New Rules

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

Close your laptops! (Silence phones etc.)

Open your eyes!
(Mind, too.)
A rose by any other name...

<table>
<thead>
<tr>
<th><strong>Hardware</strong></th>
<th>&quot;Traditional&quot; SysAdmin</th>
<th>DevOp</th>
<th>SRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knows how to rack a box, run cables</td>
<td></td>
<td>What hardware? VMs, Cloud, Containers</td>
<td>Docker</td>
</tr>
<tr>
<td>Javascript</td>
<td>Is for hit counters and web tickers</td>
<td>Pip install npm</td>
<td></td>
</tr>
<tr>
<td>Format</td>
<td>Ascii</td>
<td>Markdown, erb</td>
<td></td>
</tr>
<tr>
<td>Editor</td>
<td>Vi, Emacs; can actually use ed</td>
<td>Vim, Ace</td>
<td></td>
</tr>
<tr>
<td>Productivity</td>
<td>Mutt, Irsii, Gnupg, Make</td>
<td>Gmail, Slack, Keybase</td>
<td></td>
</tr>
<tr>
<td>Go-to language</td>
<td>C, Perl, Bourne Shell (not bash)</td>
<td>Python, Golang, Nodejs, Ruby</td>
<td></td>
</tr>
<tr>
<td>Common tools</td>
<td>Tcpdump, [dks]Trace, Vetherman, Duct Tape</td>
<td>Curl, Chef, Puppet, Homebrew</td>
<td></td>
</tr>
<tr>
<td>Login shell</td>
<td>Ksh</td>
<td>Bash</td>
<td></td>
</tr>
<tr>
<td>Login prompt</td>
<td>$ or #, depending on euid</td>
<td>[User@hostname cwd]$</td>
<td></td>
</tr>
<tr>
<td>Social media</td>
<td>Usenet</td>
<td>Twitter</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Facebook</td>
<td></td>
</tr>
</tbody>
</table>
How we see ourselves
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?

https://is.gd/8vKPhl
The Job of a System Administrator
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NetBSD 5.0.2 (PANIX-VC) #2: Tue Oct 19 16:30:57 EDT 2010
root@juggler.panic.com:/misc3/obj/misc2/devel/netbsd/5.0.2/src/sys/arch
amd64/compile/PANIX-VC
total memory = 768 MB
avail memory = 732 MB
timecounter: Timecounters tick every 10.000 msec
mainbus0 (root)
hypervisor0 at mainbus0: Xen version 3.4
vcpu0 at hypervisor0: Intel 686-class, 2333Mhz, id 0x10676
debug virtual interrupt using event channel 3
xenbus0 at hypervisor0: Xen Virtual Bus Interface
xencons0 at hypervisor0: Xen Virtual Console Driver
xencons0: console major 143, unit 0
xencons0: using event channel 2
timecounter: Timecounter "clockinterrupt" frequency 100 Hz quality 0
Xen clock: using event channel 4
timecounter: Timecounter "xen_system_time" frequency 1000000000 Hz quality 10000
/var/run/dmesg.boot 50%
The Job of a System Administrator
The Job of a System Administrator

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
The Job of a System Administrator
The Job of a System Administrator
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
The Job of a System Administrator

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The Job of a System Administrator

What exactly does a System Administrator do?

- no precise job description

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.
The Job of a System Administrator

What exactly does a System Administrator do?

- no precise job description
- often learned by experience

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*one who, as a primary job function, manages computer and network systems on behalf of another, such as an employer or client.*
The Job of a System Administrator

What exactly does a System Administrator do?

- no precise job description
- often learned by experience
- “makes things run”

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- often learned by experience
- “makes things run”
- work behind the scenes

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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.
So what is a *System*?

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

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- the network
- the user(s)
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

This is not helping at all.
Computering, at its heart, is a people problem.
... 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
... and Administration?

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

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- reliability studies
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System Administration frequently also includes other tasks such as

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- reliability studies
- resource management
... 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
... and Administration?

Merriam Webster:

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System Administration frequently also includes other tasks such as

- system design and architecture
- reliability studies
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- ...

Lecture 01: Introduction

January 22, 2018
... 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 may involve a fair amount of *software development, programming* and *scripting.*
System Administration is a profession with no fixed career path.
Learning System Administration

System Administration is a profession with no fixed career path.

- few degree granting programs
Learning System Administration

System Administration is a profession with no fixed career path.

- few degree granting programs
- heavy reliance on practical experience
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- breadth of expertise as necessary as depth in some areas
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
- ...

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 22, 2018
People think the internet looks like this.
Or like this.

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

5 Minute Break
In reality...
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.

Most App Development / what most people actually hire for.

Nobody knows what this is.

You lose without this part.

Operations

Mostly duct tape.

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

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

GitHub

SEO

HTML

CSS

VC pitching

automation, CI/CD, config mgmt, monitoring, ...

Lecture 01: Introduction

Computer Science

January 22, 2018
We can only cover *some* of the aspects of System Administration.
SysAdmins’ favorite tool

https://www.netmeister.org/blog/duct-tape-and-wd40.html
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
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
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Three Pillars of Exceptional System Design: Simplicity
SysAdmins’ favorite Laws

Ockham’s Razor:

“Of two equivalent theories or explanations, all other things being equal, the simpler one is to be preferred.”
SysAdmins’ favorite Laws

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2nd Law of Thermodynamics:

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Murphy’s Law:

“If it can happen, it will happen.”
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Pareto’s Principle:
“80% of consequences stem from 20% of the causes.”

Sturgeon’s Law:
“90% of everything is crud.”

Murphy’s Law:
“If it can happen, it will happen.”

Throw in some philosophy for good measure:
Causality: For every effect, there must be a cause.
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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- 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

https://www.cs.stevens.edu/~jschauma/615/meetup.html
Syllabus

Dates and Topics subject to change:

- 01/22: Introduction, UNIX history and basics
- 01/29: Filesystems and Disks
- 02/05: Software Installation Concepts
- 02/12: Multi-user basics
- 02/21 - 02/26: Networking
- 03/05 - 03/19: DNS, HTTP, HTTPS, Monitoring
- 03/26: Writing System Tools
- 04/02: SMTP; Backup and Disaster Recovery
- 04/09: Configuration Management
- 04/16: Ethics and Social Responsibility
- 04/23: System Security
About this class

No textbook, but plenty of recommended reading materials.

Mandatory pre-class surveys.

Grading:

- course participation, course notes
- homework assignments
- group project(s)
- no curve
- no late submissions
- no extra credit
- no make-up assignments

https://lists.stevens.edu/mailman/listinfo/cs615asa
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
- share
- at the end of the semester, submit all your notes

https://www.cs.stevens.edu/~jschauma/615/course-notes.html
UNIX History
UNIX history

http://www.unix.org/what_is_unix/history_timeline.html

- 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
## Some UNIX versions

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

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

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**Lecture 01: Introduction**  
**January 22, 2018**
UNIX Everywhere

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

```bash
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
dolinks -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
```
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

https://www.cs.stevens.edu/~jschauma/615/course-notes.html
https://www.cs.stevens.edu/~jschauma/615/s18-hw1.html
https://www.cs.stevens.edu/~jschauma/cgi-bin/CS615-02.cgi
The End

Hooray!
Reading

Miscellaneous:
- http://www.opsschool.org/
- http://nixsrv.com/llthw
- http://linuxcommand.org/lc3_learning_the_shell.php
- http://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)