CS615 - Aspects of System Administration

Department of Computer Science
Stevens Institute of Technology
Jan Schaumann
jschauma@stevens.edu
https://stevens.netmeister.org/615/

Lecture 01: Introduction
January 28, 2019
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>Traditional SysAdmin</th>
<th>DevOps</th>
<th>SRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware: knows how to rack a box, run cables</td>
<td>what hardware? VMs, Cloud, Containers</td>
<td>docker docker docker docker docker</td>
</tr>
<tr>
<td>Javascript: is for hit counters and web tickers</td>
<td>pip install npm</td>
<td>pip install npm; npm install bower;</td>
</tr>
<tr>
<td>Format: ascii</td>
<td>markdown, erb</td>
<td>bower install jquery</td>
</tr>
<tr>
<td>Editor: vi, emacs; can actually use ed</td>
<td>vim, ace</td>
<td>yaml, json</td>
</tr>
<tr>
<td>Productivity: mutt, irssi, gnupg, make</td>
<td>gmail, Slack, keybase</td>
<td>nano, eclipse</td>
</tr>
<tr>
<td>Go-to language: C, perl, bourne shell (not bash)</td>
<td>python, golang, nodejs, ruby</td>
<td>github pull requests, Slack</td>
</tr>
<tr>
<td>Common tools: tcpdump, [dks]trace, lethman, duct tape</td>
<td>curl, chef, puppet, homebrew</td>
<td>java, nodejs, ruby, rust</td>
</tr>
<tr>
<td>Login shell: ksh</td>
<td>bash</td>
<td>Chrome, git, jenkins, chef, splunk</td>
</tr>
<tr>
<td>Login prompt: $ or #, depending on euid</td>
<td>[user@hostname cwd]$</td>
<td>zsh, fish</td>
</tr>
<tr>
<td>Social media: Usenet</td>
<td>Twitter</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></td>
<td></td>
<td>Facebook</td>
</tr>
</tbody>
</table>
Choose sides!

https://stevens.netmeister.org/615/teams.html
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
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
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
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
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
The Job of a System Administrator
The Job of a System Administrator

NetBSD 5.0.2 (PANIX-VC) #2: Tue Oct 19 16:30:57 EDT 2010
root@juggler.panix.com:/misc3/obj/misc2/devel/netbsd/5.0.2/src/sys/arch/
amd64/compile/PANIX-VC

NetBSD 5.0.2 (PANIX-VC) #2: Tue Oct 19 16:30:57 EDT 2010
root@juggler.panix.com:/misc3/obj/misc2/devel/netbsd/5.0.2/src/sys/arch/
amd64/compile/PANIX-VC

total memory = 768 MB

NetBSD 5.0.2 (PANIX-VC) #2: Tue Oct 19 16:30:57 EDT 2010
root@juggler.panix.com:/misc3/obj/misc2/devel/netbsd/5.0.2/src/sys/arch/
amd64/compile/PANIX-VC

free memory = 732 MB
timecounter: Timecounters tick every 10.000 msec

NetBSD 5.0.2 (PANIX-VC) #2: Tue Oct 19 16:30:57 EDT 2010
root@juggler.panix.com:/misc3/obj/misc2/devel/netbsd/5.0.2/src/sys/arch/

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

NetBSD 5.0.2 (PANIX-VC) #2: Tue Oct 19 16:30:57 EDT 2010
root@juggler.panix.com:/misc3/obj/misc2/devel/netbsd/5.0.2/src/sys/arch/
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
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
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
The Job of a System Administrator
The Job of a System Administrator
The Job of a System Administrator

See also: http://is.gd/WUezLL
The Job of a System Administrator
The Job of a System Administrator

https://www.netmeister.org/blog/duct-tape-and-wd40.html
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
- 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.”
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.
... and *Administration*?

Merriam Webster:

administrer, *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 28, 2019
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...
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
Three Pillars of Exceptional System Design: Simplicity
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

Ockham’s Razor:

(Of two equivalent theories or explanations, all other things being equal, the simpler one is to be preferred.)

2nd Law of Thermodynamics:

(The entropy of an isolated system always increases with time.)
SysAdmins’ favorite Laws

Ockham’s Razor:

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

2nd Law of Thermodynamics:

“The entropy of an isolated system always increases with time.”

Hanlon’s Razor:

“Never attribute to malice that which can be adequately explained by stupidity.”
SysAdmins’ favorite Laws

Ockham’s Razor:

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

2nd Law of Thermodynamics:

“The entropy of an isolated system always increases with time.”

Hanlon’s Razor:

“Never attribute to malice that which can be adequately explained by stupidity.”

Pareto’s Principle:

“80% of consequences stem from 20% of the causes.”
SysAdmins’ favorite Laws

Ockham’s Razor:

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

2nd Law of Thermodynamics:

“The entropy of an isolated system always increases with time.”

Hanlon’s Razor:

“Never attribute to malice that which can be adequately explained by stupidity.”

Pareto’s Principle:

“80% of consequences stem from 20% of the causes.”

Sturgeon’s Law:

“90% of everything is crud.”
SysAdmins’ favorite Laws

Ockham’s Razor:

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

2nd Law of Thermodynamics:

“The entropy of an isolated system always increases with time.”

Hanlon’s Razor:

“Never attribute to malice that which can be adequately explained by stupidity.”

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.”
SysAdmins’ favorite Laws

Ockham’s Razor:

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

2nd Law of Thermodynamics:

“The entropy of an isolated system always increases with time.”

Hanlon’s Razor:

“Never attribute to malice that which can be adequately explained by stupidity.”

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

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

https://stevens.netmeister.org/615/meetup.html
Syllabus

Dates and Topics subject to change:

- 01/28: Introduction, UNIX history and basics
- 02/04: Filesystems and Disks
- 02/11: Software Installation Concepts
- 02/19: Multi-user basics
- 02/26 - 03/04: Networking
- 03/11 - 03/25: DNS, SMTP, HTTP, HTTPS
- 04/01: Writing System Tools
- 04/08: Monitoring, Backup and Disaster Recovery
- 04/15: Configuration Management
- 04/22: System Security
- 04/29: Ethics and Social Responsibility
About this class

Mandatory pre-class surveys, recommended exercises.

Grading:

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

https://lists.stevens.edu/mailman/listinfo/cs615asa
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
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/ptx</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>
</tr>
<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>Ultrix</td>
</tr>
<tr>
<td>Ultrix 32M</td>
<td>Ultrix-11</td>
<td>Unicos</td>
<td>Unicos/mk</td>
<td>Unicos-max</td>
</tr>
<tr>
<td>UNICOS</td>
<td>UNIX 32V</td>
<td>UNIX Interactive</td>
<td>UNIX System III</td>
<td>UNIX System IV</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>Wollogong</td>
<td>Xenix OS</td>
<td>Xinu</td>
<td>xMach</td>
</tr>
</tbody>
</table>

Lecture 01: Introduction January 28, 2019
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?

```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

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

https://stevens.netmeister.org/615/course-notes.html
https://stevens.netmeister.org/615/s18-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/NNAIIIm

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)