Operating System: Chap2 OS Structure

National Tsing Hua University

2019, Fall Semester

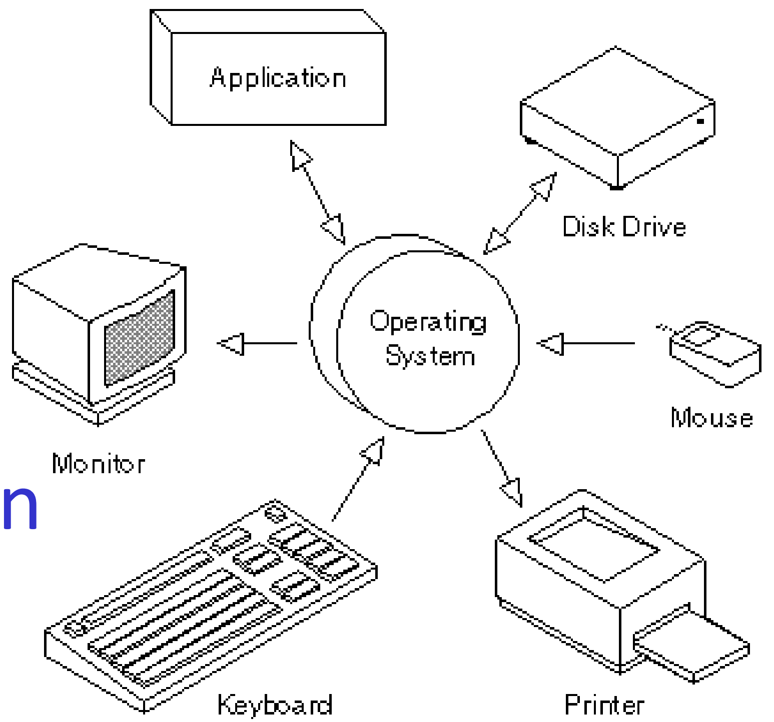
Outline

- OS Services
- OS-Application Interface
- OS Structure

OS Services

OS services

- User interface
- Program Execution
- I/O operations
- File-system manipulation
- Communication
- Error detection
- Resource allocation
- Accounting
- Protection and security



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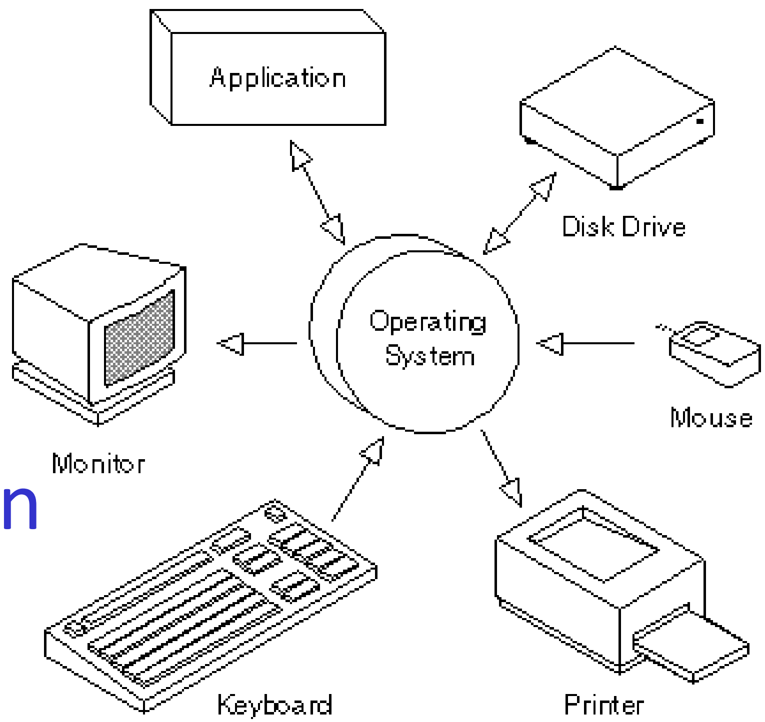

ensuring the **efficient** operation of the **system itself**

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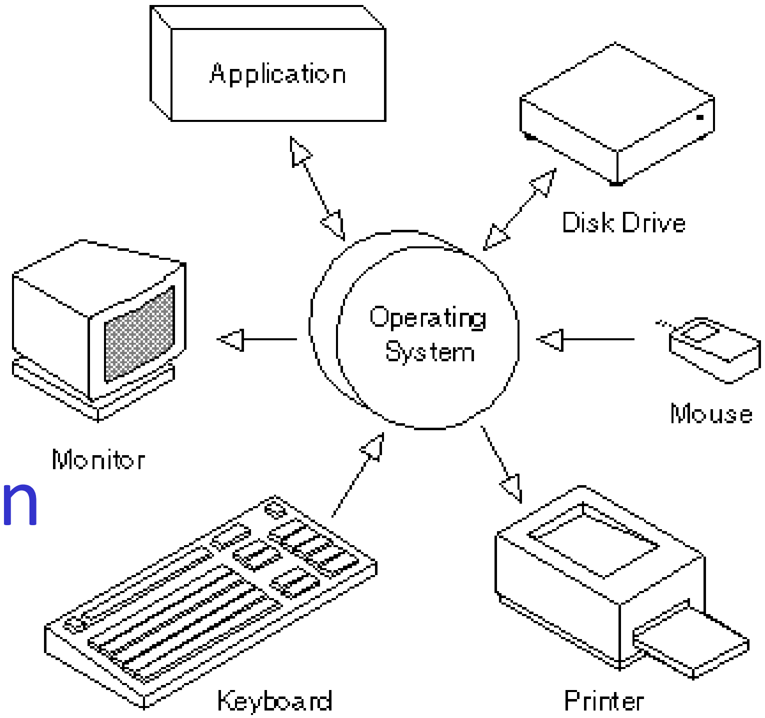

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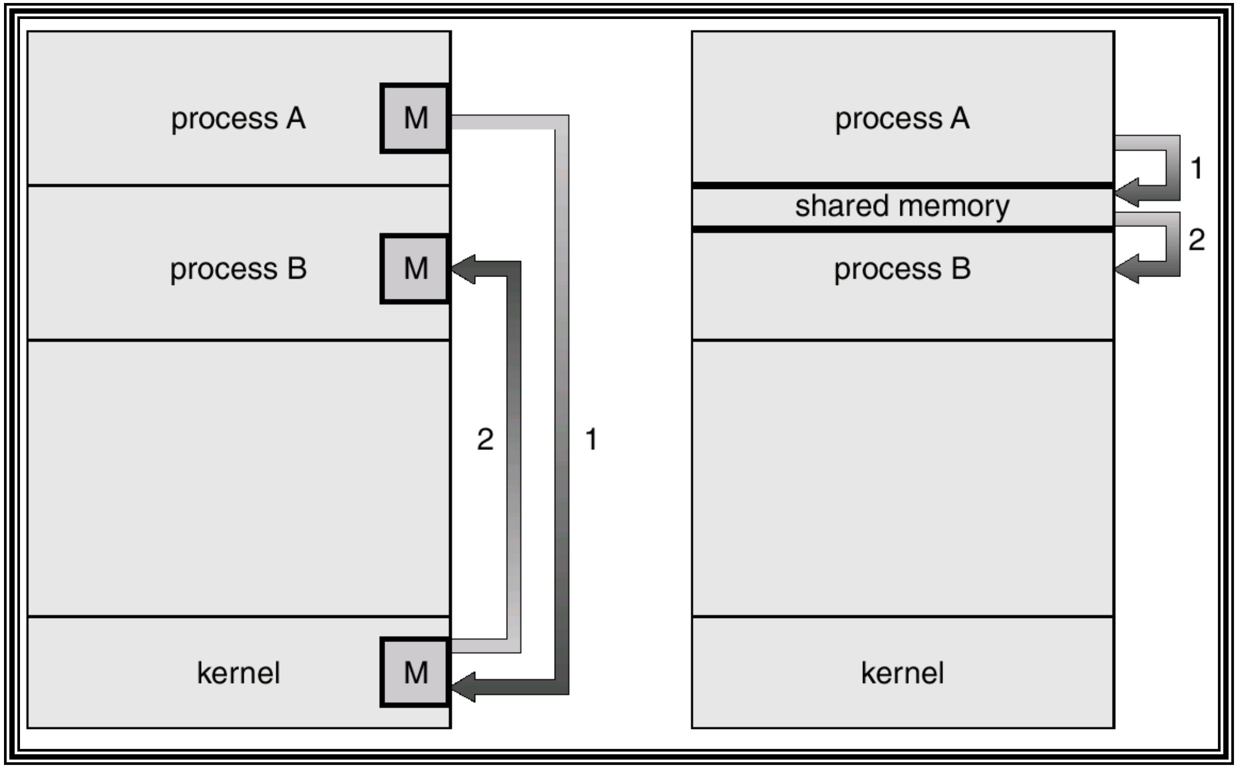
User Interface

- CLI (Command Line Interface)
  - Fetches a command from user and executes it
  - Shell: Command-line interpreter (CSHELL, BASH)
    - Adjusted according to user behavior and preference
- GUI (Graphic User Interface)
  - Usually mouse, keyboard, and monitor
  - **Icons** represent files, programs, actions, etc
  - Various mouse buttons over objects in the interface cause various actions
- Most systems have both CLI and GUI

Communication Models

- Communication may take place using either message passing or shared memory.



Msg Passing   Shared Memory

Applications-OS Interface

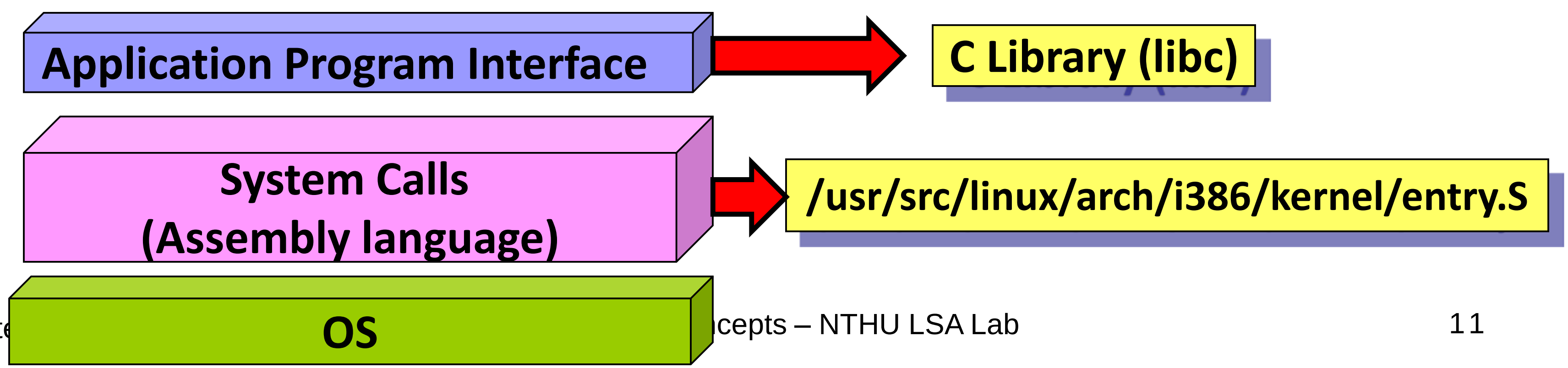
- System calls
- API

System Calls

- Request OS services
  - Process control—abort, create, terminate process allocate/free memory
  - File management—create, delete, open, close file
  - Device management—read, write, reposition device
  - Information maintenance—get time or date
  - Communications—send receive message

System Calls & API

- System calls
  - The OS interface to a running program
  - An explicit request to the kernel made via a **software interrupt**
  - Generally available as assembly-language instructions
- API: Application Program Interface
  - Users mostly program against API instead of system call
  - Commonly implemented by language libraries, e.g., C Library
  - An API call could involve zero or multiple system call
    - Both malloc() and free() use system call brk()
    - Math API functions, such as abs(), don't need to involve system call



Interface vs. Library

- User program:

  printf("%d", exp2(int x, int y));

- Interface:

  int exp2(int x, int y);

  i.e. return the value of $X \cdot 2^y$

- Library:

Imp1: int exp2(int x, int y) { for (int i=0; i<y; i++) x=x*2; return x;}

Imp2: int exp2(int x, int y) { x = x << y; return x;}

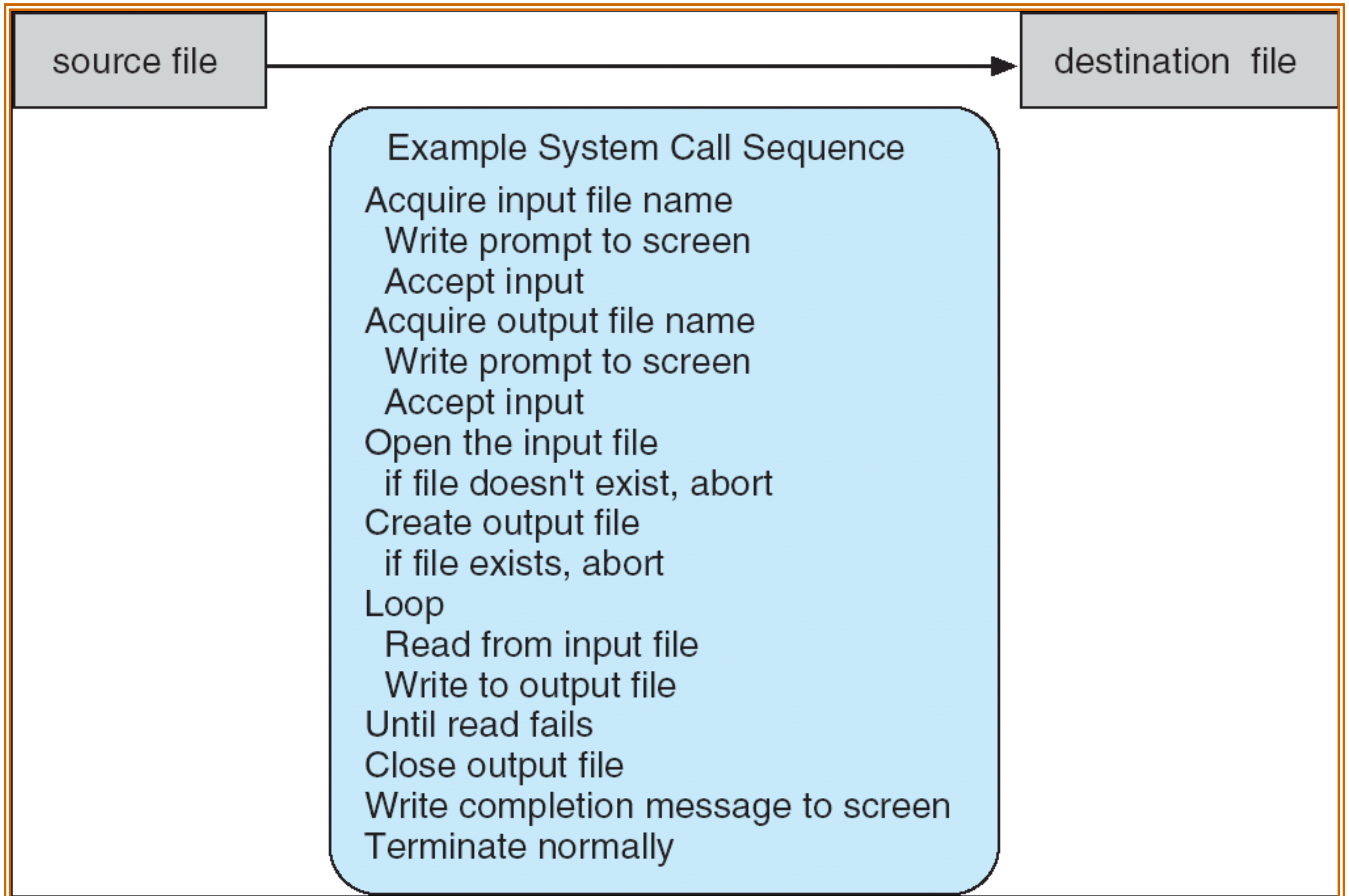
Imp3: int exp2(int x, int y) { return HW_EXP(x,y);}

API: Application Program Interface

- Three most common APIs:
  - Win32 API for Windows
    - http://en.wikipedia.org/wiki/Windows_API
    - http://msdn.microsoft.com/en-us/library/windows/desktop/ff818516%28v=vs.85%29.aspx
  - POSIX API for POSIX-based systems (including virtually all versions of UNIX, Linux, and Mac OS X)
    - POSIX → "**P**ortable **O**perating **S**ystem **I**nterface for Uni**x**"
    - http://en.wikipedia.org/wiki/POSIX
    - http://www.unix.org/version4/GS5_APIs.pdf
  - Java API for the Java virtual machine (JVM)

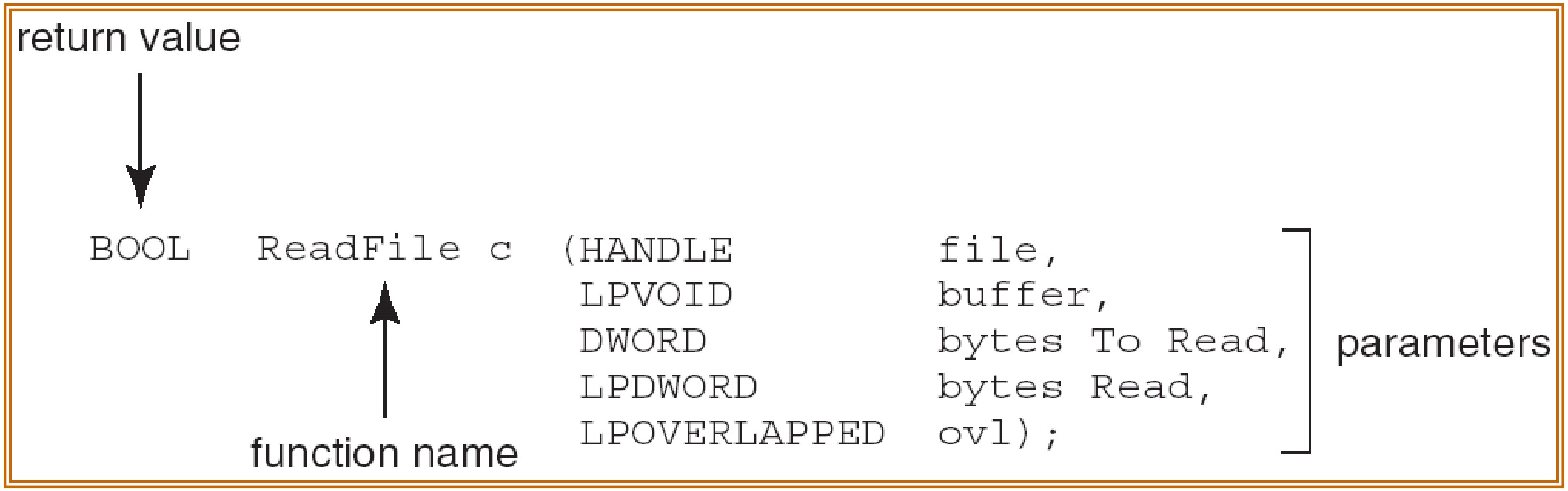
An Example of System Calls

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



An Example of Standard API

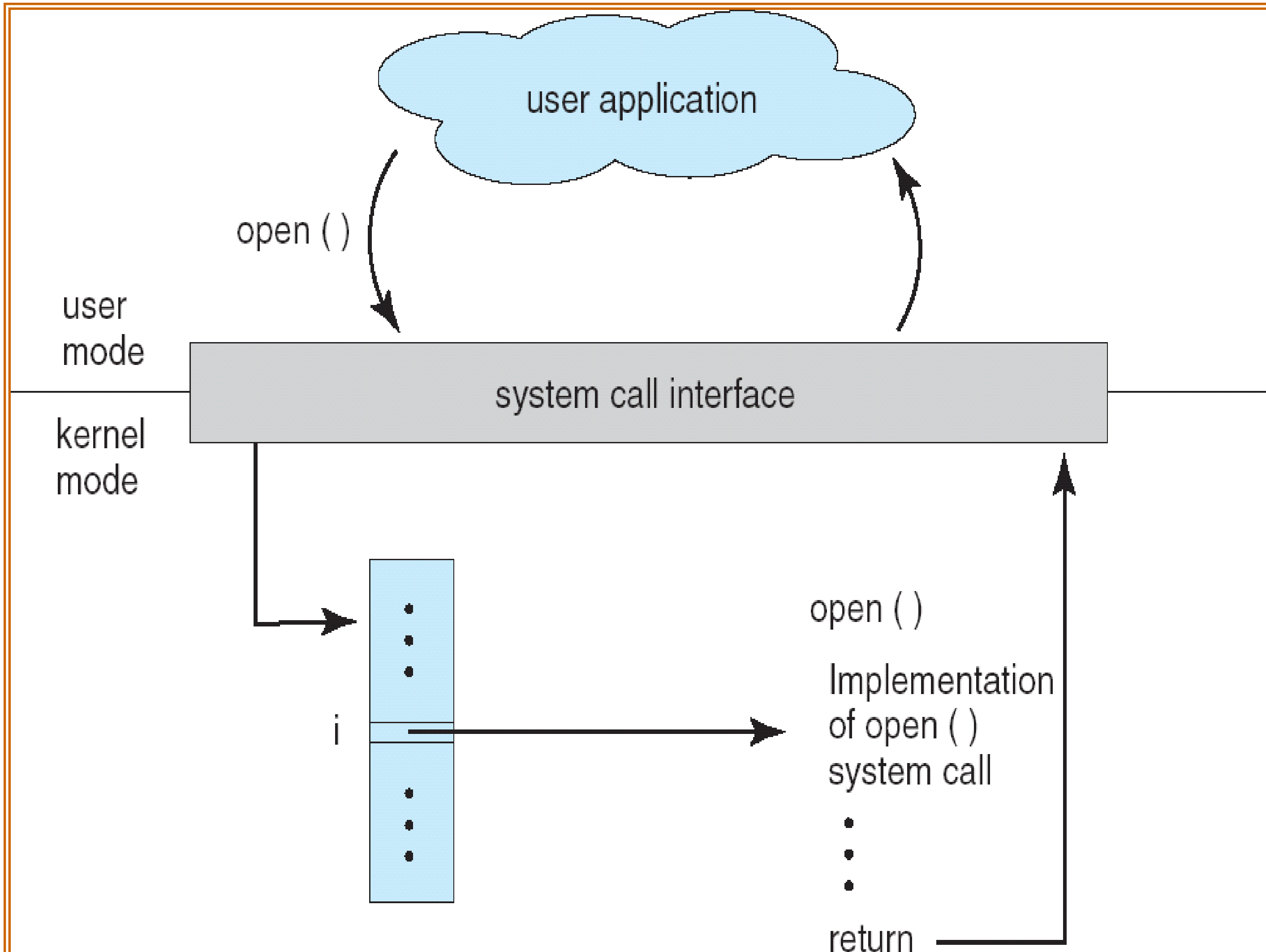
- Consider the ReadFile() function in the Win32 API—a function for reading from a file



A description of the parameters passed to ReadFile()

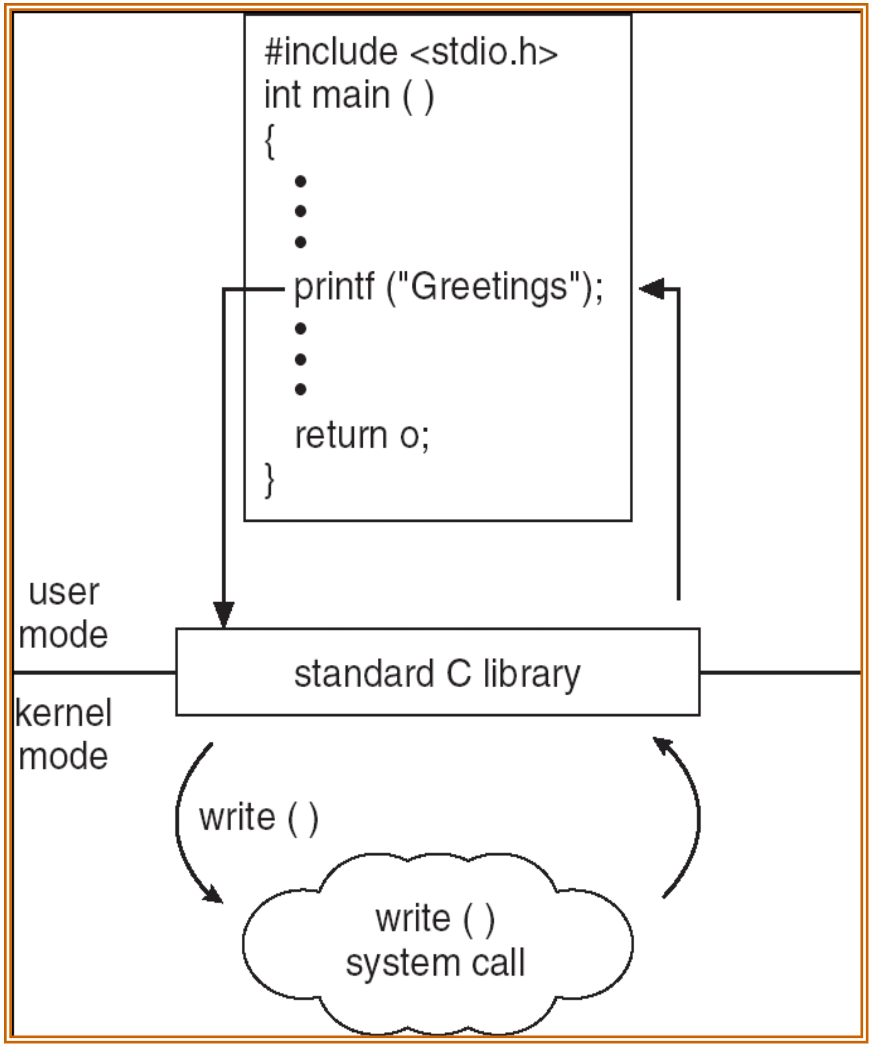
- HANDLE file—the file to be read
- LPVOID buffer—a buffer where the data will be read into and written from
- DWORD bytesToRead—the number of bytes to be read into the buffer
- LPDWORD bytesRead—the number of bytes read during the last read
- LPOVERLAPPED ovl—indicates if overlapped I/O is being used

API – System Call – OS Relationship



Standard C Library Example

- C program invoking printf() library call, which calls write() system call



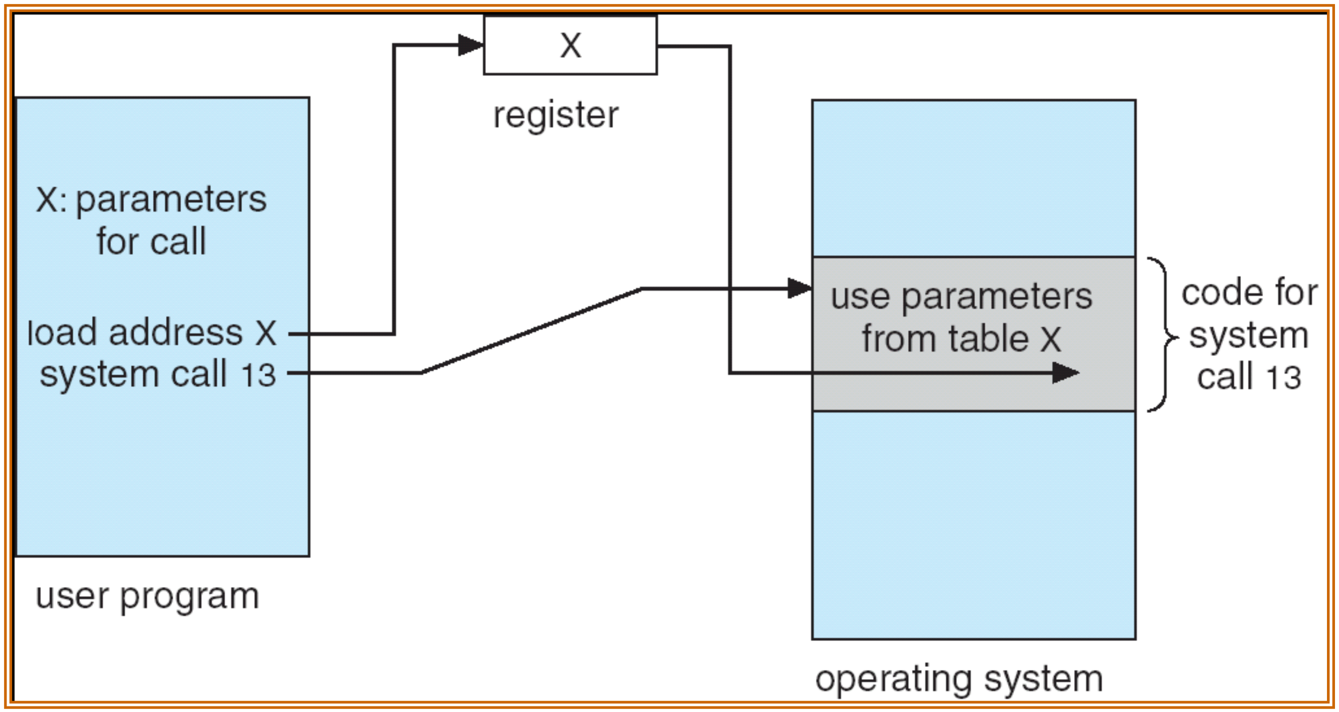
Why use API?

- Simplicity
  - API is designed for applications
- Portability
  - API is an unified defined interface
- Efficiency
  - Not all functions require OS services or involve kernel

System Calls: Passing Parameters

- Three general methods are used to pass parameters between a running program and the operating system.
  - Pass parameters in registers
  - Store the parameters in a table in memory, and the table address is passed as a parameter in a register
  - Push (store) the parameters onto the stack by the program, and pop off the stack by operating system

Parameter Passing via Table



Review Slides (1)

- What are the two communication models provided by OS?
- What is the relationship between system calls, API and C library?
- Why use API rather than system calls?

System Structure:

- Simple OS Architecture
- Layer OS Architecture
- Microkernel OS
- Modular OS Structure
- Virtual Machine
- Java Virtual Machine

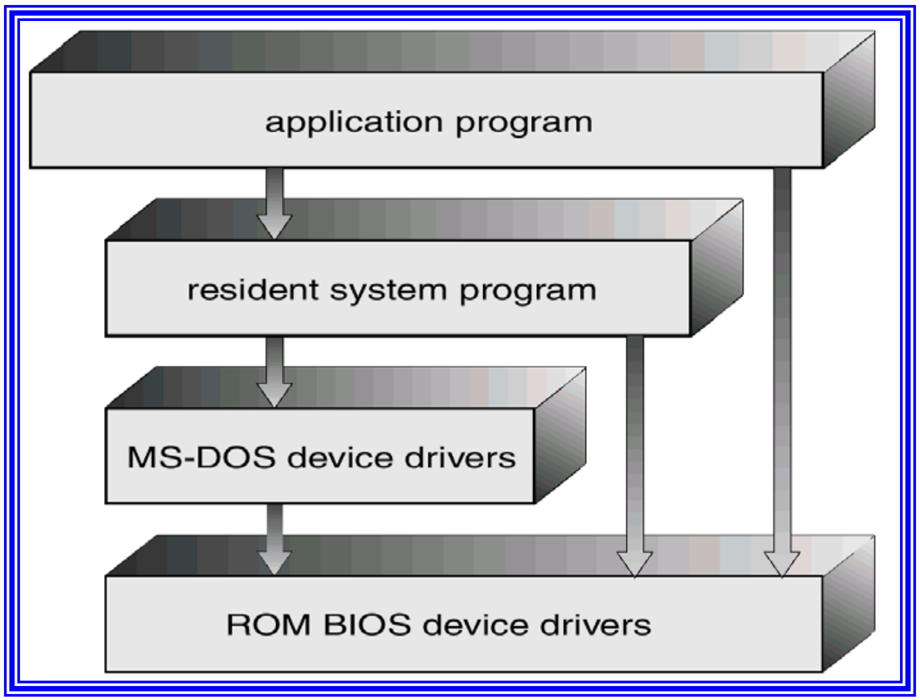
User goals and System goals

- User goals – operating system should be **easy to use** and **learn**, as well as reliable, safe, and fast

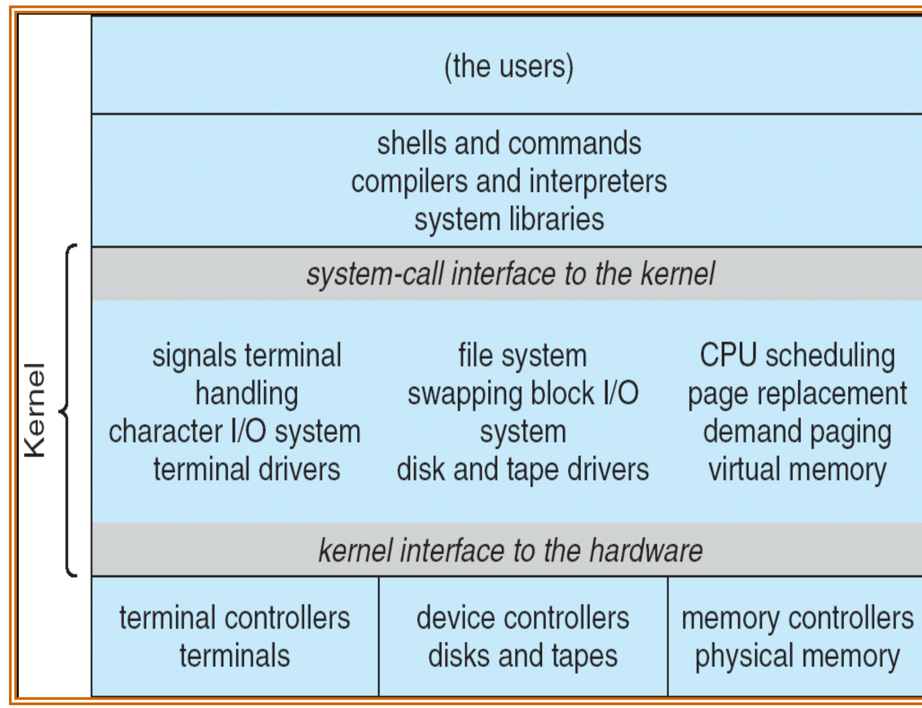
- System goals – operating system should be **easy to design**, **implement**, and **maintain**, as well as reliable, error-free, and efficient

Simple OS Architecture

- Only one or two levels of code
- Drawbacks: Un-safe, difficult to enhance



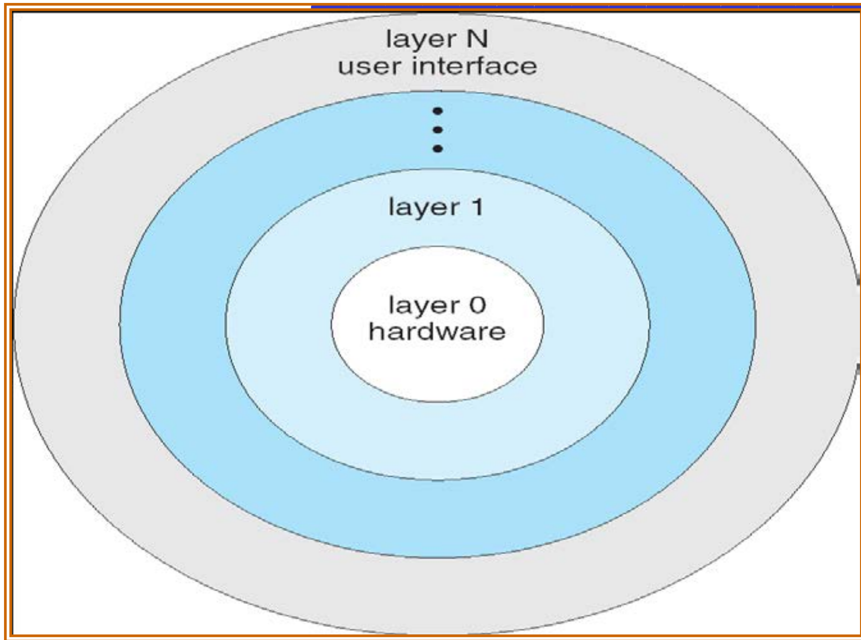
MS-DOS



UNIX

Layered OS Architecture

- Lower levels independent of upper levels
  - N^{th} layer can only access services provided by $0 \sim (N-1)^{th}$ layer
- Pros: Easier debugging/maintenance
- Cons: Less efficient, difficult to define layers



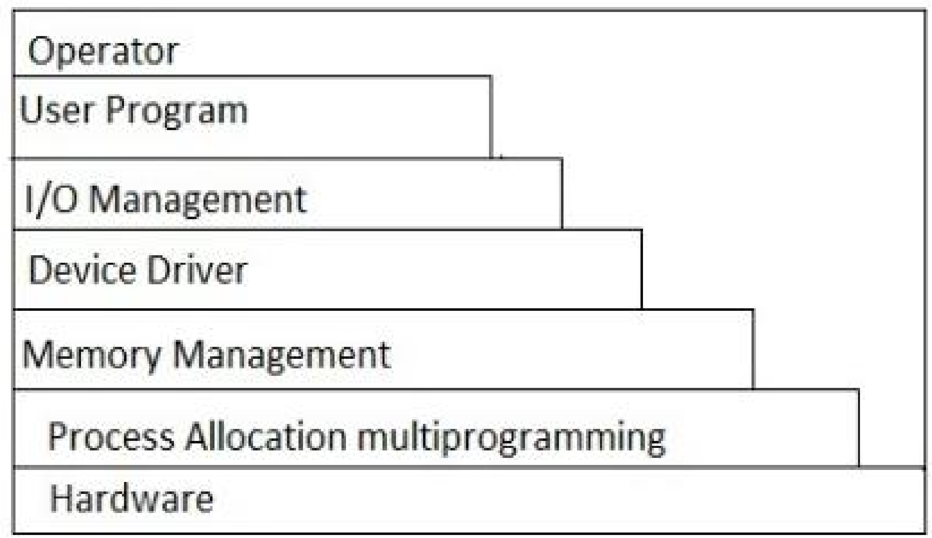
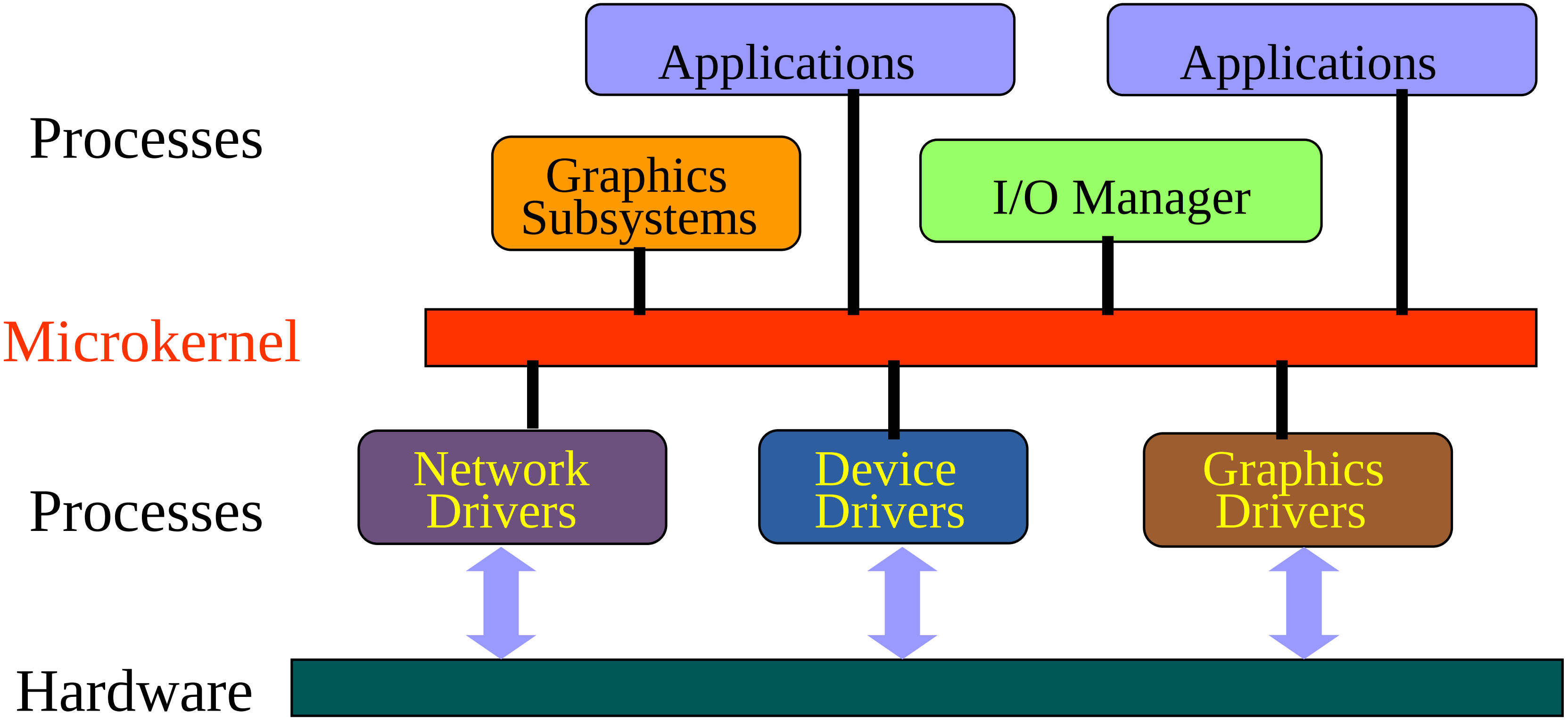


fig:- layered Architecture

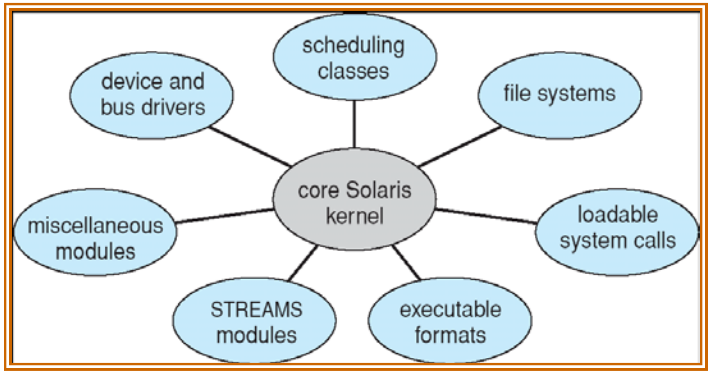
Microkernel OS

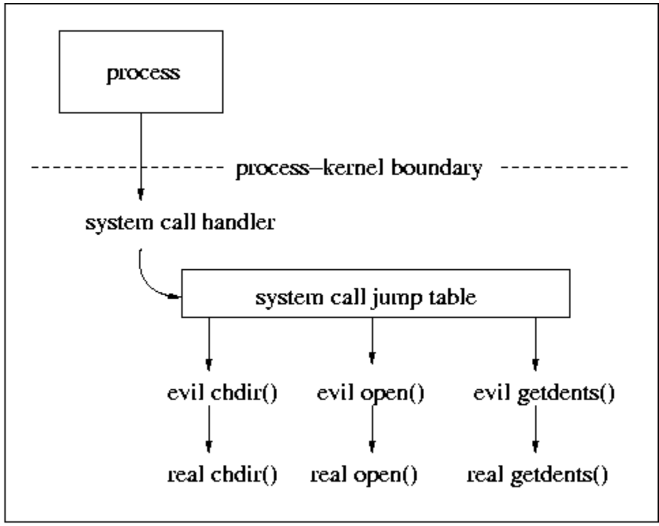
- Moves as much from the kernel into *"user"* space
- Communication is provided by message passing
- Easier for extending and porting



Modular OS Architecture

- Most modern OS implement ***kernel modules***
  - Uses object-oriented approach
  - Each core component is separate
  - Each talks to the others over known interfaces
  - Each is **loadable** as needed within the kernel
- Similar to layers but with more flexible
- E.g., Solaris



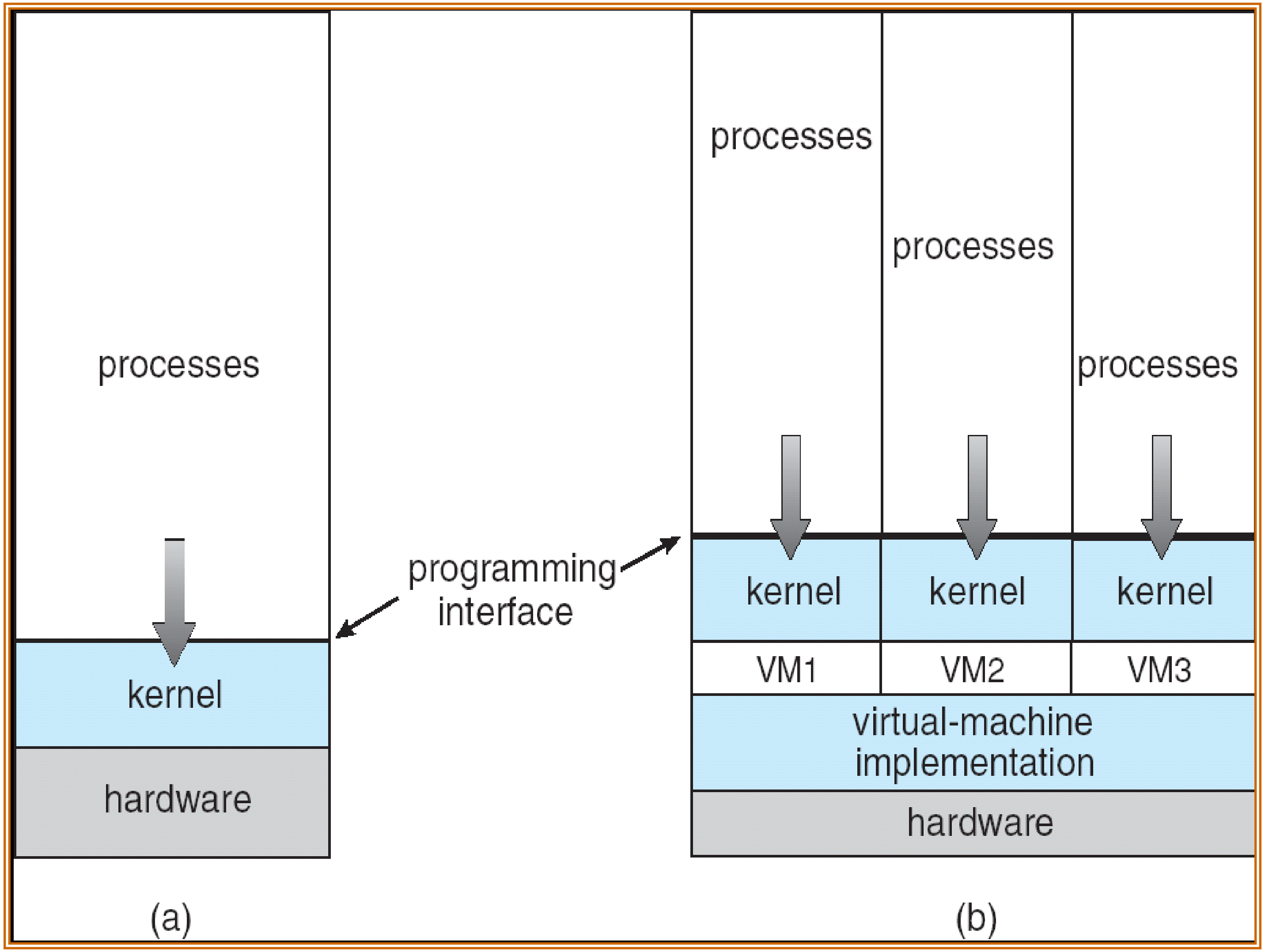


- How to write kernel module
  - http://www.linuxchix.org/content/courses/kernel_hacking/lesson8
  - http://en.wikibooks.org/wiki/The_Linux_Kernel/Modules
  - https://www.thc.org/papers/LKM_HACKING.html

Virtual Machine

- A *virtual machine* takes the layered approach to its logical conclusion
  - It treats hardware and the operating system kernel as though they were all hardware
- A virtual machine provides an interface *identical* to the underlying bare hardware
  - Each process is provided with a (virtual) copy of the underlying computer
- Difficult to achieve due to "*critical instruction*"

Virtual Machine

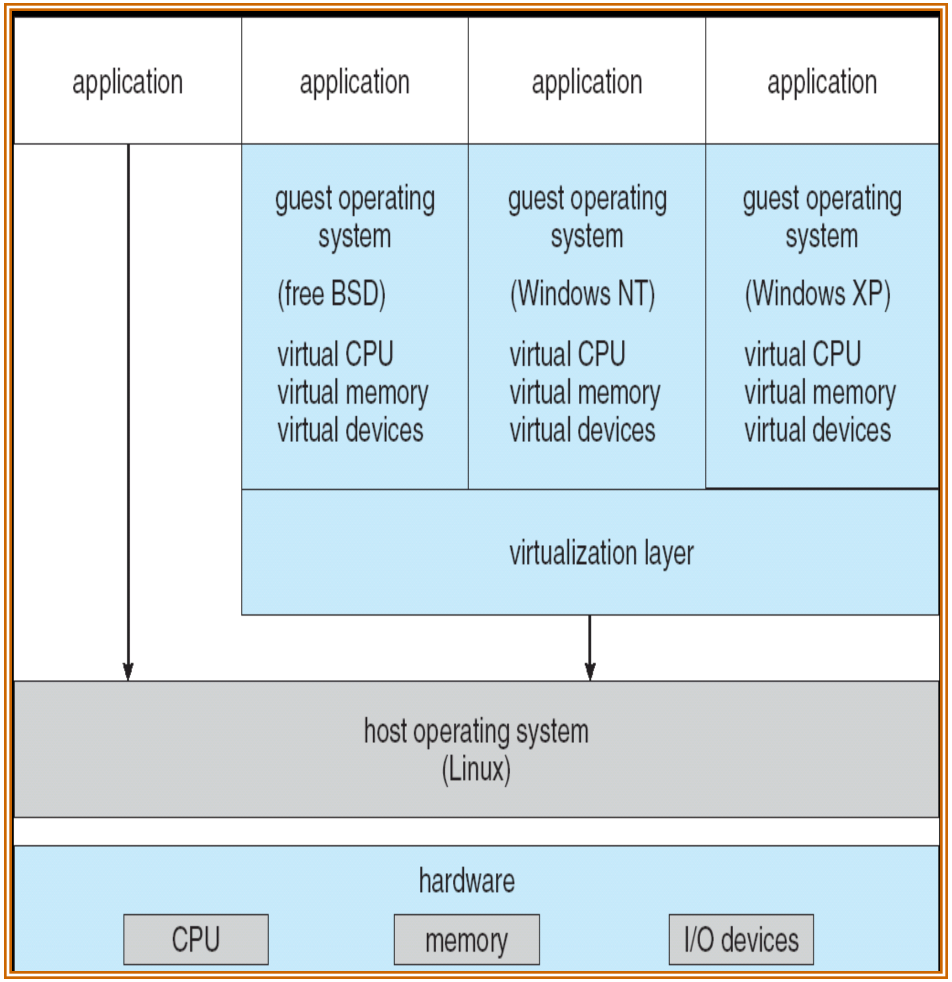


Usage of Virtual Machine

- provides complete protection of system resources
- a means to solve system compatibility problems
- a perfect vehicle for operating-systems research and development
- A mean to increase resources utilization in cloud computing

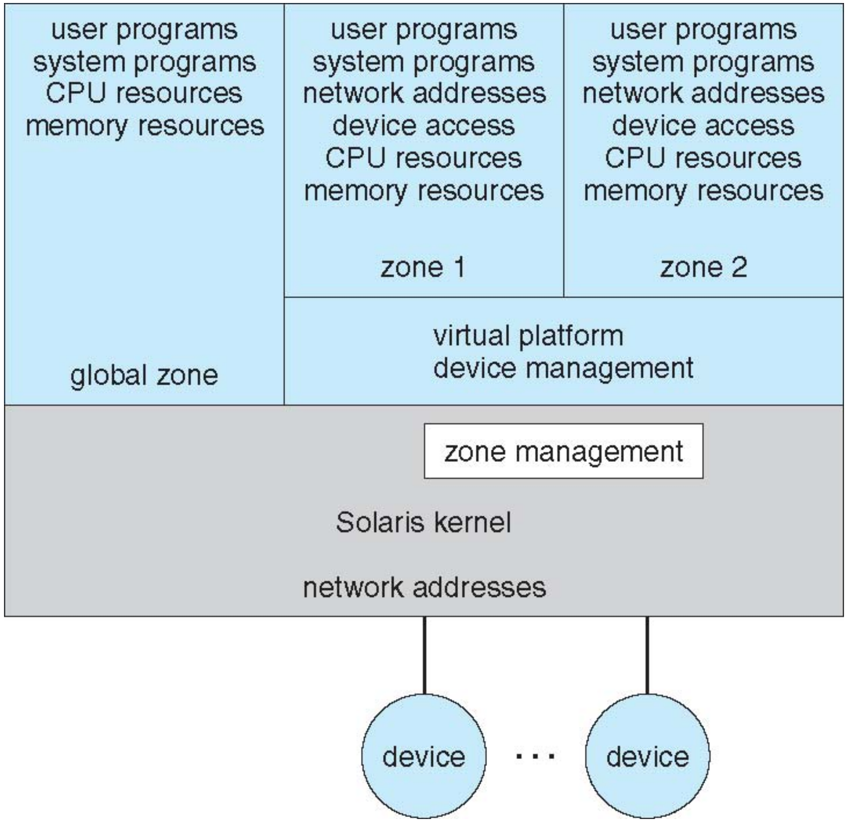
Full Virtualization: VMware/KVM

- Run in user mode as an application on top of OS
- Virtual machine believe they are running on bare hardware but in fact are running inside a user-level application



Para-virtualization: Xen

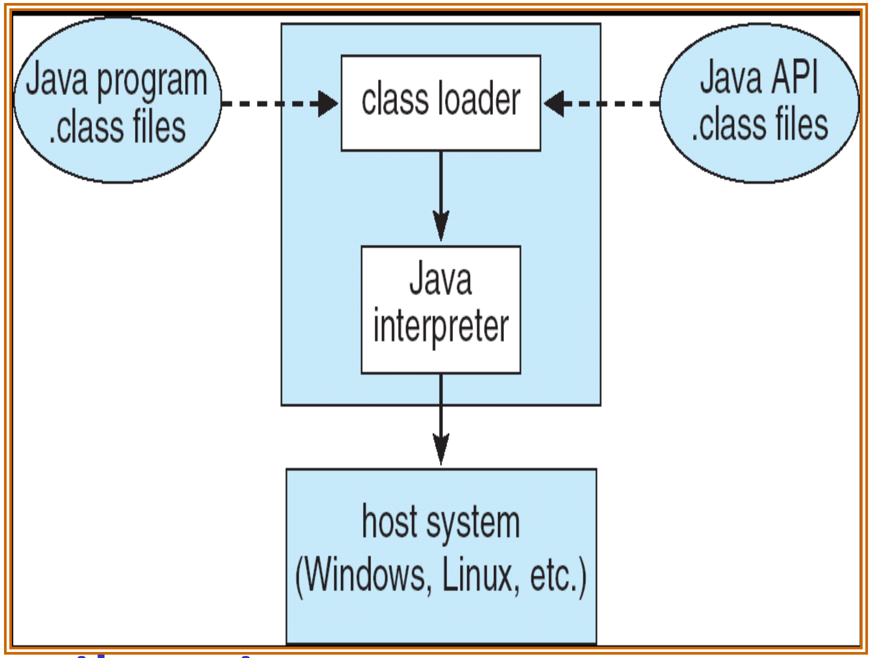
- Presents guest with system similar but not identical to the guest's preferred systems (Guest must be modified)
- Hardware rather than OS and its devices are virtualized (Only one kernel installed)
- Within a container (zone) processes thought they are the only processes on the system



- **Solaris 10**: creates a virtual layer between OS and the applications

Java Virtual Machine

- Compiled Java programs are platform-neutral bytecodes executed by a Java Virtual Machine (JVM)
- JVM consists of
  - class loader
  - class verifier
  - runtime interpreter



- Just-In-Time (JIT) compilers increase performance

Review Slides (2)

- What is the difference between the layer approach, the modular approach and microkernel?
- What are the advantages of using virtual machine?

Reading Material & HW

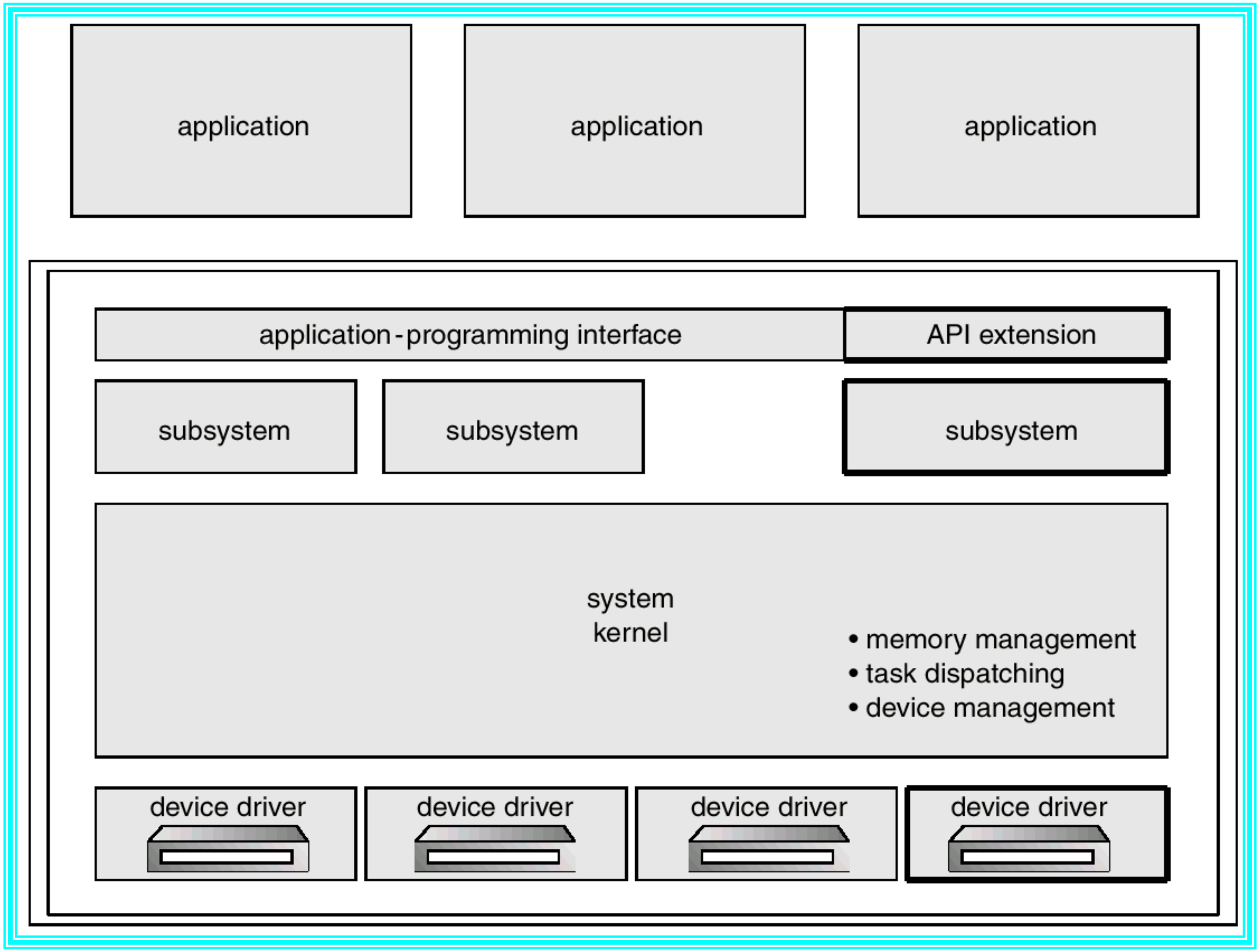
- Chap 2
- HW (Problem set)
  - 2.7: What is the purpose of the command interpreter? Why is it usually separate from the kernel?
  - 2.10: What is the main advantage of the layered approach to system design? What are the disadvantages of using the layered approach?
  - 2.13: What is the main advantage of the microkernel approach to system design? How do user programs and system services interact in a microkernel architecture? What are the disadvantages of using the microkernel approach?

Reading Material & HW

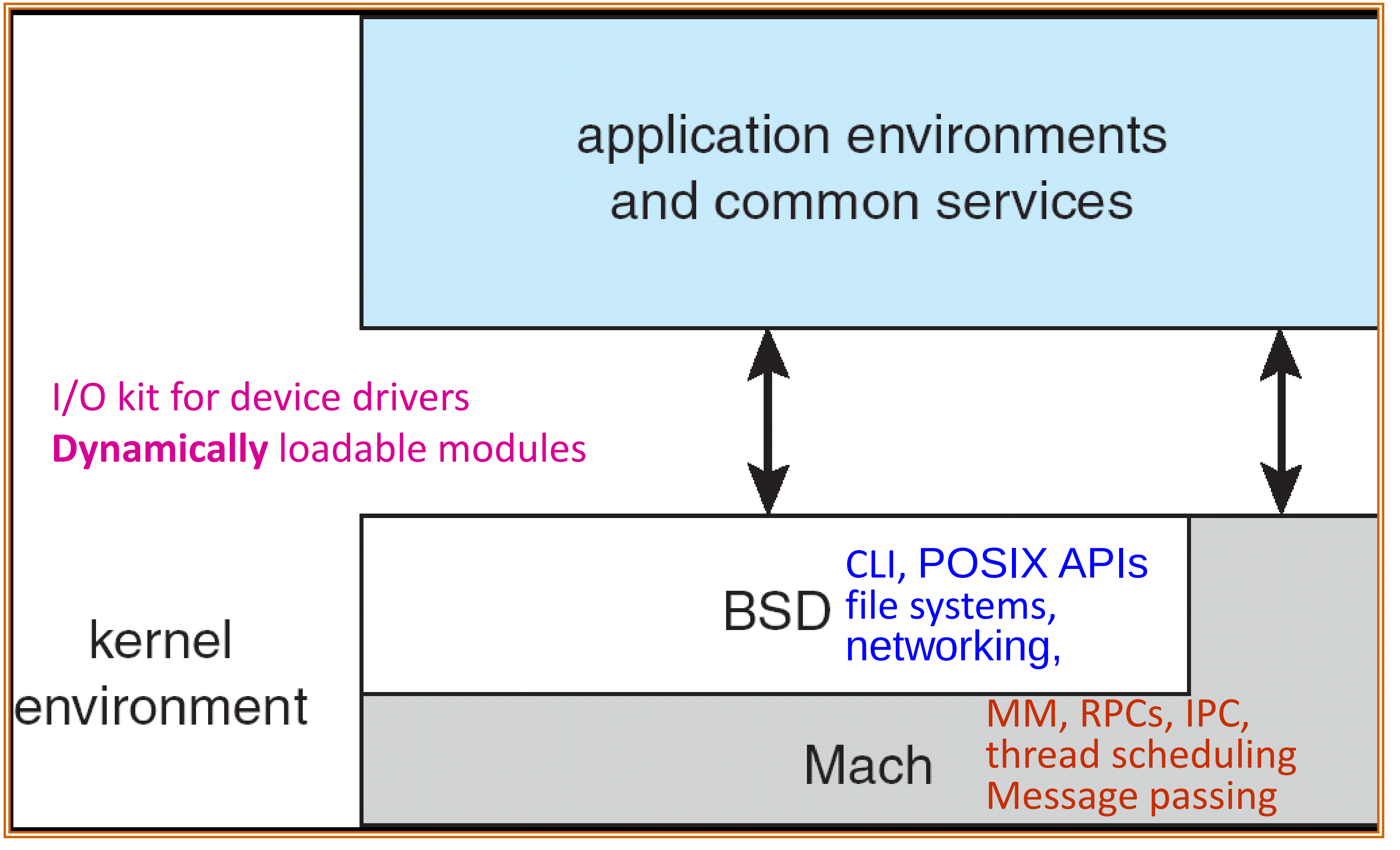
- Reference
  - *Understanding Full Virtualization, Paravirtualization, and Hardware Assist*
  - *www.vmware.com/files/pdf/VMware_**paravirtualization**.pdf*
  - *APIs, POSIX and the C Library*
  - *http://book.chinaunix.net/special/ebook/Linux_Kernel_Development/0672327201/ch05lev1sec1.html*

Backup

OS/2


application
application
application
application-programming interface
API extension
subsystem
subsystem
subsystem
system
kernel
• memory management
• task dispatching
• device management
device driver
device driver
device driver
device driver

Mac OS X Structure hybrid structured



Simulation

- Simulation: the host system has one system architecture and the guest system was complied for a different architecture
- The programs (such as important programs that were compiled for the old system) could be run in an emulator that translates each of the outdated system's instructions into the current instruction set. (disadv.: 10 times slow usually)