information technology & management

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INTRO TO OPEN SOURCE

ILLINOIS INSTITUTE OF TECHNOLOGY

Intro to Linux & Open Source

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ITMO/IT-O 456 Fall 2017

Information Technology & Management Programs

School of Applied Technology

Syllabus & Policies

- Syllabus
  - Blackboard
- Lectures
  - Lecture notes
- Readings
  - Textbooks
- Labs
- Assignments
  - Labs
  - Homework
- Exams
- Plagiarism
- Other Policies

Introduction

- What is your name?
- What year are you?
- Have you used Linux before?
  - If so what distro?
- What do you want to specialize in for your degree?

Operating Systems

- Computers have two fundamental components:
  - Hardware: Physical components inside a computer
  - Software: Set of instructions or programs that understand how to use the hardware of the computer in a meaningful way

Operating Systems

- Hardware components include:
  - Processor (CPU)
  - Physical memory (RAM)
  - Hard disk drives
  - Sound cards
  - Video cards (GPU)
  - Motherboards

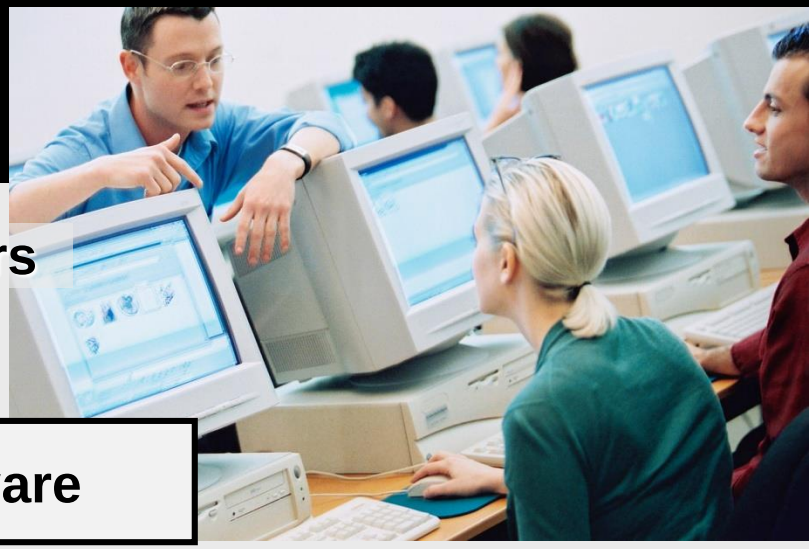
Operating Systems

- Two different types of programs are executed on a computer:
  - Applications: programs designed for a specific use and with which a user interacts
  - Operating system (OS) software: software components used to control the hardware of the computer

Operating Systems

- Device Driver
  - Software containing instructions that the OS uses to control and interact with a specific type of computer hardware
- User Interface
  - Application program that allows the user to interact with the OS and other application programs
  - Can be a command line prompt or a graphical user interface (GUI)

Operating Systems



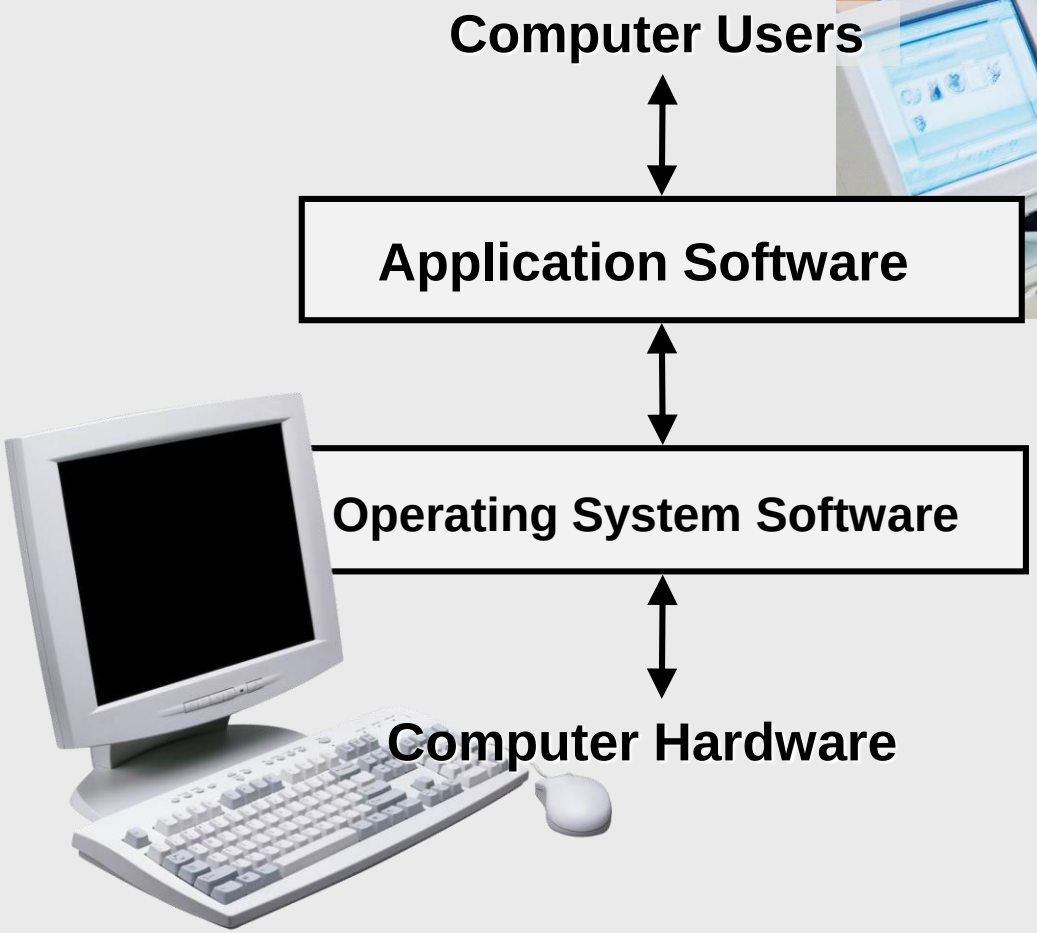


Figure 1-1: ***The role of operating system hardware***

Operating Systems

- Graphical user interface (GUI): Component of an OS that provides a user-friendly interface
- System services: Applications that handle system-related tasks
  - Printing
  - Scheduling programs
  - Network access

The Linux Operating System

- OS used to run variety of applications on a variety of different hardware
- Has the ability to manage thousands of tasks at the same time
- Allows multiple users to access the system simultaneously
  - Multiuser and multitasking OS
- Tux the Penguin™ is the mascot

The Linux Operating System: Versions

- Core component: Linux kernel
  - Written almost entirely in the C programming language (like UNIX)
- Software can modify Linux appearance, but the kernel is common to all Linux
- Important to understand Linux kernel version numbers to decide which version is appropriate for user needs
- Good understanding of system hardware important in deciding which kernel version to use

Identifying Kernel Versions

- Linux kernel versions composed of: **a.b.c**
  - Kernel version (**a**)
  - Major version (**b**)
    - Prior to kernel 2.6
      - If odd = developmental kernel
      - If even = production kernel
    - Post kernel 2.6 no longer applies
  - Minor revision version (**c**)
- Current stable kernel: 4.12.8
  - Per kernel.org

Open Source Software (OSS)

- Programs distributed and licensed so that the *source code* is available to anyone who wants to examine, utilize, or improve upon its
- Open source doesn't just mean access to the source code; software must comply with the following criteria

Open Source Software (OSS)

- Free Redistribution
  - The license shall not restrict any party from selling or giving away the software as a component of an aggregate software distribution containing programs from several different sources
  - The license shall not require a royalty or other fee for such sale.

Open Source Software (OSS)

- Source Code
  - The program must include source code, and must allow distribution in source code as well as compiled form
  - Where some form of a product is not distributed with source code, there must be a well-publicized means of obtaining the source code for no more than a reasonable reproduction cost preferably, downloading via the Internet without charge
  - The source code must be the preferred form in which a programmer would modify the program. Deliberately obfuscated source code is not allowed
  - Intermediate forms such as the output of a preprocessor or translator are not allowed

Open Source Software (OSS)

- Derived Works
  - The license must allow modifications and derived works, and must allow them to be distributed under the same terms as the license of the original software
- Integrity of The Author's Source Code
  - The license may restrict source-code from being distributed in modified form only if the license allows the distribution of "patch files" with the source code for the purpose of modifying the program at build time
  - The license must explicitly permit distribution of software built from modified source code. The license may require derived works to carry a different name or version number from the original software

Open Source Software (OSS)

- No Discrimination Against Persons or Groups
- No Discrimination Against Fields of Endeavor
  - The license must not restrict anyone from making use of the program in a specific field of endeavor
  - IE, it may not restrict the program from being used in a business, or from being used for genetic research

Open Source Software (OSS)

- Distribution of License
  - The rights attached to the program must apply to all to whom the program is redistributed without the need for execution of an additional license by those parties
- License Must Not Be Specific to a Product
  - The rights attached to the program must not depend on the program's being part of a particular software distribution
- License Must Not Restrict Other Software
- License Must Be Technology-Neutral

Implications of OSS

- Developed very rapidly through widespread collaboration
- Bugs (errors) noted & promptly fixed
- Features evolve quickly based on user needs
- Perceived value of the software increases because it is based on *usefulness*, not on price

Software License Types

Type	Description
Open Source	Software in which the source code and software can be obtained free of charge and can be modified
Closed Source	Software in which the source code is not available; although it may be distributed free of charge, it is usually quite costly
Freeware	Closed source software given out free of charge
Shareware	Closed source software that is initially given out free of charge, but that requires payment after a certain period of use

Table 1-1: *Software Types*

The GNU Public License (GPL)

- Stipulates that source code of any software distributed under this license must be made freely available
- All software distributed under the GPL requires recipients receive “a copy of the License along with the Program”

GNU Public License Provisions

- Any licensee (anyone) can modify, copy and redistribute the work or any derivative version
  - Can charge a fee or do it for free
- Right to redistribute granted only if source code (including modifications) is included
  - Distributed copies and any modifications must also be licensed under the GPL

GNU Public License Provisions

- Modified versions that are not redistributed have no requirement to divulge the modifications
  - This allows GPL open source software to be used as the basis to develop proprietary in-house information systems

Effects of the License Model

- Everybody has access to the source
  - Volunteer software development on the Internet, with central coordination
  - Linus Torvalds coordinates the kernel
  - Others coordinate other pieces of the OS
- Peer reviews are possible
  - Security
  - Performance
- The license cannot change
  - So your changes (& name) stay in forever

Types of Closed Source Licenses

- Most closed source software sold commercially
  - e.g., Microsoft, Adobe, Electronic Arts, etc.
- Freeware
  - Distributed free of charge but source code is not necessarily available
- Shareware
  - Initially free, but requires payment after a period of time or usage

OSS Advantages: Cost Reduction

- OSS provided under two models:
- Free as in Freedom
  - As in “liberty” or “having freedom”, like *free speech*
- Free as in Beer
  - “At zero price”, free in the sense that some good or service is supplied without payment
- Many OSS projects are both

OSS Advantages: Cost Reduction

- Free as in Freedom
  - Developers can (and do) charge money for the software
    - Users are free to change *anything*
    - Users alternatively can download and compile the source code themselves instead of paying
  - Best known example: Red Hat Linux
  - Nearly always still cheaper than closed source alternatives

OSS Advantages: Cost Reduction

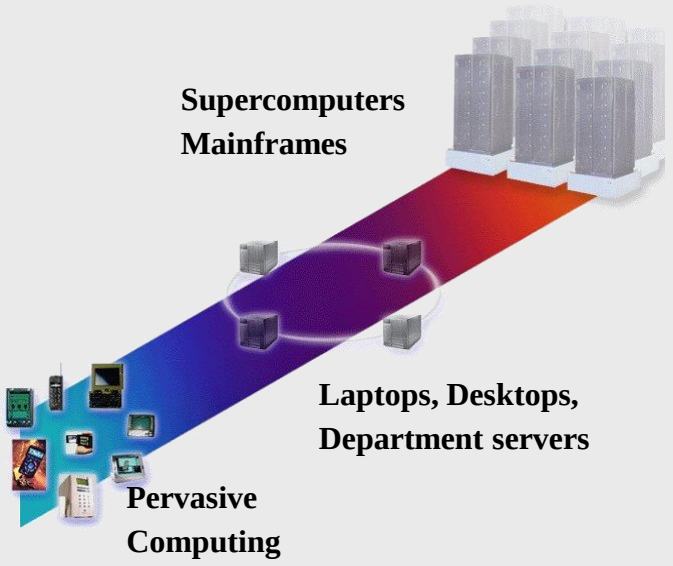
- Free as in Beer
  - Software distributed no charge or solely for the cost of distribution; the developer does not gain any monetary compensation
  - May or may not be Open Source
  - Much (most?) free software is both

OSS Advantages: Risk Reduction

- Changes in the market or customer needs may cause companies to change software frequently
  - Can be costly and time-consuming
- Support for closed source software may end
  - Vendor may go out of business
  - Software version may be retired
- OSS products offer opportunity to maintain and change the source code

Linux Today

- Linux covers the whole spectrum of computing
  - Embedded devices
  - Laptops
  - Desktop systems
  - Development systems
  - Small and large servers
  - Mainframes



Linux Today

- Linux is used throughout the world
  - ... and in space
- Linux is used by home users
  - ... and by some of the largest companies in the world
    - IBM
    - Boeing
    - NASA

Linux Advantages: Meeting Business Needs

- Common software available for Linux includes:
  - Scientific and engineering software
  - Software emulators
  - Web servers, Web browsers, and e-commerce suites
  - Desktop productivity software
  - Graphics manipulation software
  - Database software
  - Security software
  - Multimedia and CD-ROM creation

Linux Advantages: Stability and Security

- Customers using closed source OS must rely on OS vendor to fix bugs
  - Waiting for a hot fix may take weeks or months
- Bugs and security loopholes in OSS programs can be identified and fixed quickly
  - Code freely available and scrutinized by many developers

Linux Advantages: Flexibility

- Flexibility for Different Hardware Platforms
- Partial list of hardware platforms on which Linux can run:
  - Intel
  - Itanium
  - Mainframe (S/390)
  - Cirrus Logic ARM
  - DEC Alpha
  - MIPS
  - M68K
  - PA-RISC
  - SPARC
  - Ultra-SPARC
  - PowerPC
  - AMD

Linux Advantages: Ease of Customization

- Can be customized to work on mobile and embedded devices
- Ability to control inner workings of the OS
  - To use Linux as an Internet Web server, compile the kernel to include only the support needed to be an Internet Web server
    - Results in a much smaller and faster kernel
  - Can choose to install only software packages needed to perform required tasks
  - Can use shell and PERL scripts to customize or automate tasks

Linux Advantages: Ease of Obtaining Support

- Linux documentation easily found on the Internet
  - Frequently asked questions (FAQs)
  - HOWTO documents
  - http://www.tldp.org/
- Linux newsgroups
- Linux User Groups (LUGs)
  - Open forums of Linux users who discuss and assist each other in using and modifying the Linux OS

Linux Advantages

- No reboots
  - Install/remove & stop/start software without interrupting OS operation
  - Only reboot for kernel update
- Portable software
  - Same applications on Linux, UNIX and BSD (which includes OS X)
  - Mature desktops (X Windows with Gnome and KDE) also found across Linux, UNIX and BSD

Linux Advantages

- Downloadable applications (for free!)
- No settings hidden in code or registries
- Freedom
  - Rewrite code to do what you want or need it to do
  - Free software that is free as in speech AND free as in beer

UNIX

- Evolved from Multiplexed Information and Computing Service (MULTICS)
- First true multitasking, multiuser OS
  - Originally written in Assembler
- Developed by AT&T's Bell Labs
  - Ken Thompson & Dennis Ritchie

UNIX

- Rewritten in the C programming language in 1971
  - Portable OS
  - Bell Labs provided documentation and source code to universities almost at cost
- Functionalities very quickly added
- OS on which Linux was based

UNIX

- Two Major UNIX *forks* (divisions)
  - Berkeley Software Distribution (BSD)
    - Version of original UNIX source code
    - Free BSD, Net BSD, Open BSD
    - Also (as Darwin) serves as the underlying code for Apple's OS/X
    - Generally free/Open Source

UNIX

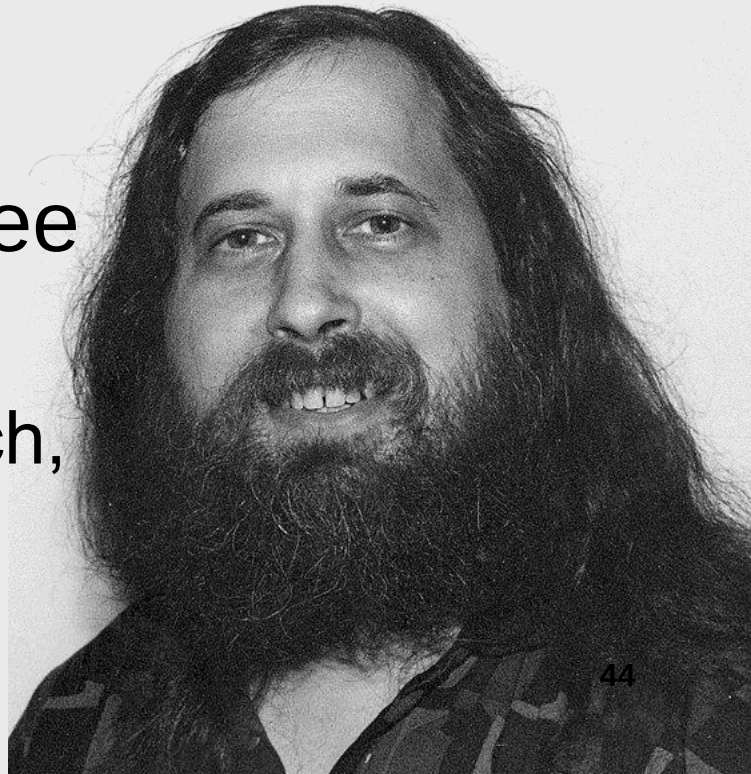
- Two Major UNIX *forks* (divisions)
  - AT&T / SystemV
    - Closed Source
    - In 1983 began marketing UNIX SystemV
      - proclaimed as “the” UNIX standard
    - Now belongs to Novell

UNIX

- Major flavors of UNIX today include:
  - Oracle (formerly Sun) Solaris (UNIX System V; has free/Open Source version but portions are still binary-only)
  - Hewlett-Packard HP-UX
  - IBM's AIX UNIX
  - Various BSD versions (mostly free)
  - Apple OS/X (built on BSD)

A Short History of Linux

- 1984: Richard Stallman starts GNU project
  - GNU's not UNIX
  - http://www.gnu.org
- Purpose: Produce a free version of UNIX
  - "Free as in Free Speech, not Free Beer"

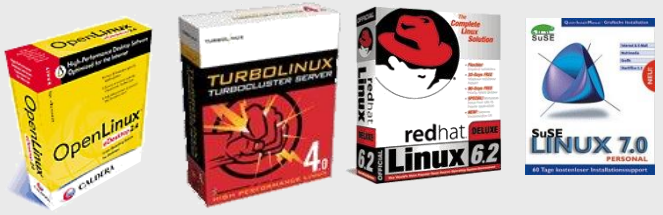


A Short History of Linux

- First step for GNU: re-implement UNIX Utilities
  - C compiler, C library
  - emacs
  - bash
- To fund the GNU project, Free Software Foundation is founded
  - http://www.fsf.org/
- Original kernel was HURD Mach
  - Attempted to create micro kernel
  - Communicated asynchronously (buggy)

A Short History of Linux

- 1991: Linus Torvalds writes first version of Linux kernel
  - Initially, research into 386 protected mode
  - Combined with the GNU and other tools to form a complete UNIX system
- 1992: First distributions emerge
  - Linux kernel
  - GNU and other tools
  - Installation procedure



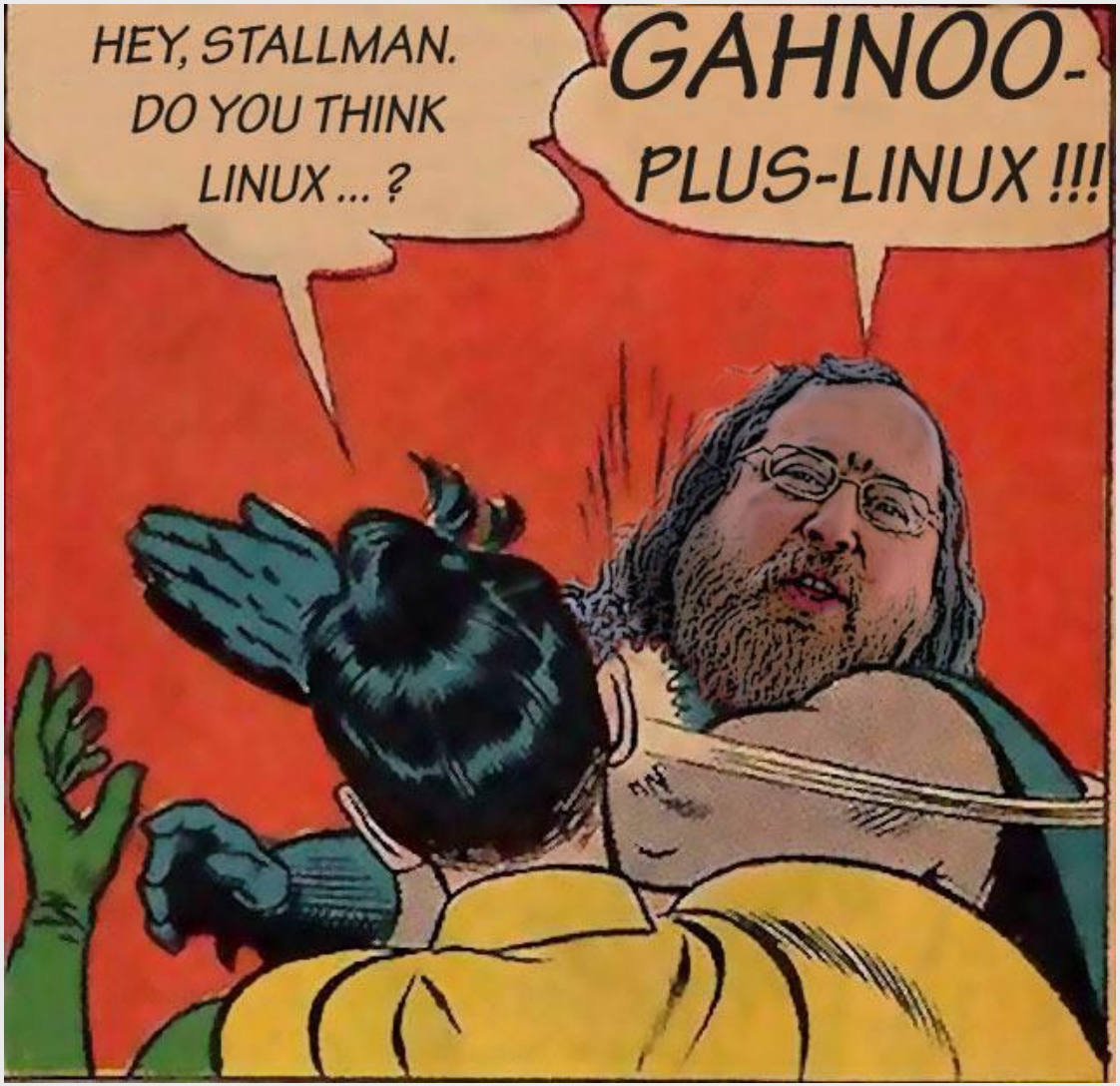
A Short History of Linux


```
From: torvalds@klaava.Helsinki.FI (Linus Benedict Torvalds)
Newsgroups: comp.os.minix
Subject: What would you like to see most in minix?
Summary: small poll for my new operating system
Message-ID:
Date: 25 Aug 91 20:57:08 GMT
Organization: University of Helsinki


Hello everybody out there using minix -

I'm doing a (free) operating system (just a hobby, won't be big and
professional like gnu) for 386(486) AT clones.  This has been brewing
since april, and is starting to get ready.  I'd like any feedback on
things people like/dislike in minix, as my OS resembles it somewhat
(same physical layout of the file-system (due to practical reasons)
among other things).

I've currently ported bash(1.08) and gcc(1.40), and things seem to work.
This implies that I'll get something practical within a few months, and
I'd like to know what features most people would want.  Any suggestions
are welcome, but I won't promise I'll implement them :-)

                Linus (torvalds@kruuna.helsinki.fi)

PS.  Yes - it's free of any minix code, and it has a multi-threaded fs.
It is NOT protable (uses 386 task switching etc), and it probably never
will support anything other than AT-harddisks, as that's all I have :-(.
```

Linux

- Developed by Linus Torvalds in 1991
  - Published under the GNU public license
- Linux kernel developed collaboratively and centrally managed (by Linus)
  - Linux OS is simply a by-product of OSS development
- Some prefer to call it GNU/Linux
  - (Richard Stallman)

Linux



Linux Distributions

- A **Linux distribution** or **GNU/Linux distribution** (or a **distro**)
  - A Unix-like operating system plus packaged application software comprising the Linux kernel, the GNU operating system, assorted free software and sometimes proprietary software
  - Many provide an install program similar to those provided with operating systems distributed in binary form

LINUX & OPEN SOURCE

Major Linux Distributions

- In Alpha Order:
  - Arch
  - Debian
  - Fedora
  - Gentoo
  - Linux Mint
  - Knoppix
  - Mandriva
  - MEPIS
  - PCLinuxOS
  - Red Hat
  - Slackware
  - SUSE
  - TurboLinux
  - Ubuntu
  - Xandros

RedHat Enterprise Distributions

- Since RedHat must release the source code for their commercial product under the GNU Public License, some groups have decided to compile & distribute the current distribution for free
- Whitebox Linux
  - Supported by Beauregard Parish Public Library in DeRidder, Louisiana (inactive)
- CentOS
  - Maintained by a community of open source contributors and users

White Box

CentOS

Linux Distribution Web Sites

LINUX & OPEN SOURCE

URL	Site Description
redhat.com	Red Hat Linux
getfedora.org	Fedora Linux
centos.org	Centos Linux
opensuse.org	openSUSE Linux
debian.org	Debian Linux
ubuntu.com	Ubuntu Linux
archlinux.org	Arch Linux
gentoo.org	Gentoo Linux
linuxmint.com	Linux Mint
knoppix.org	Knoppix Linux
slackware.com	Slackware Linux
distrowatch.com	Detailed information about Linux distributions
kernel.org	Linux kernel
ftp.uwsg.indiana.edu	ISO images of almost every Linux & BSD distribution

Linux Distribution and Kernel Sites

Linux Distributions

- Distributions may appear different on the surface, but run the same kernel
- Most distributions ship with a GUI that can be further customized to suit needs of the user
  - Core component of this GUI is the X Window System, aka X11 or just X
  - Can customer desktop environment and window manager to change look

Linux Distributions

- GUI environment
  - X Windows in combination with a window manager and desktop environment
- Two major competing GUI desktop environments in Linux:
  - GNU Network Object Model Environment (GNOME)
  - K Desktop Environment (KDE)
  - Several more exist and are becoming as popular as GNOME and KDE

Linux Desktop Environments

Figure 1-2: ***A Gnome Desktop***

Linux Desktop Environments

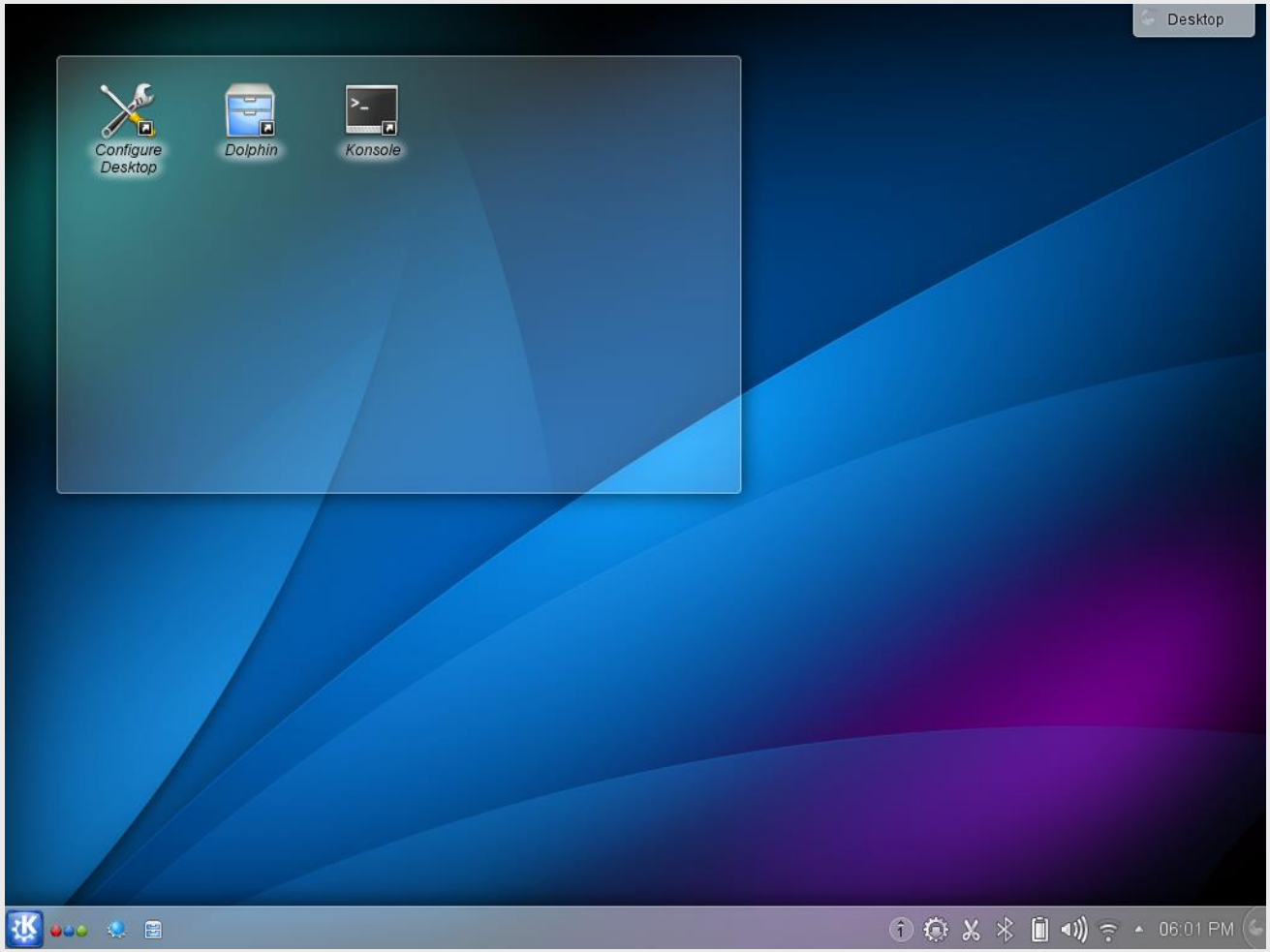


Figure 1-3: ***A KDE Desktop***

Linux Desktop Environments

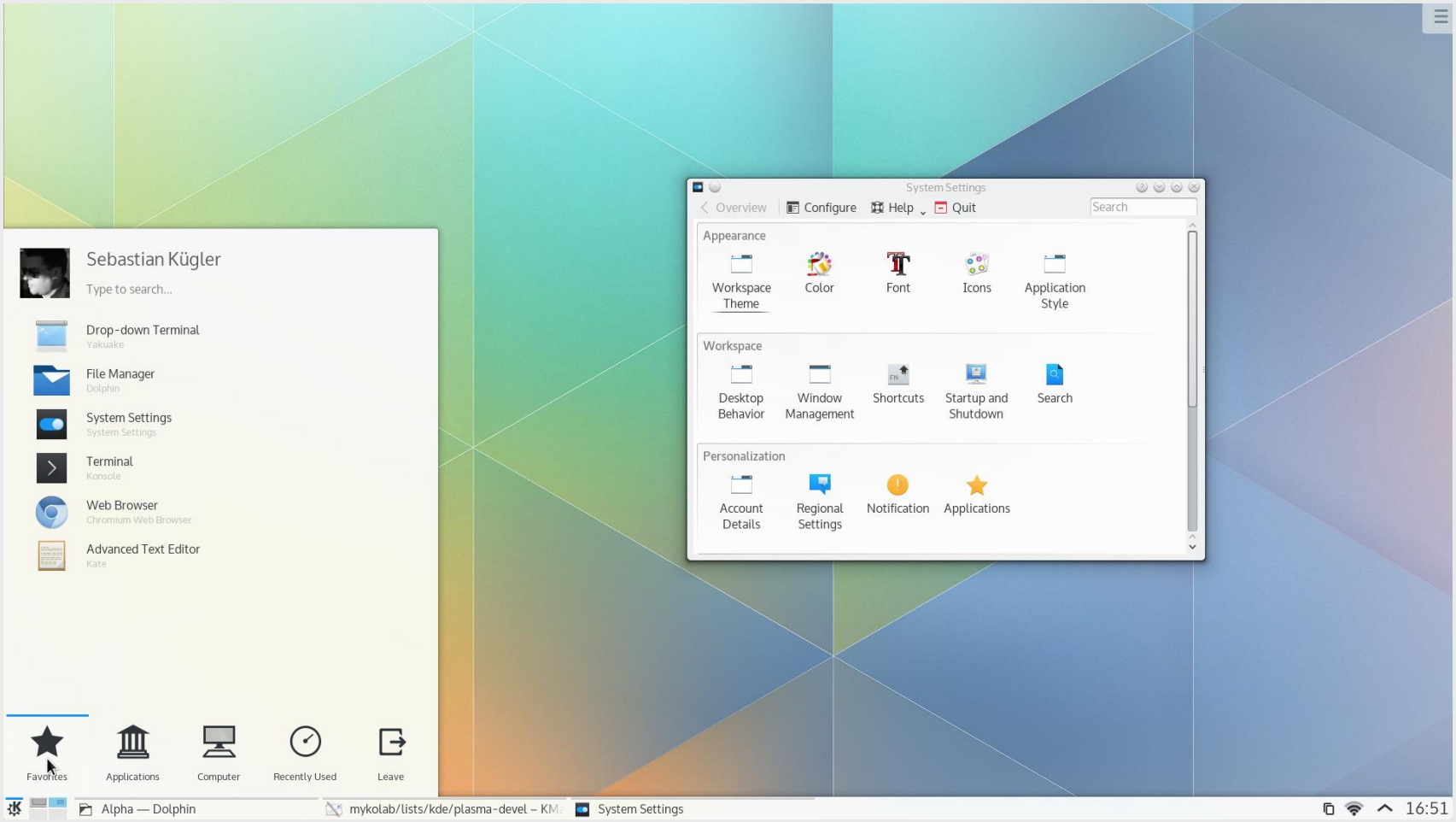


Figure 1-4: *A Plasma Desktop*

Linux Desktop Environments

Figure 1-5: ***A Unity Desktop***

Common Uses of Linux

- May be customized to provide services for a variety of companies in a variety of situations
- Workstation services
  - Services used on a local computer
- Server services
  - Made available for other computers across a network

Internet Servers: Mail Services

- Mail transfer agent (MTA)
  - An e-mail server
- Mail delivery agent (MDA)
  - Service that downloads e-mail from an MTA
- Mail user agent (MUA)
  - Program that allows e-mail to be read by a user

Internet Servers: Routing and FTP Services

- Routing
  - Provides interconnection between separate networks
  - Core service necessary for Internet to function
  - Linux provides support for routing and is easily customizable
- File Transfer Protocol (FTP) Services
  - Common method for transferring files over the Internet

Internet Servers: Firewalls and Proxy Services

- Firewall
  - Protects companies from outside intruders on the Internet
  - Linux has firewall support built into the kernel
- Proxy server
  - Requests Internet resources such as Web sites and FTP sites on behalf of computers inside the company
  - Common Linux proxy server is Squid

Internet Servers: Web Services and News Services

- Web services
  - Web servers host information (text, pictures, music, binary data, and video)
  - Can also process programs known as Common Gateway Interface (CGI) scripts and provide secure connections

Internet Servers: DNS Services

- Computers communicating on a network need to be uniquely identified
  - Each computer is assigned an Internet Protocol (IP) address
    - Long string of numbers
    - Allows computers to identify and reference each other
- Fully Qualified Domain Name (FQDN)
  - Masks IP addresses with user-friendly names

File and Print Servers

- Linux is well-suited for centrally sharing resources
  - More economical to share files and printers over a network
  - Inherently fast and light
  - A distribution specific to a certain task can be installed on the central server
  - Can share resources with a computer running another OS

Supercomputers

- Clustering
  - Combining several smaller computers to act as one large supercomputer
- Scalability
  - Computers that can increase workload as number of processors increases
  - Clustering computers often results in better scalability than adding processors to a single computer

Scientific/Engineering Workstation

- Scientific and engineering community often needs customized programs
- OSS programs can be used or modified
  - OSS software for physics, astrophysics, biophysics, bio-computation, data mining, and many other scientific and engineering fields

Office/Personal Workstation

- Workstation software designed for end users in office and home environments
  - Text editors and word processors
  - Graphics editing software
  - Desktop publishing software
  - Financial software
  - Office productivity suites
  - Bittorrent clients

Retro Gaming System

Ethical Hacking

Personal Linux Use

- Virtualization of other systems
  - VMware ESXi
- Firewall
  - Sophos UTM (previously used pfSense)
- CentOS 7 serving
  - Security Cameras
  - Network file sharing/backups via SAMBA
  - Media server using Plex & PlexPy
  - Mumble Server via Murmur
  - Game Servers

Personal Linux Use

- Raspberry Pi
  - Gen1 running pidora serving DNS via Pi-hole
  - Gen3 running retropie based on retroarch
- Security Onion
  - Hosting multiple different network security software
- Management of UPS
  - Logging/reporting and actions to take when power is out

Linux Distribution Forks

- Debian-based
  - Knoppix
  - **Ubuntu**
- Gentoo-based
- Pacman-based
  - Arch
- RPM-based
  - **Fedora**
  - RHEL
  - openSUSE
- Slackware-based

Linux Distributions for ITMO 456

- Linux has two *primary* forks:
  Red Hat and **Debian**
  - Differences primarily characterized by software distribution/installation methods
    - rpm/yum/dnf (Red Hat) versus deb/apt (Debian)

Linux Distributions for ITMO 456

- Fedora 26
  - Red Hat based
  - Geared towards workstations
    - Server version available
  - Uses RPM and Systemd
  - Released July 11, 2017
- Ubuntu Server 14.04 LTS
  - Debian-based
  - Uses DPKG and initd
    - Ubuntu 15 and above migrated to systemd
  - Released April 17, 2014
  - Long term support (April 2019)

Summary

- Linux is an OS running the Linux kernel
- Kernel and additional software are freely developed and improved upon by a large community of software developers
- Published under the GPL; is called Open Source Software (OSS)
- Companies find Linux a stable, low-risk, and flexible alternative to other OSs

Summary

- Comes in different distributions, all having a common kernel, but packaged with different OSS applications
- Wide variety of documentation and resources exist: Internet Web sites, HOWTOs, FAQs, newsgroups, and LUGs
- Extremely versatile OS that provides a wide range of workstation and server services

The End…

- Questions?