Introduction to Linux

Spring 2017

Victor Eijkhout and Charlie Dey

What is an Operating System (OS)?

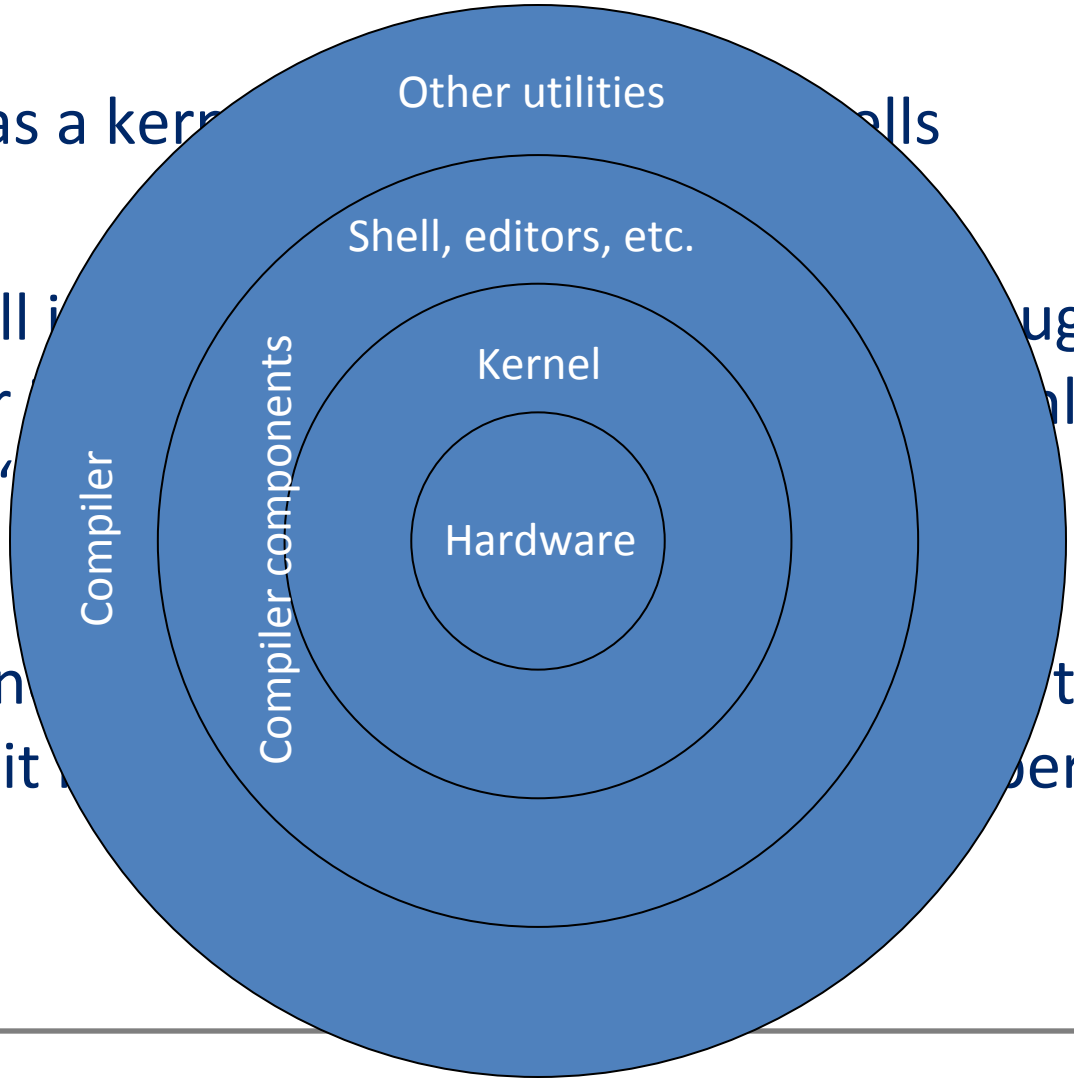
- Software interface between the user and the computer hardware
- Controls the execution of other programs
- Responsible for managing multiple computer resources (CPU, memory, disk, display, keyboard, etc.)
- Examples of OS: Windows, Unix/Linux, OS X

How does the Linux OS work?

- Linux has a kernel and one or more shells
- The shell is the command line interface through which the user interacts with the OS. Most commonly used shell is “bash”
- The kernel sits on top of the hardware and is the core of the OS; it receives tasks from the shell and performs them

How does the Linux OS work?

- Linux has a kern lls
- The shell i ugh which the user ly used shell is “
- The kern the core of the OS; it erforms them



Unix in the Real World

- Q: Before we begin, does anyone have a feel for how many machines in the Top500 list ran variants of the Unix operating System?

- Q: How about Windows?

Linux in the Real World, 06/2012 ed.

A: 97% are Linux-like

Operating System	# of Systems	Percentage
Linux	462	92.4%
Unix	22	4.8%
Mixed	11	2.2%
Windows	2	0.4%
BSD Based	1	0.20%

Linux in the Real World, 11/2016 ed.

A: 100% are Linux-like

Operating System	# of Systems	Percentage
Linux	498	99.6%
Unix	2	.4%
Mixed	0	0%
Windows	0	0%
BSD Based	0	0%

Unix
Early Movers and Shakers

Dennis Ritchie & Ken Thompson

PDP-11

Unix
Some History

- "...the number of Unix installations has grown to 10, with more expected..."
  - Dennis Ritchie and Ken Thompson, June 1972
- "... When BTL withdrew from the project, they needed to rewrite an operating system (OS) in order to play space war on another smaller machine (a DEC PDP-7 [Programmed Data Processor] with 4K memory for user programs). The result was a system which a punning colleague called UNICS (UNiplexed Information and Computing Service)--an 'emasculated Multics'; no one recalls whose idea the change to Unix was"

Unix
Some More History

- Q: How old is Unix (5, 10, 20 years, or greater)?

  A: > 35 Years

- Unix dates back to 1969 with a group at Bell Laboratories
- The original Unix operating system was written in assembler
- First 1972 Unix installations had 3 users and a 500KB disk

DEC PDP-11, 1972

Unix
And then there was C…

- In 1972, Ritchie rewrote B and called the new language C; Thompson created the pipe- "Write programs that do one thing and do it well. Write programs to work together. Write programs that handle text streams, because that is a universal interface."
- In 1973 Thompson and Ritchie finally succeeded in rewriting Unix in their new language. This was quite an audacious move; at the time, system programming was done in assembler in order to extract maximum performance from the hardware, and the very concept of a *portable* operating system was barely a gleam in anyone's eye.

Linux
Bringing Unix to the Desktop

- Unix was very expensive
- Microsoft DOS was the mainstream OS
- MINIX, tried but was not a full port
- An open source solution was needed!

1990's Movers and Shakers

Richard Stallman
father of the GNU Project

Linus Torvalds
father of Linux

Linux 0.02 – October 5, 1991

- “Do you pine for the nice days of minix-1.1, when men were men and wrote their own device drivers?
  Are you without a nice project and just dying to cut your teeth on a OS you can try to modify for your
  needs? Are you finding it frustrating when everything works on minix? No more all-nighters to get a nifty program working? Then this post might be just for you :-)” - Linus Benedict Torvalds
- "I still maintain the point that designing a monolithic kernel in 1991 is a fundamental error. Be thankful you are not my student. You would not get a high grade for such a design :-)" (Andrew Tanenbaum to Linus Torvalds)

What is Linux?

- Linux is a clone of the Unix operating system written from scratch by Linus Torvalds with assistance from developers around the globe (technically speaking, Linux is not Unix)
- Torvalds uploaded the first version of Linux in October 1991
- Only about 2% of the current Linux kernel is written by Torvalds himself but he remains the ultimate authority on what new code is incorporated into the Linux kernel.
- Developed under the GNU General Public License , the source code for Linux is freely available
- A large number of Linux-based distributions exist (for free or purchase)

Why use LINUX?

- Performance: as we've seen, supercomputers generally run Linux; rich-multi user environment
- Functionality: a number of community driven scientific applications and libraries are developed under Linux (molecular dynamics, linear algebra, fast-fourier transforms, etc).
- Flexibility/Portability: Linux lets you build your own applications and there is a wide array of support tools (compilers, scientific libraries, debuggers, network monitoring, etc.)

Why Linux is Still Used

- 30+ years of development (Unix)
  - Linux 1991
- Many academic, scientific, and system tools
- Open Source
- System Stability
- Lightweight
- Easy Development

Where is Linux Used?

Everywhere!

The Basics

- The Command Line
  - Interaction with UNIX & LINUX is based on entering commands to a text terminal
  - Often there are no ‘warnings’ with commands, no ‘undo’
- The Shell
  - The user environment that enables interaction with the kernel, or lower-system OS.
  - Windows Explorer would be a shell for Microsoft Windows.

The Basics
How does Linux work?

- Linux has a kernel and one or more shells

- The kernel is the core of the OS; it receives tasks from the shell and performs them

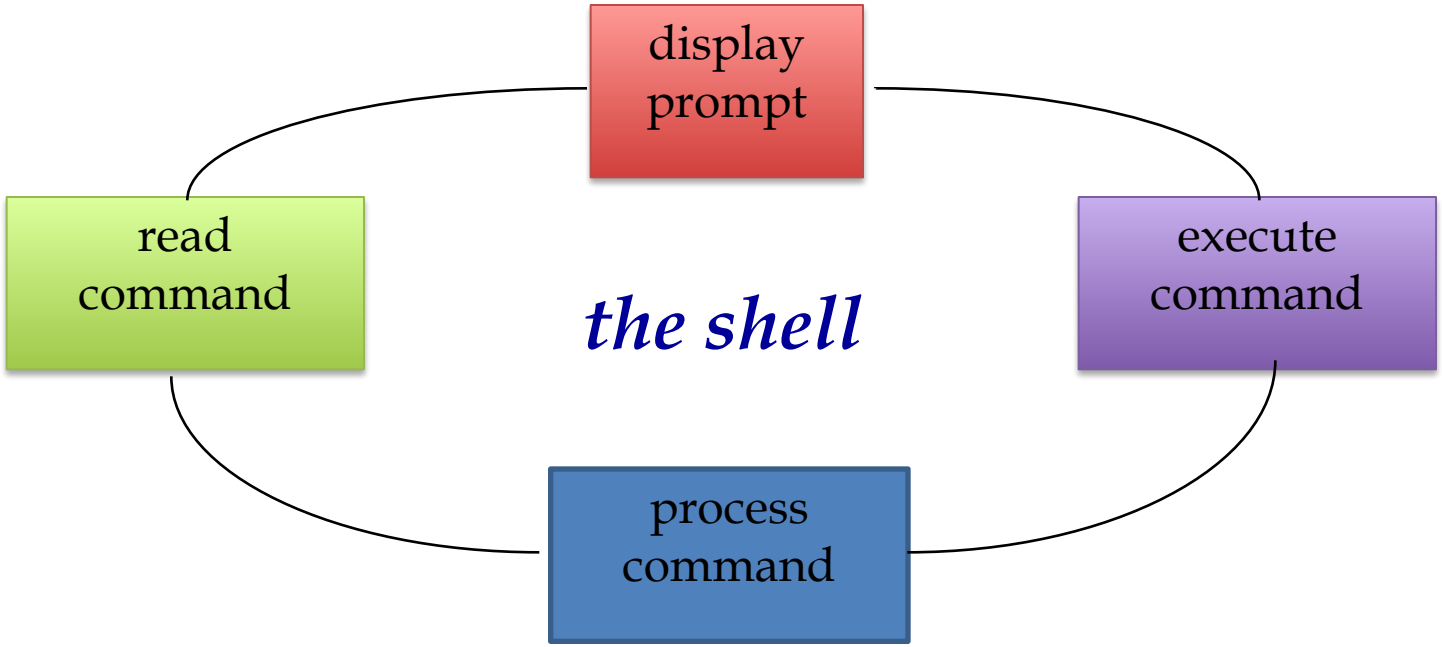
- The shell is the interface with which the user interacts

The Basics
How does Linux work?

- Everything in Linux is either a file or a process
- A process is an executing program identified by a unique PID (process identifier). Processes may be short in duration or run indefinitely
- A file is a collection of data. Files are created by users using text editors, running compilers, etc
- The Linux kernel is responsible for organizing processes and interacting with files: it allocates time and memory to each processes and handles the filesystem and communications in response to system calls

The Basics
What does the Shell Do?

- The user interface is called the *shell*.
- The shell tends to do 4 jobs repeatedly:



The Basics
Common Shells

- sh – the original Unix shell, still located in /bin/sh
- bash – a Unix shell written for the GNU Project and is installed on most Linux systems
- csh – C Shell, modeled after the C programming language used by Unix systems
- tsch – C Shell with modern improvements such as file name completion

- `echo $SHELL` – displays what shell your account is using
- `chsh` – change your shell

The Basics
Unix Interaction

- The user interacts with Unix via a shell
- The shell can be graphical (X-Windows) or text-based (command-line) shells like tcsh and bash
- To remotely access a shell session on TACC production resources, use ssh (secure shell)

X-Windows and Linux

- Several nice desktop environments exist for Linux
  - KDE
  - Gnome
- Cygwin for Windows also includes an Xserver and xterm client
- XFree86 is a freely redistributable open-source implementation of the X Window System (www.xfree86.org)