# Introduction: GNU/Linux the **Free** Operating System

*Disclaimer: The opinions expressed in this presentation are the views of the author and do not reflect the official policy or position of any agency of the U.S. government.*


email: mronell@alumni.upenn.edu

Newton Free Library
September 16, 2015

# The GNU Copyleft statement

http://www.gnu.org/copyleft/copyleft.en.html

*This information is free; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 2 of the License, or (at your option) any later version.*

*This work is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.*

*You should have received a copy of the GNU General Public License along with this work; if not, write to the Free Software Foundation, Inc., 51 Franklin Street, Fifth Floor, Boston, MA 02110-1301, USA.*

# 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

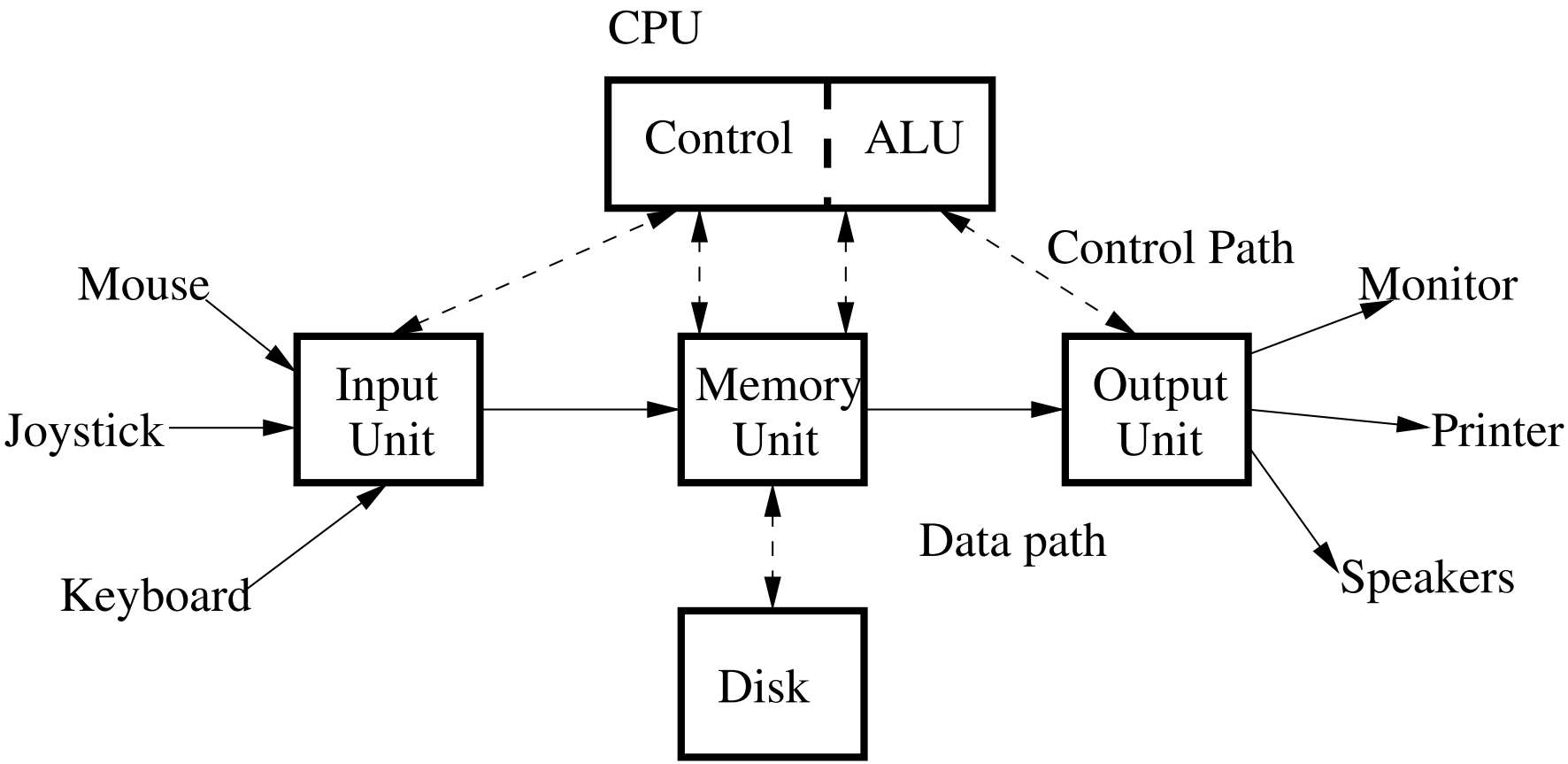
- 2nd Generation
  - Mainframes
  - Punch Cards
  - Operators to serve machines
  - Batch multiple jobs to run sequentially
  - Multiple jobs are spooled to input tape.
- 3rd Generation
  - Compatible Time Sharing System (CTSS) - Dr. Corbato, MIT
    - Timesharing between multiple running processes.
    - 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

| | | |
|---|---|---|
| LaTeX2e | 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 I 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.**

# 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.

# 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.

# 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.

# 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.

# 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.

# 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.

# 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.

# 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 $\rightarrow$ 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.

# 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`

# Acknowledgment, Credits and Special Thanks

Recognition to those individuals and institutions who made this presentation possible or contributed as a reviewer:


- John Walsh, IT and logistical support, The Free Newton Library.
- Zak Rogoff, The Free Software Foundation.
- Jack Cushman, Harvard Library Innovation Lab
- Alison Macrina, The Library Freedom Project
- William Rico, LibreBoston
- Devin Ulibarri, FreeComputer Labs