

Introduction: GNU/Linux the Free Operating System

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GNU/Linux

the Free Operating System

- Not just a Free Computer Operating System
- It's a Philosophy of Computing
 - Promotes Computer User Freedom
 - Defends the rights of free software users.
- 2015 is the 30 year anniversary.
- FSF 30 year introductory video

Why is GNU/Linux special?

It's all about control.

- What distinguishes GNU/Linux
 - Its not proprietary.
 - No one person owns it.
 - No one person controls it.
 - You can fully configure it.
 - You can add to it.
 - You can fix it.
 - You can find malicious changes or intent.
 - Ask the question it answers: "Show me your code."

What is an Operating System?

Not precisely defined.

- User Interface which is easier to work with than:
 - the underlying hardware.
- Its a more convenient interface to run hardware.
- With multiple users, tracks:
 - Who is using which computer resource (file, memory, etc.)
 - Grants resource access requests.
 - Mediates conflicting requests (from programs or users).
- Examples: DOS, Apple/Macintosh, Microsoft Windows, **GNU/Linux**, FreeBSD, Plan9, Brazil, Android, Minix, ...

Brief History - GNU Linux

Early Computers

- Charles Babbage (English 1792-1871) mathematician
 - "Analytical Engine"
 - Mechanical Design, not implemented, precision gears not available.
- The ENIAC (1945 UPenn) **1st Generation**
 - Presper Eckert & William Mauchley
 - John Von Neumann published - Visiting from Princeton
 - Introduced:
 - Electronic design - Vacuum Tubes, Filled a room.
 - Stored Program concept.
 - Register format with instruction code and data address.
 - Subroutines (Code reuse)

Brief History - GNU Linux

Introduction of Multiprogramming - Sharing

- 2nd Generation
 - Mainframes
 - Punch Cards
 - Operators to serve machines
 - Batch multiple jobs to run sequentially
 - Multiple jobs are spooled to input tape.
- 3rd Generation
 - Compatible Time Sharing System (CTSS) - Dr. Corbato, MIT
 - Timesharing between multiple running processes.
 - Needed hardware protection mechanisms.
 - Jobs were always reloaded into the same memory locations.
 - Later job relocation mechanisms (base & limit regs)

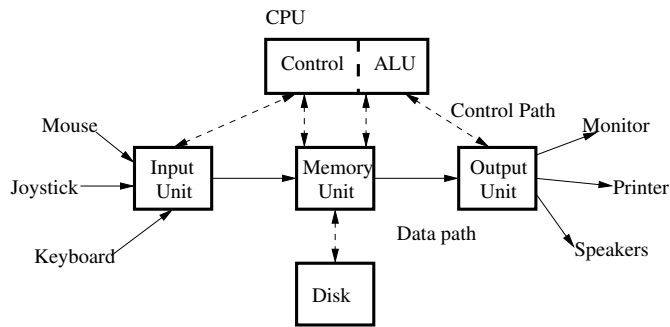
Brief History - GNU Linux

3rd and 4th generation computer

- 3rd Generation - continued
- MULTICS - progenitor of UNIX - used until 1990's, Dr. Corbato
- Introduced idea that Memory can be:
 - Segmented
 - Paged
 - Virtual
- 4th Generation Computer
 - Personal, as opposed to shared mainframes
 - Cheap, Ubiquitous

Operating System controls the Hardware

What does the hardware look like?



Operating System controls the Hardware

What does the hardware look like?

Computer Hardware Review

- Processor
 - Registers, Program Counter, Stack Pointer, Status Word
 - Arithmetic Logical Unit, Processor is pipe-lined
- Memory
 - CPU Register File, Cache Memory, Main Memory, Magnetic Disk, Tape
- I/O Devices
 - Screen, Keyboard, Mouse, headphones, microphone, etc.
- Buses
 - Peripheral Component Interconnect (PCI), Universal Serial Bus (USB)

Operating System Concepts

How does the OS help control the hardware?

- **Processes** - kernel maintains a table
 - Allow separate programs to seem to run simultaneously.
 - Process Context: Data, program, stack, Address Space
- **Deadlocks** - e.g.: processes stuck waiting for each other's resources
- **Memory Management** - swaps process contexts, files in/out automatically.
- **I/O Systems** - Standardized controls, Simplify interfaces.
- **Files** - start a / or root.
 - Grouped together in directories.
 - Block Special Files - access random disk blocks
 - Character Special Files - character stream, modem, printer, etc.
- **The Shell** - UNIX command interpreter - batch file programs.

UNIX - why bother

Brief history and why is it successful?

Ken Thompson et al. working on DEC PDP-7 at Bell Laboratories

- Wrote general purpose, time-sharing system.
- Dennis Ritchie designed and wrote first C compiler.
- **Advantages:**
 - OS not written in assembly, written in C, its **portable**.
 - Source code accessible and **written in high level language**.
 - It works and is a great programming/development environment.
 - Lots of small modular programs which work together.

UNIX - why bother

UNIX is about NOT writing programs

Solutions to a programming problem:

- Often exist as combinations of existing UNIX tools combine with glue code.
- Don't write entire functionality from scratch.
- E.g.: Relational databases can store, retrieve, search for data.
- Command line stream editors (sed, perl) can filter input, generate output.

Common Free Software Programs

For every day use, try these

L ^A T _E X ₂ ε	Typesetting, Books, Invitations, Presentations	www.tug.org/texlive/
LibreOffice	Documents, Spreadsheets, Presentations	libreoffice.org
GIMP	GNU Image Manipulation Program, Image processing	gimp.org/downloads
VLC	Watching/recording videos	videolan.org
EMACS	File editing, Email, News, & so much more...	www.gnu.org/software/

More Free Software Programs

For every day use, try these

Kdenlive	Video Editing	kdenlive.org
Blender	3D Modeling and Animation	blender.org/download
Xfig	Drawing package	xfig.org
Rhythmbox	Music library Manager, searches, burns CDs, handles > 1/2 TB of music data	www.sf.net/projects
GPG	OpenPGP encryption and signing tool	www.gnupg.org/download/
GNUmeric	Spreadsheet calculator	www.gnumeric.org/
Iceweasel	Web Browser	www.openhub.net/

More Free Software Programs

How to get these programs on my machine?

Most GNU/Linux programs have a package manager

- The package manager helps you find and install programs easily.
- Packages managers are generally *Turn key systems*.
- Aptitude (Debian), RPM (Redhat Package Manager), etc.
 - Programs and Packages are categorized by type:
 - 1 Games
 - 2 Networking
 - 3 Databases
 - 4 Development/Programming/Web Development
 - 5 Video
 - 6 Sound
 - 7 Administration
 - 8 etc.

Why defend your rights to electronic privacy?

4th Amendment to the US Constitution

Once you start putting your data onto the System, maybe you have things to protect?

'Eaves-droppers, or such as listen under walls or windows, or the eaves of a house, to hearken after discourse, and thereupon to frame slanderous and mischievous tales, are a common nuisance" punishable at common law.' – Sir William Blackstone, (7/23/1723 - 2/14/1780)
Commentaries on English Law

- 4th Amendment: Condemns incursions by authorities into private homes.
- *Olmstead v. United States* included “the right to be let alone”. – Justice Louis Brandeis, **includes electronic privacy and future technologies.**

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Why defend your rights to electronic privacy?

4th Amendment to the US Constitution

- When authorities are the intruders:
 - They are apt to prove more than a mere nuisance.
 - They are not searching to show you are innocent.
 - Intrusion is not to protect you. . .
- 4th Amendment prompted by fear of forceful and arbitrary intrusions:
 - Not necessarily spying and eavesdropping.
- Up until recently, 4th amendment was interpreted to inhibit both intrusion and spying via wiretapping and listening devices.
- **Email is not** considered private communications.

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Consider the 1st Amendment with the 4th

Right to Association and *Right to Read* aspects of privacy.

Reflect on Mobile and Online privacy concerns:

• Right to Association

- Who you hang out with can get you in trouble.
- Can you friend people on Facebook or follow others on Twitter
 - Without worrying about whether they know someone who knows someone who could get you in trouble?
- Your private documents show with whom you hangout.
 - They are private for a reason.

• Right to Read

- Can what you read or watch can get you in trouble?
- Reading doesn't mean you believe in something.

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Consider the 1st Amendment with the 4th

Your right to *Anonymity*.

• Right to Anonymity

- We are different people at different times.
 - Our family sees one facet of our personality.
 - Parents don't know everything about you that your friends know.
 - Also, vice versa.
 - If you had to be just your at-school self or just your at-home self all the time, you could only be half of yourself.
- Google knows everything about you.
- So does the data on your computer.
- Your computer must remain private.

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What data do you want protected?

Why should you care?

Protect your future from your past.

- 1 Financial information - credit card #'s, bank accounts, Social Security #'s, birth dates.
- 2 Private emails and correspondence
- 3 Aggregated Password files
- 4 Photos, **private, embarrassing photos**
- 5 Things you might not want future jobs, employers, and prosecutors to see.

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GNU Privacy Guard (GPG) and Email

Free encryption to protect data and communications

- Uses public key encryption.
- You don't give anyone your password.
 - Instead, you publicly post your public key.
 - On sites like <http://pgp.mit.edu>
 - Others encrypt messages using your public key.
 - Only you can decrypt them using your private key.
 - Don't lose or disclose your private key.
 - Messages can be encrypted by multiple public keys to allow multiple private keys to decrypt the same message.
- GPG can also be used to digitally sign and encrypt files.

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GNU Privacy Guard and Backups

Backup data in case of disk/machine failure/loss

- Tape Archive (tar)
- **tar** can use **gpg** to encrypt backup files safely.
- The corruption of 1 bit in the encrypted archive:
 - Does not cause the loss of the entire archive
 - Just the individual file is lost.
 - Create multiple archives for redundancy.
 - Safer to put encrypted archive copies off site.
- Tar combine with ssh and gpg allows:
 - Creation of secure backups across your local network.
 - Can backup multiple machines and disks.

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GNU Linux Secures data

Both from theft and hardware failure.

- RAID - Redundant Array of Inexpensive Disks.
 - Multiple disks automatically back up current data.
 - If one disk fails, other disks take over.
 - Server continues to run;
 - Replace and rebuild failed disk while machine is running.
- LUKS - Whole disk encryption.
- LVM - Logical Volume manager.
 - Separates disk into named partitions.
 - Prevents runaway write process from corrupting whole disk.
 - Can help organize encrypted partition.

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Basic Network Topology

Free GNU tools let you build a useful system.

Programs used to create a Home or Business Local Area Network (LAN)

- Domain Name Server (DNS, bind9)
 - Converts web name to IP address (www.fsf.org → 208.118.235.131)
 - local DNS can make network access faster (> 2x)
- Mail Server (exim, sendmail, etc.)
- Web Server (Apache2, Drupal)
 - You own the blog, data, etc.
- File Server (sshd, sftp)
 - Secure connections
 - Network File System (NFS) allows easy cross mounting of file systems.

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Summary and Future Proposed Course

What we introduced, OS fundamentals, encryption, backups, etc.

Summary, we looked at:

- Operating System fundamentals and history.
- Why is GNU Linux special; What is the FSF.
- Common applications; its OK to switch to GNU Linux.
- gpg, email, backups and electronic privacy.
- Server and Network configuration.

Future Directions:

- If there is interest, teach a course in October, 2015
- Here and free at the Newton Free Library!
- Express your interest now, register for the course online.
- Questions: contact mronell@alumni.upenn.edu

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