

Computer Networks, Security, and Operating Systems

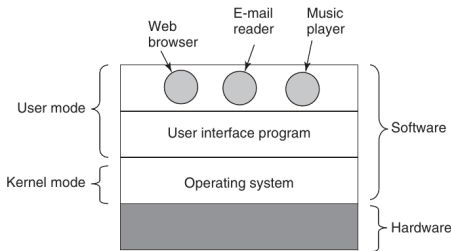
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Outline

- Review the module page
- What is an operating system?
- A little OS history
- What is Unix?
- Linux - a free, open-source OS kernel
- GNU - a suite of OS utilities
- Ubuntu - a commonly-used GNU/Linux distribution

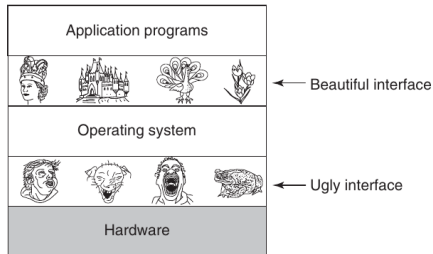
What is an operating system?



Tanenbaum and Bos, Modern Operating Systems, p.2, Pearson, 2015

- Most computers have two modes of operation: *kernel* mode and *user mode*
- Operating system runs in kernel (supervisor) mode and has complete access to the hardware; can execute any instruction that the machine is capable of
- Other software runs in user mode; only a subset of machine instructions is available

Hardware Abstraction Layer



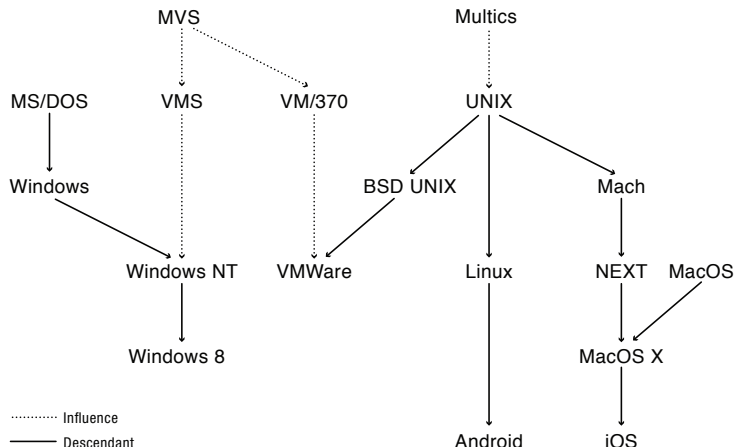
Tanenbaum and Bos, Modern Operating Systems, p.5, Pearson, 2015

- Hardware is primitive and awkward to program - especially for I/O
- A key job of an OS is to make the hardware easily and cleanly usable by application programmers
- It does this by providing an *abstract* view of the hardware, e.g. OS provides *driver* for SATA disk; at a higher level it provides a *file system*

Resource Manager

- Modern computers consist of processors, memories, timers, disks, mice, network interfaces, ...
- So another key job of an OS is to provide for an orderly and controlled allocation of all of these components to the programs that need to use them
- Computer may be executing multiple programs 'concurrently' so the OS needs to allocate resources so that the programs don't interfere with each other
- A computer may have multiple users – the OS needs to
 - ▶ grant resource requests
 - ▶ account for usage
 - ▶ avoid conflicts
- Resource management mechanisms
 - ▶ time multiplexing
 - ▶ space multiplexing

Where does Unix fit in OS history?



Anderson, T. and Dahlin, M., *Operating systems: principles and practice*, Recursive Books, 2014

Why is Unix important today?

OS penetration by sector

Type	Unix-based %	Windows %	Other %	Source	Year
Desktop/Laptop	8.61	91.39	0.0	Net Applications	2016
Smartphones	99.3	0.4	0.3	Gartner	2016
Tablets	90.0	10.0	0.1	Strategy Analytics	2015
Web clients	55.25	39.65	5.72	StatCounter	2016
Servers (web)	67.8	32.3	0.0	W3Techs	2015
Mainframe	100.0	0.0	0.0	Gartner	2008
Supercomputer	100.0	0.0	0.0	TOP500	2016
Worldwide device shipments	87.9	11.7	0.4	Gartner	2015

- **Unix-based** Linux, Android, iOS, OSX, Chrome OS, AIX, FreeBSD, HP-UX, Solaris, PS4, PS3, QNX
- **Windows** All Windows OS from Windows 98 to Windows 10, including Xbox and WCE
- **Other** Symbian, Blackberry OS, ...

Projected sales 2017

Approximately 2.14 billion out of a total of about 2.47 billion devices shipped in 2017 will be smartphones and tablets (Forbes)

Unix was designed to be a:

- portable,
- multi-tasking,
- multi-user,
- time-sharing configuration.

Origins of Unix

- originally developed in 1969 at AT&T Bell Labs by a team including Dennis Ritchie, Ken Thompson and Brian Kernighan
- 1973, coded in C

Became a “commercial” product in the 1980s. Researchers at University of California, Berkeley continued to develop “academic” version distinct from these.

- BSD Unix
- includes TCP/IP implementations
- adheres to IEEE POSIX standard
- Apple has based Macintosh operating systems on BSD since 1997

POSIX IEEE based POSIX around the common structure of the major competing variants of the Unix system, publishing the first POSIX standard in 1988

SUS the Common Open Software Environment (COSE) initiative, which eventually became the Single UNIX Specification administered by The Open Group

- Starting in 1998 the Open Group and IEEE started the Austin Group, to provide a common definition of POSIX and the Single UNIX Specification.

The Filesystem Hierarchy Standard was created to provide a reference directory layout for Unix-like operating systems, particularly Linux.

GNU – Gnu's Not Unix

- Richard Stallman announced a project to develop a completely free Unix-like operating system in 1983
- A Unix-like operating system includes a kernel, compilers, editors, text formatters, mail software, graphical interfaces, libraries, games and many other things.
- By 1990, the GNU project had developed all of the major components, except the kernel

`gcc` a C compiler

`emacs` a text editor

`sh` a shell

`ls`, `grep`, `find` file utilities

... and many other components.

- In addition, MIT contributed the X Window system, a windowing system that provides the framework for a GUI-environment
- Donald Knuth developed the text processing system, TeX

Unix-like kernel first developed in early 90s by Linus Torvalds

- Original idea: a complete rewrite of the Unix kernel for “IBM-compatible” PCs
- Now in conjunction with GNU software we have a free, mature PC operating system . . .
- . . . and also an OS for servers, mobile devices, embedded devices
 - ▶ routers, satellite decoders, games consoles, mobile phones, tablet computers
- Google is hosted on half a million custom Linux machines
- The Android OS is a Linux variant
- the GNU *General Public License* (GPL)

- Now packaged in *distributions*
 - ▶ Debian, Fedora and openSUSE, ...
 - ▶ Ubuntu is a derivative of Debian
- A distribution includes a lot of software libraries including applications and utilities.
 - ▶ “office” applications (word processing, spreadsheets, presentation, ...)
 - ▶ music, multimedia, graphics, ...
- Distributions intended for desk-top/laptop PC use include a graphical “desktop”
 - ▶ based on the *X-Window system*
 - ▶ Common ones are *Unity*, *Gnome* and *KDE*
- Distributions intended for servers, embedded systems have only a command-line console.

Ubuntu Linux

- A derivative of the Debian distribution, sponsored by Canonical Ltd who make money by selling technical support, training, etc
- First released October 2004; new version every April, October with a "long-term support" version every 2 years. Versions are named by year and month of release. Both desktop and server versions released.
 - 8.04 "Hardy Heron", 8.10 "Intrepid Ibex",
 - 10.04, "Lucid Lynx", 10.10 "Maverick Meerkat",
 - 12.04 "Precise Pangolin", 12.10 "Quantal Quetzal"
 - 14.04 "Trusty Tahr", 14.10 "Utopic Unicorn",
 - 16.04 "Xenial Xerus", 16.10 "Yakkety Yak"
- A variety of desktops is available
 - Unity
 - Gnome
 - KDE
 - Mate, Cinnamon, i3wm, ...

Ubuntu Linux

- Apart from proprietary hardware drivers, software is free and open-source, mostly under GNU General Public License

- Libre Office (Open Office before 11.04) – interoperable with Microsoft Office
- Firefox
- Empathy / Pidgin messaging
- Gimp
- Much more can be installed on demand using the “Synaptic” Package Manager, a pre-installed utility. Choose
 - ▶ Free – supported free software
 - ▶ Restricted – support non-free software
 - ▶ Universe – unsupported free software
 - ▶ Multiverse – unsupported non-free software
- *ubuntu-restricted-extras* additionally includes support for some legally restricted software, such as MP3, DVD playback, Microsoft TrueType fonts, Oracle’s Java Runtime, support for RAR compression, ...

System requirements

- currently supports 32 and 64 bit architectures, PowerPC, IA-64, ARM
- current distribution expects ≥ 1 GHz CPU and ≥ 382 MiB of RAM

Installation is from a bootable CD or USB memory stick

- Run it from the boot medium before deciding to install on the hard drive!
- Download the CD image, (.iso) and burn a CD from it or make a bootable USB "drive" using the UNetbootin utility.
- Wubi (on CD) allows Ubuntu to be run within a Window session.

All practical work in this module will use a Unix-like operating system – typically a version of Ubuntu. In order to make it convenient to use both in the lab and at home, we'll show you how to install the operating system using a *virtual machine* ([VirtualBox](#)). More coming in the lab session.