1" on "9/2", with topics including "Class and Linux Overview", "Understand how the course will work", "High level overview of computers, operating systems and virtual machines", "Overview of UNIX/Linux market and architecture", "Using SSH for remote network access", and "Using terminals and the command line". There are links for "Presentation slides (download)", "Supplemental", "Assignment", "Lab 1", "CIS 90 Syllabus", "Enter virtual classroom", "Quiz 1", and "Comments".

Lesson	Date	Topics	Link
Lesson 1	9/2	Class and Linux Overview - Understand how the course will work - High level overview of computers, operating systems and virtual machines - Overview of UNIX/Linux market and architecture - Using SSH for remote network access - Using terminals and the command line Materials Presentation slides (download) Supplemental - PowerPoint: Logging into Opus (download) Assignment Student Survey Lab 1 CIS 90 Syllabus Enter virtual classroom Quiz 1 Comments	(link) 2/4/5 p163-172 p164-172 (link)

1. Browse to:
<http://simms-teach.com>
2. Click the **CIS 90** link.
3. Click the **Calendar** link.
4. Locate today's lesson.
5. Find the **Presentation slides** for the lesson and **download** for easier viewing.
6. Click the **Enter virtual classroom** link to join ConferZoom.
7. Log into Opus-II with Putty or ssh command.



Student checklist - Before class starts

☐ Google

☐ ConferZoom

☐ Downloaded PDF of Lesson Slides. I like Foxit Reader so I can take notes using annotations.

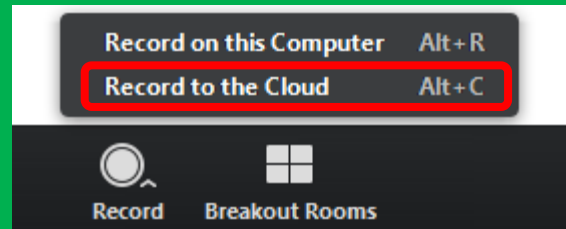
The screenshot shows a Zoom meeting interface with several windows open. The main window displays a PDF document titled "Get into the car" with a background image of a white car. Other windows include the Google homepage, the Rich's Cabrillo College CIS 90 website, and a document titled "CIS 90 - Lesson 1" showing a stack of papers. The Zoom toolbar at the bottom includes buttons for Unmute, Start Video, Invite, Participants, Share Screen, Chat, Record, and Leave Meeting.

☐ CIS 90 website
Calendar page

☐ One or more login
sessions to Opus-II

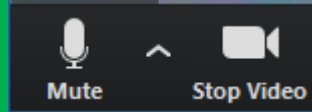


Start



Start Recording

Audio Check



Start Recording

Audio & video Check



Instructor: **Rich Simms**
Dial-in: **408-638-0968 (toll)**
Meeting ID: **426 283 384**



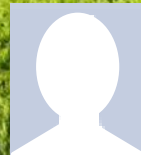
Brandon



Shane



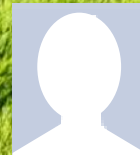
Dan



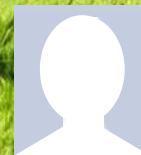
Kage



Nathan K.



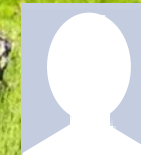
Jo Anne



Darren



Laine



Luis



Christian



Jetta



Cesar



Paul



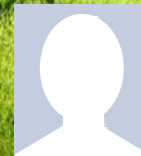
Hilary



Fritz



Jake



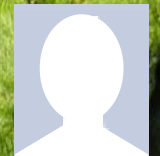
Richard



Nate P.



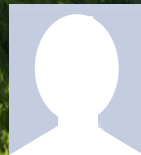
Ciarán



November



Henry



Elena



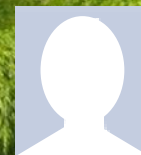
David



Claudius



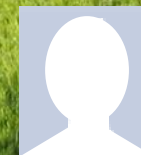
Edgar



Adam



Nathanael T.



Clara

First Minute Quiz

Please answer these questions **in the order** shown:

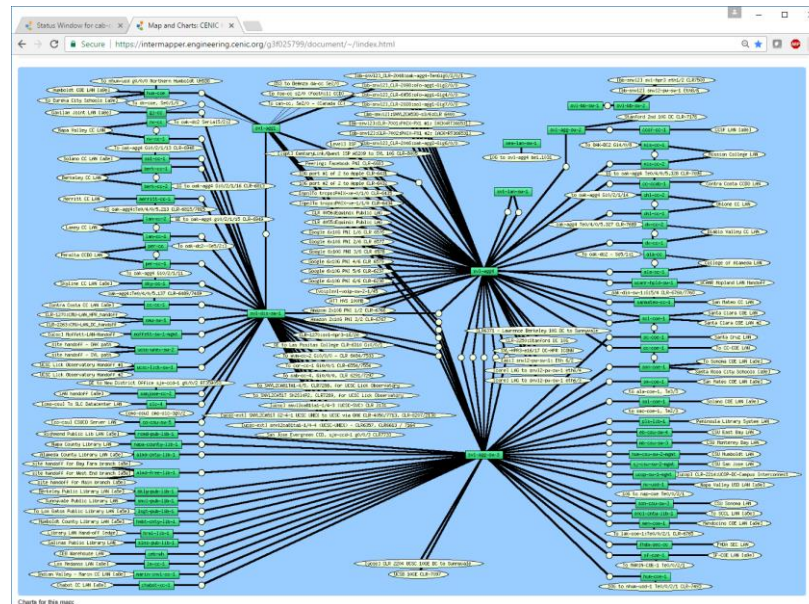
No Quiz today ... test instead

For credit email answers to:

risimms@cabrillo.edu

within the **first few minutes of class**

Network Check



<https://intermapper.engineering.cenic.org/g3f025799/document/~!/index.html>

First Minute Quiz

Please answer these questions **in the order** shown:

Use ConferZoom White Board

email answers to: risimms@cabrillo.edu

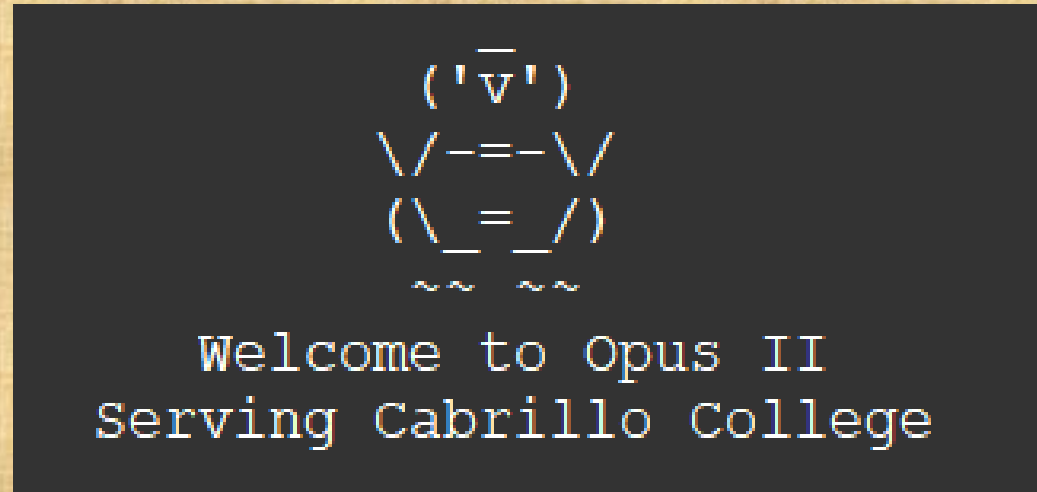
(answers must be emailed within the first few minutes of class for credit)



UNIX Processes

Objectives	Agenda
• Know the process life cycle • Interpret ps command output • Run or schedule jobs to run in the background • Send signals to processes • Configure process load balancing	• Questions • FYI: shell debugging • Housekeeping • Process definition • Process life cycle • ps command • Job control • Signals • Load balancing • Assignment • Wrap up • Test #2

Class Activity



If you haven't already,
log into Opus-II

Class Activity

3	2/19	Unit 3 Electronic Mail • Guest speaker: Denise Moore on OTC (On-The-Job) training programs • Learn how to use the LARC communication tools: write and /bin/mail • Overview on and to and mail Materials • Presentation slides (download) Supplemental • Howto #319: Accessing vlab (download) Assignment • Read/skim Lesson 3 slides	Lab 2
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<https://simms-teach.com/cis90calendar.php>

If you haven't already,
download the lesson slides

Class Activity

	• <u>Read/skim Lesson 1 slides</u> • <u>Student Survey</u> • <u>Lab 1</u>	
	ConferZoom • <u>Enter virtual classroom</u> • <u>Class archives</u>	
	Quiz 1 Commands • Understand how the UNIX login operation	

<https://simms-teach.com/cis90calendar.php>

If you haven't already, join
ConferZoom classroom



Questions



Questions?

Lesson material?

Labs? Tests?

How this course works?

- Graded work in home directories
- Answers in /home/cis90/answers

Who questions much, shall learn much, and retain much.

- Francis Bacon

If you don't ask, you don't get.

- Mahatma Gandhi

Chinese
Proverb

他問一個問題，五分鐘是個傻子，他不問一個問題仍然是一個傻瓜永遠。

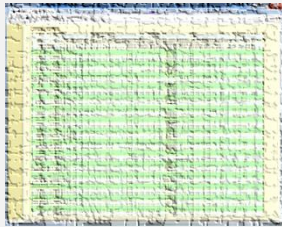
He who asks a question is a fool for five minutes; he who does not ask a question remains a fool forever.

Review your progress in the course

Send me your survey to get your LOR code name.

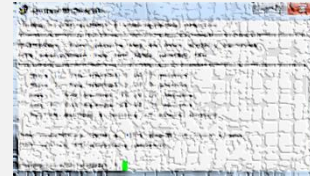
The CIS 90 website Grades page

<http://simms-teach.com/cis90grades.php>



Or check on Opus

checkgrades *codename*
(where codename is your LOR codename)



Written by Jesse Warren a past CIS 90 Alumnus

Percentage	Total Points	Letter Grade	Pass/No Pass
90% or higher	504 or higher	A	Pass
80% to 89.9%	448 to 503	B	Pass
70% to 79.9%	392 to 447	C	Pass
60% to 69.9%	336 to 391	D	No pass
0% to 59.9%	0 to 335	F	No pass

At the end of the term I'll add up all your points and assign you a grade using this table

Points that could have been earned:

7 quizzes: 21 points
7 labs: 210 points
1 test: 30 points
2 forum quarters: 40 points
Total: 301 points

Extra Credit

On the forum

Be sure to monitor the forum as I may post extra credit opportunities without any other notice!

On some labs

Extra credit (2 points)

For a small taste of what you would learn in CIS 191 let's add a new user to your Arya VM. Once added we will see how the new account is represented in `/etc/passwd` and `/etc/shadow`.

1. Log into your Arya VM as the cis90 user. Make sure it's your VM and not someone else's.
2. Install the latest updates:
`sudo apt-get update`
`sudo apt-get upgrade`
3. Add a new user account for yourself. You may make whatever username you wish. The example below shows how Benji would make the same username he uses on Opus:
`sudo useradd -G sudo -c "Benji Simms" -m -s /bin/bash simben90`

In lesson slides (search for extra credit)



On the website

<http://simms-teach.com/cis90grades.php>

For some flexibility, personal preferences or family emergencies there is an additional 90 points available of extra credit activities.

<http://simms-teach.com/cis90extracredit.php>

• **Website content review** - The first person to email the instructor pointing out an error or typo on the website will get one point of extra credit for each unique error. The email must specify the specific document or web page, pinpoint the location of the error, and specify what the correction should be. Duplicate errors count as a single point. This does not apply to pre-published material that has been updated but not yet presented in class. (Up to 20 points total)

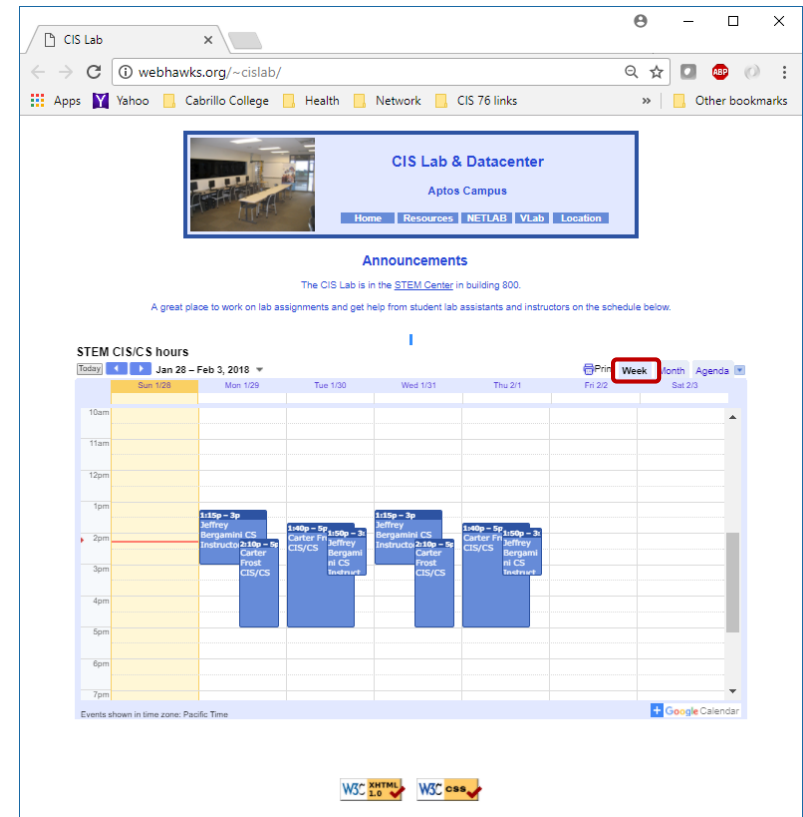
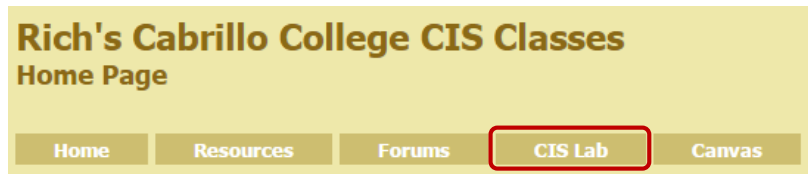
Getting Help When Stuck on a Lab Assignment

- Google the topic/error message.
- Search the Lesson Slides (they are PDFs) for a relevant example on how to do something.
- Post a question on the forum. Explain what you are trying to do and what you have tried so far.
- Talk to a STEM center tutor/assistant.
- Come see me during my office or lab hours. **I will be in the CTC (room 1403) every Wednesday afternoon from 3-5:30.**
- Make use of the Open Questions time at the start of every class.
- Make a cheat sheet of commands and examples so you never again get stuck on the same thing!

Expect to do a LOT of troubleshooting in this course!

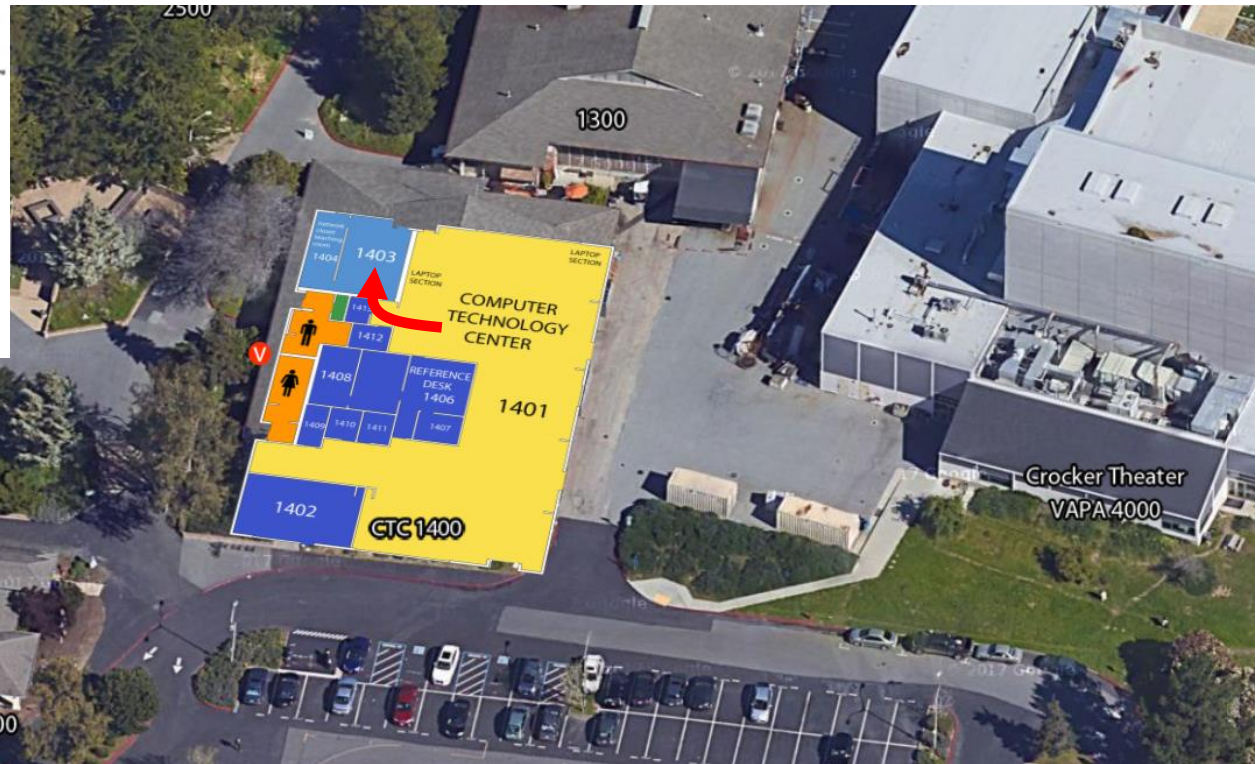
Help Available in the CIS Lab

Instructors, lab assistants and equipment are available for CIS students to work on assignments.



To see schedule, click the CIS Lab link on the website and use the "Week" calendar view

CTC - Building 1400 On lower campus



I will be in the CTC (room 1403) every Wednesday
afternoon from 3-5:30



The slippery slope



- 1) If you didn't submit the last lab ...
- 2) If you were in class and didn't submit the last quiz ...
- 3) If you didn't send me the student survey assigned in Lesson 1 ...
- 4) If you haven't made a forum post in the last quarter of the course ...

*Please contact me by email, see me during
my office hours or when I'm in the CTC*

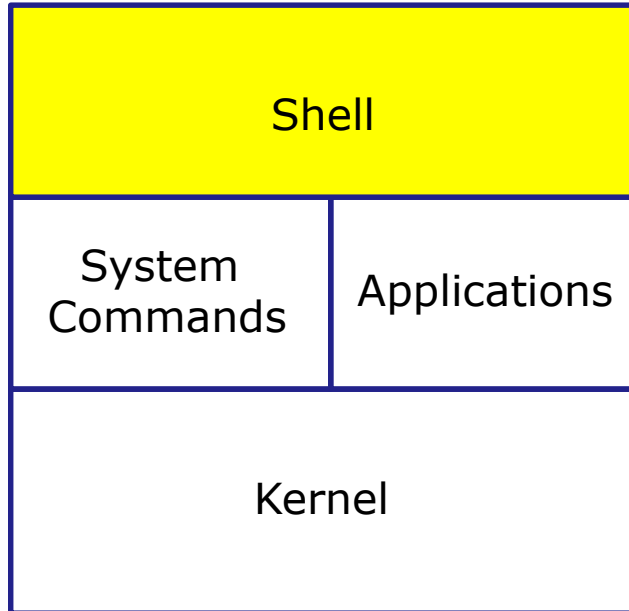
Email: risimms@cabrillo.edu

FYI

shell debugging and {}



The Shell **Parse** Step



- 1) **Prompt** for a command
- 2) **Parse** (interpret metacharacters, expand file names and dissect command line into options and arguments)
- 3) **Search** for program (along the path)
- 4) **Execute** program by loading into memory (becomes a process), hookup input and outputs, and pass along command line options and arguments.
- 5) **Nap** (wait till process is done)
- 6) **Repeat**



Important Concept to Understand

- It's a **team effort** between the **shell** and the **command** to process what a user types after the prompt
- The shell does the initial work during the **parse step** and provides a list of options and arguments to the command
- The command may not see everything the user actually typed in

FYI set -x, set +x



```
/home/cis90/rodduk $ set -x Enable shell debugging
++ printf '\033]0;%s@%s:%s\007' rodduk90 opus-ii '~'
```

```
/home/cis90/rodduk $ file /bin/pip[23]*
+ file /bin/pip2 /bin/pip2.7 /bin/pip3 /bin/pip3.4
/bin/pip2: Python script, ASCII text executable
/bin/pip2.7: Python script, ASCII text executable
/bin/pip3: Python script, ASCII text executable
/bin/pip3.4: Python script, ASCII text executable
++ printf '\033]0;%s@%s:%s\007' rodduk90 opus-ii '~'
```

```
/home/cis90/rodduk $ wc /usr/bin/p[ek]*[ct] 2> /dev/null
+ wc /usr/bin/perl doc /usr/bin/pkexec /usr/bin/pktttyagent
  10      30      203 /usr/bin/perl doc
  59     700  27680 /usr/bin/pkexec
  20     331  15320 /usr/bin/pktttyagent
  89    1061  43203 total
++ printf '\033]0;%s@%s:%s\007' rodduk90 opus-ii '~'
```

```
/home/cis90/rodduk $ set +x Disable shell debugging
+ set +x
/home/cis90/rodduk $
```

Shows what arguments are actually passed to the command being run

FYI set -x, set +x



```
/home/cis90/rodduk $ set -x Enable shell debugging
++ printf '\033]0;%s@%s:%s\007' rodduk90 opus-ii '~'
```

```
/home/cis90/rodduk $ find . -name "$LOGNAME"
+ find . -name rodduk90
find: './Hidden': Permission denied
++ printf '\033]0;%s@%s:%s\007' rodduk90 opus-ii '~'
```

```
/home/cis90/rodduk $ find . -name '$LOGNAME'
+ find . -name '$LOGNAME'
find: './Hidden': Permission denied
++ printf '\033]0;%s@%s:%s\007' rodduk90 opus-ii '~'
```

Shows variables in double (weak) quotes get expanded, while those in single (strong) quotes do not

```
/home/cis90/rodduk $ set +x Disable shell debugging
+ set +x
/home/cis90/rodduk $
```

FYI set -x, set +x



```
/home/cis90/rodduk $ set -x Enable shell debugging
++ printf '\033]0;%s@%s:%s\007' rodduk90 opus-ii '~'
```

```
/home/cis90/rodduk $ find . -name *.egg
+ find . -name 1968.egg
find: './Hidden': Permission denied
./1968.egg
++ printf '\033]0;%s@%s:%s\007' rodduk90 opus-ii '~'
```

*Shows how quoted
text strings get
handled*

```
/home/cis90/rodduk $ find . -name "*.egg"
+ find . -name '*.egg'
find: './Hidden': Permission denied
./Lab2.0/.1969.egg
./Miscellaneous/1971.egg
./bin/.1972.egg
< SNIPPED >
./Lab2.1/.1988.egg
./1968.egg
++ printf '\033]0;%s@%s:%s\007' rodduk90 opus-ii '~'
```

*Filename expansion
metacharacters
without quotes are
expanded and
those in quotes are
not*

```
/home/cis90/simben $ set +x Disable shell debugging
+ set +x
/home/cis90/simben $
```

FYI using {}



The braces {} are filename expansion metacharacters

```
/home/cis90/simben $ mkdir fast
/home/cis90/simben $ ls fast
/home/cis90/simben $ touch fast/file{1,2,3,4,5}
/home/cis90/simben $ ls fast
file1  file2  file3  file4  file5
```

Short hand for specifying multiple filenames at once

```
/home/cis90/rodduk $ set -x
++ printf '\033]0;%s@%s:%s\007' rodduk90 opus-ii '~'

/home/cis90/rodduk $ touch fast/file{1,2,3,4,5}
+ touch fast/file1 fast/file2 fast/file3 fast/file4 fast/file5
++ printf '\033]0;%s@%s:%s\007' rodduk90 opus-ii '~'
```

*Showing
how bash
did the
expansion
above*

```
simben90@oslab:/home/cis... - [X]
/home/cis90/milhom $ ls -l
1968.egg
bigfile
bin
empty
f1.graded
f2.graded
Hidden
Lab2.0
Lab2.1
letter
Miscellaneous
mission
Poems
proposal1
proposal2
proposal3
small_town
spellk
text.err
text.fxd
timecal
what_am_i
/home/cis90/milhom $
```

```
/home/cis90/milhom $ find -name *.egg
find: `./Hidden': Permission denied
./1968.egg
```

```
/home/cis90/milhom $ find -name "*.egg"
find: `./Hidden': Permission denied
./Lab2.0/.1969.egg
./Miscellaneous/1975.egg
./bin/.1976.egg
./Poems/Shakespeare/.1979.egg
<snipped>
./island/.1993.egg
./Lab2.1/filename/2001.egg
./Lab2.1/.1995.egg
./1968.egg
/home/cis90/milhom $
```



Why does the first command only find one of the egg files ... yet the second command finds multiple egg files?

Put your answer in the chat window

Housekeeping



Overlap Students

Don't forget to update the Google
Docs Log when watching the
recording

Housekeeping

1. No labs due today!
2. Lab 8 is due next week.
3. Practice test & server will shut down shortly before the real test starts.
4. Test 2 during the last hour of class today
 - Canvas - timed test - 60 minutes
 - OPEN book, notes, computer
 - CLOSED mouths (work solo, don't ask for or give assistance to others)
 - Working students may take the test later in the day but it must be submitted by 11:59PM

Test Instructions

HONOR CODE:

This test is open book, open notes, and open computer. HOWEVER, you must work alone. You may not discuss the test questions or answers with others during the test period. You may not ask or receive assistance from anyone other than the instructor when doing this test. Likewise you may not give any assistance to anyone taking the test.

INSTRUCTIONS:

Test system: sun-hwa-t2.cis.cabrillo.edu (port 22)

This test should be completed using the sun-hwa-t2 system only. Because this system is on a private network, log into Opus-II first, then ssh into sun-hwa-t2.

Grading will be based on your answers AND that you correctly implemented the "DO THIS FIRST" portion of each question.

Highlighted text indicates a portion of a question that differs from the practice test.

If you get stuck on a question and can't proceed you can ask the instructor for help and forfeit the point. The instructor will be available during class and available by email (risimms@cabrillo.edu) later in the evening from 8:00-10:00PM.

Please KEEP YOUR ANSWERS TO A SINGLE LINE ONLY !!

This test must be completed in one sitting. The submittal will be made automatically when the time is up. If you submit early by accident you will not be able to re-enter and continue. If that happens don't panic! Just email the instructor any remaining answers before the time is up.

Heads up on Final Exam

Test #3 (final exam) is **Wednesday May 23rd 7-9:50AM**

Wed	5/23	Test #3 (the final exam) Time - WEDNESDAY 7:00AM - 9:50AM in Room 828 Materials - Presentation slides (download) - Test (canvas) ConferZoom Enter virtual classroom Class archives	5 posts Lab X1 Lab X2
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*Extra credit
labs and
final posts
due by
11:59PM*

- All students will take the test at the same time. The test must be completed by **9:50AM**.
- Working and long distance students can take the test online via ConferZoom and Canvas.
- Working students will need to plan ahead to arrange time off from work for the test.
- Test #3 is **mandatory** (even if you have all the points you want)

SPRING 2018 FINAL EXAMINATIONS SCHEDULE MAY 21 TO MAY 26

DAYTIME FINAL SCHEDULE

Daytime Classes: All times in bold refer to the beginning times of classes. **MW/Daily** means Monday alone, Wednesday alone, Monday and Wednesday or any 3 or more days in any combination. **TTH** means Tuesday alone, Thursday alone, or Tuesday and Thursday. **Classes meeting other combinations of days and/or hours not listed must have a final schedule approved by the Division Dean.**

STARTING CLASS TIME / DAY(S)	EXAM HOUR	EXAM DATE
Classes starting between:		
6:30 am and 8:55 am, MW/Daily	7:00 am-9:50 am	Monday, May 21
9:00 am and 10:15 am, MW/Daily	7:00 am-9:50 am	Wednesday, May 23

CIS 90

Introduction to UNIX/Linux

Provides a technical overview of the UNIX/Linux operating system, including hands-on experience with commands, files, and tools. Recommended Preparation: CIS 1L or CIS 72.

Transfer Credit: Transfers to CSU;UC

Section	Days	Times	Units	Instructor	Room
1	W	9:00AM-12:05PM	3.00	R.Simms	OL
&	Arr.	Arr.		R.Simms	OL

Section 1-(102385) is an ONLINE course. Meets weekly throughout the semester online during the scheduled times by remote technology with an additional 50 min arranged online lab per week. For details, see instructor's web page at go.cabrillo.edu/online.

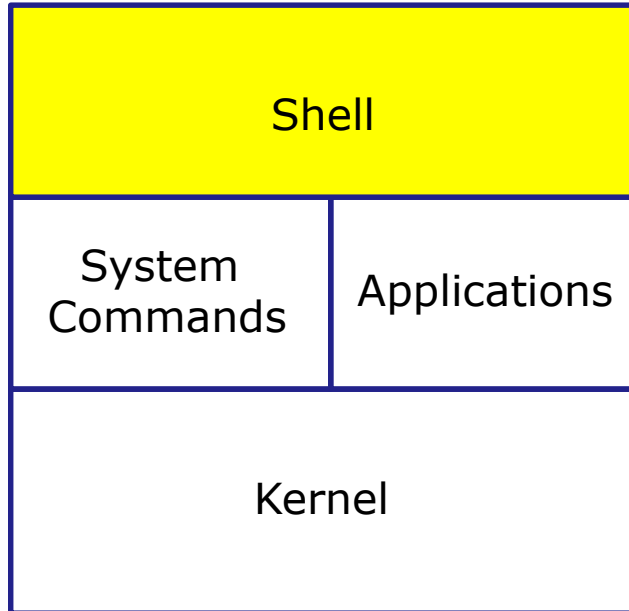
2	W	9:00AM-12:05PM	3.00	R.Simms	828
&	Arr.	Arr.		R.Simms	OL

Section 2-(102386) is a Hybrid ONLINE course. Meets weekly throughout the semester at the scheduled times with an additional 50 min online lab per week. For details, see instructor's web page at go.cabrillo.edu/online.

Process Definition



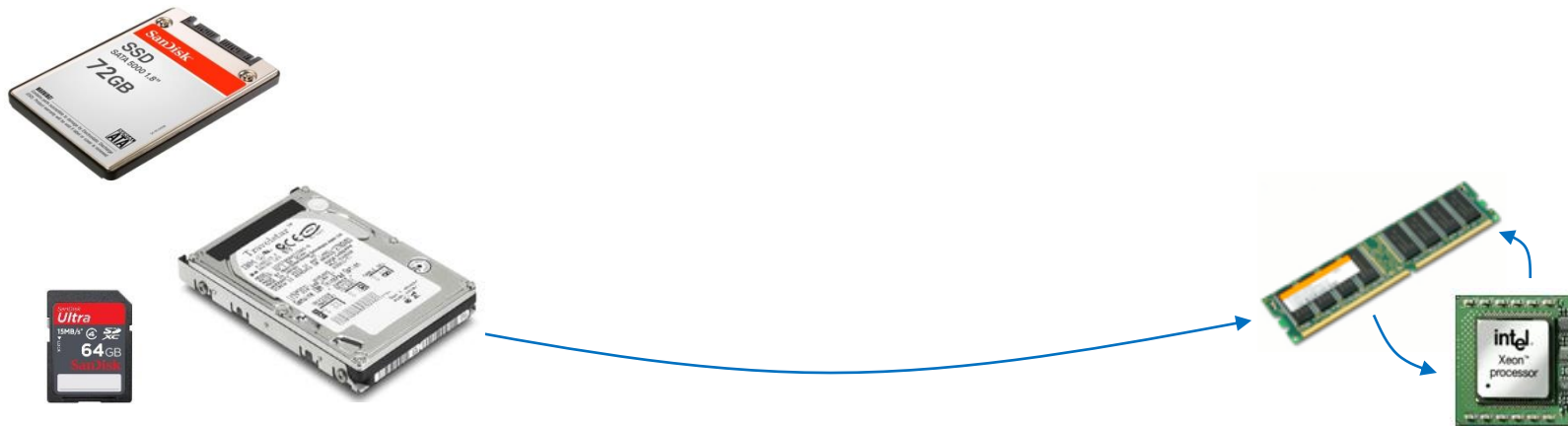
The Shell **Execute** Step



- 1) **Prompt** for a command
- 2) **Parse** (interpret metacharacters, expand file names and dissect command line into options and arguments)
- 3) **Search** for program (along the path)
- 4) **Execute** program by loading it into memory (as a process) and providing it with the parsed options/arguments. In addition hook up all inputs and outputs (stdin, stdout and stderr)
- 5) **Nap** (wait till process is done)
- 6) **Repeat**

Definition of a process

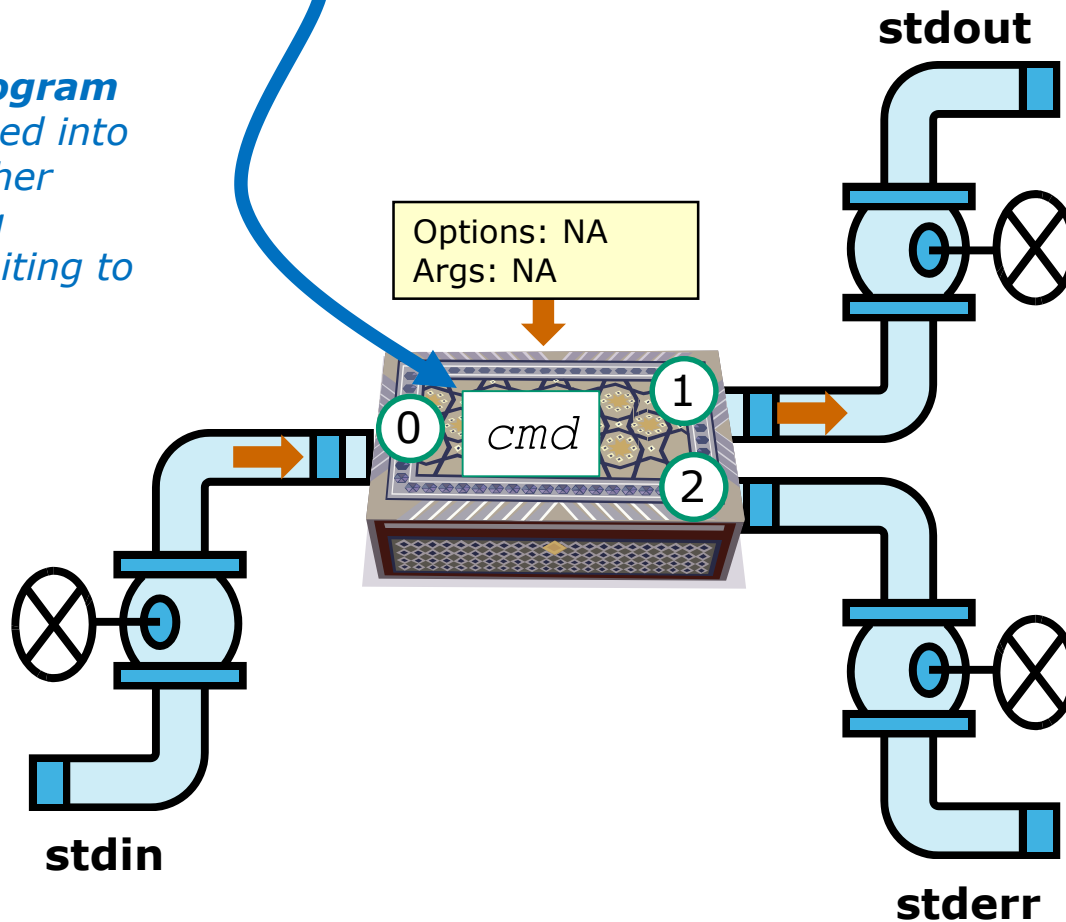
A **process** is a **program** that has been copied (loaded) into memory by the kernel and is either running (executing instructions) or waiting to run.



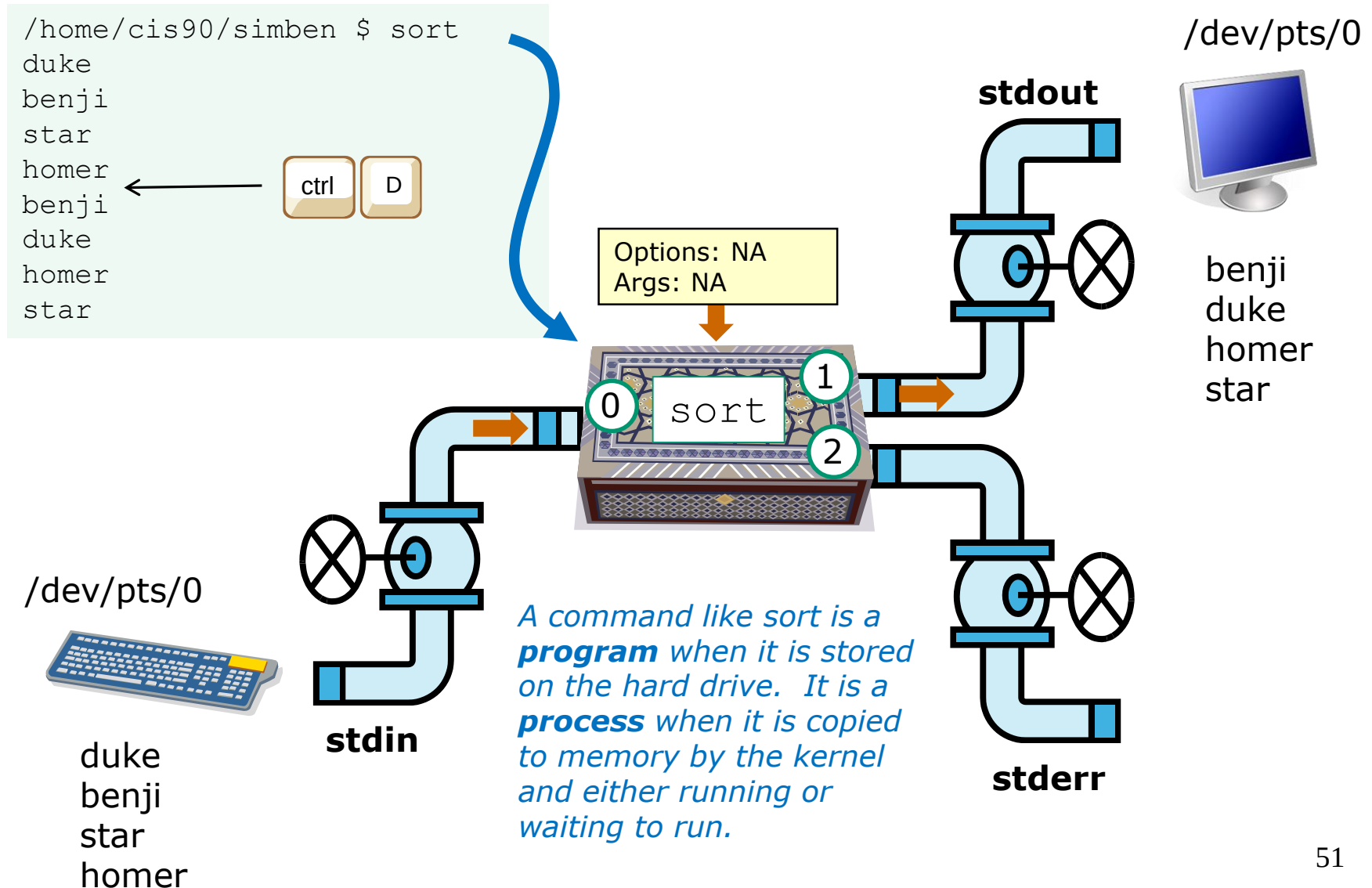
Program to process

```
/home/cis90/simben $cmd
```

A **process** is a **program** that has been loaded into memory and is either running (executing instructions) or waiting to run



Example program to process: sort command



A simple example:

```
CODE
void function1() {
    int A = 10;
    A += 66;
}
```

compiles to...

```
function1:
1   pushl %ebp #
2   movl %esp, %ebp #,
3   subl $4, %esp #,
4   movl $10, -4(%ebp) #, A
5   leal -4(%ebp), %eax #,
6   addl $66, (%eax) #, A
7   leave
8   ret
```

Explanation:

1. push ebp
2. copy stack pointer to ebp
3. make space on stack for local data
4. put value 10 in A (this would be the address A has now)
5. load address of A into EAX (similar to a pointer)
6. add 66 to A

... don't think you need to know the rest

Mixing C and Assembly Language

The way to mix C and assembly language is to use the "asm" directive. To access C-language variables from inside of assembly language, you simply use the C identifier name as a memory operand. These variables cannot be local to a procedure, and also cannot be static inside a procedure. They *must* be global (but can be static global). The

Done

Many programs are written in the C language

The C compiler translates the C code into binary machine code instructions the CPU can execute.

Example program to process: sort command

```
[rsimms@opus ~]$ type sort
sort is /bin/sort
```

Use **type** to find where the
sort program is located

```
[rsimms@opus ~]$ file /bin/sort
/bin/sort: ELF 32-bit LSB executable, Intel 80386, version 1 (SYSV), for GNU/Linux
2.6.9, dynamically linked (uses shared libs), for GNU/Linux 2.6.9, stripped
[rsimms@opus ~]$
```

Use **file** to see sort is a
binary executable

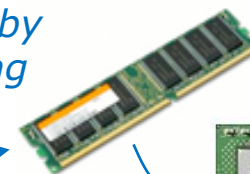
```
[rsimms@opus ~]$ xxd /bin/sort | more
```

```
00000000: 7f45 4c46 0101 0100 0000 0000 0000 0000  .ELF.....
00000010: 0200 0300 0100 0000 e093 0408 3400 0000  .....4...
00000020: 2cdb 0000 0000 0000 3400 2000 0800 2800  ,.....4. ...(.
00000030: 1f00 1e00 0600 0000 3400 0000 3480 0408  .....4...4...
00000040: 3480 0408 0001 0000 0001 0000 0500 0000  4.....
00000050: 0400 0000 0300 0000 3401 0000 3481 0408  .....4...4...
00000060: 3481 0408 1300 0000 1300 0000 0400 0000  4.....
```

< snipped >

Use **xxd** to produce a
hexadecimal dump of the
sort file

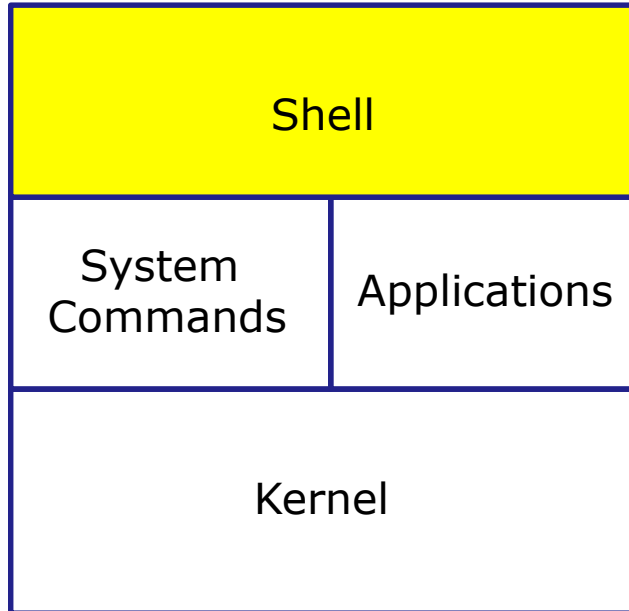
A command like **sort** is a **program**
when it is stored on the drive. It is a
process when it is copied to memory by
the kernel and either running or waiting
to run by the CPU



Process Life Cycle



The Shell **Execute** Step

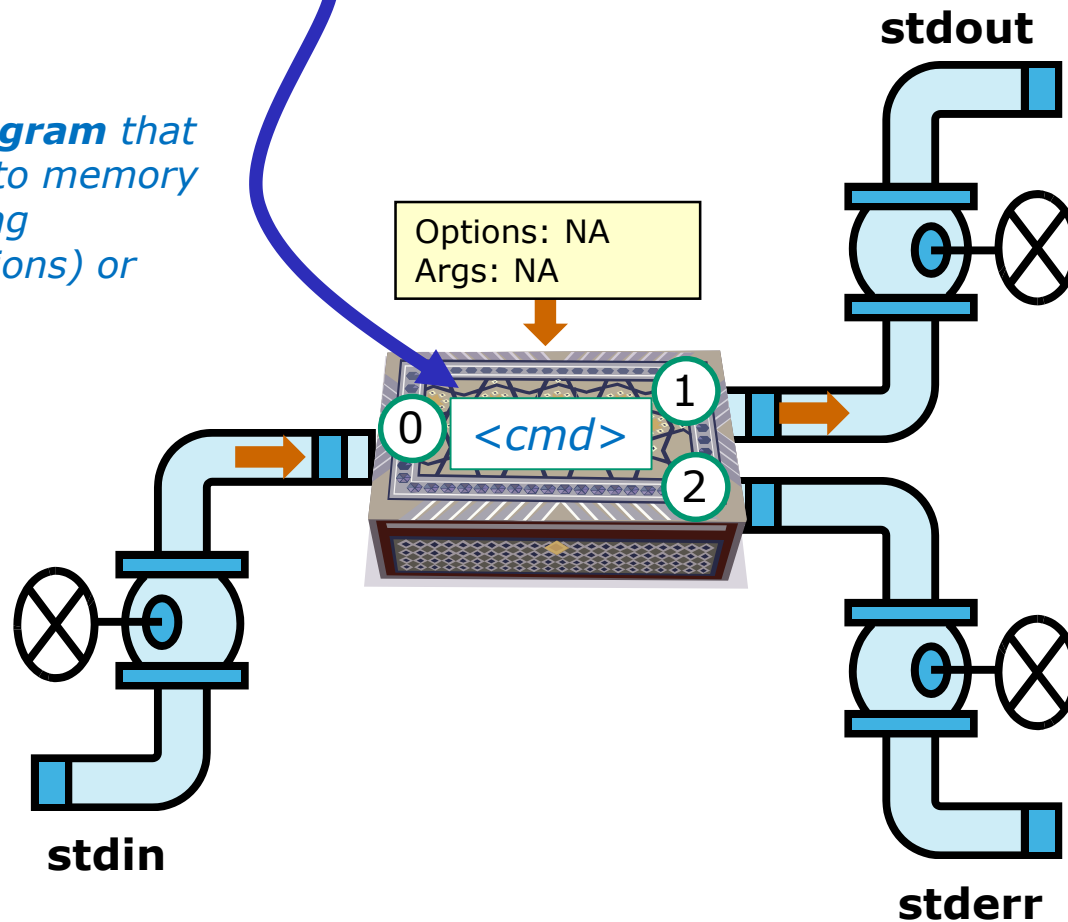


- 1) **Prompt** for a command
- 2) **Parse** (interpret metacharacters, expand file names and dissect command line into options and arguments)
- 3) **Search** for program (along the path)
- 4) **Execute** program by loading it into memory (as a process) and providing it with the parsed options/arguments. In addition hook up all inputs and outputs (stdin, stdout and stderr)
- 5) **Nap** (wait till process is done)
- 6) **Repeat**

Executing a command `<cmd>`

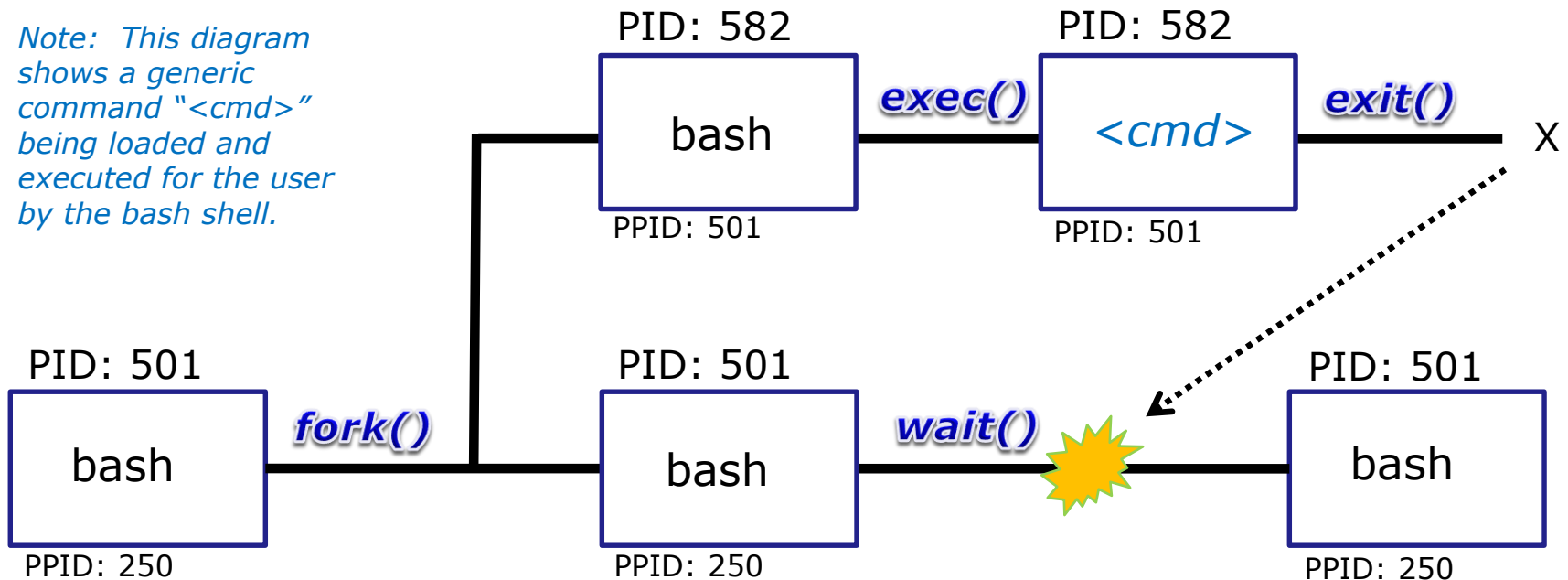
```
/home/cis90/simben $ <cmd>
```

A **process** is a **program** that has been loaded into memory and is either running (executing instructions) or waiting to run



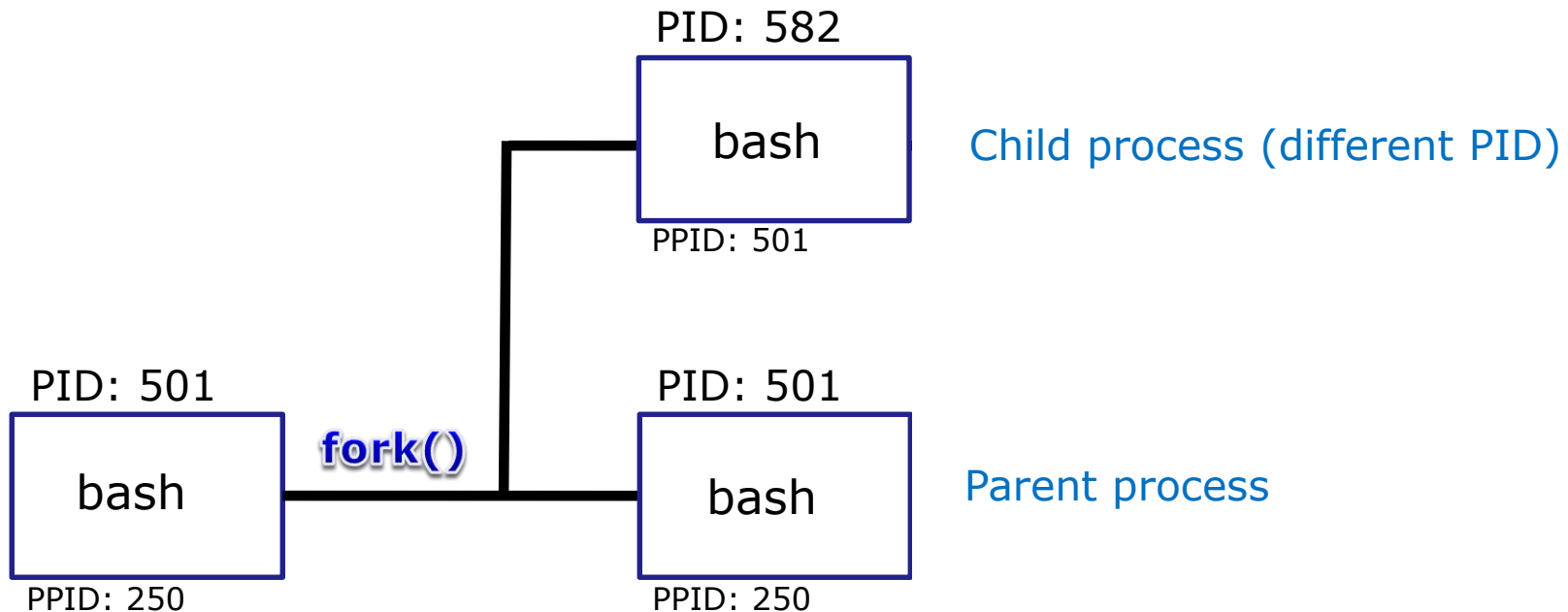
Process Lifecycle

Note: This diagram shows a generic command "<cmd>" being loaded and executed for the user by the bash shell.



*A process uses system calls (e.g. **fork**, **exec**, **wait**, **exit**) to request services from the kernel*

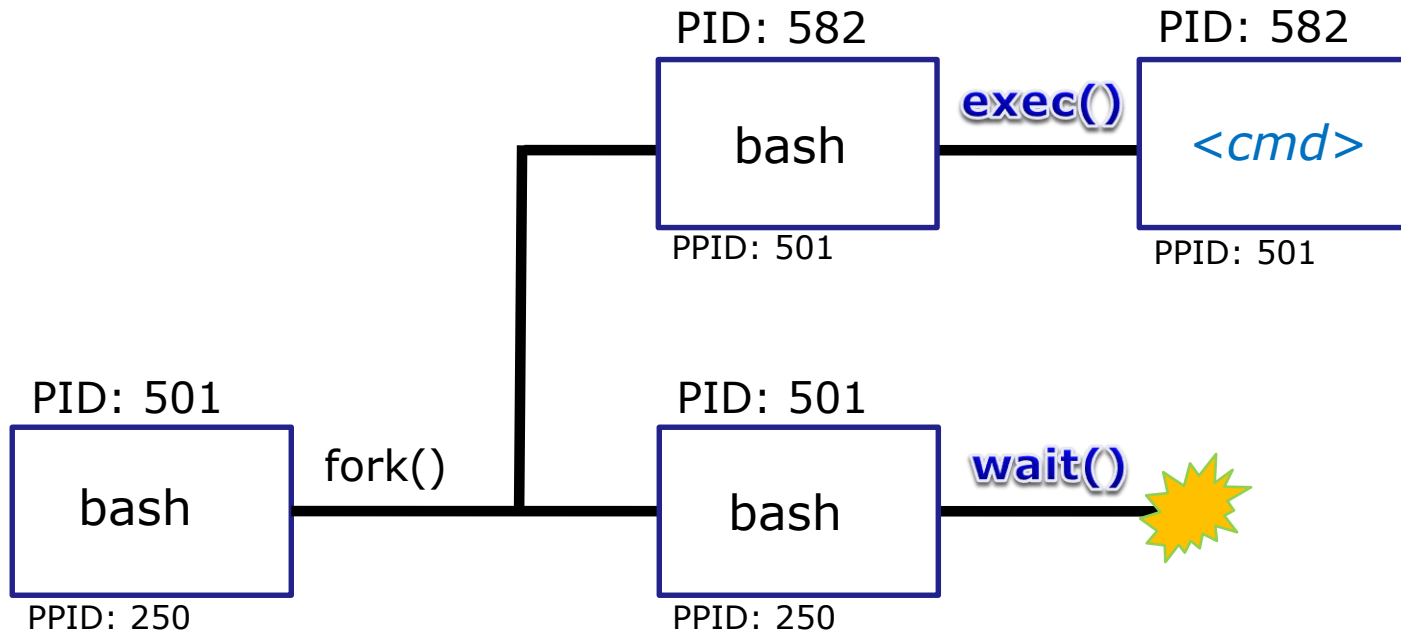
Process Lifecycle - fork child process



1) The first step in executing a command is to create a new child process

- This is done by the **parent** process (bash) making a copy of itself using the **fork** system call.
- The new **child** process is a duplicate of the **parent** but it has a different PID.

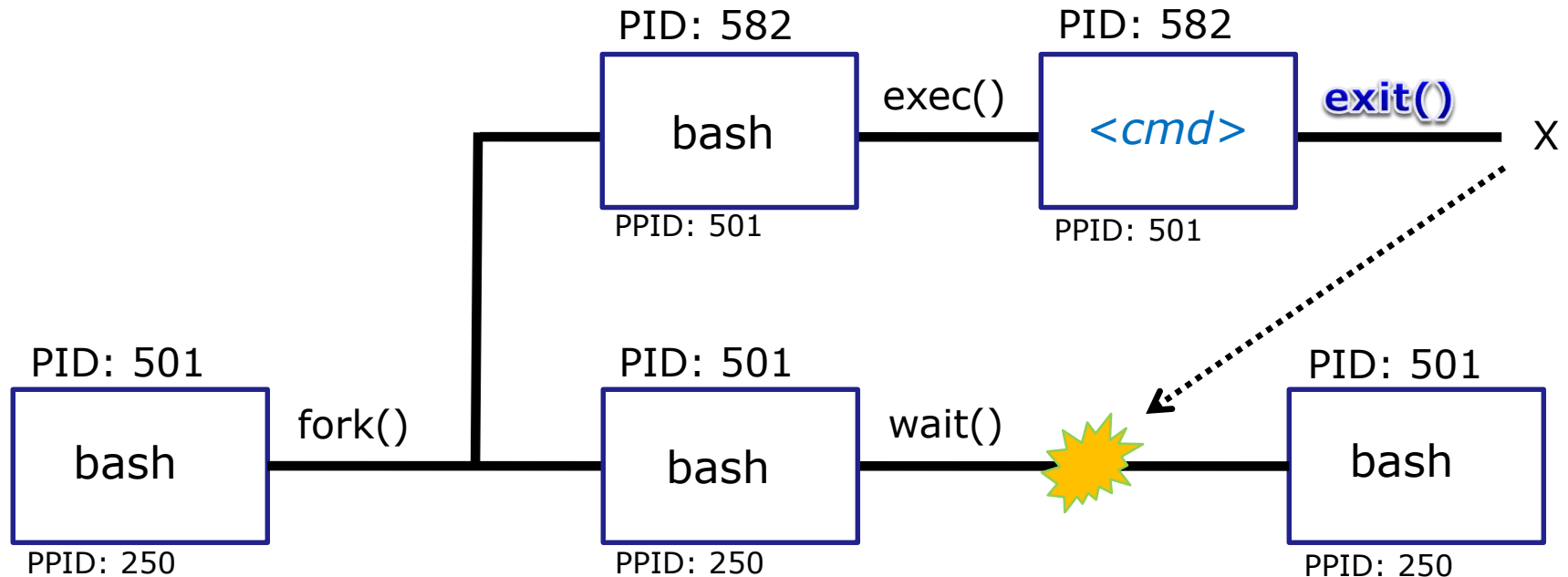
Process Lifecycle



2) The next step is to load the command into the new child process

- An **exec** system call is issued to overlay the **child** process with the instructions of the requested command. The new instructions then are executed.
- The **parent** process issues the **wait** system call and goes to sleep.

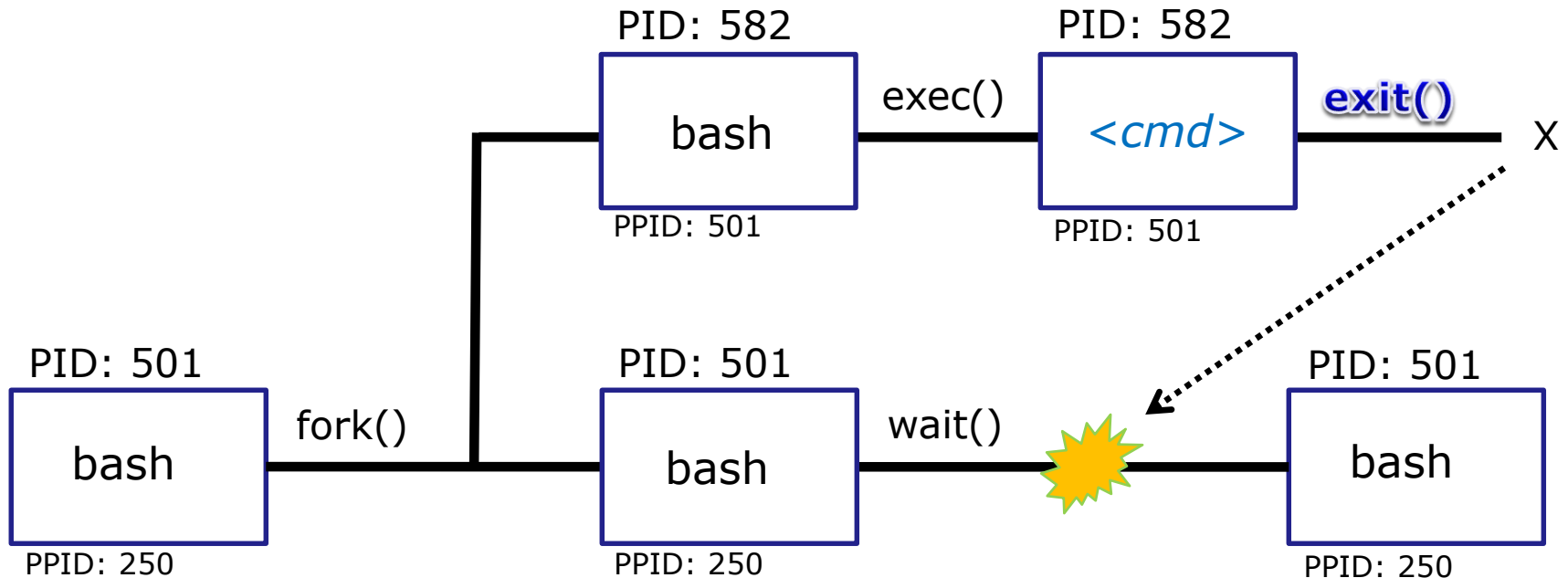
Process Lifecycle



3) The final step is to terminate the new child process after it has finished

- When the **child** process finishes executing the instructions it issues the **exit** system call. At this point it gives up all its resources and becomes a **zombie**.
- The **parent** is woken up. Once the **parent** has informed the kernel it has finished working with the **child**, the **child** process is killed and removed from the process table.

Process Lifecycle



*Note: If the **parent** process were to die before the **child**, the zombie will become an **orphan**.*

*Fortunately the init process will adopt any orphaned **zombies**!*



Process Information ps command



Tools for your toolbox

ps - report a snapshot of the current processes

ps command

Basic syntax

(see man page for the rest of the story)

ps *<options>*

Examples

ps *(shows your shell and ps processes in current session)*

ps -a *(show all processes you are running on all sessions)*

ps -u simben90 *(shows sshd, shell and current processes all login sessions)*

ps -l *(shows your shell and ps processes using long format)*

ps -ef *(shows every process on system using full format)*



Column Header	Description
PID	Process Identification Number, a unique number identifying the process
PPID	Parent PID, the PID of the parent process (like .. in the file hierarchy)
UID	The user running the process
TTY	The terminal that the process's stdin and stdout are connected to
S	The status (state) of the process: S=Sleeping, R=Running, T=Stopped, Z=Zombie, D=uninterruptable sleep (usually IO)
PRI	Process priority
SZ	Process size in pages
CMD	The name of the process (the command being run)
C	The CPU utilization of the process
WCHAN	Waiting channel (name of kernel function in which the process is sleeping)
F	Flags (1=forked but didn't exit, 4=used superuser privileges)
TIME	Cumulative CPU time
NI	Nice value

Column headers on ps command output

Just a few of the types of information kept on a process.

*Use **man ps** to see a lot more.*

ps command

/dev/pts/3

```
/home/cis90/simben $ ps
  PID TTY          TIME CMD
 11424 pts/3        00:00:00 bash
 12006 pts/3        00:00:00 ps
```

With no options it shows my shell and ps processes for the terminal device I'm using

```
simben90@oslab:~
/home/cis90/simben $ ps
  PID TTY          TIME CMD
 11424 pts/3        00:00:00 bash
 12006 pts/3        00:00:00 ps
/home/cis90/simben $
```

/dev/pts/2

```
simben90@oslab:~
PS (1) Linux User's Manual PS (1)
NAME
  ps - report a snapshot of the current processes.
SYNOPSIS
  ps [options]
DESCRIPTION
  ps displays information about a selection of the active processes. If
  you want a repetitive update of the selection and the displayed
  information, use top(1) instead.
  This version of ps accepts several kinds of options:
  1  UNIX options, which may be grouped and must be preceded by a dash.
  2  BSD options, which may be grouped and must not be used with a dash.
  3  GNU long options, which are preceded by two dashes.
  Options of different types may be freely mixed, but conflicts can
  appear. There are some synonymous options, which are functionally
  identical, due to the many standards and ps implementations that this
  ps is compatible with.
```

man ps

- PID Process Identification Number, a unique number identifying the process
- TTY The terminal that the process's stdin and stdout are connected to
- CMD The name of the process (the command being run)
- TIME Cumulative CPU time

ps command with -a option

```
/home/cis90/simben $ ps -a
  PID TTY          TIME CMD
12098 pts/2    00:00:00 man
12101 pts/2    00:00:00 sh
12102 pts/2    00:00:00 sh
12106 pts/2    00:00:00 less
12139 pts/3    00:00:00 ps
/home/cis90/simben $
```

The -a option shows all processes being run by all users (does not include shell or sshd processes)

/dev/pts/3

```
simben90@oslab:~
/home/cis90/simben $ ps -a
  PID TTY          TIME CMD
12098 pts/2    00:00:00 man
12101 pts/2    00:00:00 sh
12102 pts/2    00:00:00 sh
12106 pts/2    00:00:00 less
12139 pts/3    00:00:00 ps
/home/cis90/simben $
```

/dev/pts/2

```
simben90@oslab:~
PS (1) Linux User's Manual PS (1)
NAME
ps - report a snapshot of the current processes.
SYNOPSIS
ps [options]
DESCRIPTION
ps displays information about a selection of the active processes. If
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3  GNU long options, which are preceded by two dashes.
Options of different types may be freely mixed, but conflicts can
appear. There are some synonymous options, which are functionally
identical, due to the many standards and ps implementations that this
ps is compatible with.
```

man ps

PID	Process Identification Number, a unique number identifying the process
TTY	The terminal that the process's stdin and stdout are connected to
CMD	The name of the process (the command being run)
TIME	Cumulative CPU time

ps command with -u option

```
/home/cis90/simben $ ps -u simben90
```

PID	TTY	TIME	CMD
11343	?	00:00:00	sshd
11344	pts/2	00:00:00	bash
11423	?	00:00:00	sshd
11424	pts/3	00:00:00	bash
12098	pts/2	00:00:00	man
12101	pts/2	00:00:00	sh
12102	pts/2	00:00:00	sh
12106	pts/2	00:00:00	less
12324	pts/3	00:00:00	ps

```
/home/cis90/simben $
```

Use the -u (user) option to look at processes owned by a specific user (includes shell and sshd processes)

/dev/pts/3

```
simben90@oslab:~/
/home/cis90/simben $ ps -u simben90
  PID TTY          TIME CMD
 11343 ?            00:00:00 sshd
 11344 pts/2        00:00:00 bash
 11423 ?            00:00:00 sshd
 11424 pts/3        00:00:00 bash
 12098 pts/2        00:00:00 man
 12101 pts/2        00:00:00 sh
 12102 pts/2        00:00:00 sh
 12106 pts/2        00:00:00 less
 12324 pts/3        00:00:00 ps
/home/cis90/simben $
/home/cis90/simben $ ps -u rsimms
  PID TTY          TIME CMD
 10300 ?            00:00:00 sshd
 10301 pts/0        00:00:00 bash
/home/cis90/simben $
```

/dev/pts/2

```
simben90@oslab:~/
Linux User's Manual
PS (1)
NAME
    ps - report a snapshot of the current processes.
SYNOPSIS
    ps [options]
DESCRIPTION
    ps displays information about a selection of the active processes. If
    you want a repetitive update of the selection and the displayed
    information, use top(1) instead.
    This version of ps accepts several kinds of options:
    1  UNIX options, which may be grouped and must be preceded by a dash.
    2  BSD options, which may be grouped and must not be used with a dash.
    3  GNU long options, which are preceded by two dashes.
    Options of different types may be freely mixed, but conflicts can
    appear. There are some synonymous options, which are functionally
    identical, due to the many standards and ps implementations that this
    ps is compatible with.
```

man ps

PID	Process Identification Number, a unique number identifying the process
TTY	The terminal that the process's stdin and stdout are connected to
CMD	The name of the process (the command being run)
TIME	Cumulative CPU time

ps command with -l option

Use **-l** (long format) to show additional process information

11424 is sleeping
12438 is running

```
/home/cis90/simben $ ps -l
```

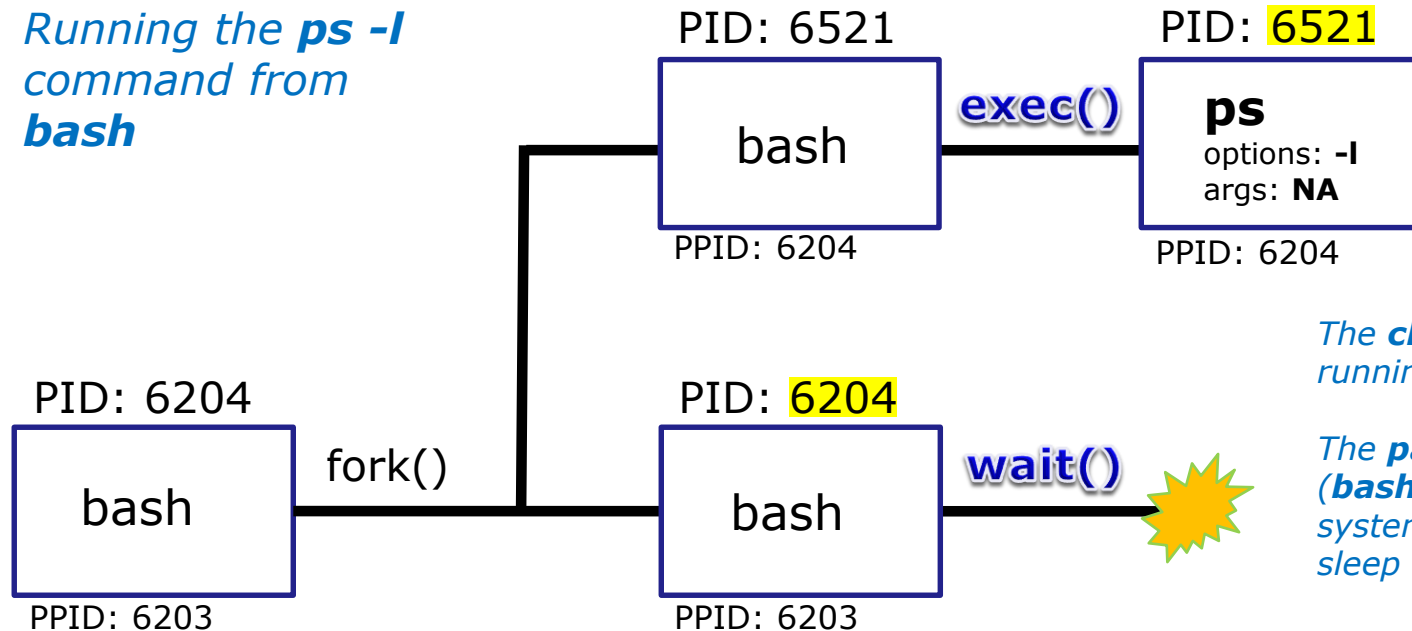
F	S	UID	PID	PPID	C	PRI	NI	ADDR	SZ	WCHAN	TTY	TIME	CMD
0	S	1201	11424	11423	0	80	0	-	1315	-	pts/3	00:00:00	bash
0	R	1201	12438	11424	0	80	0	-	1220	-	pts/3	00:00:00	ps



UID	The user running the process
S	The status of the process: S=Sleeping, R=Running, T=Stopped, Z=Zombie, D=uninterruptable sleep (usually IO)
PRI	Process priority
C	The CPU utilization of the process
WCHAN	Waiting channel (name of kernel function in which the process is sleeping)
F	Flags (1=forked but didn't exit, 4=used superuser privileges)
TIME	Cumulative CPU time
NI	Nice value

Deep Dive View of **ps -l** command

Running the **ps -l**
command from
bash



The **child** process (**ps**) is
running (status=R)

The **parent** process
(**bash**) issues the **wait**
system call and goes to
sleep (status=S)

6204 is sleeping
6521 is running

```
[rsimms@opus ~]$ ps -l
```

F	S	UID	PID	PPID	C	PRI	NI	ADDR	SZ	WCHAN	TTY	TIME	CMD
0	S	201	6204	6203	0	75	0	-	1165	wait	pts/6	00:00:00	bash
0	R	201	6521	6204	0	77	0	-	1050	-	pts/6	00:00:00	ps

An **exec** system call is issued to overlay the **child** process with the instructions of the requested command. The new instructions then are executed.

ps command with -ef options (page 1)

```
/home/cis90/simben $ ps -ef
```

UID	PID	PPID	C	STIME	TTY	TIME	CMD
root	1	0	0	Aug27	?	00:00:36	/sbin/init
root	2	0	0	Aug27	?	00:00:00	[kthreadd]
root	3	2	0	Aug27	?	00:00:14	[migration/0]
root	4	2	0	Aug27	?	00:00:04	[ksoftirqd/0]
root	5	2	0	Aug27	?	00:00:00	[migration/0]
root	6	2	0	Aug27	?	00:00:35	[watchdog/0]
root	7	2	0	Aug27	?	00:00:10	[migration/1]
root	8	2	0	Aug27	?	00:00:00	[migration/1]
root	9	2	0	Aug27	?	00:00:18	[ksoftirqd/1]
root	10	2	0	Aug27	?	00:00:30	[watchdog/1]
root	11	2	0	Aug27	?	00:00:10	[migration/2]
root	12	2	0	Aug27	?	00:00:00	[migration/2]
root	13	2	0	Aug27	?	00:00:07	[ksoftirqd/2]
root	14	2	0	Aug27	?	00:00:30	[watchdog/2]
root	15	2	0	Aug27	?	00:00:12	[migration/3]
root	16	2	0	Aug27	?	00:00:00	[migration/3]
root	17	2	0	Aug27	?	00:00:10	[ksoftirqd/3]
root	18	2	0	Aug27	?	00:00:30	[watchdog/3]
root	19	2	0	Aug27	?	00:03:37	[events/0]
root	20	2	0	Aug27	?	00:04:37	[events/1]
root	21	2	0	Aug27	?	00:03:50	[events/2]
root	22	2	0	Aug27	?	00:04:42	[events/3]
root	23	2	0	Aug27	?	00:00:00	[cgroupl]
root	24	2	0	Aug27	?	00:00:00	[khelper]

*Use -ef option to
see everything
with full format*

ps command with -ef options (page 2)

```

root      25      2   0  Aug27 ?           00:00:00 [netns]
root      26      2   0  Aug27 ?           00:00:00 [async/mgr]
root      27      2   0  Aug27 ?           00:00:00 [pm]
root      28      2   0  Aug27 ?           00:00:28 [sync_supers]
root      29      2   0  Aug27 ?           00:00:31 [bdi-default]
root      30      2   0  Aug27 ?           00:00:00 [kintegrityd/0]
root      31      2   0  Aug27 ?           00:00:00 [kintegrityd/1]
root      32      2   0  Aug27 ?           00:00:00 [kintegrityd/2]
root      33      2   0  Aug27 ?           00:00:00 [kintegrityd/3]
root      34      2   0  Aug27 ?           00:01:18 [kblockd/0]
root      35      2   0  Aug27 ?           00:00:17 [kblockd/1]
root      36      2   0  Aug27 ?           00:00:22 [kblockd/2]
root      37      2   0  Aug27 ?           00:00:33 [kblockd/3]
root      38      2   0  Aug27 ?           00:00:00 [kacpid]
root      39      2   0  Aug27 ?           00:00:00 [kacpi_notify]
root      40      2   0  Aug27 ?           00:00:00 [kacpi_hotplug]
root      41      2   0  Aug27 ?           00:00:00 [ata_aux]
root      42      2   0  Aug27 ?           00:00:00 [ata_sff/0]
root      43      2   0  Aug27 ?           00:00:00 [ata_sff/1]
root      44      2   0  Aug27 ?           00:00:00 [ata_sff/2]
root      45      2   0  Aug27 ?           00:00:00 [ata_sff/3]
root      46      2   0  Aug27 ?           00:00:00 [ksuspend_usbd]
root      47      2   0  Aug27 ?           00:00:00 [khubd]
root      48      2   0  Aug27 ?           00:00:00 [kseriod]
root      49      2   0  Aug27 ?           00:00:00 [md/0]
root      50      2   0  Aug27 ?           00:00:00 [md/1]
root      51      2   0  Aug27 ?           00:00:00 [md/2]
root      52      2   0  Aug27 ?           00:00:00 [md/3]

```

ps command with -ef options (page 3)

```

root      2534      1   0 Sep10 ?        00:00:00 ./hpiod
root      2539      1   0 Sep10 ?        00:00:00 python ./hpssd.py
root      2556      1   0 Sep10 ?        00:00:00 cupsd
root      2575      1   0 Sep10 ?        00:00:11 /usr/sbin/sshd
root      2600      1   0 Sep10 ?        00:00:01 sendmail: accepting connections
smmsp     2609      1   0 Sep10 ?        00:00:00 sendmail: Queue runner@01:00:00 for
root      2626      1   0 Sep10 ?        00:00:00 crond
xfs        2662      1   0 Sep10 ?        00:00:00 xfs -droppriv -daemon
root      2693      1   0 Sep10 ?        00:00:00 /usr/sbin/atd
root      2710      1   0 Sep10 ?        00:00:00 rhnsd --interval 240
root      2743      1   0 Sep10 ?        00:01:33 /usr/bin/python -tt /usr/sbin/yum-up
root      2745      1   0 Sep10 ?        00:00:00 /usr/libexec/gam_server
root      2749      1   0 Sep10 ?        00:00:00 /usr/bin/vmnet-netifup -d /var/run/v
root      2758      1   0 Sep10 ?        00:00:00 /usr/bin/vmnet-netifup -d /var/run/v
root      2768      1   0 Sep10 ?        00:00:00 /usr/bin/vmnet-netifup -d /var/run/v
root      2827      1   0 Sep10 ?        00:00:00 /usr/bin/vmnet-dhcpd -cf /etc/vmware
root      2858      1   0 Sep10 ?        00:00:00 /usr/bin/vmnet-dhcpd -cf /etc/vmware
root      2859      1   0 Sep10 ?        00:00:00 /usr/bin/vmnet-dhcpd -cf /etc/vmware
68         2875      1   0 Sep10 ?        00:00:01 hald
root      2876      2875 0 Sep10 ?        00:00:00 hald-runner
68         2883      2876 0 Sep10 ?        00:00:00 hald-addon-acpi: listening on acpid
68         2886      2876 0 Sep10 ?        00:00:00 hald-addon-keyboard: listening on /d
68         2890      2876 0 Sep10 ?        00:00:00 hald-addon-keyboard: listening on /d
root      2898      2876 0 Sep10 ?        00:02:46 hald-addon-storage: polling /dev/hda
root      2944      1   0 Sep10 ?        00:00:00 /usr/sbin/smartd -q never
root      2949      1   0 Sep10 tty2      00:00:00 /sbin/mingetty tty2

```


ps command with -ef options (page 4)

```

root      53      2   0 Aug27 ?           00:00:00 [md_misc/0]
root      54      2   0 Aug27 ?           00:00:00 [md_misc/1]
root      55      2   0 Aug27 ?           00:00:00 [md_misc/2]
root      56      2   0 Aug27 ?           00:00:00 [md_misc/3]
root      57      2   0 Aug27 ?           00:00:00 [linkwatch]
root      58      2   0 Aug27 ?           00:00:02 [khungtaskd]
root      59      2   0 Aug27 ?           00:00:03 [kswapd0]
root      60      2   0 Aug27 ?           00:00:00 [ksmd]
root      61      2   0 Aug27 ?           00:00:00 [aio/0]
root      62      2   0 Aug27 ?           00:00:00 [aio/1]
root      63      2   0 Aug27 ?           00:00:00 [aio/2]
root      64      2   0 Aug27 ?           00:00:00 [aio/3]
root      65      2   0 Aug27 ?           00:00:00 [crypto/0]
root      66      2   0 Aug27 ?           00:00:00 [crypto/1]
root      67      2   0 Aug27 ?           00:00:00 [crypto/2]
root      68      2   0 Aug27 ?           00:00:00 [crypto/3]
root      73      2   0 Aug27 ?           00:00:00 [kthrotld/0]
root      74      2   0 Aug27 ?           00:00:00 [kthrotld/1]
root      75      2   0 Aug27 ?           00:00:00 [kthrotld/2]
root      76      2   0 Aug27 ?           00:00:00 [kthrotld/3]
root      77      2   0 Aug27 ?           00:00:00 [pciehp]
root      79      2   0 Aug27 ?           00:00:00 [kpsmouse]
root      80      2   0 Aug27 ?           00:00:00 [usbhid_resumer]
root     110      2   0 Aug27 ?           00:00:00 [kstripped]
root     194      2   0 Aug27 ?           00:00:00 [scsi_eh_0]
root     195      2   0 Aug27 ?           00:00:00 [scsi_eh_1]
root     209      2   0 Aug27 ?           00:00:00 [scsi_eh_2]

```

ps command with -ef options (page 5)

```

root      210      2   0  Aug27 ?           00:00:00 [vmw_pvscsi_wq_2]
root      321      2   0  Aug27 ?           00:00:19 [jbd2/sda1-8]
root      322      2   0  Aug27 ?           00:00:00 [ext4-dio-unwrit]
root      414      1   0  Aug27 ?           00:00:00 /sbin/udev -d
root      530      2   0  Aug27 ?           00:02:17 [vmmemctl]
root      776      2   0  Aug27 ?           00:00:29 [jbd2/sda5-8]
root      777      2   0  Aug27 ?           00:00:00 [ext4-dio-unwrit]
root      778      2   0  Aug27 ?           00:05:28 [jbd2/sda3-8]
root      779      2   0  Aug27 ?           00:00:00 [ext4-dio-unwrit]
root      822      2   0  Aug27 ?           00:00:43 [kauditd]
root     1457      1   0  Aug27 ?           00:02:13 auditd
root     1475      1   0  Aug27 ?           00:00:00 /sbin/portreserve
root     1482      1   0  Aug27 ?           00:00:45 /sbin/rsyslogd -i /var/run/syslo
root     1511      1   0  Aug27 ?           00:28:03 irqbalance --pid=/var/run/irqbal
rpc       1525      1   0  Aug27 ?           00:00:09 rpcbind
rpcuser   1543      1   0  Aug27 ?           00:00:00 rpc.statd
root     1555      1   0  Aug27 ?           00:00:12 mdadm --monitor --scan -f --pid-
dbus      1681      1   0  Aug27 ?           00:00:07 dbus-daemon --system
root     1698      1   0  Aug27 ?           00:00:42 cupsd -C /etc/cups/cupsd.conf
root     1723      1   0  Aug27 ?           00:00:00 /usr/sbin/acpid
68        1732      1   0  Aug27 ?           00:00:42 hald
root     1733    1732   0  Aug27 ?           00:00:00 hald-runner
root     1765    1733   0  Aug27 ?           00:00:00 hald-addon-input: Listening on /
68        1773    1733   0  Aug27 ?           00:00:00 hald-addon-acpi: listening on ac
root     1800      1   0  Aug27 ?           00:02:50 automount --pid-file /var/run/au
root     1863      1   0  Aug27 ?           00:00:00 /bin/sh /usr/bin/mysqld_safe --d
mysql     1965    1863   0  Aug27 ?           01:42:39 /usr/libexec/mysqld --basedir=/u

```

ps command with -ef options (page 6)

```

root      1997      1   0 Aug27 ?           00:03:33 sendmail: accepting connections
smmsp     2006      1   0 Aug27 ?           00:00:01 sendmail: Queue runner@01:00:00
root      2028      1   0 Aug27 ?           00:00:00 abrt-dump-oops -d /var/spool/abr
root      2036      1   0 Aug27 ?           00:04:06 /usr/sbin/httpd
root      2044      1   0 Aug27 ?           00:02:17 crond
root      2055      1   0 Aug27 ?           00:00:02 /usr/sbin/atd
root      2076      1   0 Aug27 tty1        00:00:00 /sbin/mingetty /dev/tty1
root      2078      1   0 Aug27 tty2        00:00:00 /sbin/mingetty /dev/tty2
root      2080      1   0 Aug27 tty3        00:00:00 /sbin/mingetty /dev/tty3
root      2082      1   0 Aug27 tty4        00:00:00 /sbin/mingetty /dev/tty4
root      2088      1   0 Aug27 tty5        00:00:00 /sbin/mingetty /dev/tty5
root      2090      1   0 Aug27 tty6        00:00:00 /sbin/mingetty /dev/tty6
apache    3716     2036   0 Nov02 ?           00:01:22 /usr/sbin/httpd
apache    5550     2036   0 Nov02 ?           00:01:15 /usr/sbin/httpd
apache    5551     2036   0 Nov02 ?           00:01:20 /usr/sbin/httpd
apache    5552     2036   0 Nov02 ?           00:01:17 /usr/sbin/httpd
apache    5554     2036   0 Nov02 ?           00:01:16 /usr/sbin/httpd
apache    6611     2036   0 Nov02 ?           00:01:18 /usr/sbin/httpd
root      10295    18067   0 07:28 ?           00:00:00 sshd: rsimms [priv]
rsimms    10300    10295   0 07:28 ?           00:00:00 sshd: rsimms@pts/0
rsimms    10301    10300   0 07:28 pts/0        00:00:00 -bash
apache    10326     2036   0 Nov02 ?           00:01:07 /usr/sbin/httpd
root      11088    18067   0 08:06 ?           00:00:00 sshd: lamnav90 [priv]
lamnav90  11092    11088   0 08:06 ?           00:00:01 sshd: lamnav90@pts/1
lamnav90  11093    11092   0 08:06 pts/1        00:00:00 -bash
root      11336    18067   0 08:12 ?           00:00:00 sshd: simben90 [priv]
simben90  11343    11336   0 08:12 ?           00:00:00 sshd: simben90@pts/2
simben90  11344    11343   0 08:12 pts/2        00:00:00 -bash

```

ps command with -ef options (page 6)

```

root      11415 18067  0 08:13 ?          00:00:00 sshd: simben90 [priv]
simben90  11423 11415  0 08:13 ?          00:00:00 sshd: simben90@pts/3
simben90  11424 11423  0 08:13 pts/3    00:00:00 -bash
root      11767      2  0 Sep17 ?          00:00:00 [rpciod/0]
root      11768      2  0 Sep17 ?          00:00:00 [rpciod/1]
root      11769      2  0 Sep17 ?          00:00:00 [rpciod/2]
root      11770      2  0 Sep17 ?          00:00:00 [rpciod/3]
root      11772      2  0 Sep17 ?          00:00:00 [kslowd000]
root      11773      2  0 Sep17 ?          00:00:00 [kslowd001]
root      11774      2  0 Sep17 ?          00:00:00 [nfsiod]
lamnav90  12591 11093  0 08:57 pts/1    00:00:00 ssh sun-hwa-p2
root      12613      2  0 Sep08 ?          00:05:57 [flush-8:0]
simben90  12684 11344  0 08:59 pts/2    00:00:00 ssh sun-hwa-p2
root      12824 18067  0 09:05 ?          00:00:00 sshd: smimat90 [priv]
smimat90  12845 12824  0 09:06 ?          00:00:00 sshd: smimat90@pts/4
smimat90  12846 12845  0 09:06 pts/4    00:00:00 -bash
root      12875 18067  0 09:06 ?          00:00:00 sshd: pikann90 [priv]
pikann90  12879 12875  0 09:06 ?          00:00:00 sshd: pikann90@pts/5
pikann90  12880 12879  0 09:06 pts/5    00:00:00 -bash
root      12906 18067  0 09:06 ?          00:00:00 sshd: pikann90 [priv]
pikann90  12925 12906  0 09:07 ?          00:00:00 sshd: pikann90@pts/6
pikann90  12926 12925  0 09:07 pts/6    00:00:00 -bash
pikann90  12957 12926  0 09:07 pts/6    00:00:00 ssh sun-hwa-p2
root      13008 18067  0 09:09 ?          00:00:00 sshd: smimat90 [priv]
smimat90  13013 13008  0 09:10 ?          00:00:00 sshd: smimat90@pts/7
smimat90  13014 13013  0 09:10 pts/7    00:00:00 -bash
root      13330 18067  0 09:20 ?          00:00:00 sshd: quifra90 [priv]

```

ps command with -ef options (page 7)

```

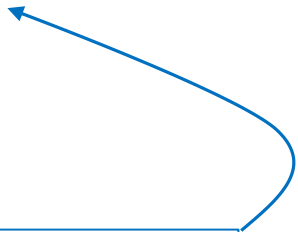
quifra90 13355 13330 0 09:21 ? 00:00:00 sshd: quifra90@pts/8
quifra90 13356 13355 0 09:21 pts/8 00:00:00 -bash
apache 13456 2036 0 09:24 ? 00:00:00 /usr/sbin/httpd
apache 13458 2036 0 09:24 ? 00:00:00 /usr/sbin/httpd
apache 13459 2036 0 09:24 ? 00:00:00 /usr/sbin/httpd
smimat90 13548 13014 0 09:28 pts/7 00:00:00 man grep
smimat90 13551 13548 0 09:28 pts/7 00:00:00 sh -c (cd "/usr/share/man" && (e
smimat90 13552 13551 0 09:28 pts/7 00:00:00 sh -c (cd "/usr/share/man" && (e
smimat90 13557 13552 0 09:28 pts/7 00:00:00 /usr/bin/less -is
simben90 13640 11424 0 09:30 pts/3 00:00:00 ps -ef
tinsam90 14869 1 0 Sep09 ? 00:00:00 SCREEN
tinsam90 14870 14869 0 Sep09 pts/20 00:00:00 /bin/bash
tinsam90 14886 14869 0 Sep09 pts/21 00:00:00 /bin/bash
tinsam90 14932 14869 0 Sep09 pts/23 00:00:00 /bin/bash
root 15152 414 0 Sep30 ? 00:00:00 /sbin/udevd -d
root 15153 414 0 Sep30 ? 00:00:00 /sbin/udevd -d
root 18067 1 0 Sep25 ? 00:00:04 /usr/sbin/sshd
root 18962 2 0 Sep09 ? 00:00:00 [bluetooth]
ntp 25613 1 0 Sep29 ? 00:00:16 ntpd -u ntp:ntp -p /var/run/ntpd
apache 32671 2036 0 Nov02 ? 00:01:37 /usr/sbin/httpd
apache 32674 2036 0 Nov02 ? 00:01:34 /usr/sbin/httpd
apache 32675 2036 0 Nov02 ? 00:01:35 /usr/sbin/httpd
apache 32676 2036 0 Nov02 ? 00:01:34 /usr/sbin/httpd
apache 32677 2036 0 Nov02 ? 00:01:35 /usr/sbin/httpd
apache 32678 2036 0 Nov02 ? 00:01:33 /usr/sbin/httpd
apache 32679 2036 0 Nov02 ? 00:01:34 /usr/sbin/httpd
apache 32680 2036 0 Nov02 ? 00:01:36 /usr/sbin/httpd

```



Job Control


```
find / -user simben90 2> /dev/null
```



Some commands, like the one we used in Lab 7, take a long time to complete. Until it finishes you can't type any more commands!

*It is running in the **foreground***

Job Control

A feature of the bash shell

Foreground processes

- Processes that receive their input and write their output to the terminal.
- The parent shell waits on these processes to die.

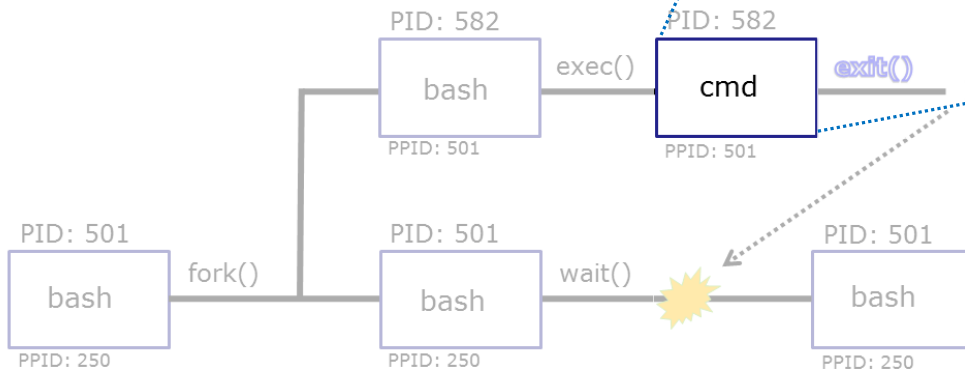
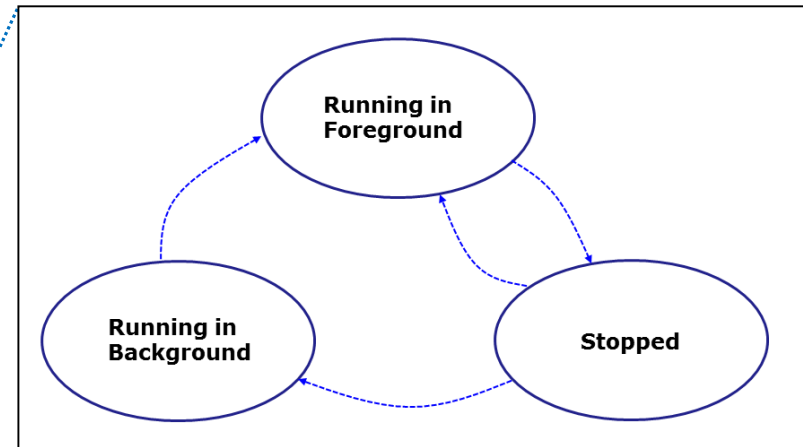
Background Processes

- Processes that do not get their input from a user keyboard.
- The parent shell does not wait on these processes; it re-prompts the user for next command.

Job Control

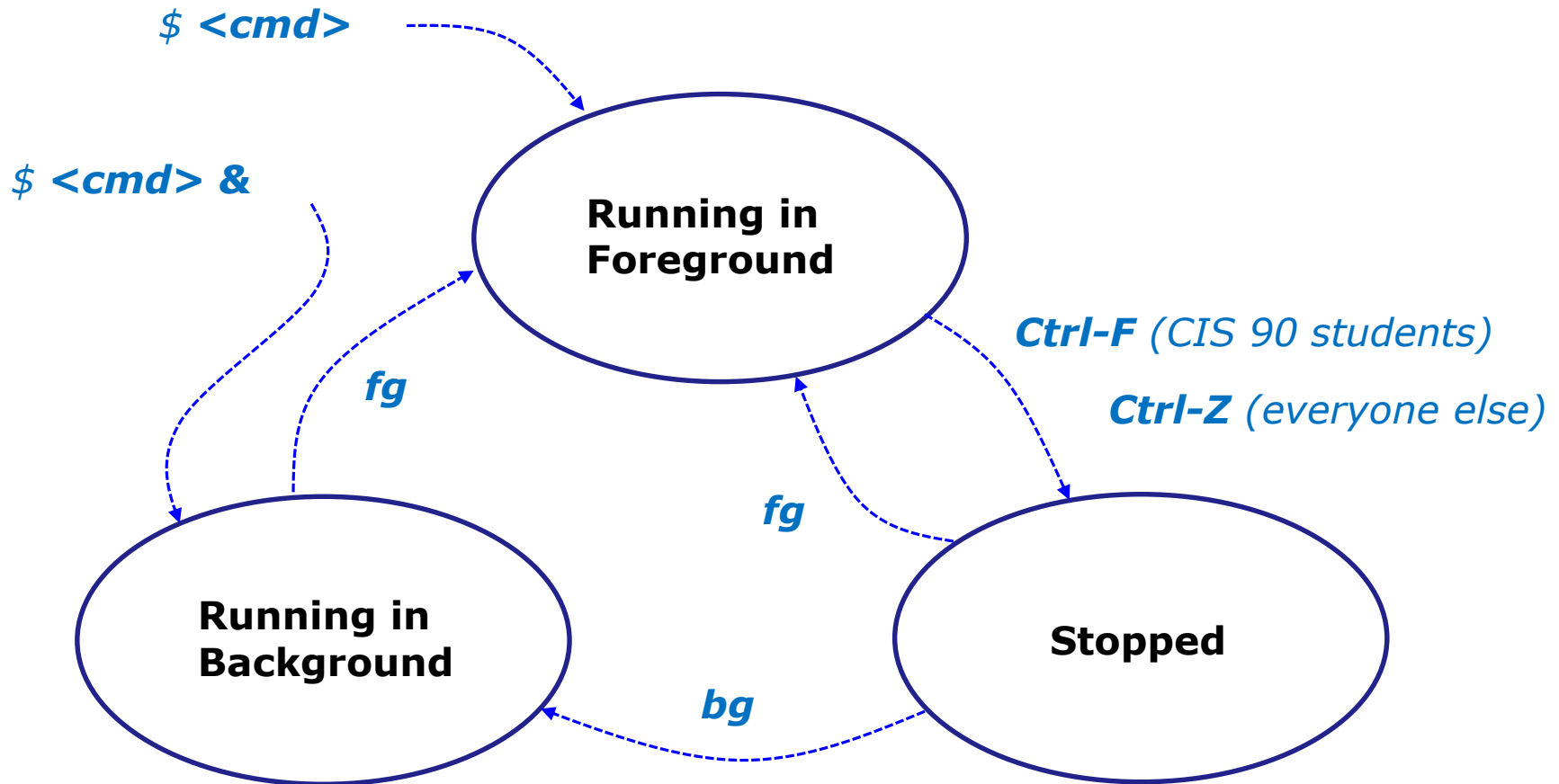
A feature of the bash shell

When a process is **running** the user can **stop** it and choose whether it runs in the **background** or **foreground**



Job Control

A feature of the bash shell



Use the **jobs** command to view
stopped and background jobs

Job Control

Suspending and Resuming

Ctrl-F

- Stops (suspends) a foreground process by sending it a "TTY Stop" (SIGTSTP) signal

Note, CIS 90 students will be using Ctrl-F which has been configured in their shell environment. Normally Ctrl-Z is used.

bg

- resumes the currently suspended process and runs it in the background

Job Control

Keyboard customization for CIS 90

Ctrl-Z or Ctrl-F

- To send a SIGTSTP signal from the keyboard
- Stops (suspends) a foreground process

```
/home/cis90/simben $ stty -a
```

```
speed 38400 baud; rows 26; columns 78; line = 0;  
intr = ^C; quit = ^\; erase = ^?; kill = ^U; eof = ^D; eol = <undef>;  
eol2 = <undef>; swch = <undef>; start = ^Q; stop = ^S; susp = ^F; rprnt = ^R;  
werase = ^W; lnext = ^V; flush = ^O; min = 1; time = 0;
```

*CIS 90 accounts use **Ctrl-F***

```
[rsimms@opus ~]$ stty -a
```

```
speed 38400 baud; rows 39; columns 84; line = 0;  
intr = ^C; quit = ^\; erase = ^?; kill = ^U; eof = ^D; eol = <undef>; eol2 = <undef>;  
swch = <undef>; start = ^Q; stop = ^S; susp = ^Z; rprnt = ^R; werase = ^W;  
lnext = ^V; flush = ^O; min = 1; time = 0;
```

*Other Opus accounts use **Ctrl-Z***

The bash shell environment for the CIS 90 accounts was customized to use a different keystroke for sending a SIGTSTP signal

Example - suspending a **find** command

```
$ find / -name "stage[12]" 2> /dev/null
```

Suspend a long find command, then resume it in the background

Running in Foreground

***Ctrl-F** (CIS 90 students)*

***Ctrl-Z** (everyone else)*

Running in Background

Stopped

bg

Example - suspending a **find** command

```
/home/cis90/simben $ find / -name "stage[12]" 2> /dev/null
/home/cis90/bownic/bin/stage1
/home/cis90/bownic/bin/stage2
/home/cis90/zemric/stage1
/home/cis90/zemric/stage2
/home/cis90/boyjef/bin/stage1
/home/cis90/boyjef/bin/stage2
/home/cis90/porrya/bin/stage1
/home/cis90/porrya/bin/stage2
/home/cis90/isoric/stage1
/home/cis90/isoric/stage2
^F
[1]+  Stopped                  find / -name "stage[12]" 2> /dev/null
/home/cis90/simben $
```

Ctrl-F (CIS 90 accounts) or
Ctrl-Z (other accounts) is
tapped to suspend the
find command

*Notice, we can type more commands again after
the find command was stopped*

In the same session we can monitor the find process

*Process ID 25907
(find) is stopped
(status =T)*

```
/home/cis90/simben $ ps -l
F S  UID  PID  PPID  C PRI  NI ADDR SZ WCHAN  TTY          TIME CMD
0 S  1201 11344 11343  0  80   0 -  1315 -          pts/2        00:00:00 bash
0 T  1201 25907 11344  4  80   0 -  1219 -          pts/2        00:00:00 find
0 R  1201 25925 11344  0  80   0 -  1219 -          pts/2        00:00:00 ps
/home/cis90/simben $
```

Example - suspending a **find** command

```
/home/cis90/simben $ bg
[1]+ find / -name "stage[12]" 2> /dev/null &
/home/cis90/simben $ /usr/share/grub/i386-redhat/stage1
/usr/share/grub/i386-redhat/stage2
/boot/grub/stage1
/boot/grub/stage2

[1]+  Exit 1                  find / -name "stage[12]" 2> /dev/null
/home/cis90/simben $
```

bg resumes the find command in the background

Notice, we can't type more commands again in this session until the find command finishes

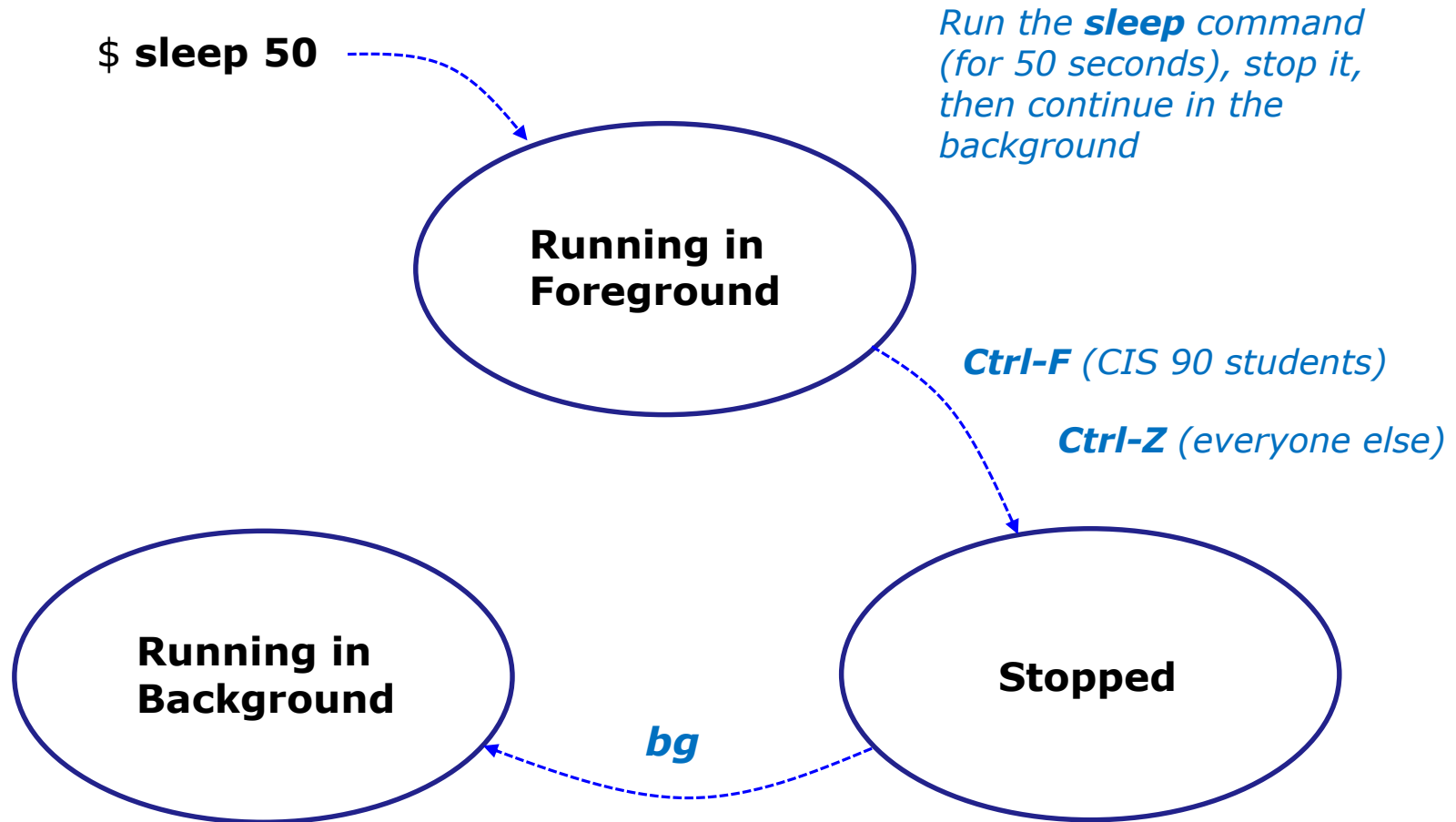
In a different session we can monitor the find process

```
/home/cis90/simben $ ps -l -u simben90
F S   UID    PID   PPID  C PRI  NI ADDR SZ WCHAN  TTY          TIME CMD
5 S   1201  11343 11336  0  80   0 -  3010 ?             ?           00:00:01 sshd
0 S   1201  11344 11343  0  80   0 -  1315 -             pts/2       00:00:00 bash
5 R   1201  11423 11415  0  80   0 -  3200 ?             ?           00:00:01 sshd
0 S   1201  11424 11423  0  80   0 -  1315 -             pts/3       00:00:00 bash
0 R   1201  25907 11344  0  80   0 -  1186 -             pts/2       00:00:01 find
0 R   1201  25956 11424  0  80   0 -  1234 -             pts/3       00:00:00 ps
/home/cis90/simben $
```

*Process ID 25907
(find) is running
(status=R)*

Job Control

Example - suspending a **sleep** command



Job Control

Example - suspending a **sleep** command

```
[rsimms@opus ~]$ sleep 50
```

```
[1]+  Stopped                  sleep 50
[rsimms@opus ~]$
```

Ctrl-F (CIS 90 accounts) or **Ctrl-Z**
(other accounts) is tapped while
sleep is running

PID 25389
(sleep) is
stopped

```
[rsimms@opus ~]$ ps -l -u rsimms
```

F	S	UID	PID	PPID	C	PRI	NI	ADDR	SZ	WCHAN	TTY	TIME	CMD
5	S	201	25055	25044	0	75	0	-	2481	stext	?	00:00:00	sshd
0	S	201	25056	25055	0	76	0	-	1168	-	pts/3	00:00:00	bash
5	S	201	25087	25084	0	75	0	-	2481	stext	?	00:00:00	sshd
0	S	201	25088	25087	0	75	0	-	1168	wait	pts/4	00:00:00	bash
0	T	201	25389	25056	0	76	0	-	929	finish	pts/3	00:00:00	sleep
0	R	201	25391	25088	0	77	0	-	1065	-	pts/4	00:00:00	ps

Job Control

Example - suspending a **sleep** command

```
[rsimms@opus ~]$ bg  
[1]+  sleep 50 &
```

***bg** resumes the sleep
command and it
finishes*

*PID 25389 is
sleeping and
no longer
stopped
(status=S)*

```
[rsimms@opus ~]$ ps -l -u rsimms
```

F	S	UID	PID	PPID	C	PRI	NI	ADDR	SZ	WCHAN	TTY	TIME	CMD
5	S	201	25055	25044	0	75	0	-	2481	stext	?	00:00:00	sshd
0	S	201	25056	25055	0	75	0	-	1168	-	pts/3	00:00:00	bash
5	R	201	25087	25084	0	81	0	-	2481	stext	?	00:00:00	sshd
0	S	201	25088	25087	0	75	0	-	1168	wait	pts/4	00:00:00	bash
0	S	201	25389	25056	0	75	0	-	929	322807	pts/3	00:00:00	sleep
0	R	201	25394	25088	0	77	0	-	1065	-	pts/4	00:00:00	ps

```
[rsimms@opus ~]$
```

Job Control

Additional Control Options

&

- Append to a command to run it in the background

fg

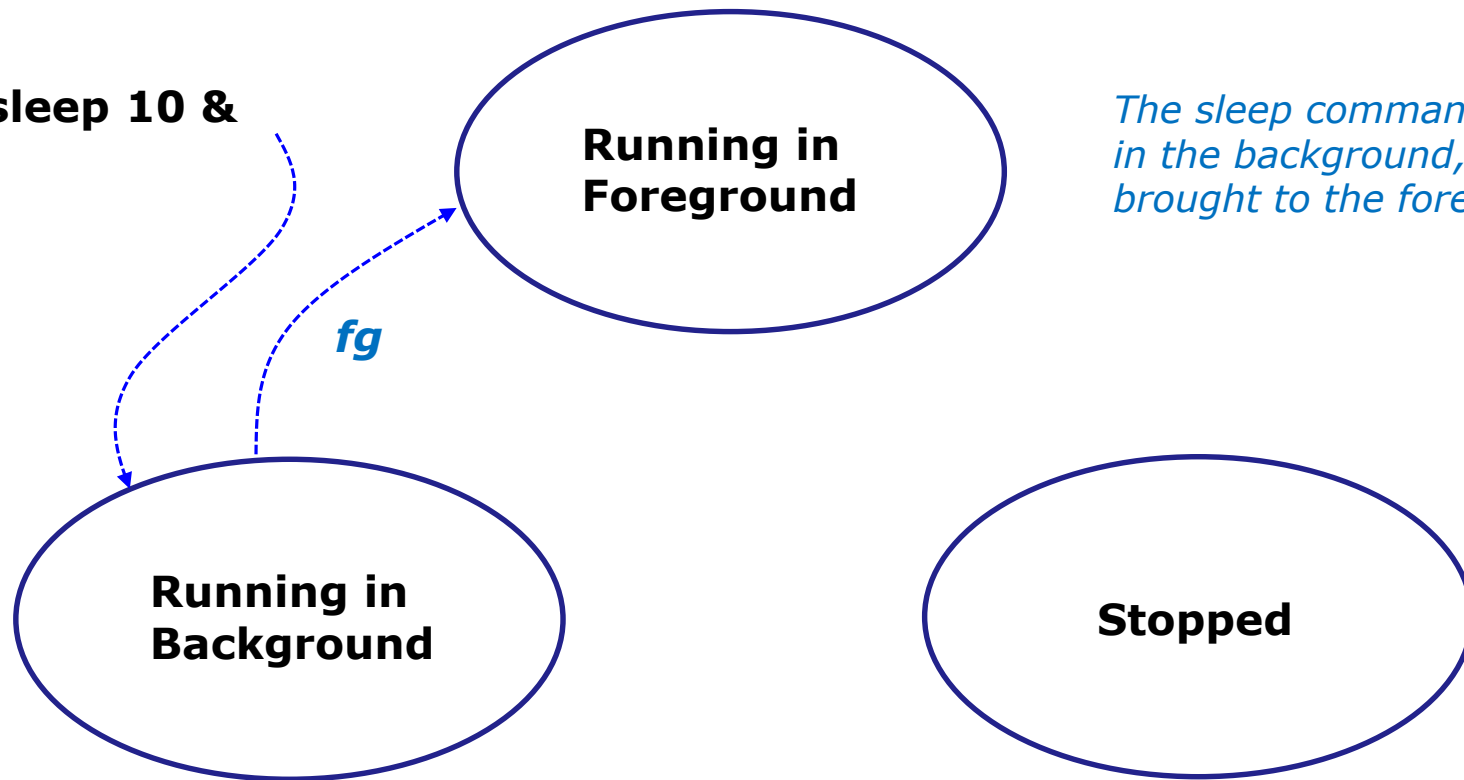
- Brings the most recent background process to the foreground

jobs

- Lists all background jobs

Job Control Example

\$ **sleep 10 &**



The sleep command is started in the background, then brought to the foreground

Job Control Example

```
[rsimms@opus ~]$ sleep 10 &  
[1] 7761  
[rsimms@opus ~]$ jobs  
[1]+  Running                  sleep 10 &  
[rsimms@opus ~]$ fg  
sleep 10
```

*The **&** has **sleep** run in the background and jobs shows the shows it as the one and only background job*

*After **fg**, sleep now runs in the foreground. The prompt is gone. Need to wait until **sleep** finishes for prompt to return.*

```
[rsimms@opus ~]$  
[rsimms@opus ~]$
```

***&** is often used when running GUI tools like **firefox** or **wireshark** from the command line. This allows you to keep using the terminal for more commands while those applications run.*

Signals

Signals

PLATE 4

COMMERCIAL CODE SIGNALS

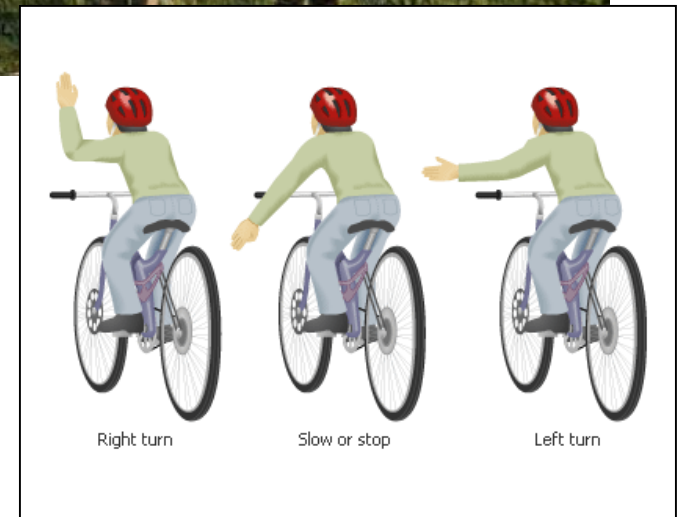
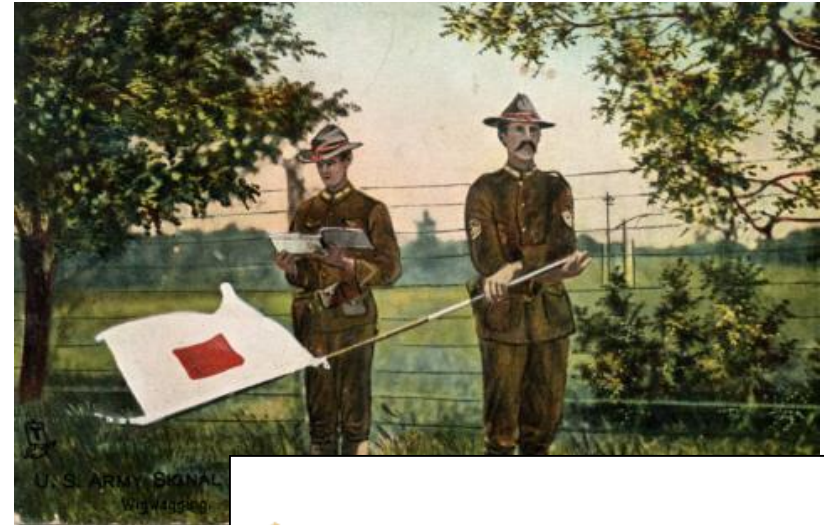
EXAMPLES OF THE SEVERAL HOISTS

WHICH CAN BE MADE HAVING TWO, THREE, OR FOUR FLAGS.

When a word contains two letters of the same name, the second time of its occurrence it must begin or be in the 2nd Hoist; and on its 3rd occurrence, it must begin or be in the 3rd Hoist.

URGENT & IMPORTANT SIGNALS		COMPASS SIGNALS		3 FLAGS	
CODE FLAG OVER 1 FLAG OR 2 FLAG SIGNALS					
CODE FLAG	A	A	Q	A	K
P	C	E		X	
"I Am about to Sail"	"Do Not"	N 1/2 E		S 57° W	
LATITUDE & LONGITUDE SIGNALS		CODE FLAG OVER 2 FLAGS		GENERAL SIGNAL	
CODE FLAG	Q	CODE FLAG	Q		
A	OR H	E	OR Y		
O	X	H	Z		
12° Latitude	North Latitude	23° Longitude	East Longitude		
NUMERAL TABLE		GENERAL VOCABULARY		GEOGRAPHICAL SIGNALS ALPHABETICAL ORDER	
CODE FLAG UNDER 2 FLAGS		3 FLAG SIGNAL		4 FLAG SIGNAL	
Y	I		A		
S	X		E		
CODE FLAG	K		Y		
10,000	Tons of Coal		Z		
ALPHABETICAL SPELLING TABLE		NAMES OF VESSELS FROM CODE LIST		4 FLAG SIGNAL	
SPELLING SIGNAL	4 FLAG SIGNALS				
J	C	C	S	H	
O	B	D	F	C	
H	N	P		L	
N				B	
John	Abb	off			
				Glasgow, Scotland.	
				Graysa of Glasgow 1058 Tons N° 52636	

1, 2, 3 OR 4 FLAG SIGNALS



Signals

Signals are asynchronous messages sent to processes



Asynchronous means it can happen at any time

Signals

Signals are asynchronous messages sent to processes

They can result in one of three courses of action:

1. be ignored,
2. default action (die)
3. execute some predefined function.

Signals are sent:

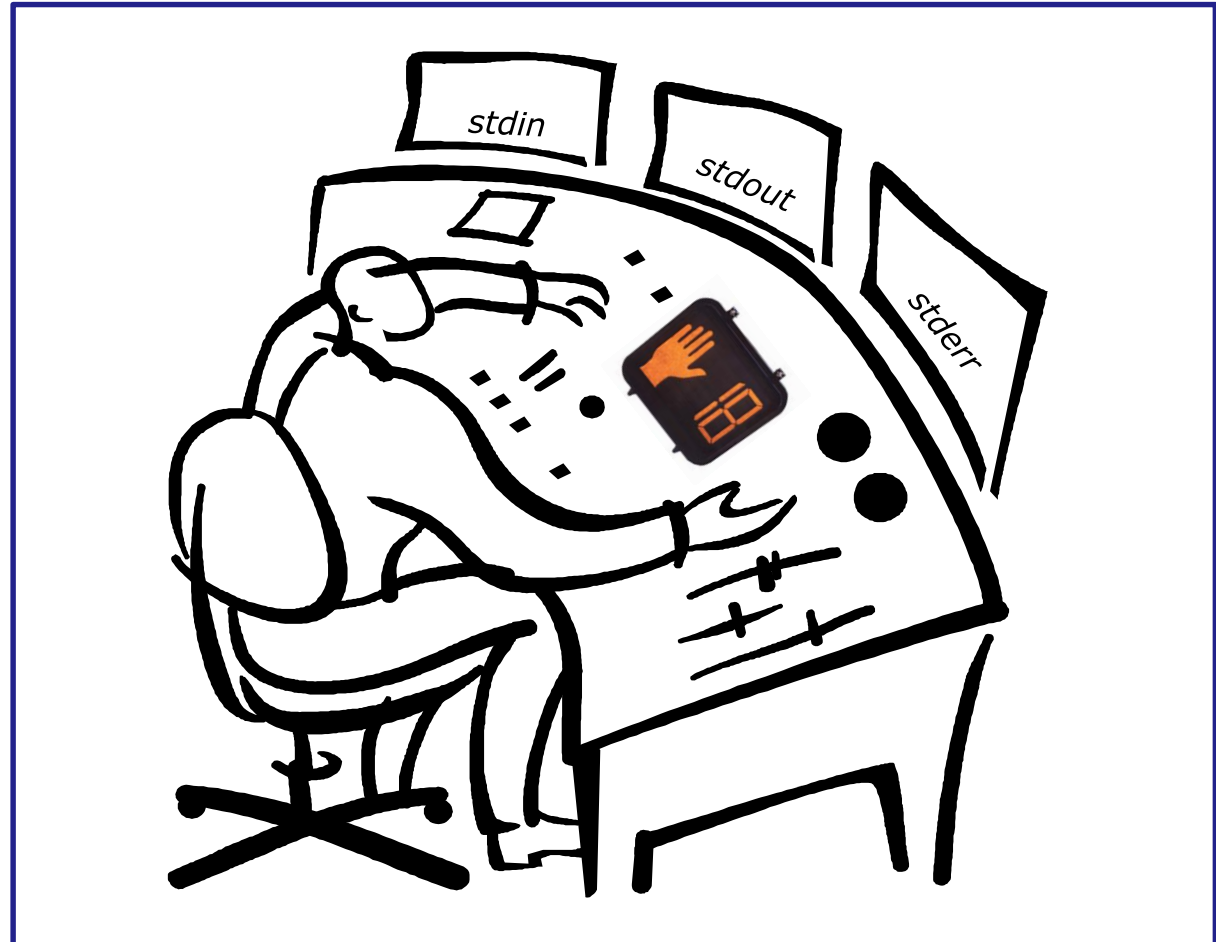
- Using the **kill** command: `$ kill -# PID`
 - Where `#` is the signal number and PID is the process id.
 - if no signal number is specified, SIGTERM is sent.
- Using special **keystrokes** (e.g. Ctrl-Z for SIGTSTP/20)
 - limited to just a few signals
 - sent to the process running in the foreground

Use `kill -l` to see all signals

If you are stuck on the final exam trying to figure out how to send a signal to a process you have come to the right place! :)

Signals

Signals are asynchronous messages sent to processes



Running process gets a signal



Tools for your toolbox



kill - send signal to process (by PID)



killall - send signal to process (by name)

kill command

Basic syntax

(see man page for the rest of the story)

kill *<signal>* *<PID>*

Examples

kill -s sigquit 14151 *(Send signal SIGQUIT/3 to process 14151)*

kill -s 3 14151 *(Send signal SIGQUIT/3 to process 14151)*

kill -3 14151 *(Send signal SIGQUIT/3 to process 14151)*

kill -9 14151 *(Send signal SIGKILL/9 to process 14151)*

kill -l *(list all signal numbers)*

killall command

Basic syntax

(see man page for the rest of the story)

killall *<signal>* *<process>*

Examples

killall -s sigquit app *(Send signal 3 to process named app)*

killall -s 3 app *(Send signal 3 to process named app)*

killall -3 app *(Send signal 3 to process named app)*

killall -9 app *(Send signal 9 to process named app)*

Signals

Use kill -l to see all signals

```
/home/cis90/rodduk $ kill -l
```

1) SIGHUP	2) SIGINT	3) SIGQUIT	4) SIGILL
5) SIGTRAP	6) SIGABRT	7) SIGBUS	8) SIGFPE
9) SIGKILL	10) SIGUSR1	11) SIGSEGV	12) SIGUSR2
13) SIGPIPE	14) SIGALRM	15) SIGTERM	16) SIGSTKFLT
17) SIGCHLD	18) SIGCONT	19) SIGSTOP	20) SIGTSTP
21) SIGTTIN	22) SIGTTOU	23) SIGURG	24) SIGXCPU
25) SIGXFSZ	26) SIGVTALRM	27) SIGPROF	28) SIGWINCH
29) SIGIO	30) SIGPWR	31) SIGSYS	34) SIGRTMIN
35) SIGRTMIN+1	36) SIGRTMIN+2	37) SIGRTMIN+3	38) SIGRTMIN+4
39) SIGRTMIN+5	40) SIGRTMIN+6	41) SIGRTMIN+7	42) SIGRTMIN+8
43) SIGRTMIN+9	44) SIGRTMIN+10	45) SIGRTMIN+11	46) SIGRTMIN+12
47) SIGRTMIN+13	48) SIGRTMIN+14	49) SIGRTMIN+15	50) SIGRTMAX-14
51) SIGRTMAX-13	52) SIGRTMAX-12	53) SIGRTMAX-11	54) SIGRTMAX-10
55) SIGRTMAX-9	56) SIGRTMAX-8	57) SIGRTMAX-7	58) SIGRTMAX-6
59) SIGRTMAX-5	60) SIGRTMAX-4	61) SIGRTMAX-3	62) SIGRTMAX-2
63) SIGRTMAX-1	64) SIGRTMAX		

```
/home/cis90/rodduk $
```

Signals

SIGHUP	1	Hangup (POSIX)
SIGINT	2	Terminal interrupt (ANSI) Ctrl-C
SIGQUIT	3	Terminal quit (POSIX) Ctrl-\
SIGILL	4	Illegal instruction (ANSI)
SIGTRAP	5	Trace trap (POSIX)
SIGIOT	6	IOT Trap (4.2 BSD)
SIGBUS	7	BUS error (4.2 BSD)
SIGFPE	8	Floating point exception (ANSI)
SIGKILL	9	Kill (can't be caught or ignored) (POSIX)
SIGUSR1	10	User defined signal 1 (POSIX)
SIGSEGV	11	Invalid memory segment access (ANSI)
SIGUSR2	12	User defined signal 2 (POSIX)
SIGPIPE	13	Write on a pipe with no reader, Broken pipe (POSIX)
SIGALRM	14	Alarm clock (POSIX)
SIGTERM	15	Termination (ANSI) (default kill signal when not specified)

Signals

SIGSTKFLT	16	Stack fault
SIGCHLD	17	Child process has stopped or exited, changed (POSIX)
SIGCONT	18	Continue executing, if stopped (POSIX)
SIGSTOP	19	Stop executing(can't be caught or ignored) (POSIX)
SIGTSTP	20	Terminal stop signal (POSIX) Ctrl-Z or Ctrl-F
SIGTTIN	21	Background process trying to read, from TTY (POSIX)
SIGTTOU	22	Background process trying to write, to TTY (POSIX)
SIGURG	23	Urgent condition on socket (4.2 BSD)
SIGXCPU	24	CPU limit exceeded (4.2 BSD)
SIGXFSZ	25	File size limit exceeded (4.2 BSD)
SIGVTALRM	26	Virtual alarm clock (4.2 BSD)
SIGPROF	27	Profiling alarm clock (4.2 BSD)
SIGWINCH	28	Window size change (4.3 BSD, Sun)
SIGIO	29	I/O now possible (4.2 BSD)
SIGPWR	30	Power failure restart (System V)

Signals

Special keystrokes

```
/home/cis90/rodduk $ stty -a
speed 38400 baud; rows 26; columns 78; line = 0;
intr = ^C; quit = ^\; erase = ^?; kill = ^U; eof = ^D; eol = <undef>;
eol2 = <undef>; swch = <undef>; start = ^Q; stop = ^S; susp = ^F; rprnt = ^R;
werase = ^W; lnext = ^V; flush = ^O; min = 1; time = 0;
```

```
[rsimms@opus ~]$ stty -a
speed 38400 baud; rows 39; columns 84; line = 0;
intr = ^C; quit = ^\; erase = ^?; kill = ^U; eof = ^D; eol = <undef>; eol2 = <undef>;
swch = <undef>; start = ^Q; stop = ^S; susp = ^Z; rprnt = ^R; werase = ^W;
lnext = ^V; flush = ^O; min = 1; time = 0;
```

use Ctrl-C to send a SIGINT/2 "Terminal Interrupt"

or Ctrl-\ to send a SIGQUIT/3 "Terminal Quit"

Signals

Jim's app script

```
rsimms@opus:/home/cis90/depot
#!/bin/sh
#
# app - script to demonstrate use of signals
#
# Usage:  run app with no options or parameters
#
# Send signals to it with keystrokes or kill command
#
# Notes:
# stty -echo stop the display of characters typed
# stty echo makes typed characters visible again
# stty susp ^Z sets suspend keystroke to Ctrl-Z (to stop foreground processes)
# stty susp @ sets suspend character to @ (to stop foreground processes)
#
trap '' 2 #Ignore SIGINT
trap 'echo -n quit it!' 3 #Handle SIGQUIT
trap 'stty echo susp ^Z;echo ee; echo cleanup;exit' 15 #Handle SIGTERM
clear
banner testing
stty -echo susp @
sleep 1
echo one
sleep 1
echo two
sleep 1
echo -n thr
while :
do sleep 1
done
~
```

13,1 All

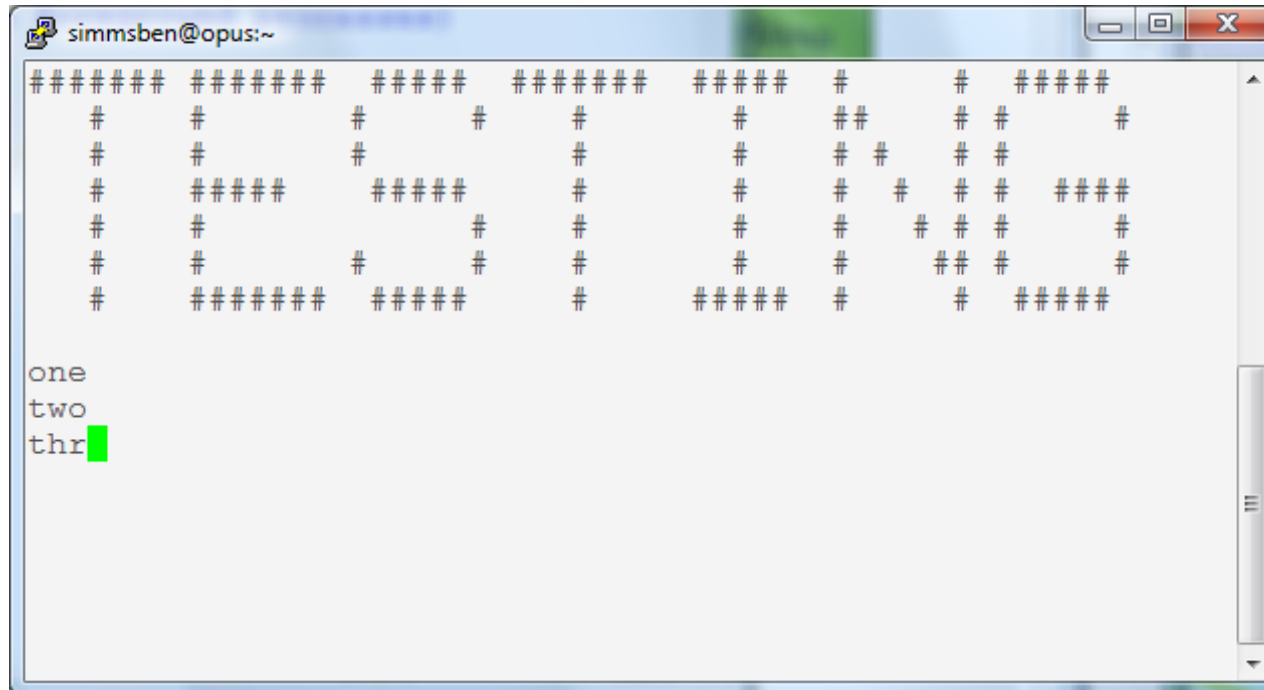
Signals

Class Exercise

- View Jim's script with: **cat bin/app**
- Look for the three trap handlers
 - Signal 2 (SIGINT)
 - Signal 3 (SIGQUIT)
 - Signal 15 (SIGTERM)

Signals

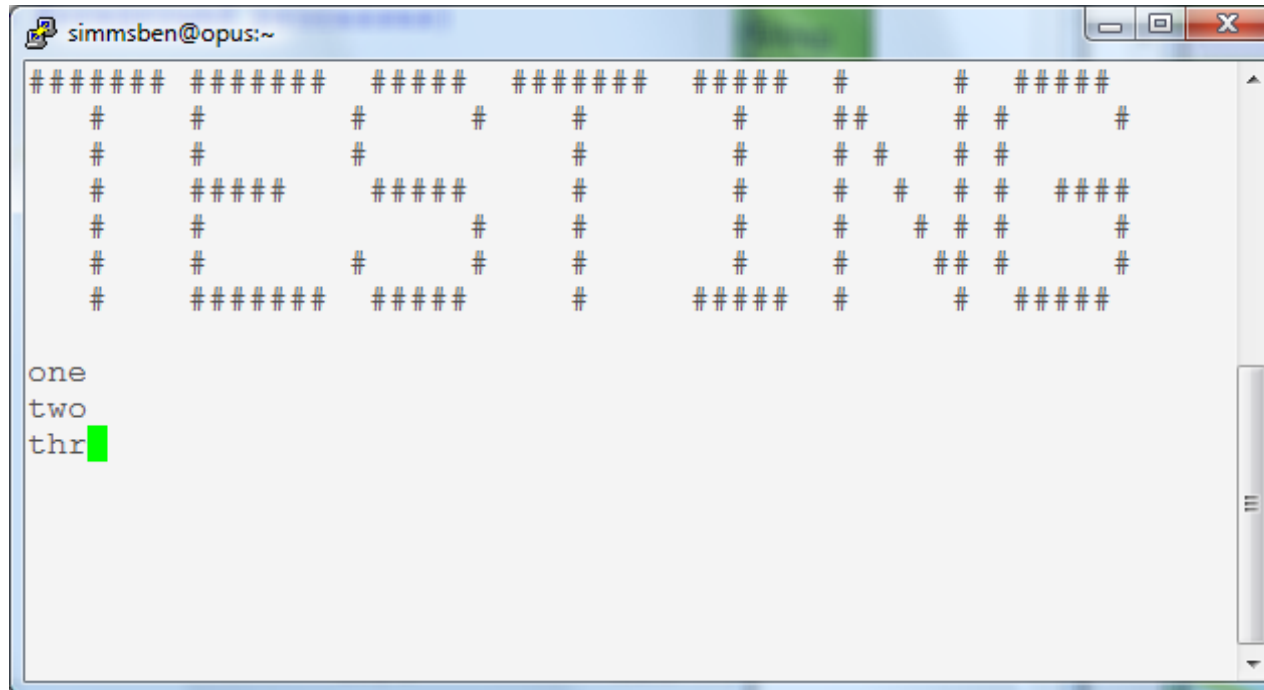
Benji runs app



Benji logs in and runs app ... uh oh, its stuck !

Signals

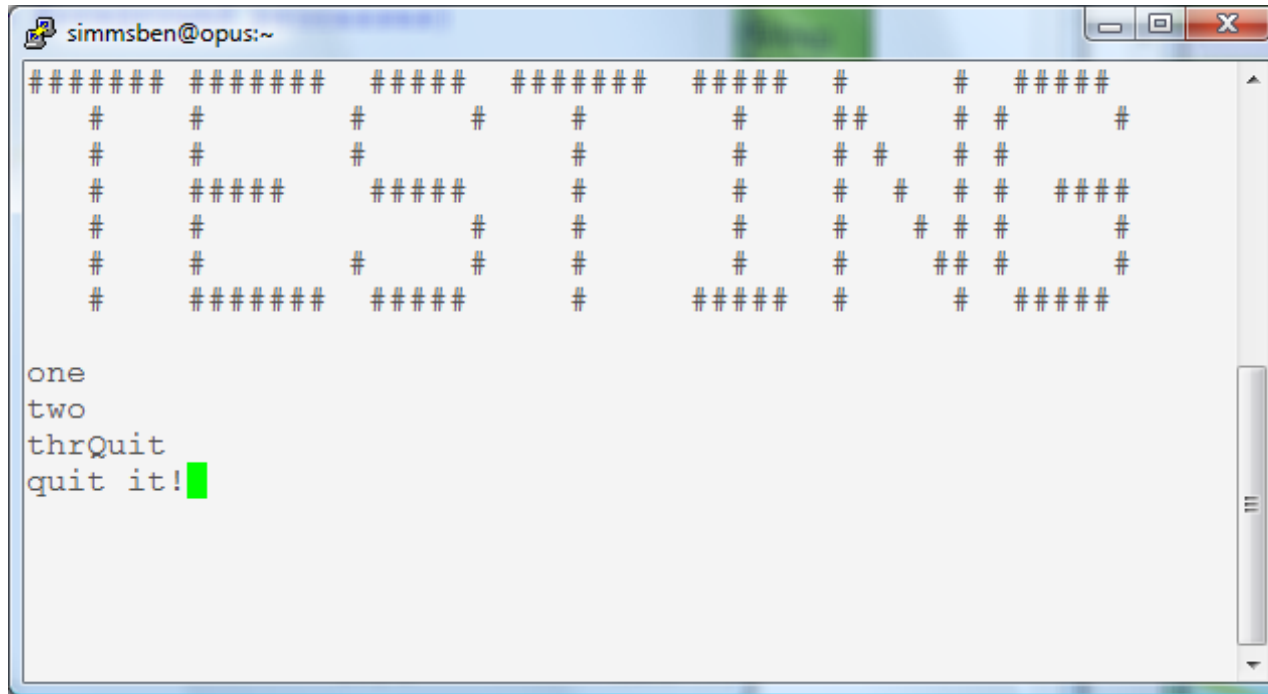
Benji runs app



*Benji tries using the keyboard to send a SIGINT/2 using **Ctrl-C** but nothing happens (because app is ignoring SIGINT)*

Signals

Benji runs app



```
simmsben@opus:~  
#####          #####          #####          #####          #####          #          #          #####  
#          #          #          #          #          #          ##          #          #          #  
#          #          #          #          #          #          #          #          #          #  
#          #####          #####          #          #          #          #          #          #####  
#          #          #          #          #          #          #          #          #          #  
#          #          #          #          #          #          #          #          #          #  
#          #####          #####          #          #####          #          #          #####  
  
one  
two  
thrQuit  
quit it!█
```

*Benji tries using the keyboard to send a SIGQUIT/3 using **Ctrl-** but app reacts by saying "quit it"*

Signals

Benji runs app



```
rododyduk@opus:~  
/home/cis90/rododyduk $ ps -u simmsben  
  PID TTY          TIME CMD  
 6657 ?            00:00:00 sshd  
 6658 pts/1        00:00:00 bash  
 7033 ?            00:00:00 sshd  
 7034 pts/2        00:00:00 bash  
 7065 pts/2        00:00:00 app  
 7579 pts/2        00:00:00 sleep  
/home/cis90/rododyduk $ kill 7065  
-bash: kill: (7065) - Operation not permitted  
/home/cis90/rododyduk $
```

*Benji asks his friend Duke to kill off his stalled app process. Duke uses **ps** to look it up but does not have permission to kill it off*

Signals

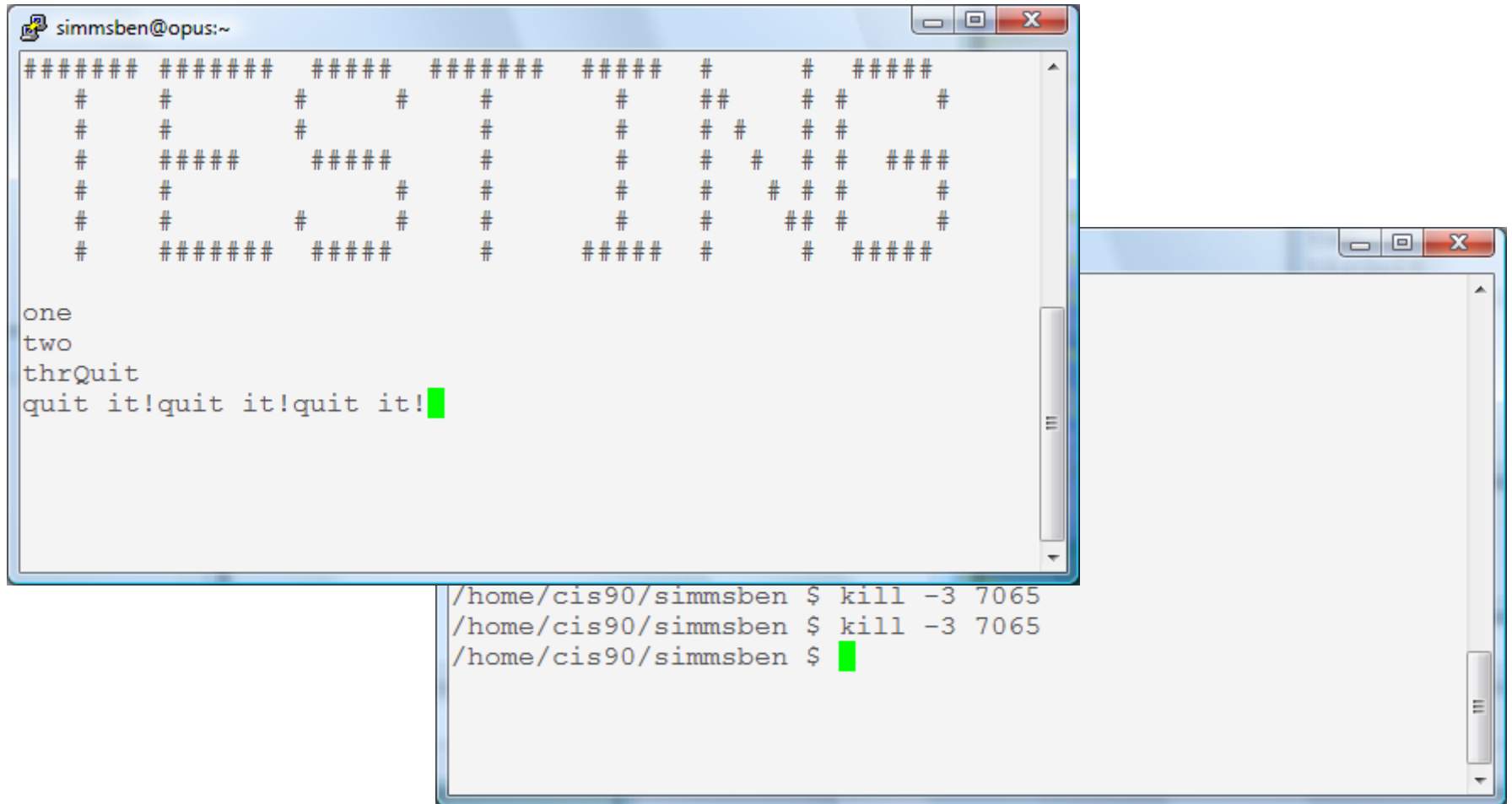
Benji runs app

[illegible]

*Benji logs into another Putty session and sends a SIGINT/2 using the **kill** command but nothing happens*

Signals

Benji runs app



```
simmsben@opus:~  
#####  
#           #           #           #           #           #           #           #  
#           #           #           #           #           #           #           #  
#           #           #           #           #           #           #           #  
#           #           #           #           #           #           #           #  
#           #           #           #           #           #           #           #  
#           #           #           #           #           #           #           #  
#####  
  
one  
two  
thrQuit  
quit it!quit it!quit it!█  
  
/home/cis90/simmsben $ kill -3 7065  
/home/cis90/simmsben $ kill -3 7065  
/home/cis90/simmsben $ █
```



Benji ups the anty and sends two SIGQUIT/3's but the app process shrugs them off with "quit it!" messages

Signals

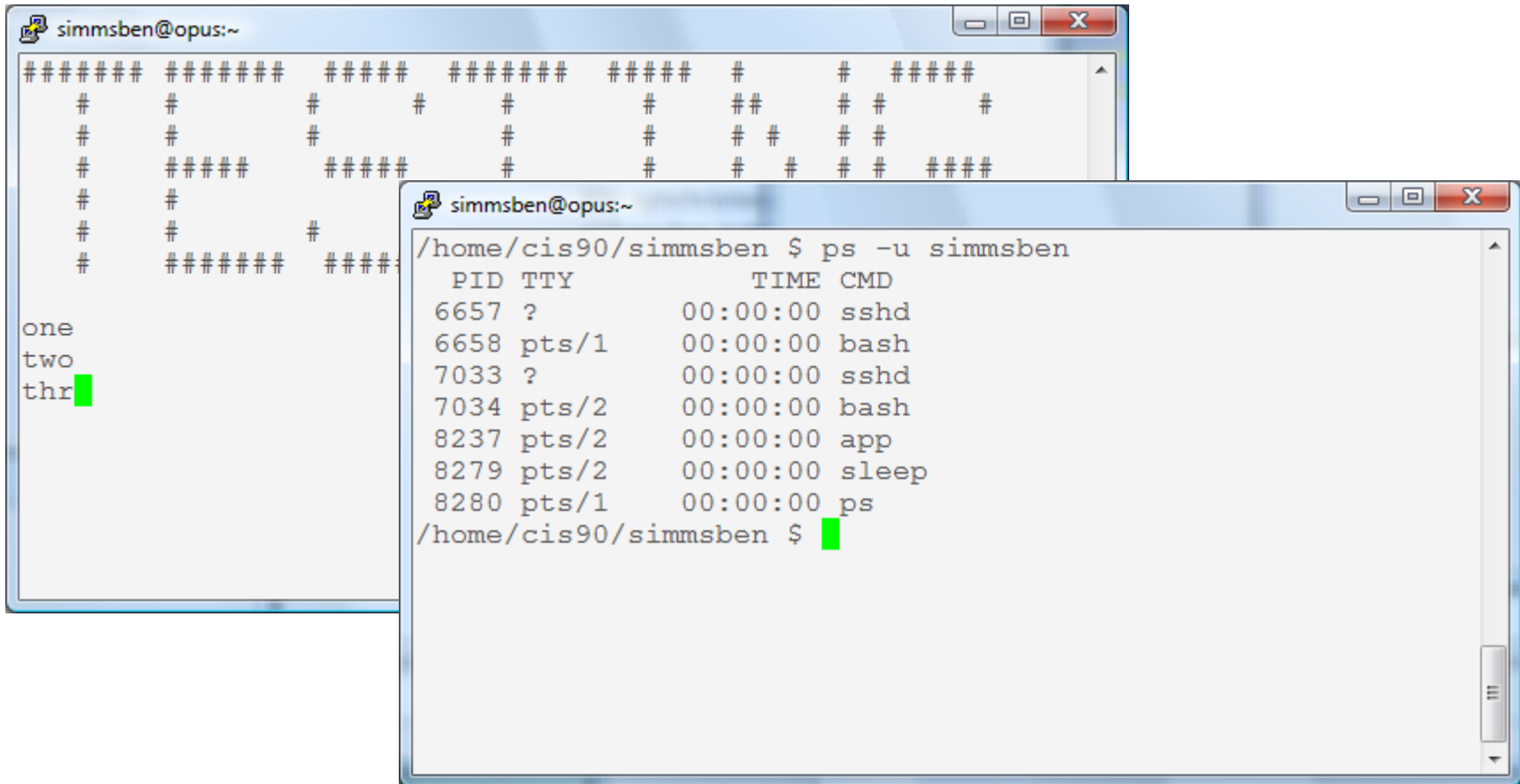
Benji runs app

[illegible]

Benji decides to send a SIGTERM/15 this time and the app process finishes, cleans up and exits

Signals

Benji runs app



```

simmsben@opus:~
#####
# # # # #
# # # # #
# #####
# #
# #
# #####
# #####

one
two
thr

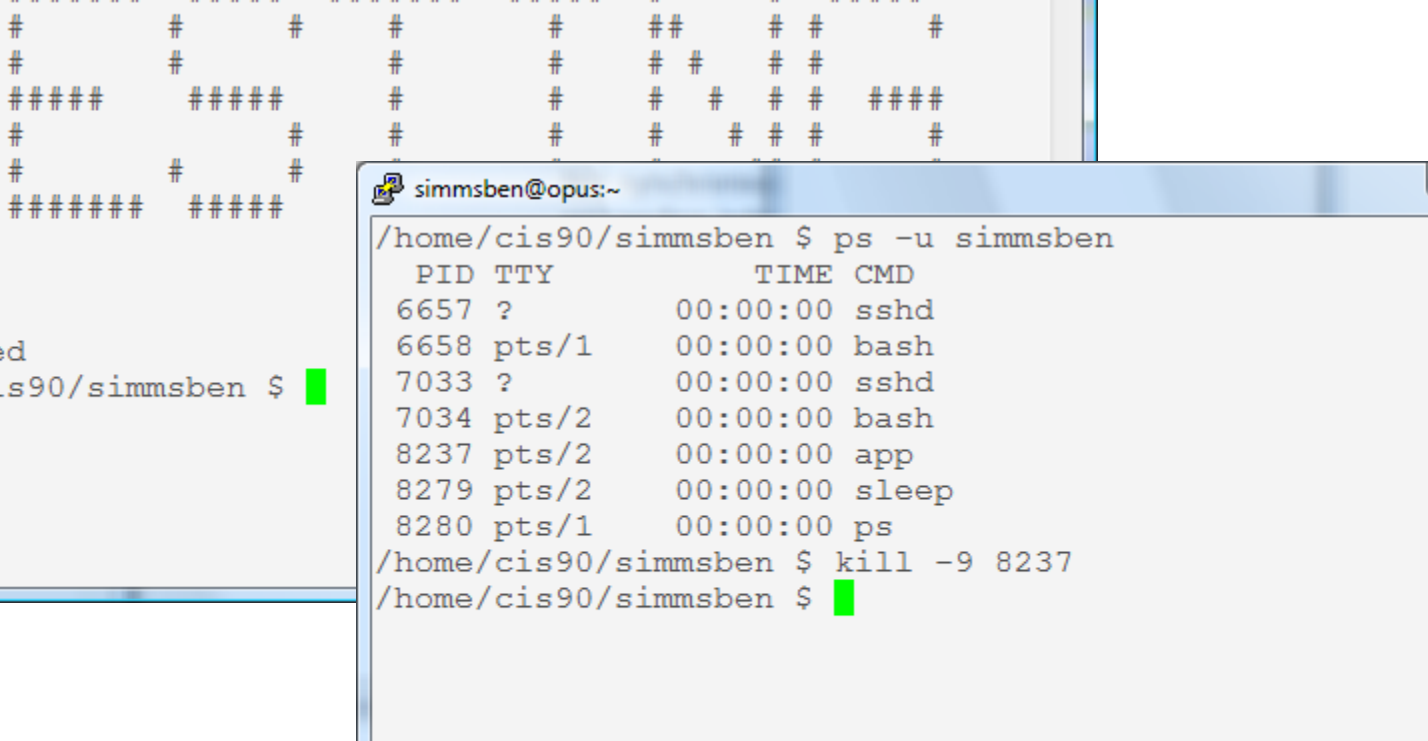
/home/cis90/simmsben $ ps -u simmsben
  PID TTY          TIME CMD
 6657 ?            00:00:00 sshd
 6658 pts/1        00:00:00 bash
 7033 ?            00:00:00 sshd
 7034 pts/2        00:00:00 bash
 8237 pts/2        00:00:00 app
 8279 pts/2        00:00:00 sleep
 8280 pts/1        00:00:00 ps
/home/cis90/simmsben $
  
```



The same thing happens again another day. This time Benji does not care what happens with app ...

Signals

Benji runs app



The image shows two terminal windows. The top window displays a pattern of hash symbols (#) arranged in a grid-like structure, with some lines containing the words 'one', 'two', 'thrKilled', and a prompt. The bottom window shows a terminal session where the user runs 'ps -u simmsben' to list processes, and then 'kill -9 8237' to terminate a process with PID 8237.

```
simmsben@opus:~  
#####  
# # # # # # #  
# # # # # #  
# # # # # #  
# #####  
# # # # #  
# # # # #  
# #####  
# # # # #  
  
one  
two  
thrKilled  
/home/cis90/simmsben $  
  
simmsben@opus:~  
/home/cis90/simmsben $ ps -u simmsben  
PID TTY          TIME CMD  
6657 ?              00:00:00 sshd  
6658 pts/1          00:00:00 bash  
7033 ?              00:00:00 sshd  
7034 pts/2          00:00:00 bash  
8237 pts/2          00:00:00 app  
8279 pts/2          00:00:00 sleep  
8280 pts/1          00:00:00 ps  
/home/cis90/simmsben $ kill -9 8237  
/home/cis90/simmsben $
```



So he sends a SIGKILL/9 this time ... and app never even sees it coming poof ... app is gone

Signals

Class Exercise

- Run app
- Try sending it a SIGINT from the keyboard (Ctrl-C)
- Try sending it a SIGQUIT from the keyboard (Ctrl-\\)
- Login to another Putty session
 - Use the `ps -u $LOGNAME` to find the app PID
 - Send it a SIGINT (`kill -2 PID`)
 - Send it a SIGQUIT (`kill -3 PID`)
 - Now send either a SIGKILL (9) or SIGTERM (15)



Load Balancing (scheduling)

Load Balancing with **at** command

So that the multiprocessing CPU on a UNIX system does not get overloaded, some processes need to be run during low peak hours such as early in the morning or later in the day.

The **at** command reads from **stdin** for a list of commands to run, and begins running them at the time of day specified as the first argument.

Any output sent to **stdout** or **stderr** by the list of commands will be emailed to the user unless redirected elsewhere.



Tools for your toolbox

NEW

at - schedule a job to run in the future

NEW

atq - list queue of pending jobs

NEW

atrm - remove a pending job

at command

Basic syntax

(see man page for the rest of the story)

at <time>

(the at command will then read commands from stdin)

Examples

at 3:00pm wednesday

at> **echo Meet with Sarah | mail -s 'Reminder' simben90**

at> **Ctrl-D**

End of file means no more commands to process

at prompt (you don't type this, the at command does)

at command

Specifying future time examples:

`at now + 5 minutes`

`at now + 2 hours`

`at now + 1 week`

`at 1:00AM`

`at 3:00PM wednesday`

`at 12:00AM 12/25/2014`

`at teatime`

Activity

You try it:

```
/home/cis90/simben $ at now + 1 minute
at> banner Hola Benji
at> <EOT>
job 875 at 2014-11-03 14:11
/home/cis90/simben $ mail
```

Use Ctrl-D for End of File

Then read your mail a minute later

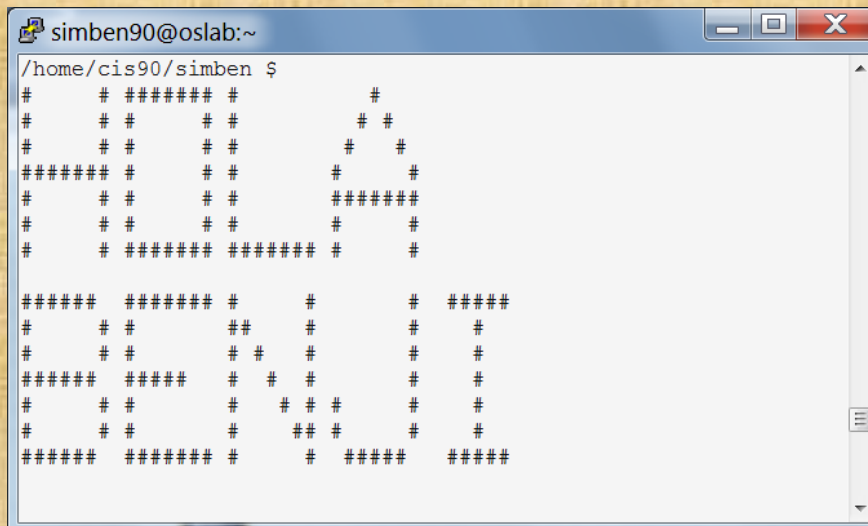
[illegible]

Write in the chat window the name of the sender of the email sent to you

Activity

You try it:

```
/home/cis90/simben $ tty  
/dev/pts/2  
/home/cis90/simben $ at now + 1 minute  
at> echo > /dev/pts/2  
at> banner Hola Benji > /dev/pts/2  
at> <EOT>  
job 873 at 2014-11-03 14:04
```



```
simben90@oslab:~  
/home/cis90/simben $  
# ##### #  
# # # #  
# # # # #  
##### # # #  
# # # # #  
# # # # #  
# # # # #  
# # # # #  
#####  
##### # # # #  
# # # # # #  
# # # # # #  
#####  
# # # # # #  
# # # # # #  
# # # # # #  
#####
```

*Write in the chat window
the reason for doing a echo
command before the
banner command when
writing to the terminal
device*

at examples

```
at 12:00 am wednesday  
  chmod 700 /home/rsimms/turnin
```

```
at 9:00 am wednesday  
  chmod 750 /home/rsimms/turnin
```

```
at 11:59pm  
  cat files.out bigshell > lab08  
  cp lab08 /home/rsimms/turnin/cis90/lab08.$LOGNAME
```

```
at 2:50pm tuesday  
  cp /etc/nologin.bak /etc/nologin  
  shutdown -P +10
```

at job management

```
/home/cis90/simben $ echo chmod 000 letter | at 3:00pm
job 878 at 2014-11-03 15:00
/home/cis90/simben $ echo chmod 644 letter | at 3:05pm
job 879 at 2014-11-03 15:05
/home/cis90/simben $ echo chmod 640 letter | at 1:00am friday
job 880 at 2014-11-07 01:00
```

```
/home/cis90/simben $ atq
879      2014-11-03 15:05 a simben90
880      2014-11-07 01:00 a simben90
878      2014-11-03 15:00 a simben90
```

*The **atq** command lists the queue of pending jobs scheduled to run in the future.*

```
/home/cis90/simben $ atrm 879
/home/cis90/simben $ atq
880      2014-11-07 01:00 a simben90
878      2014-11-03 15:00 a simben90
```

*The **atrm** command is used to remove jobs from the queue.*

```
/home/cis90/simben $ atrm 878 880
/home/cis90/simben $ atq
/home/cis90/simben $
```


at command error handling

```
/home/cis90/simben $ at now + 1 minute  
at> kitty letter  
at> <EOT>  
job 150 at 2011-04-20 10:47
```

*Oops, specified a non-existent
command to run in the future
(**kitty** should have been **cat**)*

```
/home/cis90/simben $ atq  
150      2011-04-20 10:47 a simmsben  
/home/cis90ol/simmsben $ atq
```

```
/home/cis90/simben $ mail  
Mail version 8.1 6/6/93.  Type ? for help.  
"/var/spool/mail/simben": 1 message 1 new  
>N 1 simben@Opus.cabrillo.edu Wed Apr 20 10:47 16/709 "Output from your job "  
& 1  
Message 1:  
From simben@Opus.cabrillo.edu Wed Apr 20 10:47:01 2011  
Date: Wed, 20 Apr 2011 10:47:01 -0700  
From: Benji Simms <simben@Opus.cabrillo.edu>  
Subject: Output from your job 150  
To: simben@Opus.cabrillo.edu
```

*Because, you may not be online
when the command runs, any
error messages are mailed to you.*

```
/bin/bash: line 2: kitty: command not found
```

Viewing an at jobs

```
/home/cis90/simben $ atq
882      2014-11-03 15:05 a simben90
881      2014-11-03 15:00 a simben90
883      2014-11-07 01:00 a simben90
```

```
/home/cis90/simben $ at -c 883
```

```
#!/bin/sh
# atrun uid=1201 gid=190
# mail simben90 0
umask 2
HOSTNAME=cablab.cis.cabrillo.edu; export HOSTNAME
SELINUX_ROLE_REQUESTED=; export SELINUX_ROLE_REQUESTED
SHELL=/bin/bash; export SHELL
HISTSIZE=1000; export HISTSIZE
SSH_CLIENT=2601:9:6680:53b:8d5f:4722:4af4:186e\ 59885\ 2220; export SSH_CLIENT
SELINUX_USE_CURRENT_RANGE=; export SELINUX_USE_CURRENT_RANGE
QTDIR=/usr/lib/qt-3.3; export QTDIR
QTINC=/usr/lib/qt-3.3/include; export QTINC
SSH_TTY=/dev/pts/2; export SSH_TTY
USER=simben90; export USER
LS_COLORS=rs=0:di=01;34:ln=01;36:mh=00:pi=40;33:so=01;35:do=01;35:bd=40;33:01:cd=40;33:01:or=40;31:01:mi=01;05;37;41:sg=30;42:ca=30;41:tw=30;42:ow=34;42:st=37;44;
ex=01;32;*.tar=01;31;*.tgz=01;31;*.arj=01;31;*.taz=01;31;*.lzh=01;31;*.lma=01;31;*.lzo=01;31;*.txz=01;31;*.zip=01;31;*.z=01;31;*.z=01;31;*.d=01;31;*.gz=01;31;*.i
z=01;31;*.xz=01;31;*.bz2=01;31;*.tbz2=01;31;*.bz=01;31;*.bz=01;31;*.deb=01;31;*.rpm=01;31;*.rpm=01;31;*.rar=01;31;*.ace=01;31;*.zoo=01;31;*.cpio=01;31;
*.7z=01;31;*.xz=01;31;*.jpg=01;35;*.jpeg=01;35;*.gif=01;35;*.bmp=01;35;*.pnm=01;35;*.pgm=01;35;*.ppm=01;35;*.tga=01;35;*.xpm=01;35;*.xpm=01;35;*.tif=01;35;*.tiff=01;
35;*.png=01;35;*.svg=01;35;*.svgz=01;35;*.mng=01;35;*.pcx=01;35;*.mov=01;35;*.mpg=01;35;*.mpeg=01;35;*.m2v=01;35;*.mkv=01;35;*.ogm=01;35;*.mp4=01;35;*.m4v=01;35;*.
mp4=01;35;*.vob=01;35;*.qt=01;35;*.nuv=01;35;*.wmv=01;35;*.asf=01;35;*.rm=01;35;*.rmvb=01;35;*.flc=01;35;*.avi=01;35;*.flv=01;35;*.gl=01;35;*.d1=01;35;
*.act=01;35;*.xwd=01;35;*.yuv=01;35;*.cgm=01;35;*.emf=01;35;*.asm=01;35;*.ogv=01;35;*.ogv=01;35;*.aac=01;36;*.aif=01;36;*.mid=01;36;*.midi=0
1;36;*.mka=01;36;*.mp3=01;36;*.mpc=01;36;*.ogg=01;36;*.ra=01;36;*.wav=01;36;*.axa=01;36;*.oga=01;36;*.spx=01;36;*.xspf=01;36; export LS_COLORS
USERNAME=; export USERNAME
MAIL=/var/spool/mail/simben90; export MAIL
PATH=/usr/lib/qt-3.3/bin:/usr/local/bin:/bin:/usr/bin:/usr/local/sbin:/usr/sbin:/sbin:/home/cis90/simben/..bin:/home/cis90/simben/bin:; export PATH
PWD=/home/cis90/simben; export PWD
LANG=en_US.UTF-8; export LANG
SELINUX_LEVEL_REQUESTED=; export SELINUX_LEVEL_REQUESTED
HISTCONTROL=ignoredups; export HISTCONTROL
SHLVL=1; export SHLVL
HOME=/home/cis90/simben; export HOME
BASH_ENV=/home/cis90/simben/.bashrc; export BASH_ENV
LOGNAME=simben90; export LOGNAME
QTLIB=/usr/lib/qt-3.3/lib; export QTLIB
CVS_RSH=ssh; export CVS_RSH
SSH_CONNECTION=2601:9:6680:53b:8d5f:4722:4af4:186e\ 59885\ 2607:f380:80f:f425::230\ 2220; export SSH_CONNECTION
LESSOPEN=|/usr/bin/lesspipe.sh %s; export LESSOPEN
G_BROKEN_FILENAMES=1; export G_BROKEN_FILENAMES
cd /home/cis90/simben || {
    echo 'Execution directory inaccessible' >&2
    exit 1
}
```

Use the -c option to view the contents of an at job

reduced in size to fit on slide

All these environment variables must be set to appropriate values so your commands since you may be no longer logged in

```
${SHELL:-/bin/sh} << 'marcinDELIMITER7acf33a1'
```

```
chmod 640 letter
```

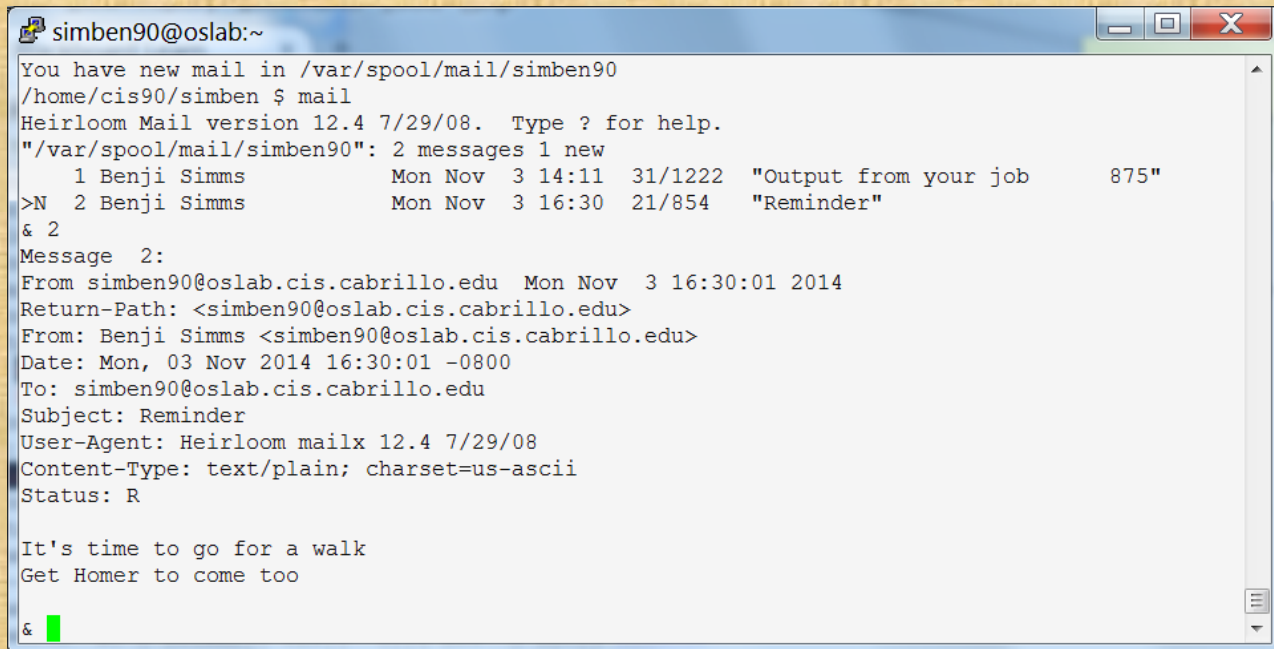
This is where you will see your own commands

```
marcinDELIMITER7acf33a1
/home/cis90/simben $
```

Activity

Schedule an email reminder

```
/home/cis90/simben $ at 16:30
at> echo "It's time to go for a walk" > /tmp/message.benji
at> echo "Get Homer to come too" >> /tmp/message.benji
at> cat /tmp/message.benji | mail -s "Reminder" simben90
at> rm /tmp/message.benji
at> <EOT>
/home/cis90/simben $
```



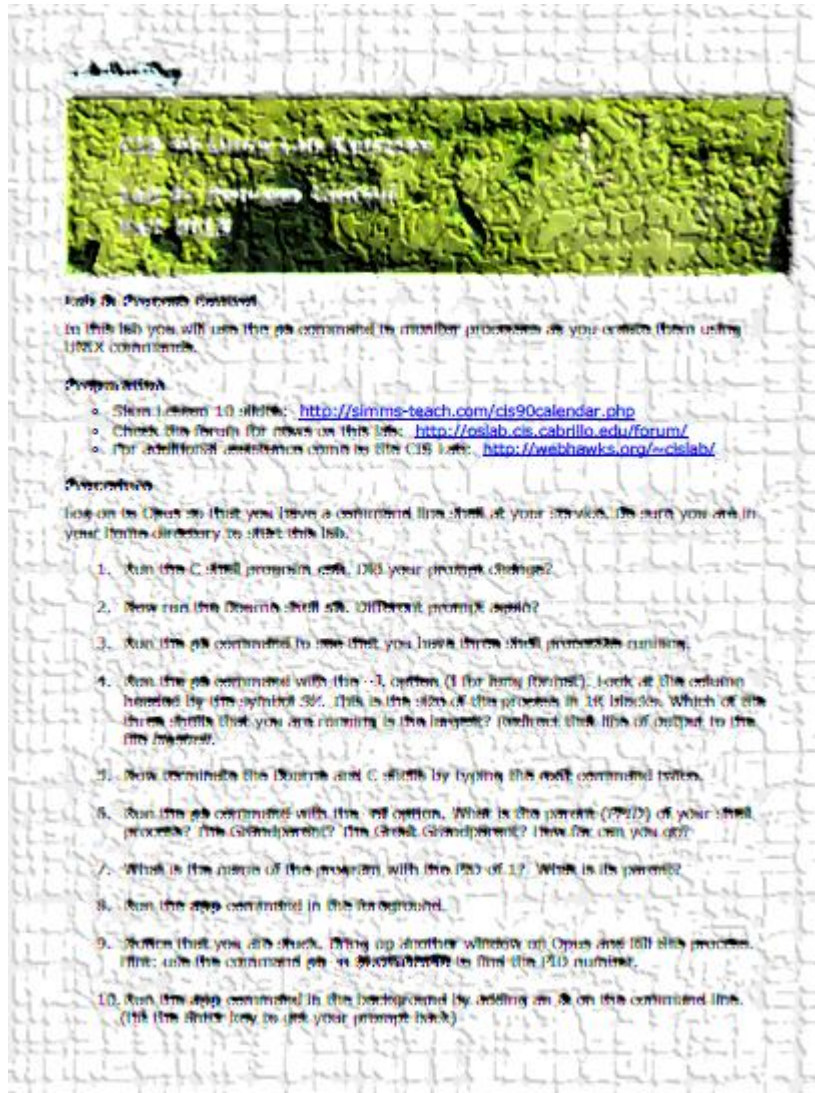
```
simben90@oslab:~
You have new mail in /var/spool/mail/simben90
/home/cis90/simben $ mail
Heirloom Mail version 12.4 7/29/08. Type ? for help.
"/var/spool/mail/simben90": 2 messages 1 new
 1 Benji Simms      Mon Nov  3 14:11  31/1222  "Output from your job      875"
>N 2 Benji Simms      Mon Nov  3 16:30  21/854   "Reminder"
& 2
Message 2:
From: simben90@oslab.cis.cabrillo.edu Mon Nov  3 16:30:01 2014
Return-Path: <simben90@oslab.cis.cabrillo.edu>
From: Benji Simms <simben90@oslab.cis.cabrillo.edu>
Date: Mon, 03 Nov 2014 16:30:01 -0800
To: simben90@oslab.cis.cabrillo.edu
Subject: Reminder
User-Agent: Heirloom mailx 12.4 7/29/08
Content-Type: text/plain; charset=us-ascii
Status: R

It's time to go for a walk
Get Homer to come too

&
```


Assignment





Lab 8: Process Management

In this lab you will use the `ps` command to monitor processes as you create them using UNIX commands.

Prerequisites

- Read Lesson 10 at: <http://simms-teach.com/cis90/calendar.php>
- Check the forum for notes on this lab: <http://oslab.cis.cabrillo.edu/forum/>
- For additional assistance come to the CIS Lab: <http://webhawks.org/~cislab/>

Procedure

Log on to Opus so that you have a confirmed line shell at your service. Be sure you are in your home directory to start this lab.

1. Run the C shell program with the prompt change?
2. Now run the Bourne shell with different prompt again?
3. Run the `ps` command to see that you have three shell processes running.
4. Run the `ps` command with the `-l` option (l for long format). Look at the column headed by the symbol `PPID`. This is the size of the process in 1K blocks. Which of the three shells that you are running is the largest? Redirect the list of output to the file `largest`.
5. Now terminate the Bourne and C shells by typing the `exit` command twice.
6. Run the `ps` command with the `-f` option. What is the parent (`PPID`) of your shell process? The Grandparent? The Great Grandparent? How far can you go?
7. What is the name of the program with the `PID` of 1? What is its parent?
8. Run the `ps` command in the background.
9. Notice that you are stuck. Bring up another window on Opus and kill this process. Hint: use the command `ps -a -o ppid,ppid` to find the `PID` number.
10. Run the `ps` command in the background by adding an `&` on the command line. (Hit the enter key to get your prompt back)

Lab 8

Doesn't take too long but don't wait till the last minute on this lab!

A full-page background image showing a sunset over a beach. The sky is filled with vibrant orange, pink, and purple clouds. The sun is low on the horizon, casting a warm glow. To the right, a dark, silhouetted cliff rises from the beach. The foreground shows the wet sand of the beach reflecting the colors of the sky, with some dark rocks scattered about.

Wrap up

New commands:

Ctrl-Z or F
bg

Suspends a foreground process
Resumes suspended process

&
fg

Runs command in the background
Brings background job to foreground

jobs

show background jobs

kill
killall

Send a signal to a process by PID
Send a signal to a process by name

at
atq
atrm

Run job once in the future
Show all *at* jobs queued to run
Remove *at* jobs from queue

sleep

Sleep for specified amount of time

stty

Terminal control

Next Class

Assignment: Check Calendar Page on web site to see what is due next week.

Lab 8 due

Quiz #8 questions for next class:

- What command shows the current running processes?
- Name four states a process can be in.
- What is the difference between the fork and exec system calls?

Test 2



Notes to instructor

Practice Test System

- [] Start: `echo "/root/unlock-cis90; rm /etc/nologin" | at [T-1wk+1hr]`
- [] End: `echo "/root/lock-cis90; cp /etc/nologin.bak /etc/nologin" | at [T-30]`

Canvas Practice Test:

- [] Publish
- [] availability from = `[T-1wk+1hr]`, due & available until = `[T-30]`
- [] remove password on real test on Canvas `[T-1wk]`
- [] moderate any accommodations

Real Test system

- [] Start: `echo "/root/unlock-cis90; rm /etc/nologin" | at [T-0]`
- [] End: `echo "/root/lock-cis90; cp /etc/nologin.bak /etc/nologin" | at [splashdown]`

Canvas Real Test:

- [] Publish
- [] availability from = `[T-0]`, due & available until = `[splashdown]`
- [] remove password on real test on Canvas `[T-0]`
- [] moderate any accommodations

Test Instructions

HONOR CODE:

This test is open book, open notes, and open computer. HOWEVER, you must work alone. You may not discuss the test questions or answers with others during the test period. You may not ask or receive assistance from anyone other than the instructor when doing this test. Likewise you may not give any assistance to anyone taking the test.

INSTRUCTIONS:

Test system: sun-hwa-t2.cis.cabrillo.edu (port 22)

This test should be completed using the sun-hwa-t2 system only. Because this system is on a private network, log into Opus first, then ssh into sun-hwa-t2.

Grading will be based on your answers AND that you correctly implemented the "DO THIS FIRST" portion of each question.

Highlighted text indicates a portion of a question that differs from the practice test.

If you get stuck on a question and can't proceed you can ask the instructor for help and forfeit the point. The instructor will be available during class and available by email (risimms@cabrillo.edu) later in the evening from 8:00-10:00PM.

Please KEEP YOUR ANSWERS TO A SINGLE LINE ONLY !!

This test must be completed in one sitting. The submittal will be made automatically when the time is up. If you submit early by accident you will not be able to re-enter and continue. If that happens don't panic! Just email the instructor any remaining answers before the time is up.



Test 2

In progress

Backup

umask Review

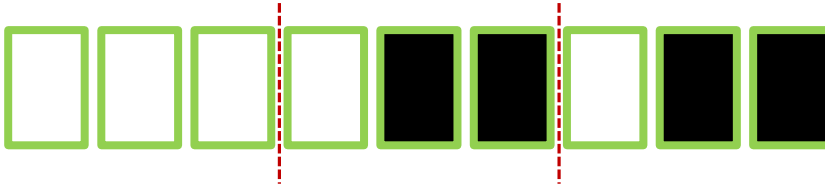
umask summary

- Use the **umask** command to specify the permissions you want stripped from future new files and directories
- Does not change permissions on existing files

To determine permissions on a new file or directory apply the umask to the initial permission starting point:

- For new files, start with **666**
- For new directories, start with **777**
- *For file copies, start with **the permission on the source file being copied***

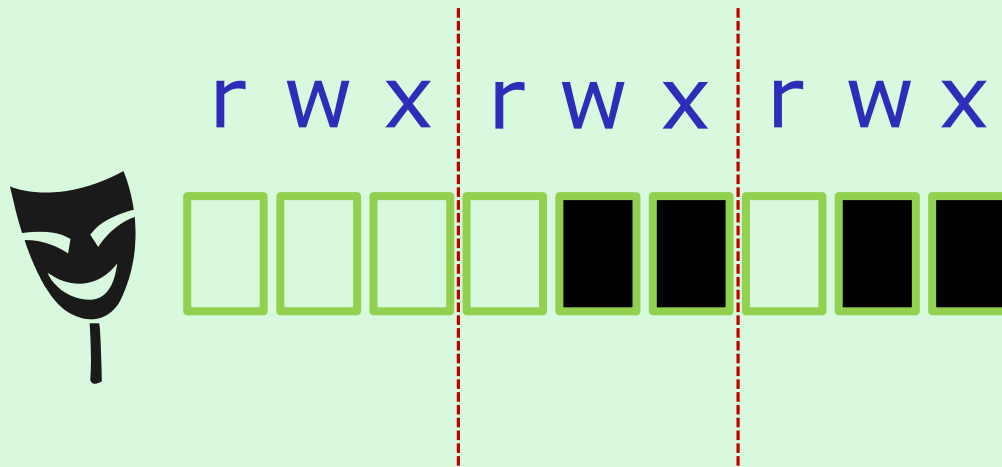
With a umask of 033 what permissions would a newly created directory have?



**umask setting of 033 strips
these bits: --- -wx -wx**

Example 1 - new directory

With a umask of 033 what permissions would a newly created directory have?

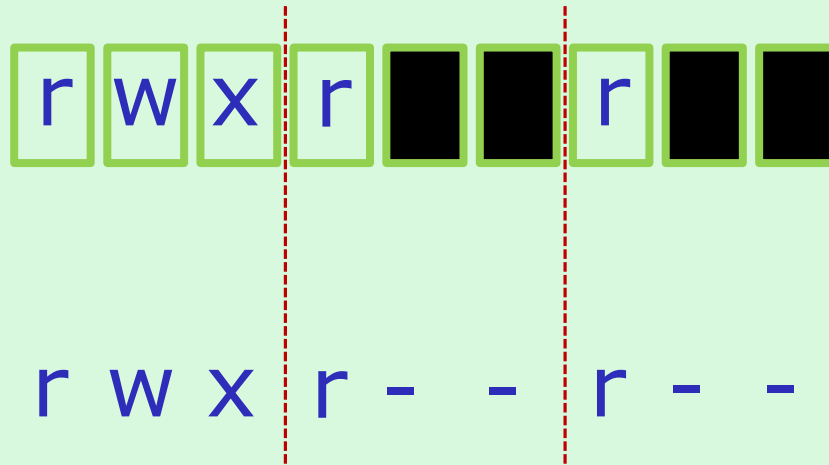


starting point = 777
(new directory)

umask setting of 033 strips
these bits: --- -wx -wx

Example 1 - new directory

With a umask of 033 what permissions would a newly created directory have?



starting point = 777
(new directory)

umask setting of 033 strips
these bits: --- -wx -wx

Answer: 744

Verify your answer on Opus:

```
/home/cis90ol/simmsben $ umask 033
/home/cis90ol/simmsben $ mkdir brandnewdir
/home/cis90ol/simmsben $ ls -ld brandnewdir/
drwxr--r-- 2 simmsben cis90ol 4096 Apr 21 12:46 brandnewdir/
```

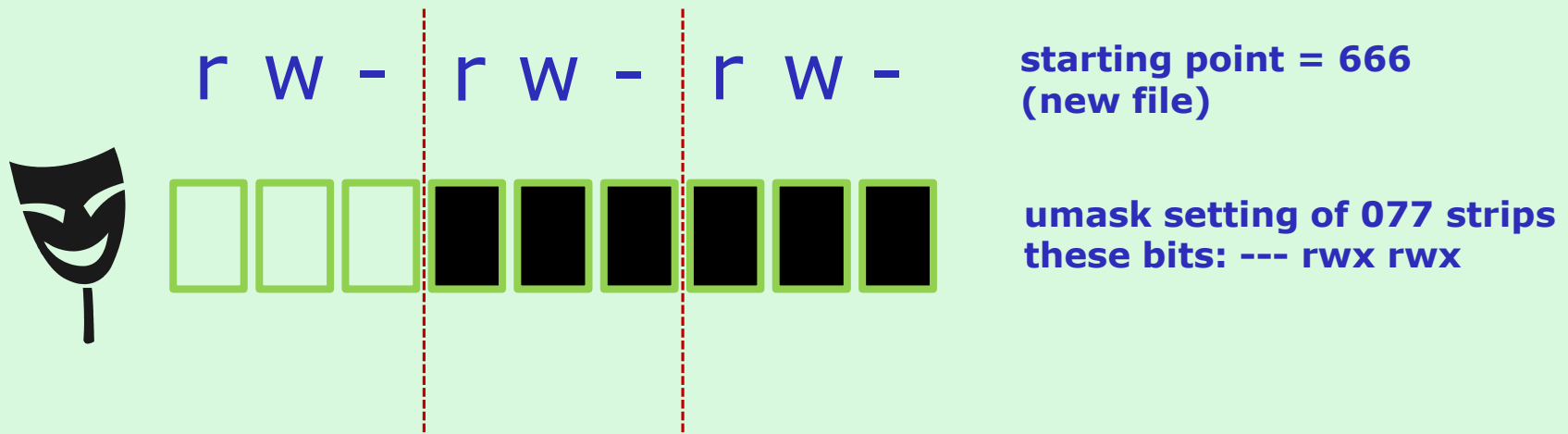
With a umask of 077 what permissions would a newly created file have?



From issuing **umask 077**

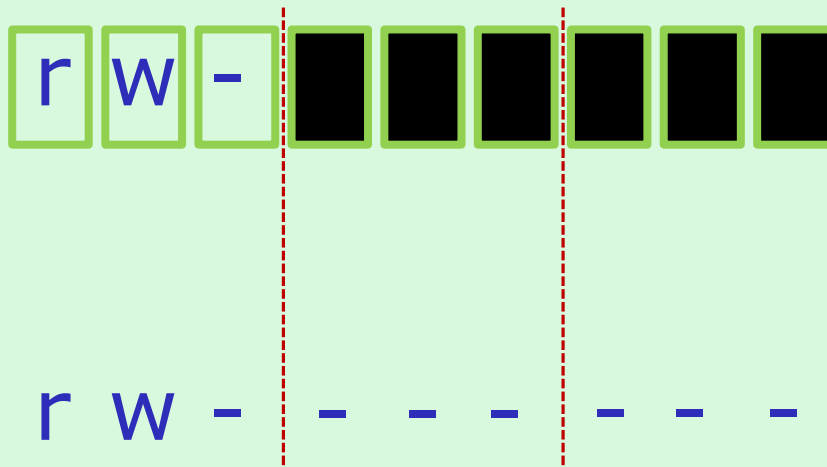
Example 2 - new file

With a umask of 077 what permissions would a newly created file have?



Example 2 - new file

With a umask of 077 what permissions would a newly created file have?



starting point = 666
(new file)

umask setting of 077 strips
these bits: --- rwx rwx

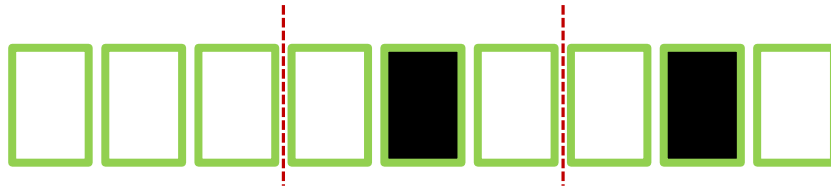
Answer: 600

Verify your answer on Opus:

```
/home/cis90ol/simmsben $ umask 077
/home/cis90ol/simmsben $ touch brandnewfile
/home/cis90ol/simmsben $ ls -l brandnewfile
-rw----- 1 simmsben cis90ol 0 Apr 21 12:50 brandnewfile
```

If `umask=022` and *cinderella* file permissions=`622`

What would the permissions be on the file *cinderella.bak* after:
`cp cinderella cinderella.bak`

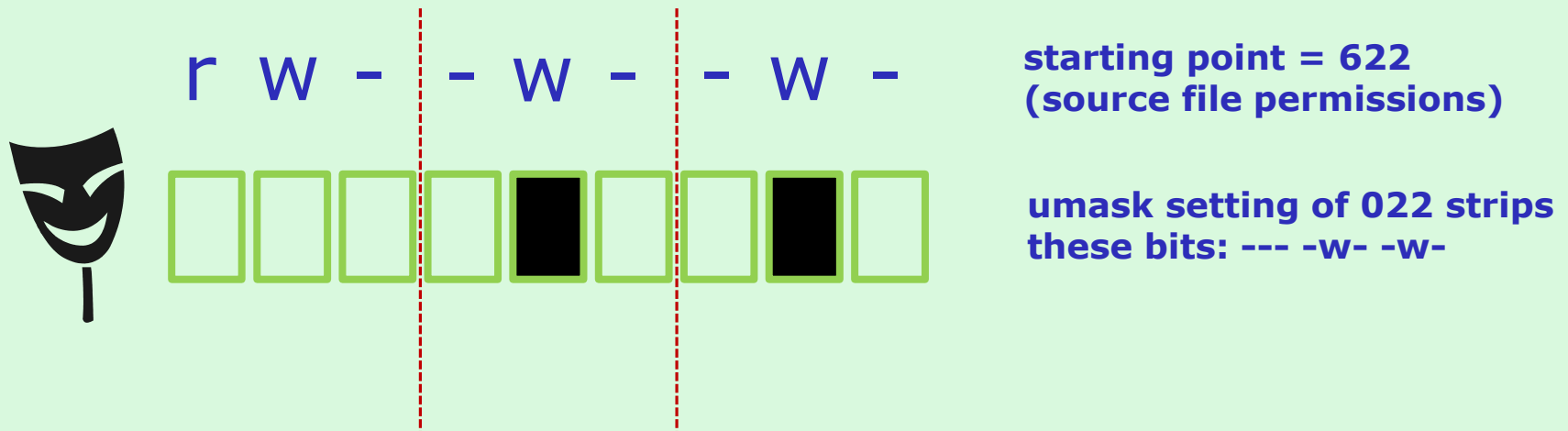


From issuing **`umask 022`**

Example 2 - file copy

If `umask=022` and the *cinderella* file permissions=`622`

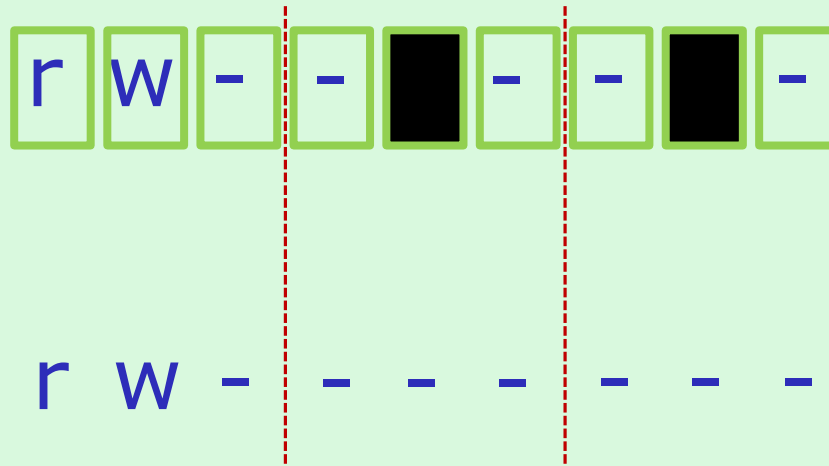
What would the permissions be on the file *cinderella.bak* after:
`cp cinderella cinderella.bak`



Example 2 - file copy

If `umask=022` and the *cinderella* file permissions=`622`

What would the permissions be on the file *cinderella.bak* after:
`cp cinderella cinderella.bak`



starting point = 622
(source file permissions)

umask setting of 022 strips
these bits: --- -w- -w-

Answer: 600

Verify your answer on Opus:

```
/home/cis90ol/simmsben $ touch cinderella
/home/cis90ol/simmsben $ chmod 622 cinderella
/home/cis90ol/simmsben $ umask 022
/home/cis90ol/simmsben $ cp cinderella cinderella.bak
/home/cis90ol/simmsben $ ls -l cinderella.bak
-rw----- 1 simmsben cis90ol 0 Apr 21 12:53 cinderella.bak
```