Ch1 Linux Basics

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Content

- What is Linux
- Linux Installation
- Using the System
- Linux Programming Prerequisite
- Linux/UNIX Overview

What is Linux?

- A free Unix-type operating system developed under the GNU General Public License.
  - Open source
  - Popular
  - Support most of the platforms available

A Short History of UNIX

- Multics: AT&T Bell Lab, GE, MIT
- UNIX: 1969, Ken Thompson, Dennis Ritchie
- Rewrite UNIX with C: 1973
- BSD: 1978, Berkeley Software Distribution
- System V: 1983
- Minix: 1987, Andrew Tannenbaum
- Commercial products
  - SunOS, Solaris, HP-UX, AIX, SCO UNIX
- Standards
  - SVID, IEEE POSIX, X/Open XPG4.2

A Short History of Linux(1)

- 1984: Richard Stallman starts GNU project
  - GNU's Not Unix
  - http://www.gnu.org

- Purpose: Free UNIX
  - "Free as in Free Speech, not Free Beer"

- First step: re-implementation of UNIX Utilities
  - C compiler, C library
  - emacs
  - bash

- To fund the GNU project, the Free Software Foundation is founded
  - http://www.fsf.org

A Short History of Linux(2)

- 1991: Linus Torvalds writes 1st version of Linux kernel
  - Initially a research project about the 386 protected mode
  - Linus' UNIX -> Linux
  - Combined with the GNU and other tools forms a complete UNIX system

- 1992: First distributions emerge
  - Linux kernel
  - GNU and other tools
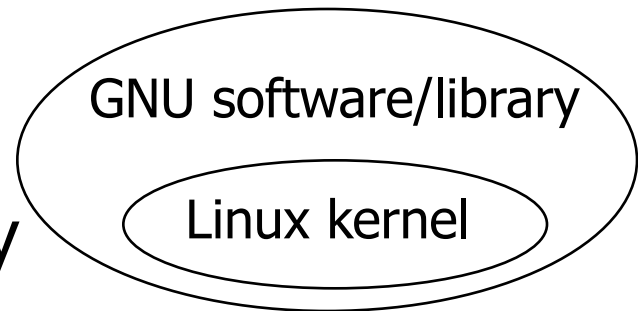 - Installation procedure

- The rest is history...

GNU & Linux

- ## GNU/Linux System
  - Linux kernel
  - GNU software/library
- ## Distributions：
  - Red Hat, Debain, SuSe, Mandrake, Redflag…

GNU software/library

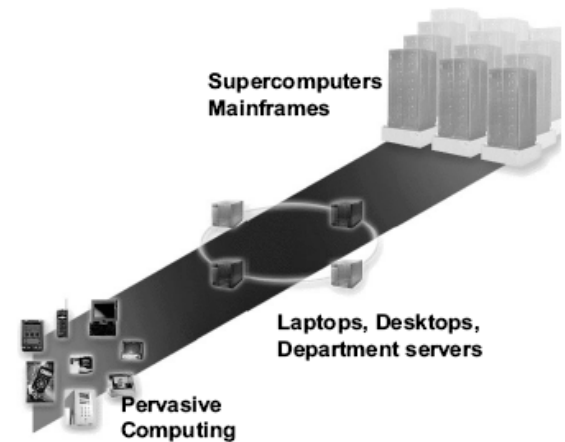Linux kernel

What is So Special for Linux?

- Most software (including the Linux kernel) is **GPL**'ed (GNU General Public License)
  - http://www.gnu.org/copyleft/gpl.html

- Is called "copyleft" (instead of "copyright")
  - You may copy the software
  - You get the source code
  - You may alter the source code and recompile it
  - You may distribute the altered source and binaries
  - You may charge money for all this

- You only may not change the license
  - So all your customers have the same rights as you
  - So you really cannot make money from selling the software alone

- Other Open Source licenses (e.g. BSD) are also used

Linux Today

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

- 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

Supercomputers Mainframes

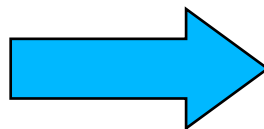**Laptops, Desktops, Department servers**

Pervasive Computing

Installation Methods

- Distributions：
  - Redhat -> Fedora
  - Debian
  - SuSe
  - Mandrake
  - Ubuntu
  - ……
- Live CD
- Using virtual machine
  - VMware, Virtual Box, etc.

Installation Methods
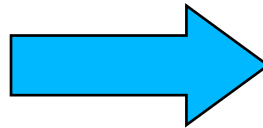
- Distributions：
  - Redhat -> Fedora
  - Debian
  - SuSe
  - Mandrake
  - Ubuntu
  - ……
- Live CD
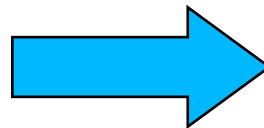- Using virtual machine
  - VMware, Virtual Box, etc.

Iceweasel 冰鼬

IceDove

Iceape

Sunbird
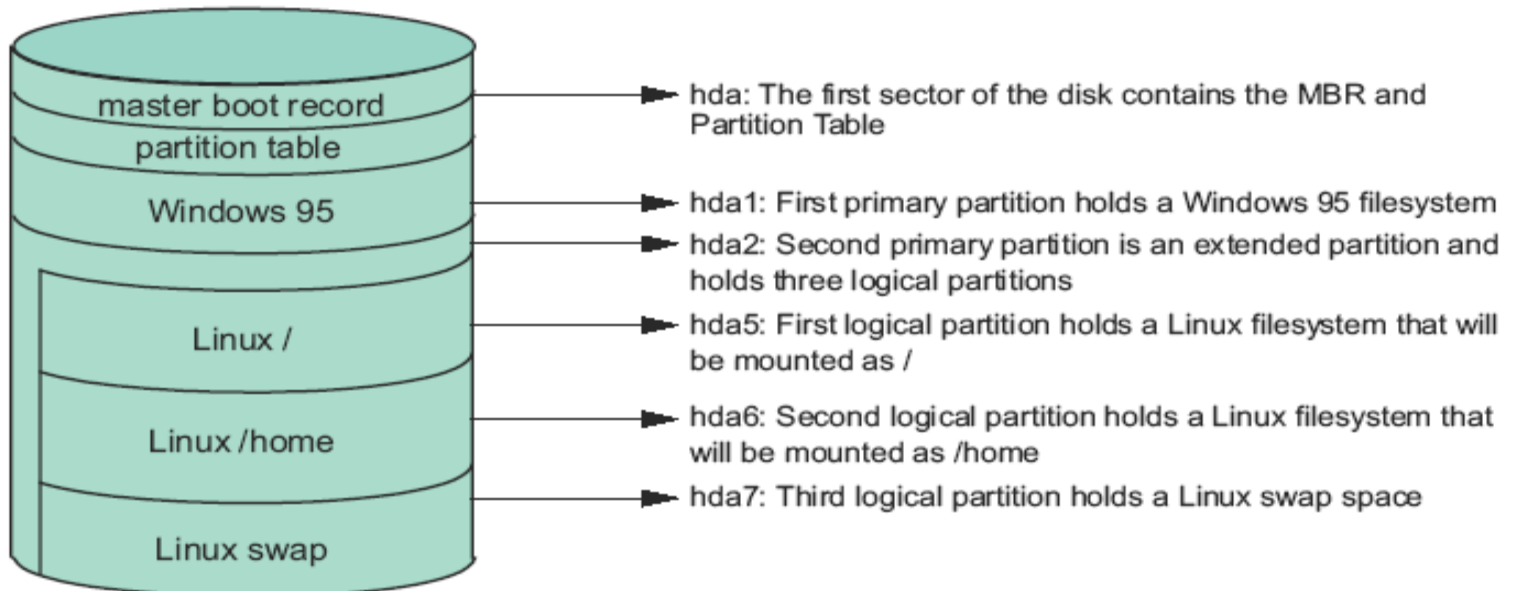
IceOwl

Installing Linux

- Boot system from bootable media
- All installation programs need to perform essentially the same steps:
  - Choose language, keyboard type, mouse type
  - Create partitions **
  - Setup a boot loader **
  - Configure network
  - Configure user and authentication
  - Select package groups
  - Configure X
  - Install packages
  - Create boot disk

Partitioning Theory

- Partitioning is necessary on Intel-based computers

- Maximum of four primary partitions

- One primary partition may be an extended partition

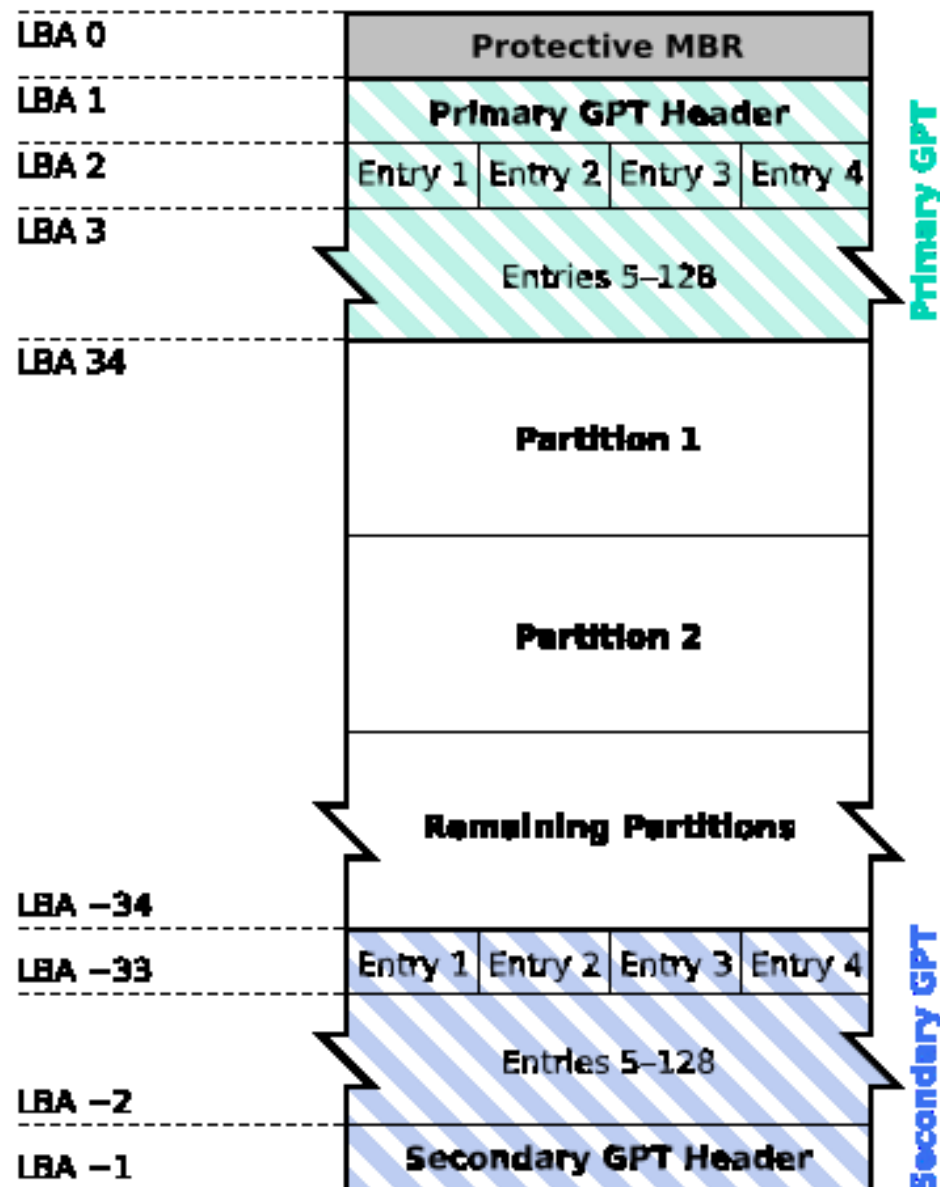- An extended partition can hold an unlimited amount of logical partitions (Linux: max 59)

Disk layout	Description
master boot record / partition table	hda: The first sector of the disk contains the MBR and Partition Table
Windows 95	hda1: First primary partition holds a Windows 95 filesystem
	hda2: Second primary partition is an extended partition and holds three logical partitions
Linux /	hda5: First logical partition holds a Linux filesystem that will be mounted as /
Linux /home	hda6: Second logical partition holds a Linux filesystem that will be mounted as /home
Linux swap	hda7: Third logical partition holds a Linux swap space

Master Boot Record

- Size: 512 bytes (first sector of hd)
- Addressed by BIOS
- Content:
  - 446 bytes program code (to boot an OS)
  - 64 bytes partition table with max. 4 entries
  - 2 bytes "magic number" (0x55AA)

GUID Partition Table Scheme

LBA 0	**Protective MBR**	
LBA 1	**Primary GPT Header**	*Primary GPT*
LBA 2	Entry 1 | Entry 2 | Entry 3 | Entry 4	
LBA 3	Entries 5–128	
LBA 34	**Partition 1**	
	Partition 2	
	Remaining Partitions	
LBA −34	Entry 1 | Entry 2 | Entry 3 | Entry 4	*Secondary GPT*
LBA −33	Entries 5–128	
LBA −2		
LBA −1	**Secondary GPT Header**	

File System

- ## What is File System
  - 操作系统中负责存取和管理文件的部分
  - A collection of files and certain of their attributes. It provides a name space for file serial numbers referring to those files. (susv3)
- ## File System in Linux:
  - VFS
 - EXT2, EXT3, FAT32, ...

Disk Partitioning

- At a minimum, create
  - /, 750MB (1.5G or more recommended)
  - Swap, size equal to amount of memory
- Recommended: /boot (16MB)
- May need/want to create other partitions:
  - /usr, /usr/local, /var, /tmp, /opt, /home
- Default partitioning program under Linux is fdisk
 - Distributions may add their own partitioning programs

Linux Startup Flow

power on
↓
BIOS
↓
boot loader
↓
Linux kernel
↓
init
↓
system ready
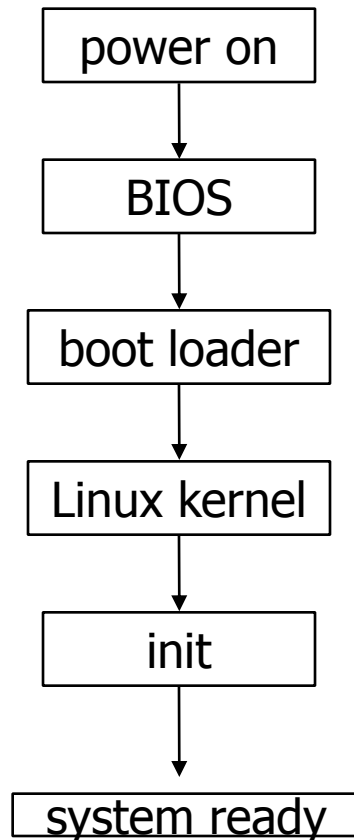
- BIOS
  - Checks memory, loads options from non-volatile memory, checks for boot devices, loads MBR of boot device and executes it
- MBR
  - Contains a "boot loader" and the partition table
  - Traditionally set up by LILO/GRUB
- Boot loader
  - Loads the compressed kernel image into memory
  - The kernel uncompress itself and starts…
- Init process
  - Configuration file /etc/inittab
  - run levels
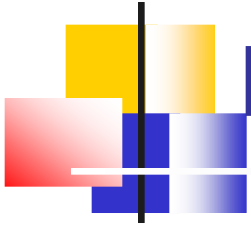
Basic Input Output System (BIOS)

- Checks memory and hardware (POST)
- Loads options from non-volatile memory
  - Memory timings
  - Order of boot devices
- Checks for boot devices
  - Floppy disks, CD-ROM, Hard disks, etc.
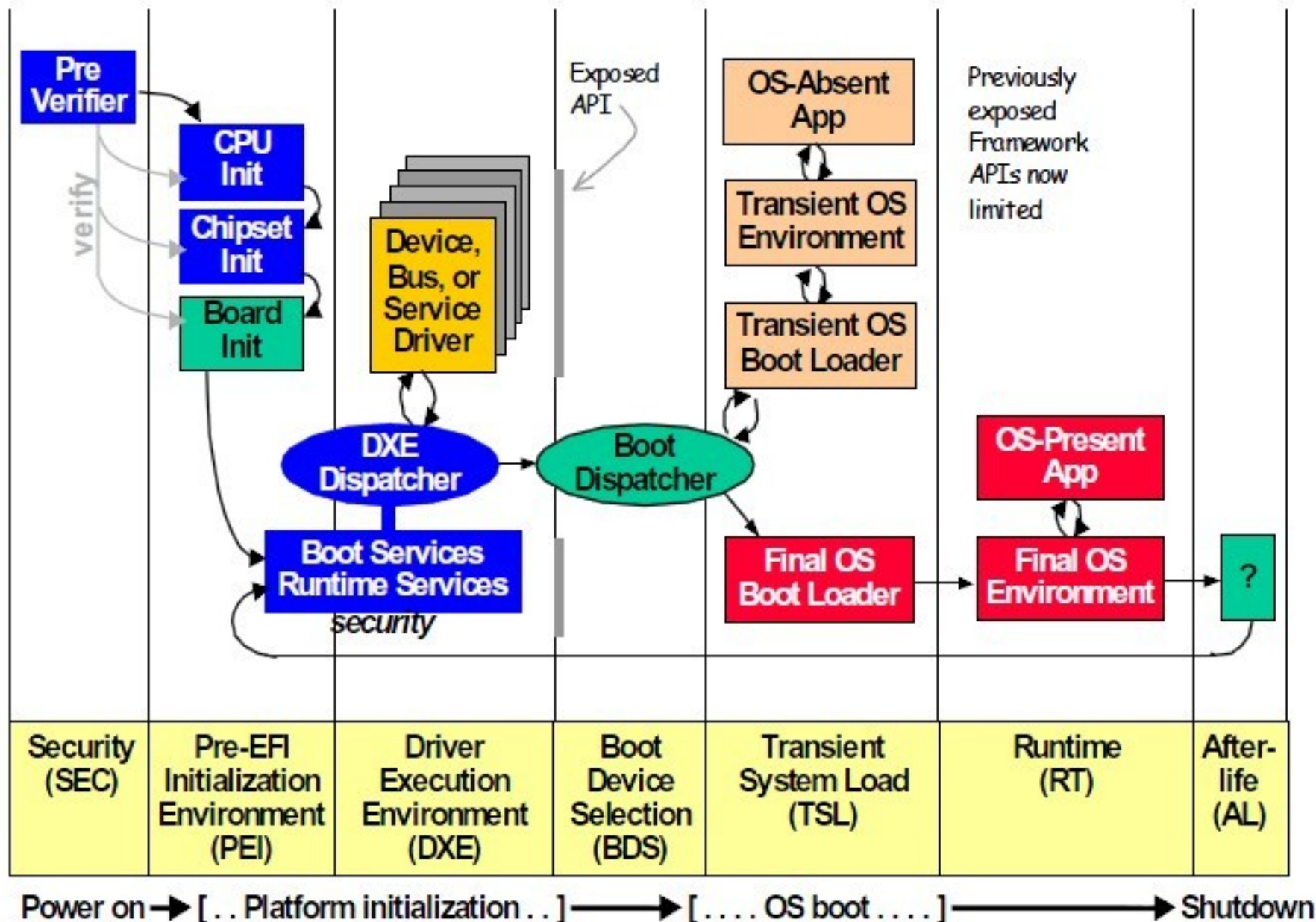- Load MBR of boot device and executes it

Figure 1-2. Framework Firmware Phases

Boot loader

- A boot loader loads and starts the Linux kernel
  - Can pass boot parameters to the Linux kernel, such as device information
  - Can optionally load an Initial Root Disk
  - Can boot other operating systems as well
- Common Boot loaders:
  - LILO: Linux Loader
  - GRUB: Grand Unified Boot Loader
- Generally configured in /dev/hda, unless other boot loader is used.
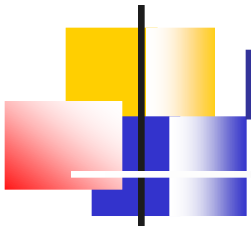
LILO - Linux Loader

- LILO
  - A Program that configures the MBR according to the configuration file.
  - Must be run as *root* with the *lilo* command.
- *lilo* command Syntax:
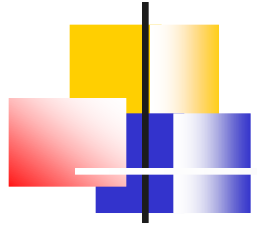 - lilo [-v] [-v] [-C config-file] [-t]
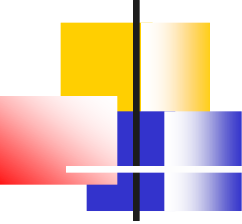 - Configuration file: /etc/lilo.conf

GRUB – GRand Unified Bootloader

- GRUB
  - Program stored in MBR (first stage) and in /boot/grub (1.5th and second stage)
  - Understand file system structure; no need to activate a configuration as with LILO
  - Configuration file /boot/grub/grub.conf
  - Installed in MBR with grub-install

- title   Ubuntu, kernel 2.6.20-16-generic
- root   (hd0,1)
- kernel   /boot/vmlinuz-2.6.20-16-generic root=UUID=3f784cd9-516f-4808-a601-b19356f6bdea ro quiet splash locale=zh_CN vga=0x318
- initrd   /boot/initrd.img-2.6.20-16-generic

- title   Microsoft Windows XP Professional
  root   (hd0,0)
  savedefault
  makeactive
  chainloader   +1

Using the System

- Basic Knowledge
- Working with Files and Directories
- Working with Processes
- Linux Documentation

CLI vs GUI

```
brushington@MacBP:~$
```

TABLE 2: Static Details

Component	Loop	LoopBound	Rec
adpcm	18	2424	
bs	1	4	
bsort	3	100	
cnt	4	10	
compress	7	50	
cover	3	120	

Installing Software on Linux

- From a tarball
  - tar zxvf application.tar.gz
  - cd application
  - ./configure
  - make
  - su -
  - make install

Installing Software on Linux (cont'd)

- apt-get command *
- dpkg
- aptitude

- yum + rpm
- RPM: RPM Package Management
    - rpm –q –a
    - rpm –ivh package-name
    - rpm –e package-name

Multi-user and Multi-tasking

- Linux is a multi-user, multi-tasking operating system
  - Multiple users can run multiple tasks simultaneously, independent of each other.
- Always need to "log in" before using the system
  - Identify yourself with user name, password
- Multiple ways to log in to the system
  - Console: Directly attached keyboard, mouse, monitor
 - Serial terminal
  - Network connection

Virtual Terminal

- In most Linux distributions, the console emulates a number of virtual terminals
- Each virtual terminal can be seen as a separate, directly attached console
  - Different users can use different virtual terminals
- Typical setup:
  - VT 1-6: text mode logins
  - VT 7: graphical mode login prompt (if enabled)
- Switch between VTs with Alt-Fn (or Ctrl-Alt-Fn if in X)
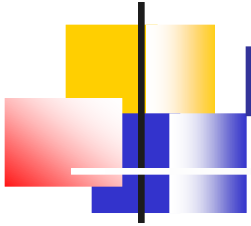
Linux Commands

- Everything on a Linux system can be done by typing commands
  - the GUI (X-Window) is not needed for running a Linux System
- In order to type commands in X-Window you need to start a terminal emulator
- Command Prompt
  - Can be configured yourself
  - $ - "logged in as a regular user",
  - # - "logged in as root"

Command Syntax

- Linux commands have the following fomat:

  $ command option(s) argument(s)

- Examples:

  $ ls

  $ ls –l

  $ ls /dev

  $ ls –l /dev

Some Basic Linux Commands

- passwd: Change your password
- mkpasswd: Generate a random password
- date, cal: Find out today's date and display a calendar
- who, finger: Find out who else is active on the system
- clear: Clear the screen
- echo: Write a message to your screen
- write, wall, talk; mesg
- ......

Working with Files & Directories

- What is a file?
    - A collection of data;
    - An object that can be written to, or read from, or both. A file has certain attributes, including access permissions and type. (susv3)
- File structure
    - Generally: byte stream, record sequence, record tree
    - In Linux: byte stream

File Types

- **regular file**
  - Text or code data; no particular internal structure
- **character special file**
- **block special file**
  - Special files: represent hardware or logical devices
  - Found in directory called /dev
- **socket**
- **symbolic link**
- **Directory**
  - A table of contents; a list of files in that directory
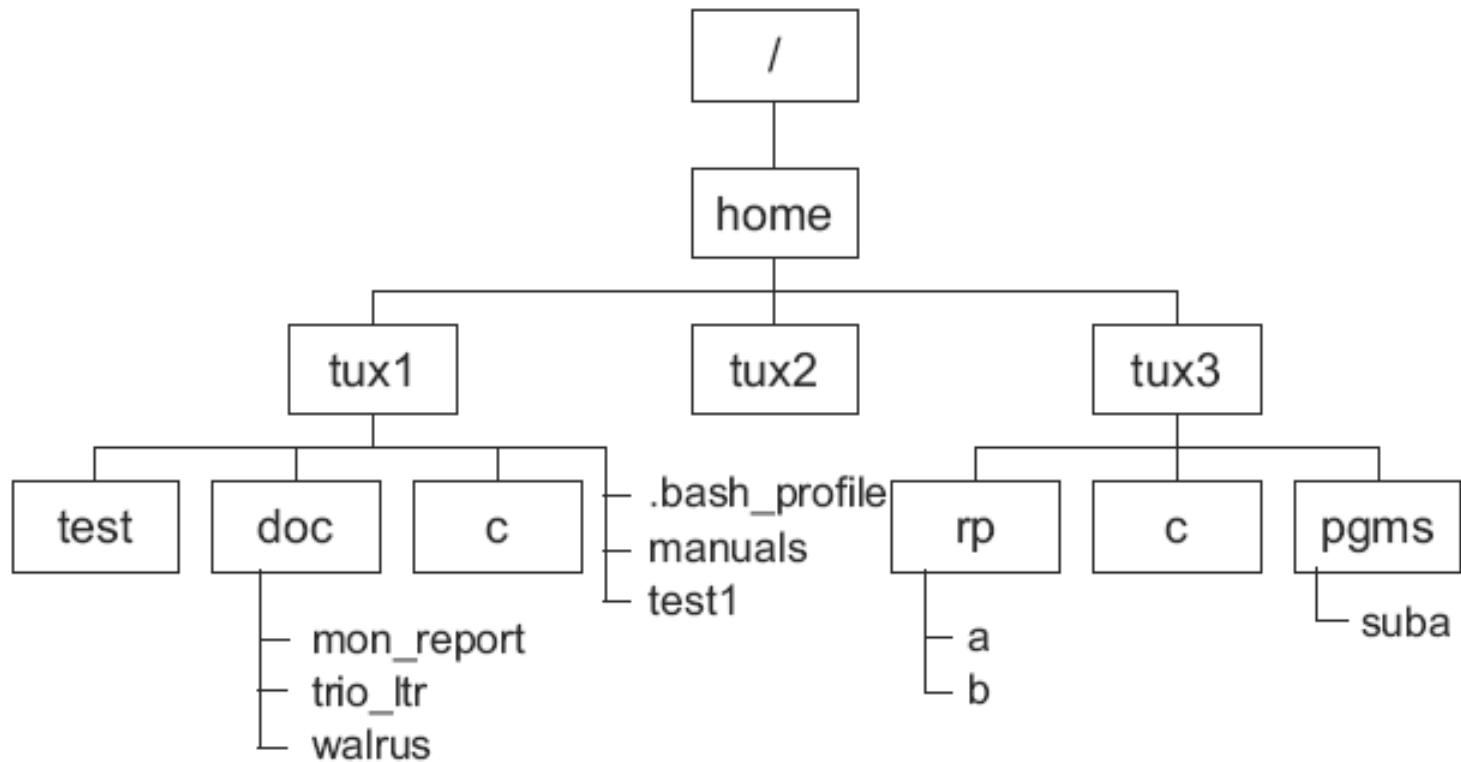
Directory Structure

- All Linux directories are contained in one, virtual, "unified file system".
- Physical devices are mounted on mount points
  - Floppy disks
  - Hard disk partition
  - CD-ROM drives
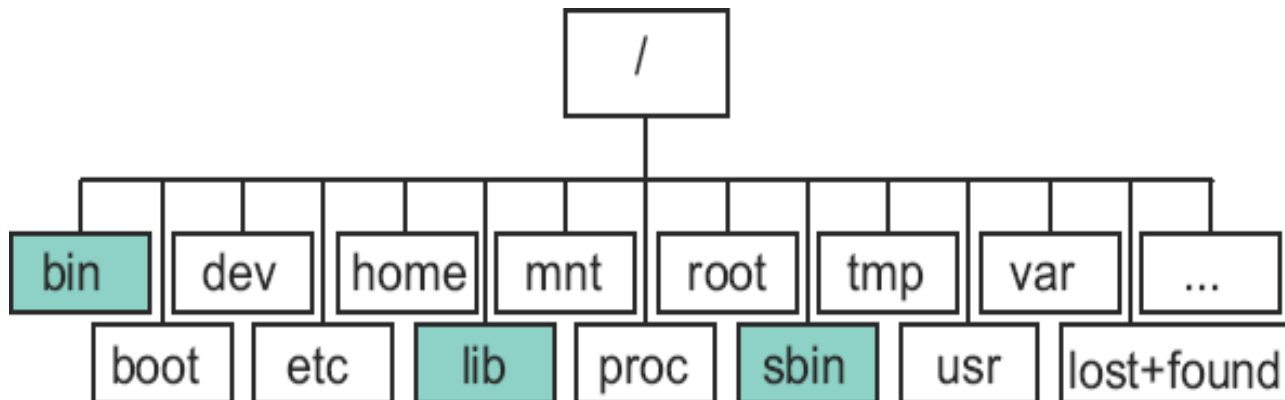- No drive letter like A:, C:, …

An Example of Directory Structure

Main Directories in Linux

Linux Filesystem Hierarchy Standard:
http://www.pathname.com/fhs

Basic Commands(1)

- Commands used with directories:
  - pwd: print working directory
  - cd: change directory
  - mkdir: make directory
  - rmdir: remove directory
  - ls: list the contents of directories
    - -l, -a, -R options

Basic Commands(2)

- commands used with files:
  - touch: update the access and/or modification time of a files
  - cp: copy files
  - mv: move and rename files
  - ln: link files
  - rm: remove files
  - cat: print file contents
  - more/less: display files page by page
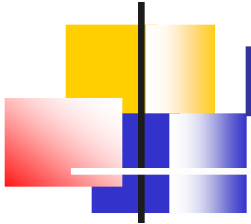
File Permission

- File Permissions help you protect your files against other users on the system

- Three access levels:
    - User: The user that created the file
    - Group: All users in the group that owns the file
    - Others: All others

- Three permissions:
    - Read (**r**): Read content of file or list content of directory
    - Write (**w**): Change content of file or create/delete files in directory
    - Execute (**x**): Execute file as program or use directory as active directory

Viewing File Permissions

To show the permissions of a file, use the **ls** command with the **-l** option

```
$ ls -l
-rw-r--r--   1 tux1   penguins   101   Jun 5 10:03   file1
-rw-r--r--   1 tux2   penguins   171   Jun 4 10:23   file2
drwxr-xr-x   2 tux1   penguins   512   Jun 7 11:13   mydir
```

File type   owner   size   name

permissions   group   mtime
(modification time)

link counter

Changing Permissions

- The `change mode` command:

```
$ chmod <who operator what> filename
```

who:
u = owner of file
g = group
o = other users on the system
a = all (owner+group+others)
operator:
+ = add permission
- = remove permission
= = clear permissions and set to mode specified
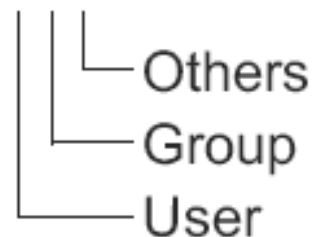**what:**
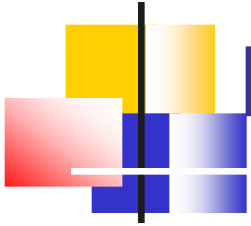r = read
w = write
x = execute

Changing Permissions (cont'd)

- File and directory permissions can also be specified as an octal number:

	User	Group	Other
Symbolic notation	rwx	rw-	r-x
Binary	111	110	101
	4+2+1	4+2+0	4+0+1
Octal	7	6	5

```
$ chmod 765 file
          │││
          ││└── Others
          │└─── Group
          └──── User
```

Default File Permissions

- The default permission for newly created files and directories are:

  File: -rw-r--r--   644

  Directory: drwxr-xr-x 755

Editing Files

- vi

- emacs

- gedit

- ...

Working with Processes

- What is a process?
  - A process is a task.
  - 进程是一个正在执行的程序实例。由执行程序、它的当前值、状态信息以及通过操作系统管理此进程执行情况的资源组成。
  - An address space with one or more threads executing within that address space, and the required system resources for those threads. (susv3)

Working with Processes (cont'd)

- A running program is an example of a process

The Process Environment	
Program name	User and group ID
Data	Process ID (PID)
Open Files	Parent PID (PPID)
Current Directory	Program variables

- A shell is a process that reads your commands and start the appropriate process.
  - echo $$

Starting and Stopping a Process

- All processes are started by other processes
  - Parent/Child relationship
  - One exception: init (PID 1) is started by the kernel itself
  - A tree hierarchy
- A process can be terminated because of two reasons:
  - The process terminates itself when done.
 - The process is terminated by a signal from another process

Basic Commands

- ps: report process status
- pstree: display a tree of processes
- jobs, fg, bg, <ctrl-z>: job controlling
- kill:
- nohup: run a command, ignoring hangup signals
- nice, renice:
- top: display top CPU processes

Daemons

- The word "Daemon" refers to a never-ending process, usually a system process that controls a system resource such as the printer queue or performs a network service

Print Queue

print job 1
print job 2
print job 3

lpd

/dev/lp0
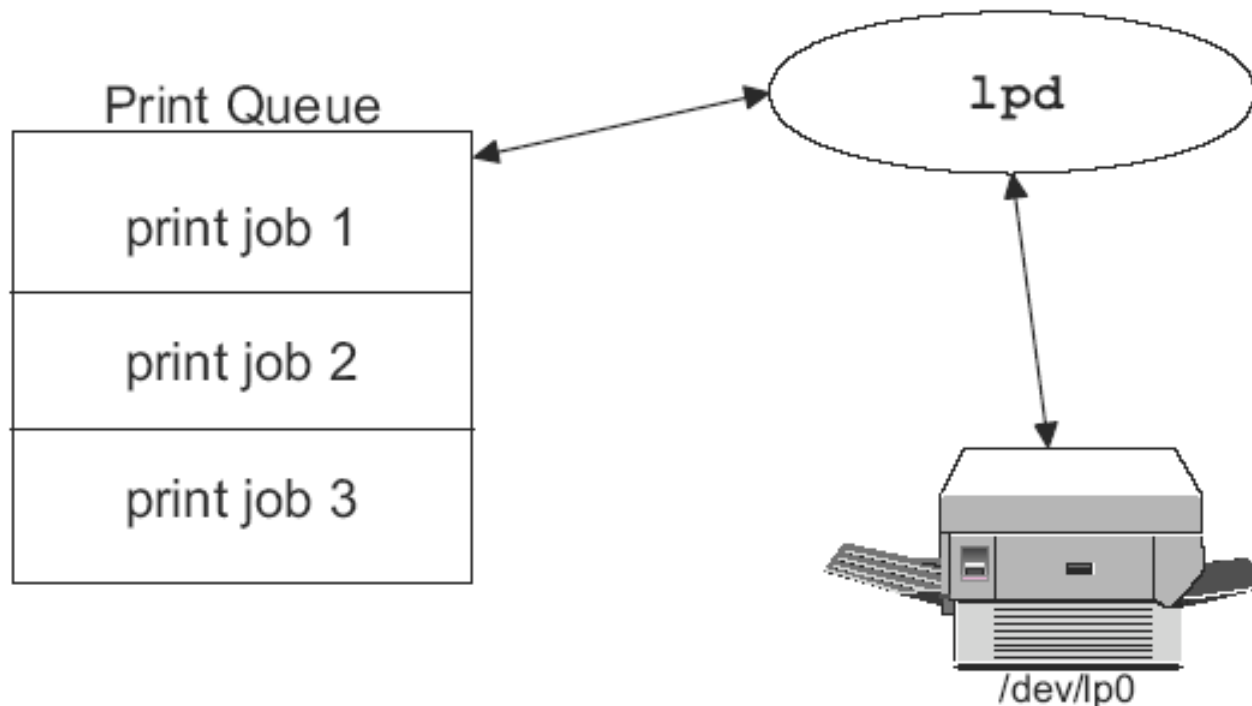
How to Find Help?

- "man" command
- "info"
- command --help
- HOWTO Documentation
- Refer to Internet

The man command

- With the man command you can read the manual page of commands

- Manual pages are stored in /usr/man

- The manual page consists of:
  - Name: The name of the command and a online description
  - Synopsis: The syntax of the command
  - Description: Explanation of how the command works and what it does
  - Files: The files used by the command
  - Bugs: Known bugs and errors
  - See also: Other commands related to this one

The man command (cont'd)

- The "-k" option
  - man –k print
- Manual pages are divided in 8 sections:
  1. User commands
  2. System calls
  3. Libc calls
  4. Devices
  5. File formats and protocols
  6. Games
  7. Conventions, macro packages and so forth
  8. System administation
- To select correct section, add section number:
  - man 1 passwd, man 5 passwd

The info command

- A program for reading documentation, sometimes a replacement for manual pages
- Information for info is stored in /usr/info
- Some info commands:
  - space: next screen of text
  - delete: previous screen of text
  - n: next node
  - p: previous node
  - u: up node
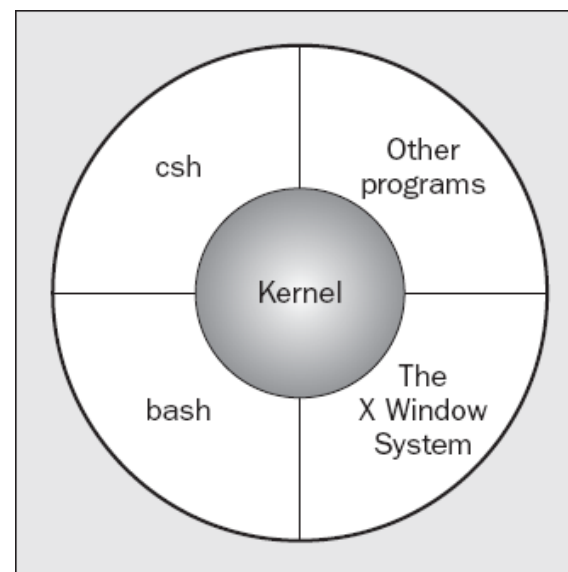 - q: quit info
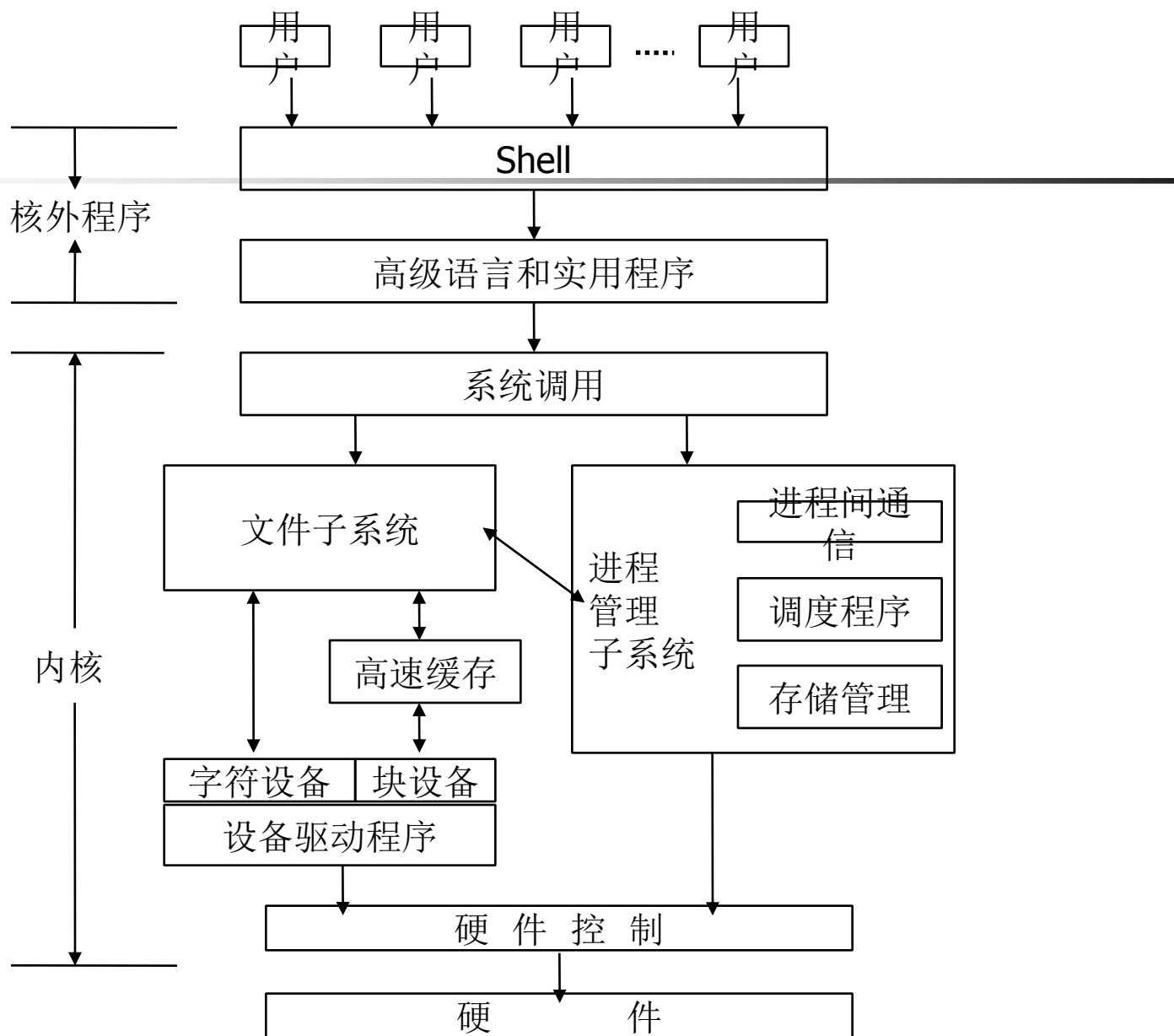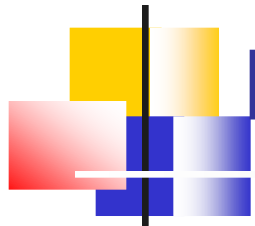 - <tab>: skip to next menu item

Exercises

- 浏览网站：
  - http://www.gnu.org
  - http://www.linux.org
- 安装一种Linux Distribution，然后在其上安装一些需要的软件
- 学习Linux基本命令的使用
- 复习C程序设计语言

UNIX Overview

- 早期的UNIX
  - 一个简单的文件系统
  - 一个进程子系统和一个 Shell
- 内核和核外程序

Programmer's Viewpoint