

Introduction to Operating System

<p>What OS do you use?</p> <ul style="list-style-type: none"> Linux Windows Mac Unix Solaris 	<p>Roles of OS</p>  <p>Managing resources</p> 	<p>Syllabus</p> <ul style="list-style-type: none"> Introduction to OS, History of OS Introduction to Processes and Threads CPU Scheduling Memory management Filesystems Process synchronization Deadlocks Memory management Virtual memory management Demand Paging 	<p>Prior Knowledge</p> 	<p>Basics</p> <ul style="list-style-type: none"> Data Structure Object Oriented Programming Programming C and Java 	<p>Evaluation Scheme</p> <ul style="list-style-type: none"> Mid terms: 30% End sems: 30% Programming assignments: 20% (4-5) Quiz: 10% (2) Class participation: 10% <p>Attendance Policy</p> <p>Attendance will be taken everyday and missing class can be expected to significantly reduce your chances of success. There will be no repetition.</p> <p>Missing Exam</p> <ul style="list-style-type: none"> If you miss a exam due to an unexcused absence, you will receive a grade of D for that mid-term. The make-up exam may be SIGNIFICANTLY MORE DIFFICULT than the original exam. <p>Office Hours</p> <ul style="list-style-type: none"> Wednesday 2:00-5:00 PM
--	--	--	--	--	--

What is an Operating System?

What is an Operating System?



A program that acts as an intermediary between a user of a computer and the computer hardware.

Computer System Structure

- Computer system can be divided into four components
 - Hardware** – provides basic computing resources
 - CPU, memory, I/O devices
 - Operating system**
 - Controls and coordinates use of hardware among various applications and users
 - Application programs** – define the ways in which the system resources are used to solve the computing problems of the users
 - Word processors, compilers, web browsers, database systems, video games
 - Users**
 - People, machines, other computers

Operating System Definition

- OS is a resource allocator**
 - Manages all resources
 - Coordinates between conflicting requests for efficient and fair resource allocation
- OS is a control program**
 - Controls execution of programs to prevent errors and improper use of the computer

Computer Startup

- Bootstrap program is loaded at power-up or reboot
- Typically stored in ROM or EPROM, generally known as **firmware**
- Initializes all aspects of system
- Loads operating system kernel and starts execution

Operating System Structure



- Multiprogramming needed for efficiency
 - Single user cannot keep CPU and I/O devices busy at all times
 - If no background tasks, several programs run in memory simultaneously, the memory is shared by the programs for efficient processing, and minimal idle time
- Multiprogramming organizes job queue and, so, CPU always has work to do
- A subset of total jobs in system is kept in memory
- One job selected and run via **job scheduling**
- When it's not in I/O (for example, OS handles another job

Operating-System Operations



- An operating system is **interrupt driven**
 - Interrupt driven by hardware
 - Hardware generates interrupt whenever its task is complete
 - CPU interrupt handler is a user program that handles service request
 - Other processes include infinite loops, processes modifying each other's memory, and processes waiting for events
- Background operation allows OS to predict what other system actions will be
 - User mode and kernel mode
 - Kernel mode is required to change job when system is running over scale or
 - Kernel code
 - User mode code is designated as **privileged**, any execution in kernel mode

Process Management



- A process is a program in execution. It is a unit of work within the system. It is created by user programs to perform specific tasks
- Process management maintains its state
 - CPU ownership, I/O, file
 - Initialization data
 - Priority
 - Current location of memory manager
- Single-threaded process has one **program counter** specifying location of next instruction to execute
 - Program counter is a variable, one at a time, until completion
- Memory manager has one **memory counter** per thread
 - Typically system has many processes, several have open threads running simultaneously on one or more CPUs
 - Coordinating by maintaining the CPU among the processes / threads

Memory Management



- All data in memory before and after processing
- All instructions in memory in order to execute
- Memory management determines what is memory when
 - Optimizing CPU utilization and computer response to users
- Memory management activities
 - Keeping track of when parts of memory are currently being used and by whom
 - Deciding which processes (or parts thereof) and data to move into and out of memory
 - Coordinating by maintaining the CPU among the processes / threads

Storage Management



- OS provides uniform, logical view of information storage
- Attaches physical properties to logical storage unit – **file**
 - Each module is controlled by device (i.e., disk drive, tape drive)
 - Varying properties include access speed, capacity, data transfer rate, reliability, and cost (sequential vs random)
- File system management
 - Files usually organized into directories
 - Access control on most systems to determine who can access what
 - OS activities include
 - Creating and deleting files and directories
 - Mapping files onto secondary storage
 - Backup files onto stable (non-volatile) storage media

I/O Subsystem



- One purpose of OS is to hide peculiarities of hardware devices from the user
- I/O subsystem responsible for
 - Buffering I/O (including buffering, storing data temporarily while it's being transferred), caching (storing parts of data in faster storage for performance), avoiding the overlapping of output of one job with input of another
- General device-driver interface
- Drivers for specific hardware devices

Protection and Security



- Protection** – any mechanism for controlling access of processes or users to resources defined by the OS
- Security** – defense of the system against threat and detected attacks
 - Hacking, including shared-access, worms, viruses, like spyware, and denial-of-service
- System generally first distinguishes among users, to determine who can do what
- User identifies **user ID**, security ID (includes name and associated with unique user per user)
- User access is controlled by certain processes of that user, system administrator controls
- Group identifier (**group ID**) allows set of users to be assigned and security managed. Then also associated with each process. We provide **user rights** alone user to change to different user with more rights

Special-Purpose OS



- Real-Time**
 - Used in dedicated application. The system reads information from sensors and must respond within a fixed amount of time to ensure correct performance.
- Embedded**
 - Special-purpose systems
 - Cell phones, wireless routers, TV's, space vehicles, etc.
 - Requires low power
 - High reliability, difficult or impossible to upgrade or reprogram, run in hostile environments, self-diagnosis and repair, another dedicated connection

Summary



Introduction to Operating System

What OS do you use?

- Linux
- Windows
- Mac
- Unix
- Solaris



Roles of OS

Managing multi-tasks: A man with multiple arms multitasking on a computer.

Managing resources: A diagram showing a central computer managing multiple resources like memory, CPU, and disk.

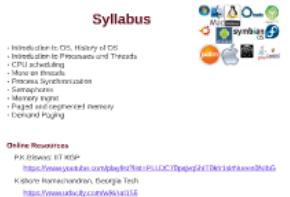


Syllabus

- Introduction to OS, History of OS
- Introduction to Processes and Threads
- CPU scheduling
- Memory management
- Process Synchronization
- Semaphore
- Paging and Segmented memory
- Demand Paging

Online Resources

- PPT Slides: [IT 409](#)
- <https://www.csail.mit.edu/classes/6.S091/Project/OS/>
- Kalay Raghavendra, Georgia Tech
<https://people.cs.gatech.edu/~kalay/>



Prior Knowledge

- Data Structure
- Object Oriented Programming
- Programming C and Java



Evaluation Scheme

- Mid sems: 30%
- End sems: 30%
- Programming assignments: 20% (4-5)
- Quiz: 10% (2)
- Class participation: 10%

Attendance Policy

Attendance will be taken everyday and missing class can be expected to significantly reduce your chances of success. There will be no repetition.

Misconduct

- If you miss a exam due to an unexcused absence, you will receive a grade of 0 for that examination.
- The make-up exam may be **SIGNIFICANTLY MORE DIFFICULT** than the original exam.

Office Hours

- Wednesday 2:00-5:00 PM



What is an Operating System?

What is an Operating System?

- A program that acts as an intermediary between a user of a computer and the computer hardware

Operating system goals:

- Execute user programs and make solving user problems easier
- Make the computer system convenient to use
- Use the computer hardware in an efficient manner



Computer System Structure

- Computer system can be divided into four components:
 - Hardware - previous user computing resources
 - CPU, memory, I/O devices
 - Operating system
 - Controls and coordinates use of hardware among various applications and users
 - Application programs - define the ways in which the system resources are used to solve the computing problems of the users
 - Word processors, compilers, web browsers, database systems, video games
 - Users
 - People, machines, other computers



Operating System Definition

- OS is a resource allocator
 - Manages resources
 - Decides between conflicting requests for efficient and fair resource use
- OS is a control program
 - Controls execution of programs to prevent errors and improper use of the computer



Operating System Definition (Cont)

- An universally accepted definition
 - “Everything a vendor says when you order an operating system” is good approximation
 - But same validity
- “The one program managing all of tasks on the computer” is the kernel. It takes care either a system program along with the operating system or an application program



Computer Startup

- **bootstrap program** is loaded at power-on reboot
- Typically stored in ROM or EPROM, generally known as **firmware**
- Initiates all aspects of system
- Loads operating system kernel and starts execution



Operating System Structure

- **Multi-programming** needed for efficiency
 - Single user cannot keep CPU and I/O devices busy all times
 - In single-programming, several programs are in memory concurrently, the system has to switch between them to keep the CPU busy, which is time consuming and inefficient
 - When there are more programs, the system can keep the CPU always busy
 - A subset of total jobs in memory is kept in memory
 - One job selected and run via **job scheduling**
 - When it has to wait (I/O for example), OS switches to another job



Operating-System Operations

- An operating system is a program that manages the computer system
 - It is an application program that runs on the computer system
 - It is a system program that manages the system
 - It is a user program that manages the user
- An operating system is a software that manages the system
 - It is a system program that manages the system
 - It is a user program for operating system services
 - User mode and kernel mode
 - User mode is for user programs
 - Kernel mode is for system programs
 - Provides ability to change from user mode to kernel mode
 - Some instructions designated as **privileged**, only executable in kernel mode
 - System call of user mode to kernel, return from kernel to user if required

Process Management

- A process is a program in execution. It is a unit of execution within the system. The system allocates resources to processes to make them active
- Processes are references to processes after they have been created
 - CPU, memory, I/O, file
- Process termination requires release of any reusable resources
- Single-threaded process has one **process owner** operating system or user
- Multi-threaded process has one **process owner** operating system or user
 - Process owner is responsible for thread creation and destruction
- Multi-threaded process has one unique owner per thread
- Typically system has many processes, same user, some operating system handles concurrently on one or more CPUs
 - Convenience by reallocation of the CPU among the processes



Memory Management

- All data in memory before and after processing
- All instructions in memory in order to execute
- Memory management is concerned what is in memory what
 - Ordering, CPU utilization and cache for response to users
- Memory management activities
 - Keeping track of which parts of memory are currently being used by whom
 - Deciding which processes (or parts thereof) and data to move in and out of memory
 - Allocating and deallocating memory spaces as needed



Storage Management

- OS provides uniform, logical view of information storage
- Abstracts physical properties to logical storage units
 - Disk, tape, memory, optical media, solid state drive
- Each medium is characterized
 - Cache, read/write speed, reliability, cost
- Typical operations include access speed, capacity, data transfer rate, access method (sequential or random)
- File-System management
 - Files usually organized into directories
 - Access control on most systems to determine who can access what
 - OS activities include
 - Creating and deleting files and directories
 - Protection to manage files and directories
 - Migrating files onto secondary storage
 - Backup files onto static (non-volatile) storage media

I/O Subsystems

- One purpose of OS is to hide peculiarities of hardware devices from the user
- I/O subsystem responsible for
 - Memory management of I/O including buffering (storing data temporarily while it is being transferred), coherency (keeping copy of data in memory consistent with copy in I/O device), cascading (the overlapping of output of one I/O with input of other ones)
 - General device driver interface
 - Drivers for specific hardware devices



Protection and Security

- **Protection** - aim is to ensure for controlling access of processes or users to resources defined by the OS
- **Security** - defense of the system against internal and external attacks
 - Hardware, software, data, network, users, viruses, identify theft, firewalls, etc.
- Systems generally limit what programs can do
 - User identities (User IDs, security IDs) include name and associated number, one password
 - User ID identifies the user in all threads, processes that user to determine access rights
 - Group identifier (group ID) allows set of users to be defined and common access rights to be assigned to all members of the group
 - Privilege escalation allows user to change to effective ID with more rights



Special-Purpose OS

- **Real-Time**
 - One used in a dedicated application. The system reads information from sensors and must respond within a fixed amount of time to ensure correct performance.
- **Embedded**
 - Special purpose systems
 - Cell phones, wireless routers, TV's, space vehicles, etc.
 - Real-time
 - High reliability, efficient or inexpensive to update after deployment, real-time environments, self-diagnose and repair, and low power operation



Summary



What OS do you use?

- Linux
- Windows
- Mac
- Unix
- Solaris



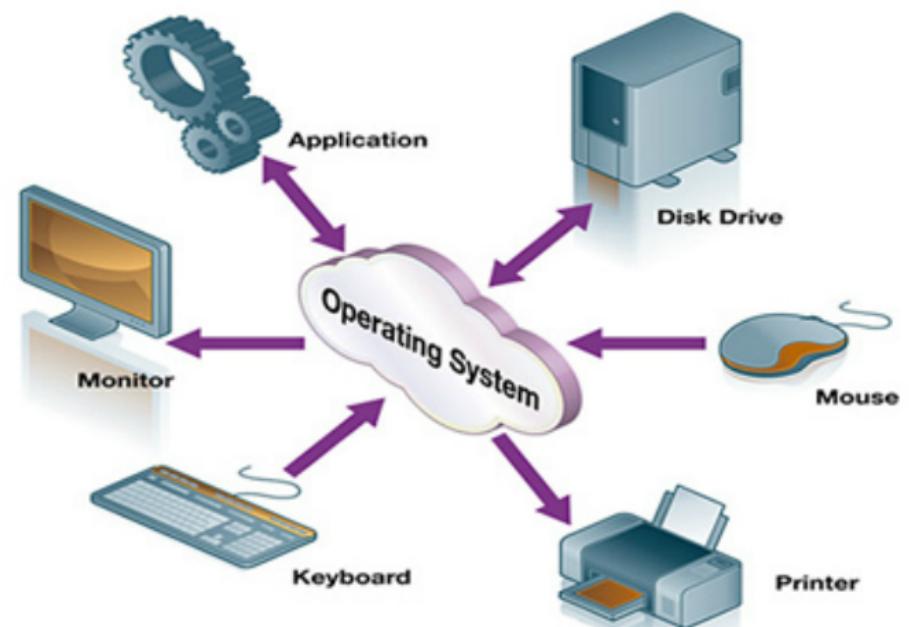
S

Roles of OS

Managing multi tasks



Managing resources



Syllabus



- Introduction to OS, History of OS
- Introduction to Processes and Threads
- CPU scheduling
- More on threads
- Process Synchronization
- Semaphores
- Memory mgmt
- Paged and segmented memory
- Demand Paging

Online Resources

P.K.Biswas: IIT KGP

<https://www.youtube.com/playlist?list=PLDC70psjvq5hIT0kfr1sirNuees0NIbG>

Kishore Ramachandran, Georgia Tech

<https://www.udacity.com/wiki/ud156>

Prior Knowledge



Basics

- Data Structure
- Object Oriented Programming
- Programming C and Java

Evaluation Scheme

- Mid sems: 30%
- End sems: 30%
- Programming assignments: 20% (4-5)
- Quiz: 10% (2)
- Class participation: 10%



Attendance Policy

Attendance will be taken everyday and missing class can be expected to significantly reduce your chances of success. There will be no repetition.

Missing Exams

- If you miss a exam due to an unexcused absence, you will receive a grade of 0 for that quiz/exam.
- The make-up exam may be **SIGNIFICANTLY MORE DIFFICULT** than the original exam.

Office Hours

- Wednesday 2:00-5:00 PM



What is an Operating System?

- A program that acts as an intermediary between a user of a computer and the computer hardware

Operating system goals:

- Execute user programs and make solving user problems easier
- Make the computer system convenient to use
- Use the computer hardware in an efficient manner

Computer System Structure



- Computer system can be divided into four components
 - Hardware – provides basic computing resources
 - ▶ CPU, memory, I/O devices
 - Operating system
 - ▶ Controls and coordinates use of hardware among various applications and users
 - Application programs – define the ways in which the system resources are used to solve the computing problems of the users
 - ▶ Word processors, compilers, web browsers, database systems, video games
 - Users
 - ▶ People, machines, other computers



Operating System Definition

- OS is a **resource allocator**
 - Manages all resources
 - Decides between conflicting requests for efficient and fair resource use
- OS is a **control program**
 - Controls execution of programs to prevent errors and improper use of the computer



Operating System Definition (Cont)

- No universally accepted definition
- “Everything a vendor ships when you order an operating system” is good approximation
 - But varies wildly
- “The one program running at all times on the computer” is the **kernel**. Everything else is either a system program (ships with the operating system) or an application program



Computer Startup

- **bootstrap program** is loaded at power-up or reboot
 - Typically stored in ROM or EPROM, generally known as **firmware**
 - Initializes all aspects of system
 - Loads operating system kernel and starts execution



Operating System Structure

■ **Multiprogramming** needed for efficiency

- Single user cannot keep CPU and I/O devices busy at all times
- In multiprogramming, several programs are in memory concurrently; the system switches among the programs for efficient processing, and minimal idle time.
- Multiprogramming organizes jobs (code and data) so CPU always has one to execute
- A subset of total jobs in system is kept in memory
- One job selected and run via **job scheduling**
- When it has to wait (for I/O for example), OS switches to another job



Operating-System Operations

- An operating system is **interrupt driven**
- **Interrupt** driven by hardware
- **exception** or **trap** is a software-generated interrupt caused either
 - by an error (ex: Division by zero or invalid memory access)
 - Or by a request from a user program for operating system service
→**System call**
- Other process problems include infinite loop, processes modifying each other or the operating system
- **Dual-mode** operation allows OS to protect itself and other system components
 - **User mode** and **kernel mode**
 - **Mode bit** provided by hardware
 - ▶ Provides ability to distinguish when system is running user code or kernel code
 - ▶ Some instructions designated as **privileged**, only executable in kernel mode
 - ▶ System call changes mode to kernel, return from call resets it to user



Process Management

- A process is a program in execution. It is a unit of work within the system.
Program is a *passive entity*, process is an *active entity*.
- Process needs resources to accomplish its task
 - CPU, memory, I/O, files
 - Initialization data
- Process termination requires reclaim of any reusable resources
- Single-threaded process has one **program counter** specifying location of next instruction to execute
 - Process executes instructions sequentially, one at a time, until completion
- Multi-threaded process has one program counter per thread
- Typically system has many processes, some user, some operating system running concurrently on one or more CPUs
 - Concurrency by multiplexing the CPUs among the processes / threads

Memory Management



- All data in memory before and after processing
- All instructions in memory in order to execute
- Memory management determines what is in memory when
 - Optimizing CPU utilization and computer response to users
- Memory management activities
 - Keeping track of which parts of memory are currently being used and by whom
 - Deciding which processes (or parts thereof) and data to move into and out of memory
 - Allocating and deallocating memory space as needed



Storage Management

- OS provides uniform, logical view of information storage
 - Abstracts physical properties to logical storage unit - **file**
 - Each medium is controlled by device (i.e., disk drive, tape drive)
 - ▶ Varying properties include access speed, capacity, data-transfer rate, access method (sequential or random)
- File-System management
 - Files usually organized into directories
 - Access control on most systems to determine who can access what
 - OS activities include
 - ▶ Creating and deleting files and directories
 - ▶ Primitives to manipulate files and dirs
 - ▶ Mapping files onto secondary storage
 - ▶ Backup files onto stable (non-volatile) storage media



I/O Subsystem

- One purpose of OS is to hide peculiarities of hardware devices from the user
- I/O subsystem responsible for
 - Memory management of I/O including buffering (storing data temporarily while it is being transferred), caching (storing parts of data in faster storage for performance), spooling (the overlapping of output of one job with input of other jobs)
 - General device-driver interface
 - Drivers for specific hardware devices



Protection and Security

- **Protection** – any mechanism for controlling access of processes or users to resources defined by the OS
- **Security** – defense of the system against internal and external attacks
 - Huge range, including denial-of-service, worms, viruses, identity theft, theft of service
- Systems generally first distinguish among users, to determine who can do what
 - User identities (**user IDs**, security IDs) include name and associated number, one per user
 - User ID then associated with all files, processes of that user to determine access control
 - Group identifier (**group ID**) allows set of users to be defined and controls managed, then also associated with each process, file
 - **Privilege escalation** allows user to change to effective ID with more rights



Special-Purpose OS

■ Real-Time

Often used in a dedicated application. The system reads information from sensors and must respond within a fixed amount of time to ensure correct performance.

■ Embedded

- Special purpose systems
 - ▶ Cell phones, wireless routers, TV's, space vehicles, etc.
- Requirements
 - ▶ High reliability, difficult or impossible to upgrade after deployed, run in hostile environments, self-diagnosis and repair, unattended operation.

Summary

