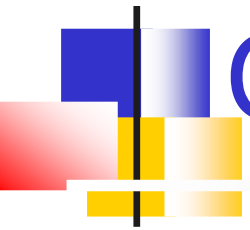
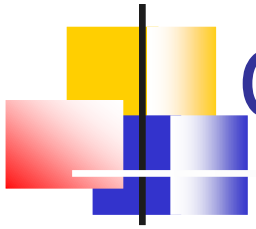


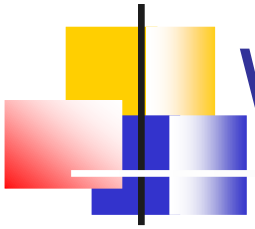
Ch1 Linux Basics

Enyi Tang
Software Institute, Nanjing University



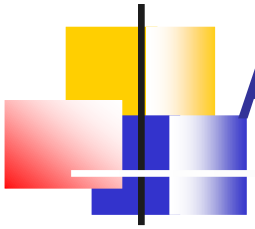
Content

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



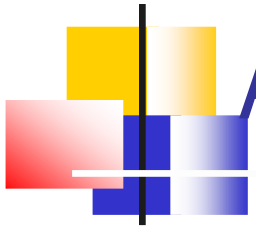
What is Linux?

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



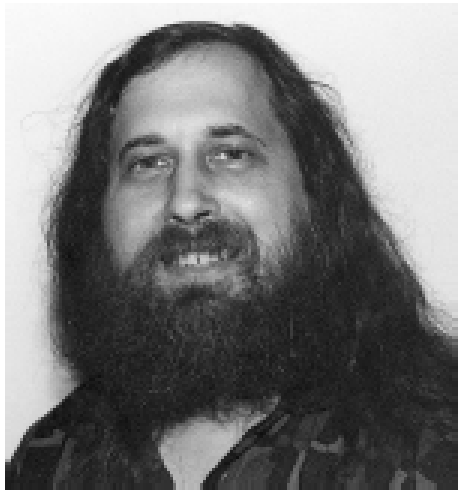
A Short History of UNIX

- 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

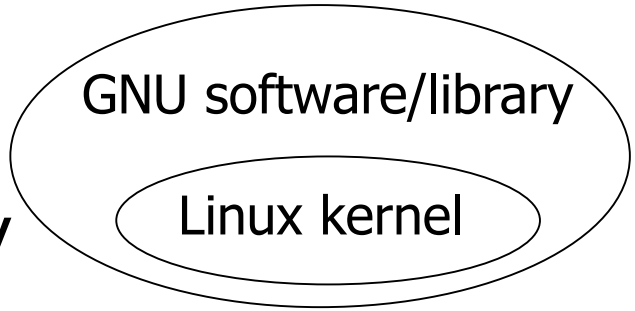


A Short History of Linux(2)

- 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：
  - Ubuntu, Debian, Mint, Red Hat, Fodore, SuSe, Mandrake, Redflag…

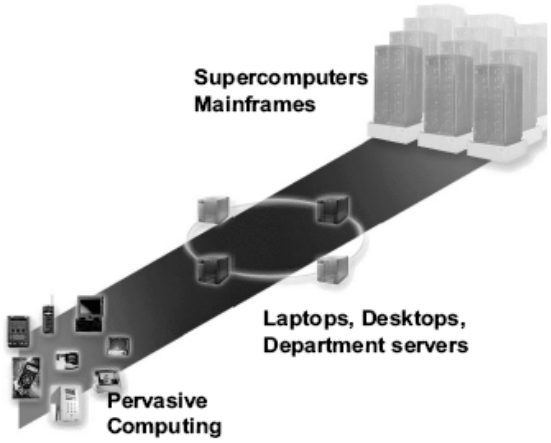
What is So Special for Linux?

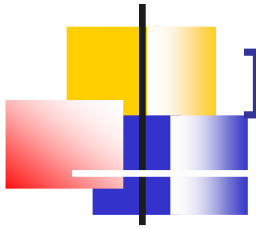
- Most software (including the Linux kernel) is **GPL**'ed (GNU General Public License)
  - http://www.gnu.org/copyleft/gpl.html

- 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

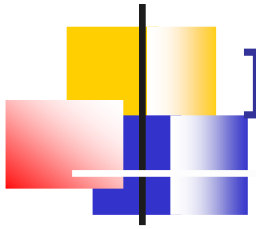
- Linux covers the whole spectrum of computing
  - Embedded devices
  - Laptops
  - Desktop systems
  - Development systems
  - Small and large servers
  - Megaclusters/supercomputers
- Linux is used throughout the world
  - ... and in space
- Linux is used by home users
  - ... and by some of the largest companies in the world
  - IBM
  - Boeing
  - NASA





Installation Methods

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



Installation Methods

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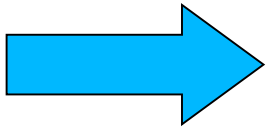
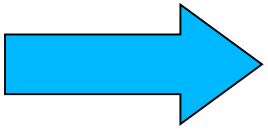
Iceweasel 冰鼬



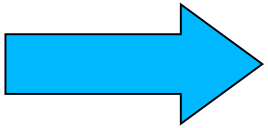
IceDove

SeaMonkey

all-in-one internet application suite

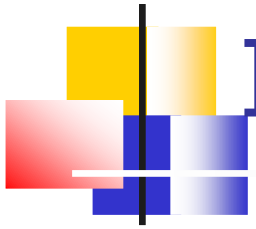


Iceape



Sunbird

IceOwl

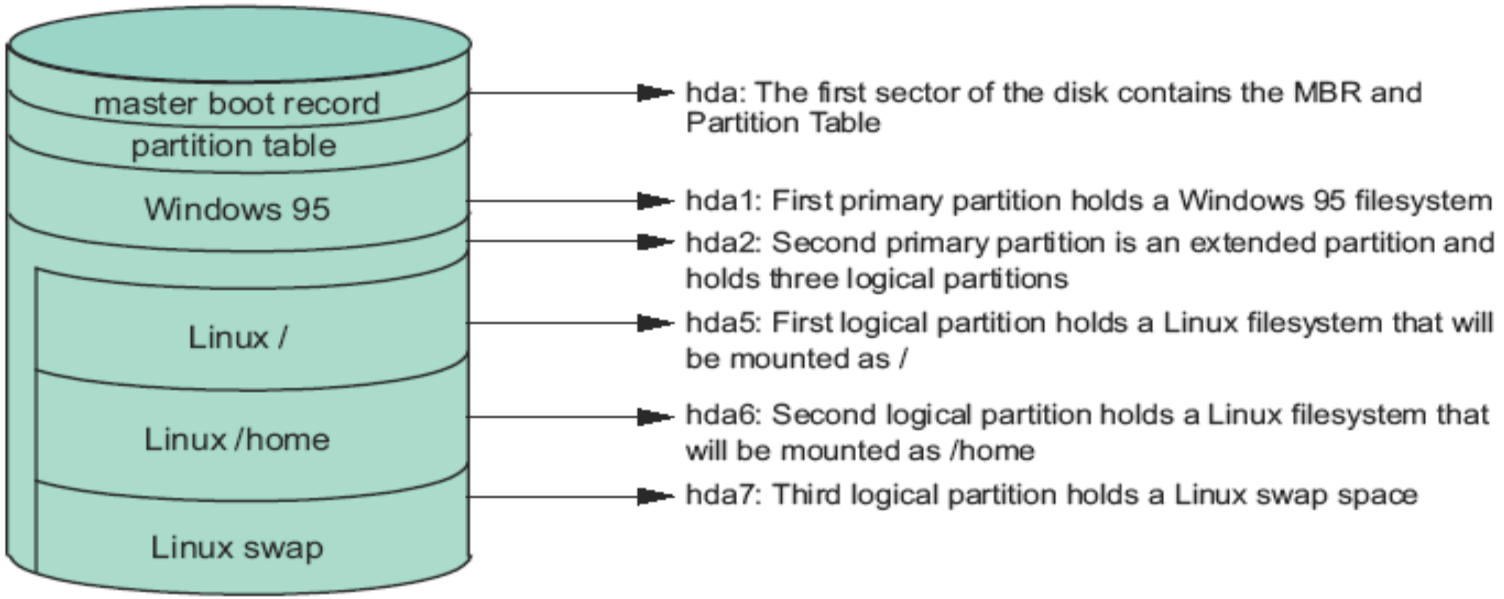


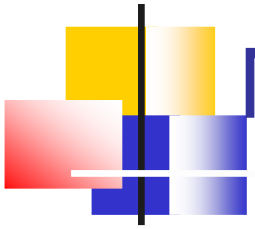
Installing Linux

- 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)

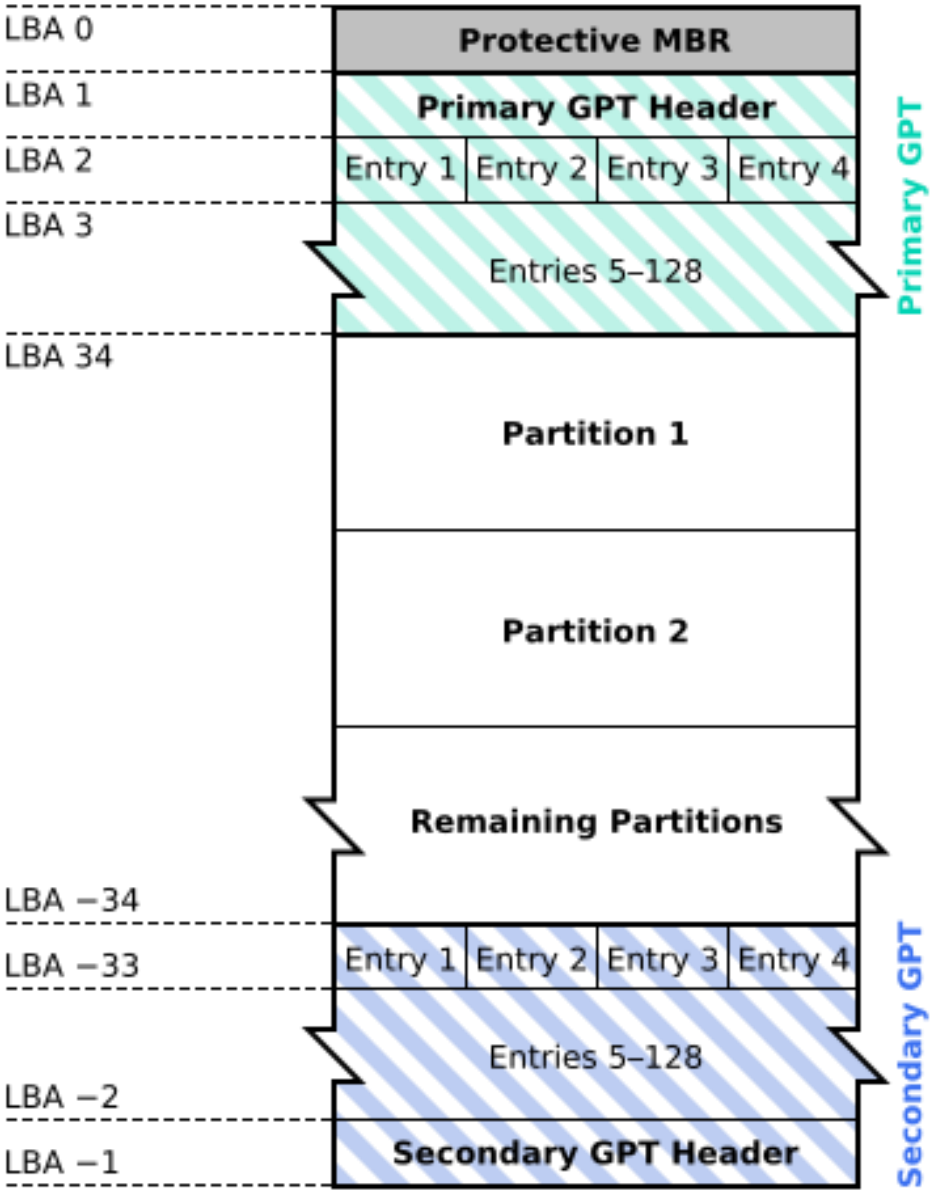


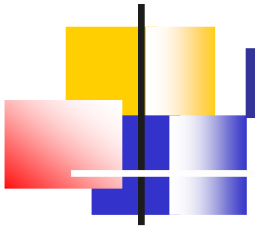


Master Boot Record

- 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)

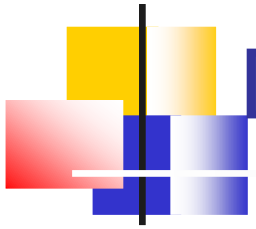
GUID Partition Table Scheme





File System

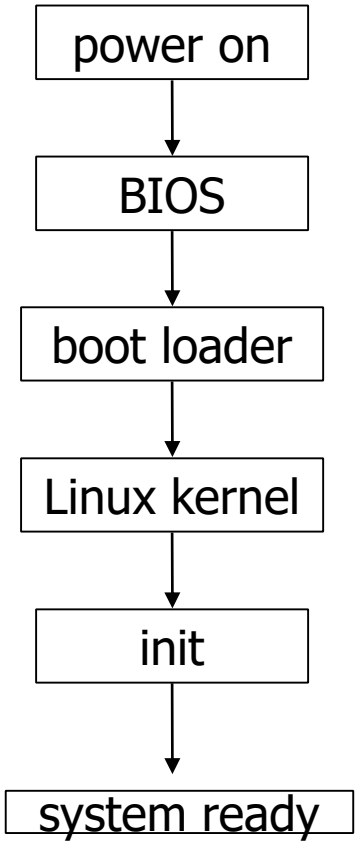
- What is File System
  - 操作系统中负责存取和管理文件的部分
  - A collection of files and certain of their attributes. It provides a name space for file serial numbers referring to those files. (susv3)
- File System in Linux:
  - VFS
  - EXT2, EXT3, FAT32, …



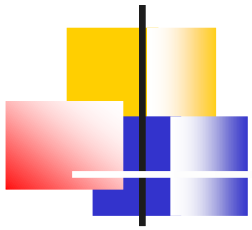
Disk Partitioning

- 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



- 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



输出设备

显示器

音箱/耳机

显卡

声卡

运算器

+

控制器

CPU

电源线

BIOS

开关

主板

输入设备+输出设备

打印机等

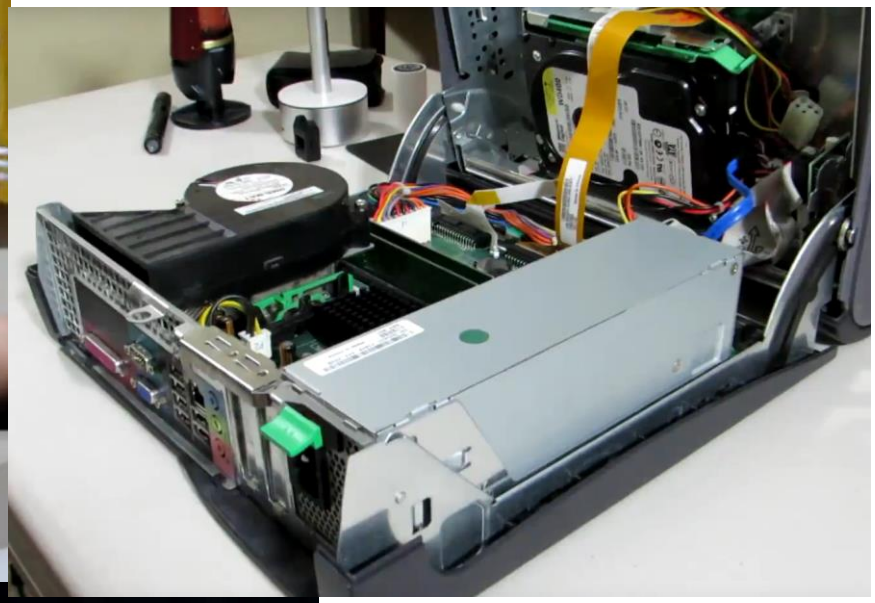
存储器

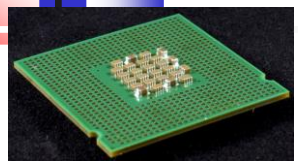
内存

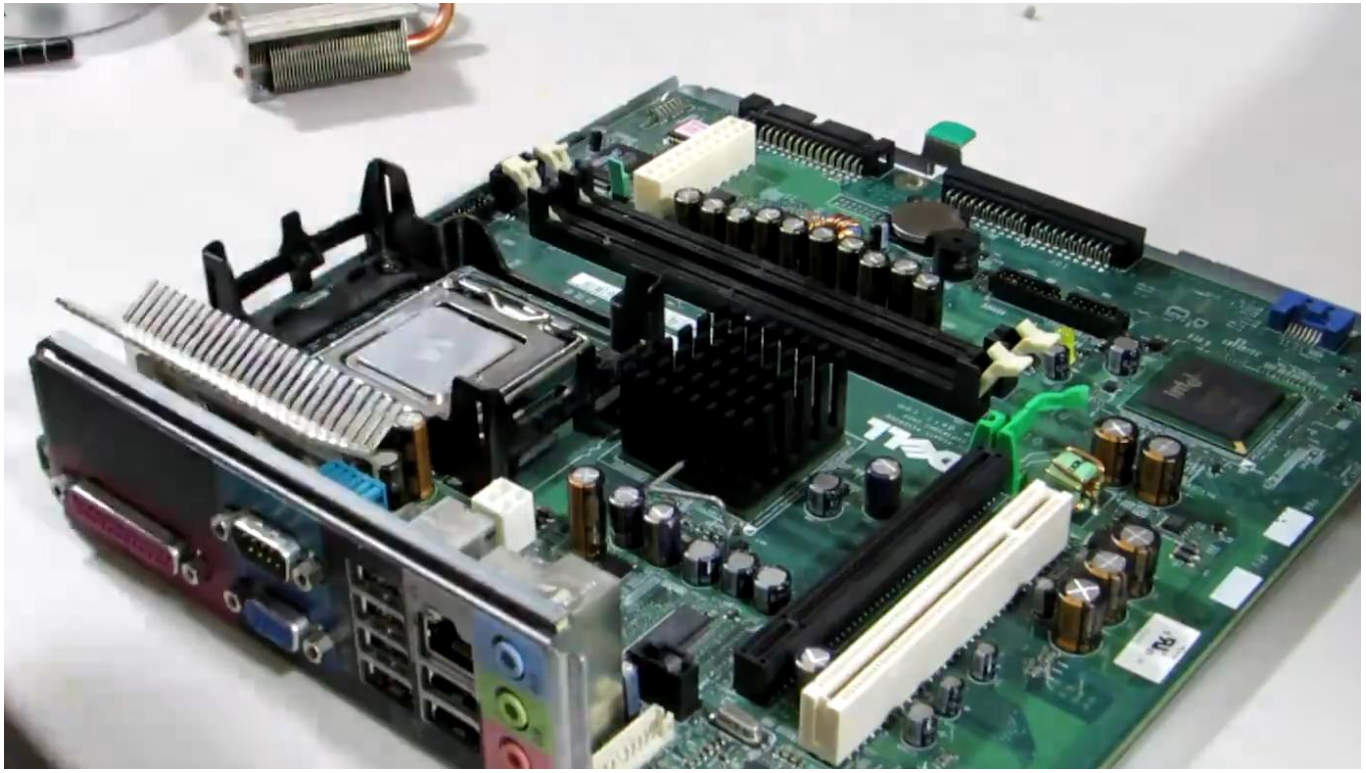
硬盘

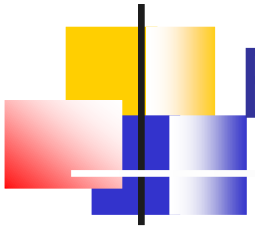
键盘

鼠标









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

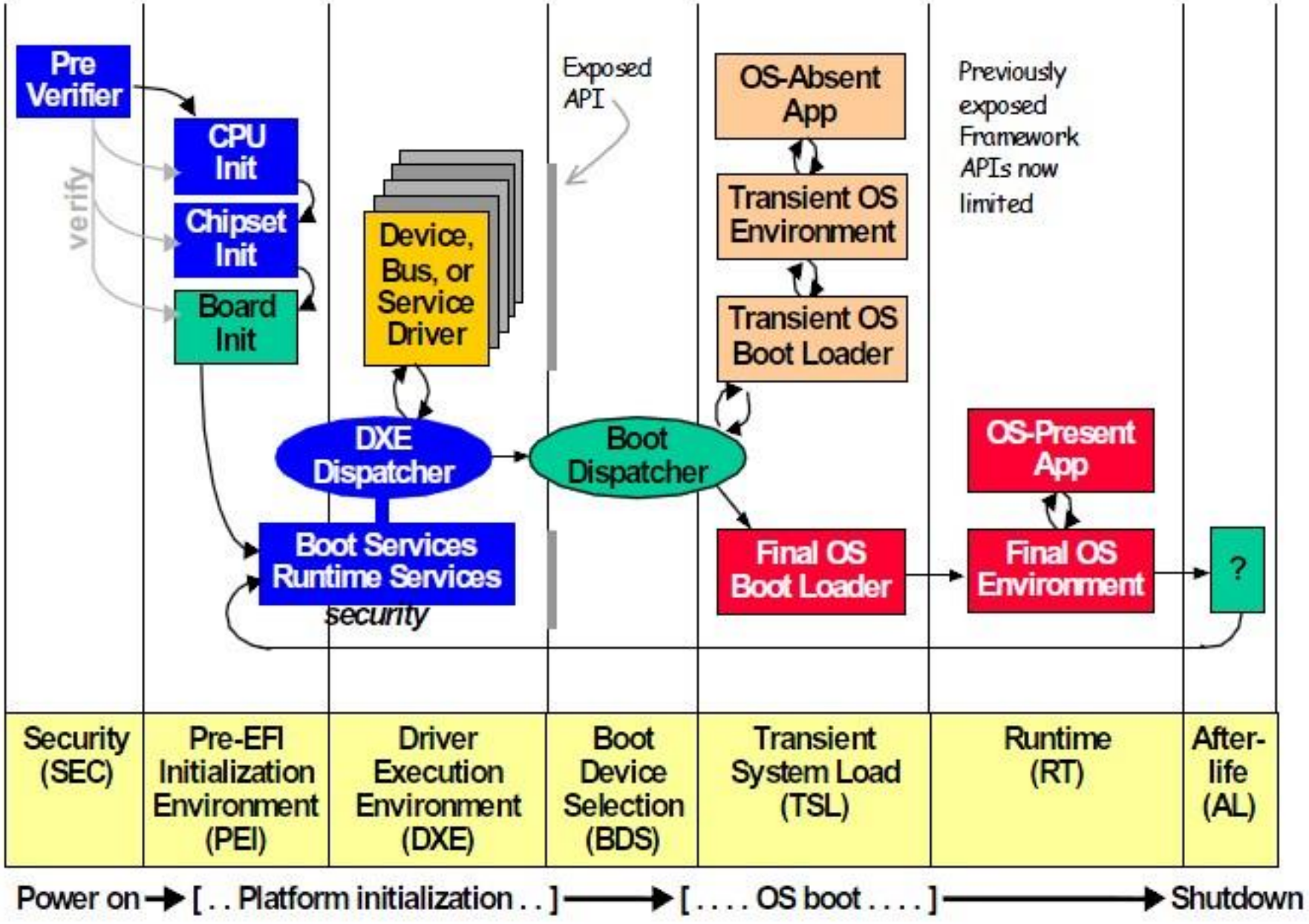
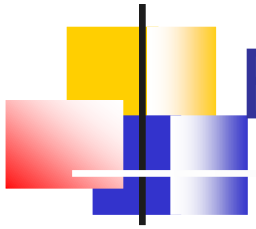
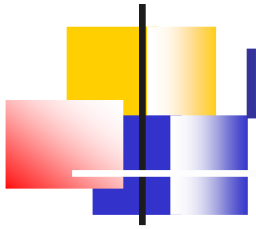


Figure 1-2. Framework Firmware Phases



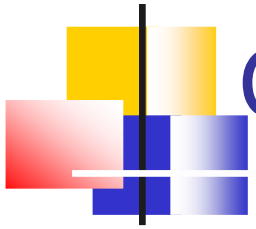
Boot loader

- 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.



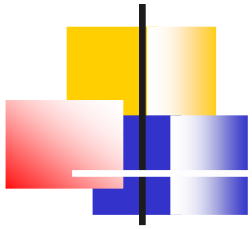
LILO - Linux Loader

- 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

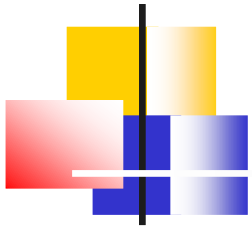


GRUB – GRand Unified Bootloader

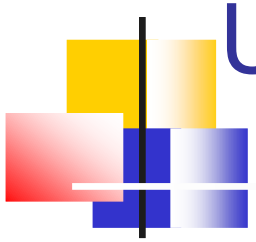
- GRUB
  - Program stored in MBR (first stage) and in /boot/grub (1.5th and second stage)
  - Understand file system structure; no need to activate a configuration as with LILO
  - Configuration file /boot/grub/grub.conf
  - Installed in MBR with grub-install



- 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

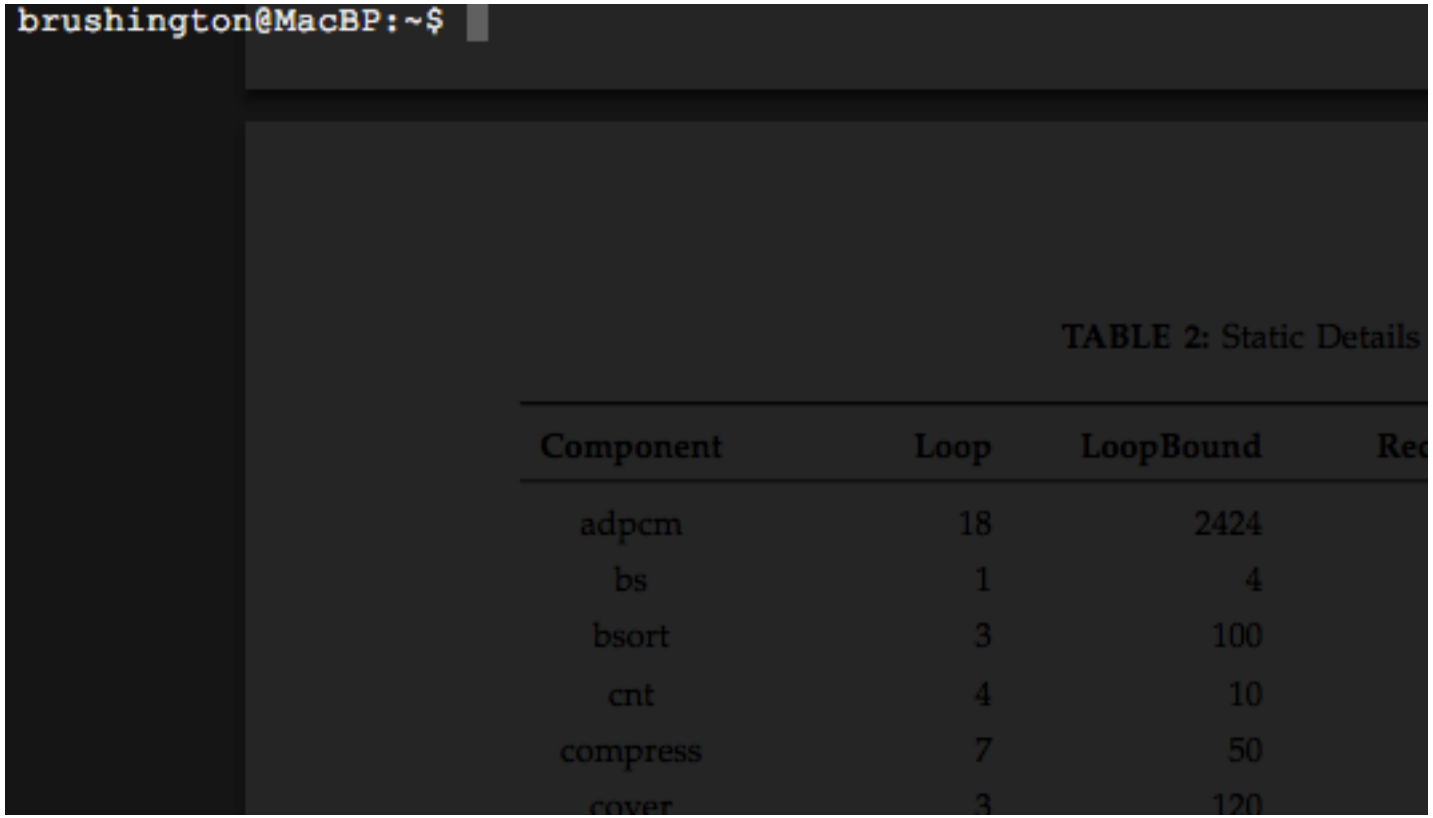
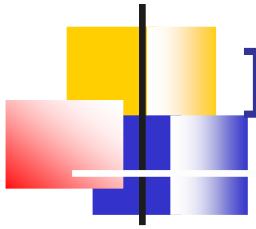


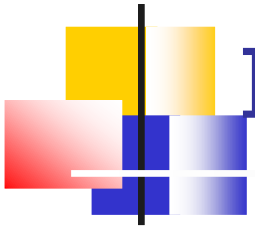
TABLE 2: Static Details

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



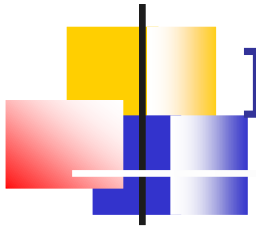
Installing Software on Linux

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



Installing Software on Linux

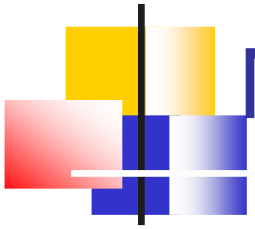
- From a tarball
  - tar zxvf application.tar.gz
  - cd application
  - mkdir build
  - cd build
  - cmake ..
  - make VERBOSE=1
  - su -
  - make install



Installing Software on Linux (cont'd)

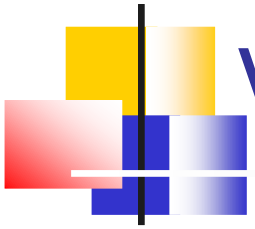
- apt-get command *
- dpkg
- aptitude

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



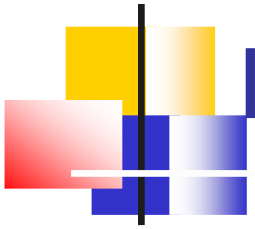
Multi-user and Multi-tasking

- 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



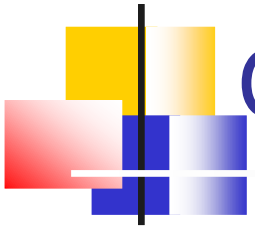
Virtual Terminal

- 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)

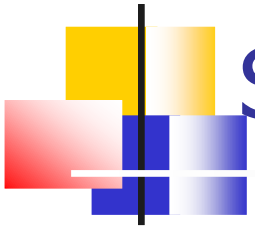
- Examples:

  $ ls

  $ ls –l

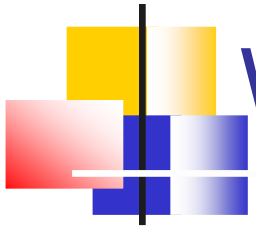
  $ ls /dev

  $ ls –l /dev



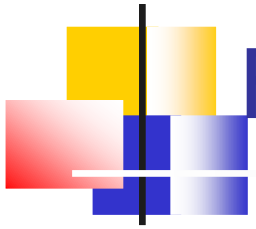
Some Basic Linux Commands

- 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
- ……



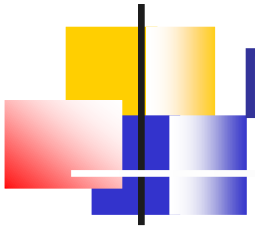
Working with Files & Directories

- 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

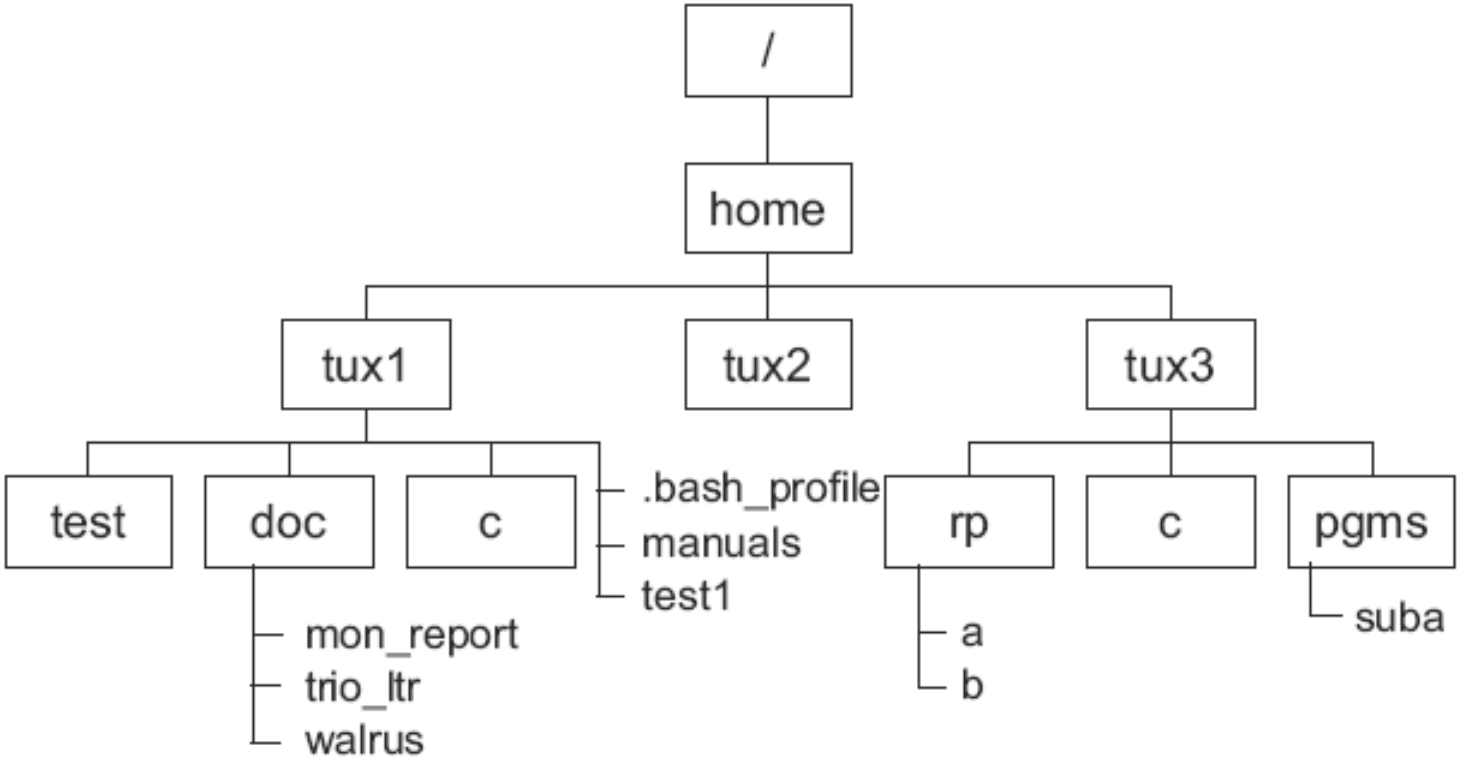
- regular file
  - Text or code data; no particular internal structure
- character special file
- block special file
  - Special files: represent hardware or logical devices
  - Found in directory called /dev
- socket
- symbolic link
- Directory
  - A table of contents; a list of files in that directory



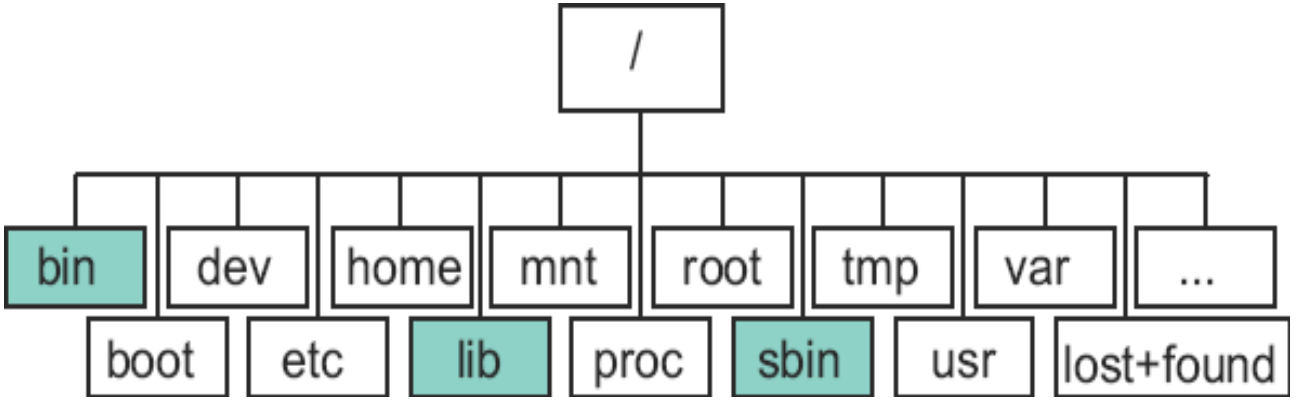
Directory Structure

- 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:, …

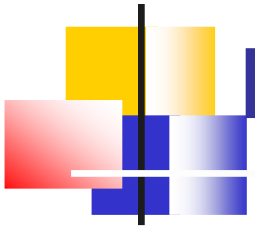
An Example of Directory Structure



Main Directories in Linux

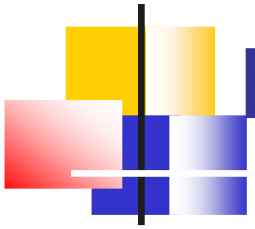


Linux Filesystem Hierarchy Standard:
http://www.pathname.com/fhs



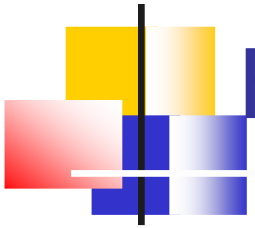
Basic Commands(1)

- 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



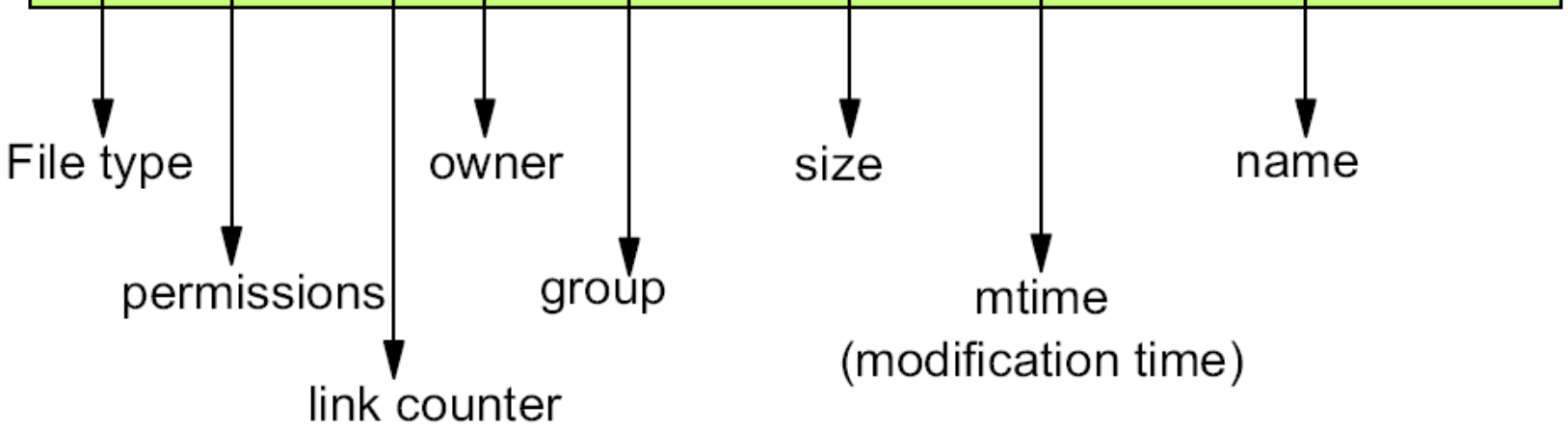
File Permission

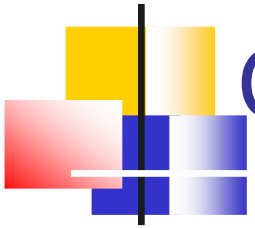
- File Permissions help you protect your files against other users on the system
- Three access levels:
  - User: The user that created the file
  - Group: All users in the group that owns the file
  - Others: All others
- Three permissions:
  - Read (**r**): Read content of file or list content of directory
  - 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
```





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

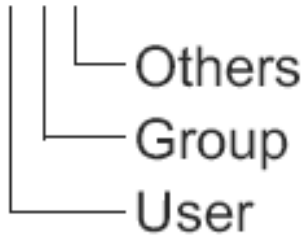
what:
r = read
w= write
x = execute

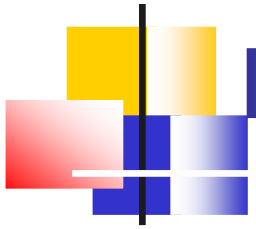
Changing Permissions (cont'd)

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

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

```
$ chmod 765 file
```



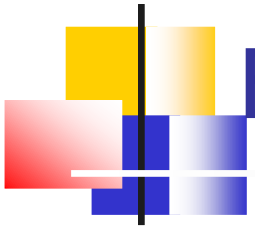


Default File Permissions

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

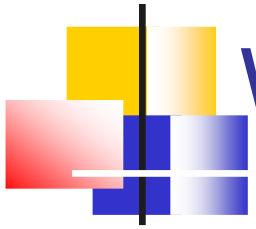
  File: -rw-r--r-- 644

  Directory: drwxr-xr-x 755



Editing Files

- vi
- emacs
- gedit
- …

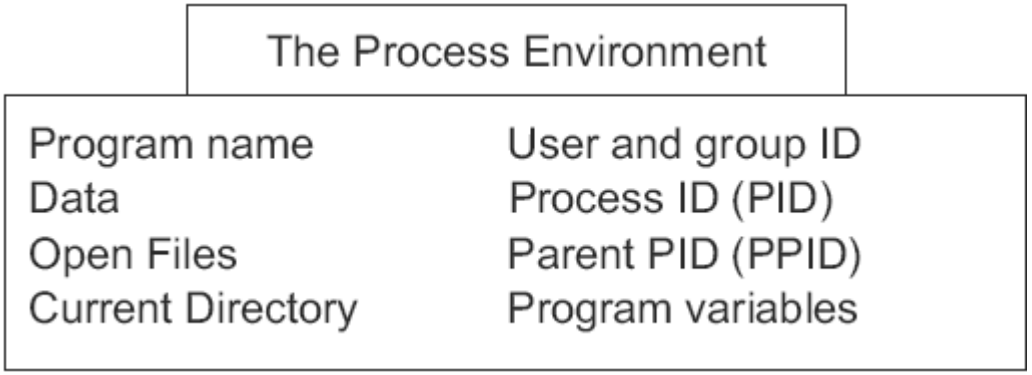


Working with Processes

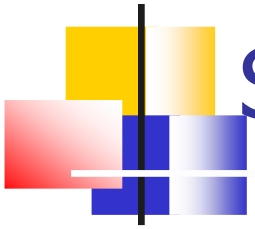
- What is a process?
  - A process is a task.
  - 进程是一个正在执行的程序实例。由执行程序、它的当前值、状态信息以及通过操作系统管理此进程执行情况的资源组成。
  - An address space with one or more threads executing within that address space, and the required system resources for those threads. (susv3)

Working with Processes (cont'd)

- A running program is an example of a process

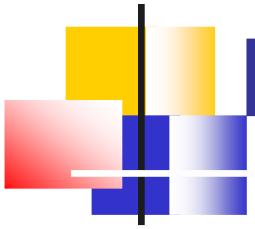


- A shell is a process that reads your commands and start the appropriate process.
  - echo $$



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

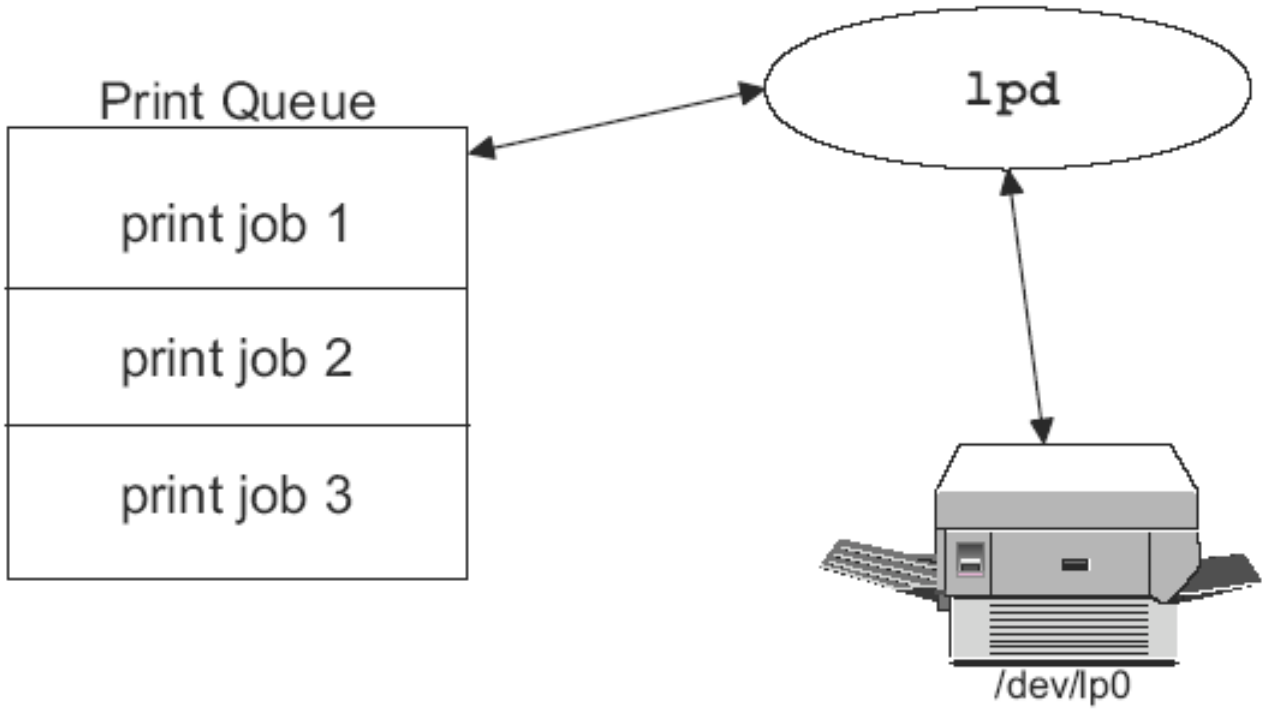


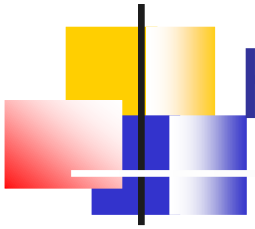
Basic Commands

- 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

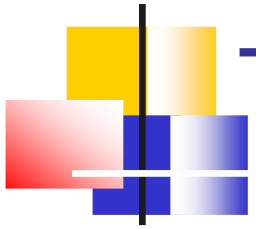
- The word "Daemon" refers to a never-ending process, usually a system process that controls a system resource such as the printer queue or performs a network service





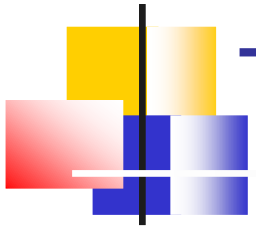
How to Find Help?

- “man” command
- “info”
- command --help
- HOWTO Documentation
- Refer to Internet



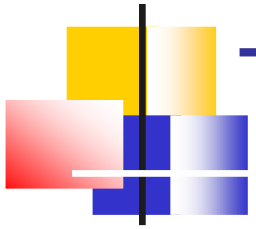
The man command

- 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



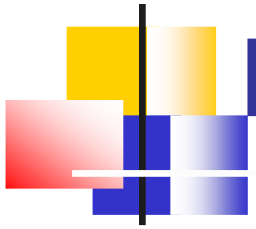
The man command (cont'd)

- 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

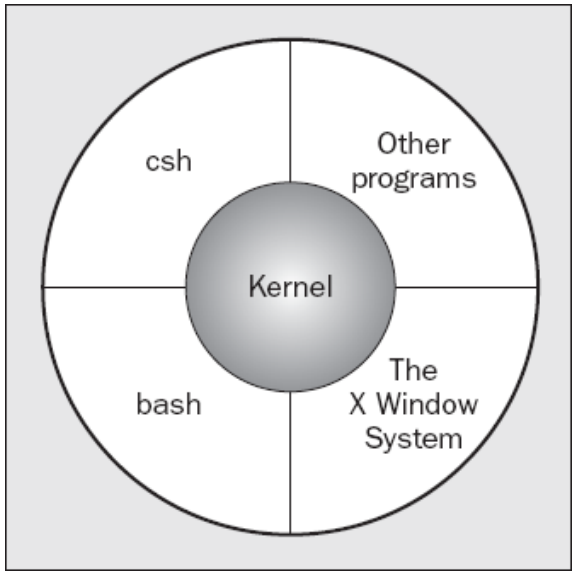


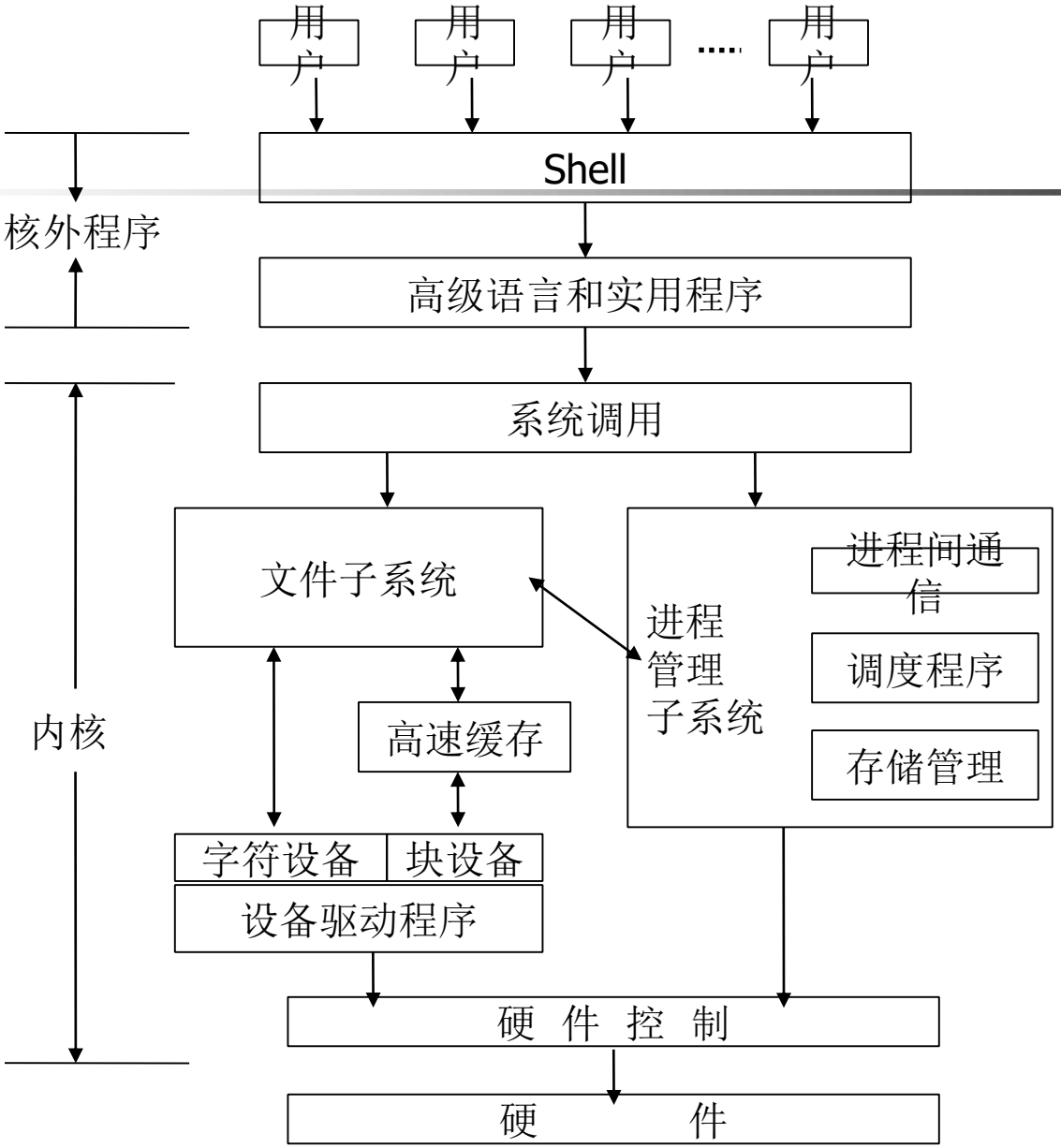
Exercises

- 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

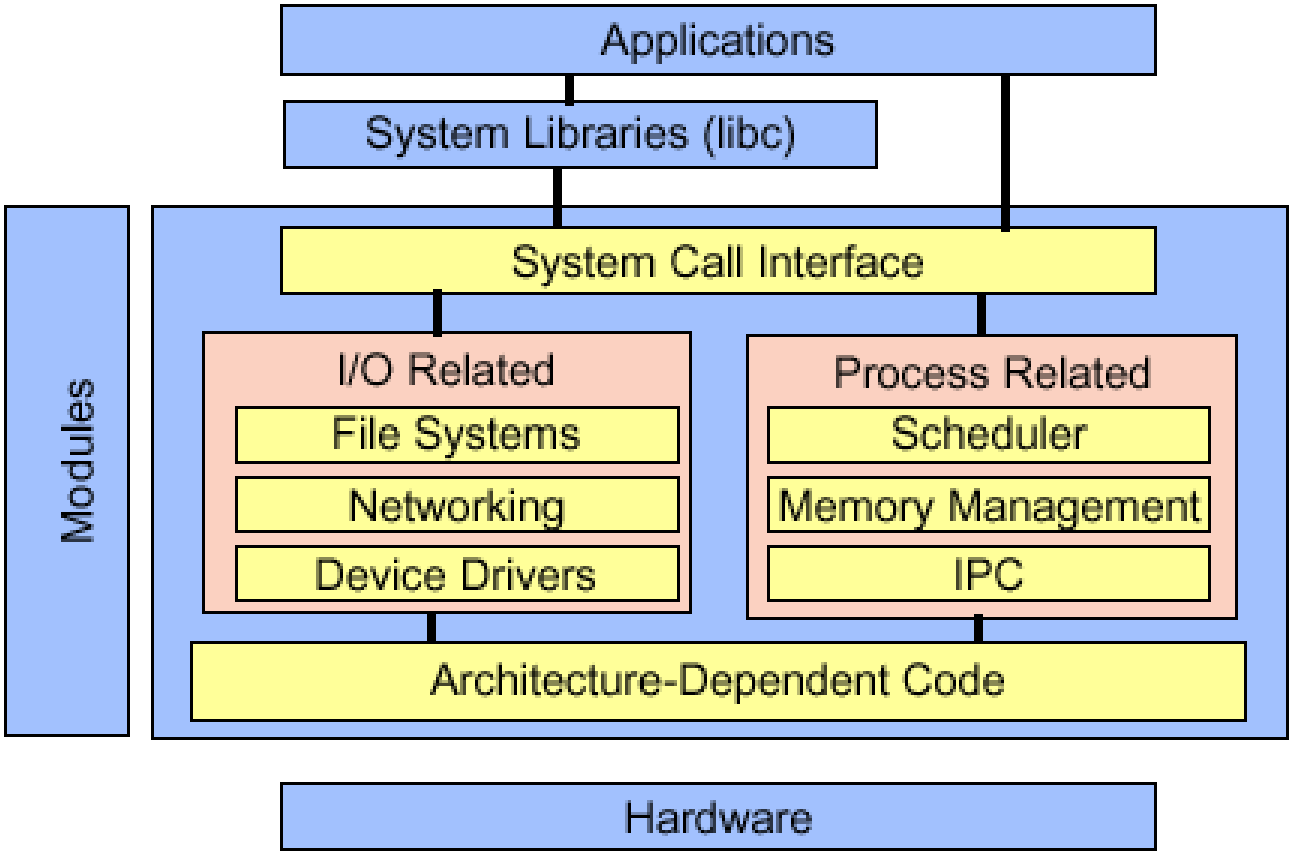
UNIX Overview

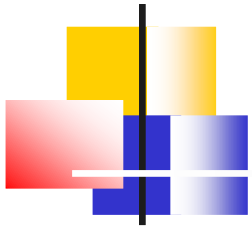
- 早期的UNIX
  - 一个简单的文件系统
  - 一个进程子系统和一个Shell
- 内核和核外程序

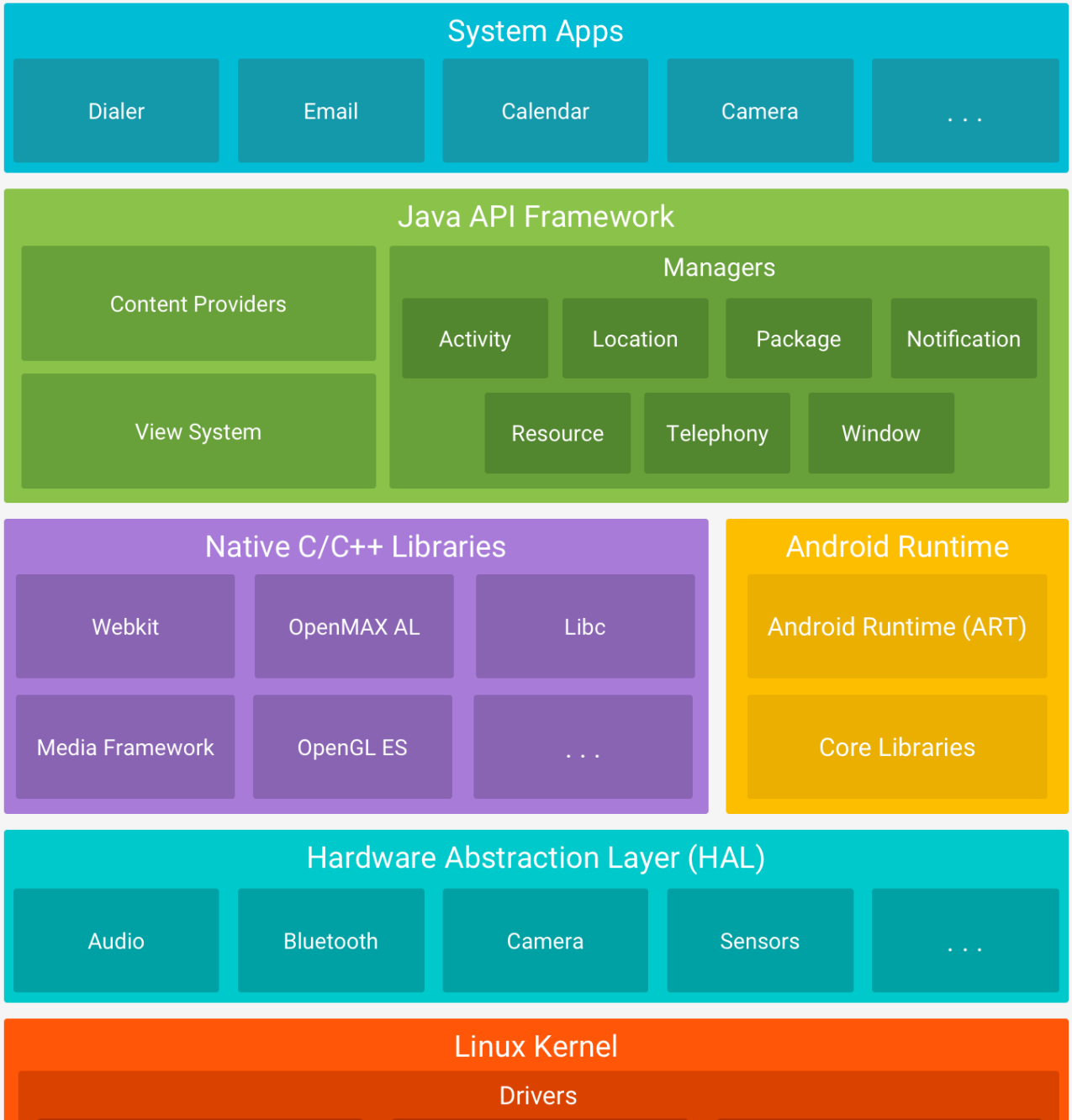


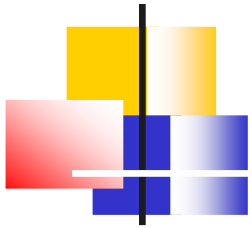

用户
用户
用户
.....
用户
Shell
核外程序
高级语言和实用程序
系统调用
文件子系统
进程间通信
进程管理子系统
调度程序
存储管理
高速缓存
内核
字符设备
块设备
设备驱动程序
硬 件 控 制
硬 件

Programmer's Viewpoint






System Apps
Dialer
Email
Calendar
Camera
. . .
Java API Framework
Content Providers
View System
Managers
Activity
Location
Package
Notification
Resource
Telephony
Window
Native C/C++ Libraries
Webkit
OpenMAX AL
Libc
Media Framework
OpenGL ES
. . .
Android Runtime
Android Runtime (ART)
Core Libraries
Hardware Abstraction Layer (HAL)
Audio
Bluetooth
Camera
Sensors
. . .
Linux Kernel
Drivers




Native C/C++ Libraries
Webkit
OpenMAX AL
Libc
Media Framework
OpenGL ES
. . .
Android Runtime
Android Runtime (ART)
Core Libraries
Hardware Abstraction Layer (HAL)
Audio
Bluetooth
Camera
Sensors
. . .
Linux Kernel
Drivers
Audio
Binder (IPC)
Display
Keypad
Bluetooth
Camera
Shared Memory
USB
WIFI
Power Management