

Introduction to Operating System

Unit-1

Operating System/01CE1401



Department of Computer Engineering
Prof. Shilpa Singhal



After completion of this course, student will be able to

- Understanding the role of operating system with its function and services.
- Application and comparison of various CPU scheduling and memory management algorithms.
- Apply various concepts and assess the requirement for inter process communication and deadlock.
- Comprehend the mechanism of I/O and File Management
- Implement algorithms and acquire a detailed understanding of various Unix commands

- Operating System: Computer System Overview.
- Architecture, Goals & Structures of O.S
- Functions of operating systems, protection and security, distributed systems,
- Operating Systems structures, services,
- Role & Function Of Kernel,
- System calls and their working.

- Computer System Overview
 - What is an OS?
 - Where does the OS fit in?
 - Flow of Communication
 - Functions of Operating system
 - Different views of OS
 - Goals/objective of OS
- Generations of Operating systems
- Types of Operating Systems
- Protection and Security in Operating System

A modern computer consists of

- One or more processors
- Main memory
- Disks
- Printers
- Various input/output devices.
- who manages(control) these hardwares?????

A modern computer consists
of

Managing all these varied components
requires a layer of software – the **Operating
System (OS)**.

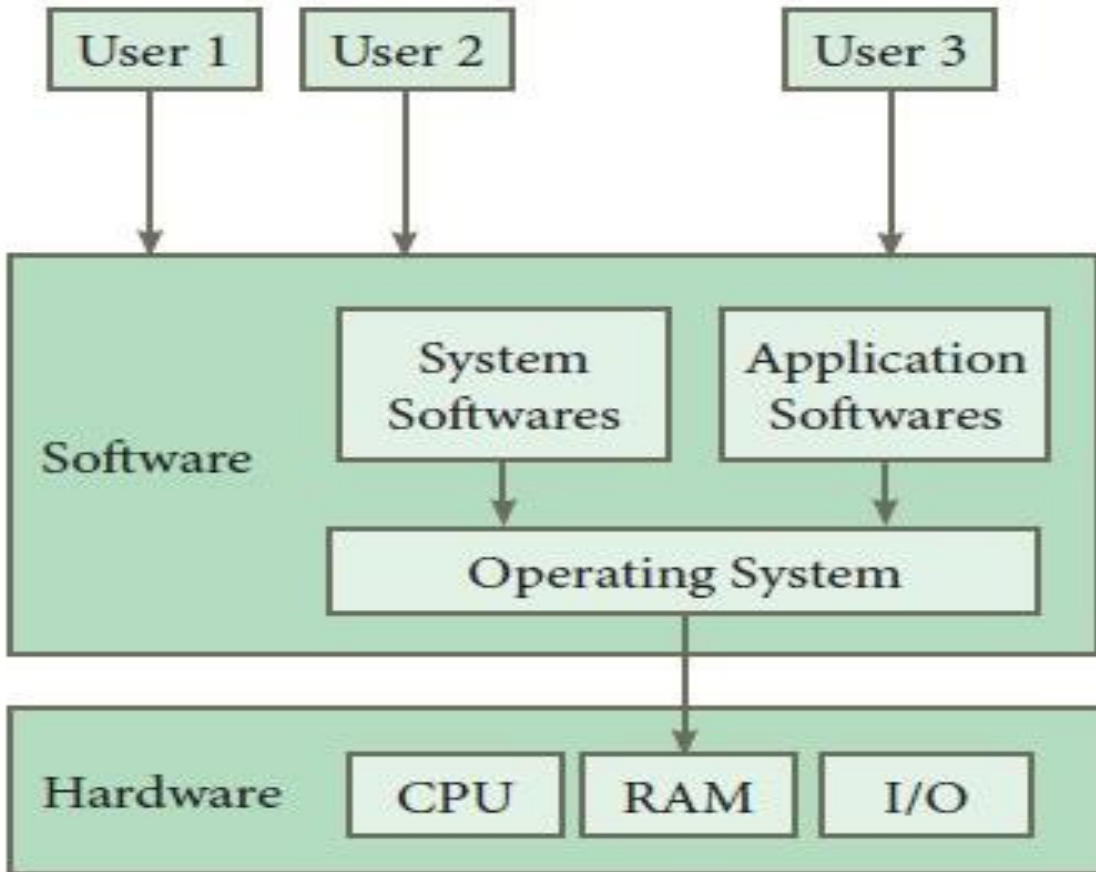
Definition: What is an Operating System ?



Definition

- An Operating System is a program that acts as an intermediary/interface between a **user** of a computer and the computer **hardware**.

Definition: What is an Operating System ?



An Operating System (OS) is a **system software** that enables the hardware to communicate and operate with other software. It also acts as an interface between the user and the hardware and controls the overall execution of the computer.

Fig. Operating System Overview

Definition



It manages hardware resources and provides various service to users

It provides a user-friendly environment in which a user may *easily* develop and execute programs.

Otherwise, hardware knowledge would be mandatory for computer programming.

So, it can be said that an OS *hides the complexity* of hardware from uninterested users.

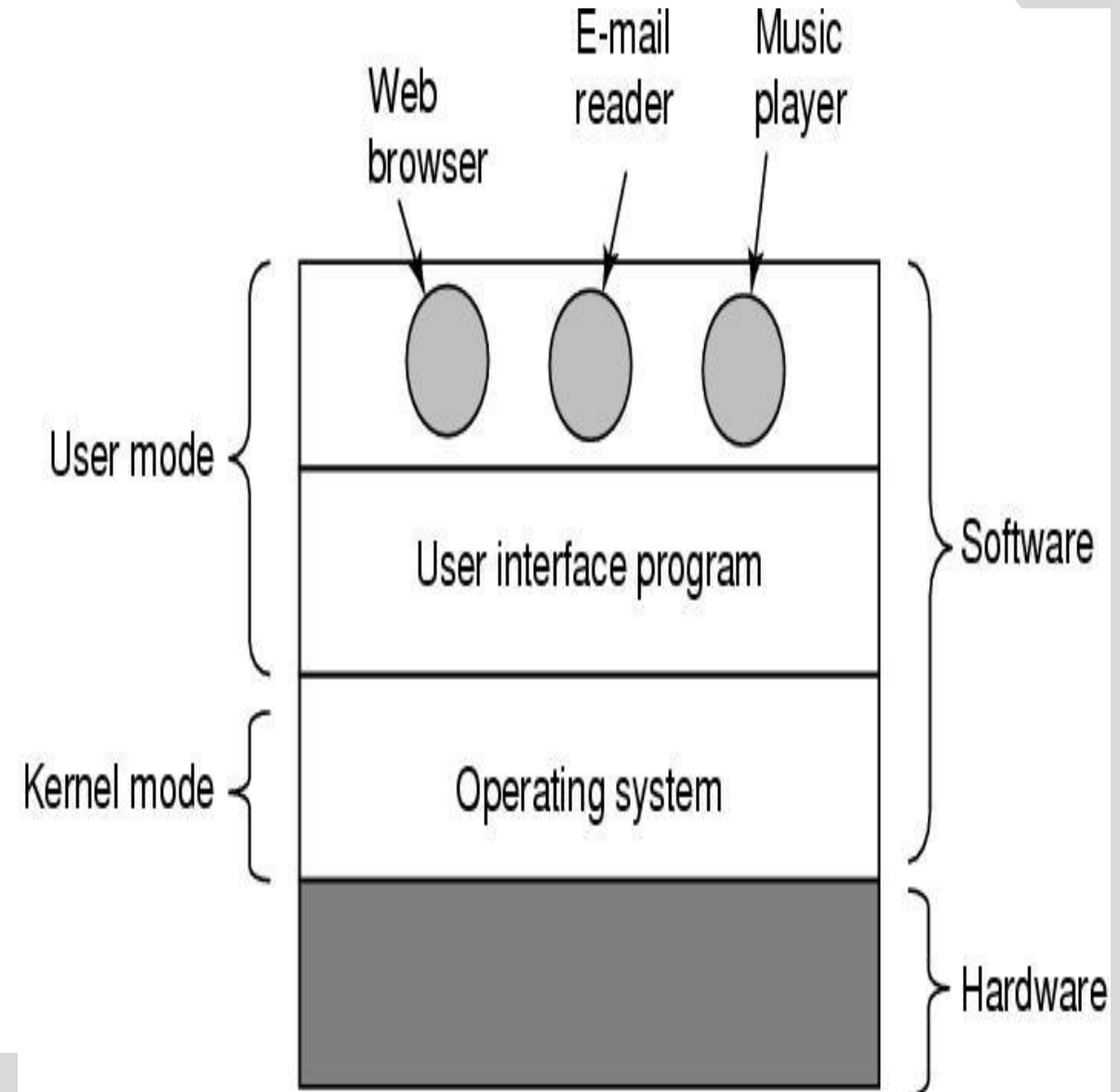
Where does the OS fit in?



As show in the figure hardware is at bottom, consist of chips, boards, disks.

On the top of hardware is the software.

Computer have two modes of operations: user mode and kernel mode.



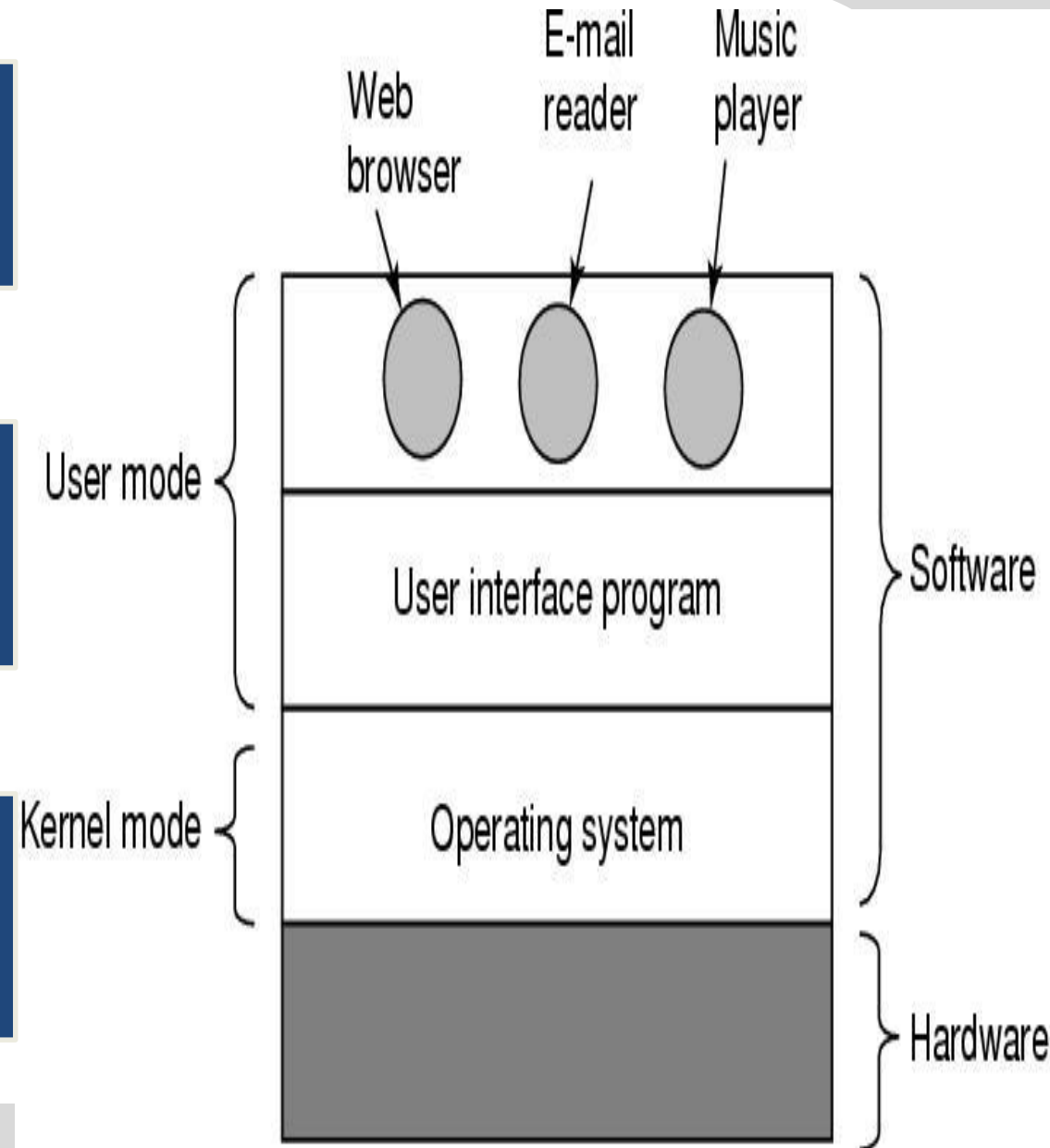
Where does the OS fit in?



OS is most fundamental software and runs in kernel mode.

Here OS have complete access to all the hardware and can *execute any instruction* on the machine.

Rest of the software runs in user mode.



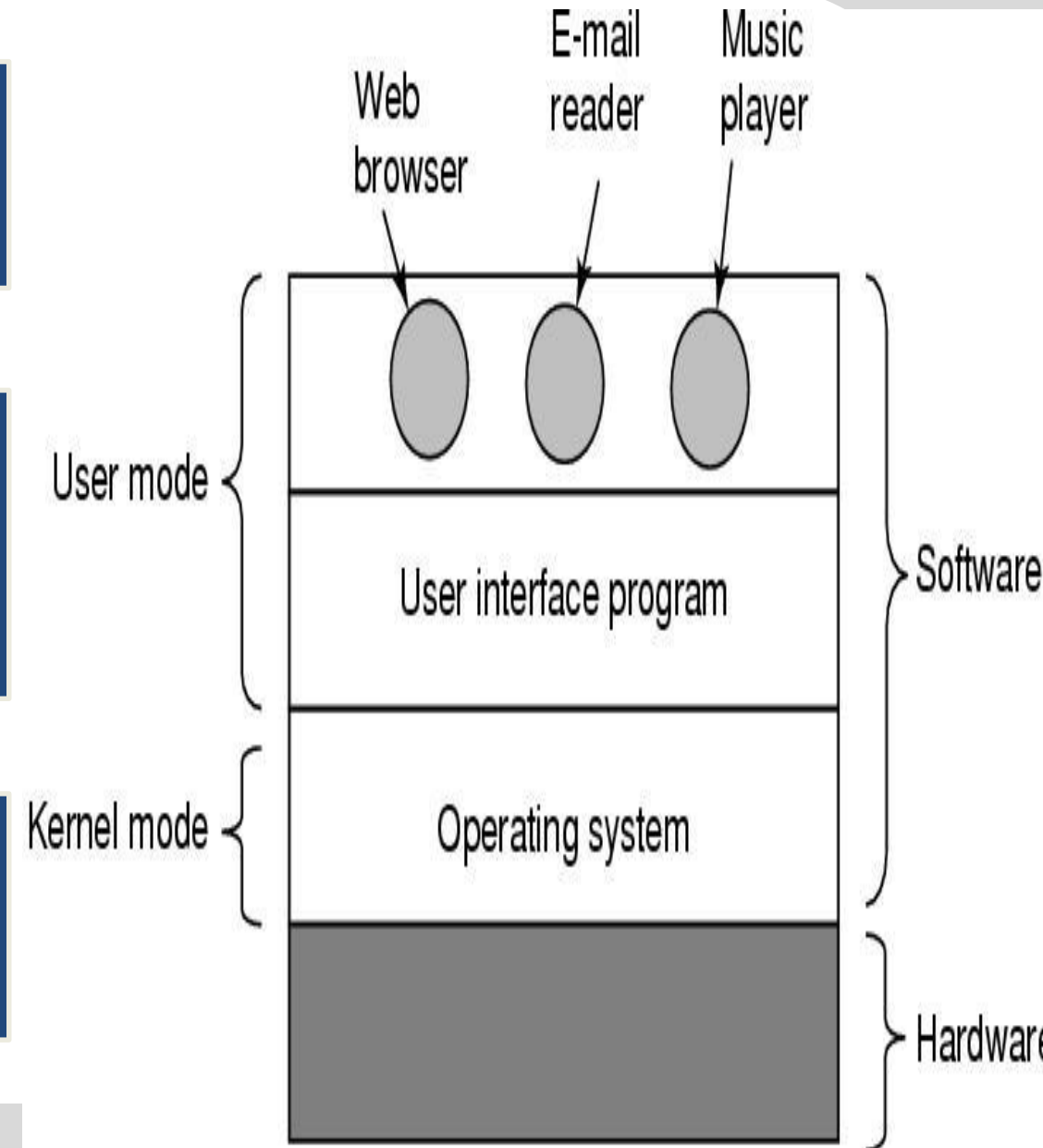
Where does the OS fit in?



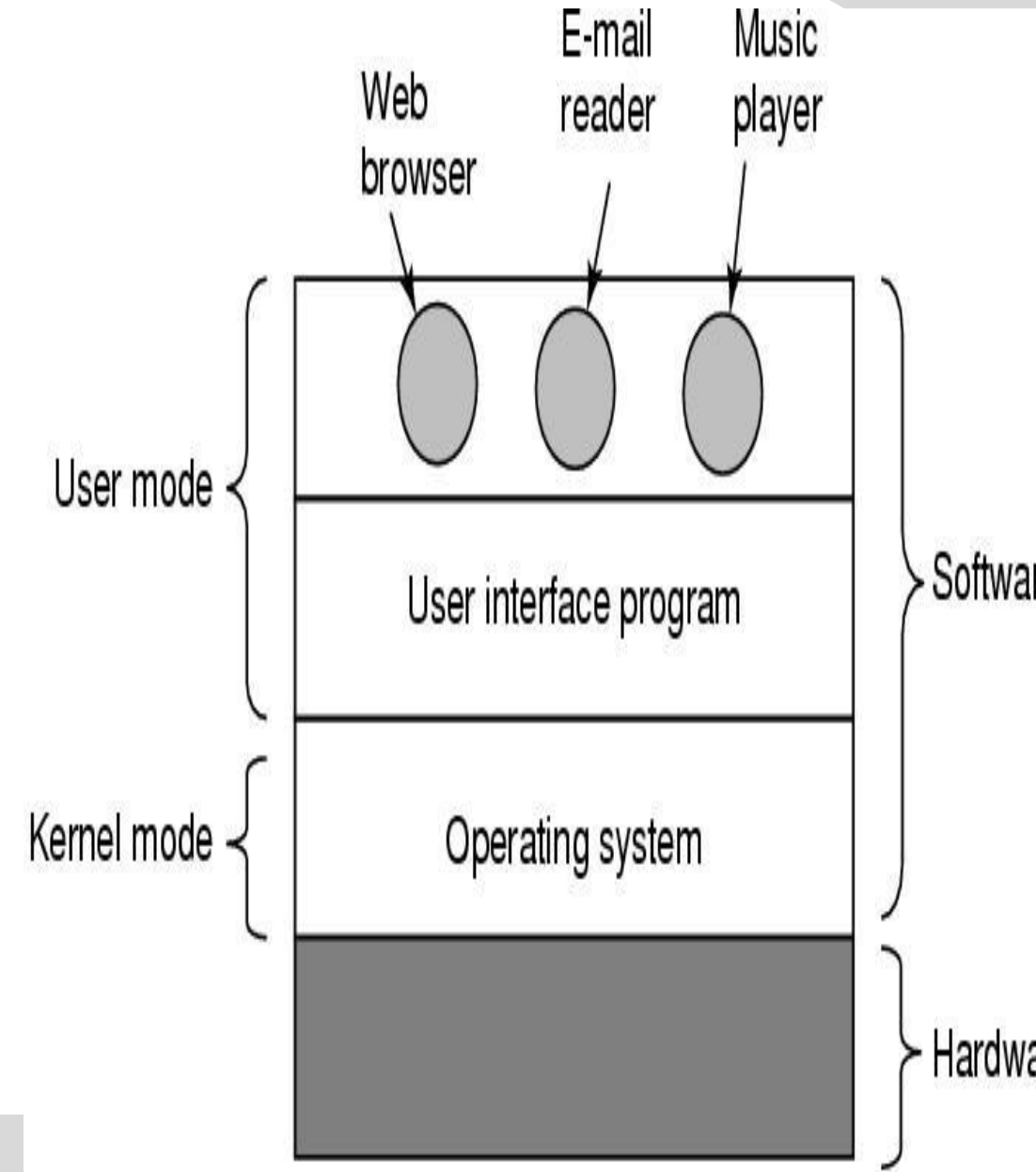
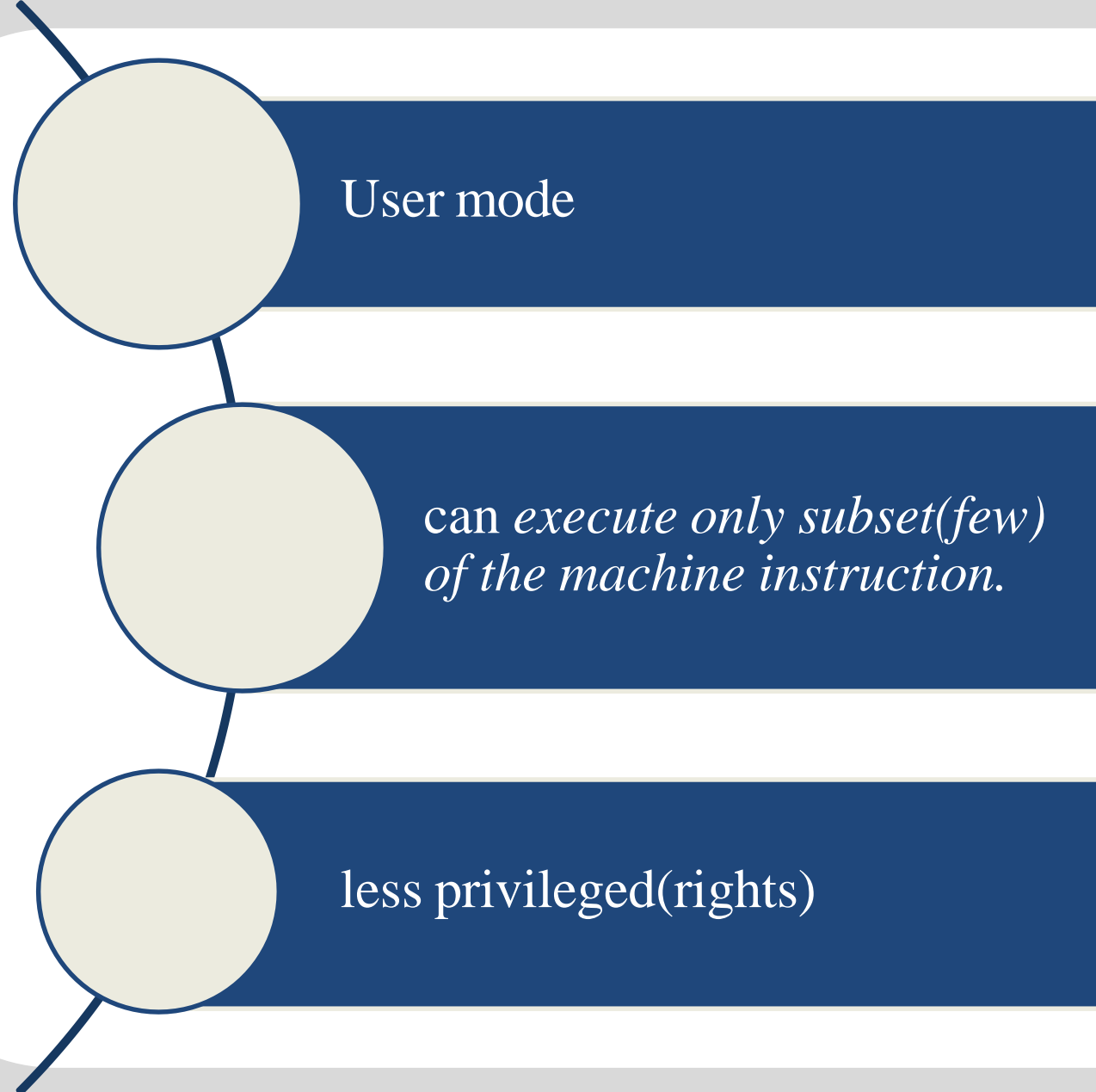
Kernel mode

Here OS have complete access to all the hardware and can *execute any instruction* on that a machine is capable of executing.

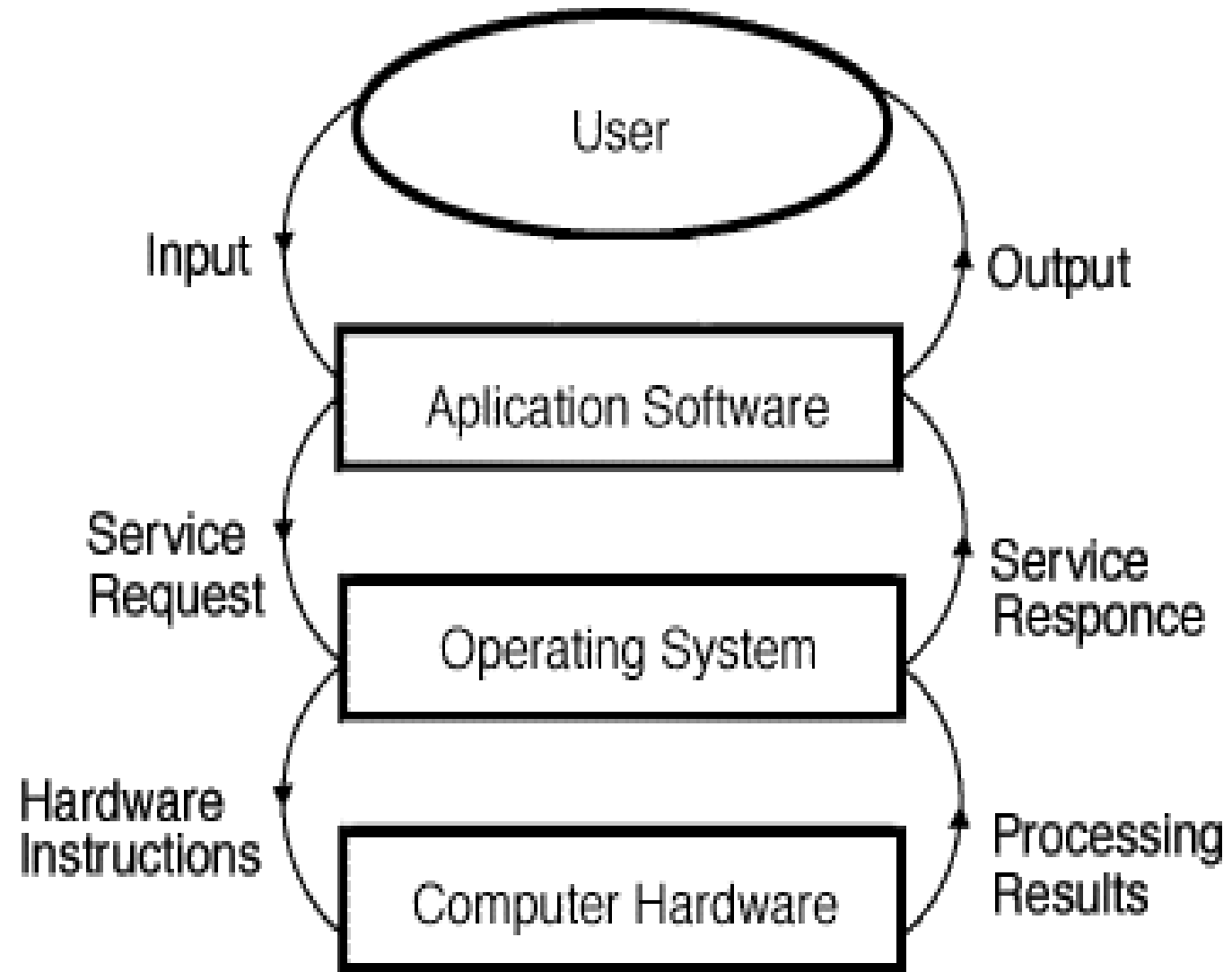
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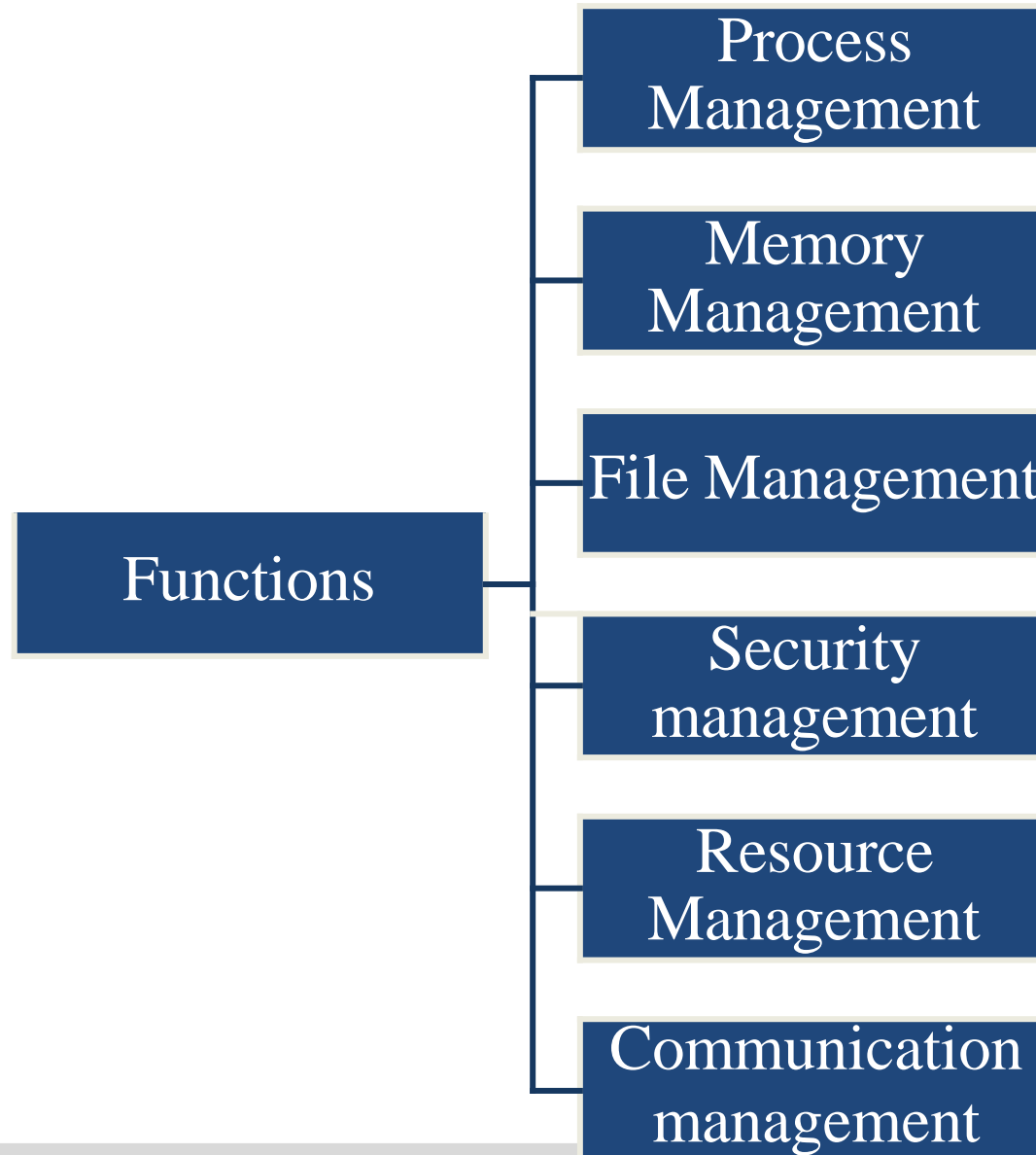
Where does the OS fit in?



Flow of Communication



Functions of Operating system



Process management

- *By process management OS manages many kinds of activities:*
 - All process from start to shut down i.e. open, save, copy, install, print.
 - Creation and deletion of user and system processes.

Memory Management

- *The major activities of an operating regard to memory-management are:*
 - Decide which process are loaded into memory when memory space becomes available.
 - Allocate and deallocate memory space as needed.

File management

- *The file management system allows the user to perform such tasks:*
 - Creating files and directories
 - Renaming files
 - Coping and moving files
 - Deleting files

Security Management

- *By security management OS manages many tasks such as:-*
 - Alert messages
 - Virus protection
 - Dialogue boxes
 - Firewall
 - Passwords

Resource Management

- *To manage Resources OS perform many tasks such as:*
 - Install drivers required for input and output, memory, power.
 - Coordination among peripherals.

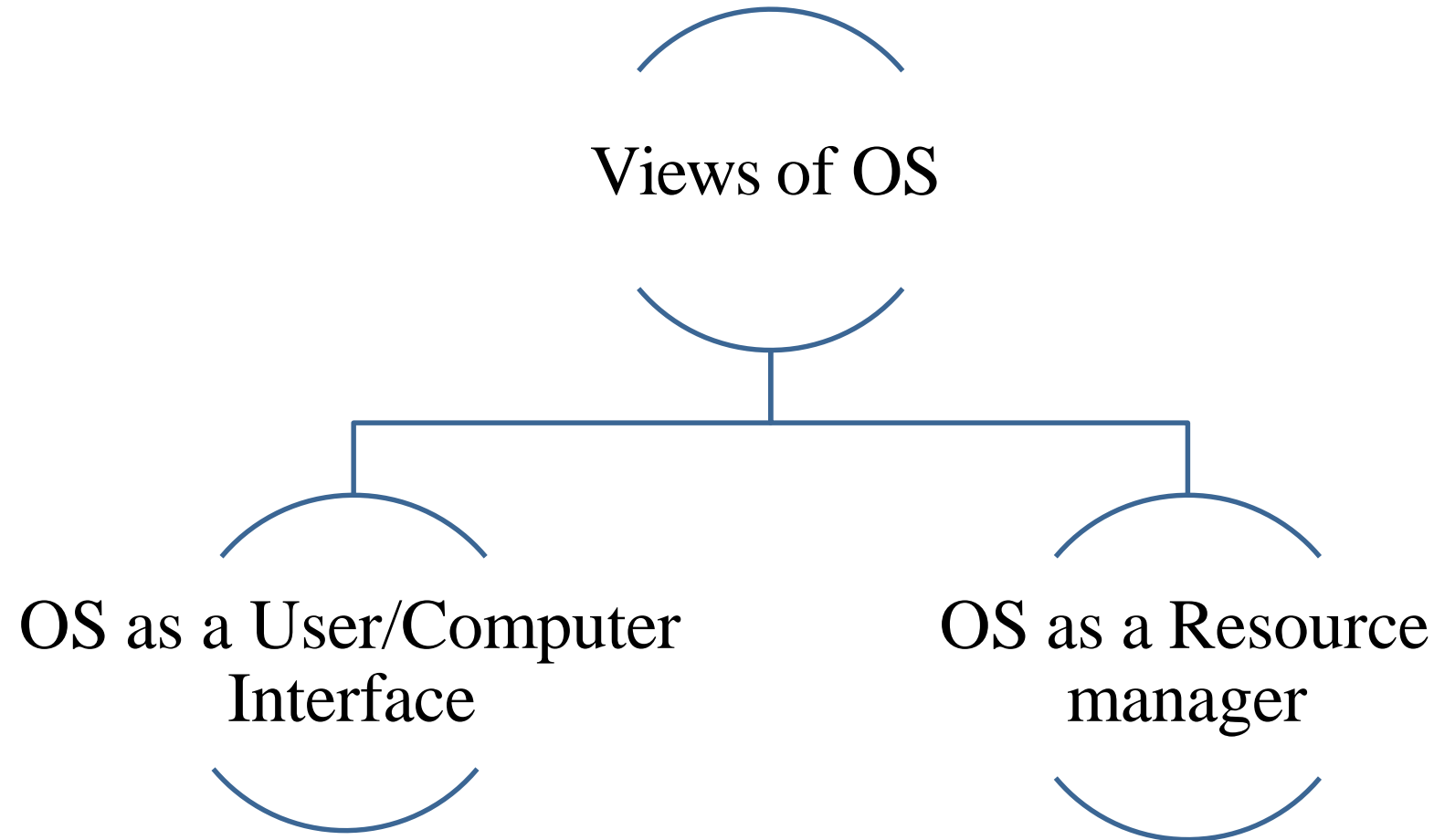
Communication Management

- *For proper coordination OS performs communication management:*
 - Communication between *user-application software-hardware.*
 - One computer to another via LAN or WAN.

Different Views of Operating System



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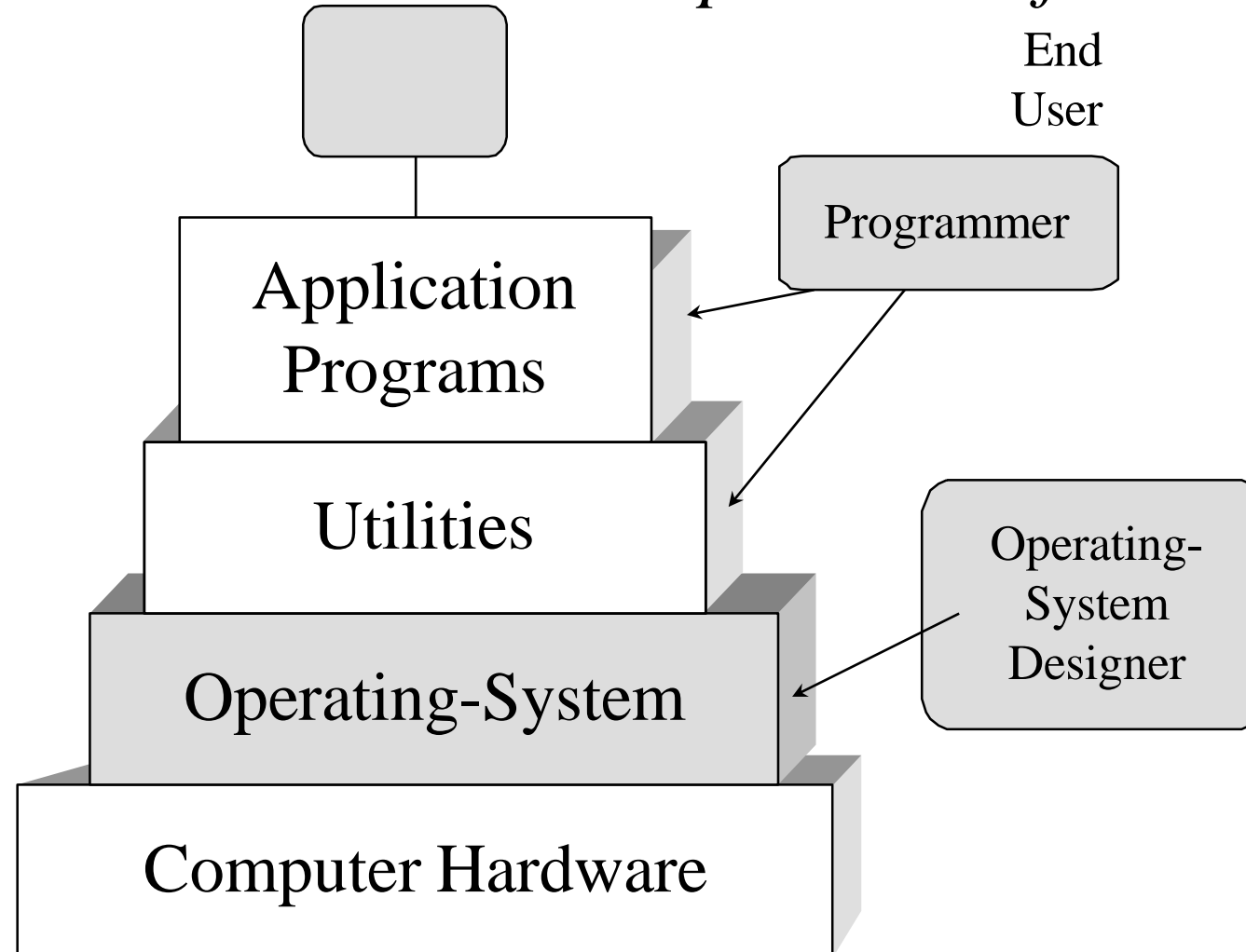
Different views of OS



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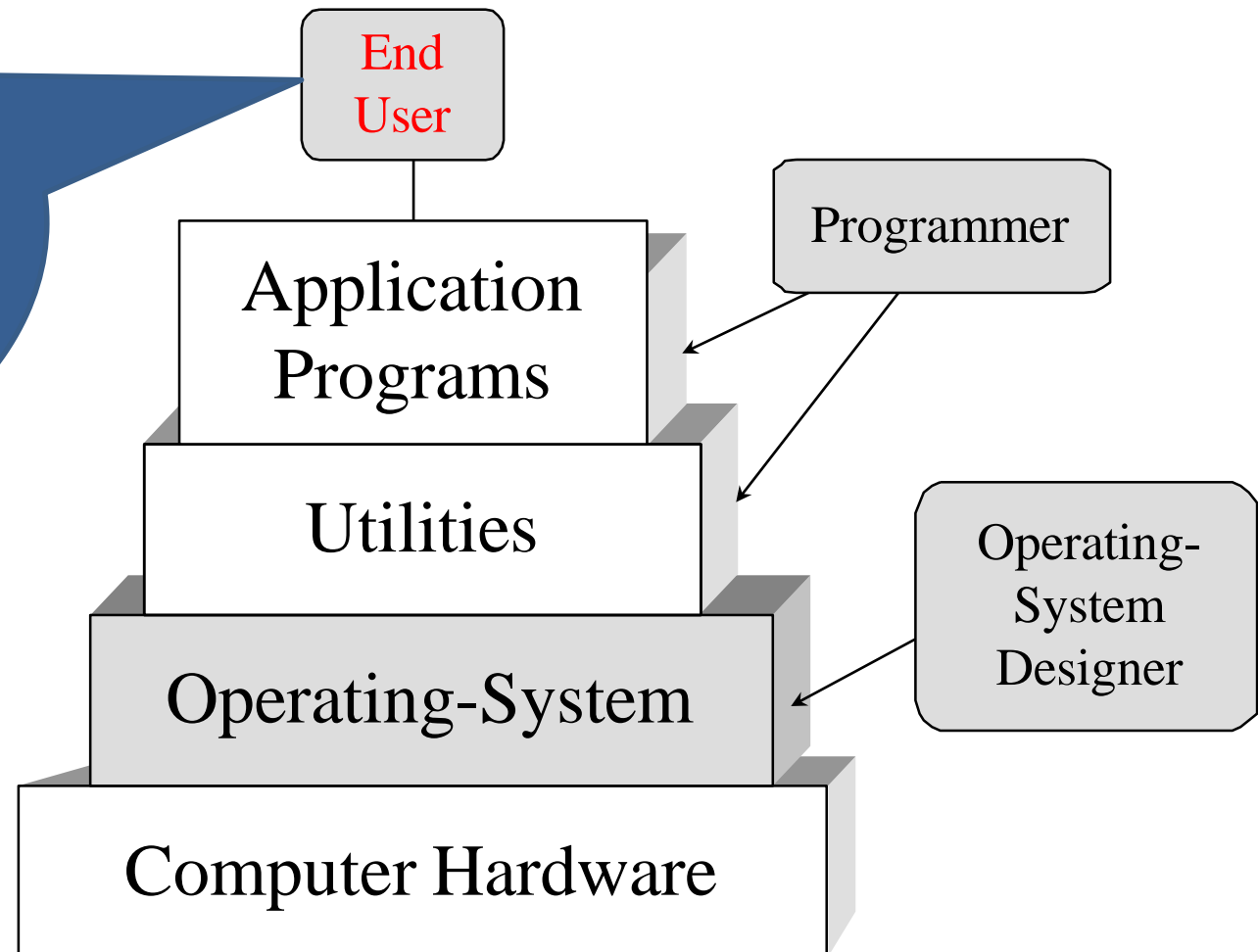
- *OS as a User/Computer Interface:*



OS as a User/Computer



End user only see the computer system in terms of set of application, he/she is not concern with the details of the computer hardware.



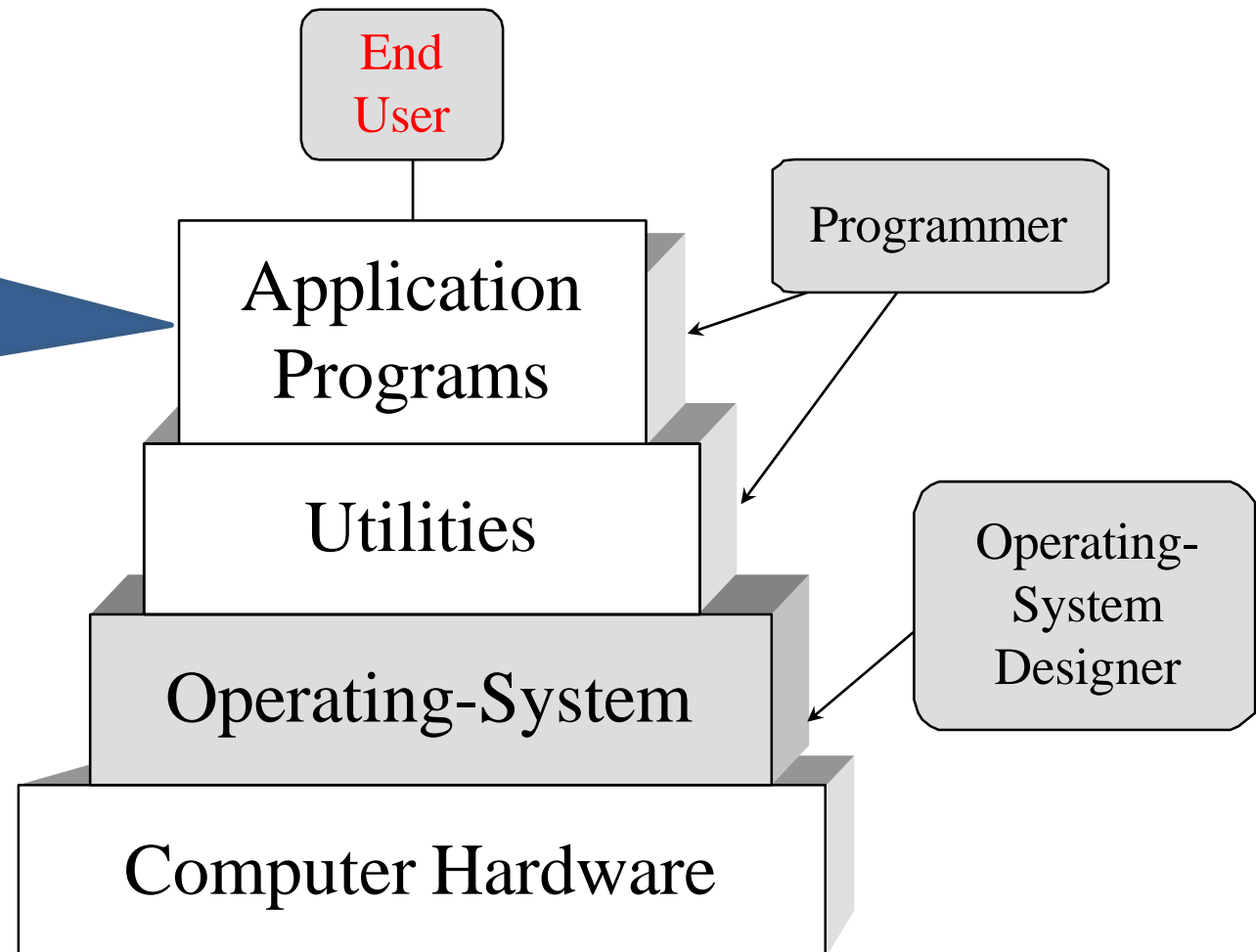
OS as a User/Computer Interface



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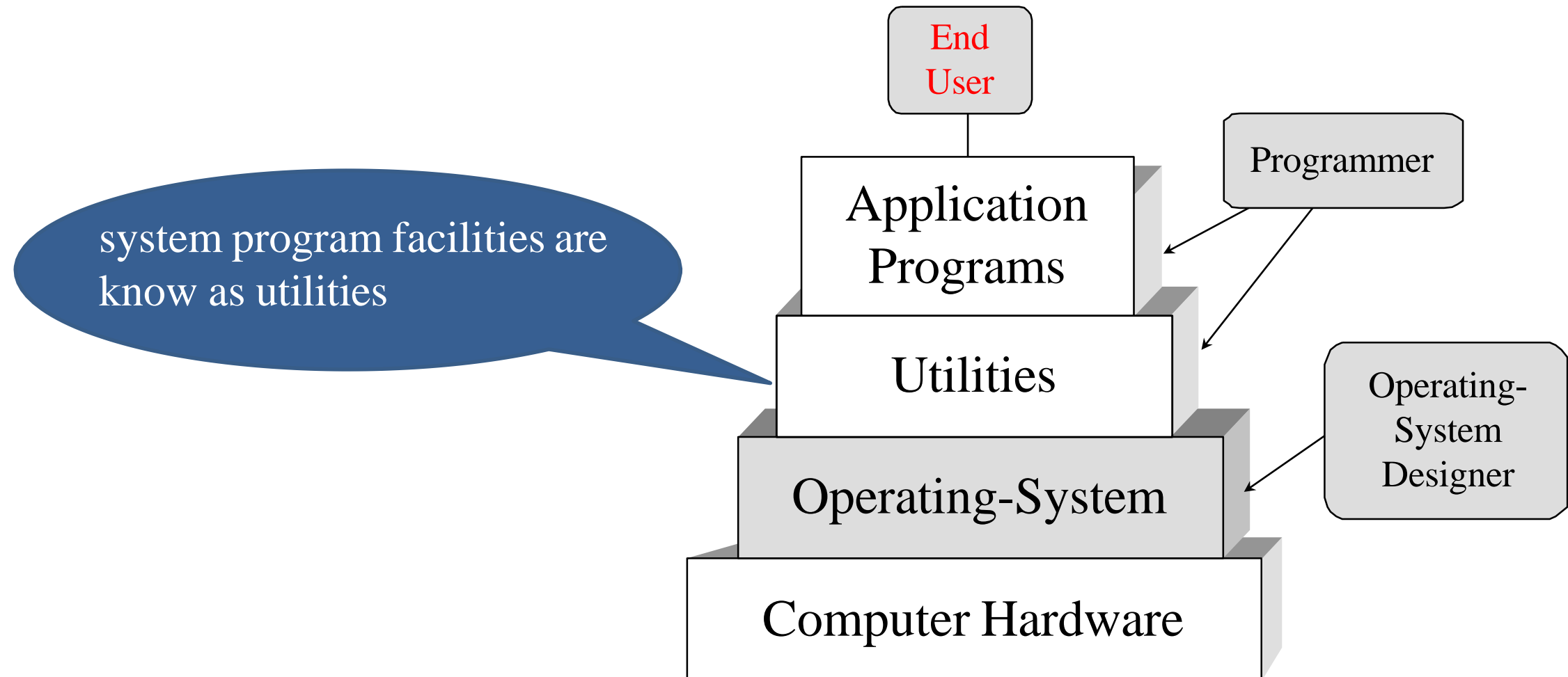
An application can be expressed in a programming language and is developed by an application programmer.



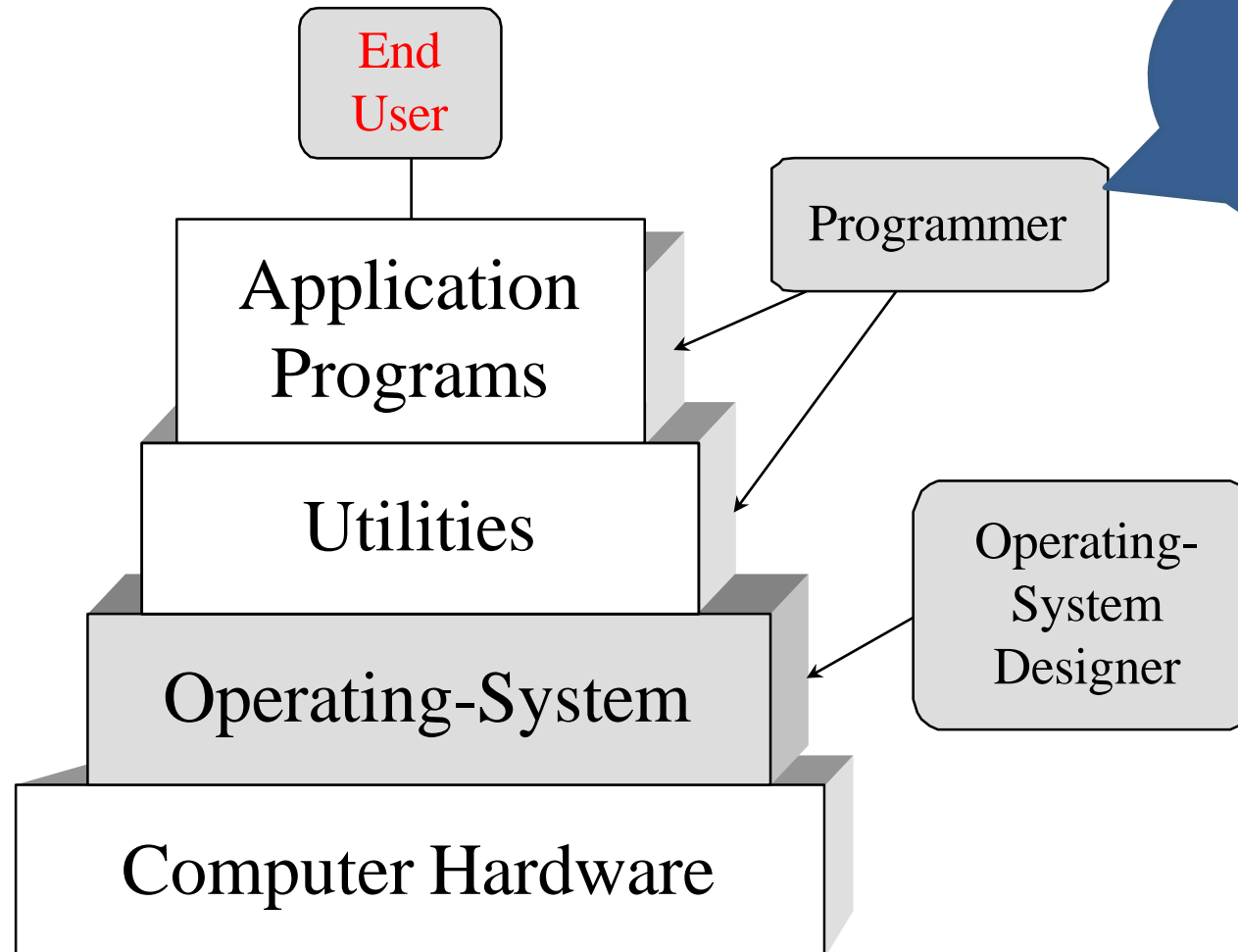
OS as a User/Computer Interface



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OS as a User/Computer Interface



A programmer uses system program facilities (Utilities) in developing an application.

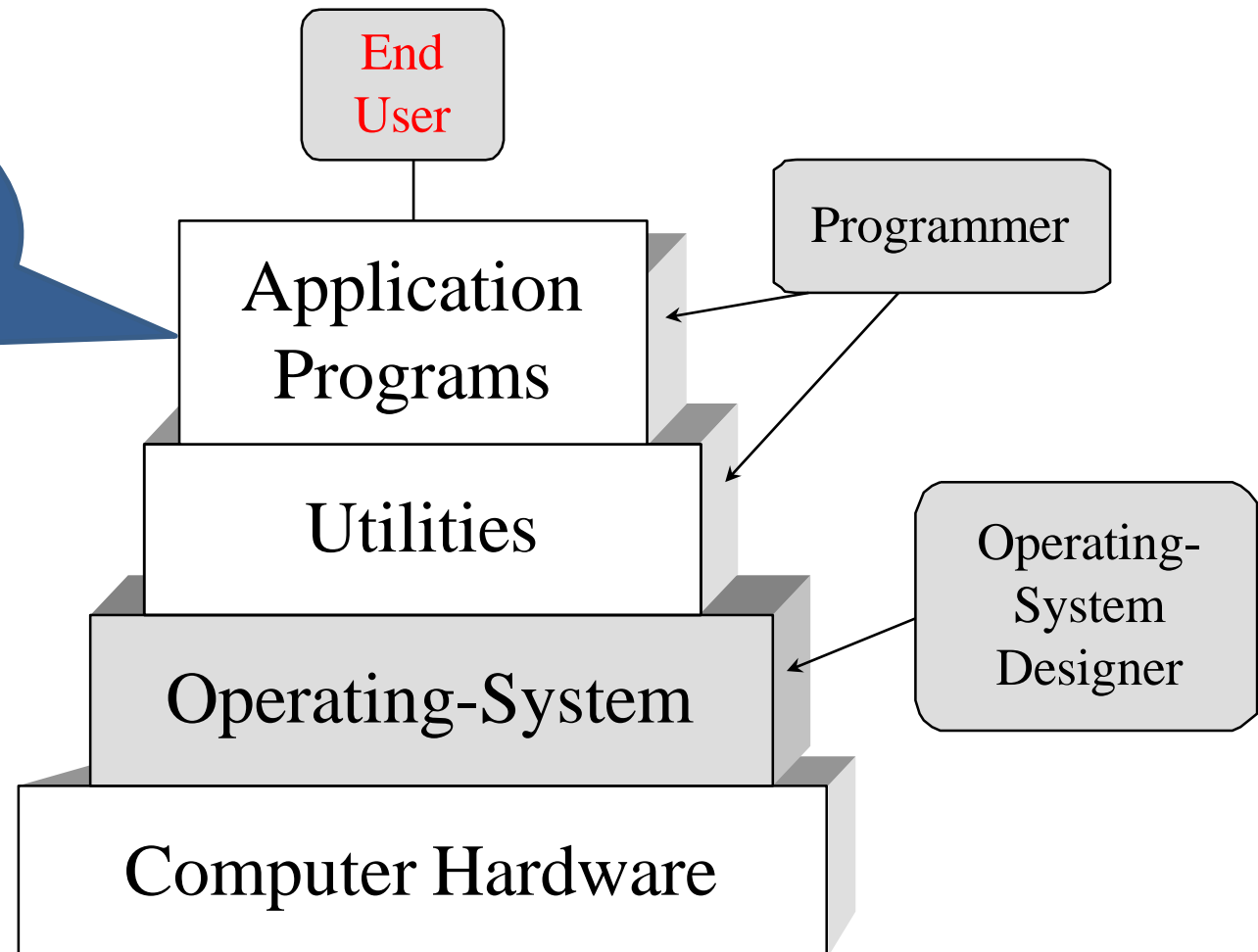
OS as a User/Computer Interface



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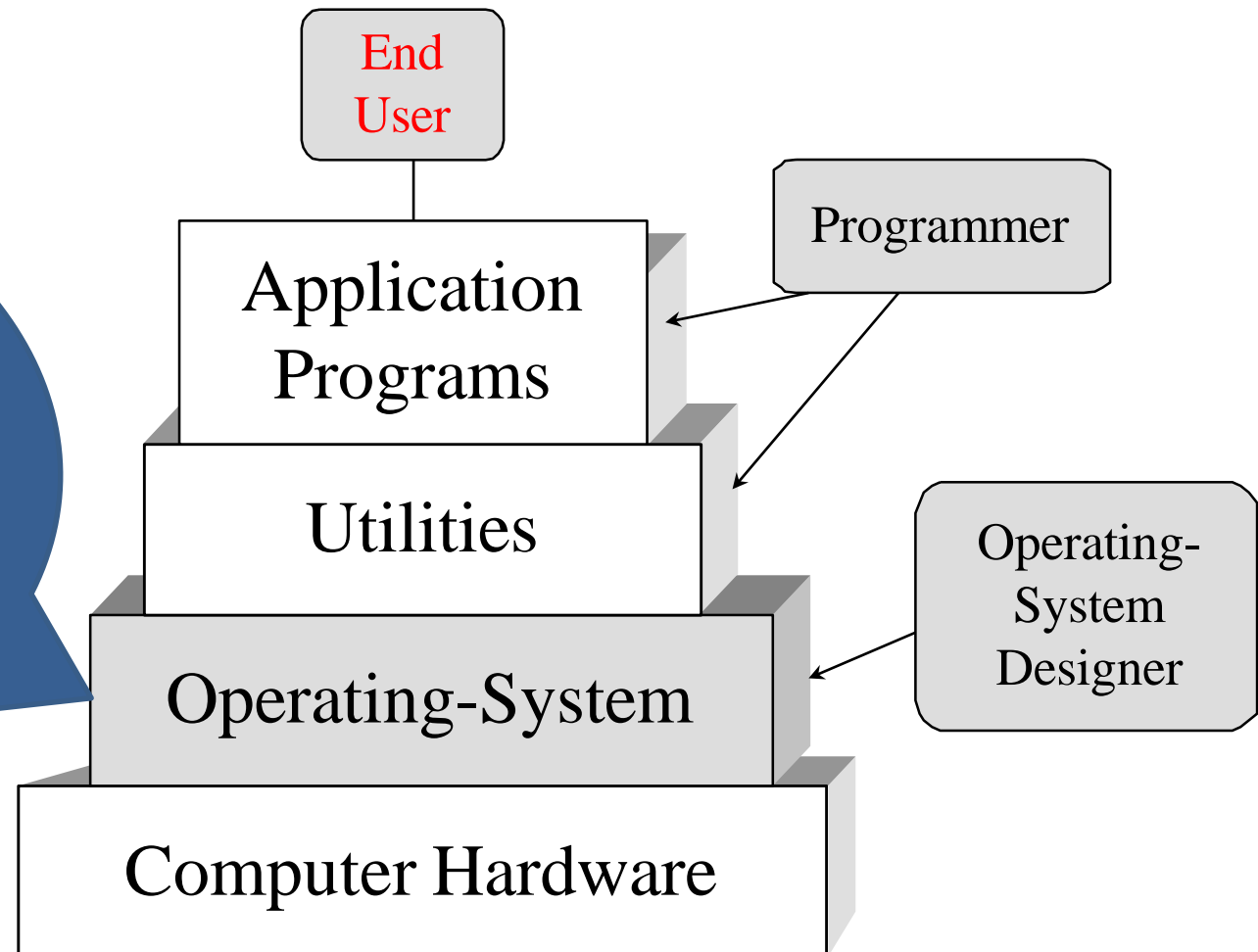
When application is running it can invoke the utilities to perform certain functions.



OS as a User/Computer Interface



OS is made up of most important collection of system programs
OS act as mediator.
Make easier for the **Programmer** and **application program** to access the facilities and services of OS.



OS as a Resource manager (OS from system view)

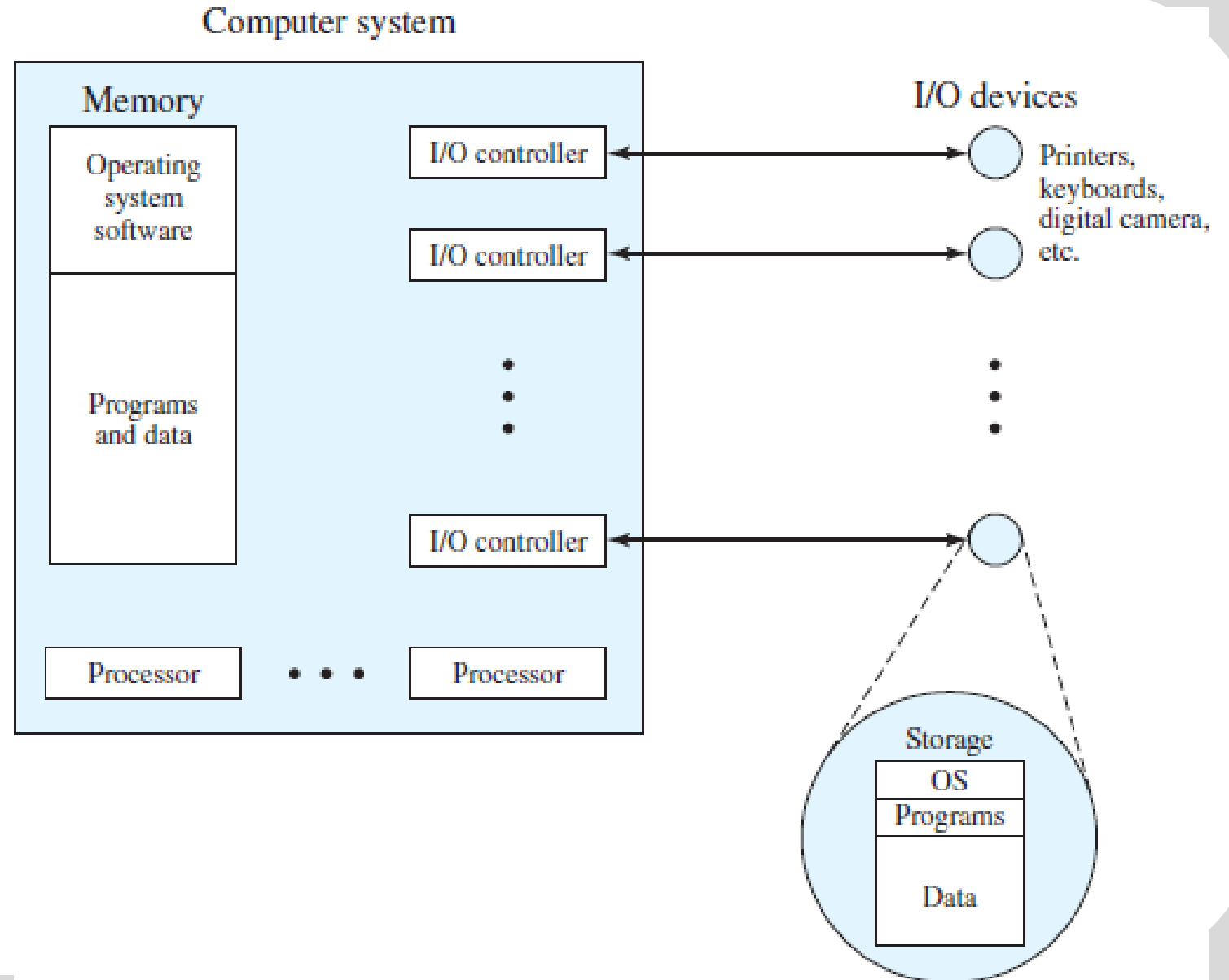
- ❑ A computer is a set of resources which perform the function such as store, process and transfer the data.
- ❑ If a computer system is used by multiple application(or users), then they will compete for these resources.
- ❑ OS is responsible for managing the resources to control these functions.

OS as a Resource manager



- Some portion of the OS is loaded in the main memory other part of the main memory may contain the user programs and data.
- Allocation of resources is controlled jointly by OS and processor(I/O controller).
- OS decides:
 - When I/O device can be used by a program in execution
 - When program can access the files.
 - How much processor time to be devoted to particular process/program.

OS as a Resource manager



Goals/objective of OS

A vertical diagram consisting of four light beige circles connected by a dark blue line. Each circle is positioned to the left of a dark blue horizontal bar containing white text. The top circle has a short diagonal line extending from its top-left edge, and the bottom circle has a short diagonal line extending from its bottom-left edge.

Control/execute user/application programs.

Make the computer system convenient to use.

Ease the solving of user problems.

Use the computer hardware in an efficient manner.

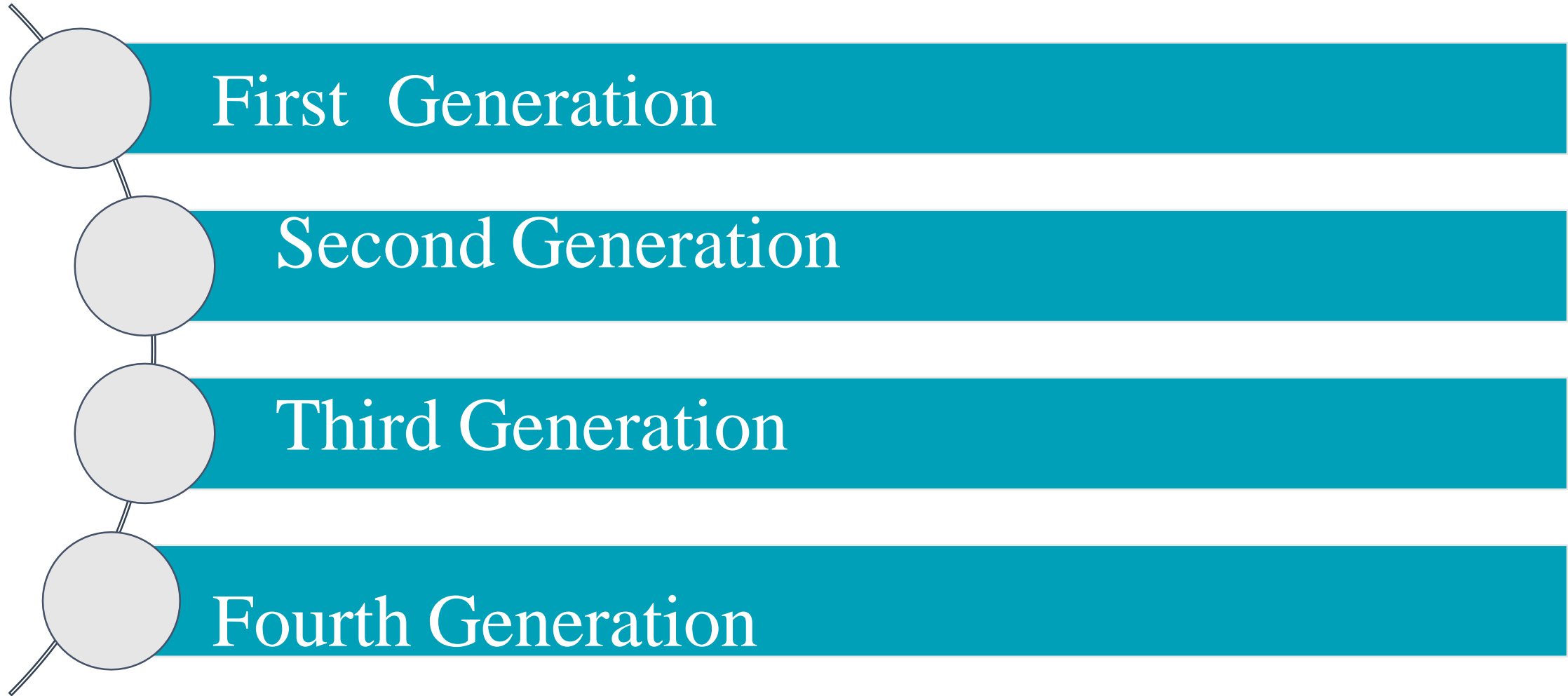


❖ Generations of Operating System

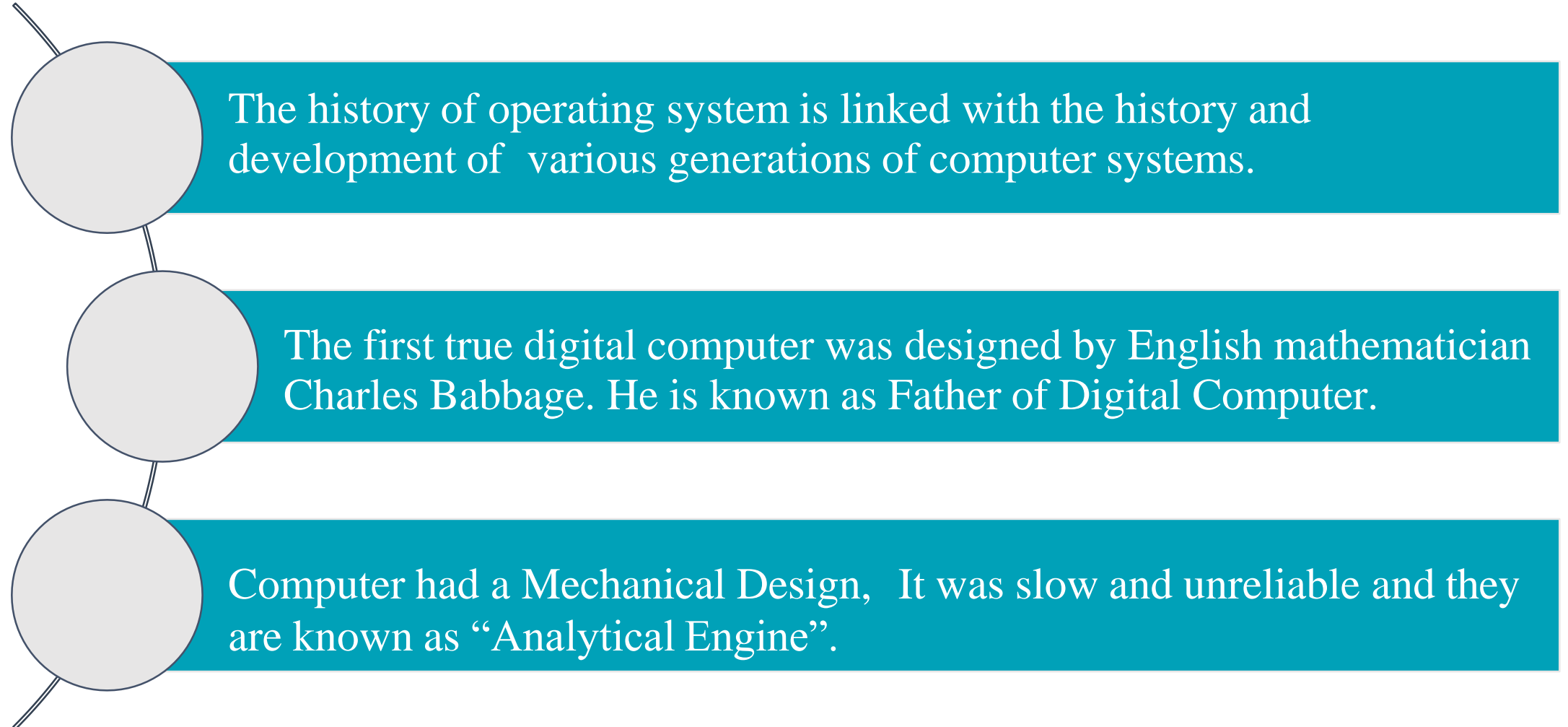
Generations of Operating systems



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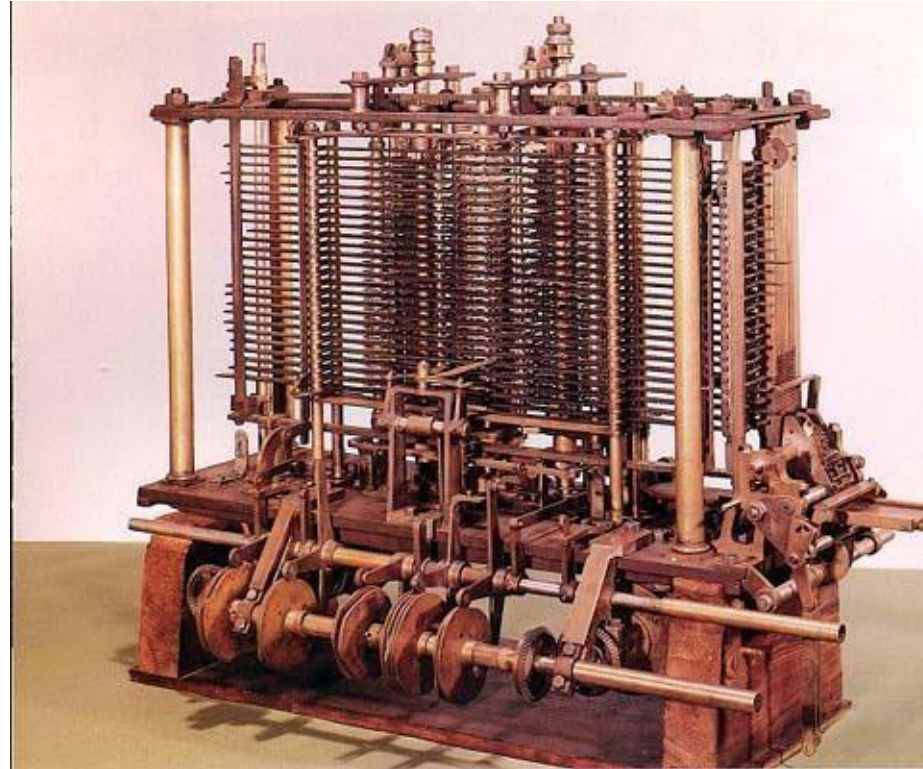
Zero generation



Zero generation



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Babbage's analytical engine

First Generation (1945-1955)

- Technology : Vacuum Tubes
- Operating System : Not present
- Language : Machine language

First generation



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Mechanical
Components are
replaced by Electronic
Components (Vacuum
Tubes)

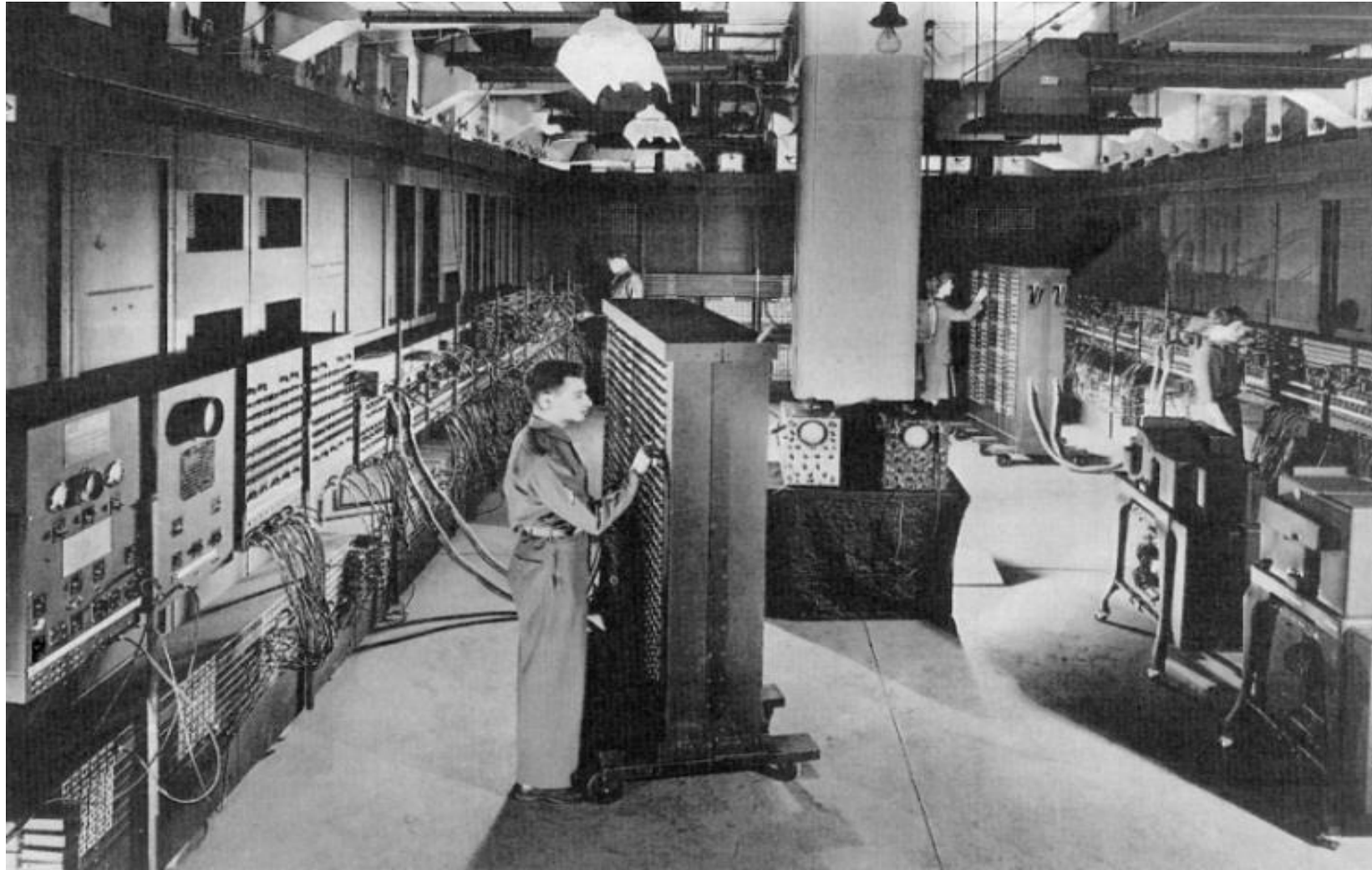


Vacuum Tubes

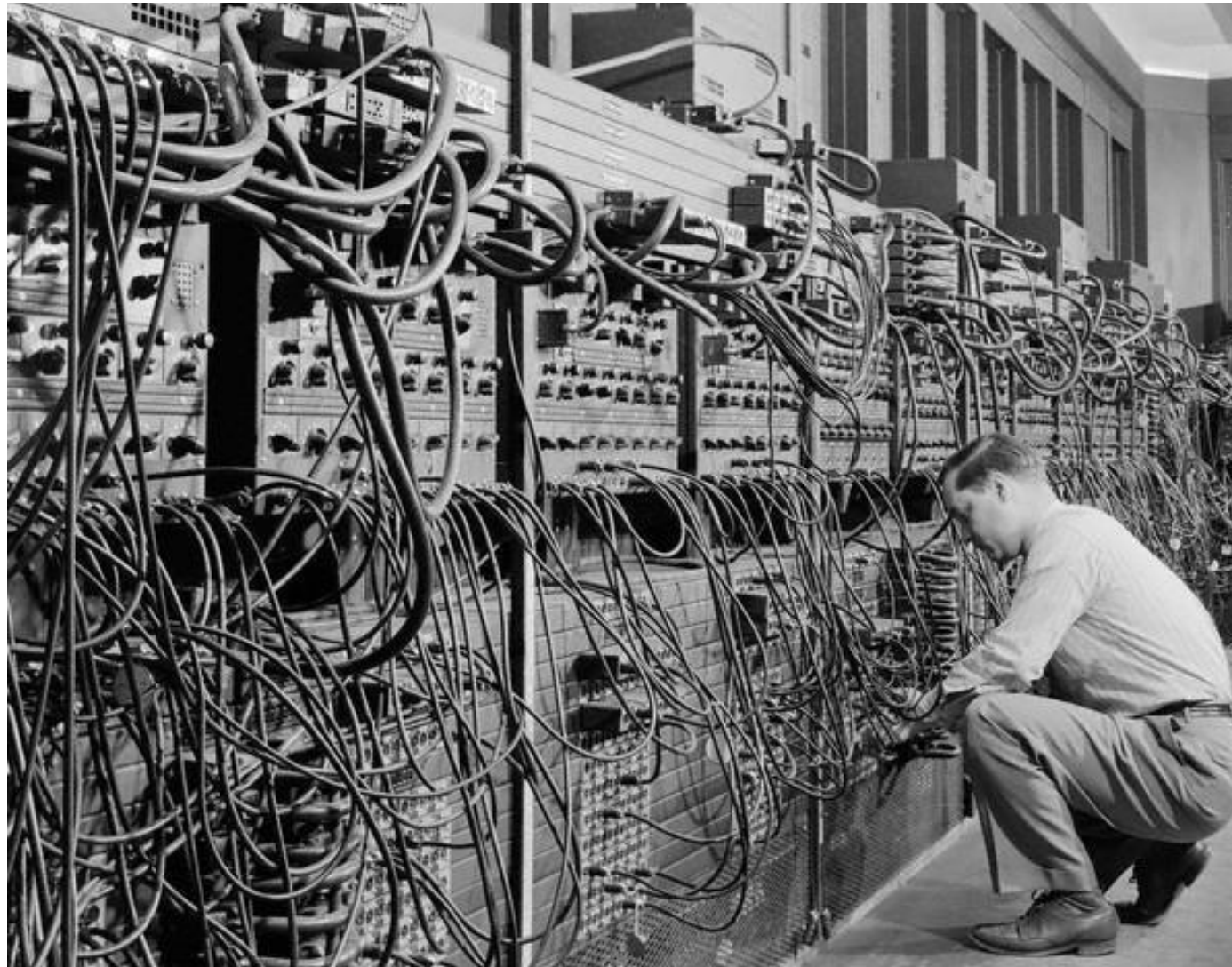
First generation



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First Generation Computers



coding by cable connections (plug board)

punch card

FREE PUNCH CARDS!



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Working

- Computer run one job at time. Programmers have to enter the plug board or punch card into the computer, run it, record the result. (might require rewiring!).

Problem

- lots of wasted computer time!
- CPU was idle during first and last steps
- Computers were *very* expensive!

Features of First Generation Computers

- They used vacuum tubes as main electronic component.
- They were large in size, slow in processing and had small storage capacity.
- They consumed lots of electricity and produced excessive heat.
- They were less reliable than later generation computers
- They used machine level language for programming

Second Generation (1955-65)

- Technology : Transistors
- Operating system : Present
- Language : Assembly and High level language

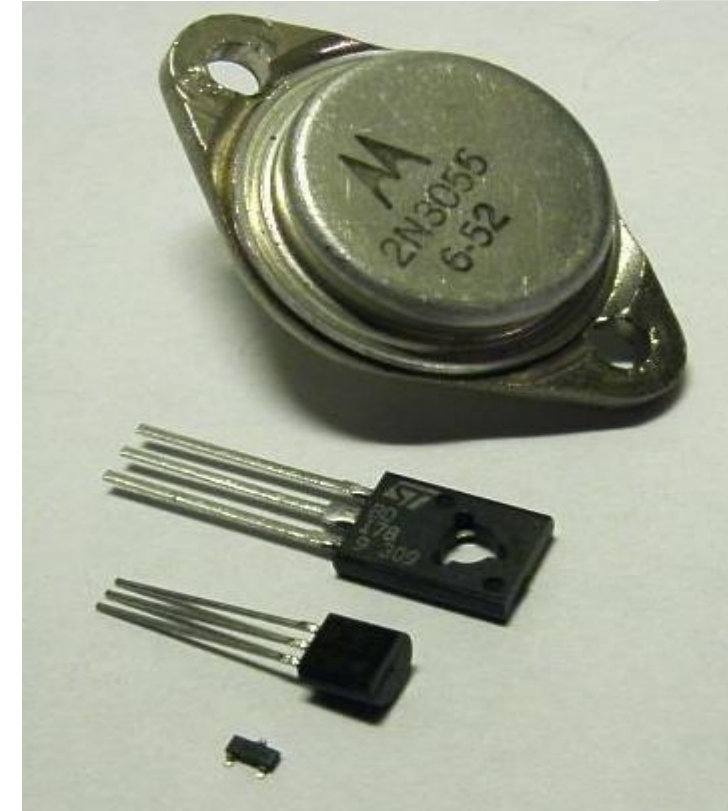
Second generation



Around 1955, Transistors were introduced.

Operating systems were designed which is known as FMS (Fortran Monitor System) and IBMSYS.

Used assembly language. Used FORTRAN as high level language.

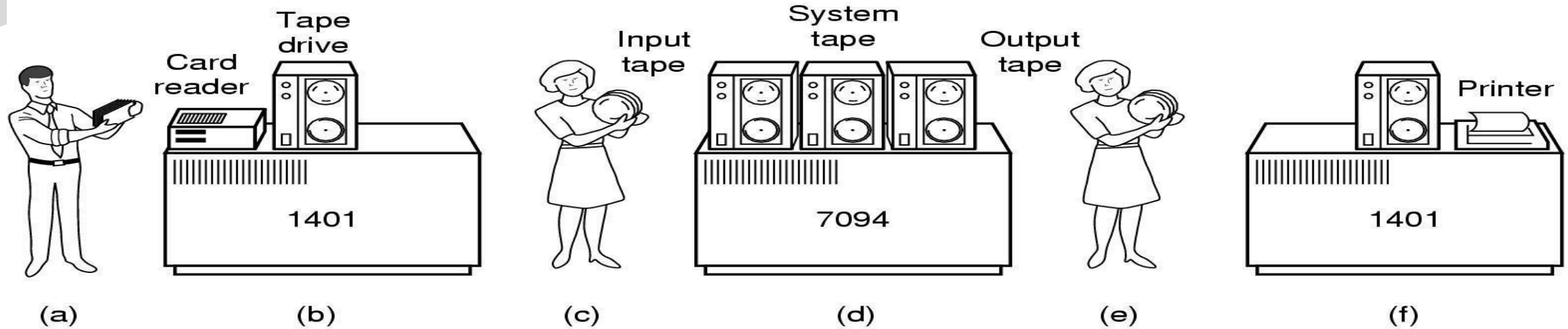


Transistors

Batch system

- To reduce the time new methodology is adopted know as batch system.
- To execute the program two commuters were used IBM 1401 for reading cards, copying tapes, and printing output, and IBM 7094 for real computing (numerical calculation).

Second generation



Batch system: Working

- Collect a tray full of jobs and read them onto magnetic tape using small computer such as IBM 1401.
- Then magnetic tapes are mounted on a tape drive., operator load special program which read the first job from tape and run it.
- Output was written onto second tape, after each job finished, the OS automatically read next job from the tape.
- Output tape inserted into IBM 1401 for printing.

Second generation



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Second Generation Computers

Second generation

Advantage:

- Able to compute scientific and engineering calculations.
- Cost and Size of a Computer is reduced.
- Programmers job was simplified.

Features of Second Generation Computers

- Second generation computers used transistors as their main electronic component.
- These computers were much smaller, reliable and more powerful
- Apart from machine language, assembly language were developed and used in this generation
- Some high level languages like COBOL & FORTRAN were introduced towards the end of second generation
- Printers, tape storage, disk storage, memory were started from second generation of computers
- Processing speed improved to microseconds

Third Generation(1965-80)

- Technology : Integrated Circuits
- Operating Systems : Present
- Language : High level language



Third Generation Computers

Need of third generation computers:

- Developing and maintaining two completely different computers (IBM 1401 and IBM 7094) was *expensive*.
- Bigger companies wanted machines that can run their programs *faster*.
- IBM solved both the problem by introducing System/360.

Third generation



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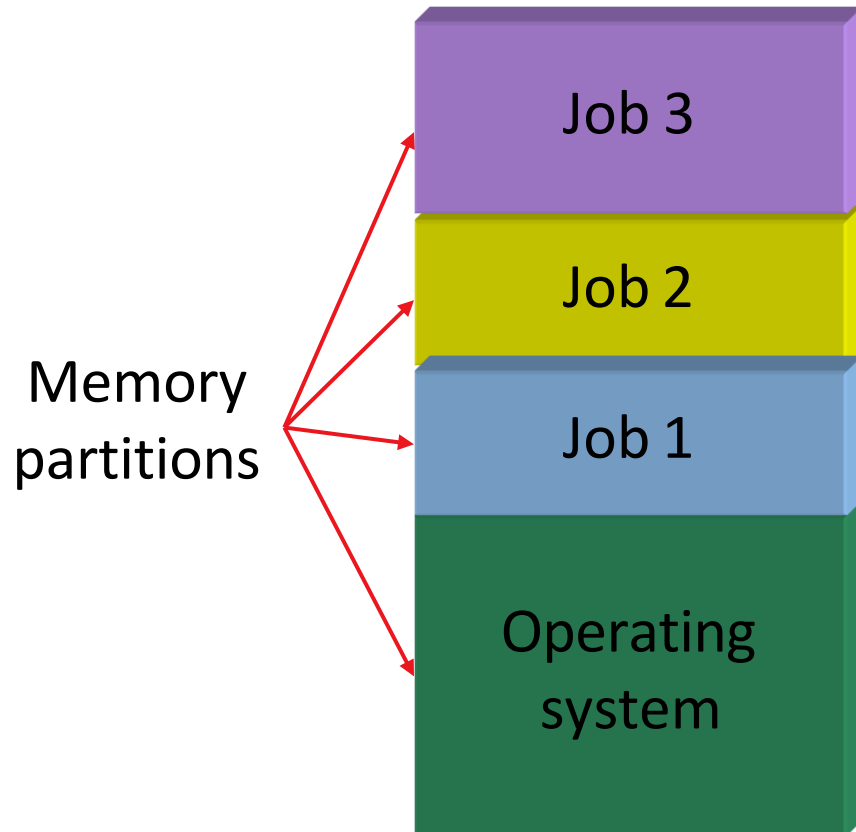


System/360

Need of third generation computers:

- 2nd generation computer when current job paused to wait for I/O or tape then CPU simply set idle until the I/O finished.
- Thus some thing had to be done to avoid having CPU idle so much.
- The solution was multiprogramming.

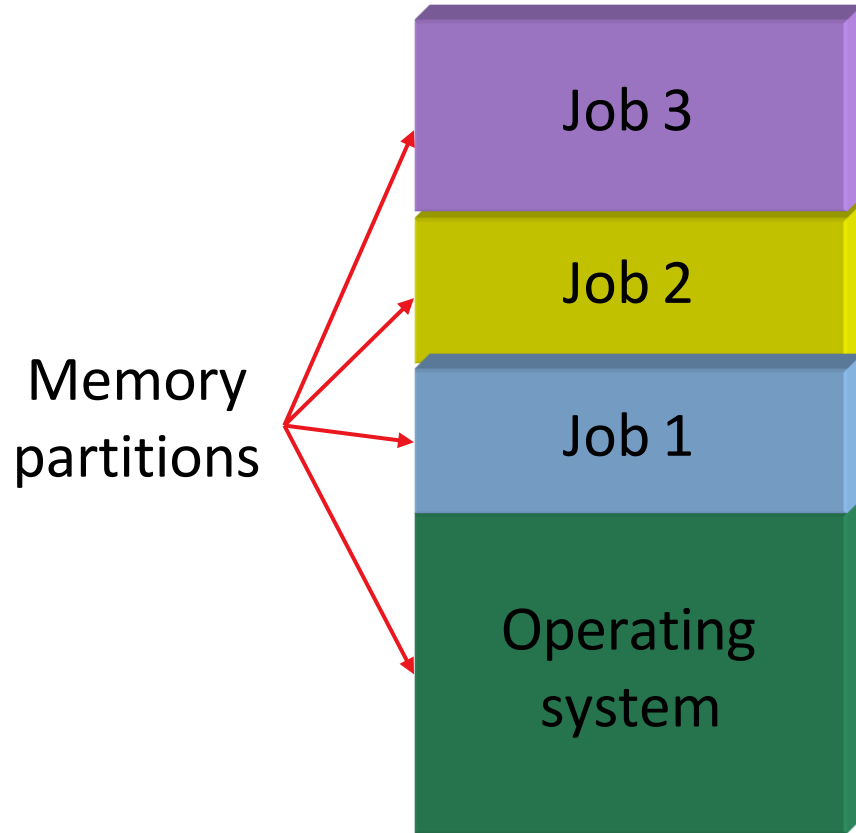
Third generation



Multiprogramming

- Partition the memory into several pieces with different job in each partition.
- While one job was waiting for I/O to complete, another job could use CPU.
- whenever running job finished, the OS load new job from the disk into the empty partition of memory. This is know as SPOOLING (Simultaneous Peripheral Operation On Line).

Third generation



- Still not interactive
 - User submit job.
 - Computer runs it.
 - User gets results after few minutes (hours, days) later.

Timesharing

- Timesharing system is interactive.
- First general purpose time sharing system is CTSS (Compatible Time Sharing System).
- After the success of CTSS system, M.I.T , Bell labs and general Electrical decide to develop “computer utility”, a machine that supports hundreds of simultaneous time sharing users. This machine known as MULTICS (MULTiplexed Information and Computing Services).

Third generation



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Another major development during
the third generation was the
minicomputers.

Characteristics of Third Generation Computer

- Third Generation Computers were based on integrated circuit (IC) technology.
- Third Generation Computers were able to reduce computational time from microseconds to nanoseconds
- Third Generation Computers utilized operating systems to centrally control and made it *possible for multiple programs* to run on a computer
- *Users interacted* with computers through keyboards and mouse rather than traditional punched cards and printers.

Characteristics of Third Generation Computer

- Third Generation Computers devices *consumed less power and generated less heat*. In some cases, air conditioning was still required.
- The size of Third Generation Computers was smaller as compared to previous computers

Fourth Generation(1980-90)

- Technology : LSI
- Operating systems : Present
- Language : High level language

Fourth generation



Large Scale Integrated Circuits (LSIC's) were introduced.

Intel came out with 8080, first microcomputer with a disk.

Kindall wrote disk based OS called CP/M (Control Program for Microcomputers).

Tim Paterson had developed OS know as Disk Operating System (DOS). Microsoft revised system and was known as MS-DOS.



LSIC

Fourth generation

A vertical timeline diagram on the left side of the slide. It consists of four light gray circles connected by a thin black line. The line starts at the top circle, goes down, then turns right to connect to the second circle, then down again to the third, and finally down to the fourth. The circles are positioned to the left of the text boxes.

Later on around 1960, Engelbart invented GUI (Graphical User Interface) with windows icons, menus, and mouse.

One day Steve Jobs co-founder of apple saw GUI and instantly realized its potential value. Job then embark on building Apple with GUI. This project leads to Lisa, which was too expensive and failed commercially.

Job second attempt was Apple Macintosh, was huge success because its more user friendly and less expensive.

For about 10 years 1985 to 1995 , Windows was just graphical environment on top of MS-DOS.

Fourth generation



Then in 1995 slightly modified version released windows 95, that incorporated many OS features.

Then slightly changed version released know as windows 98. both 95 and 98 are 16-bit intel assembly language.

Another Microsoft OS is windows NT (New Technology), its 32-bit system.

Version 5 of Windows NT is renamed as Windows 2000.

Fourth generation

A vertical timeline diagram consisting of three light gray circles connected by a thin line. Each circle is positioned to the left of a dark blue rectangular text box.

Another version of win 98 is windows ME (Millennium Edition).

In 2001 slightly upgraded version of windows 2000 known as windows XP was released.

Then in January 2007, Microsoft finally released the successor to win XP known as Vista. It came with new GUI , Aero, many upgraded user program.

Fourth generation



An interesting development that began taking place during mid- 1980s is the growth of networks of personal computer running *network OS* and *distributed OS*

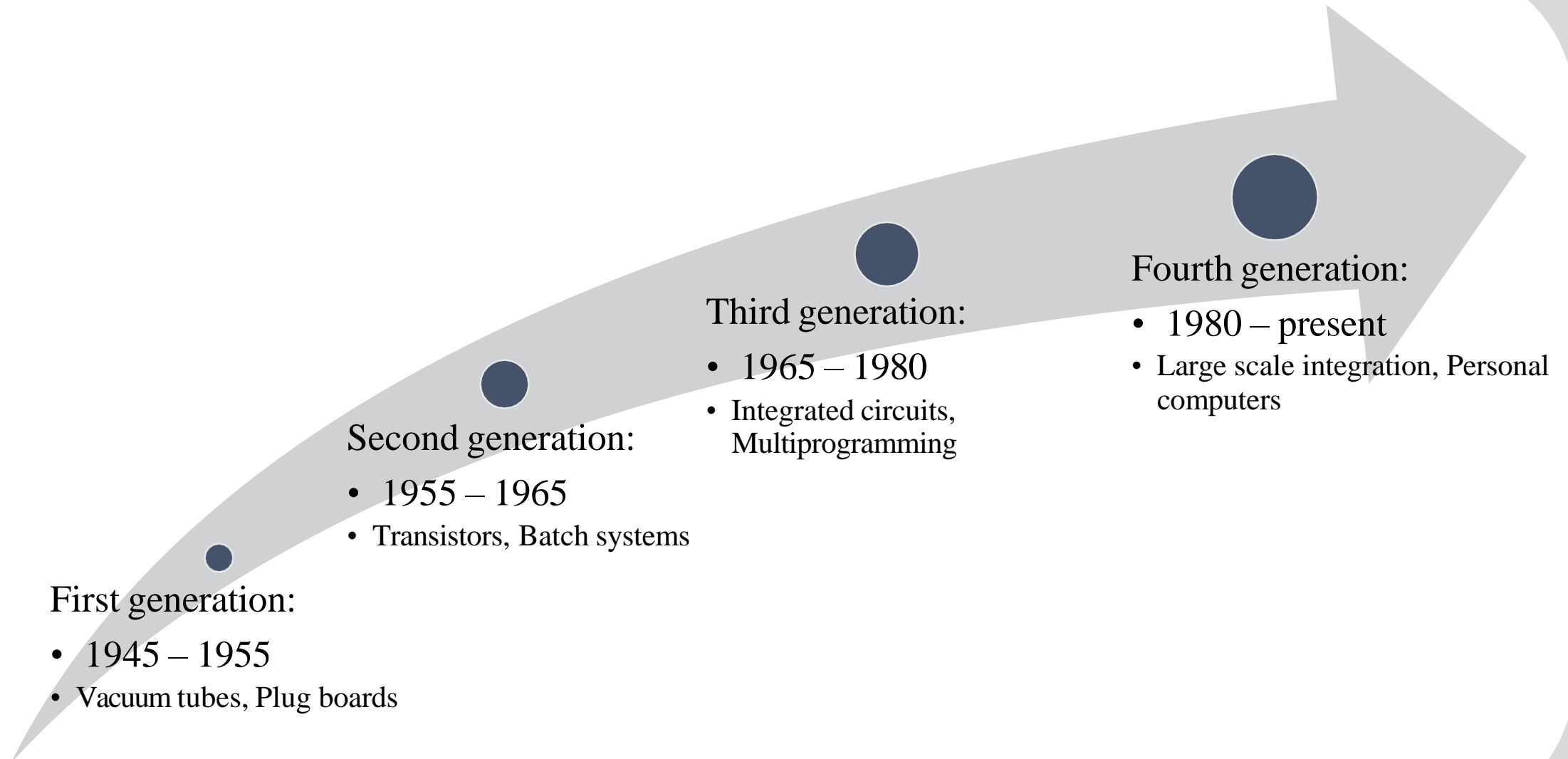
in NOS users are aware about existence of multiple users and can log into remote machine and copy files.

In contrast DOS is one that appears to its user as tradition uniprocessor system.

Generations of Operating systems: Summary



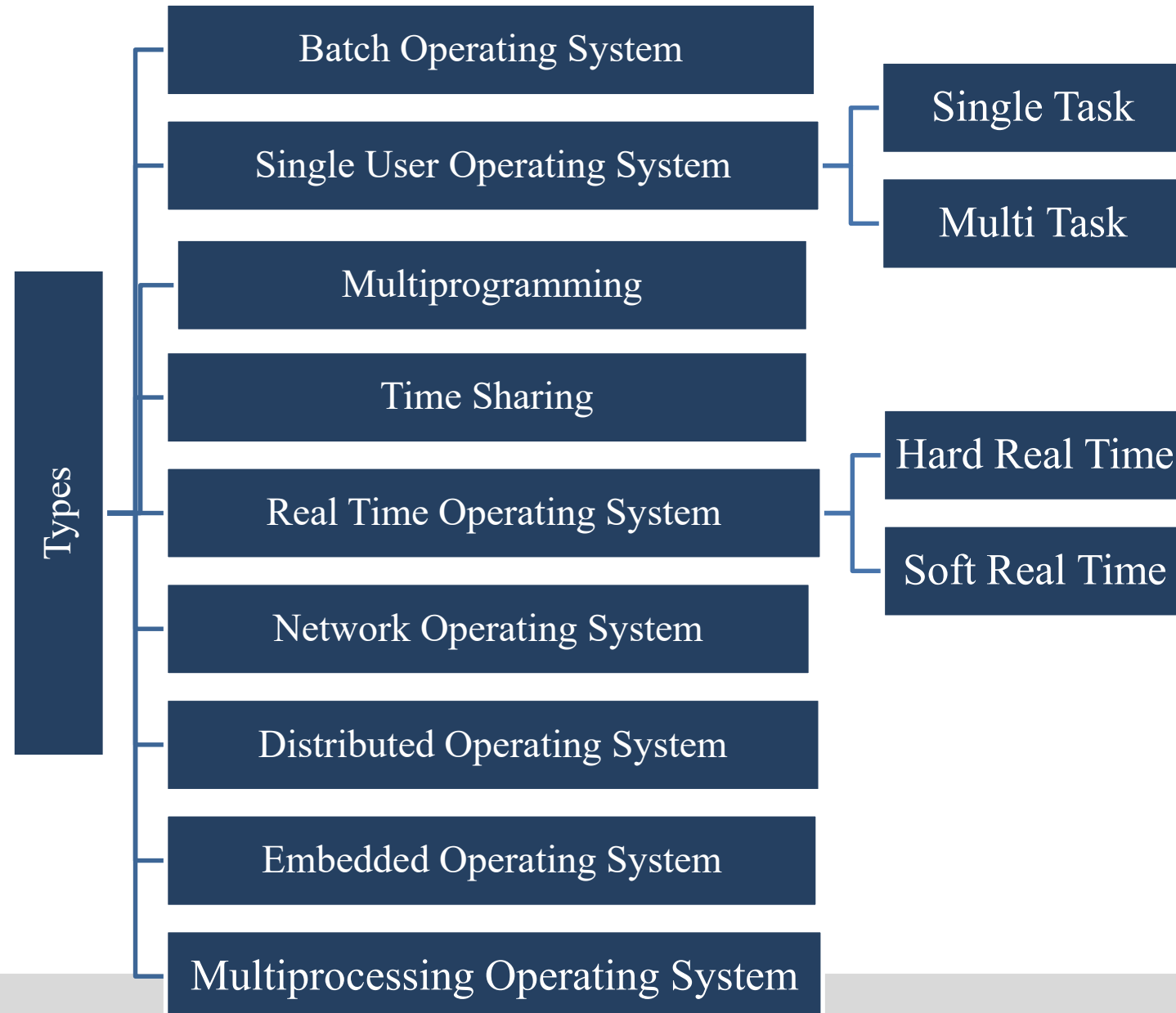
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❖ Types of Operating System

Types of Operating Systems



1. Batch Operating Systems



- In the past (1955 - 1965), computer users couldn't directly interact with the system. They relied on batch operating systems where instructions (jobs) were prepared offline using punch cards and submitted to the operator. These punch card jobs were grouped and processed together for efficiency.
- A batch is sequence of user jobs.

Batch processing

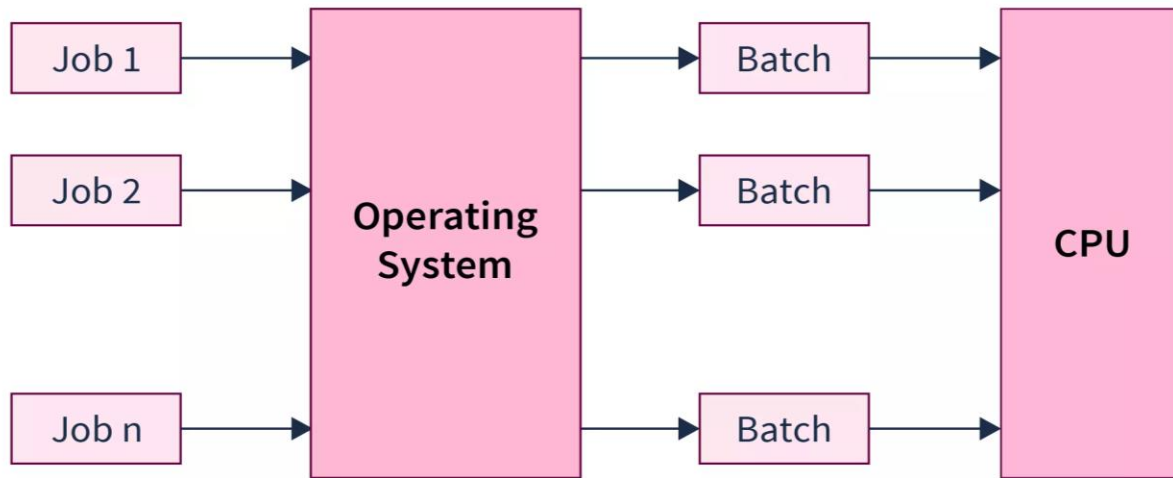


Fig. Similar jobs are organized into batch

Working:

In this operating system technique, the jobs which had similar requirements were batched together for execution, so the same jobs in the batch were executed at a higher speed. As the jobs were scheduled one after the other, whenever a job gets completed, the next job from the job spool gets executed without any user interaction.

Disadvantages

- We could not set the priority of the jobs as jobs were scheduled only based on similarities.
- The CPU was not utilized to its maximum potential as the CPU became idle (when the operator was loading jobs).

2.Single User Operating Systems



Types of Single User OS



- A single-user operating system is a type of operating system developed and intended for use on a computer or similar machine that will only have a single user at any given time.

Two types:

- *Single user, single tasking*: allows only single user to execute one program at a time.
- *Single user, multi tasking*: allows a single user to operate multiple program at a time.

Single User Single Tasking



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In the Single-User Single-Tasking operating system, only one user is permitted for performing a single task at a time. Some functions such as printing a document and downloading images and videos are performed in one given frame.

- This operating system occupies less space in memory.
- It is cost-effective.

Example: MS-DOS, Palm OS.

Single User Multi –Tasking or Time Sharing



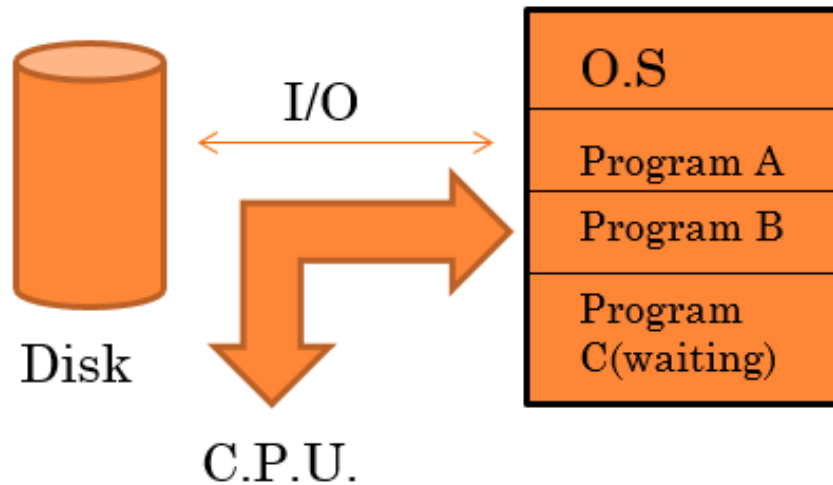
Single-User Multi-Tasking operating system is developed especially for one user, but this single user can perform multiple tasks simultaneously. For example, you can write any text while surfing the internet, downloading images, watching movies, etc. It has the following advantages:

- Time-saving.
- High productivity in less time frame.
- Less memory is used for performing multiple tasks.
- Example: Windows, Linux, Mac O/S

3. Multi-Programming Operating Systems



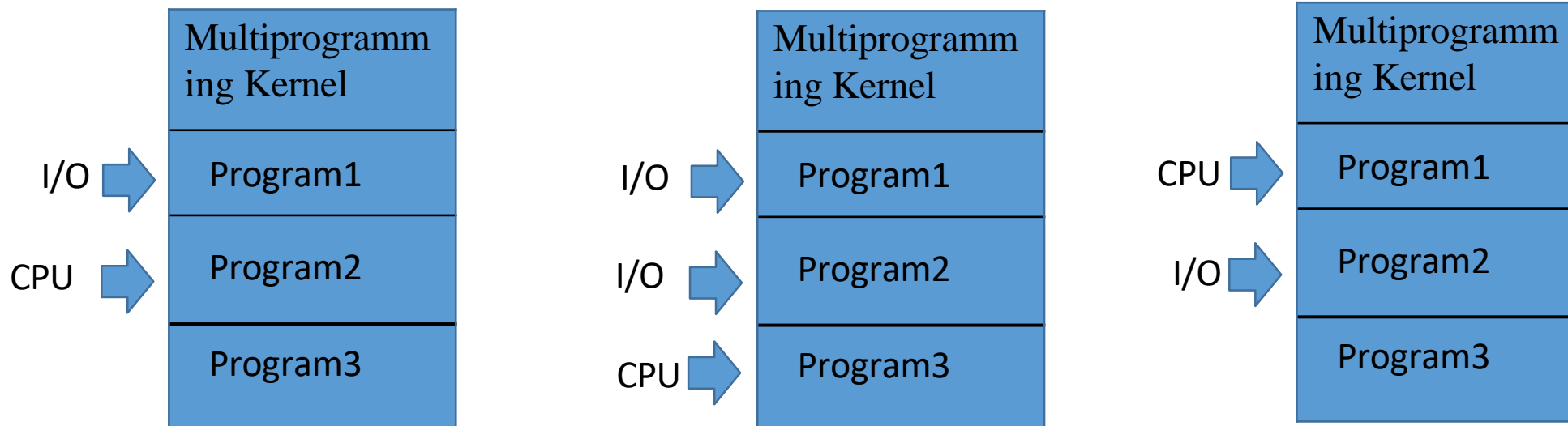
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Multiprogramming refers to execution of two or more different and independent programs by the same C.P.U. In this two or more programs reside in main memory and are executed concurrently.

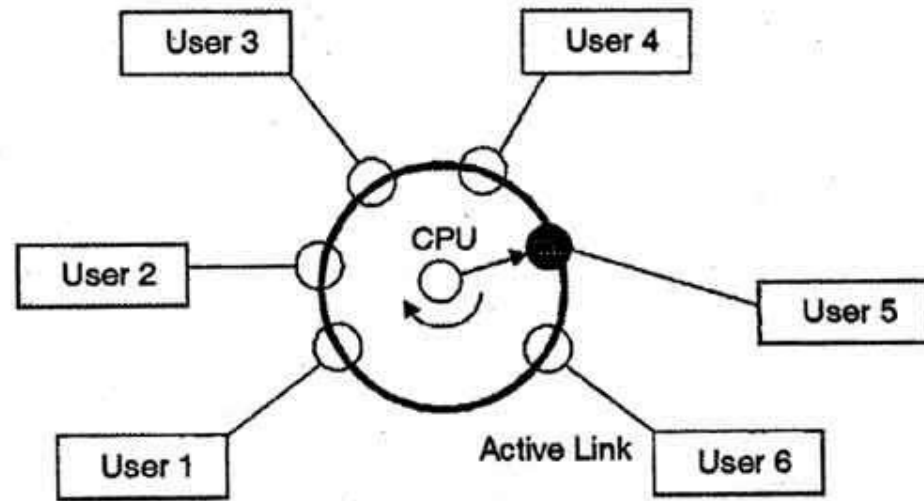
Multi-Programming Operating Systems

Example: When running program request for the I/O operation, then the CPU will be free thus CPU can be allocated to other program.



- **Advantage**
- It allows *multiple user* to execute *multiple programs* using single CPU.
- In this system collection of job is maintained on the disk, and subset of them is kept in the main memory.
- These job can be execute simultaneously using *time-multiplexed CPU*.

4. Time Sharing/Multi Tasking



In above figure the user 5 is active but user 1, user 2, user 3, and user 4 are in waiting state whereas user 6 is in ready status.

As soon as the time slice of user 5 is completed, the control moves on to the next ready user i.e. user 6.

- A time sharing system allows many users to share the computer resources simultaneously. In other words, time sharing refers to the allocation of computer resources in time slots to several programs simultaneously.
- For example a **mainframe computer** that has many users logged on to it. Each user uses the resources of the mainframe -i.e. memory, CPU etc. The users feel that they are exclusive user of the CPU, even though this is not possible with one CPU i.e. shared among different users.

Time Sharing/Multi Tasking

- Time sharing kernel uses the *interval timer* to implement time slicing.
- Time sharing OS uses *round-robin scheduling* with time slicing.
- Features of Time-sharing OS:
 - Several jobs are kept in the main memory so memory management is required.
 - Memory is limited thus swapping is used.
 - CPU scheduling must be fair for all the process.
 - Examples of Time-Sharing OSs are: Multics, Unix, etc.

Time Sharing/Multi Tasking

Advantages of Time-Sharing OS:

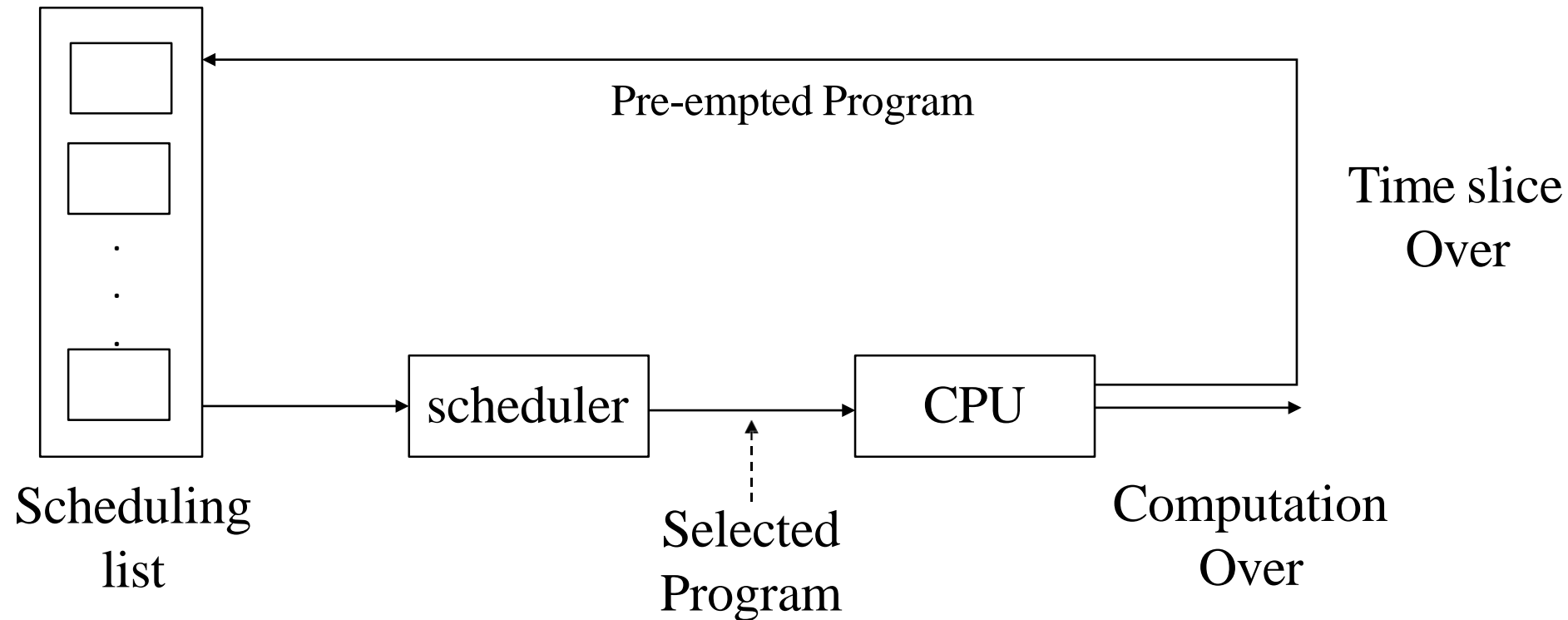
- Each task gets an equal opportunity
- Fewer chances of duplication of software
- CPU idle time can be reduced

Disadvantages of Time-Sharing OS:

- Reliability problem
- One must have to take care of the security and integrity of user programs and data
- Data communication problem

Time Sharing/Multi Tasking

- Here CPU is multiplexed by time among several job that are kept in main memory.
- Time Slice: largest amount of CPU time program can execute on CPU.



5.Real-Time Operating Systems

- A system is said to be Real Time if it is required to complete it's work & deliver it's services on time.
- A real time OS defines the completion of job within the *rigid time constraints* otherwise job loses its meaning.
- Example – Flight Control System, Air line reservation system.
 - All tasks in that system must execute on time.

Two types:

Hard Real time :

- It ensures the completion of critical tasks within the well defined constraints.
- It can not afford missing even a single deadline, single miss can lead to the critical failure.
- Example: Flight controller system, Medical Critical Care System\

Soft Real Time

- Late completion of jobs is undesirable but not fatal(does not leads to any critical failure) .
- System performance degrades as more & more jobs miss deadlines.
- Example: Online Transactions, DVD player cannot process a frame, Stock price Quotation System.

6. Network Operating Systems

Network OS is used in computer networks that allow same data and applications to be accessed by multiple users at the same time . The users can also communicate with each other.

- NOS runs on a server and provides the server the capability to manage data,users,groups,security,applications and other networking functions.
- The primary purpose of the NOS is to allow shared file and printer access among multiple computers in a network typically a local area network(LAN) ,a private network or other networks.

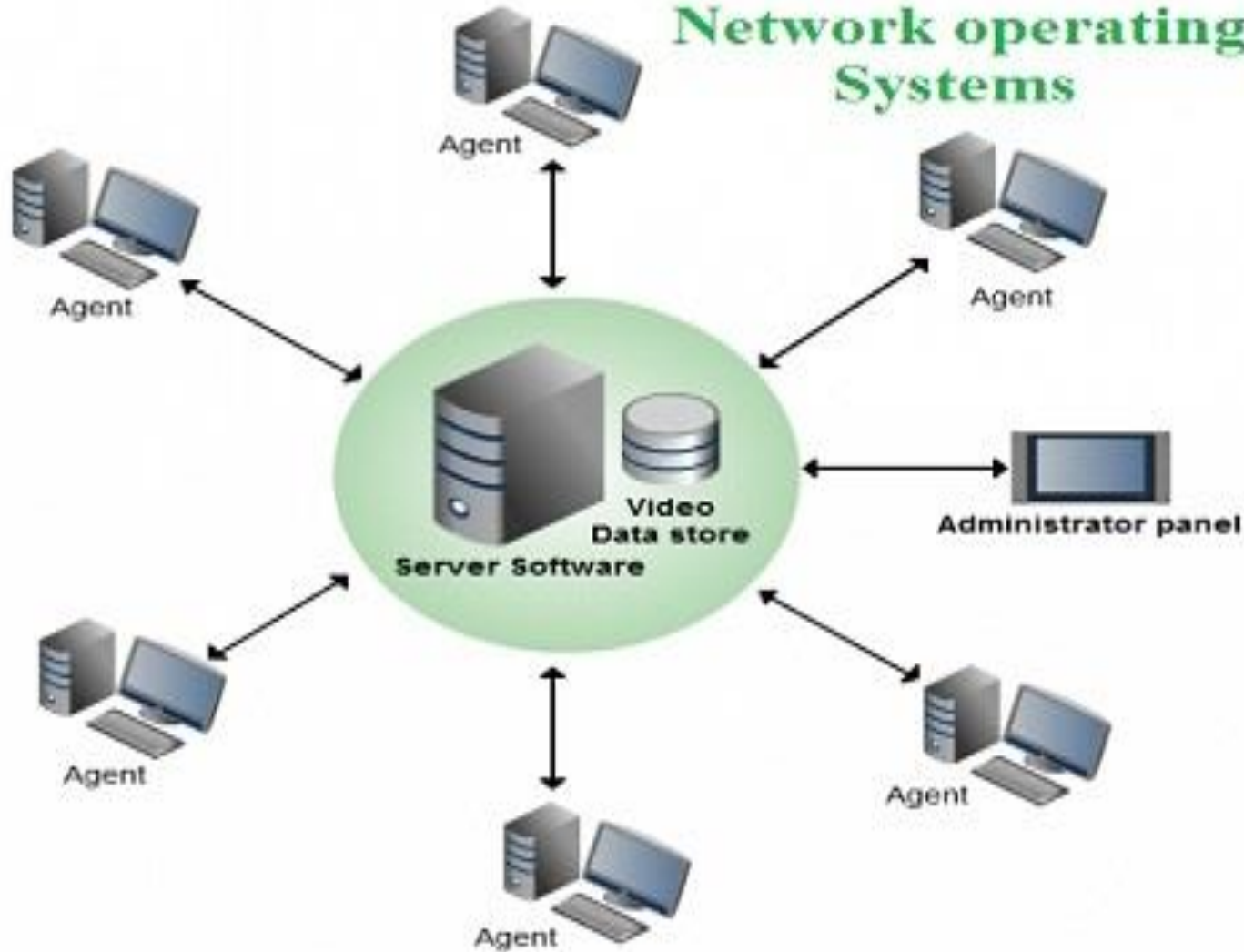
Examples of Network Operating Systems are Microsoft Windows Server 2003, Microsoft Windows Server 2008, UNIX, Linux, Mac OS X, Novell NetWare, BSD, etc.

Advantages of Network Operating System

- Highly stable centralized servers.
- Security concerns are handled through servers.
- New technologies and hardware up-gradation are easily integrated into the system.
- Server access is possible remotely from different locations and types of systems.

Network Operating Systems

Network operating Systems



Some important disadvantages of Network Operating System are:

- Single dependence on the central server.
- The server is very costly.
- Maintenance and updates are required time and again.

7.Distributed Operating Systems

Distributed System , in which whole operating system is not installed on single **machine**, it is divided into parts, and these parts are loaded on different machines. Users are not aware that on which machines their programs are run and where their files are storing. All this handled by Distributed Operating System.

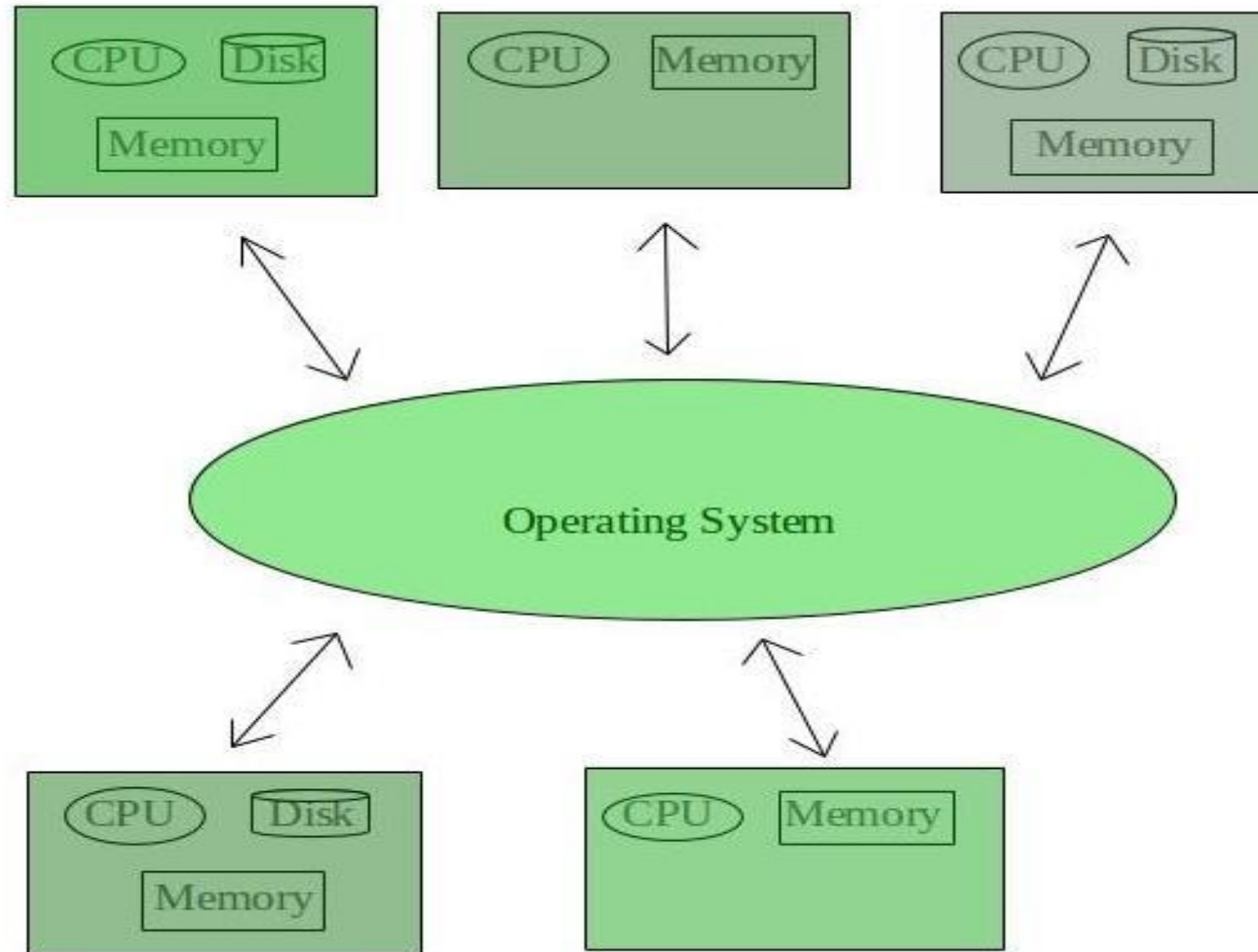
In Distributed operating system, it allow programs and processes to run on several CPUs at the same time, so it require complex processor scheduling.

Example: Cloud Computing

Distributed Operating Systems

- It consist of several individual computer system connected through network.
- A distributed system is system consisting of two or more nodes, where each node is computer system with its own memory, some network hardware, and able to compute some control function.
- It may connect devices such as memories, CPU and I/O devices.
- Examples of Distributed Operating System are- LOCUS, etc.

Distributed Operating Systems



Advantages of Distributed Operating System:

- Failure of one will not affect the other network communication, as all systems are independent from each other
- Electronic mail increases the data exchange speed
- Since resources are being shared, computation is highly fast and durable
- Load on host computer reduces
- These systems are easily scalable as many systems can be easily added to the network
- Delay in data processing reduces

Disadvantages of Distributed Operating System:

- Failure of the main network will stop the entire communication
- To establish distributed systems the language which is used are not well defined yet
- These types of systems are not readily available as they are very expensive. Not only that the underlying software is highly complex and not understood well yet

8.Embedded Operating Systems

Embedded OS is embedded in a device in the ROM. They are specific to a device and are less resource intensive.

The main goal of designing an embedded operating system is to perform specified tasks for non-computer devices. It allows the executing programming codes that deliver access to devices to complete their jobs.

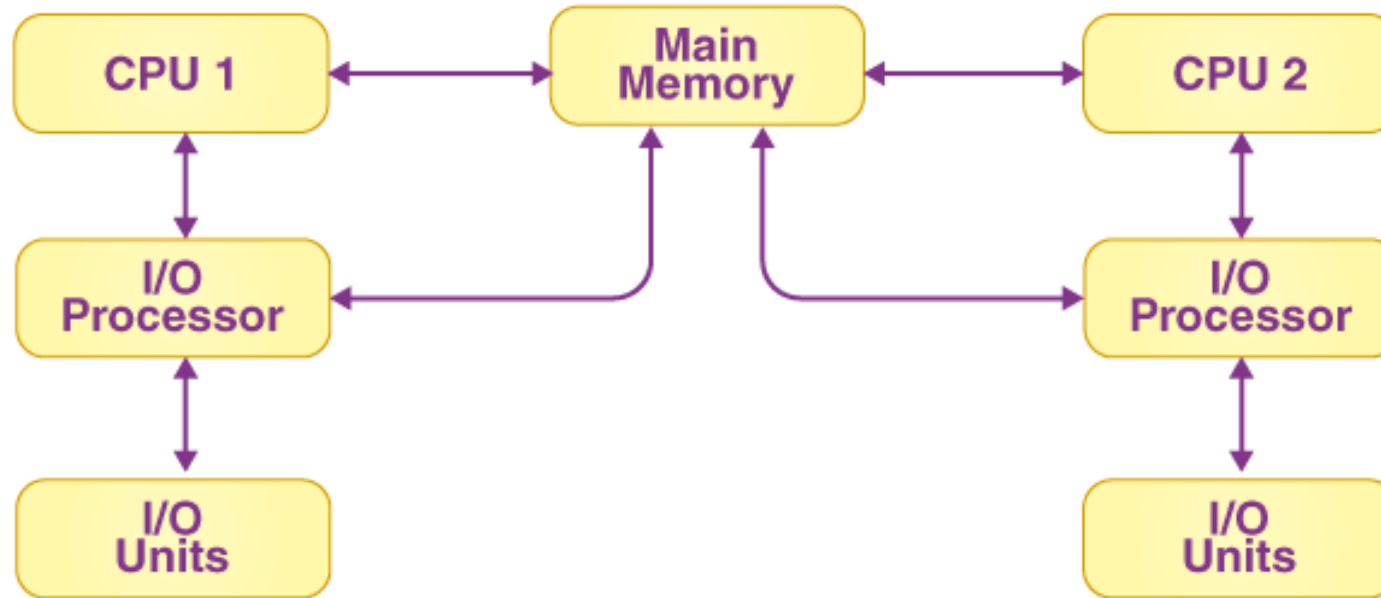
They are used in appliances like microwaves, washing machines, traffic control systems, Parking Metering, Car navigation system etc.

9. Multiprocessing Operating Systems

Multiprocessing OS have two or more processors for a single running process. Processing takes place in parallel and is also called *parallel processing*. *Each processor* works on different parts of the same task, or, on two or more different tasks. Since execution takes place in parallel, they are used for high speed execution, and to increase the power of computer.

Linux, UNIX and Windows 7 are examples of multiprocessing OS.

Multiprocessing Operating Systems



Working of Multiprocessor System

Multiprocessing Operating Systems

Working:

Multiprocessor operating systems are used in operating systems to boost the performance of multiple CPUs within a single computer system.

Multiple CPUs are linked together so that a job can be divided and executed more quickly. When a job is completed, the results from all CPUs are compiled to provide the final output. Jobs were required to share main memory, and they may often share other system resources.

Advantages:

- **Increased reliability:** Processing tasks can be spread among numerous processors in the multiprocessing system. This promotes reliability because if one processor fails, the task can be passed on to another.
- **Increased throughput:** More work could be done in less time as the number of processors increases.
- **The economy of scale:** Multiprocessor systems are less expensive than single-processor computers because they share peripherals, additional storage devices, and power sources.

Protection

- Protection tackles the system's internal threats. It provides a mechanism for controlling access to processes, programs, and user resources.
- In simple words, It specifies which files a specific user can access or view and modify to maintain the proper functioning of the system.
- It allows the safe sharing of common physical address space or common logical address space which means that multiple users can access the memory due to the physical address space.

Security

- Security tackles the system's external threats. The safety of their system resources such as saved data, disks, memory, etc. is secured by the security systems against harmful modifications, unauthorized access, and inconsistency.
- It provides a mechanism (encryption and authentication) to analyze the user before allowing access to the system.

Common Threats to Computer System



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- **Virus:** A computer virus is a form of malware, or malicious software, that transmits between computers and corrupts software and data. Generally, viruses are small pieces of code that are embedded in a system. They can corrupt files, erase data, crash systems, and other things, making them extremely dangerous. Also, they can expand by **replicating** themselves.
- **Trojan Horse:** A Trojan Horse Virus is a form of malware that downloads on a computer by impersonating a trustworthy program. A Trojan horse can get unauthorized access to a system's login information. A malicious user may then use them to enter the system.
- **Worm:** A computer worm is a sort of malware whose main purpose is to keep operating on infected systems while self-replicating and infecting other computers. By using a system's resources to extreme levels, a worm can completely destroy it. It has the ability to produce duplicate copies that occupy all available resources and prevent any other processes from using them.
- **Trap Door:** A trap door is basically a back door into software that anyone can use to access any system without having to follow the normal security access procedures. It may exist in a system without the user's knowledge. As they're so hard to detect, trap doors need programmers or developers to thoroughly examine all of the system's components in order to find them.
- **Denial of Service:** A Denial-of-Service (DoS) attack aims to shut down a computer system or network so that its intended users are unable to access it. These kinds of attacks prevent authorized users from accessing a system.

Methods to Ensure Protection and Security in Operating System



- **Keep a Data Backup:** It is a safe option in case of data corruption due to problems in protection and security, you can always require it from the Backup.
- **Beware of suspicious emails and links:** When we visit some malicious link over the internet, it can cause a serious issue by acquiring user access.
- **Secure Authentication and Authorization:** OS should provide secure authentication and authorization for access to resources and also users should keep the credentials safe to avoid illegal access to resources.
- **One Time Password:** These passwords provide a lot of security for authentication purposes. A one time password can be generated exclusively for a login every time a user wants to enter the system. It cannot be used more than once.
- **Use Secure Wi-Fi Only:** Sometimes using free wifi or insecure wifi may cause security issues, because attackers can transmit harmful programs over the network or record the activity etc, which could cause a big problem in the worst case.
- **Install anti-virus and malware protection:** It helps to remove and avoid viruses and malware from the system.
- **Manage access wisely:** The access should be provided to apps and software by thorough analysis because no software can harm our system until it acquires access. So, we can ensure to provide suitable access to software and we can always keep an eye on software to see what resources and access it is using.

Methods to Ensure Protection and Security in Operating System



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- **Firewalls Utilities:** It enables us to monitor and filter network traffic. We can use firewalls to ensure that only authorized users are allowed to access or transfer data.
- **Encryption and Decryption Based transfer:** The data content must be transferred according to an encryption algorithm that can only be reversed with the appropriate decryption key. This process protects your data from unauthorized access over the internet, also even if data is stolen it would always remain unreadable.
- **Be cautious when sharing personal information:** The personal information and credentials must be shared only with trusted and safe sources by not doing so attackers can use this information for their intent which could be harmful to the system's security.



Thank You