Development Technologies: Using Linux

COMS 3102
Fall 2016

Dan Mechanic

Lecture 1: What is Linux?

Welcome!

- Instructor
  - Dan Mechanic (mechanic@columbia.edu)
  - Office Hours:
    - Mon 5:30pm - 6:30pm - Uris 328
    - Fri 5pm-6pm - Uris 329
- TAs
  - Sneha Nagaraj Bangalore (sb3889@columbia.edu)
    - Fri Noon - 1PM; TA Room; Mudd 122
  - Tushar Agarwal (ta2482@columbia.edu)
    - Tues 1:30 - 2:30 PM; TA Room; Mudd 122

Please put `COMS3102` in the subject line!

What is this course?

- NOT internals
- NOT system administration (although we might do a little of that)
- 'practical' 'applied'

GOAL: Be comfortable with Linux; Anything you need to do, from now on, Linux is not the obstacle. Hopefully you also like Linux and become a regular user.

This course.

- Attendance
- Academic Honesty (I **strongly** dislike cheating)

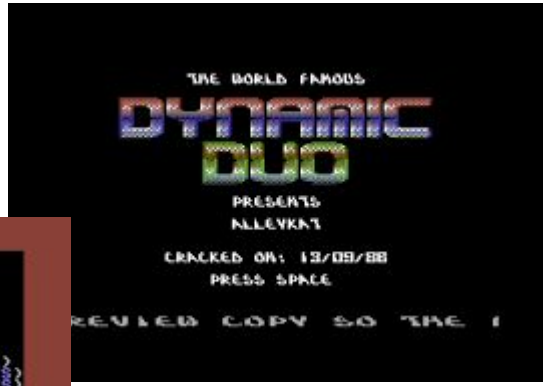
  http://www.cs.columbia.edu/education/honesty

Who am I?


**** COMMODORE 64 BASIC V2 ****
64K RAM SYSTEM 38911 BASIC BYTES FREE
READY.


commodore


FAST HACK'EM
BY
MIKE J. HENRY
(C)1985 BASEMENT BOYS SOFTWARE
THE MENU
SINGLE -TWO MINUTE BACKUP
DOUBLE -35 SEC. NO VERIFY
DOUBLE V-58 SEC. VERIFY
SD2 V2.0-60 SEC. PROTECTED
SD2 V3.0-68 SEC. PROTECTED
NIBBLER -COPIES PROTECTED
ART'S BACKUP
PARAMETER COPIER
AUTO BACKUP VERSIONS
DOUBLE
SD2 V2.0
DOUBLE V
SD2 V3.0
BOOT WHICH ROUTINE?


THE WORLD FAMOUS
DYNAMIC
DUO
PRESENTS
ALLEYKAT
CRACKED ON: 13/09/88
PRESS SPACE


EAGLE SOFT INCORPORATED
MINI PUTT

Who am I?

Who am I?

What is an Operating System?

An *operating system* (**OS**) is software that manages computer hardware and software resources and provides common services for computer programs. The operating system is an essential component of the system software in a computer system. Application programs usually require an operating system to function.

- Wikipedia

What is an Operating System?

OS is a **resource allocator**

- Manages all resources
- Decides between conflicting requests for efficient and fair resource use

OS is a **control program**

- Controls execution of programs to prevent errors and improper use of the computer

-Jae Woo Lee's OS1 class

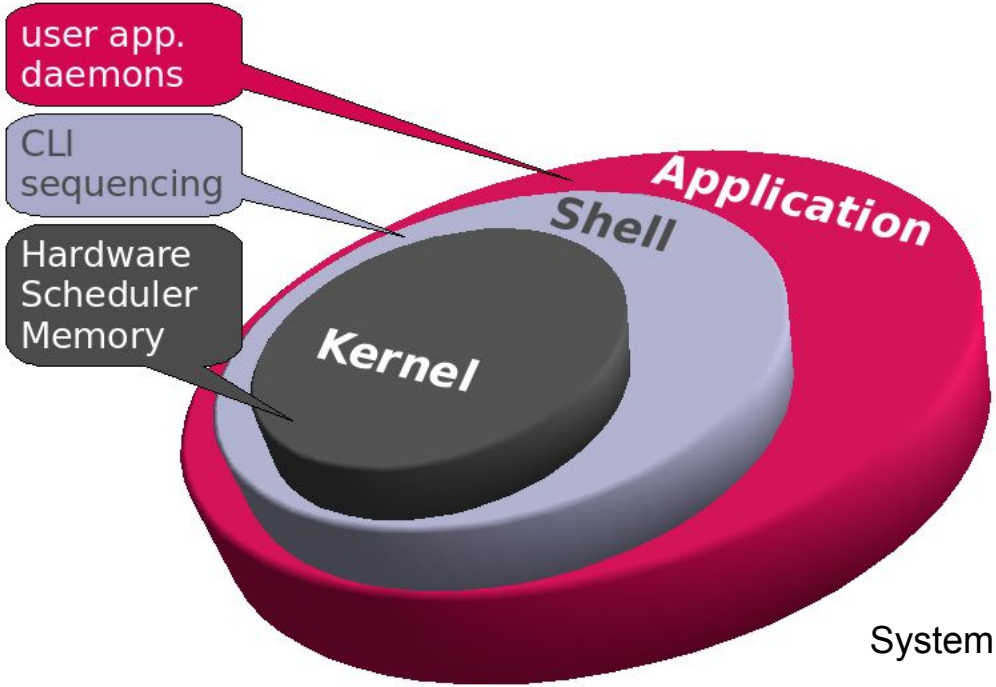
What is an Operating System?

filesystem

kernel

toolset

What is a kernel?



System calls from 'userspace'

What is an Operating System?

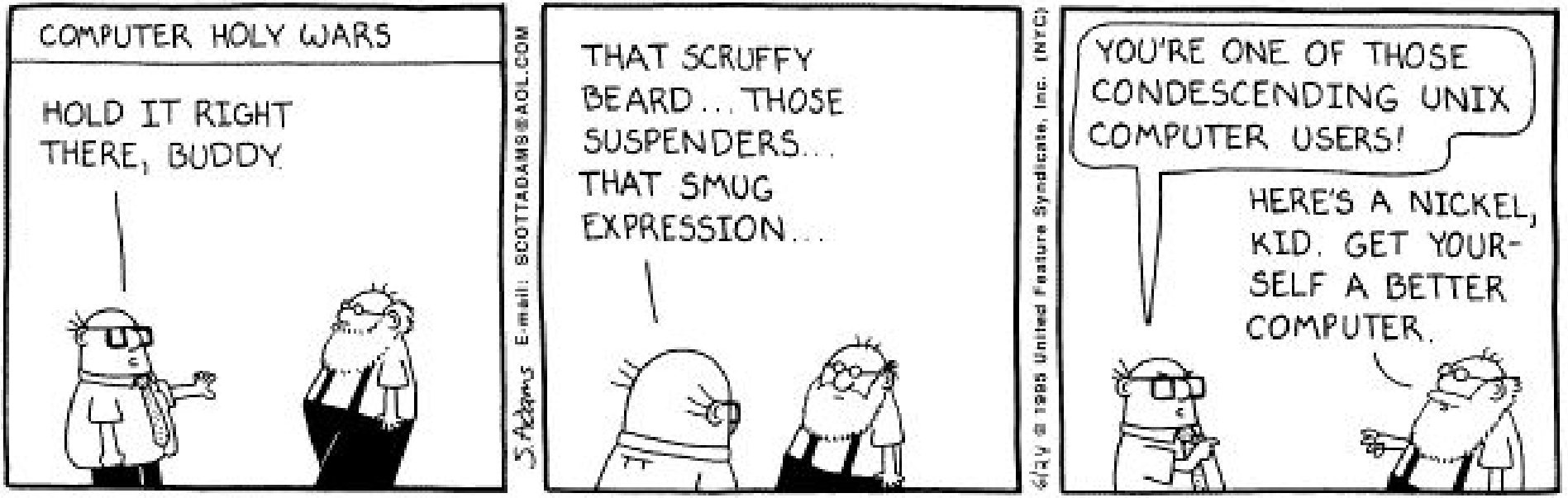
- US vs Microsoft 2001

Is a browser part of an OS?

The Unix Operating System

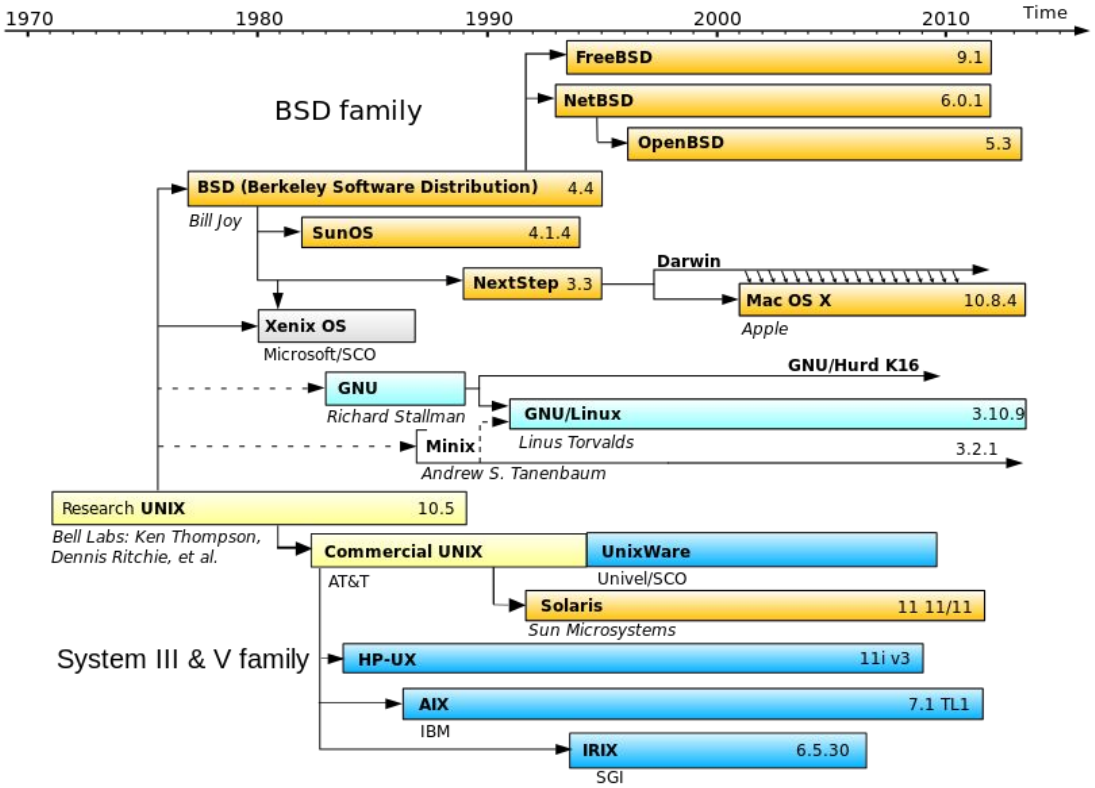
- AT&T Bell Labs 1969 on a pdp11 by Dennis M. Ritchie and Ken Thompson
- Announced 'officially' in ACM July 1974

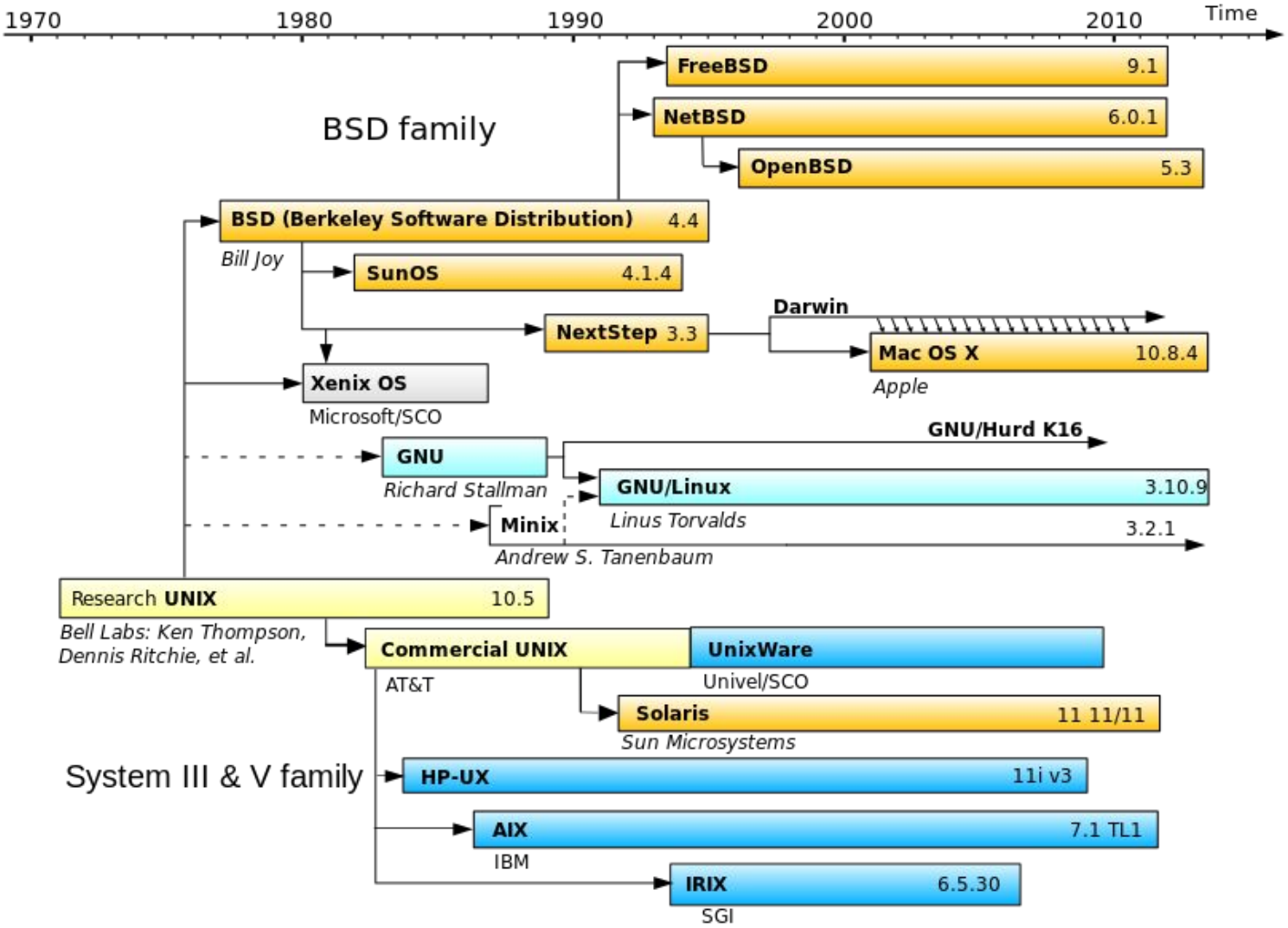
The Unix Operating System



Dilbert cartoon by Scott Adams - June 1995

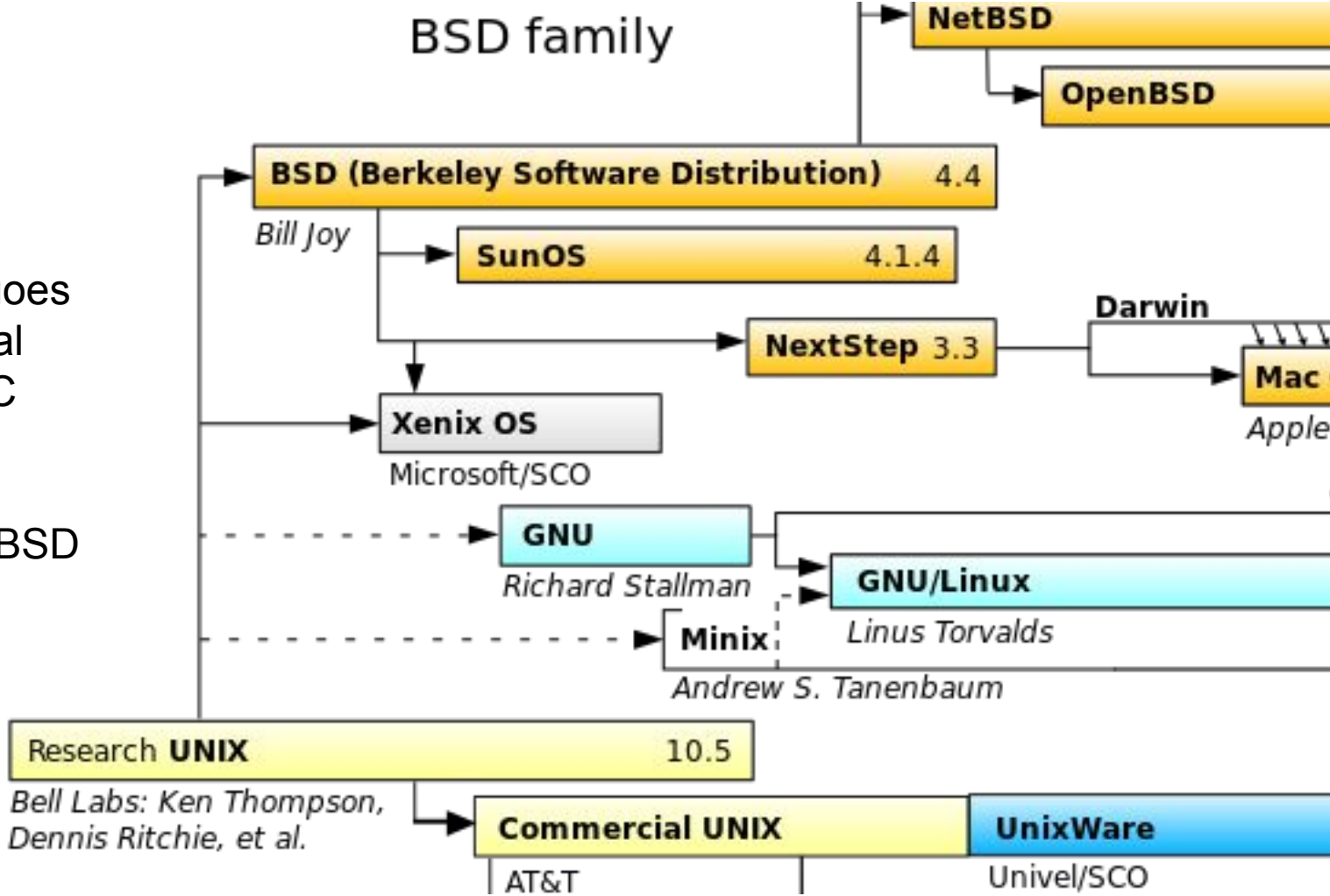
Unix Family Tree




1970
1980
1990
2000
2010
Time
BSD family
FreeBSD 9.1
NetBSD 6.0.1
OpenBSD 5.3
BSD (Berkeley Software Distribution) 4.4
Bill Joy
SunOS 4.1.4
NextStep 3.3
Darwin
Mac OS X 10.8.4
Apple
Xenix OS
Microsoft/SCO
GNU/Hurd K16
GNU
Richard Stallman
GNU/Linux 3.10.9
Linus Torvalds
Minix 3.2.1
Andrew S. Tanenbaum
Research UNIX 10.5
Bell Labs: Ken Thompson, Dennis Ritchie, et al.
Commercial UNIX
AT&T
UnixWare
Univel/SCO
Solaris 11 11/11
Sun Microsystems
System III & V family
HP-UX 11i v3
AIX 7.1 TL1
IBM
IRIX 6.5.30
SGI

1975 - Ken Thompson goes on Sabbatical and visits UC Berkeley

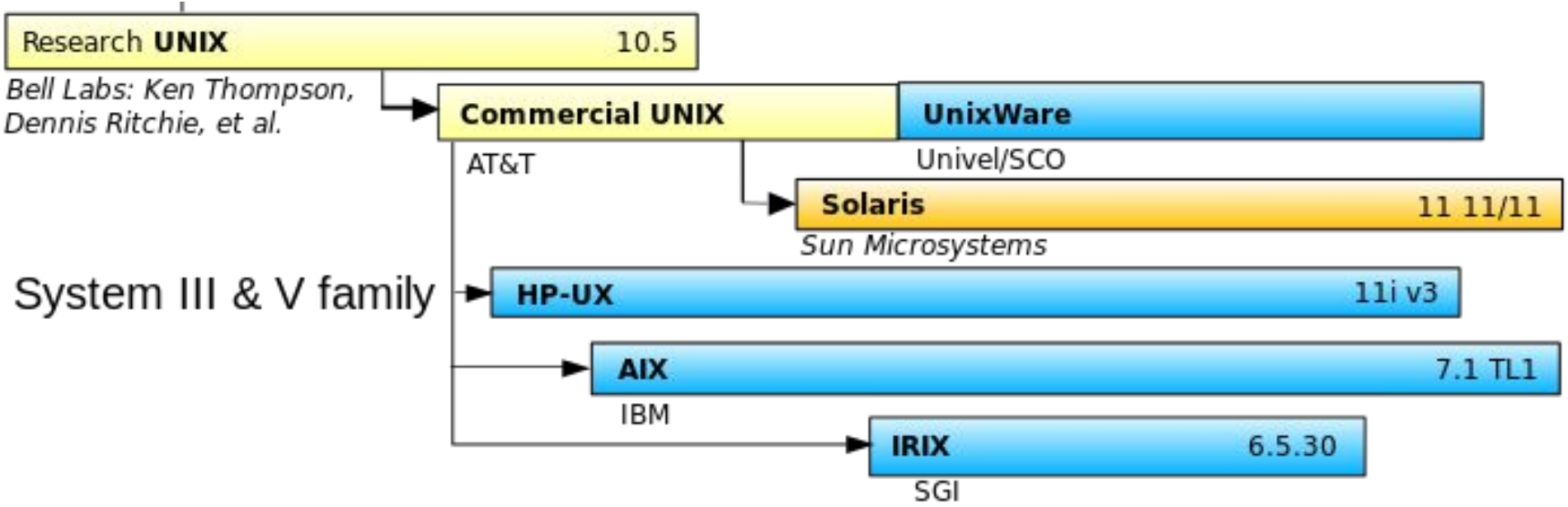
1978 - First BSD Release



1982- Bill Joy becomes a co-founder of Sun Microsystems.

1985- Steve Jobs kicked out of Apple, forms NeXT. NextStep is an Object-Oriented OS based on Objective-C

1992 - Sun Microsystems switches to System5 - Solaris



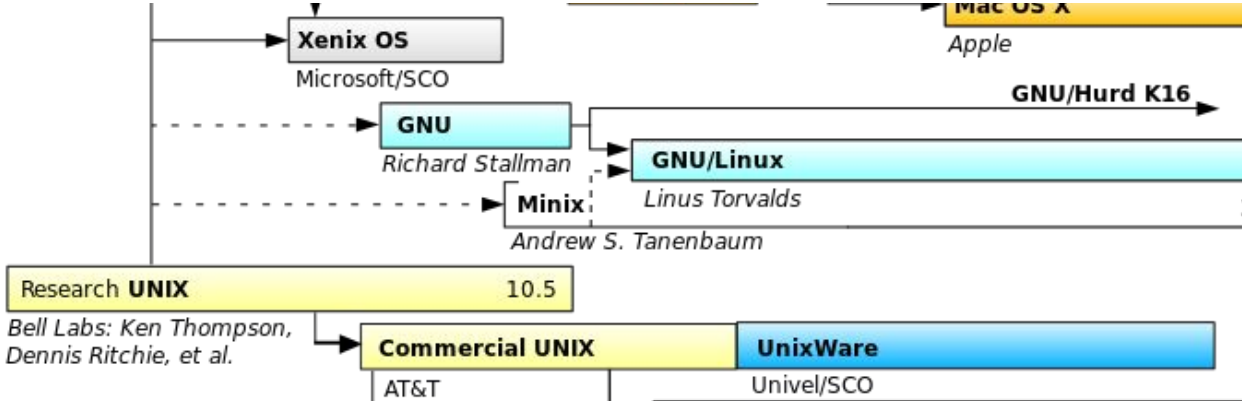
1997 - Steve Jobs rejoins Apple.

2000 - OSX Public Beta released

OS X


MICROSOFT
XENIX OPERATING SYSTEM
10/15/84
VERSION:1.00
INSTALLATION DISKETTE
(C) 1984 IBM CORPORATION
(C) 1984 MICROSOFT CORPORATION
MICROSOFT

SCO


Xenix OS
Microsoft/SCO
Mac OS X
Apple
GNU/Hurd K16
GNU
Richard Stallman
GNU/Linux
Linus Torvalds
Minix
Andrew S. Tanenbaum
Research UNIX
10.5
Bell Labs: Ken Thompson,
Dennis Ritchie, et al.
Commercial UNIX
UnixWare
AT&T
Univel/SCO

The Unix Philosophy

from *Doug McIlroy, Inventor of Unix pipes*

- Make each program do one thing well. To do a new job, build afresh rather than complicate old programs by adding new features.
- Expect the output of every program to become the input to another, as yet unknown, program. Don't clutter output with extraneous information. Avoid stringently columnar or binary input formats. Don't insist on interactive input.

The Unix Philosophy

from *Doug McIlroy, Inventor of Unix pipes*

- Use tools in preference to unskilled help to lighten a programming task, even if you have to detour to build the tools and expect to throw some of them out after you've finished using them.

The Unix Philosophy

from *The Unix Philosophy* by Mike Gancarz 1994

Small is beautiful.

The Unix Philosophy

from *The Unix Philosophy* by Mike Gancarz 1994

Build a prototype as soon as possible.

The Unix Philosophy

from *The Unix Philosophy* by Mike Gancarz 1994

Choose portability over efficiency.

(Good programs never die--they are ported to new hardware platforms.)

The Unix Philosophy

from *The Unix Philosophy* by Mike Gancarz 1994

Store data in flat ASCII files.

The Unix Philosophy

from *The Unix Philosophy* by Mike Gancarz 1994

Use software leverage to your advantage

(Good programmers write good code; great programmers "borrow" good code.)

The Unix Philosophy

from *The Unix Philosophy* by Mike Gancarz 1994

Avoid captive user interfaces.

CUIs assume that the user is human. Programs having CUIs are hard to combine with other programs.

Unix Conventions

- Three button mouse
- 'Meta'key
- The root user and sudo.

Command Conventions

Commands usually take the form:

```
command argument argument ...
```

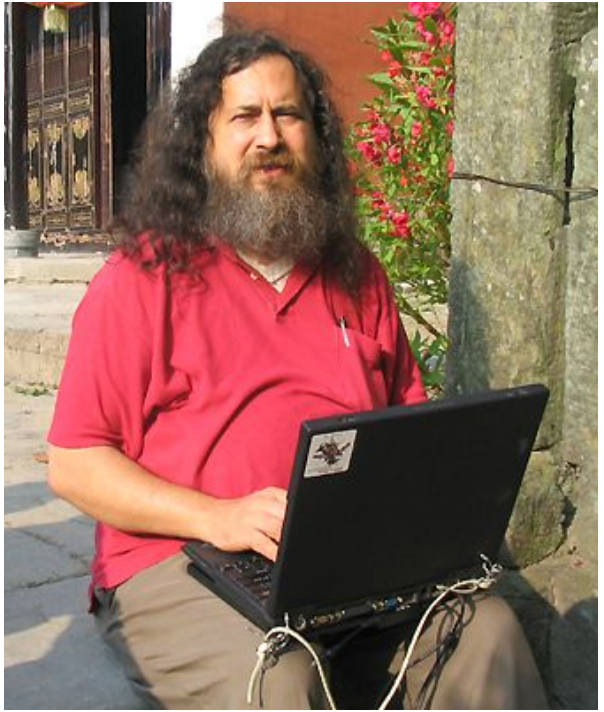
- arguments also known as 'options'
- arguments typically preceded by a '-' or '--'
    - \- short option
    - -- long option

EX:

```
cat -n
cat --number
```

Richard Stallman - GNU & FSF

- Contributed to Emacs,gcc
- Experience with James Gosling and Emacs led to GPL (other events included a timebomb in Scribe markup, and closed source Xerox 9700 printer - 1980 MIT AI lab)
- Insists on 'GNU Linux'



Richard Stallman with his x60 running libreboot

Richard Stallman - GNU & FSF

- Wrote the GNU Manifesto in March 1985 https://www.gnu.org/gnu/manifesto.html
- GNU Emacs Version 13, the first public release, was made on March 20, 1985
- Founded Free Software Foundation in October 1985
- "GNU's NOT Unix!"

Richard Stallman - GNU Manifesto

"Why I Must Write GNU

I consider that the Golden Rule requires that if I like a program I must share it with other people who like it. Software sellers want to divide the users and conquer them, making each user agree not to share with others. I refuse to break solidarity with other users in this way. "

https://www.gnu.org/gnu/manifesto.html

Richard Stallman - GNU & FSF

- "Free as in speech, not as in beer"
- "Free software is a political movement; open source is a development model."
- GPL (copyleft)

Richard Stallman with his Leemote Yeelong; a machine built with the intention of being used with free software.

Richard Stallman - What is free software?

"A program is free software if the program's users have the **four essential freedoms**:

- The **freedom to run the program** as you wish, for any purpose (freedom 0).
- The **freedom to study how the program works**, and change it so it does your computing as you wish (freedom 1). Access to the source code is a precondition for this.
- The **freedom to redistribute copies** so you can help your neighbor (freedom 2).
- The **freedom to distribute copies of your modified versions** to others (freedom 3). Access to the source code is a precondition for this.

Richard Stallman with his Leemote Yeelong; a machine built with the intention of being used with free software.

Richard Stallman - GPL

"Everyone is permitted to copy and distribute verbatim copies of this license document, but changing it is not allowed.

The GNU General Public License is a free, copyleft license for software and other kinds of works.

The **licenses for most software and other practical works are designed to take away your freedom to share and change the works**. By contrast, the GNU General Public License is **intended to guarantee your freedom to share and change all versions of a program**--to make sure it remains free software for all its users."

http://www.gnu.org/licenses/gpl-3.0.en.html

GPL - Free Software Licenses Today

GPLv1,v2 - Linux Kernel GPLv2

LGPL ("Lesser" - allows linking to proprietary modules)

GPLv3 - "tivoization" / DRM

BSD - 'Permissive' No Warranty; Do what you like; Original writer keeps copyright.

ISC - Simplified BSD

Linus Torvalds - The Linux Kernel

August 1991; Usenet news post to comp.os.minix

"Hello everybody out there using minix -

I'm doing a (free) operating system (just a hobby, **won't be big and professional like gnu**)..."

Linus Torvalds - The Linux Kernel

Version 1.0 was released on March 14, 1994

"**Sadly, a kernel by itself gets you nowhere.** To get a working system you need a shell, compilers, a library etc. These are separate parts and may be under a stricter (or even looser) copyright. Most of the tools used with linux are GNU software and are under the GNU copyleft. These tools aren't in the distribution - ask me (or GNU) for more info."

Unix Flavors Today

Unix SYSV

- Solaris
- AIX

BSD

- FreeBSD
- OpenBSD
- OSX
- NetBSD

Linux: .rpm

- Fedora
- RedHat
- CentOS
- Suse

Linux: .deb

- Debian
- Ubuntu
- Mint
- Raspian
- Knoppix

...arch (pacman)

...android

Does GPL Work?

- Redhat Enterpise Linux & CentOS
- Linux (GPLv2) and ZFS (Common Development and Distribution License)

Standards

- POSIX
  - Portable Operating Systems Interface - defines APIs for UNIX-like systems
- LSB
  - Linux Standard Base
  - Defines ABI, making binaries compatible for Linux OSs

Let's Login! - ssh client

- SSH - Secure Shell - Port 22
- PuTTY on Windows (or mobaXterm)
- ssh on Mac

```
# ssh userid@linuxmachine.columbia.edu
```

...later we'll see other utilities that use the ssh protocol

Let's Login!

- Your password will NOT be echo'd to the screen! You won't see ******** either…
- Unix is case-sensitive!
- You have a prompt!
  - Typically a 'superuser' (root) has a # prompt.

- Logout with 'exit', 'logout' or Cntrl-D.

Let's follow tradition: "Hello World"

```
# echo hello world
```

Let's follow tradition: "Hello World"

```
# echo hello                    world
hello world


# echo "hello                      world"
hello                  world
```

echo

- echo can print variables
  - `dan=cool;`
  - `echo $dan`

Man Pages

```
# man echo

...
-e     enable interpretation of backslash escapes

\n - newline
\a - alert
...
```

Use SPACE to page through man page; 'Enter for line-by-line.
Use 'q' to exit the man page

man pages

- page down - space
- page up - b
- quit - q
- beginning/end - g/G
- search forward - / (can repeat to search next)
- search backward - ?

(the same as many commands such as 'vim' & 'less')

man pages have sections

```
# man man
...
1   Executable programs or shell commands
2   System calls (functions provided by the kernel)
3   Library calls (functions within program libraries)
4   Special files (usually found in /dev)
5   File formats and conventions eg /etc/passwd
6   Games
7   Miscellaneous (including macro packages and conventions), e.g.
man(7),groff(7)
8   System administration commands (usually only for root)
9   Kernel routines [Non standard]
...
```

man pages

```
# man signal
# man -f signal (whatis)
# man -s 2 signal
# man -a signal
# man -k signal
```

Who are you anyways?

- Who are you?
  - `id`
  - `whoami`

uid - numeric userid… this is what the OS uses
gid - numeric primary groupid

Change your password

```
# passwd
```

What Host are we on?

hostname - print system hostname

```
# hostname
servicestation.gsb.columbia.edu
```

What is this machine? ...uptime

```
$ hostname
research
$ uptime
 14:41:28 up 105 days, 13:49, 119 users,  load average: 0.53, 0.50,
0.50
```

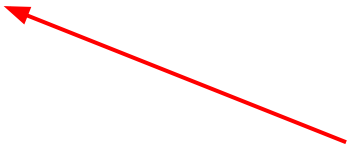
What OS are we on?

uname - print system information

```
# uname
SunOS

# uname
Linux

$ uname -a
Linux research 2.6.18-402.el5 #1 SMP Thu Jan 8 06:22:34 EST 2015 x86_64
x86_64 x86_64 GNU/Linux

# cat /etc/redhat-release
Red Hat Enterprise Linux Server release 5.7 (Tikanga)
```

cat - concatenate files

```
# cat filename
Here is the contents of filename
# cat binaryfile
```



bad news

Use `reset` to reset your terminal

What Linux are we on?

```
# cat /etc/lsb-release
DISTRIB_ID=LinuxMint
DISTRIB_RELEASE=17
DISTRIB_CODENAME=qiana
DISTRIB_DESCRIPTION="Linux Mint 17 Qiana"

$ lsb_release -a
LSB Version:
:core-4.1-amd64:core-4.1-noarch:cxx-4.1-amd64:cxx-4.1-noarch:desktop-4.1-amd64:de
sktop-4.1-noarch:languages-4.1-amd64:languages-4.1-noarch:printing-4.1-amd64:prin
ting-4.1-noarch
Distributor ID:   Fedora
Description: Fedora release 20 (Heisenbug)
Release: 20
Codename:    Heisenbug
```

What kernel are we running?

```
# uname -a
Linux research 2.6.18-274.7.1.el5 #1 SMP Mon Oct 17 11:57:14 EDT 2011 x86_64 x86_64
x86_64 GNU/Linux


# uname -a
SunOS banana 5.9 Generic_122300-61 sun4u sparc SUNW,Sun-Fire-V240 Solaris
```

Want to see the source?

http://rhkernel.org/RHEL5-2.6.18

https://lxr.missinglinkelectronics.com/linux+v2.6.32

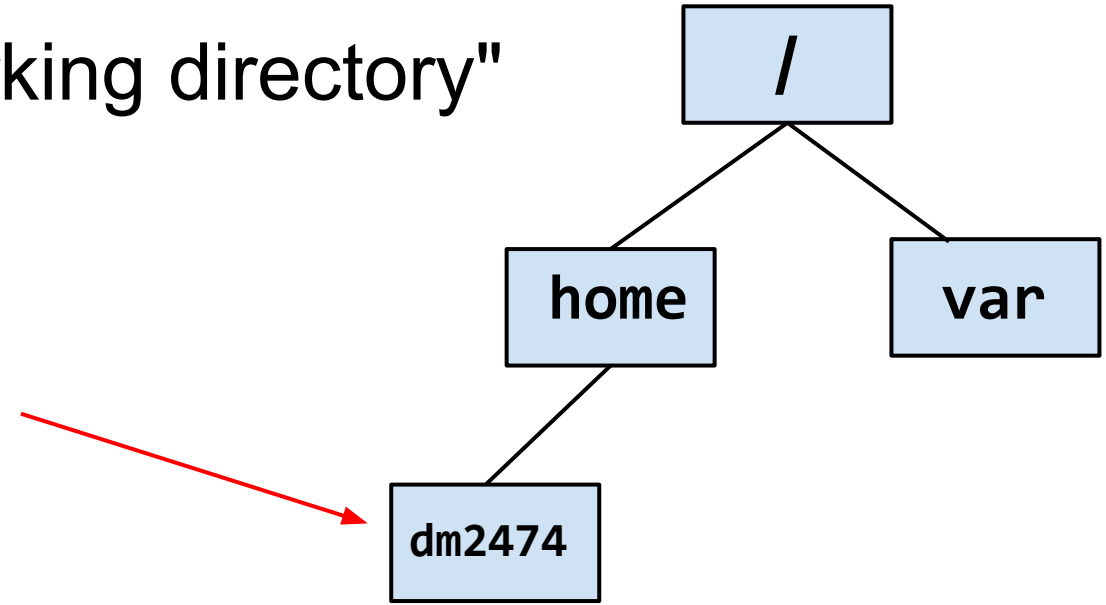
lxr - linux cross reference

Navigating The Filesystem

Where am I?

pwd - "print working directory"

```
$ pwd
/home/dm2474
```



Your HOME directory

- The directory you land in when you first login
- Stored in an environment variable '$HOME'
- `cd` with no arguments always takes you HOME
- Can use the shorthand ~user ie: `~dm2474`

cd - change directory

cd - change directory

```
$ pwd
/home/dm2474
$ cd /var
$ pwd
/var
$ cd /home/dm2474
$ pwd
/home/dm2474
```

SIMPLE editor - nano

- Free version of 'pico'
- VERY Simple to use
- ^ means Ctrl

Use `ls` to see your file...

'Sourcing' a file

'Sourcing a file means to read a file and treat each line as if it were commands entered at the shell. Two ways:

```
# . filename
# source filename
```

'Sourcing' a file

```
# cat filetosource
hostname
date
uptime
# . filetosource
servicestation.gsb.columbia.edu
Sat Sep 12 18:19:47 EDT 2015
 18:19:47 up 227 days,  4:37, 18 users,  load average: 0.12,
0.14, 0.13
```

back to your prompt

- echo can print variables
  - `dan=cool; echo $dan`
- Your prompt can be configured via the built-in PS1 variable
  - PS1='yes Dan > '
  - [dm2474@research ~]
    - uid
    - hostname
    - ~ - home directory of
    - man bash -> PROMPTING section

END LECTURE 1

Thank You!