

Graduate Operating Systems

Spring 2022

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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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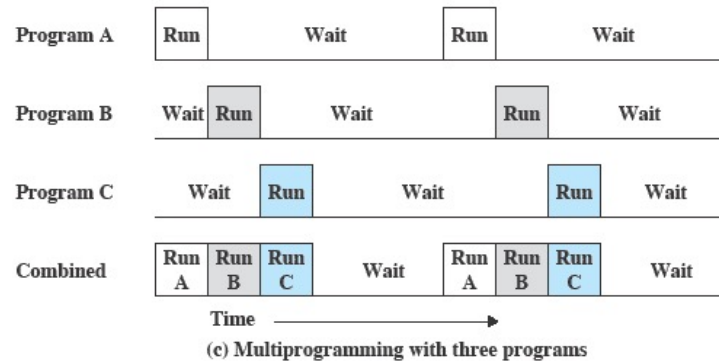
User vs Kernel Mode

- 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



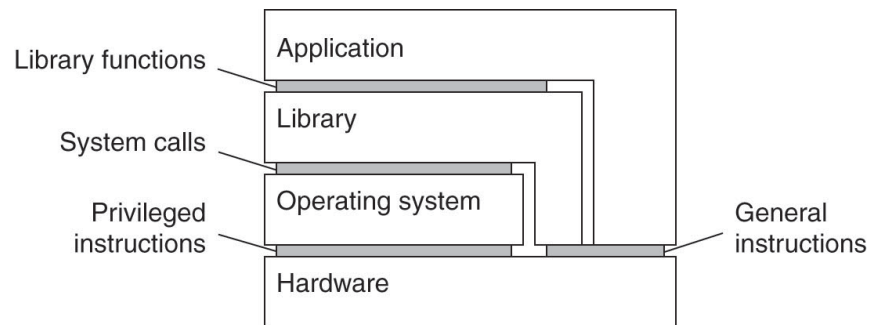
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OS Responsibilities

- 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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Four Interfaces

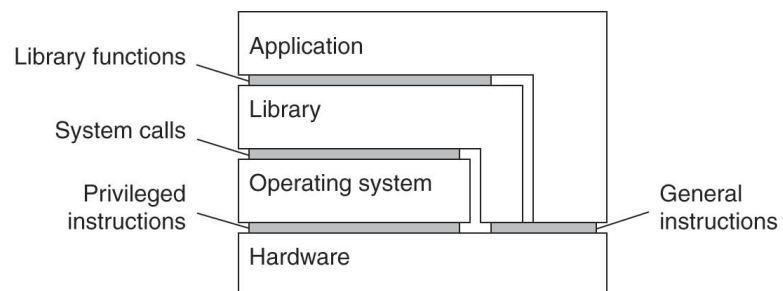


- Figure 3-6. Various interfaces offered by computer systems.

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Four Interfaces (1)

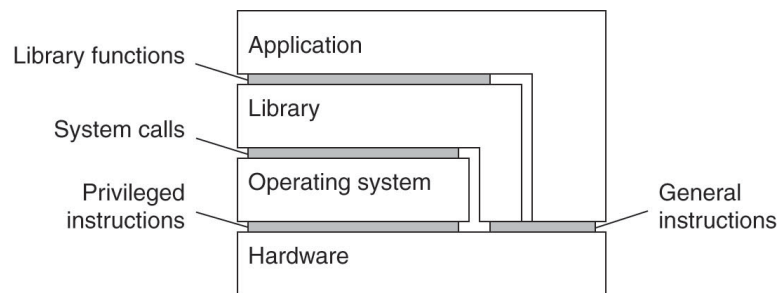
- An interface between the hardware and software, consisting of **machine instructions** – that can be invoked by any program



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Four Interfaces (2)

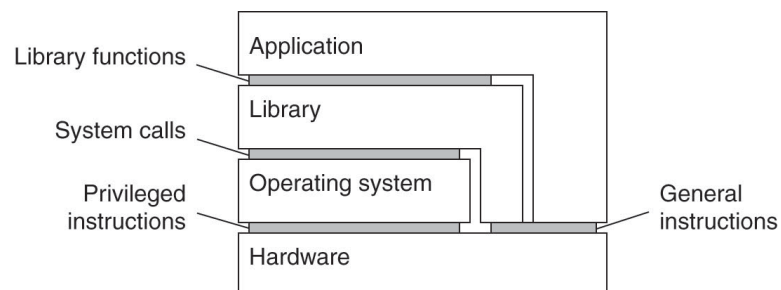
- An interface between the hardware and software, consisting of **machine instructions** – that can be invoked only by privileged programs, such as an operating system



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Four Interfaces (3)

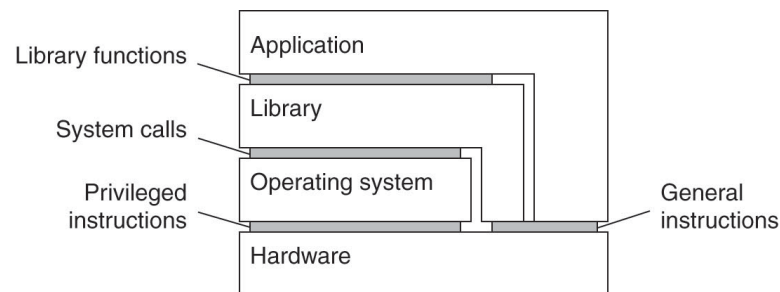
- An interface consisting of **system calls** as offered by an operating system



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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

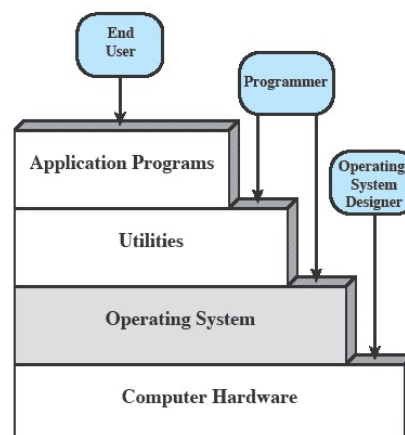


Figure 2.1 Layers and Views of a Computer System

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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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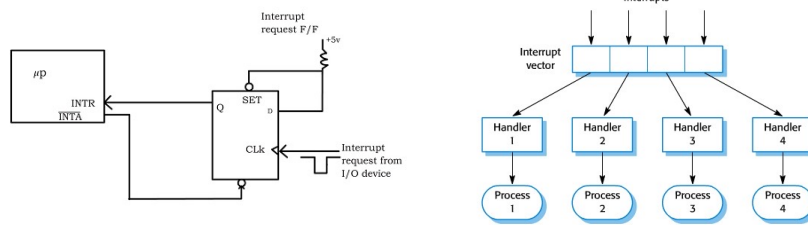
“Nucleus” of a System

- **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

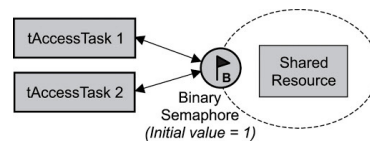
- Process: internal (execution) & external (I/O)
- What is the difference between a **program** and a **process**?
- Nucleus: “interrupt response program”?



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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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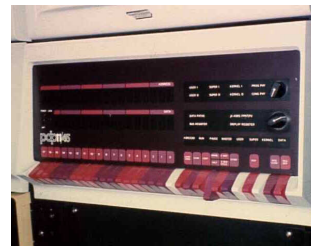
“Nucleus” of a System

- 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?

