

CPE3201

Principles of Operating Systems

Dr. Pongrapee Kaewsaiha



What is an operating system

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An operating system (OS) is system software that manages hardware and resources, and provides common services for programs and applications.



Types of operating systems

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by functionalities

Batch OS

Time-sharing OS

Multi-programming OS

Network OS

Multi-processing OS

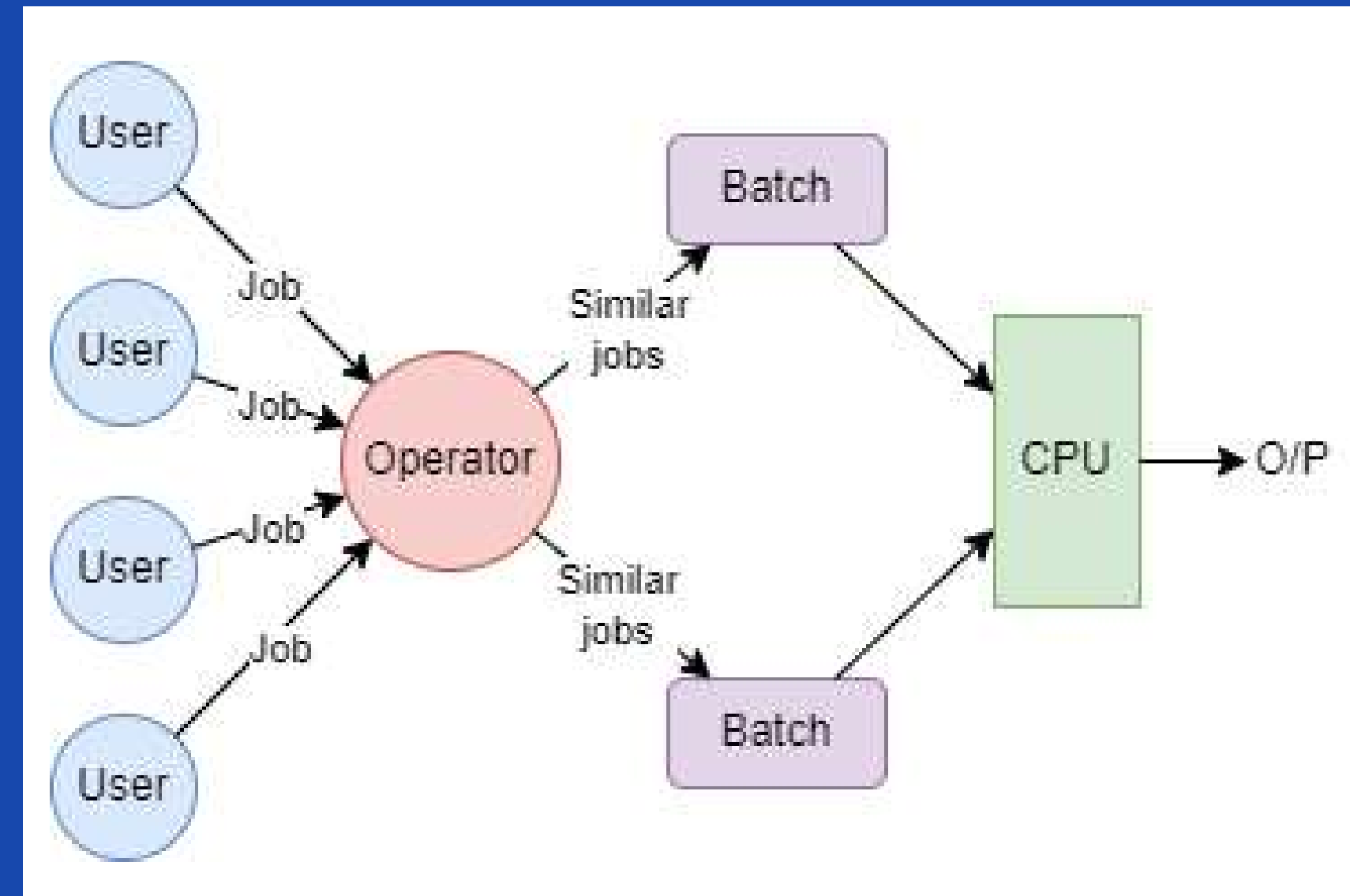
Distributed OS

Multi-tasking OS

Real-time OS

Batch OS

- Users prepare the jobs (elsewhere offline) and submits to the operator.
- Jobs often contain repetitive tasks, such as payroll and bank statement.
- The operator batched similar jobs together and run as a group.
- No real user interface.

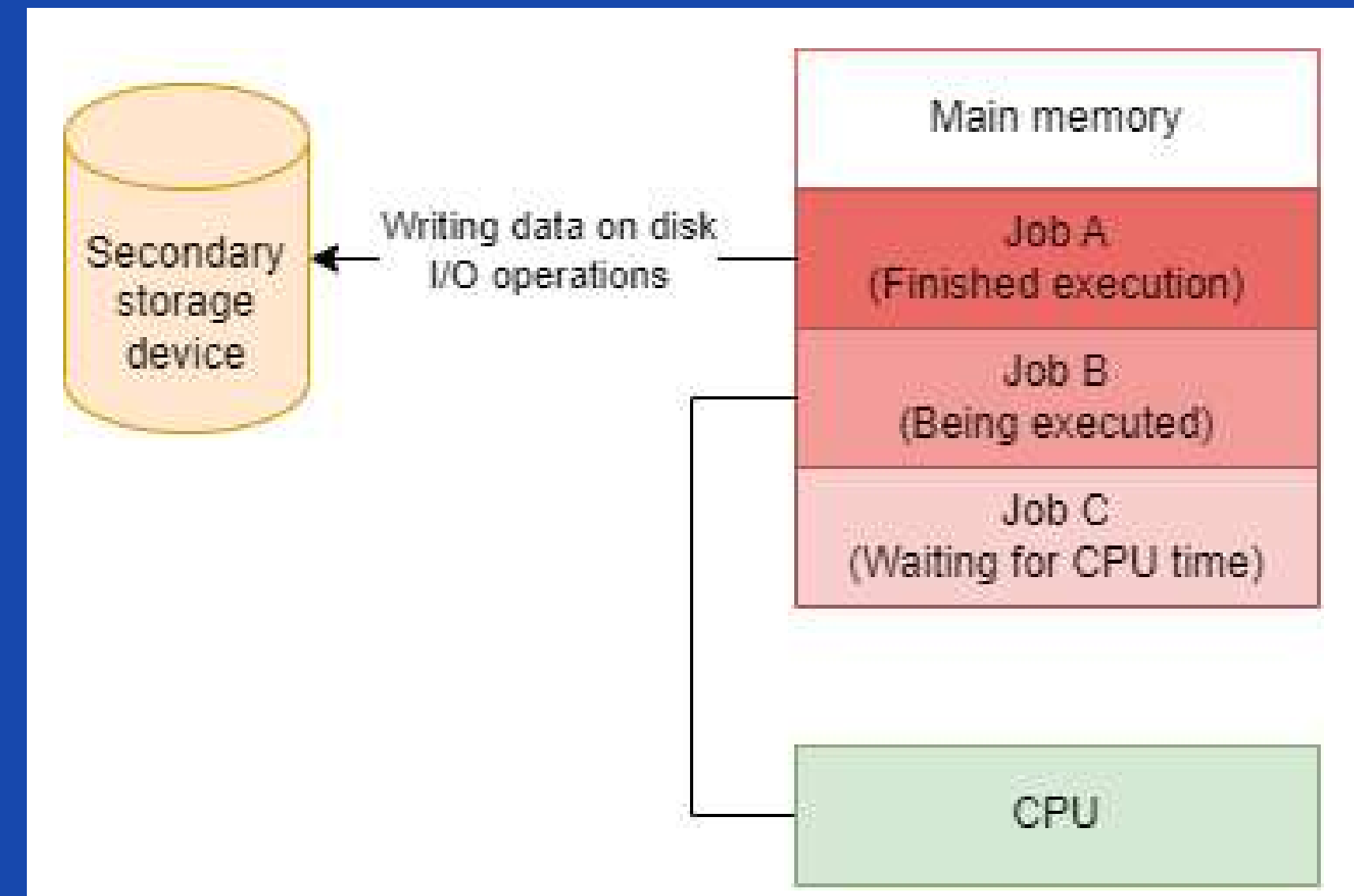


Examples: Payroll, exam paper grading

Multiprogramming OS

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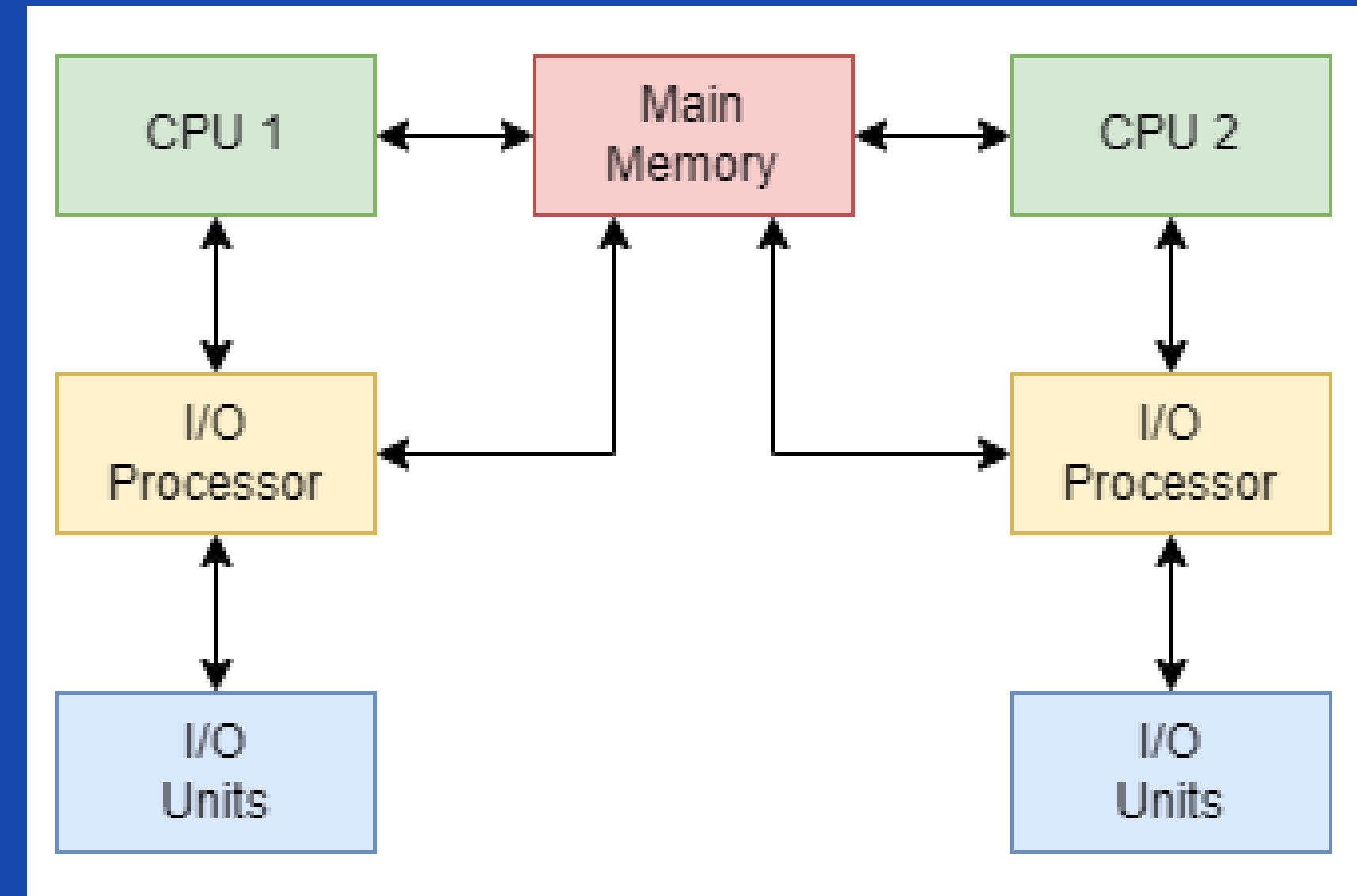
- Each process needs CPU and I/O time.
- When a process does its I/O, the CPU can start another processes.
- Improves the efficiency of the batch processing by keeping the CPU busy.
- Still lack of user interaction.



Examples: Downloading, rendering

Multiprocessing OS

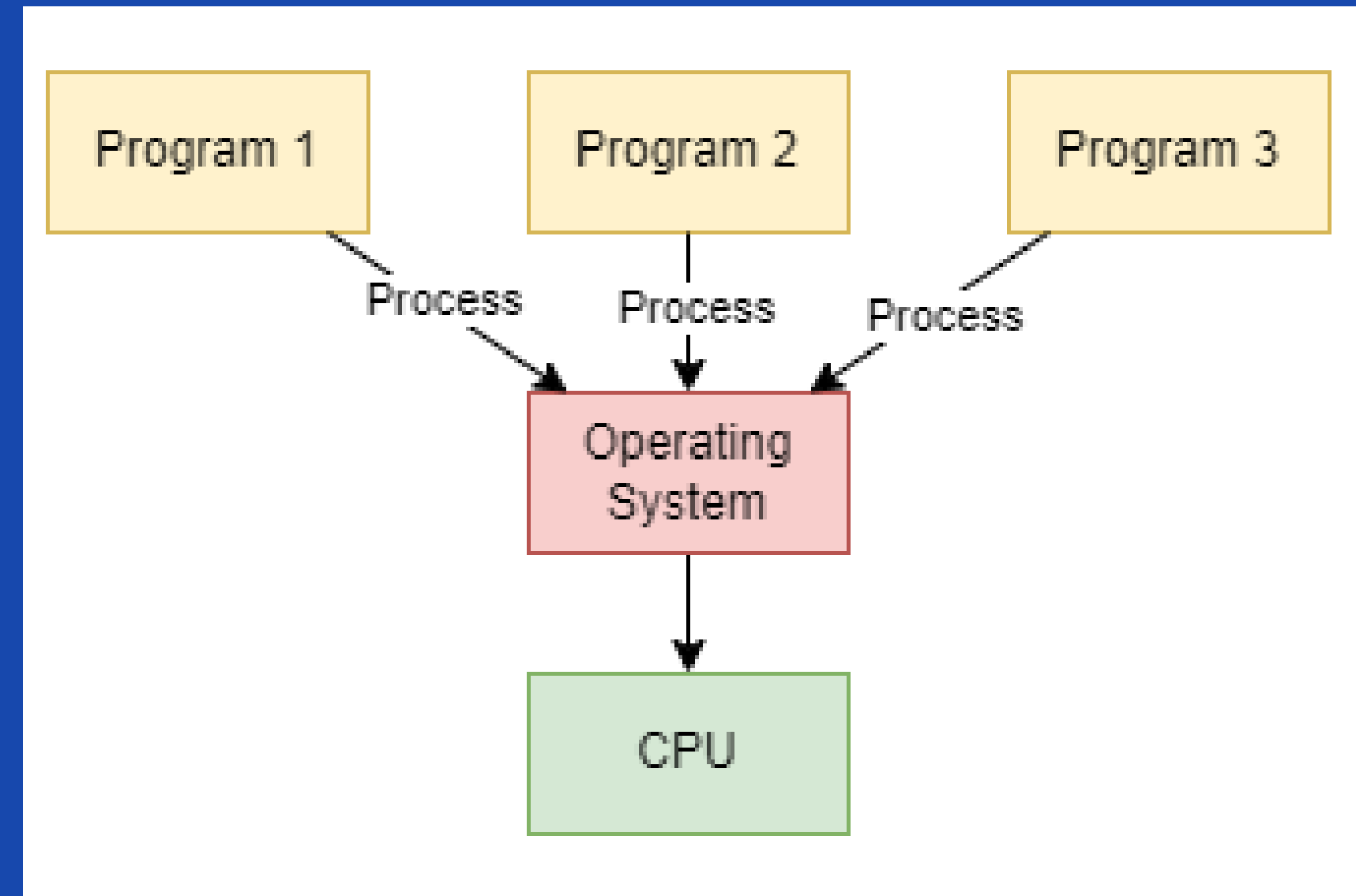
- There are more than one CPUs.
- The system can execute more than one process at a time.
 - Asymmetric - A master CPU takes the lead.
 - Symmetric - CPUs are load-balanced (a concept of parallel computing).
- Increase the throughput.
- If one processor fails, the system can proceed with another processor.



Examples: UNIX

Multitasking OS

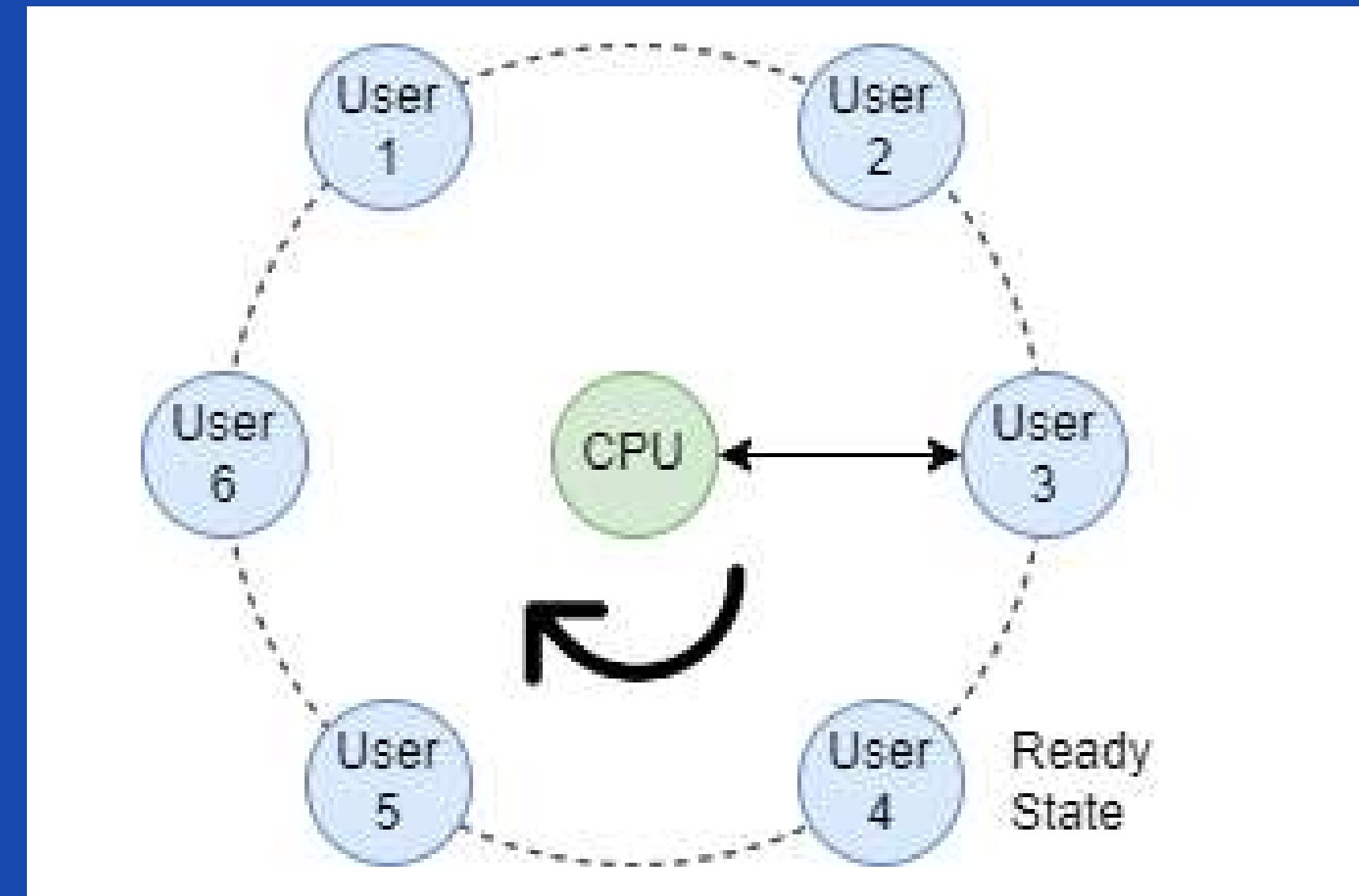
- Allows multiple programs to run simultaneously.
- Allows a user to perform more than one task at a time.
 - Preemptive - Allows CPUs to stop running the current process and switch to another.
 - Cooperative - Never switch from the running process to another.
- The device can be overheated.



Examples: Most general-purpose OS

Time-sharing OS

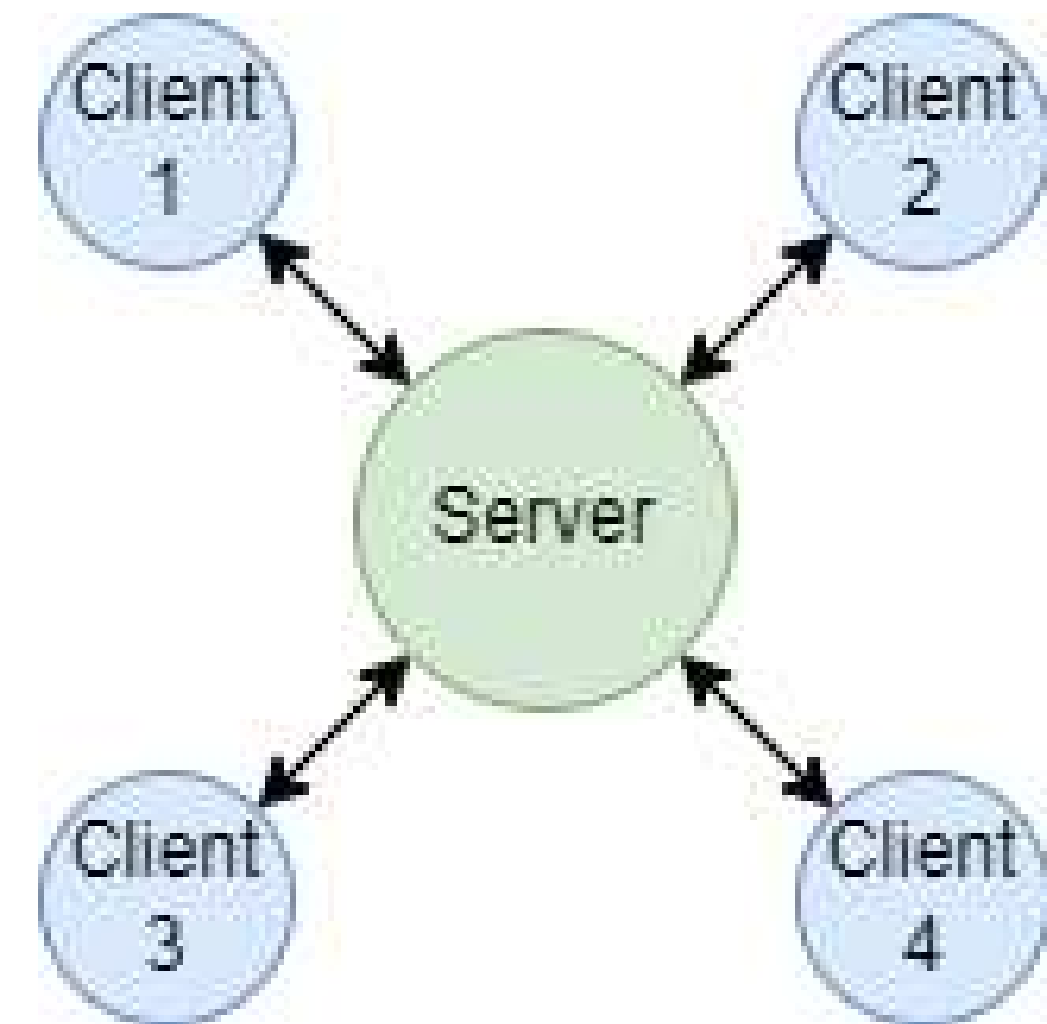
- Allows people at different terminals to use the system at the same time.
- CPU time is shared among users in a regular clock interrupt (round-robin).
- The time each task gets to execute, called "quantum," is very small.
- Process switches occur rapidly to minimize user waiting time.



Examples: IBM VM/CMS, Windows Terminal Services

Network OS

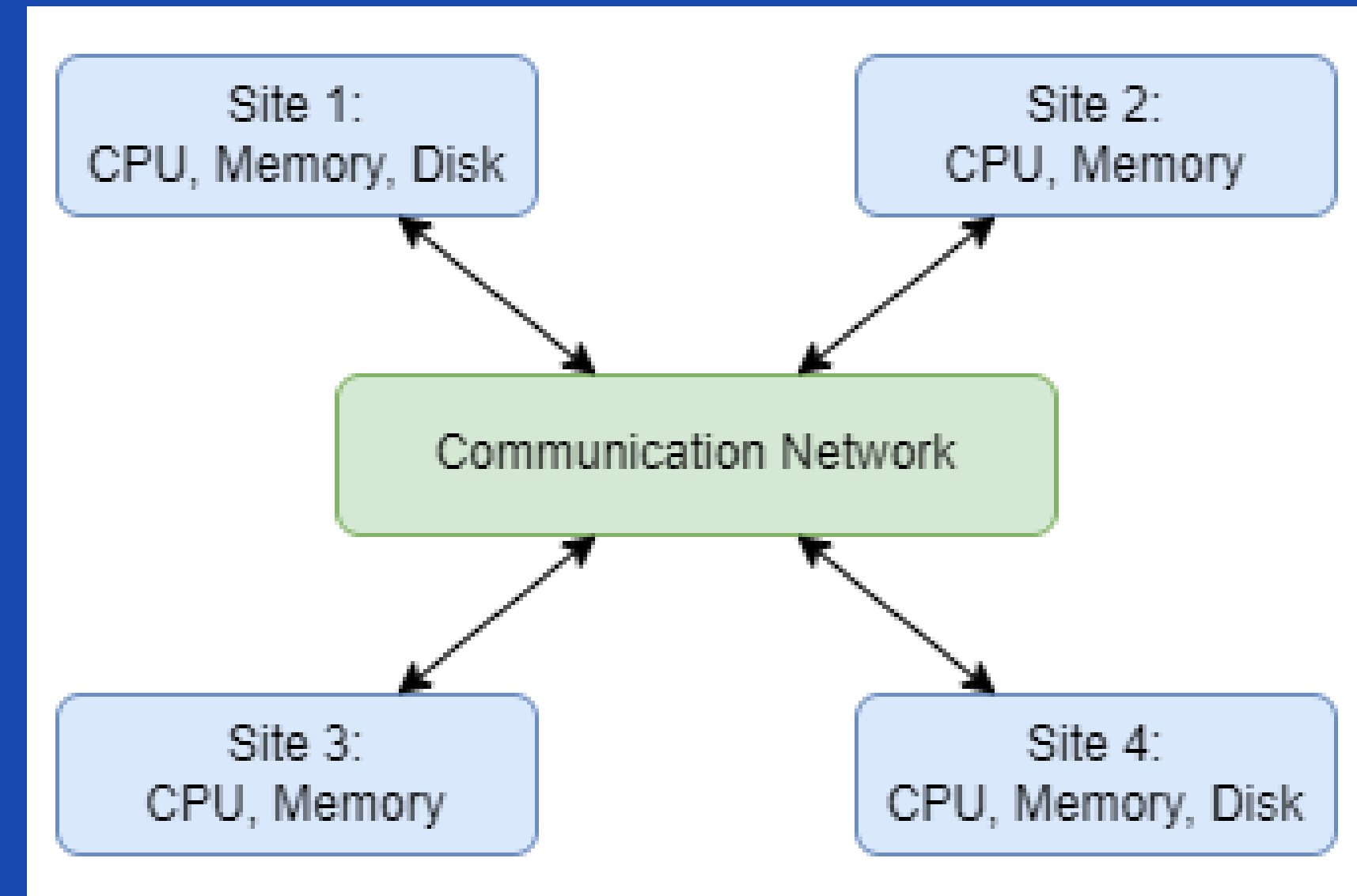
- Known as a client-server model.
- A server provides the capability to manage data, users, applications, and other networking functions.
- Allows shared file and device among multiple computers in a network, typically a local area network (LAN).
- Rely on the central node availability.



Examples: Most server computers

Distributed OS

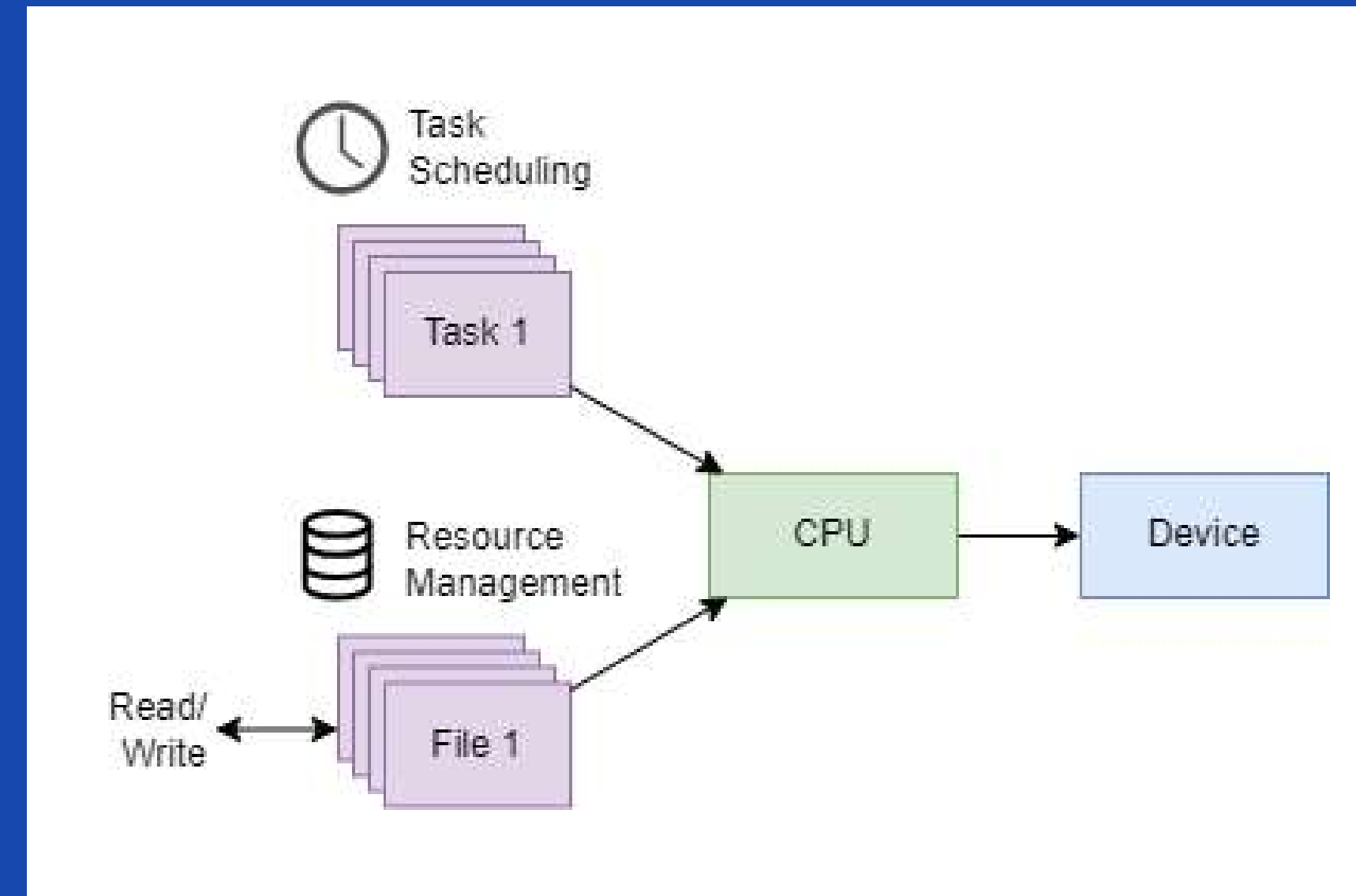
- The system is divided into parts loaded on different machines.
- Tasks are distributed among processors located on remote locations referred to as sites or nodes.
- They communicate through a network.
- Failure of one site will not affect the entire system.
- A concept of cloud computing.



Examples: Most cloud servers

Real-time OS

- For systems with critically-defined time constraints, such as air traffic control.
- The time interval required to process and respond to inputs (response time) is very small.
- Use advanced algorithm for scheduling.
 - Hard real-time - Guarantee that critical tasks complete on time.
 - Soft real-time - A critical task retains the priority until it completes.



Examples: Industrial control systems, weapon systems, air traffic control

Types of operating systems

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by devices and platforms

Desktop OS



Windows, Linux, Mac

Mobile OS



Android, iOS, Symbian

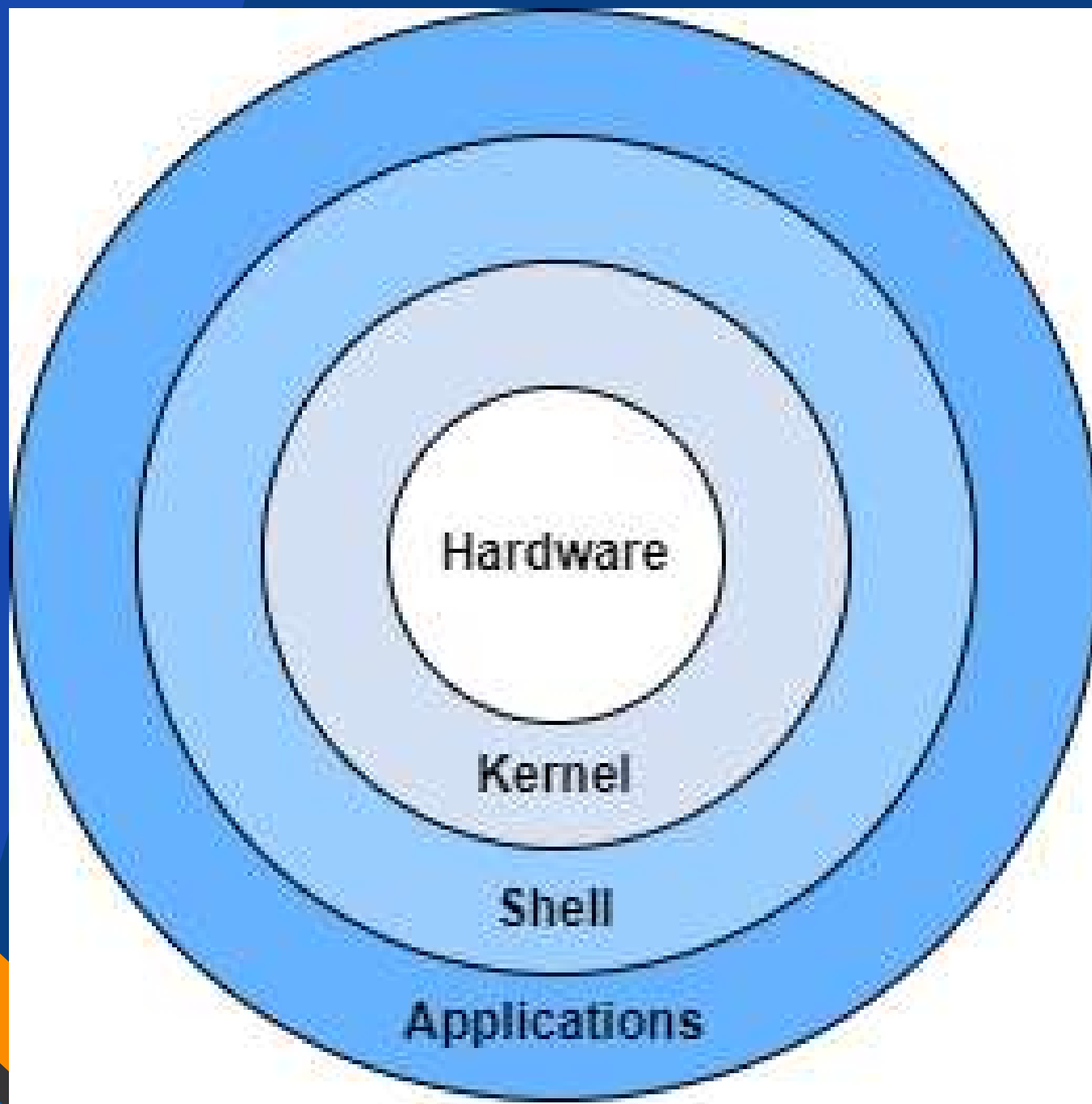
Server OS



Windows Server,
Ubuntu, Debian

Note: A server can run on a desktop OS with lower performance.

OS structure



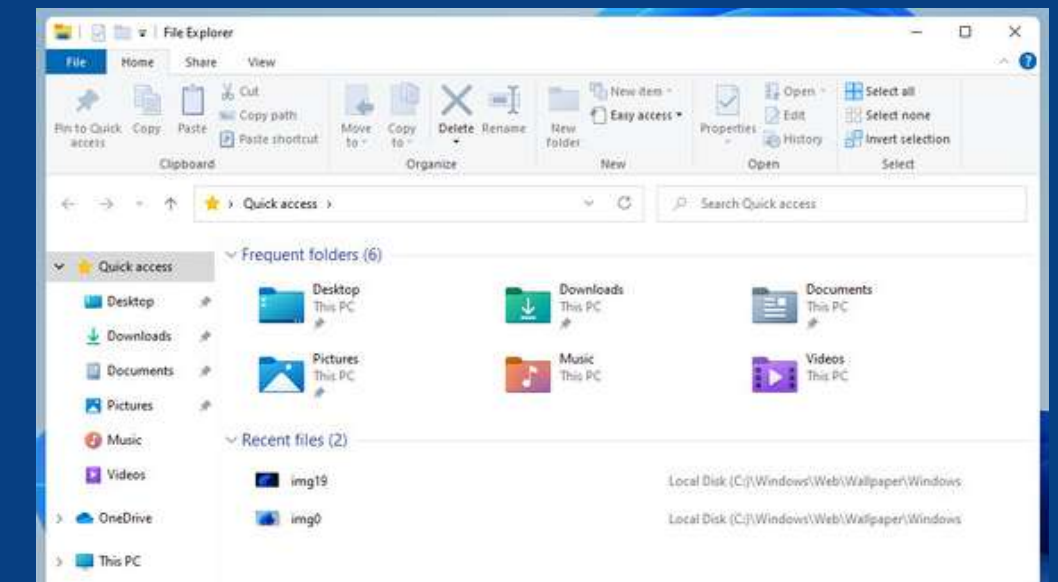
- **Applications** - Software and users
- **Shell** - Takes commands from the user/app and gives them to the OS to perform.
- **Kernel** - Control everything in the system and facilitates interactions between hardware and software components.
- **Hardware** - CPU, memory, devices

Interacting with the OS

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Users can interact with the operating system through a user interface.

- Command-line interface (CLI)
- Graphical user interface (GUI)



Windows 11 GUI



Windows-based

GUI > CLI



Linux-based

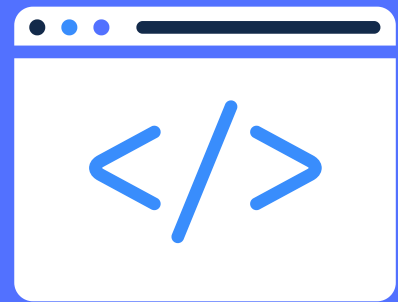
CLI > GUI

```
mars@marsmain /usr/portage/app-shells/bash $ date
Sat Aug  8 02:42:24 MSD 2009
mars@marsmain /usr/portage/app-shells/bash $ lsmod
Module                Size  Used by
rndis_wlan             23424  0
rndis_host             8696   1 rndis_wlan
cdc_ether              5672   1 rndis_host
usbnet                 18688  3 rndis_wlan,rndis_host,cdc_ether
parport_pc            38424  0
fglrx                 2388128 20
parport               39648  1 parport_pc
iTCO_wdt              12272  0
i2c_i801              9380   0
mars@marsmain /usr/portage/app-shells/bash $
```

Linux Shell

Windows CLI

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- CLI has been an inseparable part of most Microsoft OSs.
- MS-DOS (1981) runs exclusively on CLI.
- Windows 9x family came bundled with **COMMAND.COM**
- Windows NT and CE families came with a new **cmd.exe**

```
Command Prompt
Microsoft Windows [Version 10.0.22621.1848]
(c) Microsoft Corporation. All rights reserved.
C:\>
```

Windows command prompt

COMMAND.COM and **cmd.exe** support a few basic internal commands and a primitive scripting language (batch files). They do not support all facets of Windows GUI.



- PowerShell has replaced Command Prompt since Windows 10 and became the default command shell for File Explorer.

PowerShell is based on the .NET Framework, using all its functions, classes, scripts, and modules.

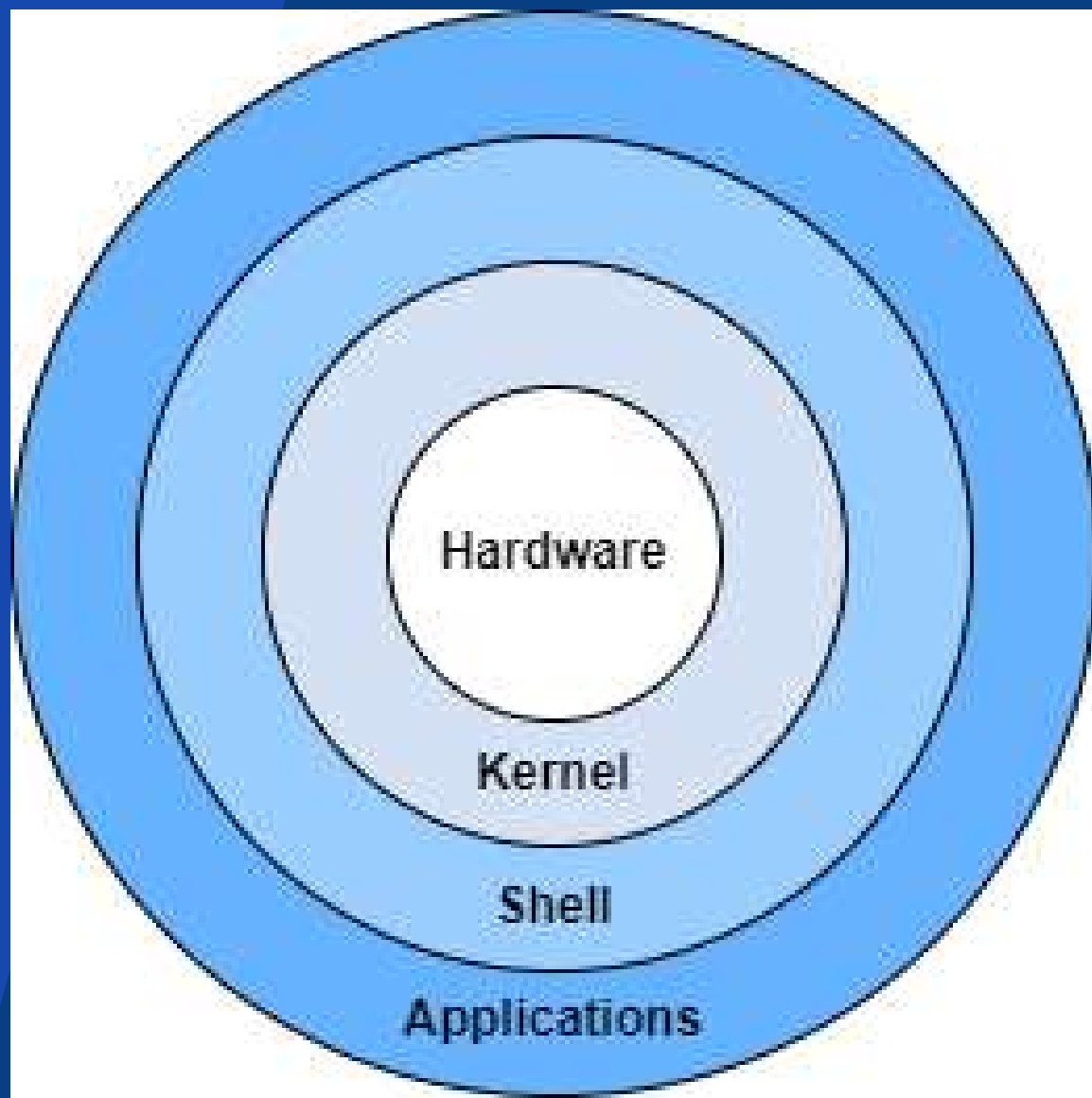
```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Install the latest PowerShell for new features and improvements!
https://aka.ms/PSWindows

PS C:\Users\>
```

Windows PowerShell

Linux CLI



- A command-line interpreter for Linux is typically called a "shell" which is a common term for an interface between kernel and user/app.
- Bash is a scripting language for Linux shell.

Example

```
$ echo {1..10}
```

```
1 2 3 4 5 6 7 8 9 10
```