

# Graduate Operating Systems

Spring 2023

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## Today's Paper(s)

- **[1]** P. Brinch Hansen, "The Nucleus of a Multiprogramming System", Communications of the ACM, 238-242, April 1970.
- **[2]** Dennis M. Ritchie and Ken Thompson, "The UNIX Time-Sharing System", Communications of the ACM, volume 17, number 7, July 1974.

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## Operating System

- A program that controls the execution of application programs
- An interface between applications and hardware

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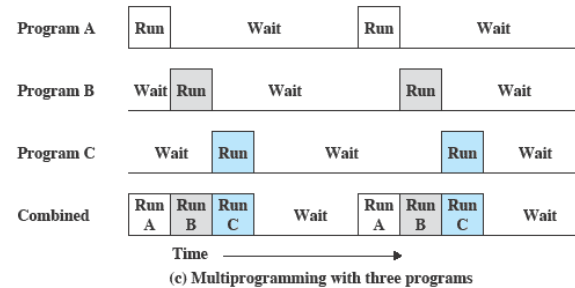
## User vs Kernel Mode

- User program executes in **user mode**
  - Certain instructions may not be executed
  - Certain memory areas are protected from user's use and may not be accessed
- OS/kernel executes in **system (kernel) mode**
  - Privileged instructions are executed
  - Protected areas of memory may be accessed

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## Multiprogramming

- When one job needs to wait for I/O, the processor can switch to the other job

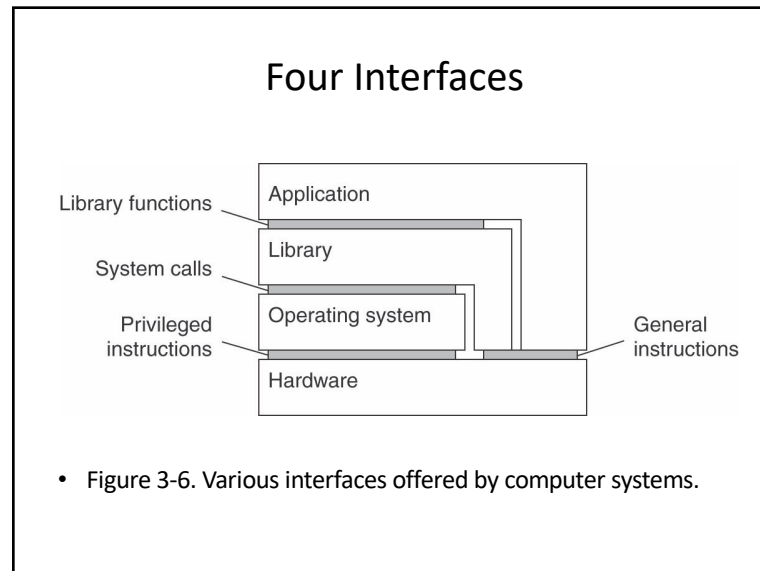


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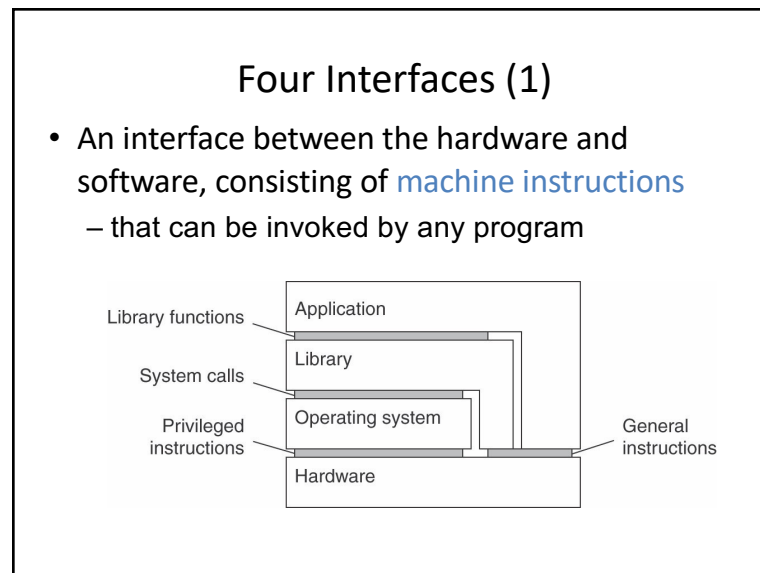
## OS Responsibilities

- Program Development and Execution
- Process Management
- Memory Management
- I/O & File Management
- Protection and Security
- Inter-Process Communication
- Synchronization (Deadlocks)
- Accounting & Logging
- ...

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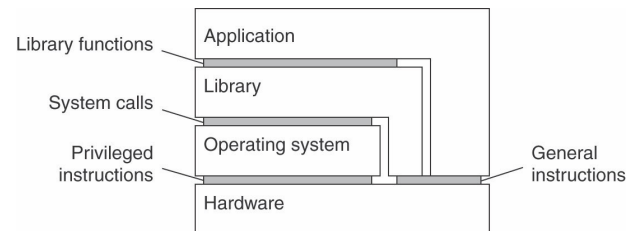
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## Four Interfaces (2)

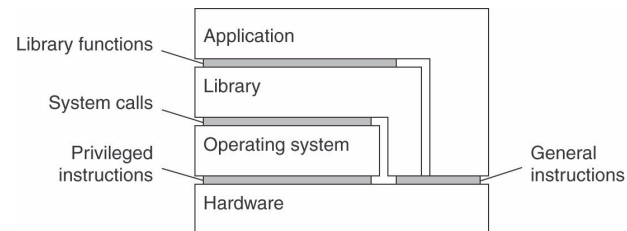
- An interface between the hardware and software, consisting of **machine instructions**
  - that can be invoked only by privileged programs, such as an operating system



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## Four Interfaces (3)

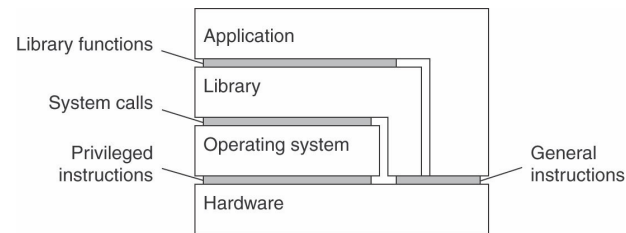
- An interface consisting of **system calls** as offered by an operating system



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## Four Interfaces (4)

- An interface consisting of **library calls**
  - Generally forming what is known as an application programming interface (API)
  - In many cases, the aforementioned system calls are hidden by an API



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## Layers and Views

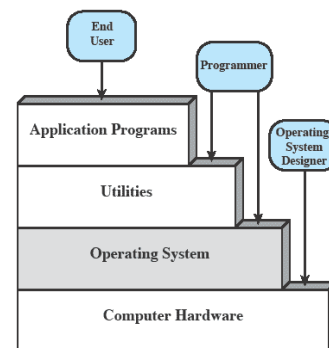


Figure 2.1 Layers and Views of a Computer System

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## “Nucleus” of a System

- RC 4000 **multiprogramming system**
  - OS is group of programs communicating via a **message passing** kernel
  - Sparked the concept of **microkernels**
  - Ideas that drove further research in the 70s and 80s

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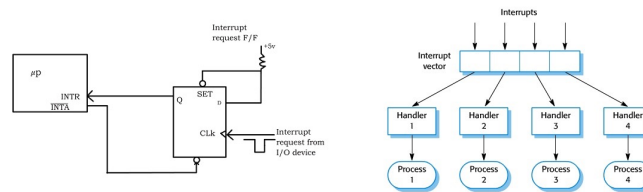
## “Nucleus” of a System

- **What is the problem addressed in this work?**
  - Batch, priority, RT, interactive
- **What is the “idea” presented here?**
  - System nucleus that can be extended with new OS features
- Process, synchronization, communication, process management

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## “Nucleus” of a System

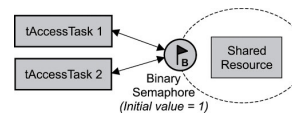
- Process: internal (execution) & external (I/O)
- What is the difference between a **program** and a **process**?
- Nucleus: “interrupt response program”?



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## “Nucleus” of a System

- Process Communication (IPC)
  - Binary semaphores
  - Message buffering
  - Blocking (synchronous communication)
  - FCFS (alternatives?)
  - What if buffer is full?
  - How is addressing performed?
  - Protection, efficiency, resource problem



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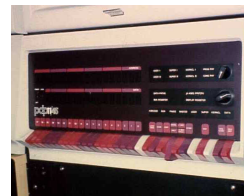
## “Nucleus” of a System

- External processes
  - Reservation & release
  - Backing store
  - Real-time synchronization (timer)
- Internal processes
  - Typical UNIX creation/removal process
  - Scheduling not part of nucleus
  - Process hierarchy
- Final thoughts on paper?

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## UNIX Time-Sharing System

- PDP-11/45
- File systems & files
  - Ordinary, directories, special
  - “mount” system call
  - Protection
  - I/O Calls



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## UNIX Time-Sharing System

- Processes
  - What is the difference between image and process?

