

Operating Systems : Overview

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CSE421

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Topics for discussion

- ◆ What will you learn in this course? (goals)
- ◆ What is an Operating System (OS)?
- ◆ Evolution of OS
- ◆ Important OS Components
- ◆ Major achievements
- ◆ Operating system design hierarchy
- ◆ Sample systems

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Goals for the course

- ◆ Study the working of an OS.
- ◆ Study the design and implementation of various components of an OS.
- ◆ Learn about the alternatives available to a designer at all levels of abstraction in an OS.
- ◆ Learn concurrent programming using processes, threads, and system calls.
- ◆ Understand the basics of distributed systems.
- ◆ Explore how you may contribute to solving many open problems in OS and distributed systems.

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What is an Operating system?

- ◆ Interface manager
 - Human interaction made easy
 - interfacing, abstraction, control and sharing
- ◆ Resource manager
 - Efficient use of resources
- ◆ Enhances hardware features
 - "virtual" time, space and resource (processes, threads)
- ◆ System and data security and protection provider

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User Interface

- ◆ Operating system provides these facilities for the user:
 - Program creation : editors, debuggers, other development tools.
 - Program execution : load, files, IO operations.
 - Access to IO devices: Read and writes.
 - Controlled access to files: protection mechanisms, abstraction of underlying device.
 - System access: Controls who can access the system.
 - Error detection and response: external, internal, software or hardware error.
 - Accounting: Collect stats., load sharing , for billing purposes.

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Resource Manager

- ◆ Processors : Allocation of processes to processors, preemption, scheduling.
- ◆ Memory: Allocation of main memory.
- ◆ IO devices : when to access io devices, which ones etc.
- ◆ Files: Partitions, space allocation and maintenance.
- ◆ Applications, Data, objects.

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Multiprogramming

- ◆ From uniprogramming to multiprogramming systems:
- ◆ Multiprogramming systems: batch programs, objective : maximize system (processor) utilization.
- ◆ Time sharing systems: Objective is minimize response time. Typical programs are interactive.

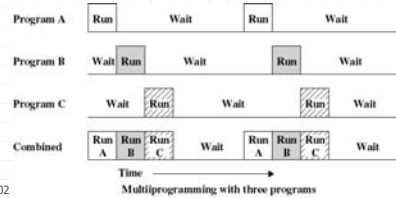
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Multiprogrammed Batch Systems

- ◆ If memory can hold several programs, then CPU can switch to another one whenever a program is awaiting for an I/O to complete
- ◆ This is multitasking (multiprogramming)



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Processes

- ◆ A program in execution,
- ◆ An entity that can be assigned to and executed on a processes,
- ◆ It is a unit of work.
- ◆ Multiprogramming, time-sharing and real-time transaction systems lead to the refinement of the concept of process.
- ◆ A process can be defined by its attributes and behaviors : it can be viewed as an Abstract Data Type (ADT).
- ◆ When instances of this ADT co-exist we have concurrent processing.
- ◆ Issues in concurrent processing : synchronization, mutual exclusion, deadlock, communication.

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Process

- ◆ Introduced to obtain a systematic way of monitoring and controlling program execution
- ◆ A process is an executable program with:
 - associated data (variables, buffers...)
 - execution context: ie. all the information that
 - the CPU needs to execute the process
 - content of the processor registers
 - the OS needs to manage the process:
 - priority of the process
 - the event (if any) after which the process is waiting
 - other data (that we will introduce later)

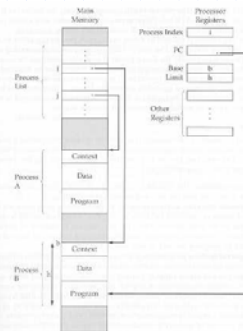
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A simple implementation of processes

- ◆ The process index register contains the index into the process list of the currently executing process (B)
- ◆ A process switch from B to A consist of storing (in memory) B's context and loading (in CPU registers) A's context
- ◆ A data structure that provides flexibility (to add new features)



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Memory management

- ◆ Requirements: Process isolation, automatic allocation and maintenance, protection and access control, long-term storage facilities.
- ◆ Virtual memory and file system facilities together satisfy all these requirements.
- ◆ Virtual memory allows programs to address the memory from a logical point of view without regard to the amount of main memory available.
- ◆ File : persistent storage for programs and data.
- ◆ Can view file also as an ADT? File concept makes access control and protection convenient for the OS.

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Protection and Security

- ◆ When sharing resources, protection of the systems and user resources from intentional as well as inadvertent misuse.
- ◆ Protection generally deals with access control. Ex: Read only file
- ◆ Security deals usually with threats from outside the system that affects the integrity and availability of the system and information with the system.
- ◆ Example: username, password to access system. Data encryption to protect information.

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Scheduling and resource management

- ◆ Scheduling and resource management is an Operations Research (OR) problem.
- ◆ Goals : Efficient use of resources, satisfy the service time requested by a process, say, in a real-time system and of course, fairness.
- ◆ Short-term and long-term scheduling.
- ◆ Queuing is one of the basic operations associated with scheduling. Interrupt is another important concept in the context of scheduling.

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Scheduling and Resource Management

- ◆ Differential responsiveness
 - discriminate between different classes of jobs
- ◆ Fairness
 - give equal and fair access to all processes of the same class
- ◆ Efficiency
 - maximize throughput, minimize response time, and accommodate as many users as possible

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File System

- ◆ Implements long-term store (often on disk)
- ◆ Information stored in named objects called files
 - a convenient unit of access and protection for OS
- ◆ Files (and portions) may be copied into virtual memory for manipulation by programs

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System Structure

- ◆ Because of its enormous complexity, we view the OS system as a series of levels
- ◆ Each level performs a related subset of functions
- ◆ Each level relies on the next lower level to perform more primitive functions
- ◆ Well defined interfaces: one level can be modified without affecting other levels
- ◆ This decomposes a problem into a number of more manageable sub problems

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Structure of OS

- ◆ Client-Server Model
 - **SERVERS:** Splitting the OS into parts, each of which handles one facet of the system, such as **file service, process service, terminal service, or memory service**
 - **CLIENTS:** User processes : A client process obtains services by sending messages to the servers.
 - Advantages:
 - Modularity : A bug in fileserver will crash only the fileserver and not the whole OS
 - **Adaptability to distributed system:** Services could be provided from a remote computer.

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Characteristics of Modern Operating Systems

- ◆ New design elements were introduced recently
- ◆ In response to new hardware development
 - multiprocessor machines
 - high-speed networks
 - faster processors and larger memory
- ◆ In response to new software needs
 - multimedia applications
 - Internet and Web access
 - Client/Server applications

Microkernel architecture

- ◆ Only a few essential functions in the kernel
 - primitive memory management (address space)
 - Interprocess communication (IPC)
 - basic scheduling
- ◆ Other OS services are provided by processes running in user mode (servers)
 - device drivers, file system, virtual memory...
- ◆ More flexibility, extensibility, portability...
- ◆ A performance penalty by replacing service calls with message exchanges between process...

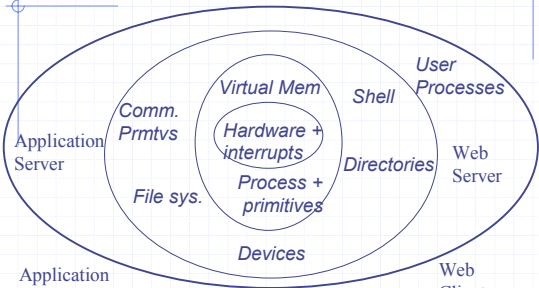
Multithreading

- ◆ A process is a collection of one or more threads that can run simultaneously
- ◆ Useful when the application consists of several tasks that do not need to be serialized
- ◆ Gives the programmer a greater control over the timing of application-related events
- ◆ All threads within the same process share the same data and resources and a part of the process's execution context
- ◆ It is easier to create or destroy a thread or switch among threads (of the same process) than to do these with processes

Symmetric Multiprocessing (SMP)

- ◆ A computer with multiple processors
- ◆ Each processor can perform the same functions and share same main memory and I/O facilities (symmetric)
- ◆ The OS schedule processes/threads across all the processors (real parallelism)
- ◆ Existence of multiple processors is transparent to the user.
- ◆ Incremental growth: just add another CPU!
- ◆ Robustness: a single CPU failure does not halt the system, only the performance is reduced.

Operating system Modular View



Types of OS

- ◆ Multiprocessing - multiple CPUs
- ◆ Multiprogramming - Time sharing, interactive
- ◆ Real-time : deadlines, time constraints, predictability
- ◆ Distributed systems : Sharing and fault tolerance, reliability, dependability.
- ◆ Network OS
- ◆ Network Transparent Systems : CORBA-like
- ◆ Network-centric Systems : Jini-like
- ◆ Component-based systems: Enterprise Java
- ◆ Read Chapter 1