CS615 - System Administration

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https://stevens.netmeister.org/615/

Lecture 01: Introduction
January 27, 2020
New Rules

Close your laptops! (Silence phones etc.)
New Rules

Close your laptops! (Silence phones etc.)

Open your eyes!
(Mind, too.)
The Job of a System Administrator

What exactly does a System Administrator do?
The Job of a System Administrator
The Job of a System Administrator

What exactly does a System Administrator do?

https://is.gd/8vKPhl
The Job of a System Administrator
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http://www.opte.org/maps/
The Job of a System Administrator
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See also: http://is.gd/WUezLL
The Job of a System Administrator
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https://www.netmeister.org/blog/duct-tape-and-wd40.html
The Job of a System Administrator
The Job of a System Administrator

What exactly does a System Administrator do?
The Job of a System Administrator

What exactly does a System Administrator do?

- no precise job description
- often learned by experience
- “makes things run”
- work behind the scenes
- often known as Operator, Network Administrator, System Programmer, System Manager, Service Engineer, Site Reliability Engineer etc.

system administrator n.:

one who, as a primary job function, manages computer and network systems on behalf of another, such as an employer or client.
A rose by any other name...

<table>
<thead>
<tr>
<th></th>
<th>&quot;Traditional&quot; SysAdmin</th>
<th>DevOp</th>
<th>SRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware</td>
<td>knows how to rack a box, run cables</td>
<td>what hardware? VMs, Cloud, Containers</td>
<td>docker , docker , docker , docker , docker , docker</td>
</tr>
<tr>
<td>Javascript</td>
<td>is for hit counters and web tickers</td>
<td>pip install npm</td>
<td>pip install npm; npm install bower; bower install jquery</td>
</tr>
<tr>
<td>Format</td>
<td>ascii</td>
<td>markdown, erb</td>
<td>yaml, json</td>
</tr>
<tr>
<td>Editor</td>
<td>vi, emacs; can actually use ed</td>
<td>vim, ace</td>
<td>nano, eclipse</td>
</tr>
<tr>
<td>Productivity</td>
<td>mutt, irssi, gnu, make</td>
<td>gmail, Slack, keybase</td>
<td>github pull requests,Slack</td>
</tr>
<tr>
<td>Go-to language</td>
<td>C, perl, bourne shell (not bash)</td>
<td>python, golang, nodejs, ruby</td>
<td>java, nodejs, ruby, rust</td>
</tr>
<tr>
<td>Common tools</td>
<td>tcpdump, [dks]trace, leterman, duct tape</td>
<td>curl, chef, puppet, homebrew</td>
<td>Chrome, git, jenkins, chef, splunk</td>
</tr>
<tr>
<td>Login shell</td>
<td>ksh</td>
<td>bash</td>
<td>zsh, fish</td>
</tr>
<tr>
<td>Login prompt</td>
<td>$ or #, depending on euid</td>
<td>[user@hostname cwd]$</td>
<td>git branch/status, newline, date/time, fqdn,newline, full pathlast exit status color code and unicode symbol, newline, some ascii art</td>
</tr>
<tr>
<td>Social media</td>
<td>Usenet</td>
<td>Twitter</td>
<td>Facebook</td>
</tr>
</tbody>
</table>
The Job of a System Administrator

- Site Operations
- System Administration
- Network Operations
- Network Architecture
- Systems Architecture
- Infrastructure Architecture

Medium Environment

Large Environment

Small Environment

Increase in staff

Increase in specialization, experience, pay grade

Long term planning

Day to day "Ops"

Business as usual - it's all "ops"
So what is a *System*?

“A group of interacting, interrelated, or interdependent elements that together form a complex whole.”
So what is a System?

“A group of interacting, interrelated, or interdependent elements that together form a complex whole.”

In the context of this class, we generally consider computer-human systems consisting of

- the computer(s)
- the network
- the user(s)
- the organization’s goals and policies
The Job of a System Administrator
The Job of a System Administrator

This is not helping at all.
Computering, at its heart, is a people problem.
Choose sides!

https://stevens.netmeister.org/615/teams.html
... and *Administration*?

Merriam Webster:

`administer, v: to manage or supervise the execution, use, or conduct of`
... and Administration?

Merriam Webster:

administer, v: to manage or supervise the execution, use, or conduct of

System Administration frequently also includes other tasks such as
- system design and architecture
- reliability studies
- resource management
- system fault diagnosis
- ...

...all of which my involve a fair amount of software development, programming and scripting.
Learning System Administration

System Administration is a profession with no fixed career path.

- few degree granting programs
- heavy reliance on practical experience
- specializations in many different areas possible
- breadth of expertise as necessary as depth in some areas
- background knowledge and requirements vary
Learning System Administration

Breadth of knowledge:
- operating system concepts
- TCP/IP networking
- programming
- cloud computing
- ...

Depth of knowledge:
- certain OS flavor
- specific service (DNS, E-Mail, Databases, Content-Delivery, ...)
- specific implementation/vendor (Oracle, Hadoop, Apache, Cisco, ...)
- specific area of expertise (security, storage, network, data center, ...)
- ...

Lecture 01: Introduction
January 27, 2020
People think the internet looks like this.
Or like this.

http://www.opte.org/maps/
SysAdmins know it looks like this.
Syllabus

Dates and Topics subject to change:

- 01/27: Introduction, UNIX history and basics
- 02/03: Filesystems and Disks
- 02/10: Software Installation Concepts
- 02/17: Multi-user basics
- 02/24 - 03/02: Networking
- 03/09 - 03/23: DNS, SMTP, HTTP, HTTPS
- 03/30: Writing System Tools
- 04/06: Monitoring, Backup and Disaster Recovery
- 04/13: Configuration Management
- 04/20: System Security
- 04/27: Ethics and Social Responsibility
Grading

You are responsible for your work.
Know when assignments are due!

Grading:

- course participation, questionnaires, course notes
- team mission
- homework assignments
- group project(s)

Team missions, discussions, announcements etc.:
https://lists.stevens.edu/mailman/listinfo/cs615asa
Grading

You are responsible for your work.

There are no make-up assignments, no extra credit work at the end of the semester.

Allocate your time wisely. If medical or family emergencies arise, contact me ASAP, as late submissions are otherwise not allowed.
Course Notes

- create a git repository with a single text file for each lecture
- before each lecture, note:
  - what you read
  - what questions you have
- after each lecture:
  - answers you’ve found, or especially interesting new things you learned
  - what questions remain
  - what new questions arose
  - what additional reading might be relevant
- at the end of the semester, submit all your notes

https://stevens.netmeister.org/615/course-notes.html
Course Notes

Let's set up git real quick...

https://stevens.netmeister.org/615/git.html
Hooray!

5 Minute Break
Computer Science

Programming

Most App Development / what most people actually hire for.

Nobody knows what this is.

GitHub

SEO

HTML

CSS

VC pitching

You lose without this part.

Computer Science

Stuff that helps us understand all the other parts.

Future ideas (not all good, not all profitable).

Sometimes you get interviewed for some of the basic parts from over here.

analytics, performance, benchmarking, provable state convergence, ...

E.g. design/development of infrastructure components such as config mgmt, CI/CD

Mostly duct tape.

Operations
Three Pillars of Exceptional System Design

We will give particular attention to these three core features:

- Scalability
- Security
- Simplicity
Three Pillars of Exceptional System Design: Scalability

System Overload
Three Pillars of Exceptional System Design: Scalability

Scaling Vertically
Three Pillars of Exceptional System Design: Scalability

Scaling Horizontally
Three Pillars of Exceptional System Design: Scalability

Scaling Down
Three Pillars of Exceptional System Design: Security

Diagram showing a trade-off between Security and Usability, with Security increasing as Usability decreases.
Three Pillars of Exceptional System Design: Security
Three Pillars of Exceptional System Design: Security

https://www.netmeister.org/blog/infosec-basics.html
Three Pillars of Exceptional System Design: Simplicity
Three Pillars of Exceptional System Design: Simplicity
Three Pillars of Exceptional System Design: Simplicity
Learning is critical

Know how to find answers:

- know *how* to ask questions
- know *where* to ask questions
- read critically
- know what you don’t know (Dunning-Kruger effect)
- understand *what* you’re doing
- understand *why* you’re doing it
- seek information exchange
Learning is critical

“Computer Science projects are opportunities, not assignments.”
Learning is critical

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https://stevens.netmeister.org/615/meetup.html
SysAdmins’ favorite Laws

Ockham’s Razor:

“Of two equivalent theories or explanations, all other things being equal, the simpler one is to be preferred.”
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Throw in some philosophy for good measure:

*Causality:* For every effect, there must be a cause.
UNIX History
UNIX history

https://is.gd/TU0AB2

- Originally developed in 1969 at Bell Labs by Ken Thompson and Dennis Ritchie.
- 1973, Rewritten in C. This made it portable and changed the history of OS
- 1974: Thompson, Joy, Haley and students at Berkeley develop the Berkeley Software Distribution (BSD) of UNIX
- two main directions emerge: BSD and what was to become “System V”
Notable dates in UNIX history

- 1984 4.2BSD released (TCP/IP), 1986 4.3BSD released (NFS)
- 1991 Linus Torvalds starts working on the Linux kernel
- 1993 Settlement of USL vs. BSDi; NetBSD, then FreeBSD are created
- 1994 Single UNIX Specification introduced
- 1995 4.4BSD-Lite Release 2 (last CSRG release); OpenBSD forked off NetBSD
- 2000 Darwin created (derived from NeXT, FreeBSD, NetBSD)
- 2003 Xen; SELinux
- 2005 Hadoop; DTrace; ZFS; Solaris Containers
- 2006 AWS ("Cloud Computing" comes full circle)
- 2007 iOS; KVM appears in Linux
- 2008 Android; Solaris open sourced as OpenSolaris
Notable dates in UNIX history

- 2010 Systemd
- 2011 Chrome OS; rise of Microservices
- 2013 Docker
- 2014 Kubernetes
- 2016 Windows Subsystem for Linux
- ...

...
Some UNIX versions

More UNIX (some generic, some trademark, some just unix-like):

<table>
<thead>
<tr>
<th>UNIX Versions</th>
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<tbody>
<tr>
<td>1BSD</td>
</tr>
<tr>
<td>4.4BSD Lite 2</td>
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<tr>
<td>AIX PS/2</td>
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<tr>
<td>AMiX</td>
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<tr>
<td>Atari Unix</td>
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<tr>
<td>BSD/386</td>
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<tr>
<td>Coherent</td>
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<tr>
<td>Digital Unix</td>
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<tr>
<td>FreeBSD</td>
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<tr>
<td>HP-UX BLS</td>
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<tr>
<td>IRIX</td>
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<tr>
<td>Mac OS X Server</td>
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<tr>
<td>Minix</td>
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<tr>
<td>Monterey</td>
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<tr>
<td>NeXTSTEP</td>
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<tr>
<td>OpenServer</td>
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<tr>
<td>PC/IX</td>
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<tr>
<td>QNX RTOS</td>
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<tr>
<td>RISC iX</td>
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<tr>
<td>SCO Xenix System V/386</td>
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<tr>
<td>SPIX</td>
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<tr>
<td>Trusted Xenix</td>
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<tr>
<td>Ultrix 32M</td>
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<td>UNICS</td>
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<tr>
<td>UNIX System V</td>
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<td>UNIX System V/386</td>
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<tr>
<td>Venix</td>
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<tr>
<td>2BSD</td>
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<tr>
<td>386 BSD</td>
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<td>AIX/370</td>
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<td>AOS Lite</td>
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<td>BOS</td>
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<tr>
<td>BSD/OS</td>
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<tr>
<td>CTIX</td>
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<tr>
<td>DragonFly BSD</td>
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<tr>
<td>GNU</td>
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<tr>
<td>IBM AOS</td>
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<tr>
<td>Linux</td>
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<td>Mach</td>
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<td>Minix-VMD</td>
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<tr>
<td>more/BSD</td>
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<tr>
<td>NonStop-UX</td>
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<tr>
<td>OPENSTEP</td>
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<tr>
<td>OS/390 OpenEdition</td>
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<tr>
<td>Plan 9</td>
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<tr>
<td>QNX/Neutrino</td>
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<tr>
<td>RT</td>
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<tr>
<td>Security-Enhanced Linux</td>
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<tr>
<td>SunOS</td>
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<tr>
<td>TS</td>
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<tr>
<td>Ultrix-11</td>
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<tr>
<td>UNIX Interactive</td>
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<tr>
<td>UNIX System V Release 2</td>
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<tr>
<td>UNIX System V Release 3</td>
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<td>UNIX System V Release 4</td>
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<tr>
<td>UNIX System V/286</td>
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<tr>
<td>UNIX Time-Sharing System</td>
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<tr>
<td>Wollogong</td>
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<tr>
<td>3BSD</td>
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<tr>
<td>A/UX</td>
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<td>AIX/6000</td>
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<tr>
<td>AOS Reno</td>
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<td>BRL Unix</td>
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<td>CB Unix</td>
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<td>Darwin</td>
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<tr>
<td>Dynix</td>
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<tr>
<td>GNU-Darwin</td>
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<td>IBM IX/370</td>
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<tr>
<td>Lites</td>
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<td>MERT</td>
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<td>MIPS OS</td>
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<td>Open Desktop</td>
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<td>OS/390 OpenEdition</td>
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<td>PWB</td>
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<td>QUNIX</td>
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<td>SCO UNIX</td>
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<td>Sinix</td>
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<td>Tru64 Unix</td>
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<td>UCLA Locus</td>
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<tr>
<td>Unicos</td>
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<tr>
<td>4BSD</td>
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<tr>
<td>Acorn RISC iX</td>
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<tr>
<td>AIX/ESA</td>
</tr>
<tr>
<td>ArchBSD</td>
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<tr>
<td>BSD Net/1</td>
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<tr>
<td>Chorus</td>
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<tr>
<td>Debian GNU/Hurd</td>
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<tr>
<td>Dynix/px</td>
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<tr>
<td>HPBSD</td>
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<tr>
<td>Interactive 386/ix</td>
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<td>LSX</td>
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<tr>
<td>MicroBSD</td>
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<tr>
<td>MirBSD</td>
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<tr>
<td>MVS/ESA OpenEdition</td>
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<tr>
<td>NetBSD</td>
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<tr>
<td>Open UNIX</td>
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<tr>
<td>OS/390 Unix</td>
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<tr>
<td>PWB/UNIX</td>
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<tr>
<td>ReliantUnix</td>
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<tr>
<td>SCO UnixWare</td>
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<tr>
<td>Sinix ReliantUnix</td>
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<tr>
<td>Trusted IRIX/B</td>
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<tr>
<td>Trusted Solaris</td>
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<tr>
<td>Ultrix</td>
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<tr>
<td>Unicos/mk</td>
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<tr>
<td>UNIX System III</td>
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<td>UNIX System IV</td>
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<tr>
<td>USG</td>
</tr>
<tr>
<td>xMach</td>
</tr>
</tbody>
</table>
UNIX Everywhere

Today, your desktop, server, cloud, TV, phone, watch, stereo, car navigation system, thermostat, door lock, etc. all run a Unix-like OS...
UNIX Everywhere

Today, your desktop, server, cloud, TV, phone, watch, stereo, car navigation system, thermostat, door lock, etc. all run a Unix-like OS...

...with all the risks that entails.
UNIX Basics
UNIX Basics

The OS is divided into

- kernel
- shell
- tools & applications

Basic UNIX features:

- multitasking
- multiuser
- portability
- networking capabilities
UNIX Basics

These features necessitate/result in:

- multi-user concepts
  - user privileges
  - file permissions
  - process ownership and priorities
  - disk quotas

- security considerations
  - protect users’ data
  - protect communication
  - protect superuser account
UNIX Basics: Pipelines

What is the longest word found on the ten most frequently retrieved English Wikipedia pages?

```
for f in $(curl -L http://is.gd/c6F2fs | zgrep -i "\^en " |
    sort -k3 -n | tail -10 |
    sed -e 's/en \((.*) [0-9]* [0-9]*/\1/'); do
    links -dump http://en.wikipedia.org/wiki/${f}
    done | tr '[:punct:]' '' | tr '[:space:]' '\n' | tr '[:upper:]' '[:lower:]' |
    egrep '^[a-z]+$' | awk '{ print length() " " $0; }' |
    sort | uniq | sort -n | tail -1
```

See also: https://blog.jessfraz.com/post/for-the-love-of-pipes/
Program Design


UNIX programs...
- ...are simple
- ...follow the element of least surprise
- ...accept input from stdin
- ...generate output to stdout
- ...generate meaningful error messages to stderr
- ...have meaningful exit codes
- ...have a manual page
HW

Make sure you have:

- an account on linux-lab.cs.stevens.edu
- an AWS account
- bookmarked the course website
- subscribed to the class mailing list
- started your course notes
- know your team and understood your team mission

https://stevens.netmeister.org/615/course-notes.html
https://stevens.netmeister.org/615/s19-hw1.html
https://stevens.netmeister.org/cgi-bin/CS615-02.cgi
https://stevens.netmeister.org/615/filesystems-exercise.html
The End

Hooray!
Reading

Miscellaneous:
- http://www.opsschool.org/
- https://archive.is/Akjau
- http://linuxcommand.org/lc3_learning_the_shell.php
- https://is.gd/NNAIIm

UNIX history:
- http://www.futuretech.blinkenlights.nl/admin/day1a.html
- http://www.levenez.com/unix/
Reading

UNIX basics:

- chmod(1), chown(1), ls(1)
- intro(1), login(1), passwd(5)
- su(1), sudo(8)