Graduate Operating Systems

Spring 2022

Today’s Paper(s)


Operating System

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

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
Multiprogramming

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

OS Responsibilities

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

(c) Multiprogramming with three programs
• Figure 3-6. Various interfaces offered by computer systems.

Four Interfaces (1)

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

![Diagram showing four interfaces](image)

Four Interfaces (3)

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

![Diagram showing four interfaces](image)
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

![Diagram of interfaces]

Layers and Views

![Diagram of layers and views]

*Figure 2.1 Layers and Views of a Computer System*
“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**
“Nucleus” of a System

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

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
“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?

UNIX Time-Sharing System

• PDP-11/45

• File systems & files
  – Ordinary, directories, special
  – “mount” system call
  – Protection
  – I/O Calls
UNIX Time-Sharing System

• Processes
  – What is the difference between image and process?