Welcome to OS @ UNSW

COMP3231/9201/3891/9283

(Extended) Operating Systems

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(slides designed by Dr. Kevin Elphinstone)

Operating Systems

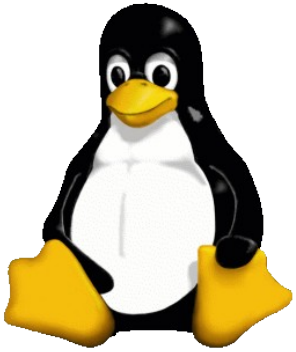
Chapter 1 – 1.3
Chapter 1.5 – 1.9

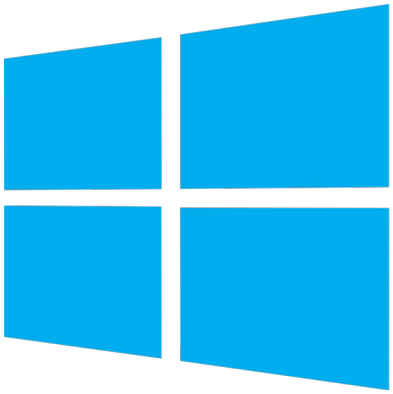
(in “Modern Operating Systems” by Tanenbaum & Bos)

Learning Outcomes

- High-level understand what is an operating system and the role it plays
- A high-level understanding of the structure of operating systems, applications, and the relationship between them.

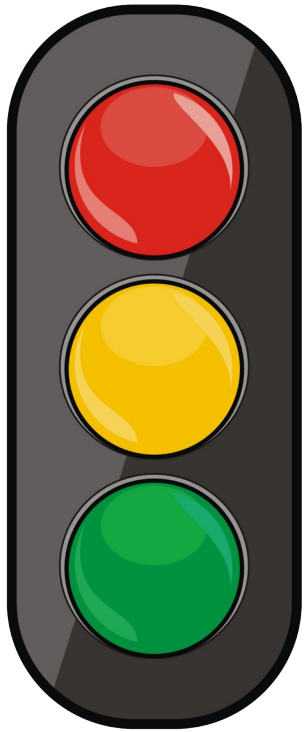
What is an Operating System?

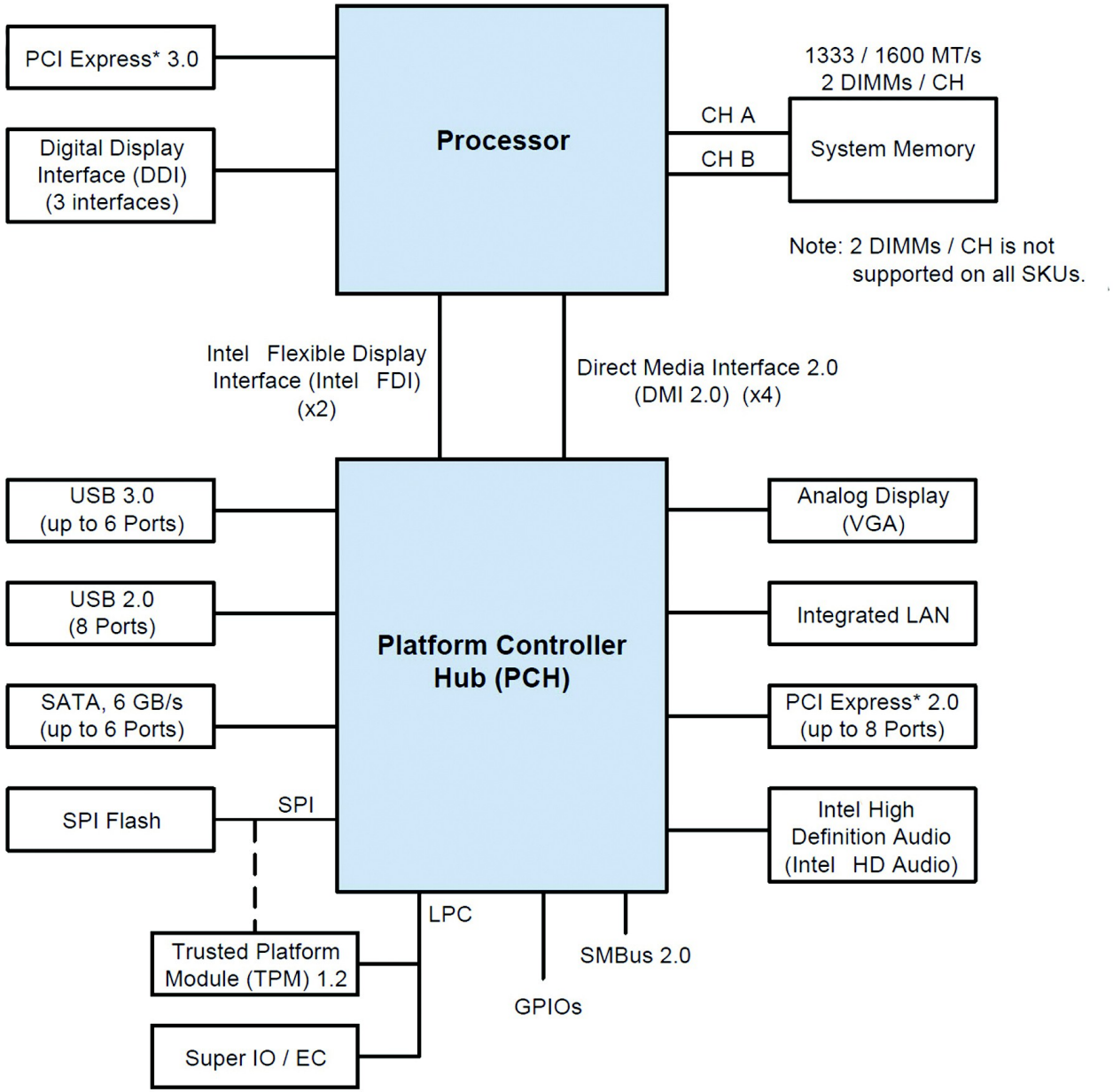




What is a traffic light?

- A signalling device that controls the flow of traffic
  - Defined in terms of the **role** it plays
- A signalling device consisting of three lights mounted at an intersection
  - Defined in terms of what it **is**



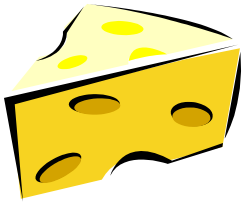


Block Diagram of Haswell Platform Architecture http://www.pcquest.com

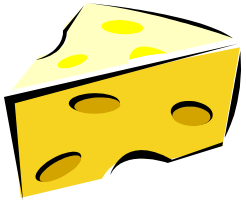
Role 1: The Operating System is an Abstract Machine

- Extends the basic hardware with added functionality
- Provides high-level abstractions
  - More programmer friendly
  - Common core for all applications
    - E.g. Filesystem instead of just registers on a disk controller
- It hides the details of the hardware
  - Makes application code portable

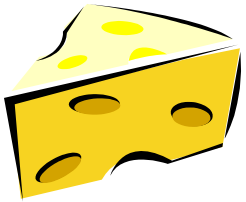
Disk



Memory

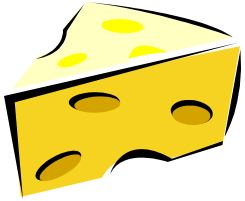


CPU



Network

Bandwidth

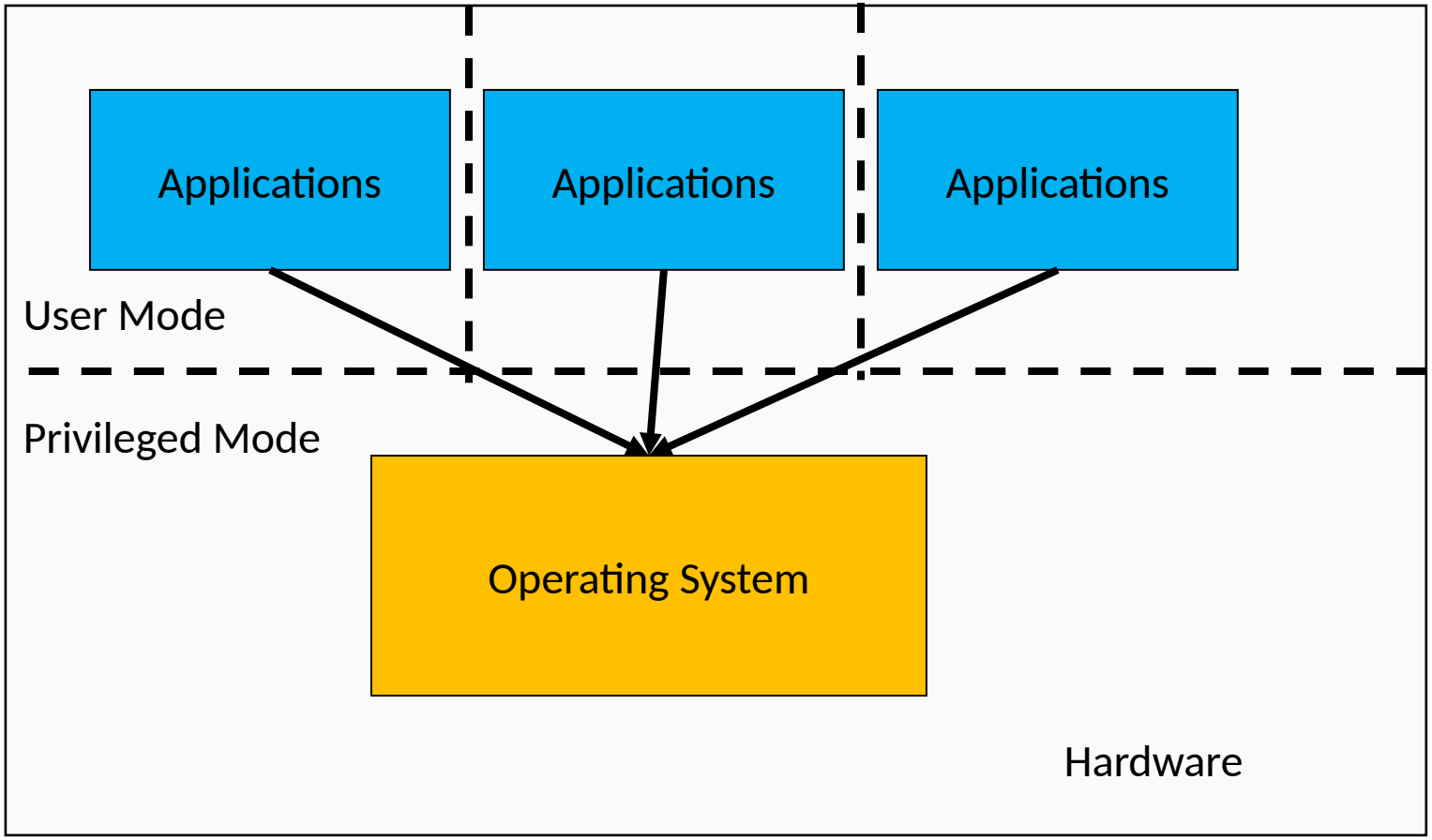


Users

Role 2: The Operating System is a Resource Manager

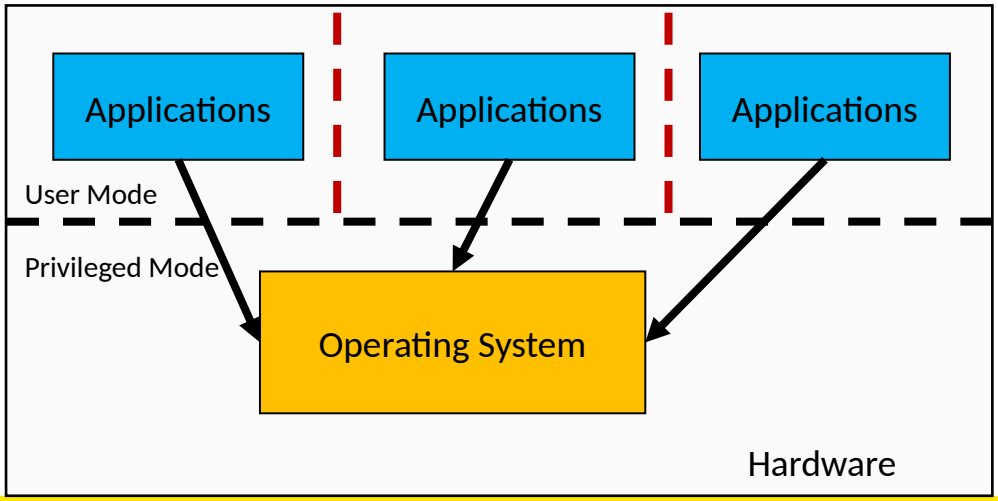
- Responsible for allocating resources to users and processes
- Must ensure
  - No Starvation
  - Progress
  - Allocation is according to some desired policy
    - First-come, first-served; Fair share; Weighted fair share; limits (quotas), etc…
  - Overall, that the system is efficiently used

Structural (Implementation) View: the Operating System ***is*** the software in *Privileged* mode.



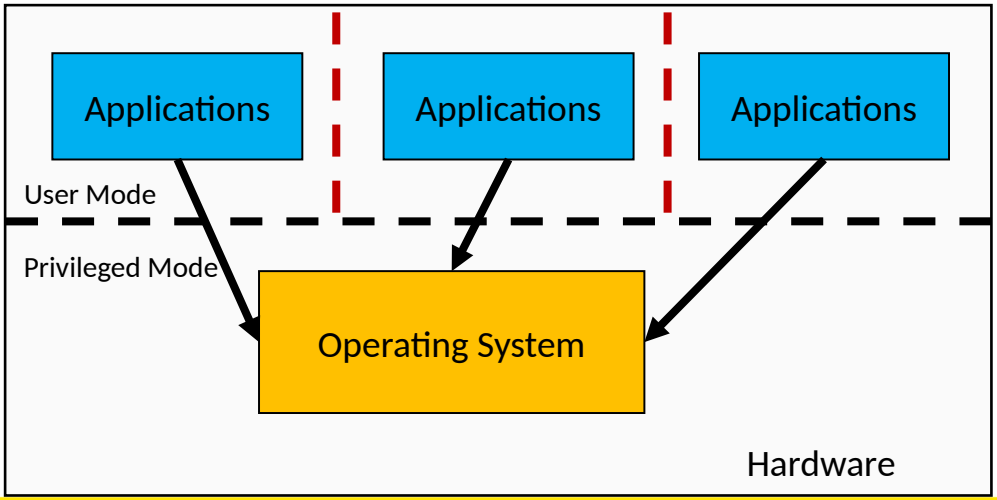
Operating System Kernel

- Portion of the operating system that is running in *privileged mode*
- Contains fundamental functionality
  - Whatever is required to implement other services
  - Whatever is required to provide security
- Contains most-frequently used functions
- Also called the nucleus or supervisor

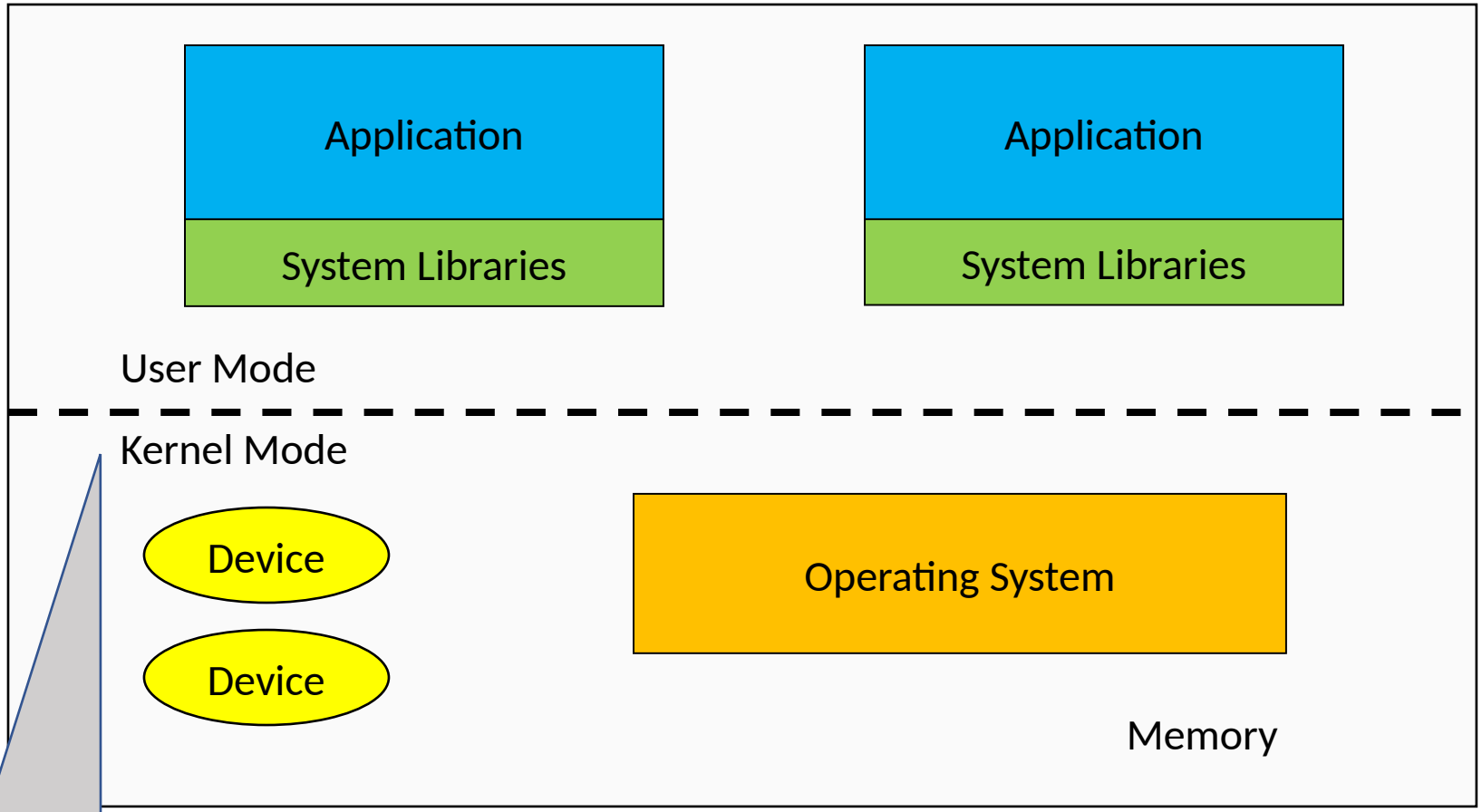


The Operating System is Privileged

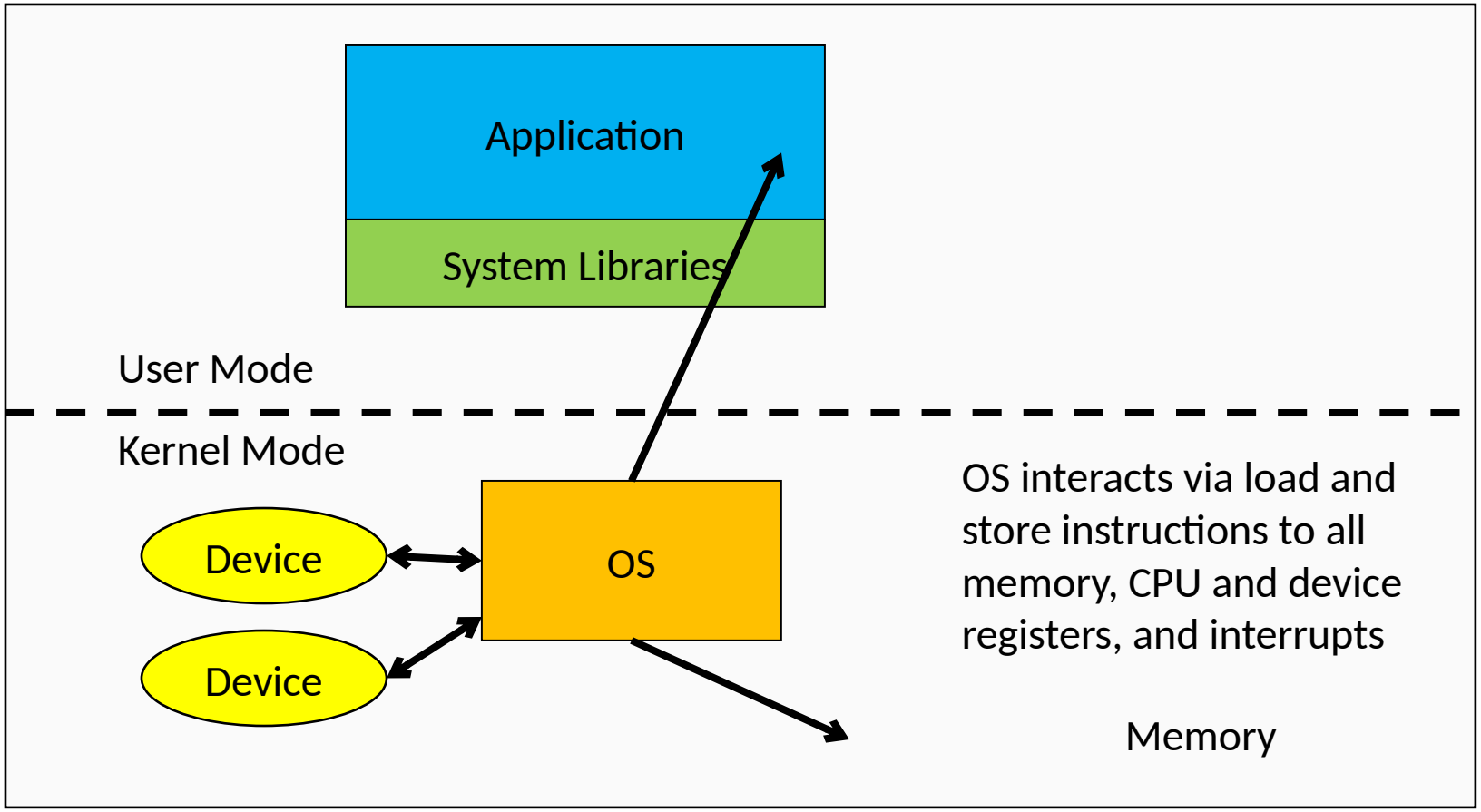
- Applications should not be able to interfere or bypass the operating system
  - OS can enforce the “extended machine”
  - OS can enforce its resource allocation policies
  - Prevent applications from interfering with each other



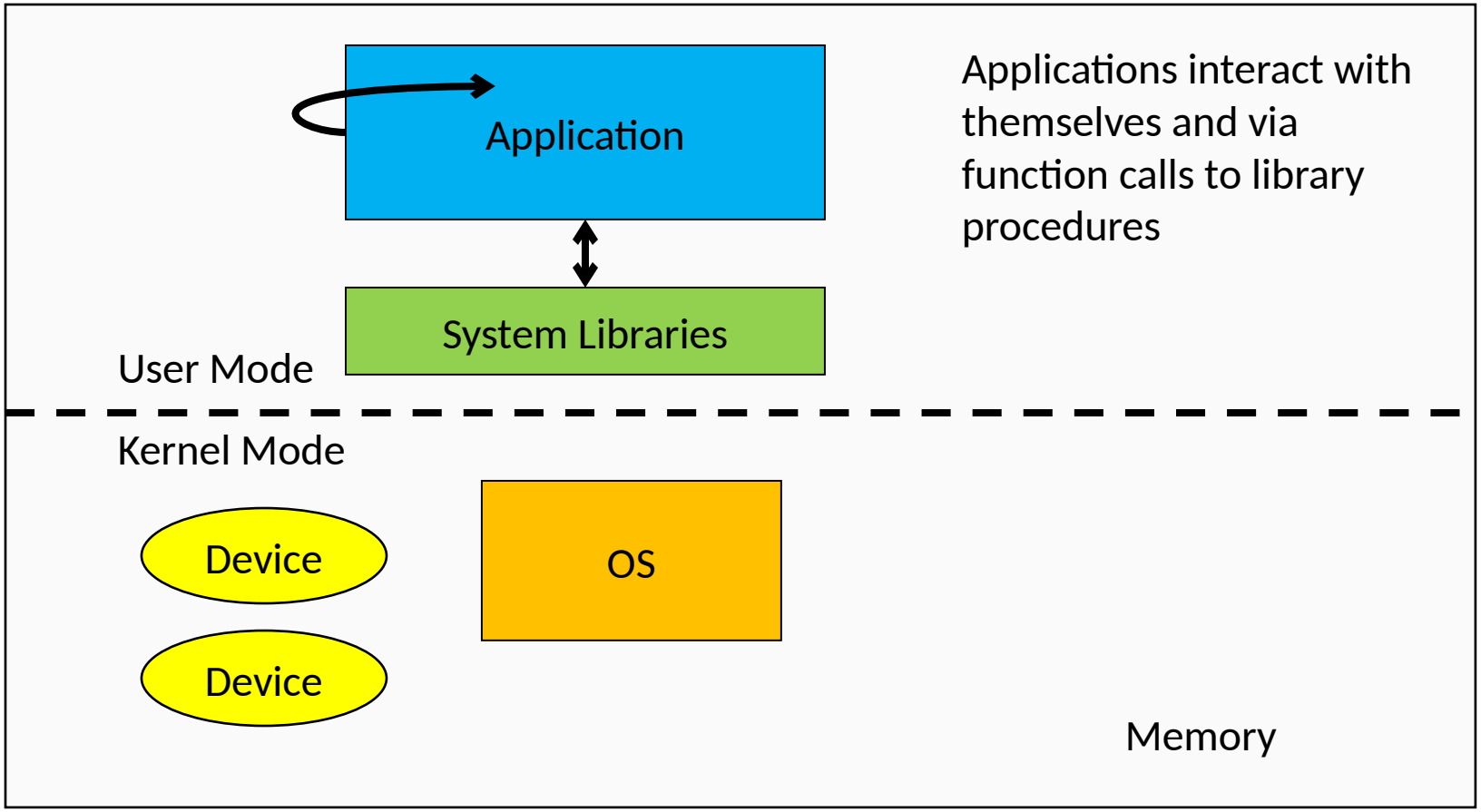
Delving Deeper:
The Structure of a Computer System



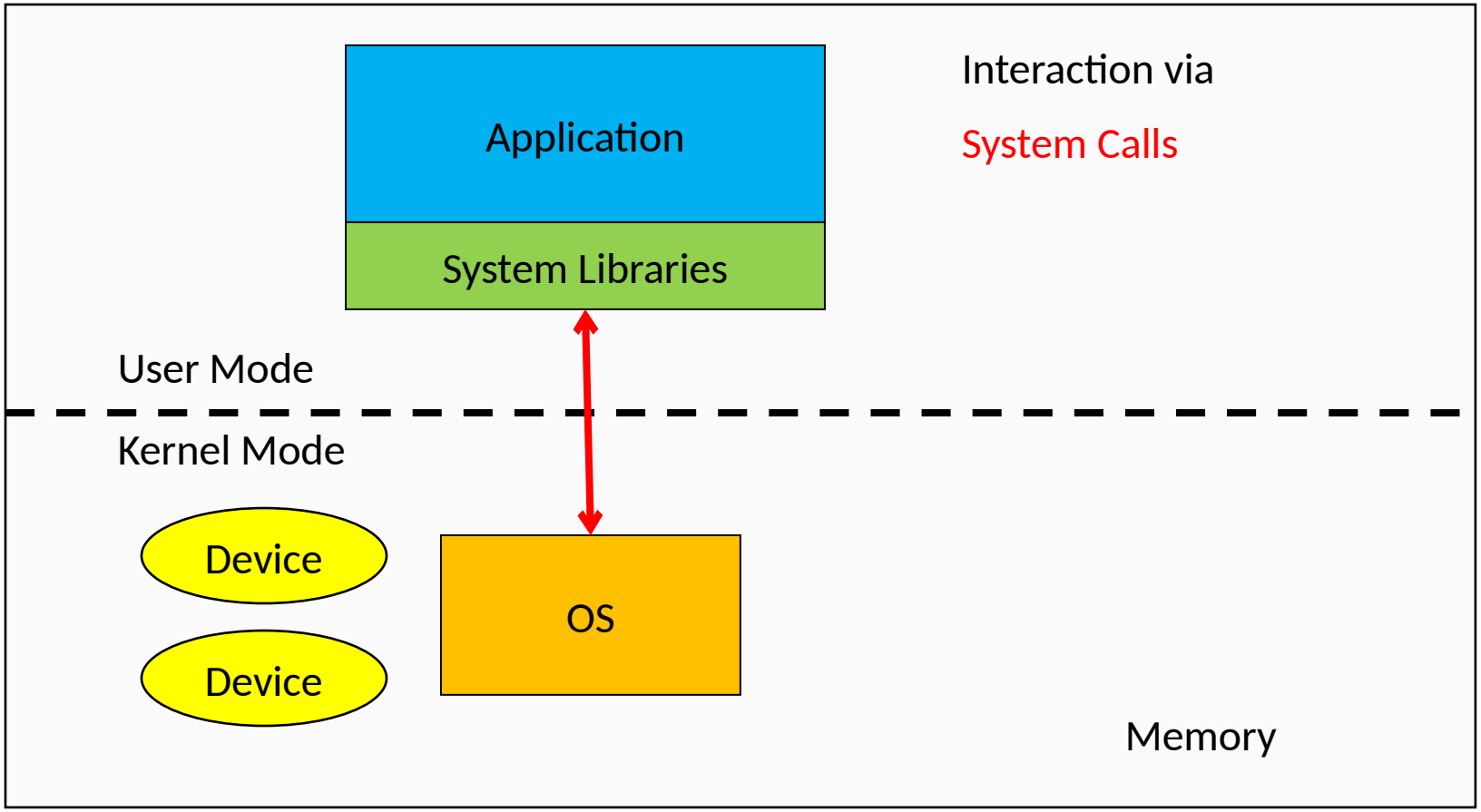
The Structure of a Computer System



The Structure of a Computer System

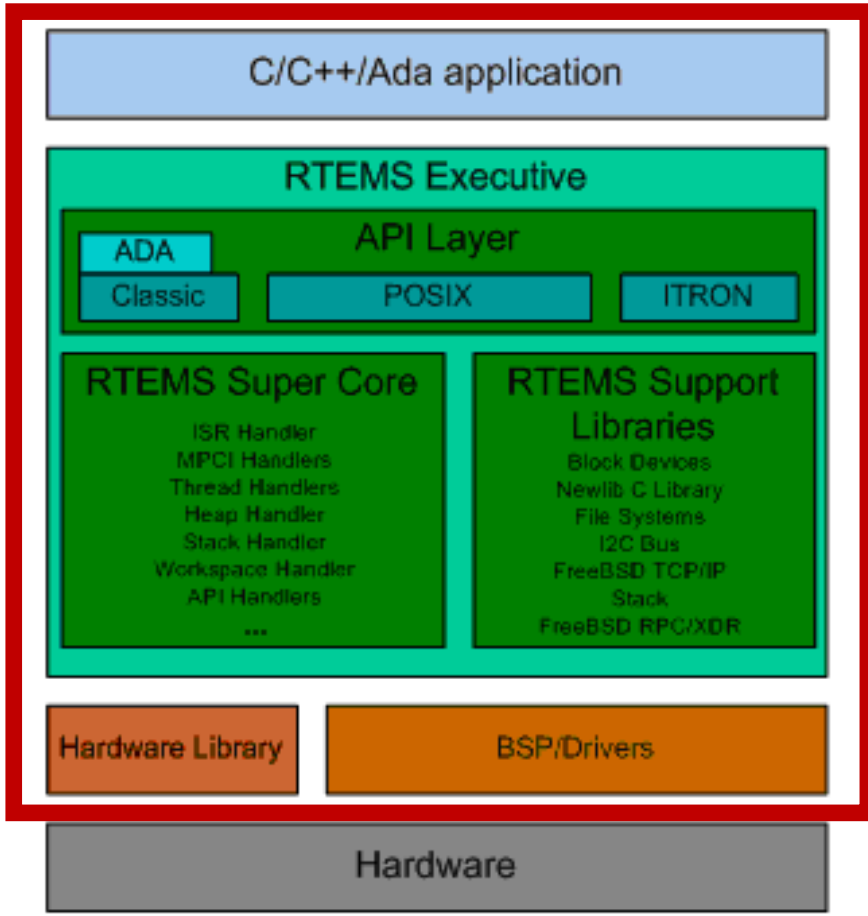


The Structure of a Computer System



Privilege-less OS

- Some Embedded OSs have no privileged component
  - e.g. PalmOS, Mac OS 9, RTEMS
  - Can implement OS functionality, but cannot enforce it.
    - All software runs together
    - No isolation
    - One fault potentially brings down entire system



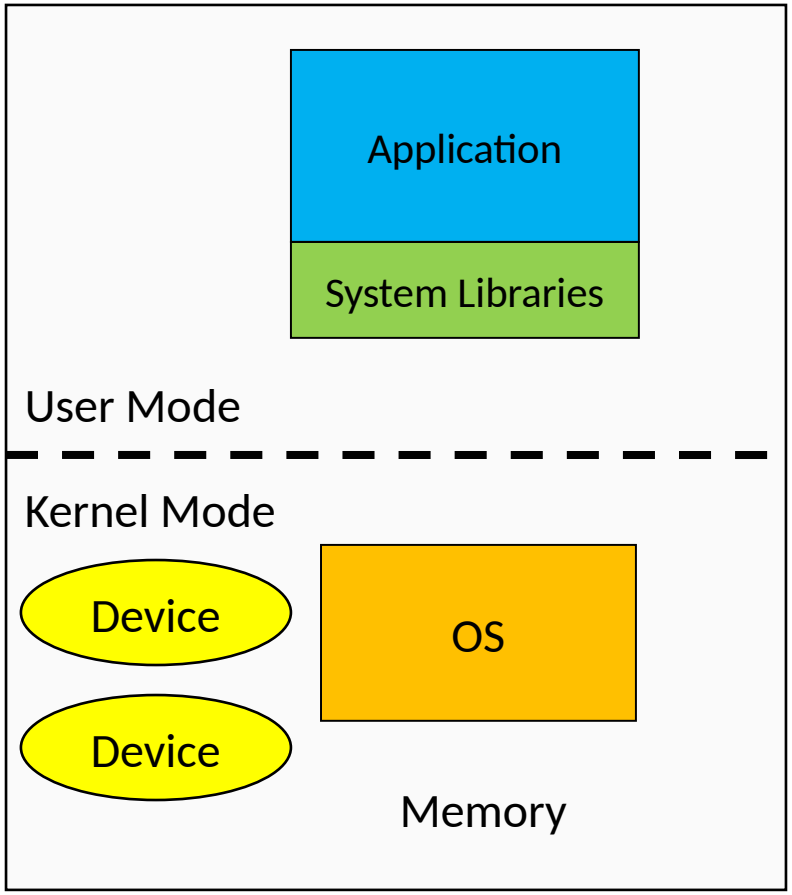
A Note on System Libraries

System libraries are just that, libraries of support functions (procedures, subroutines)

- Only a subset of library functions are actually system calls
  - strcmp(), memcpy(), are pure library functions
    - manipulate memory within the application, or perform computation
  - open(), close(), read(), write() are system calls
    - they cross the user-kernel boundary, e.g. to read from disk device
    - the user-level syscall implementation is focused on passing request to OS and returning result to application
  - fprintf(), malloc() are hybrids
    - only perform a system call if necessary
- System call functions are in the library for convenience
  - try `man syscalls` on Linux

Operating System Software

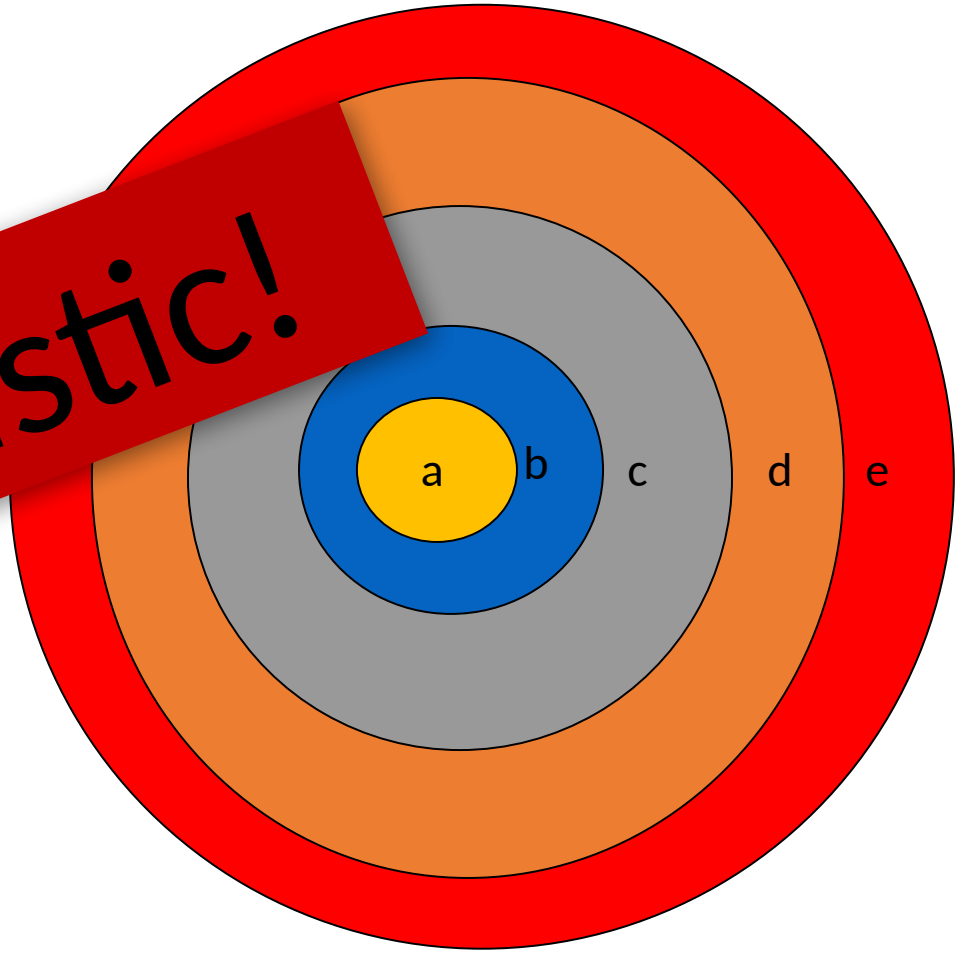
- Fundamentally, OS functions the same way as ordinary computer software
  - It is machine code that is executed (same machine instructions as application)
  - It has more privileges (extra instructions and access)
- Operating system relinquishes control of the processor to execute other programs
  - Reestablishes control after
    - System calls
    - Interrupts (especially timer interrupts)



Operating System Internal Structure?

Classic Operating System Structure

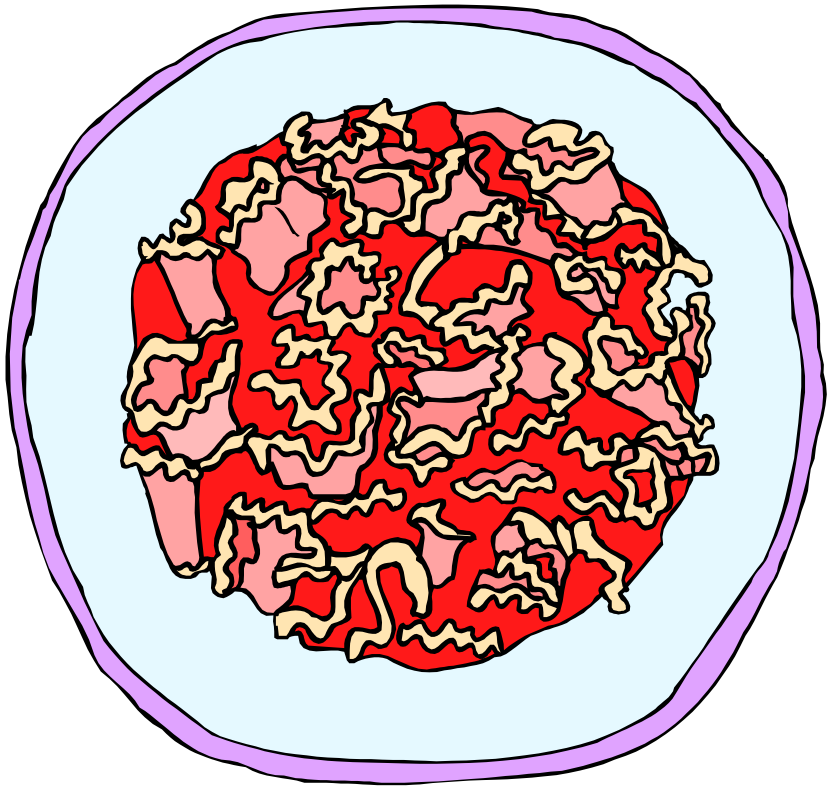
- The layered approach
  a) Processor allocation and multiprogramming
  b) Memory Mana
  c) Device
  d) Fil
  e) Use
- Each lay depends on the inner layers
- What might you call the outer layer?



Unrealistic!

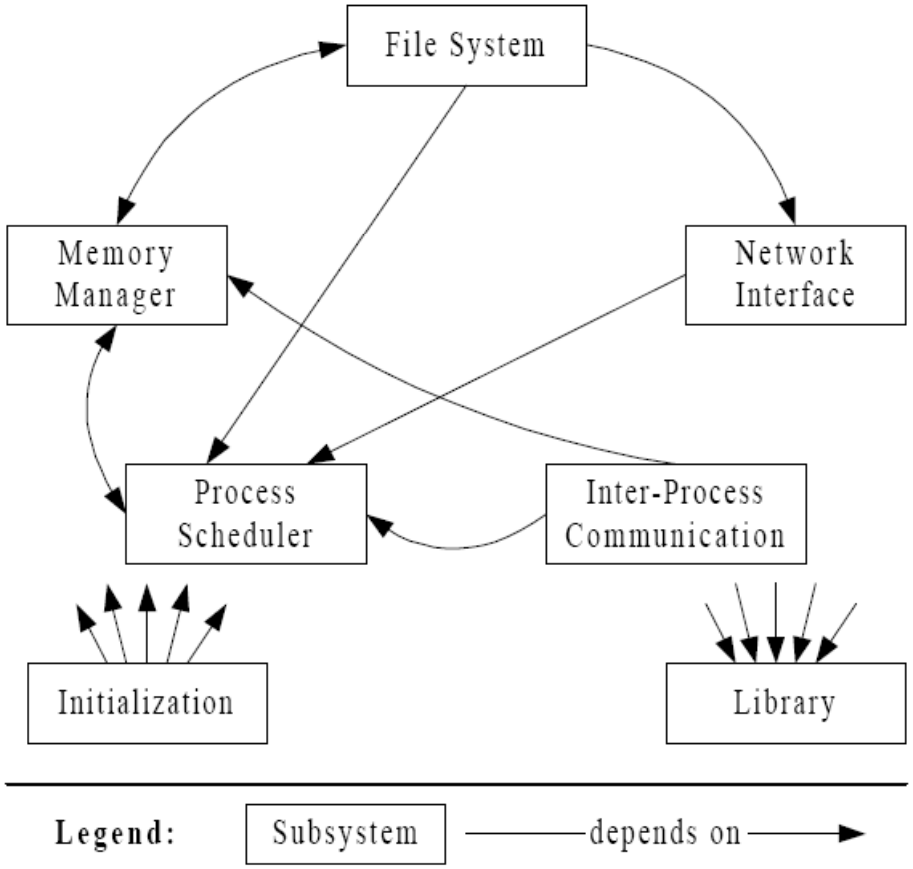
The Monolithic Operating System Structure

- Also called the “spaghetti nest” approach
  - Everything is tangled up with everything else.
- Linux, Windows, ….

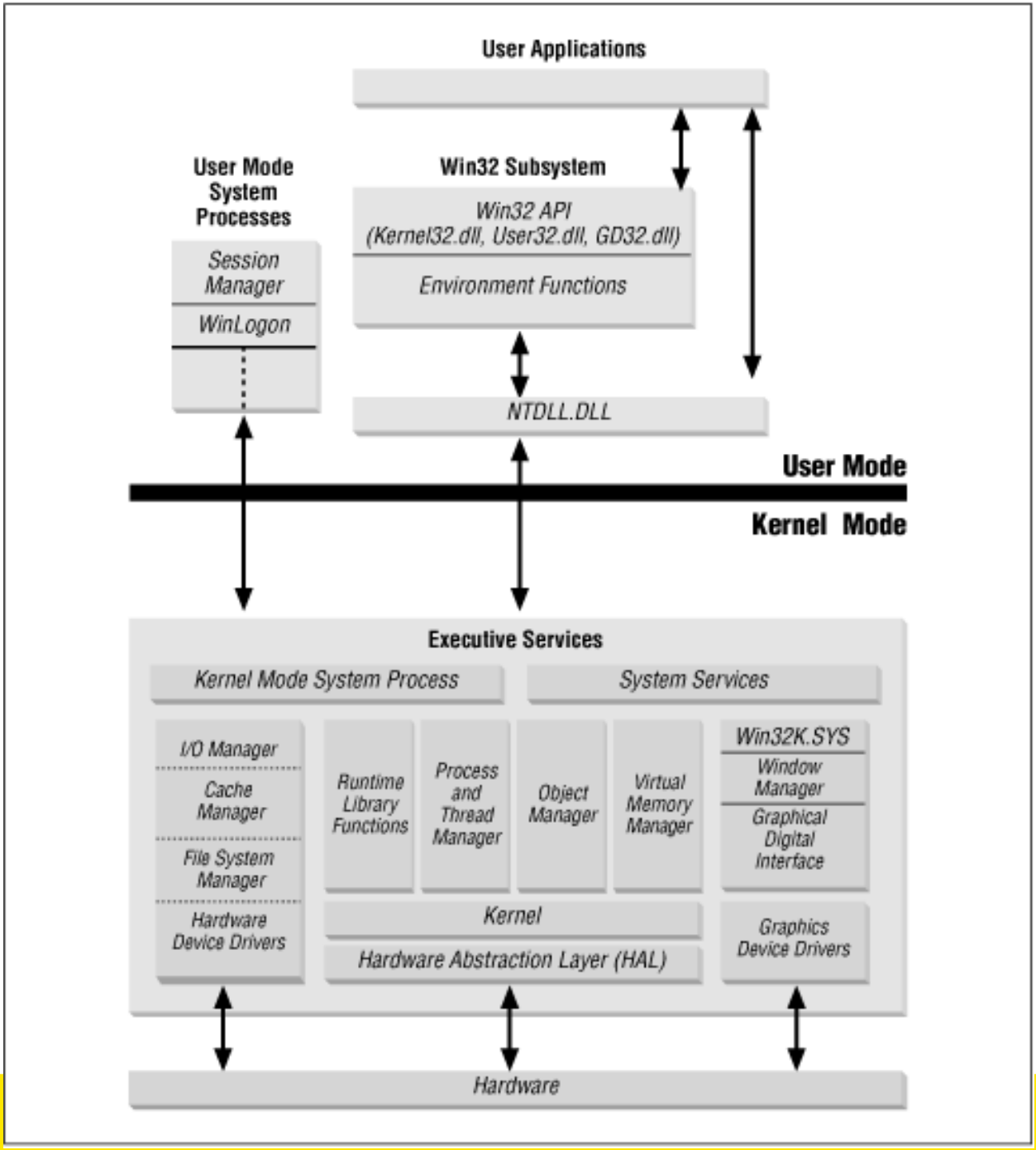


The Monolithic Operating System Structure

- However, some reasonable structure usually prevails



Bowman, I. T., Holt, R. C., and Brewster, N. V. 1999. Linux as a case study: its extracted software architecture. In *Proceedings of the 21st international Conference on Software Engineering* (Los Angeles, California, United States, May 16 - 22, 1999). ICSE '99. ACM, New York, NY, 555-563. DOI= http://doi.acm.org/10.1145/302405.302691


User Applications
User Mode System Processes
Win32 Subsystem
Win32 API (Kernel32.dll, User32.dll, GD32.dll)
Environment Functions
Session Manager
WinLogon
NTDLL.DLL
User Mode
Kernel Mode
Executive Services
Kernel Mode System Process
System Services
I/O Manager
Cache Manager
File System Manager
Hardware Device Drivers
Runtime Library Functions
Process and Thread Manager
Object Manager
Virtual Memory Manager
Win32K.SYS
Window Manager
Graphical Digital Interface
Kernel
Hardware Abstraction Layer (HAL)
Graphics Device Drivers
Hardware

Cathedrals and Bazaars and Blogs

Some interesting articles and thoughts on this topic:

- "The Cathedral and the Bazaar"
  - Essay by Eric S. Raymond.
  - Argues that open-source development is intrinsically less organised but more vital than corporate designs.
- Various authors think the opposite is true of Linux
  - One lead developer for its entire existence.
- Here is a snippet I found in comment on an essay about Longhorn/Vista:

  > disclaimer - I was a manager at Microsoft during some of this period (a member of the class of 17 uninformed decision makers) although not on this feature, er, menu.
  >
  > Note: the open source community does not have this problem (at least not to the same degree) as they tend not to take dependencies on each other to the same degree, specifically:
  >
  > - rarely take dependencies on unshipped code
  > - rarely make circular dependencies
  > - mostly take depemdencies on mature stable components.

  - https://moishelettvin.blogspot.com/2006/11/windows-shutdown-crapfest.html

Today:

- What is an operating system?
  - Role
  - Structure
- The User/Kernel division
- Operating System internal structure
  - (or lack of structure)