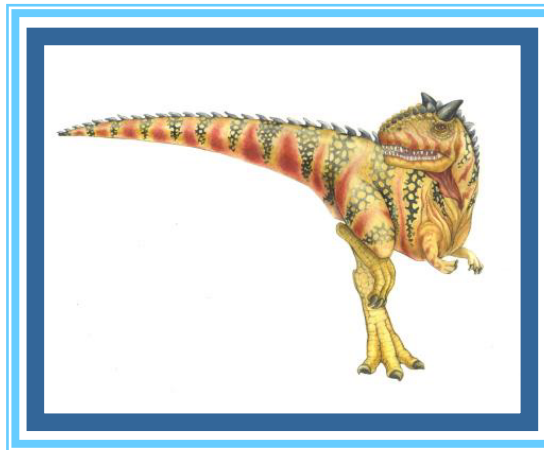
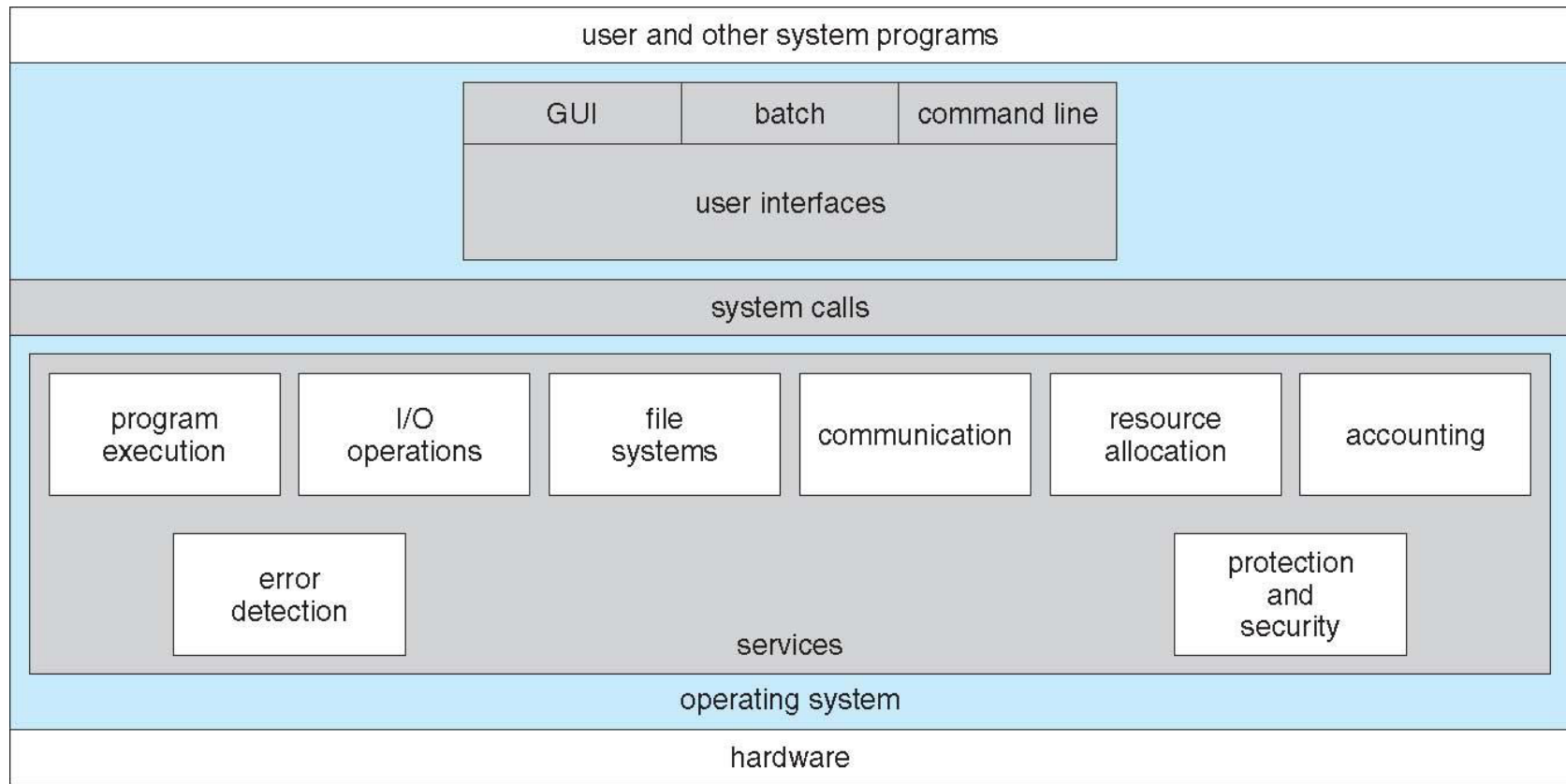


Chapter 2: Operating-System Structures





A View of Operating System Services





Operating System Services

- Operating systems provide an environment for execution of programs and services to programs and users
- One set of operating-system services provides functions that are helpful to the user:
 - **User interface** - Almost all operating systems have a user interface (**UI**).
 - ▶ Varies between **Command-Line (CLI)**, **Graphics User Interface (GUI)**, **Touch screen interface**
 - **Program execution** - The system must be able to load a program into memory and to run that program, end execution, either normally or abnormally (indicating error)
 - **I/O operations** - A running program may require I/O, which may involve a file or an I/O device





Operating System Services (Cont.)

- One set of operating-system services provides functions that are helpful to the user (Cont.):
 - **File-system manipulation** - The file system is of particular interest. Programs need to read and write files and directories, create and delete them, search them, list file Information, permission management.
 - **Communications** – Processes may exchange information, on the same computer or between computers over a network
 - ▶ Communications may be via shared memory or through message passing (packets moved by the OS)
 - **Error detection** – OS needs to be constantly aware of possible errors
 - ▶ May occur in the CPU and memory hardware, in I/O devices, in user program
 - ▶ For each type of error, OS should take the appropriate action to ensure correct and consistent computing
 - ▶ Debugging facilities can greatly enhance the user' s and programmer' s abilities to efficiently use the system





Operating System Services (Cont.)

- Another set of OS functions exists for ensuring the efficient operation of the system itself via resource sharing
 - **Resource allocation** - When multiple users or multiple jobs running concurrently, resources must be allocated to each of them
 - ▶ Many types of resources - CPU cycles, main memory, file storage, I/O devices.
 - **Accounting** - To keep track of which users use how much and what kinds of computer resources
 - **Protection and security** - The owners of information stored in a multiuser or networked computer system may want to control use of that information, concurrent processes should not interfere with each other
 - ▶ **Protection** involves ensuring that all access to system resources is controlled
 - ▶ **Security** of the system from outsiders requires user authentication, extends to defending external I/O devices from invalid access attempts





User Operating System Interface - CLI

CLI or **command interpreter** allows direct command entry

- Sometimes implemented in kernel, sometimes by systems program
- Sometimes multiple flavors implemented – **shells**
- Primarily fetches a command from user and executes it
- Sometimes commands built-in, sometimes just names of programs
 - ▶ If the latter, adding new features doesn't require shell modification





Bourne Shell Command Interpreter

```
Default
New Info Close Execute Bookmarks

Default Default
PBG-Mac-Pro:~ pbg$ w
15:24 up 56 mins, 2 users, load averages: 1.51 1.53 1.65
USER TTY FROM LOGIN@ IDLE WHAT
pbg console - 14:34 50 -
pbg s000 - 15:05 - w
PBG-Mac-Pro:~ pbg$ iostat 5
disk0 disk1 disk10 cpu load average
KB/t tps MB/s KB/t tps MB/s KB/t tps MB/s us sy id 1m 5m 15m
33.75 343 11.30 64.31 14 0.88 39.67 0 0.02 11 5 84 1.51 1.53 1.65
5.27 320 1.65 0.00 0 0.00 0.00 0 0.00 4 2 94 1.39 1.51 1.65
4.28 329 1.37 0.00 0 0.00 0.00 0 0.00 5 3 92 1.44 1.51 1.65
^C
PBG-Mac-Pro:~ pbg$ ls
Applications Music WebEx
Applications (Parallels) Pando Packages config.log
Desktop Pictures getsmartdata.txt
Documents Public imp
Downloads Sites log
Dropbox Thumbs.db panda-dist
Library Virtual Machines prob.txt
Movies Volumes scripts
PBG-Mac-Pro:~ pbg$ pwd
/Users/pbg
PBG-Mac-Pro:~ pbg$ ping 192.168.1.1
PING 192.168.1.1 (192.168.1.1): 56 data bytes
64 bytes from 192.168.1.1: icmp_seq=0 ttl=64 time=2.257 ms
64 bytes from 192.168.1.1: icmp_seq=1 ttl=64 time=1.262 ms
^C
--- 192.168.1.1 ping statistics ---
2 packets transmitted, 2 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 1.262/1.760/2.257/0.498 ms
PBG-Mac-Pro:~ pbg$
```





User Operating System Interface - GUI

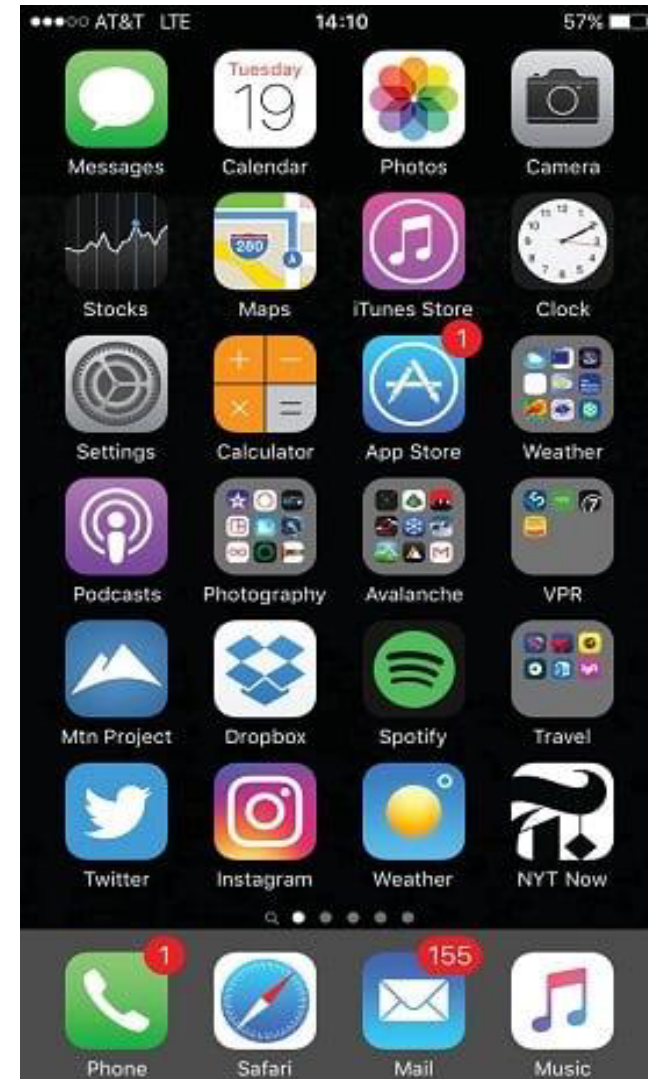
- User-friendly **desktop** metaphor interface
 - Usually mouse, keyboard, and monitor
 - **Icons** represent files, programs, actions, etc
 - Various mouse buttons over objects in the interface cause various actions (provide information, options, execute function, open directory (known as a **folder**))
 - Invented at Xerox PARC — **Palo Alto Research Center in California**
- Many systems now include both CLI and GUI interfaces
 - Microsoft Windows is GUI with CLI “command” shell
 - Apple Mac OS X is “Aqua” GUI interface with UNIX kernel underneath and shells available
 - Unix and Linux have CLI with optional GUI interfaces (CDE, KDE, GNOME)





Touchscreen Interfaces

- ❑ Touchscreen devices require new interfaces
 - ❑ Mouse not possible or not desired
 - ❑ Actions and selection based on gestures
 - ❑ Virtual keyboard for text entry
- ❑ Voice commands.





System Calls

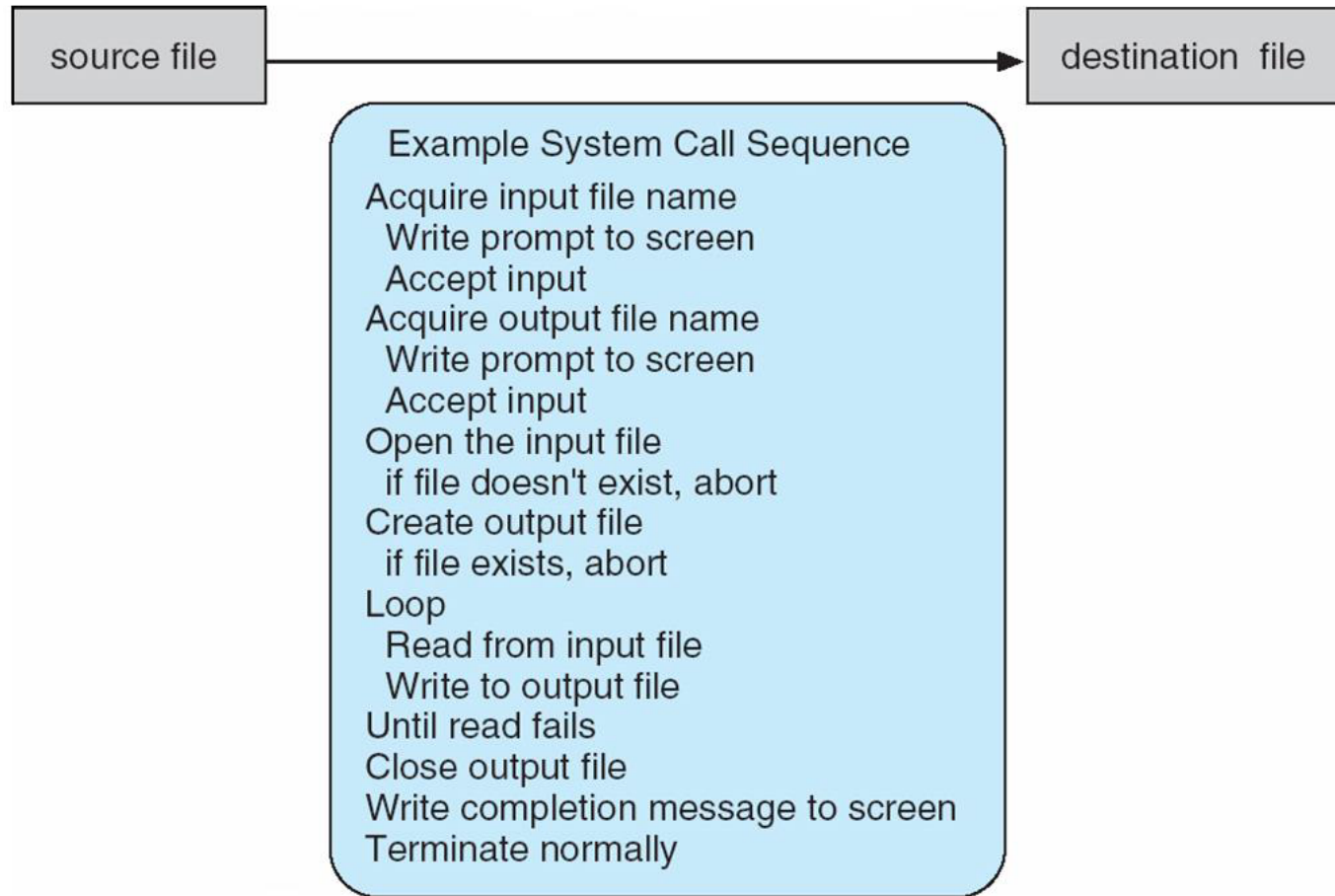
- Programming interface to the services provided by the OS
- Typically written in a high-level language (C or C++)
- Mostly accessed by programs via a high-level **Application Programming Interface (API)** rather than direct system call use
- Three most common APIs are Win32 API for Windows, POSIX API for POSIX-based systems (including virtually all versions of UNIX, Linux, and Mac OS X), and Java API for the Java virtual machine (JVM)





Example of System Calls

- System call sequence to copy the contents of one file to another file





Types of System Calls

- Process control
 - create process, terminate process
 - end, abort
 - load, execute
 - get process attributes, set process attributes
 - wait for time
 - wait event, signal event
 - allocate and free memory
 - Dump memory if error
 - **Debugger** for determining **bugs, single step** execution
 - **Locks** for managing access to shared data between processes





Types of System Calls

- File management
 - create file, delete file
 - open, close file
 - read, write, reposition
 - get and set file attributes
- Device management
 - request device, release device
 - read, write, reposition
 - get device attributes, set device attributes
 - logically attach or detach devices





Types of System Calls (Cont.)

- Information maintenance
 - get time or date, set time or date
 - get system data, set system data
 - get and set process, file, or device attributes
- Communications
 - create, delete communication connection
 - send, receive messages if **message passing model** to **host name** or **process name**
 - ▶ From **client** to **server**
 - **Shared-memory model** create and gain access to memory regions
 - transfer status information
 - attach and detach remote devices





Types of System Calls (Cont.)

- Protection
 - Control access to resources
 - Get and set permissions
 - Allow and deny user access





Examples of Windows and Unix System Calls

	Windows	Unix
Process Control	CreateProcess() ExitProcess() WaitForSingleObject()	fork() exit() wait()
File Manipulation	CreateFile() ReadFile() WriteFile() CloseHandle()	open() read() write() close()
Device Manipulation	SetConsoleMode() ReadConsole() WriteConsole()	ioctl() read() write()
Information Maintenance	GetCurrentProcessID() SetTimer() Sleep()	getpid() alarm() sleep()
Communication	CreatePipe() CreateFileMapping() MapViewOfFile()	pipe() shmget() mmap()
Protection	SetFileSecurity() InitializeSecurityDescriptor() SetSecurityDescriptorGroup()	chmod() umask() chown()





Review

- OS services
- OS interfaces
- System calls

Next Class

- System Programs
- OS Design and Implementation
- OS Structure
- OS Debugging



Quiz

1. Types of interface?
2. Command Line Interpreter is implemented depending on the type of OS and is commonly called as
3. GUI is invented at
4. The programming interface to the services provided by the OS is known as
5. A single type of system call is used to manage the whole process in a system - True or False?