

# Introduction to Operating Systems

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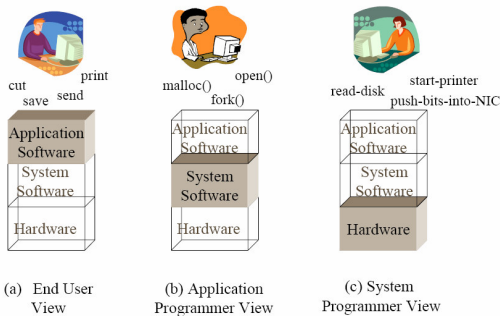
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## Perspective of the Computer



(a) End User View

(b) Application Programmer View

(c) System Programmer View

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## System Software

- A general piece of software with common functionalities that support many applications.
- Example:
  - C compiler
  - shell – command line interpreter
  - A window system

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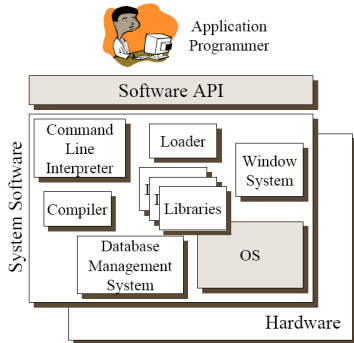
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## The Structure of Computer System




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## What does an Operating System do?

- It is an extended machine:
  - Hides the messy details about hardware resources.
  - Presents users with a resource abstraction that is easy to use.
- It is a resource manager
  - Allows multiple users / programs to share resources and coordinate the sharing.

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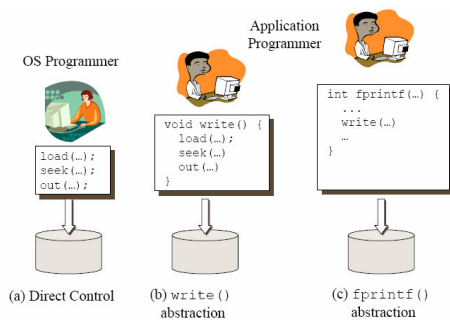
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## Abstraction




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## Under the Abstraction

- Functional complexity
- A single abstraction over multiple devices
- Replication -> reliability

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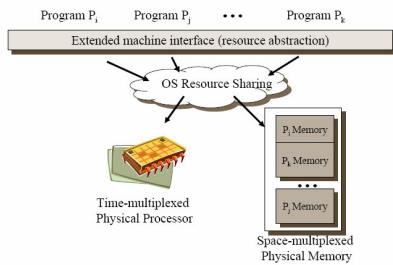
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## Resource Sharing



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## Objectives of Resource Sharing

- Efficiency
- Fairness
- Security

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## Specific Types of OS

- Batch processing
- Timesharing OS
- Real-time OS
- Distributed OS
- Small Computers

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## Batch Processing

- Jobs (sequence of OS commands) prepared offline
- Batch of jobs given to OS at one time
- OS processes jobs one after the other
- No human-computer Interaction
- E.g. running compute-intensive simulations

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## Timesharing Systems

- Users connect send commands and receive results from consoles.
- Consoles relay the commands to a big machine.

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## Real-Time Systems

- Computer is dedicated to a single purpose.
- It needs to respond to external events in fixed time (e.g. industrial process control, multimedia servers)
- An area of growing interest

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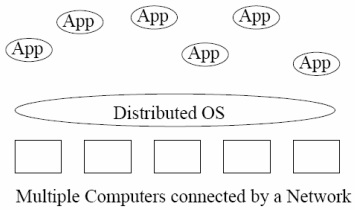
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## Distributed OS



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## Small Computers

- PDAs, embedded systems, computer sensors became more significant
- Have an OS, but
  - Not general purpose
  - Limited hardware resources and power
  - PalmOS, Pockt PC(WinCE)

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## Different Issues

- Timesharing system: scheduling, protection.
- PC & Wkstation: Human-Computer Interface
- Distributed OS: client-server model, network protocols.
- Real-Time OS: RT scheduling
- Small Computer: Power Management

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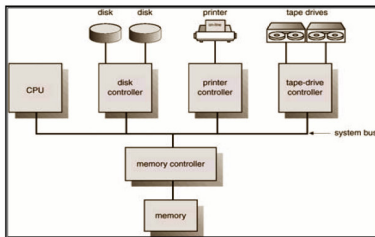
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## Computer-system Architecture



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## I/O Operations

- I/O devices are much slower than CPU
- Synchronous (polling)  
After I/O starts, busy polling the device status register until it shows the operation completes.
- Asynchronous (interrupt-driven)  
After I/O starts, control returns to user program without waiting for I/O completion.  
Device controller later informs CPU that it has finished its operation by causing an interrupt.  
When an interrupt occur, current execution is put on hold; the CPU jumps to a service routine called "interrupt handler"

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## System Protection

- User programs are generally not trusted.  
A user program may use unfair amount of resource.  
A user program may maliciously cause other programs or the OS to fail.
- Need protection against untrusted user programs; the system must differentiate between two modes of operations:  
User mode – execution of user programs  
Kernel mode – execution of the operating system
- Hardware support is needed in such protection.

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## Memory Protection

- Goal of memory protection?  
A user program can't use arbitrary amount of memory.  
A user program can't access data belonging to the operating system or other user programs.
- How to achieve memory protection?  
Indirect memory access: memory access with a virtual address which needs to be translated into physical address.

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## CPU Protection

- Goal of CPU protection  
A user program cannot hold the CPU for ever.
- Timer – interrupts computer after specified period to ensure the OS kernel maintains control.  
Timer is decremented every clock tick.  
When timer reaches the value 0, an interrupt occurs.  
CPU time sharing is implemented in the timer interrupt.

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## Operation System Organization

- System Components
  - process management
  - memory management
  - I/O system
  - File and storage
  - Networking

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## Process Management

- A process is a program in execution. A process needs certain resources, including CPU time, memory, files and I/O devices, to accomplish its task.
- OS responsibilities for process management:
  - Process creation and deletion
  - Process scheduling, suspension, and resumption.
  - Process synchronization, inter-process communication.

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## Memory Management

- Memory
  - A large array of addressable words or bytes
  - A data repository by the CPU and I/O devices.
- OS responsibility for memory management:
  - Allocate and deallocate memory space as requested.
  - Keep track of **which** parts of memory are currently being used and by **whom**.
  - Efficient utilization when the memory resource is heavily competed.

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## I/O System Management

- A computer needs I/O to interact with outside world:
  - console/terminal
  - disks
  - Networking
- The I/O system consists of:
  - A buffer-caching system
  - A general device-driver interface
  - Drivers for specific hardware devices

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## File and Storage Management

- A file is a collection of information defined by its user. Commonly, both programs and data are stored as files.
- OS responsibilities for file management:
  - Manipulation of files and directories.
  - Map files onto secondary storage.
- Os responsibilities for disk management:
  - Free space management and storage allocation.
- The above two issues are not all always together.

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## Networking

- A distributed system
  - A collection of processors that do not share memory.
  - Processors are connected through a communication network.
  - Communication takes place using a protocol.
- A distributed system provides user access to various shared system resources, which allows:
  - Computation speed-up
  - Enhanced reliability.

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