CSI3660 – System Administration

Prof. Fredericks fredericks@oakland.edu
TA: TBD
Fall 2018

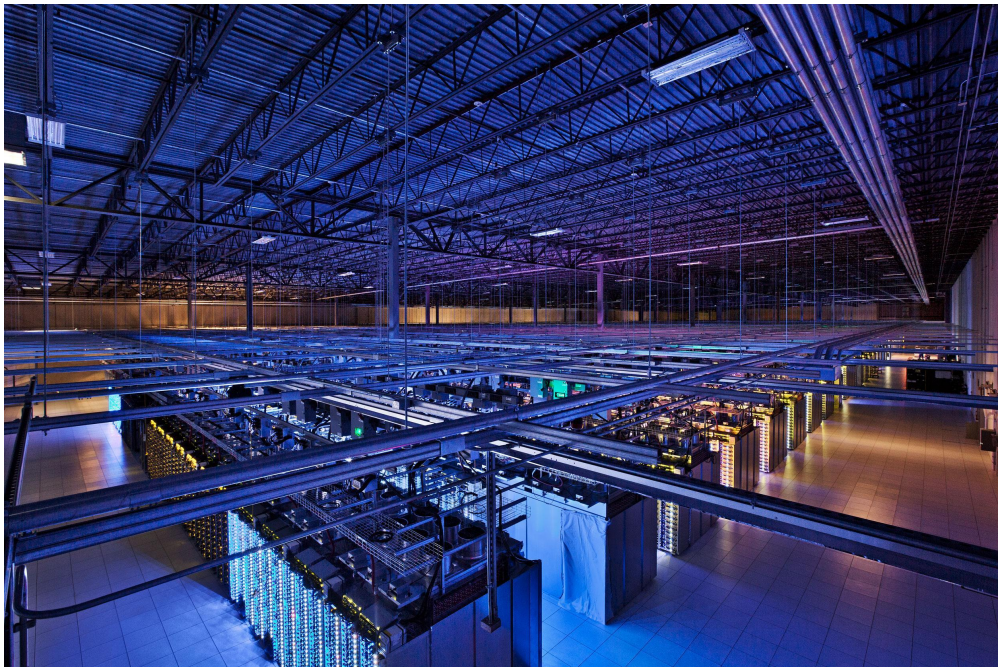
Course Introduction

Outline

- Course introduction
- System administrator responsibilities
- Free and open-source software
- History of Linux
- Linux distributions
- Shell introduction

What we **will** cover

- Understand roles and responsibilities of a system administrator
- Configure and manage a **Linux** operating system
- User authentication management
- Automate tasks
- Network file servers
- Data backup techniques
- Server deployments
- Performance and analysis



What we will **not** cover

- Windows
  - (He said, teaching a Linux course from a Windows machine)
- Hardware-specific issues
- Network security
  - CIT448
  - MIS406/452
- Anything related to certification
  - Many certification courses and books available
    - CompTIA, Red Hat, etc.

What do you want to cover?

- Other than the topics previously mentioned, what are you expecting to take away from this course?
  - If relevant, we can try to fit those topics in

Course Outline

- ~6-8 homework assignments
  - Due at 11:55pm on due date **via Moodle**
- 2 exams
  - Midterm: **October 17th, in-class**
  - Final: **December 10th, 3:30pm-6:30pm**
- No official lab section for this course
  - Practical portion of course built into homework
  - Some in-class labs where possible

Grading

- Exams: **30%** *(15% each)*
- Homework: **30%**
- Project **30%**
- Participation: **10%**
  - Class activities, attendance, etc.

- **Homework**
  - You have until **11:55PM** the **date** that it is due to submit your assignment. A **10%** penalty will be assessed for each day an assignment is late. Assignments are to be submitted to Moodle.

Book (NOT REQUIRED)

- **Linux Command Line and Shell Scripting Bible 3rd Edition** (Blum and Bresnahan)
  - Very good reference for all things Linux
    - File systems
    - Scripting
    - Text editors
    - Managing users
    - Logging
    - Etc.
- Good reference for all technical aspects of course
  - Syllabus lists the ISBN # and a link for a discounted ebook version

Project

- Course project throughout the semester
- Teams of 1-3 will deploy and configure a specialized server
  - Basic configuration
  - Common web services (Apache, MySQL, email, etc.)
  - Specialized service
    - Deploy some complex, specialized service on your server and make it available to the rest of the class
- Graded on:
  - Ability to deploy server and demonstrate to class
  - Documentation
  - Presentation(s)
- More details to follow

Homework

- Intended to get the 'basics' of your project out of the way while you work on the harder aspects
  - Topics include setting up SSH, MySQL, securing system, etc.
  - ~ 2 weeks per assignment
  - If you are working in a team, then **each of you** will have to do the homework assignments **separately on your own machine**
    - Pick a **main** server for the actual project

- Course content
  - Course material that will be on the exam will be based on these questions

Syllabus

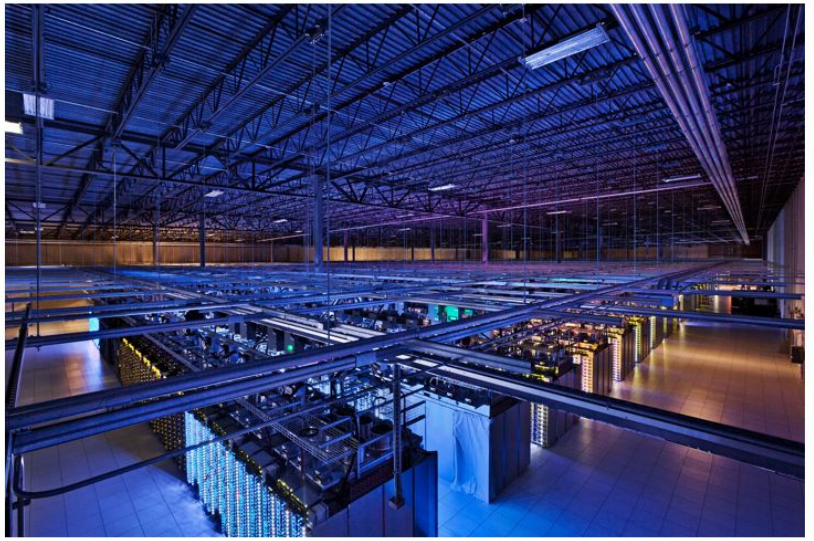
System Administrator Responsibilities

- What does the sysadmin do?

System Administrator Responsibilities

- What does the sysadmin do?

  - Configure and manage a **Linux** operating system
  - User authentication management
  - Automate tasks
  - Network file servers
  - Data backup techniques
  - Server deployments
  - Performance and analysis



System Administrator Responsibilities

- Also document, document, document

- Why document?
  - **Helpdesk**: customers resolve issues themselves
  - **Tasks**: ability to delegate to other team members
  - **Checklists**: avoid problems that already have a solution

- Types of documentation
  - Text documents
  - Internal/external wiki
  - Email exchanges

User Authentication

- Create and manage user accounts
- Manage user email settings
- Setup user directories
  - Quotas, permissions, group memberships, etc.
- Discuss server policies with user

Task Automation

- Automate common tasks
  - Save yourself and your team time
  - User creation
  - Backups
  - Logging
  - etc.

Network Servers

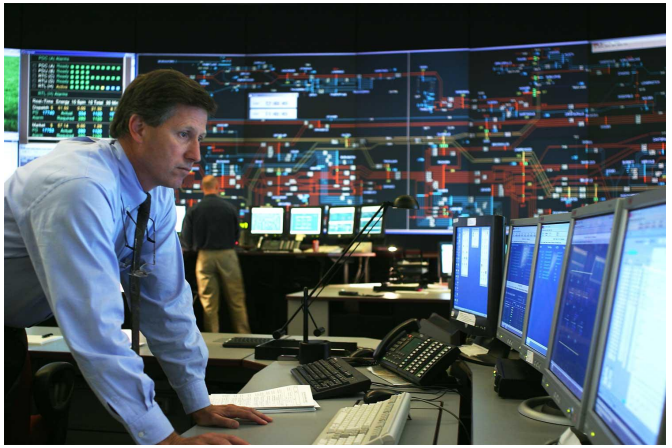
- Share resources / files / applications
- Provide centrally-configured services
  - Database system
  - Application management
  - Cloud server
- Manage server AND user access

Data Backup

- One of the **most important aspects** of system administration
  - Mainly because users can't be trusted
- To perform data backups:
  - Hardware planning (disk capacity, backup media)
  - Examine impacts to system/network performance
- Disaster recovery
  - Onsite : keep customers happy
  - Offsite : recover system from comfort of your own office
  - Keep many copies of data (periodic backups, etc.)
- Speak with customers
  - Backup schedule
  - Procedures for restoration
  - Any tolerances for data loss

Monitoring

- Monitoring will be a large part of your job
- System logs
  - Periodically examine for intrusion, system performance, etc.
  - Handle user requests for specific information
- System security
  - Maintain user passwords (constantly rotating)
  - Protect against and monitor for intrusions
- System capacity
  - Monitor drives, CPU, and RAM
  - Network performance



Performance and Analysis

- Goes hand in hand with monitoring
- Ensure system performance is acceptable with respect to:
  - User capacity
  - System capacity
- Visualizations of server load
- Provide management with usage statistics
- Analyze your system to find out what you need!
  - Make proposal for more <X>
    - Hard drives, nodes, etc.

Performance and Analysis

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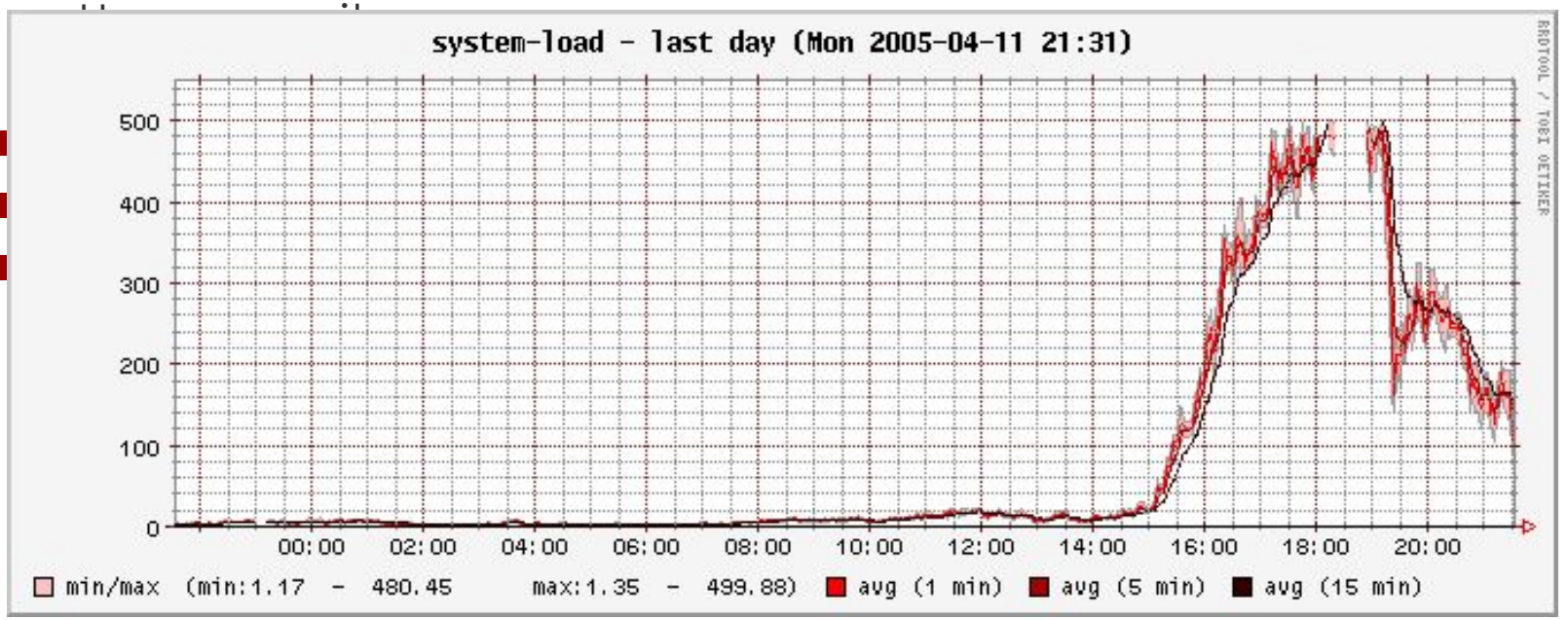
- Ensure system performance is acceptable with respect to:



Troubleshooting

- Be able to diagnose a problem
  - Efficiently and quickly
  - Is it software or hardware?
  - Client's fault or your fault?
- Be able to communicate the solution to client and/or management!
- Document solution to problem!

Hardware Procurement

- Capacity and inventory planning / purchase
- Configure and install hardware
- Run cables and wire up servers
- Evaluate hardware
- Keep server room cool

- Important things that we won't cover in this course
  - But be aware!

Summary

- Sysadmins ensure that infrastructure is readily available
- In charge of all things IT-related
  - Backups
  - Documentation
  - Software / hardware
  - Configurations
- Go-to person when there is a problem!

In-Class Assignment

- With the people you "met" earlier…
  - Come up with two sample "time drains" that can occur in a corporate environment
  - For each, provide a sample solution that a sysadmin can use to fix the problem
- Put your names on it and turn in at the end of class

Free and Open-source Software

- 1970s: UNIX source code typically stripped from distribution
  - Exorbitant sums of money required to acquire source
- UNIX was the first true multi-user, multi-tasking OS
  - Written in C
- 1980s: Richard Stallman preaches that software should be free
  - Free as in speech, not as in beer
  - Ship entire product, including source code
  - Differs from open-source software (OSS)
    - OSS still contains proprietary binaries

Stallman Video

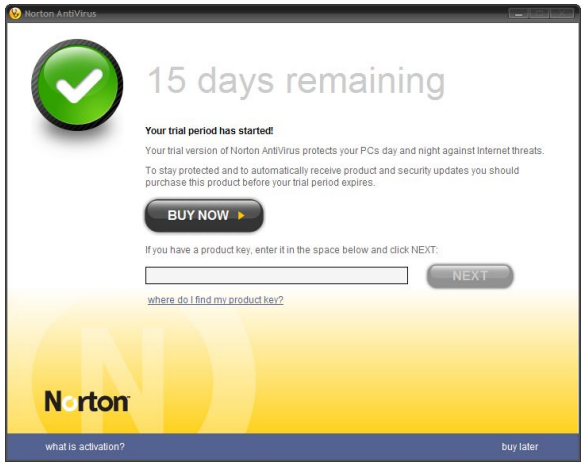
- Free software:
  - https://www.youtube.com/watch?v=uJi2rkHiNqg
- Prayer of St. IGNUcius:
  - https://www.youtube.com/watch?v=qIF5xnkcncI
- Free Software Foundation (FSF) Linux distributions:
  - https://www.gnu.org/distros/free-distros.en.html

GNU Public License

- GNU project (GNU's Not UNIX) created to support and distribute a full UNIX system including tools
- GNU Public License (GPL) created as a result
  - Software released is free and can't be revoked
  - Software can be sold, however full source code must be released
    - Programmers not liable for any damages caused
- Other popular licenses: BSD, Apache, Mozilla Public License, etc.

Closed Source Licenses

- Software often sold commercially from manufacturer
  - Requires purchase for use/distribution
- Freeware
  - Software is distributed for free but source code not available
- Shareware
  - Software initially free but requires payment after period of time
    - Certain features may be disabled
    - "Nag" screens



History of *nux

- UNIX
  - 1969: Started at AT&T's Bell Laboratories (Ken Thompson, Dennis Ritchie)
  - Full history here: http://www.unix.org/what_is_unix/history_timeline.html
- Linux
  - Linus Torvalds (Finnish graduate student) – 1991
  - Based on Minix
  - Linux Kernel v1.0 released 1994
  - Full history here: https://www.cs.cmu.edu/~awb/linux.history.html
  - First major distributions: Slackware, Debian, Red Hat
  - Developed collaboratively and centrally managed

Linux Kernel

- Most Linux commands are separate programs
  - Generally part of GNU project (and the reason for the GNU project)
- Kernel
  - Interface between hardware and software
  - Manages processes, low-level communications, etc.
- Types of kernel:
  - Monolithic (e.g., Linux)
  - Microkernel (e.g., MINIX)
  - Hybrid (Windows, OSX)

Time Drains

- Basically, anything repeatable

Favorite:

- Hackers!
- Fix: `sudo rm -rf /`

Advantages: Risk Reduction

- Changes in the market or customer needs may cause companies to change software frequently
  - Can be costly and time-consuming
- Support for closed source software may end
  - Vendor may go out of business
  - Software version may be retired
- OSS products offer the opportunity to maintain and change the source code

Advantages: Business Needs

- Common software available for Linux includes:
  - Scientific and engineering software
  - Software emulators
  - Web servers, web browsers, and e-commerce suites
  - Desktop productivity software
  - Graphics manipulation software
  - Database software
  - Security software

Advantages: Stability and Security

- Customers using a closed source OS must rely on the OS vendor to fix any bugs
  - Waiting for a hot fix may take weeks or months
- The collaborative open source approach to testing and fixing bugs increases the stability of Linux
- Bugs and security loopholes in OSS programs can be identified and fixed quickly
  - Code is freely available and scrutinized by many developers

Advantages: Flexibility

- Partial list of hardware platforms on which Linux can run:

– Intel x86/x64	– M68K
– Itanium	– PA-RISC
– Mainframe (S/390)	– SPARC
– ARM	– Ultra-SPARC
– Alpha	– PowerPC
– MIPS	

- Linux can be customized to work on mobile and embedded devices

Advantages: Customization

- Ability to control the inner workings of the OS
  - To use Linux as an Internet Web server, recompile the kernel to include only the support needed to be an Internet Web server
    - Results in a much smaller and faster kernel
  - Can choose to install only software packages needed to perform required tasks
  - Linux supports several programming languages, such as shell and PERL scripts to customize or automate tasks

Advantages: Support

- Linux documentation can be found on the Internet
  - Frequently asked questions (FAQs)
  - HOWTO documents
- HOWTO documents are maintained by their authors but are centrally collected by the Linux Documentation Project (LDP)
- Linux newsgroups
- Linux User Groups (LUGs): Open forum of Linux users who discuss and assist each other in using and modifying the Linux OS

Advantages: Cost Reduction

- Linux is less expensive than other OSs
  - There is no cost associated with acquiring the software
  - A wealth of OSS can run on a variety of different hardware platforms running Linux
- The largest costs associated with Linux:
  - Costs associated with hiring people to maintain the Linux system
- Total cost of ownership (TCO): overall cost of using a particular OS

Disadvantages

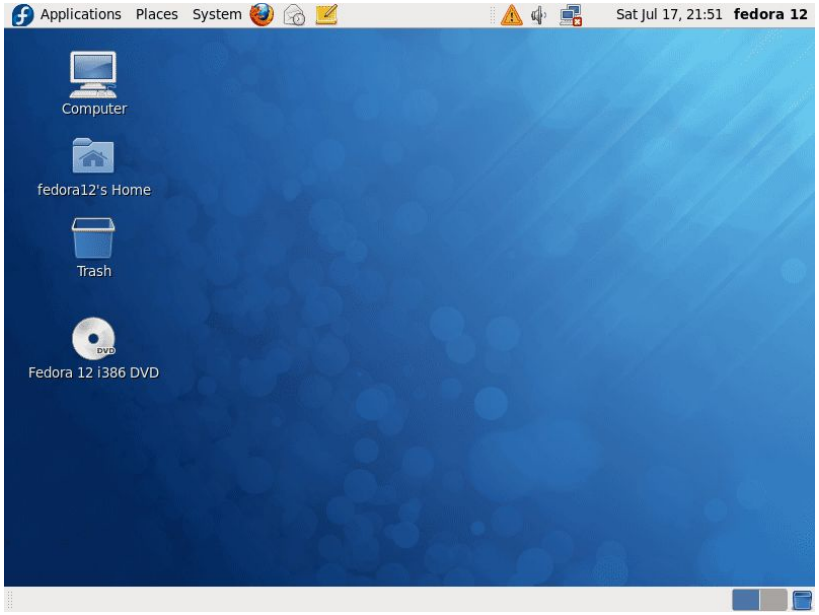
- According to one of the books that I own: none
- However…
  - No standard edition of Linux
  - Support means that you'll be searching for very specific fixes
    - Browsing SuperUser/ServerFault, forums, etc.
  - Not as easy to use as closed-source (Windows)
  - Program support

Common Uses of Linux

- Internet servers
- File/print server
- Application server
- Cloud servers
- Supercomputing
- Workstations (Office, personal, scientific, etc.)
- Mobile

Common Distributions

- Ubuntu
  - Most well known (support!)
  - Based on Debian
  - Focused on usability
  - Unity environment
- Debian
  - Operating since 1993
  - Slow update process
  - Very stable
- Fedora
  - Focus on free software (less proprietary)
  - Sponsored by Red Hat
  - "Bleeding edge"



Common Distributions

- Slackware / ArchLinux
  - Minimal distributions
  - No graphical tools by default
  - "Old school"
- Knoppix
  - Super minimal (LiveCD / USB key)
  - Great for fixing broken versions of Windows
- Many many more….
  - Gentoo, Mandriva, openSUSE, Linux Mint, …..

Course-Specific Distribution

- Each student has been provided with a Scientific Linux 7 virtual machine on OU's server
  - https://www.scientificlinux.org/
- Based on Red Hat Enterprise Linux
- You will also receive access to Google Cloud's virtualization platform
  - Details pending
- Homework must be completed on either the school VM or the Google VM
  - However, you will need to provide access details for myself and the TA as needed

Connecting to Server

- Follow the instructions here:
  - http://cto.secs.oakland.edu/docs/pdf/linuxServers.pdf
  - Keep in mind that forwarding the desktop can be quite slow at times, so become comfortable in the terminal!

- Windows users: PuTTY, MobaXterm, Cygwin…
- OSX users: Built-in Terminal

THE SHELL

- Receives keyboard input and provides commands to operating system
  - **bash** (Bourne Again SHell – enhanced version of sh) is commonly used as the main shell
    - Other shells: zsh, tcsh, ksh, … the list goes on
- Terminal (emulator)
  - Allows shell interaction
    - Examples: **xterm**, rxvt, gnome-terminal, konsole, eterm, …

Which shell / terminal am I using?

- Several ways to accomplish this
- On our systems…

$ echo $SHELL
/bin/bash

$ echo $TERM
xterm

THE DESKTOP

- Multiple ways to access the desktop
  - X-forwarding
  - VMWare vSphere
  - NoMachine
  - VNC
  - Microsoft RDP (worked *relatively* fast for me)
- Full desktop forwarding:
  - (1) Install service on virtual machine (nxnode, **xrdp**)
  - (2) Run client program from your machine (NoMachine, **RDP**)
- Keep in mind that you need to be very familiar with the shell over the GUI for this class!

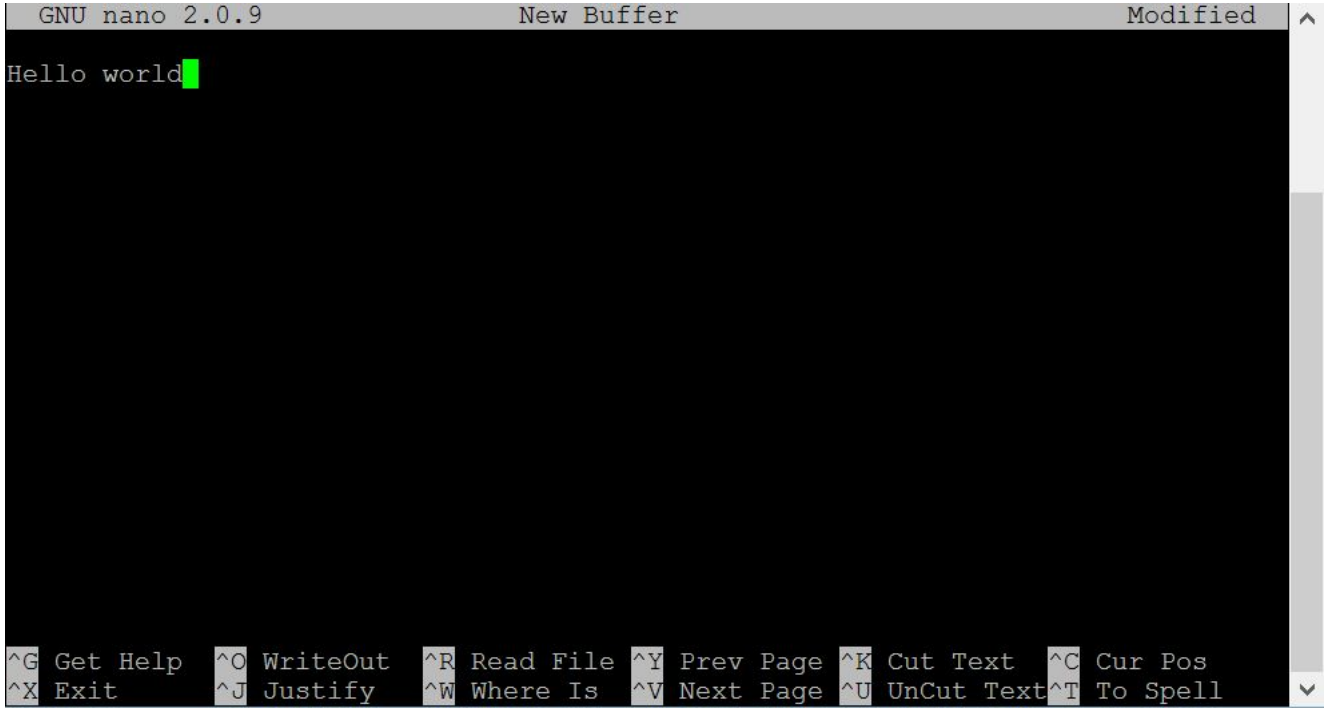
Editors

- Many text editors available for Linux
  - Common: Nano, VIM, Emacs

- Nano → Easier to use
- **Vim → The one true way**
- Emacs → Bleh

- Historically you were a VI user or an Emacs user, and much fun was had complaining about the other camp
  - https://en.wikipedia.org/wiki/Editor_war

Nano


GNU nano 2.0.9 New Buffer Modified
Hello world
^G Get Help ^O WriteOut ^R Read File ^Y Prev Page ^K Cut Text ^C Cur Pos
^X Exit ^J Justify ^W Where Is ^V Next Page ^U UnCut Text ^T To Spell

VIM

Shell Commands

- Common commands you'll use all the time
  - ls
    - List directory contents
  - rm
    - Remove file
  - cd
    - Change working directory

Shell Demo

Manuals (READ THEM!)

- All default Bash commands have an associated manual
  - man <command>
    - Describes the command, all flags that are accepted, etc.
  - info <command>
    - More organized than man (usually)
    - Relies on texinfo document
    - Provides linking, menus, etc.
- Documentation provided with distribution
- Search engine

VPN/CLI

- (VPN/CLI tutorial)
  - Don’t forget to change password!
    - **passwd**

Flags

- Command options
- Can be combined
- ls – lists directory structure by default
  - ls –l: Full listing (sizes, dates, permissions)
  - ls –a: List all files, including hidden files
  - ls –la: Full listing of all files

WILDCARDS

- Say we have a directory full of files…

```
[fredericks@SciLinux6 ~]$ ls /etc
acpi                        drirc                   kdump.conf          passwd-                         sane.d
adjtime                     enscript.cfg            krb5.conf           pbm2ppa.conf                    sasl2
aliases                     environment             latrace.conf        pcmcia                          scl
aliases.db                  ethers                  latrace.d           pinforc                         securetty
alsa                        event.d                 ld.so.cache         pkcs11                          security
alternatives                exports                 ld.so.conf          pki                             selinux
anacrontab                  favicon.png             ld.so.conf.d        plymouth                        services
anthy-conf                  festival                libaudit.conf       pm                              sestatus.conf
asound.conf                 filesystems             libreport           pm-utils-hd-apm-restore.conf    setuptool.d
at.deny                     fonts                   libuser.conf        pnm2ppa.conf                    sgml
audisp                      foomatic                localtime           polkit-1                        shadow
audit                       fprintd.conf            login.defs          popt.d                          shadow-
autofs.conf                 fstab                   logrotate.conf      portreserve                     shells
autofs_ldap_auth.conf       gai.conf                logrotate.d         postfix                         skel
auto.master                 gconf                   lsb-release         ppp                             smartd.conf
auto.misc                   gcrypt                  lsb-release.d       prelink.cache                   snmp
auto.net                    gdm                     ltrace.conf         prelink.conf                    sos.conf
auto.smb                    ghostscript             lvm                 prelink.conf.d                  sound
avahi                       gnome-vfs-2.0           magic               printcap                        ssh
bash_completion.d           gnupg                   mailcap             profile                         ssl
bashrc                      group                   mail.rc             profile.d                       sssd
blkid                       group-                  makedev.d           protocols                       statetab
bluetooth                   grub.conf               man.config          pulse                           statetab.d
bonobo-activation           gshadow                 maven               purple                          subversion
cas.conf                    gshadow-                mime.types          quotagrpadmins                  sudo.conf
certmonger                  gssapi_mech.conf        mke2fs.conf         quotatab                        sudoers
chkconfig.d                 gtk-2.0                 modprobe.d          rc                              sudoers.d
ConsoleKit                  hal                     motd                rc0.d                           sudo-ldap.conf
cron.d                      host.conf               mtab                rc1.d                           sysconfig
cron.daily                  hosts                   mtools.conf         rc2.d                           sysctl.conf
cron.deny                   hosts.allow             my.cnf              rc3.d                           system-release
cron.hourly                 hosts.deny              nanorc              rc4.d                           system-release-cpe
cron.monthly                hp                      netconfig           rc5.d                           terminfo
crontab                     httpd                   NetworkManager      rc6.d                           Trolltech.conf
cron.weekly                 idmapd.conf             networks            rc.d                            udev
crypttab                    init                    nfsmount.conf       rc.local                        updatedb.conf
csh.cshrc                   init.d                  nsswitch.conf       rc.sysinit                      vimrc
csh.login                   inittab                 ntp                 readahead.conf                  virc
cups                        inputrc                 ntp.conf            redhat-lsb                      vmware-tools
dbus-1                      ipa                     NX                  redhat-release                  warnquota.conf
default                     iproute2                obex-data-server    request-key.conf                wgetrc
depmod.d                    issue                   oddjob              request-key.d                   wpa_supplicant
dhcp                        issue.net               oddjobd.conf        resolv.conf                     X11
DIR_COLORS                  java                    oddjobd.conf.d      rpc                             xdg
DIR_COLORS.256color         jvm                     openldap            rpm                             xinetd.d
DIR_COLORS.lightbgcolor     jvm-commmon             opt                 rsyslog.conf                    xml
dnsmasq.conf                kde                     PackageKit          rsyslog.d                       yp.conf
```

WILDCARDS

- How do we look at files of a certain type?
  - ls *.conf

```
[fredericks@SciLinux6 etc]$ ls *.conf
asound.conf             grub.conf         libaudit.conf   ntp.conf                      resolv.conf     Trolltech.conf
autofs.conf             gssapi_mech.conf  libuser.conf    oddjobd.conf                  rsyslog.conf    updatedb.conf
autofs_ldap_auth.conf   host.conf         logrotate.conf  pbm2ppa.conf                  sestatus.conf   warnquota.conf
cas.conf                idmapd.conf       ltrace.conf     pm-utils-hd-apm-restore.conf  smartd.conf     yp.conf
dnsmasq.conf            kdump.conf        mke2fs.conf     pnm2ppa.conf                  sos.conf        yum.conf
dracut.conf             krb5.conf         mtools.conf     prelink.conf                  sudo.conf
fprintd.conf            latrace.conf      nfsmount.conf   readahead.conf                sudo-ldap.conf
gai.conf                ld.so.conf        nsswitch.conf   request-key.conf              sysctl.conf
```

  - ls auto*

```
[fredericks@SciLinux6 etc]$ ls auto*
autofs.conf  autofs_ldap_auth.conf  auto.master  auto.misc  auto.net  auto.smb
```

Relative vs. Absolute Paths

/home/fredericks/dir1/dir2/dir3/file.txt
/home/fredericks/all-the-answers.csv
/etc/sysconfig/iptables

vs.

~/dir1/dir2/dir3/file.txt
./all-the-answers.csv
../../etc/sysconfig/iptables

Moving Around

- Change directory: **cd**
- Go up a level: cd ..
- Go to folder **in current directory:** cd newfolder
- Go to **absolute folder**: cd /home/fredericks/newfolder
- Go to **relative folder**: cd ../../newfolder

Copying and Moving

- Copy: **cp**
- Move: **mv**

- **cp** file1 file2
- **mv** oldfile newfile

Deleting Files/Directories

- **rm** – remove object
  - rm *.txt : remove all files with .txt extension
- **rm** *–rf* – recursively remove and force deletion
  - rm –f <directory> : remove files inside directory and then delete directory
- **rmdir** – remove directory
  - Doesn't work if files exist in directory!

Users and Groups

- Linux permissions based around users and groups

- UID identifies each user / service
  - Login name tied to UID

- /etc/passwd

  $less /etc/passwd

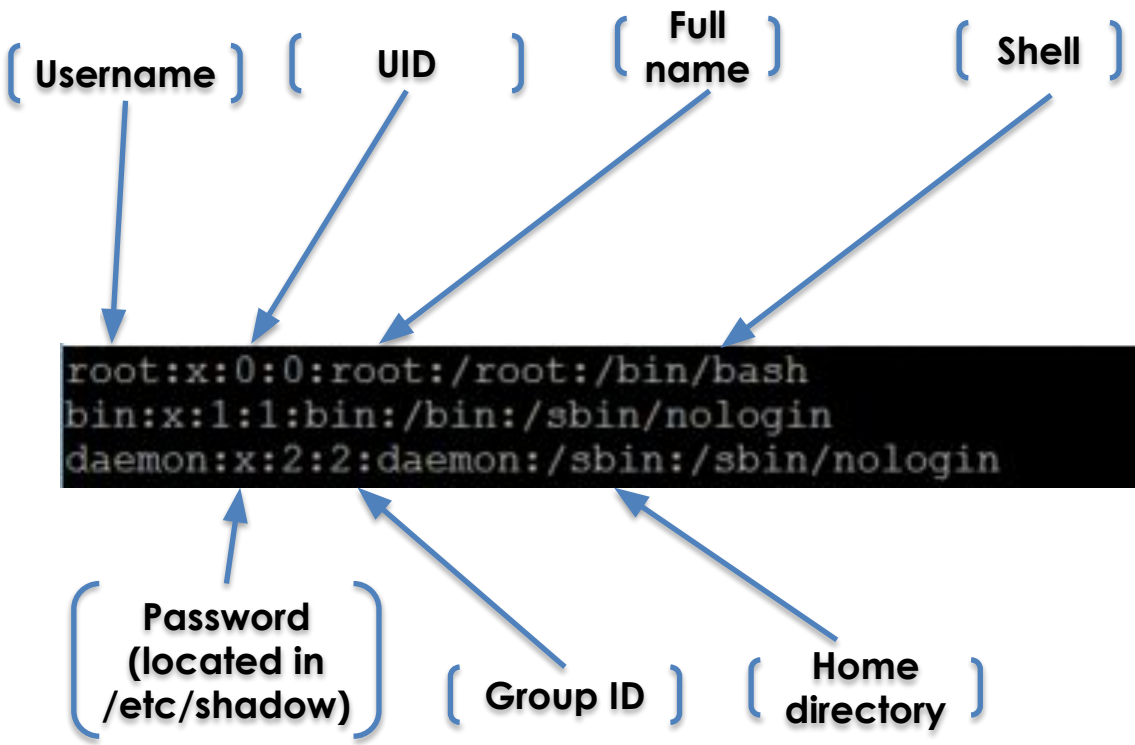
```
root:x:0:0:root:/root:/bin/bash
bin:x:1:1:bin:/bin:/sbin/nologin
daemon:x:2:2:daemon:/sbin:/sbin/nologin
```

...

```
sshd:x:74:74:Privilege-separated SSH:/var/empty/sshd:/sbin/nologin
tcpdump:x:72:72::/:/sbin/nologin
fredericks:x:500:501::/home/fredericks:/bin/bash
nx:x:496:502::/var/NX/nx:/etc/NX/nxserver
mysql:x:27:27:MySQL Server:/var/lib/mysql:/bin/bash
```

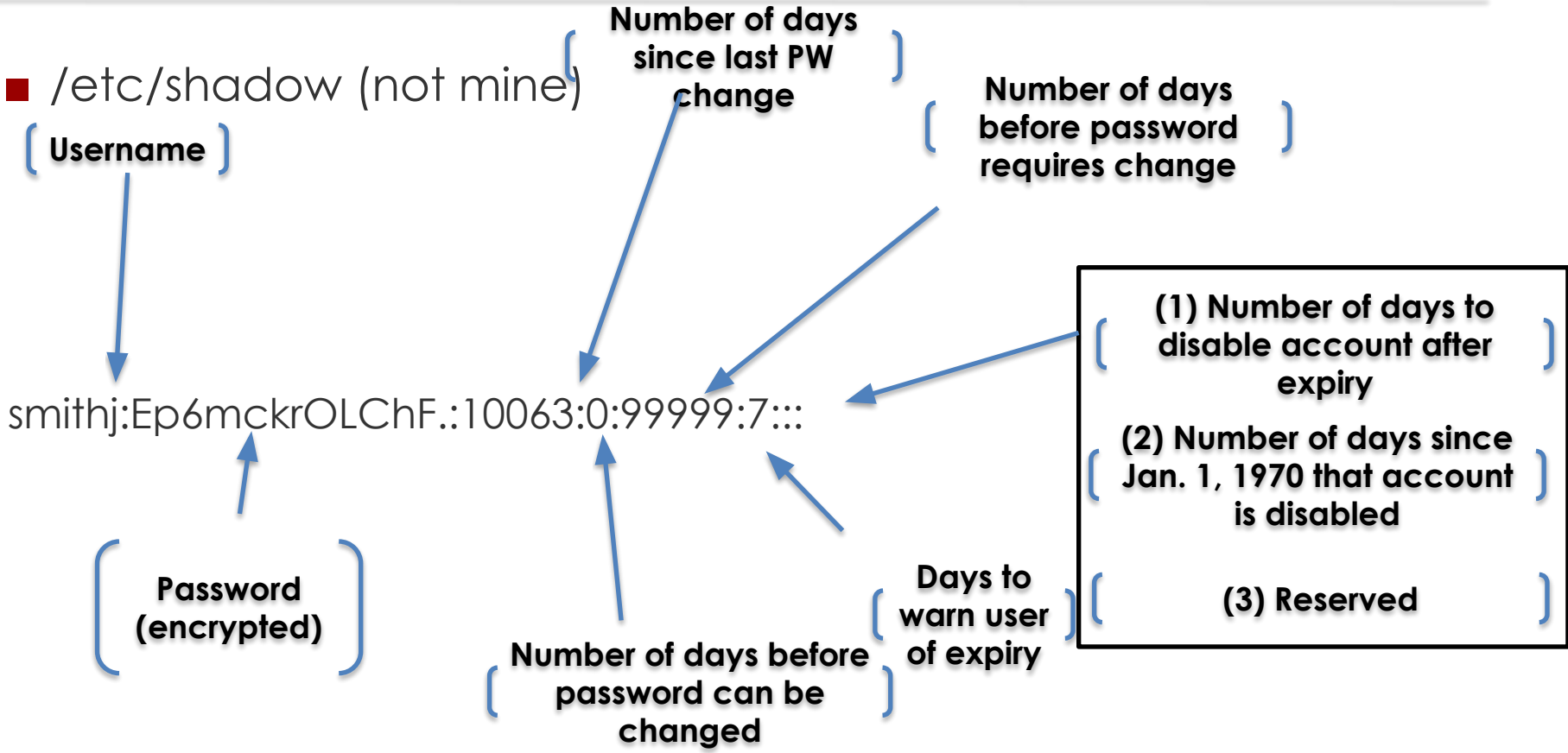
Users and Groups

- /etc/passwd
  - Fields separated by ':'



Shadow File

- /etc/shadow (not mine)



Root and Super User

- Root
  - Administrator of Linux system
  - Always assigned UID of 0
  - Full permissions to do **anything** on system
  - Login as **root**

- Super user
  - Temporary access to root-level permissions
  - Login as normal user
    - **sudo**
      - Execute single command with root privileges
    - **su**
      - Switch account to specified user (default is root) and execute

Groups

- Share resources between users
  - Common set of permissions
- Each group has unique GID (and name)
- $ **less** /etc/group

```
root:x:0:
bin:x:1:bin,daemon
daemon:x:2:bin,daemon
sys:x:3:bin,adm
adm:x:4:adm,daemon
tty:x:5:
disk:x:6:
lp:x:7:daemon
mem:x:8:
kmem:x:9:
wheel:x:10:fredericks
mail:x:12:mail,postfix
uucp:x:14:
man:x:15:
games:x:20:
gopher:x:30:
video:x:39:
dip:x:40:
ftp:x:50:
lock:x:54:
audio:x:63:
nobody:x:99:
users:x:100:
```

Groups


Group password
GID
Group name
User members
root:x:0:
bin:x:1:bin,daemon
daemon:x:2:bin,daemon
sys:x:3:bin,adm
adm:x:4:adm,daemon
tty:x:5:
disk:x:6:
lp:x:7:daemon
mem:x:8:
kmem:x:9:
wheel:x:10:fredericks
mail:x:12:mail,postfix
uucp:x:14:
man:x:15:
games:x:20:
gopher:x:30:
video:x:39:
dip:x:40:
ftp:x:50:
lock:x:54:
audio:x:63:
nobody:x:99:
users:x:100:

Permissions

- If you do not have permission to look at / delete files
  - Get superuser privileges
    - **sudo** ls / **sudo** rm
    - **su** –
  - Join group with appropriate privileges
    - **newgrp** <groupname>

Demo Time

- Lab 1 will be posted later this week