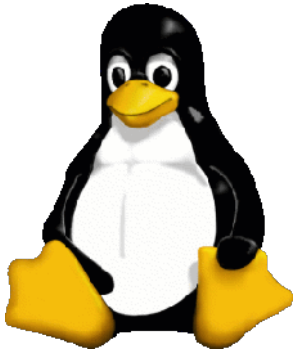
Welcome to OS @ UNSW

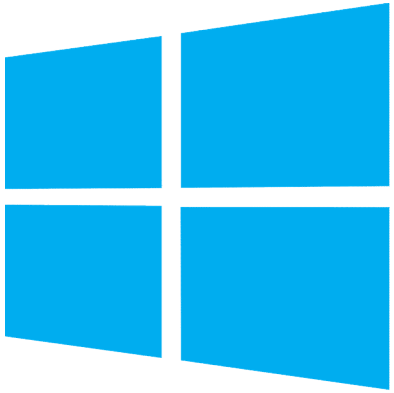
COMP3231/9201/3891/9283

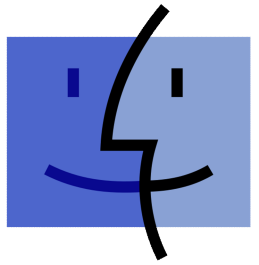
(Extended) Operating Systems

Dr. Kevin Elphinstone

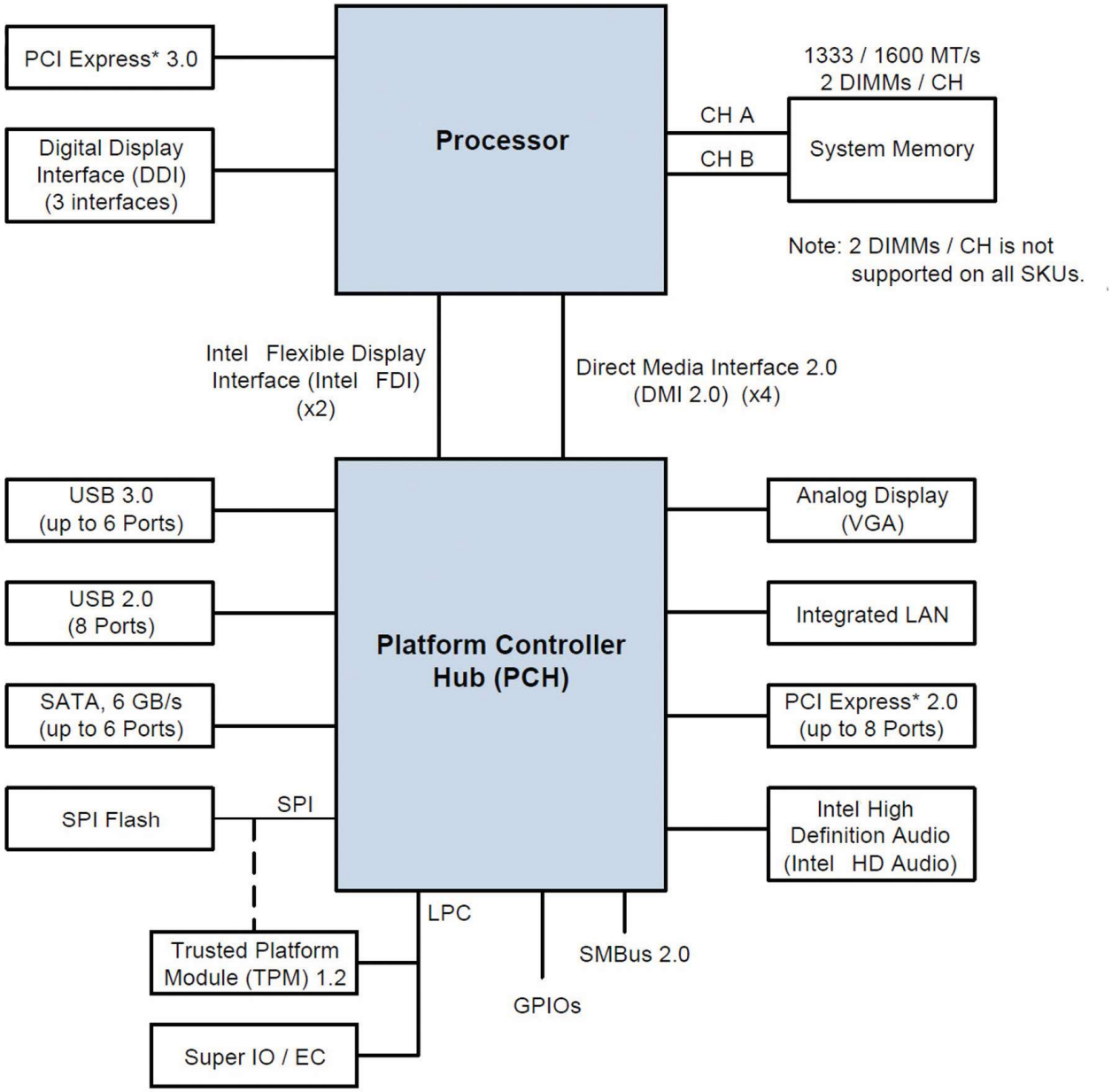
What is an Operating System?







Mac OS

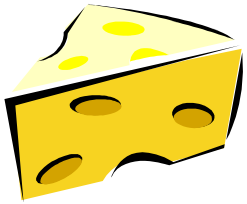


Block Diagram of Haswell Platform Architecture http://www.pcquest.com

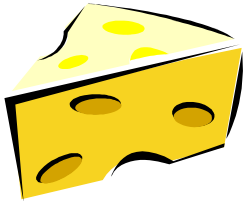
Role 1: The Operating System is an Abstract Machine

- 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

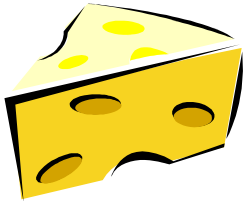
Disk



Memory

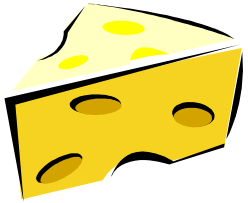


CPU



Network

Bandwidth

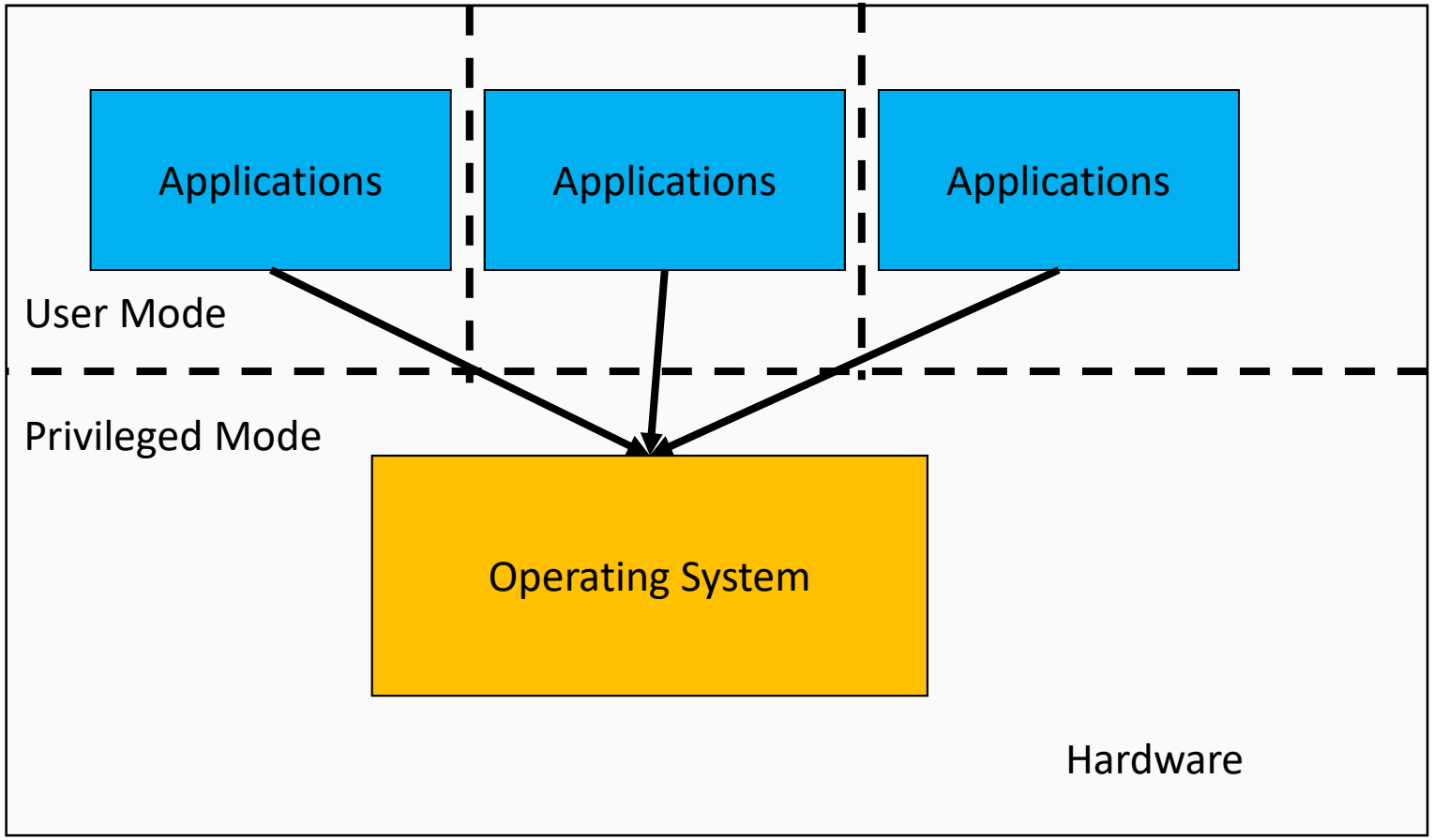


Users

Role 2: The Operating System is a Resource Manager

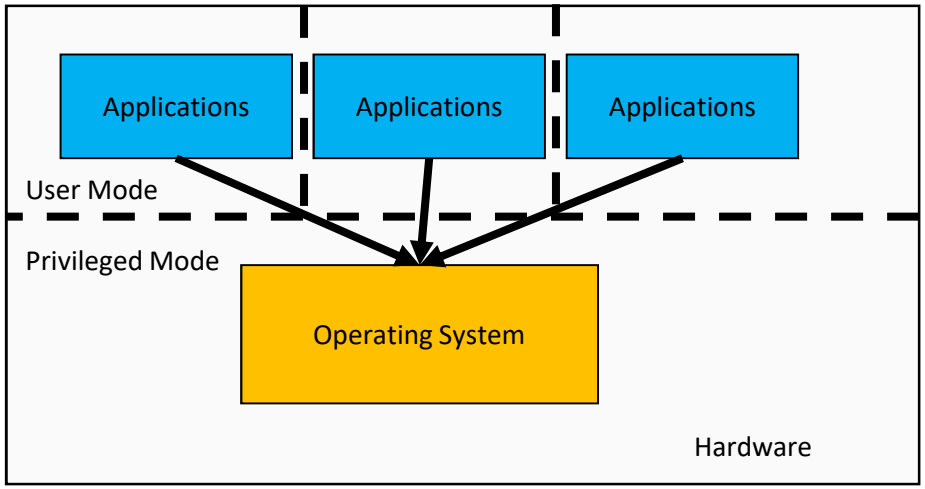
- Responsible for allocating resources to users and processes
- Must ensure
  - No Starvation
  - Progress
  - Allocation is according to some desired policy
    - First-come, first-served; Fair share; Weighted fair share; limits (quotas), etc…
  - Overall, that the system is efficiently used

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



Course Aim

- A deep understanding of the key concepts and mechanisms of modern operating systems:
  - processes and process management, including threads and concurrency management,
  - physical and virtual memory management,
  - on-line storage methods (file systems)



Course Approach

- Operating system background and theory in the lectures
- Practical application of theory through challenging assignments
  - Implementing functionality in a rudimentary OS (OS/161)
  - Challenging as OSes are large and complex
- Tutorials to re-enforce concepts being taught and provide support for assignments
- Learn collaboratively through group assignments (the last 2 assignments)

Assumed Knowledge

- Computing Theory and Background
  - Basic computer architecture
    - CPUs, memory, buses, registers, machine instructions, interrupts/exceptions.
  - Common CS algorithms and data structures
    - Links lists, arrays, hashing, trees, sorting, searching…
  - Ability to read assembly language
  - Exposure to programming using low-level systems calls (e.g. reading and writing files)
- Practical computing experience
  - Capable UNIX command line users
  - Familiar with the git revision control system
  - Competent C programmers
    - Understand pointers, function pointers, memory allocation (malloc())
  - Comfortable navigating around an existing code base.
  - Able to debug an implementation.

Why does this fail?

```
void set(int *x)
{
    *x = 1;
}
void main()
{
    int *a;
    set(a);
    printf("%d\n",*a);
}
```

Operating System Coding

Why does this fail?

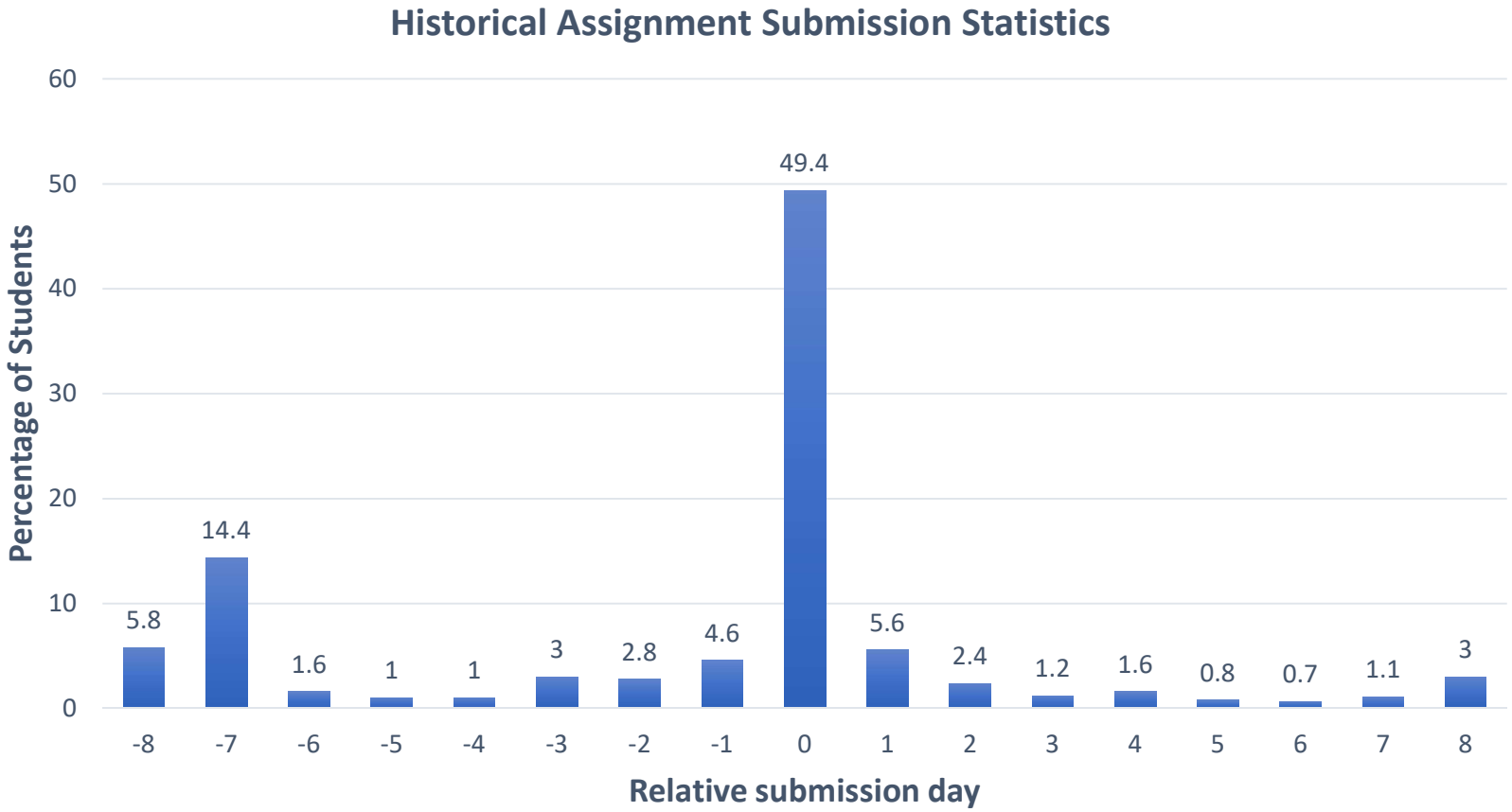
```
void set(int *x)
{
    *x = 1;
}
void main()
{
    int a;
    set(&a);
    printf(“%d\n”,a);
}
```

Assignments

- We will be using OS/161,
  - an educational operating system
  - developed by the Systems Group At Harvard
  - It contains roughly 20,000 lines of code and comments
- To encourage you to start early,
  - Bonus 10% of awarded mark for the assignment for finishing a week early
  - See course outline for exact details
    - Read the fine print!!!!
- If you start a couple days before they are due, you are likely to be late.

Assignments

16% late



UNSW SYDNEY

Assignments

- Late penalty
  - 4% of total assignment value per day
    - Assignment is worth 20%
    - You get 18, and are 2 days late
    - Final mark = 18 – (20*0.04*2) = 16 (16.4)
- Assignments are only accepted up to four days late.
  - Greater than 4 days = 0

Assignments

- Warmup assignment (ASST0)
  - Done individually
  - Available NOW!!!!
- Approximate due dates below
- ASST2 and ASST3 are in pairs
  - Info on how to pair up available soon
- Additional, advanced versions of the assignment 2 & 3
  - Available bonus marks are small compared to amount of effort required.
  - Student should do it for the challenge, not the marks.
  - Attempting the advanced component is not a valid excuse for failure to complete the normal component of the assignment

Assignment	Due
ASST0	Week 2
ASST1	Week 4
ASST2	Week 7
ASST3	Week 10

Assignments

```
Submission test failed. Continue with submission
(y/n)? y
```

- Lazy/careless submitter penalty: 15%

- Submitted the wrong assignment version penalty: 15%
  - Assuming we can validly date the intended version

Plagiarism

- We take cheating seriously!!!
- We systematically check for plagiarised code
  - Penalties are generally sufficient to make it difficult to pass
- We can google as easy as you can
  - Some solutions are wrong
  - Some are greater scope than required at UNSW
    - You do more than required
    - Makes your assignment stick out as a potential plagiarism case
- Avoid developing your code in public bitbucket and github repositories!!
  - Obtain a free academic account.

Exams

- There is NO mid-session
- The final written exam is 2 hours
- Supplementary exam are available according to UNSW & school policy, not as a second chance.
  - Medical or other special consideration only

Piazza Forums

- Forum for Q/A about assignments and course
  - Ask questions there for the benefit of everybody
  - Share your knowledge for the benefit of your peers
  - Look there before asking
  - Apps for phone

- https://piazza.com/
  - Longer link on class web page
    - You will have received an invite from them to your UNSW email address.
    - Please join and contribute.

Consultations/Questions

- Questions should be directed to the forum.
- Admin and Personal queries can be directed to the class account cs3231@cse.unsw.edu.au
- We reserve the right to ignore email sent directly to us (including tutors) if it should have been directed to the forum.
- Consultation Times
  - See course web site.
  - Must email (cs3231@cse) at least an hour in advance and show up on time.

Back to Operating Systems

Chapter 1 – 1.3

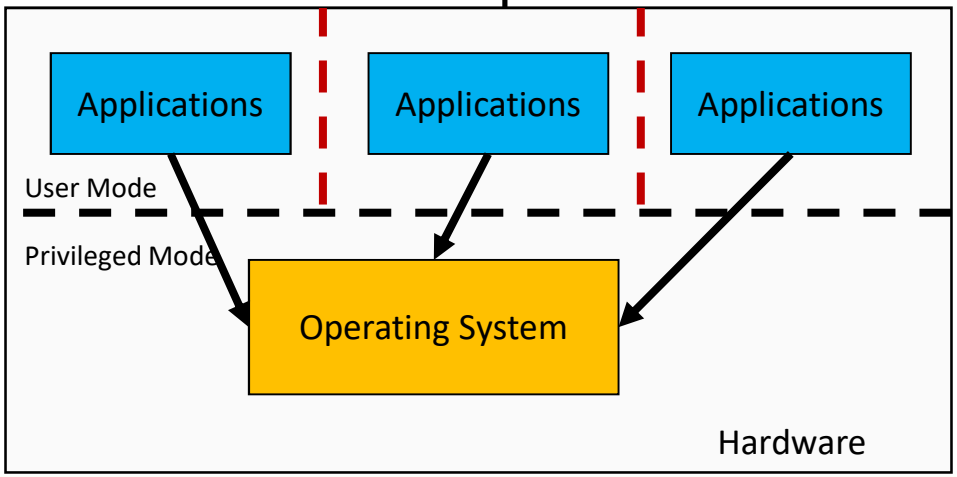
Chapter 1.5 – 1.9

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.

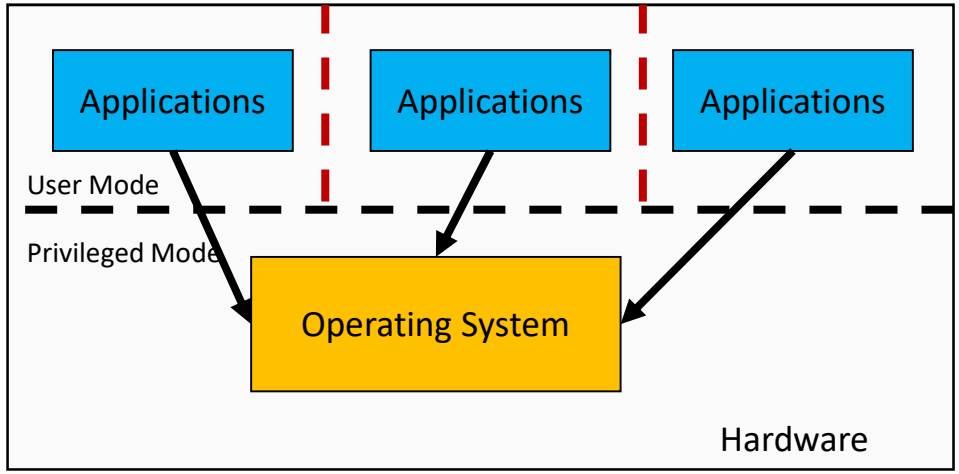
Operating System Kernel

- Portion of the operating system that is running in *privileged mode*
- Usually resident (stays) in main memory
- 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

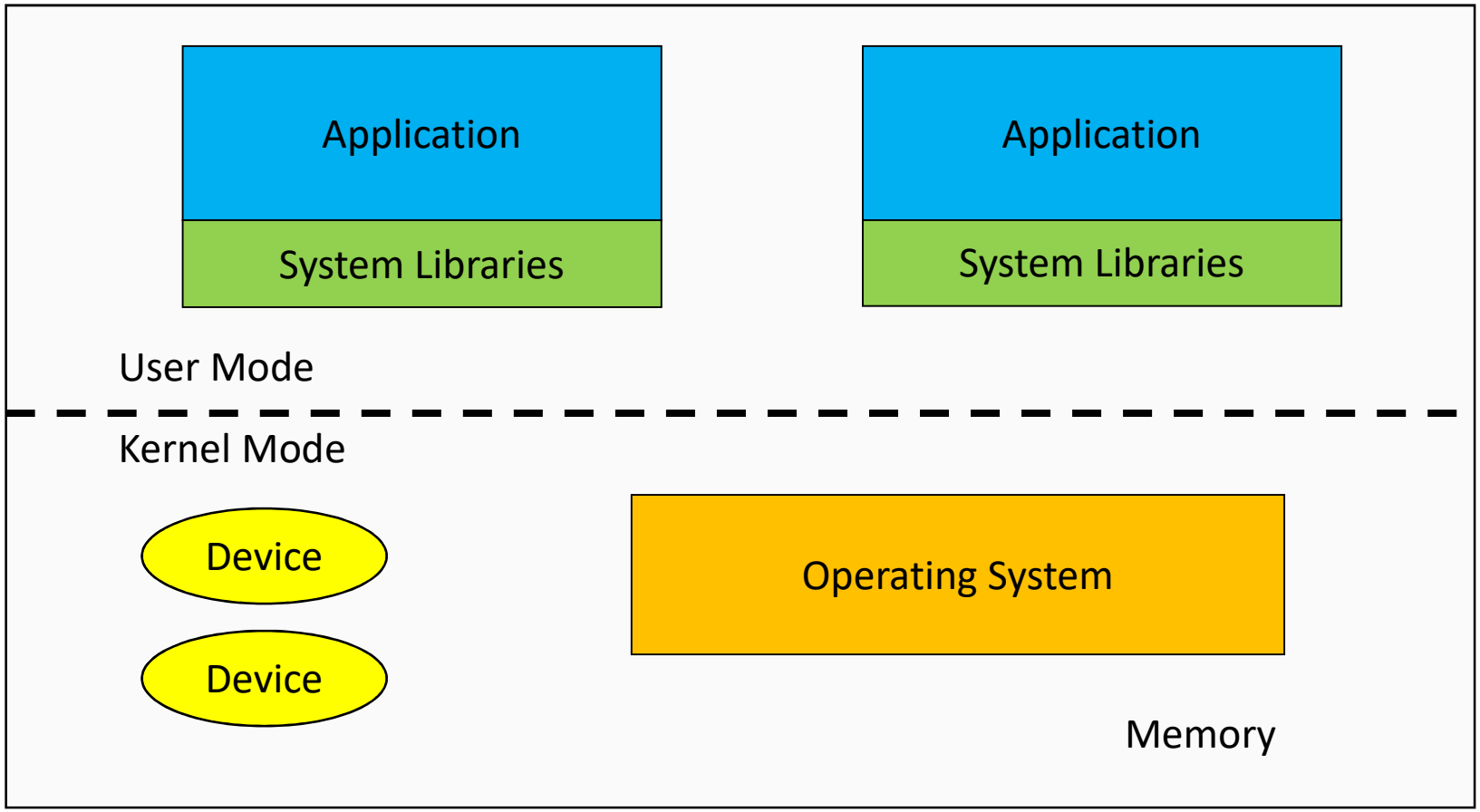


The Operating System is Privileged

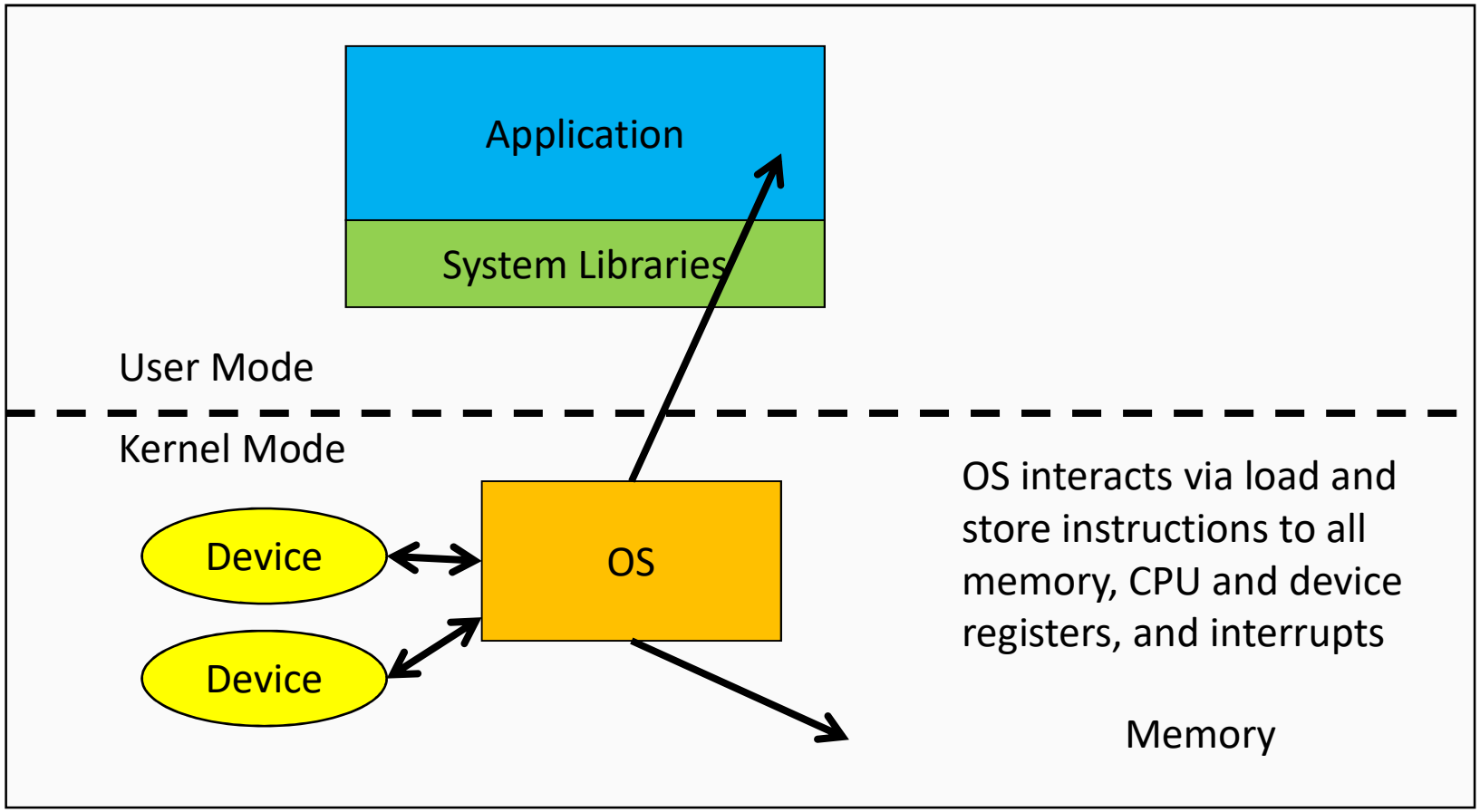
- Applications should not be able to interfere or bypass the operating system
  - OS can enforce the “extended machine”
  - OS can enforce its resource allocation policies
  - Prevent applications from interfering with each other



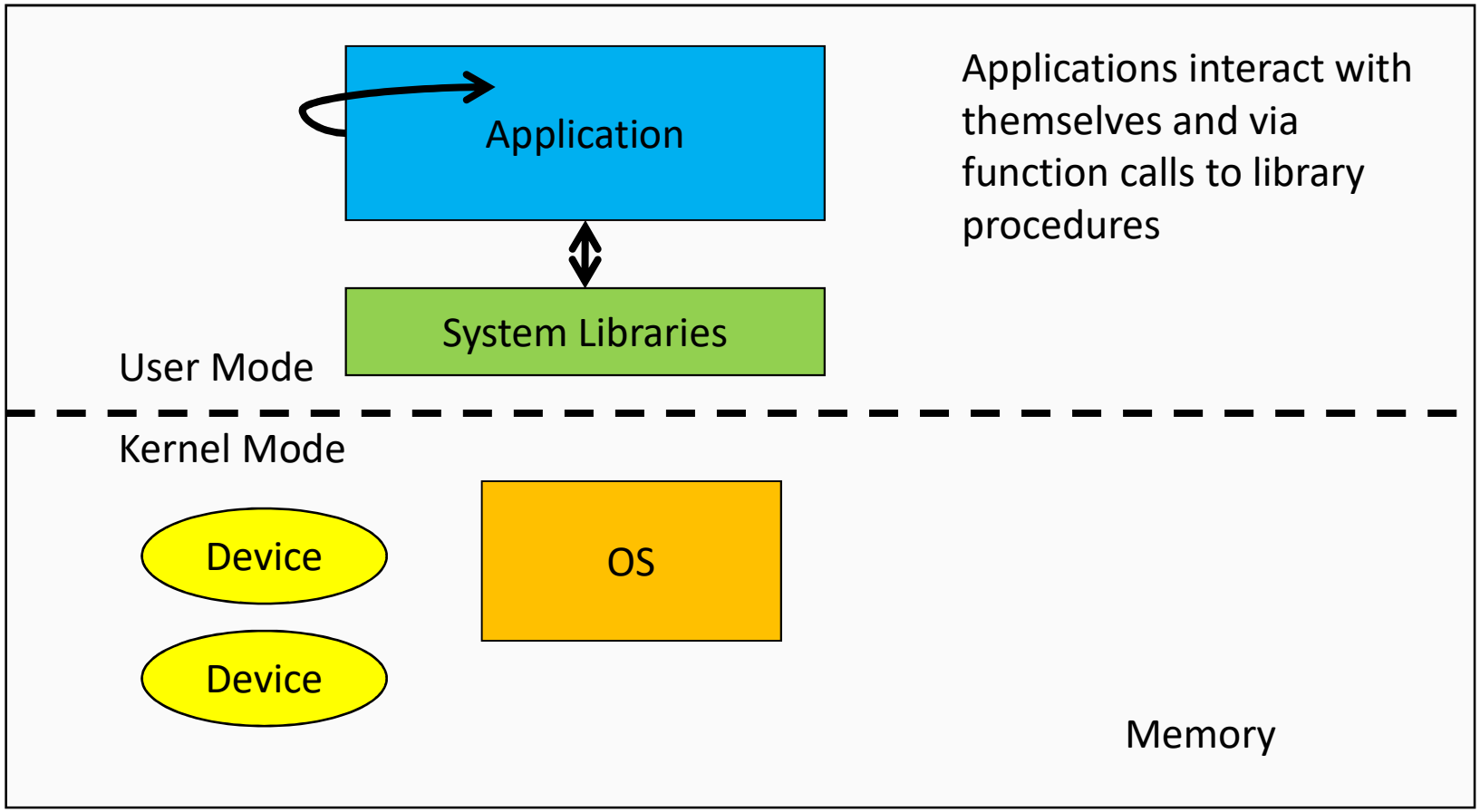
Delving Deeper:
The Structure of a Computer System



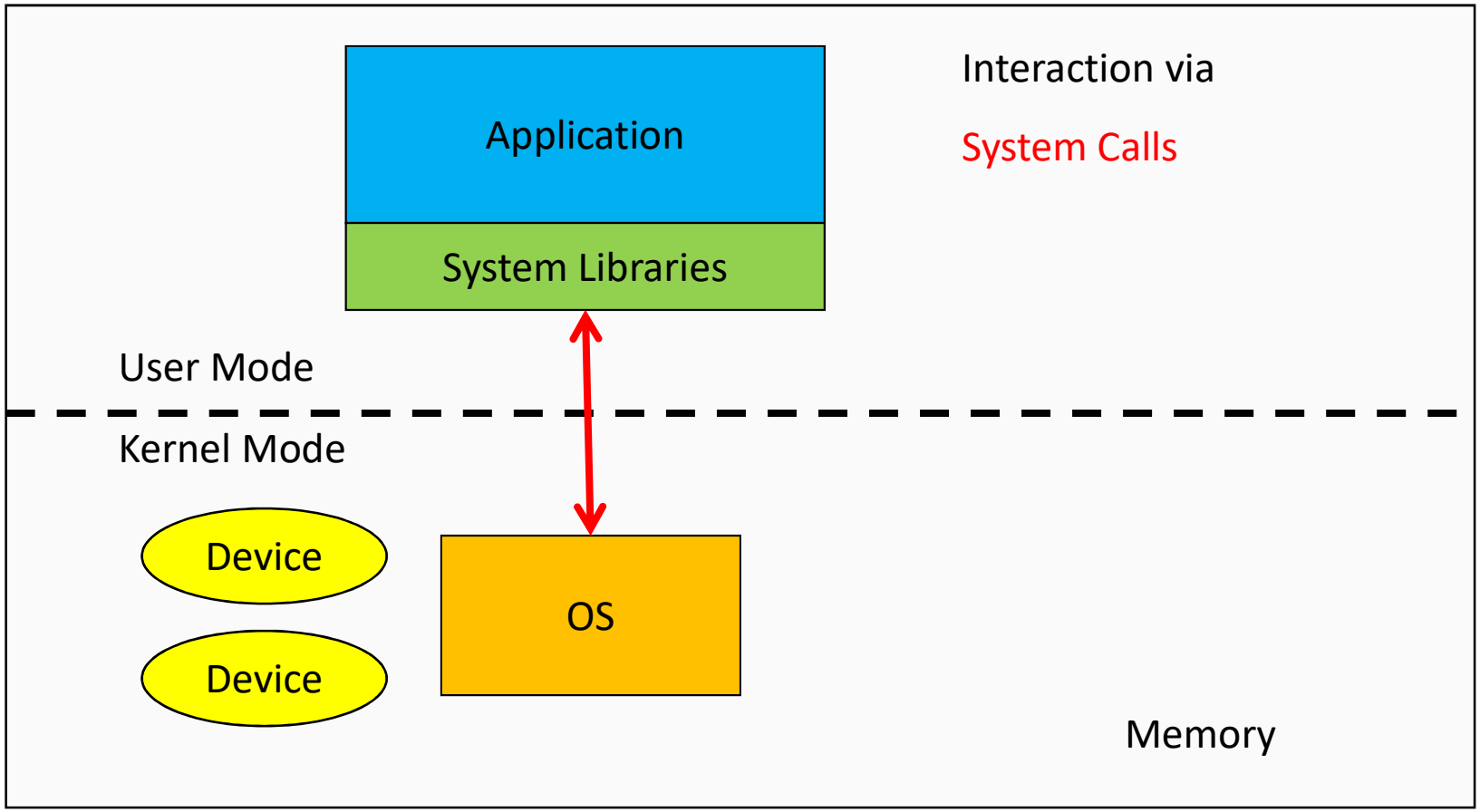
The Structure of a Computer System



The Structure of a Computer System

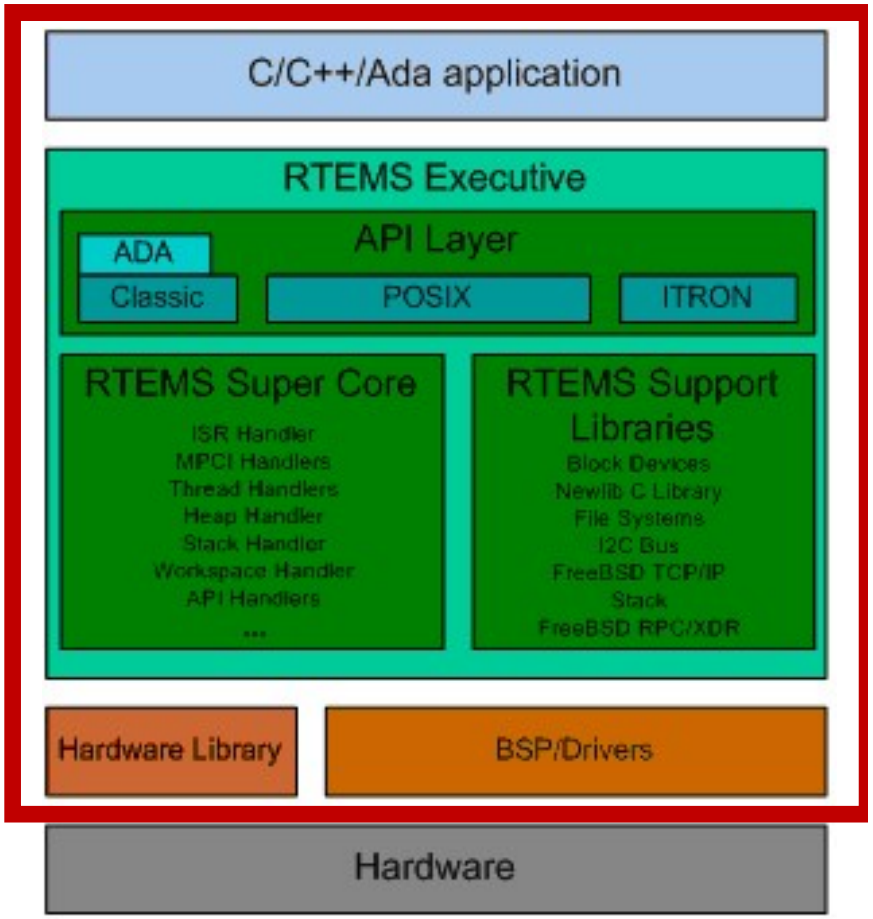


The Structure of a Computer System



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



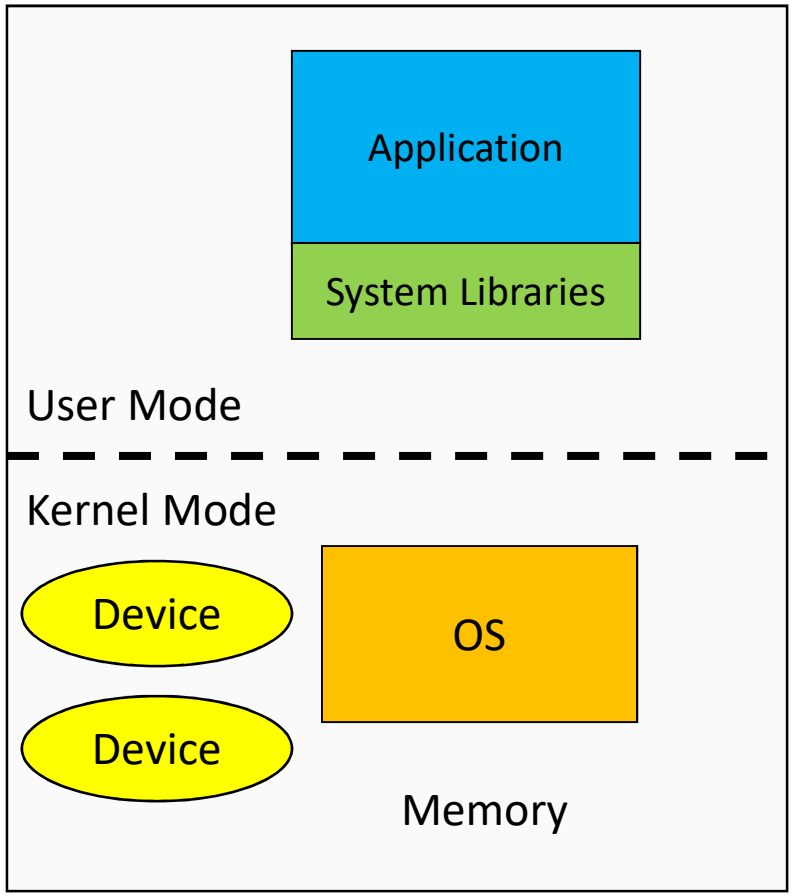
A Note on System Libraries

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

- Only a subset of library functions are actually systems 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
    - Implementation mainly focused on passing request to OS and returning result to application
- 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 a program that is executed (just like applications)
  - It has more privileges
- Operating system relinquishes control of the processor to execute other programs
  - Reestablishes control after
    - System calls
    - Interrupts (especially timer interrupts)

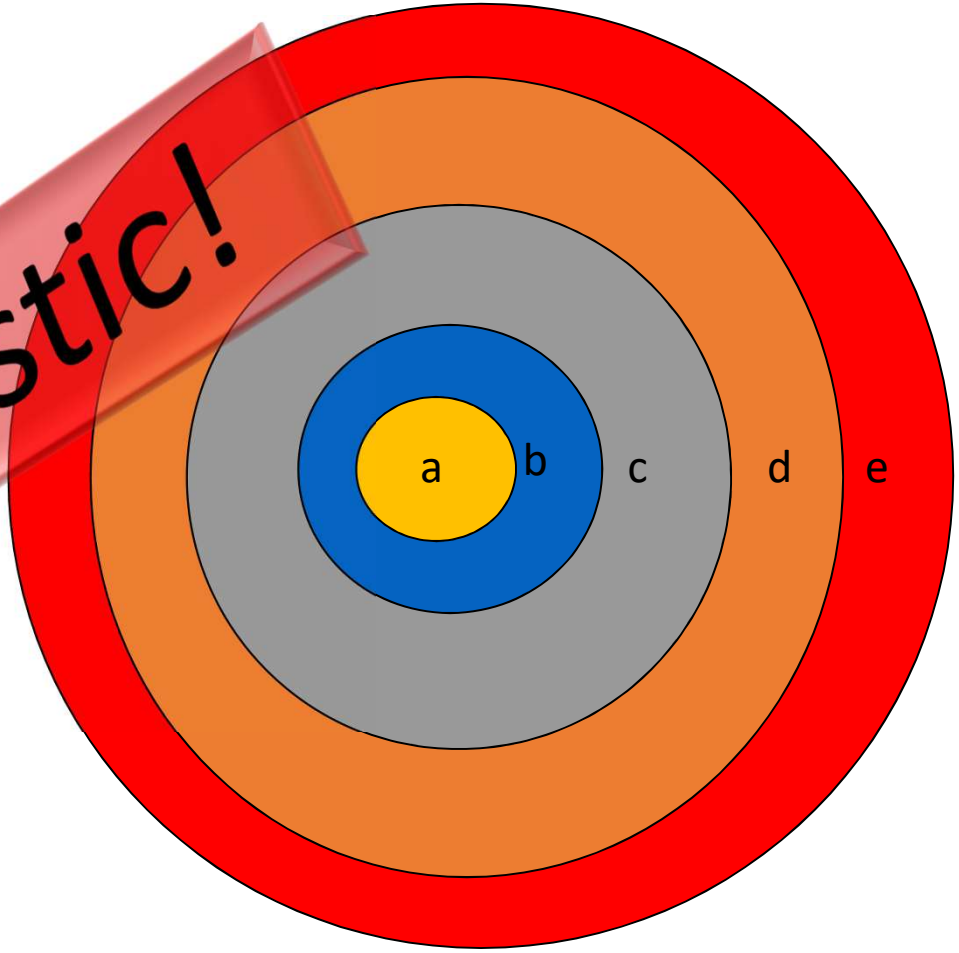


Operating System Internal Structure?

Classic Operating System Structure

- The layered approach
  a) Processor allocation and multiprogramming
  b) Memory Management
  c) Devices
  d) File system
  e) Users
- Each layer depends on the inner layers

Unrealistic!

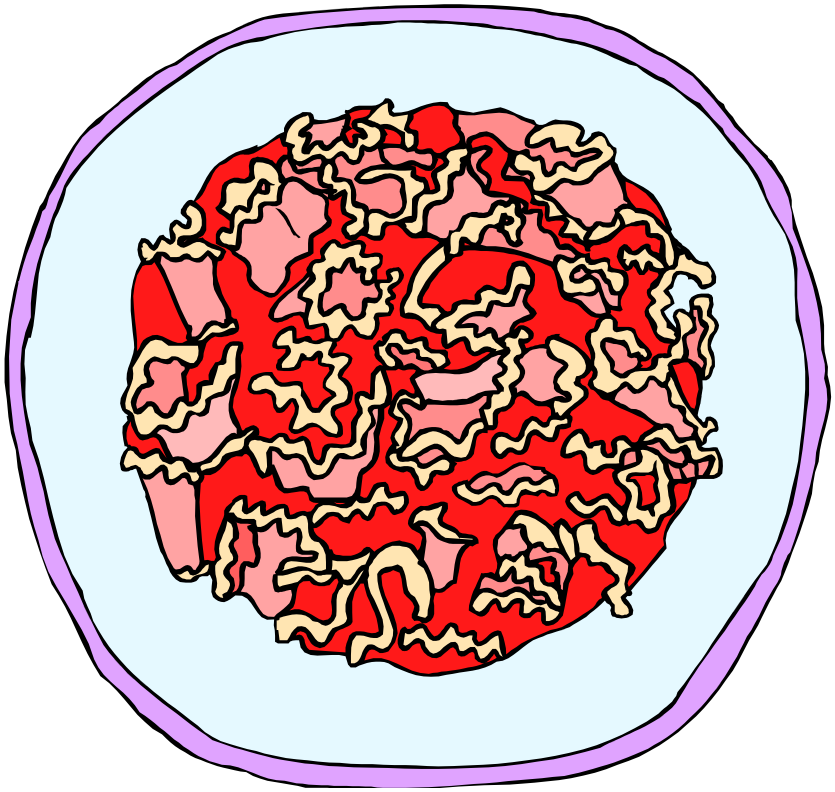


Operating System Structure

- In practice, layering is only a guide
  - Operating Systems have many interdependencies
    - Scheduling on virtual memory
    - Virtual memory (VM) on I/O to disk
    - VM on files (page to file)
    - Files on VM (memory mapped files)
    - And many more…

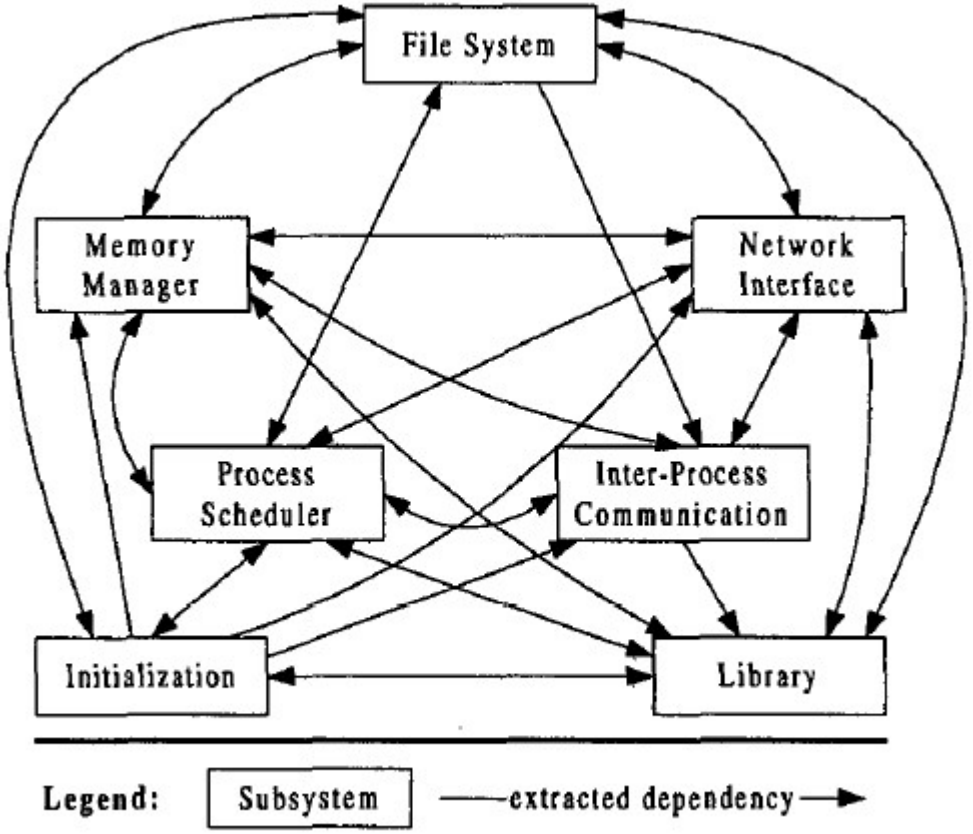
The Monolithic Operating System Structure

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

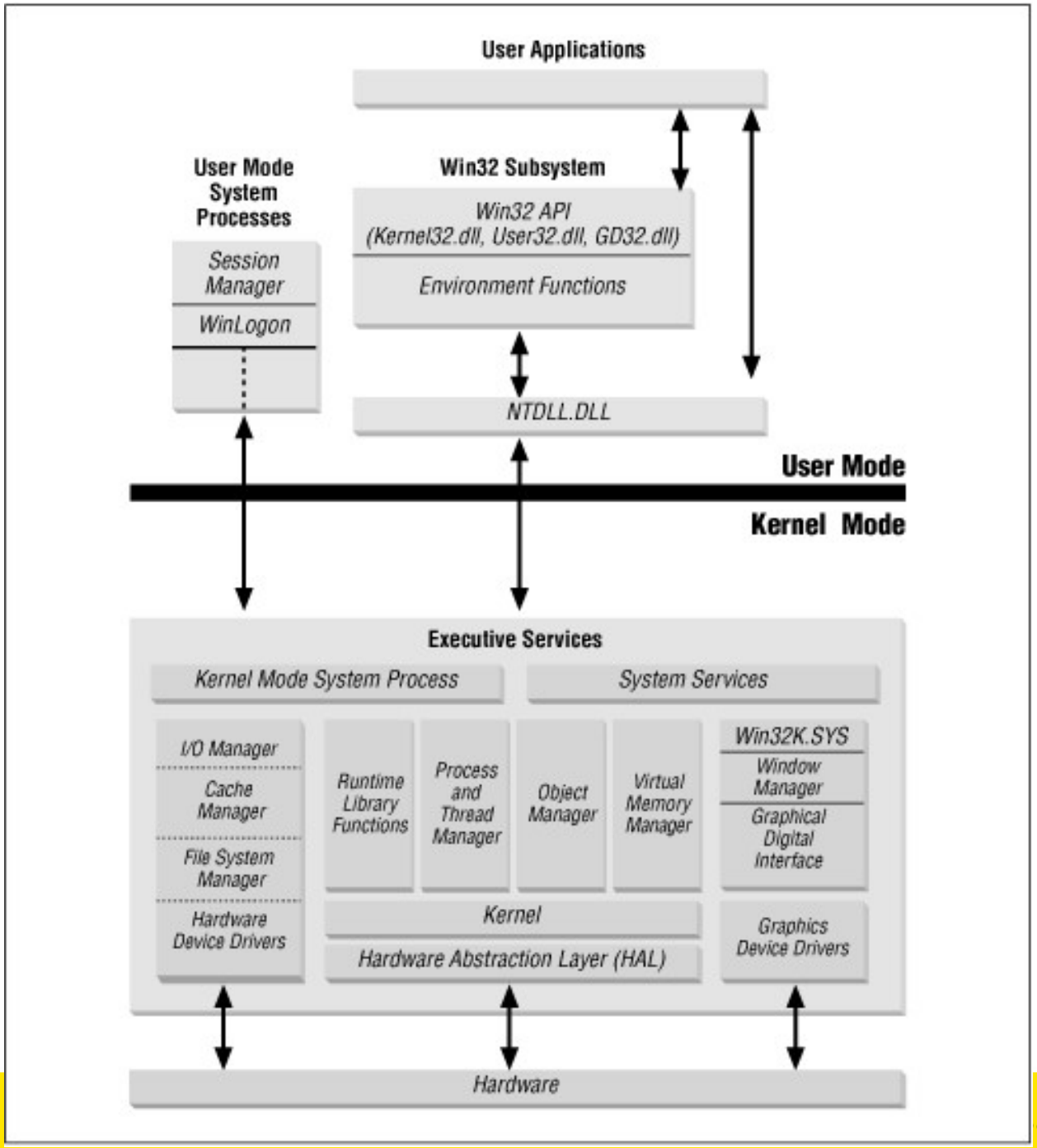


The Monolithic Operating System Structure

- 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

The end