PW SKILLS

System Fundamentals

PW SKILLS

Process Scheduling Concepts

Multitasking with real-world examples

Multitasking refers to the ability of an operating system (OS) to execute multiple tasks or processes simultaneously. This is achieved through process scheduling, which allows the OS to manage the execution of various tasks efficiently.

Real-World Examples of Multitasking:

- Office Work
- Smartphones
- Cooking

Pop Quiz

Q. Which of the following is an example of multitasking in the workplace?

A

Completing a report without any interruptions

B

Answering emails while attending a conference call

Pop Quiz

Q. Which of the following is an example of multitasking in the workplace?

A

Completing a report without any interruptions

B

Answering emails while attending a conference call

Time - Slicing

Time-slicing is a technique used in multitasking operating systems that allocates a fixed time period, known as a time slice or quantum, for each process to execute on the CPU.

How it enables CPU sharing among processes:

When a process's time slice expires, the CPU switches to another process. This method enables efficient CPU sharing among processes by ensuring that all active processes receive regular access to CPU resources.

Pop Quiz

Q. What is a time slice in the context of CPU scheduling?

A

The time taken for a context switch

B

A fixed duration allocated to each process for execution

Pop Quiz

Q. What is a time slice in the context of CPU scheduling?

A

The time taken for a context switch

B

A fixed duration allocated to each process for execution

Priority based scheduling

Priority-based scheduling is a method where processes are assigned priority levels, determining their order of execution. Higher-priority processes are executed before lower-priority ones, allowing critical tasks to complete more quickly.

Scenarios:

- **Critical Tasks:** In a medical application, a heart rate monitoring system may have high priority over other background tasks like data logging. If an emergency alert is triggered, this process must execute immediately to ensure patient safety.
- **Background Tasks:** A file backup process might run with lower priority since it does not require immediate attention. It can be scheduled during times when CPU usage is low or when higher-priority tasks are not running.

Pop Quiz

Q. What is the main principle of priority-based scheduling?

A

The process with the highest priority is executed first.

B

Processes are executed in a round-robin manner.

Pop Quiz

Q. What is the main principle of priority-based scheduling?

A

The process with the highest priority is executed first.

B

Processes are executed in a round-robin manner.

PW SKILLS

Concept of Virtual memory

Virtual Memory

Virtual memory is a memory management technique that allows an operating system to use a portion of the hard drive to extend the apparent size of the computer's physical memory (RAM).

Benefits of Virtual Memory:

- Increased Capacity
- Improved Multitasking

Virtual Memory

How it extends physical memory:

- When the system runs out of physical memory, it temporarily transfers inactive data from RAM to a designated space on the hard drive, known as the swap space or page file. This process, called swapping, frees up RAM for active processes.

- When the data stored on the hard drive is needed again, it is swapped back into RAM, allowing multiple applications to run simultaneously without exhausting physical memory resources.

Pop Quiz

Q. In which scenario would virtual memory be particularly beneficial?

A

Performing calculations with minimal data requirements

B

Executing multiple large applications simultaneously

Pop Quiz

Q. In which scenario would virtual memory be particularly beneficial?

A

Performing calculations with minimal data requirements

B

Executing multiple large applications simultaneously

PW SKILLS

Paging and Segmentation as memory management techniques

Paging

Definition: Paging is a memory management scheme that eliminates the need for contiguous allocation of physical memory.

How it works:

- When a process is executed, its pages can be loaded into any available page frames in physical memory, allowing non-contiguous allocation.
- The operating system maintains a page table for each process, which maps logical pages to physical page frames. This table helps in translating logical addresses into physical addresses.

Segmentation

Definition: Segmentation is another memory management technique that divides the logical address space of a process into variable-sized segments based on the logical structure of the program, such as functions, arrays, or objects.

How it works:

- Each segment has a name and a length, and the logical address consists of a segment number and an offset within that segment.
- The operating system maintains a segment table for each process, which contains the base address and length of each segment.

Pop Quiz

Q. What is the primary purpose of paging in memory management?

A

To increase the size of physical memory

B

To eliminate external fragmentation

Pop Quiz

Q. What is the primary purpose of paging in memory management?

A

To increase the size of physical memory

B

To eliminate external fragmentation

Pop Quiz

Q. Which of the following statements is true regarding segmentation?

A

Segmentation provides a logical view of memory.

B

Segments are always of fixed size.

Pop Quiz

Q. Which of the following statements is true regarding segmentation?

A

Segmentation provides a logical view of memory.

B

Segments are always of fixed size.

PW SKILLS

Memory allocation and fragmentation with practical examples.

Memory Allocation

Memory allocation refers to the process of reserving a portion of memory for a program or process to use during its execution. There are two primary types of memory allocation:

1. **Static Allocation**
2. **Dynamic Allocation**

Practical Example:

1. **Consider a program that requires memory for various data structures. If it requests 3 KB of memory, the operating system allocates that space from the heap. If later it needs another 4 KB, and the previous allocation was freed, the OS must find a suitable block of memory to accommodate this request.**

Fragmentation

Fragmentation occurs when free memory is inefficiently utilized due to the allocation and deallocation of memory blocks. There are two main types:

1. Internal Fragmentation:

Practical Example of Internal Fragmentation:

- Imagine a system where memory is divided into fixed-size blocks of 1 KB. If an application allocates 750 bytes, the remaining 250 bytes in that block cannot be used for other allocations, leading to internal fragmentation.

2. External Fragmentation:

Practical Example of External Fragmentation:

Consider a scenario where a system has allocated various sizes of memory blocks:

- Allocated: 1 MB (used), 512 KB (free), 256 KB (used), 128 KB (free), and 512 KB (used).
- If a new request comes in for 600 KB, it cannot be fulfilled despite having enough total free space (640 KB) because it is not contiguous.

Pop Quiz

Q. What is the primary purpose of memory allocation in an operating system?

A

To increase the speed of the CPU.

B

To reserve memory for processes during execution

Pop Quiz

Q. What is the primary purpose of memory allocation in an operating system?

A

To increase the speed of the CPU.

B

To reserve memory for processes during execution

PW SKILLS

Swap Memory

Swap Memory

Swap memory, also known as swap space, plays a crucial role in managing system memory, particularly during periods of high memory usage. It serves as an overflow area on a hard disk or SSD where inactive data from RAM can be temporarily stored.

- This allows the operating system to continue functioning even when physical RAM is fully utilized.

Role of Swap Memory:

- Virtual Memory Extension
- Memory Management
- System Stability

Swap Memory

Its Impact on performance during high memory usage:

During high memory usage, swap memory significantly impacts system performance in several ways:

- Performance Degradation
- Disk I/O Bottlenecks
- Fragmentation Issues
- Insufficient Swap Space Risks

Pop Quiz

Q. Which of the following statements is true regarding swap space?

A

It can create bottlenecks in system performance.

B

It is faster than accessing physical memory.

Pop Quiz

Q. Which of the following statements is true regarding swap space?

A

It can create bottlenecks in system performance.

B

It is faster than accessing physical memory.

PW SKILLS

Take A 5-Minute Break!

- Stretch and relax
- Hydrate
- Clear your mind
- Be back in 5 minutes

PW SKILLS

File Systems

Structure & Use cases

Structure and Use Cases of Common File Systems: ext4, NTFS, FAT32

ext4 (Fourth Extended File System):

- Structure:
- Extents
- Inodes
- Journaling

Use Cases:

- General-Purpose Systems
- Large Files

Structure & Use cases

Structure and Use Cases of Common File Systems: ext4, NTFS, FAT32

NTFS (New Technology File System):

Structure:

- Master File Table (MFT)
- Journaling

Use Cases:

- Windows Operating Systems
- Large Volumes & Files

Structure & Use cases

Structure and Use Cases of Common File Systems: ext4, NTFS, FAT32

FAT32 (File Allocation Table 32):

Structure:

- File Allocation Table
- Limited Metadata

Use Cases:

- Compatibility
- Smaller Files

Structure & Use cases

Feature	ext4	NTFS	FAT32
Maximum File Size	16 TiB	16 TiB	4 GiB
Maximum Volume Size	1 EiB	256 TiB (theoretical)	8 TiB (with some OS limitations)
Journaling Support	Yes	Yes	No
File Permissions	Yes	Yes	No
File-Level Encryption	Yes (via EFS)	Yes (built-in encryption)	No
Compatibility	Backward compatible with ext2/ext3	Primarily Windows; limited Linux support	Widely compatible across OS platforms
Subdirectory Limit	Unlimited	Limited by volume size	Limited by volume size
Performance Features	Extents, delayed allocation, online defragmentation	Sparse files, compression, indexing	Basic performance with no advanced features

Pop Quiz

Q. Which file system is best suited for external storage devices due to its compatibility across multiple operating systems?

A

ext4

B

FAT32

Pop Quiz

Q. Which file system is best suited for external storage devices due to its compatibility across multiple operating systems?

A

ext4

B

FAT32

Differences in Performance, Compatibility & Use cases

Differences in Performance, Compatibility, and Use Cases of ext4, NTFS, and FAT32

ext4 (Fourth Extended File System):

- **Performance:** Offers superior performance, especially for large files.
- **Compatibility:** Primarily designed for Linux-based operating systems.

Use Cases:

- Linux servers/desktops.

Differences in Performance, Compatibility & Use cases

Differences in Performance, Compatibility, and Use Cases of ext4, NTFS, and FAT32

NTFS (New Technology File System):

- **Performance:** Provides good performance with support for large files (up to 16 EiB) and efficient data management through journaling.
- **Compatibility:** Fully compatible with Windows operating systems (from Windows NT onward). macOS can read NTFS but requires third-party software for writing.

Use Cases:

- Windows internal drives

Differences in Performance, Compatibility & Use cases

Differences in Performance, Compatibility, and Use Cases of ext4, NTFS, and FAT32

FAT32 (File Allocation Table 32):

- **Performance:** Has limited performance capabilities, with a maximum file size of 4 GiB and a maximum partition size of 2 TiB.
- **Compatibility:** Highly compatible across various operating systems.

Use Cases:

- USB/external drives

Pop Quiz

Q. Which file system is primarily used in Windows environments and supports features like file-level encryption and permissions?

A

FAT32

B

NTFS

Pop Quiz

Q. Which file system is primarily used in Windows environments and supports features like file-level encryption and permissions?

A

FAT32

B

NTFS

PW SKILLS

IP addresses & Subnetting

IP Address

IP addresses are unique identifiers assigned to devices on a network, enabling them to communicate with each other. They are essential for routing data across the internet or local networks.

IP Address Structure:

- IPv4
- IPv6

Simple Examples:

- IP Address: 192.168.1.10
- Subnet Mask: 255.255.255.0
- Network Portion: 192.168.1
- Host Portion: 10

Subnetting

Subnetting is the process of dividing a larger network into smaller, manageable sub-networks (subnets). This helps improve network performance and security by isolating traffic and controlling access.

Subnet Mask: A subnet mask defines which part of an IP address is the network portion and which part is the host portion.

- Network Portion: 192.168.1
- Host Portion: .1 (indicating this specific device)

Simple Examples:

- A company has a network with the IP address 10.0.0.0/24 (subnet mask 255.255.255.0), allowing for up to 256 addresses (from 10.0.0.0 to 10.0.0.255).

Pop Quiz

Q. What is the primary purpose of an IP address?

A

To manage network traffic

B

To identify devices on a network

Pop Quiz

Q. What is the primary purpose of an IP address?

A

To manage network traffic

B

To identify devices on a network

PW SKILLS

CIDR notation & Its role in efficient IP allocation

CIDR Notation & Its Role

- **CIDR (Classless Inter-Domain Routing)** is a method for allocating and routing IP addresses that improves the efficiency of IP address usage.

CIDR Notation: Its consists of an IP address followed by a slash (/) and a number that indicates the number of bits in the network prefix. For example, in the CIDR notation 192.168.1.0/24:

- 192.168.1.0 is the network address.
- /24 indicates that the first 24 bits are used for the network portion, leaving 8 bits for host addresses.

CIDR Notation & Its Role

Role in Efficient IP Allocation:

1. Flexible Addressing
2. Aggregation
3. Efficient Use Of IP Space
4. Simplified Management

Example

Consider two networks:

- 192.168.0.0/24 (providing 256 addresses)
- 192.168.1.0/24 (also providing 256 addresses)

Using CIDR, these can be combined into a single block:

- 192.168.0.0/23, which covers both networks and provides 512 addresses (from 192.168.0.0 to 192.168.1.255).

Pop Quiz

Q. What is the effect of using CIDR on router performance?

A

It decreases the load on routers by reducing routing table size.

B

It increases the load on routers by adding complexity.

Pop Quiz

Q. What is the effect of using CIDR on router performance?

A

It decreases the load on routers by reducing routing table size.

B

It increases the load on routers by adding complexity.

PW SKILLS

Comparing TCP, UDP, and ICMP protocols

Overview Of Protocols

- **TCP (Transmission Control Protocol):** A connection-oriented protocol that ensures reliable and ordered delivery of data packets. It is widely used in applications requiring high reliability.

- **UDP (User Datagram Protocol):** A connectionless protocol that allows fast data transmission without ensuring delivery or order. It is suited for applications where speed is more critical than reliability.

- **ICMP (Internet Control Message Protocol):** Primarily used for network diagnostics and error reporting rather than for direct data transmission.

Comparing Protocols

Feature	TCP	UDP	ICMP
Connection	Connection-oriented (requires handshake)	Connectionless	Not applicable
Reliability	Reliable (guarantees delivery)	Unreliable (no guarantee of delivery)	Not applicable
Data Order	Ensures ordered delivery	No order guarantee	Not applicable
Error Checking	Extensive error-checking mechanisms	Basic error-checking with checksums	Error reporting and diagnostics
Speed	Slower due to overhead	Faster with minimal overhead	N/A
Header Size	Larger header (20 bytes)	Smaller header (8 bytes)	Varies based on message type
Use Cases	Web browsing, email, file transfers	Video streaming, online gaming, VoIP	Network diagnostics (e.g., ping)

Applications Of Protocols

1. TCP Applications:

- Web Browsing
- Emails
- File Transfers

2. UDP Applications:

- Streaming services
- Online Gaming
- VoIP

3. ICMP Applications:

- Network Diagnostics
- Error reporting

Pop Quiz

Q. Which of the following protocols is connection-oriented?

A

UDP

B

TCP

Pop Quiz

Q. Which of the following protocols is connection-oriented?

A

UDP

B

TCP

Pop Quiz

Q. Which protocol is best suited for applications that require fast data transmission without the need for reliability?

A

TCP

B

UDP

Pop Quiz

Q. Which protocol is best suited for applications that require fast data transmission without the need for reliability?

A

TCP

B

UDP

PW SKILLS

Network Services

Roles Of DNS & DHCP In Networking

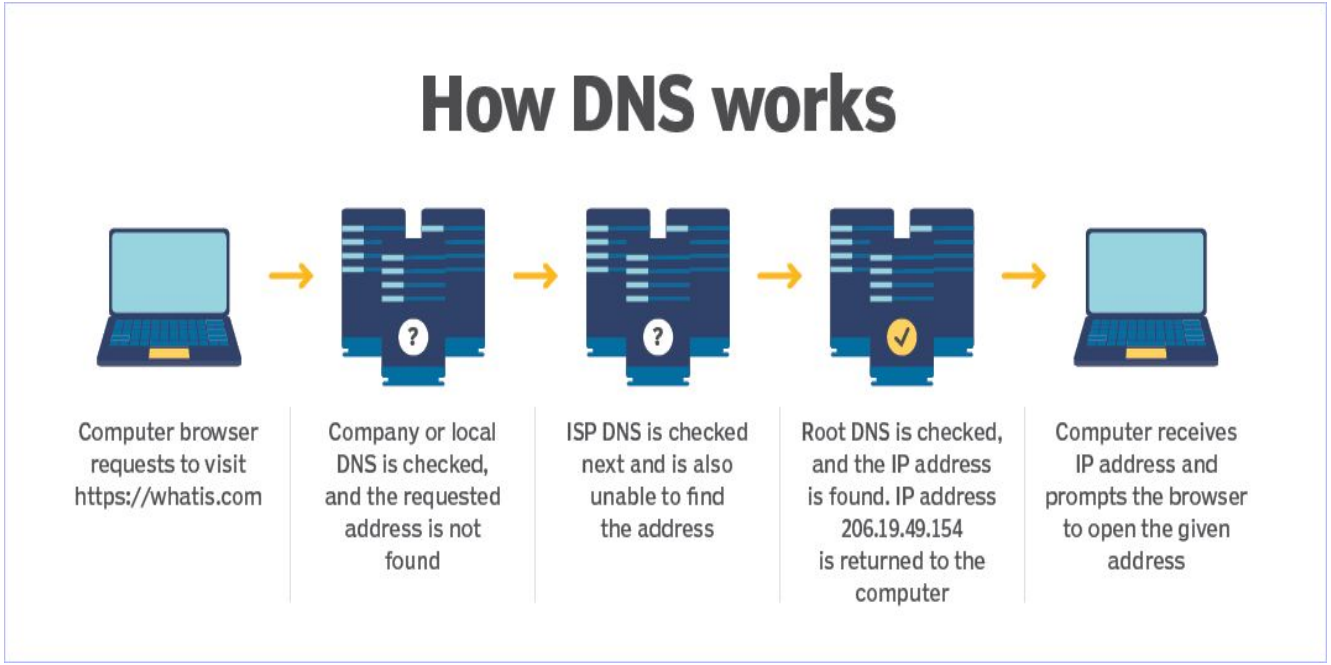
DNS (Domain Name System)

Function: DNS translates human-readable domain names (like www.example.com) into machine-readable IP addresses (like 192.0.2.1).

Key Roles:

- Address Resolution
- Caching
- Load Balancing
- Security

Roles Of DNS & DHCP In Networking



Roles Of DNS & DHCP In Networking

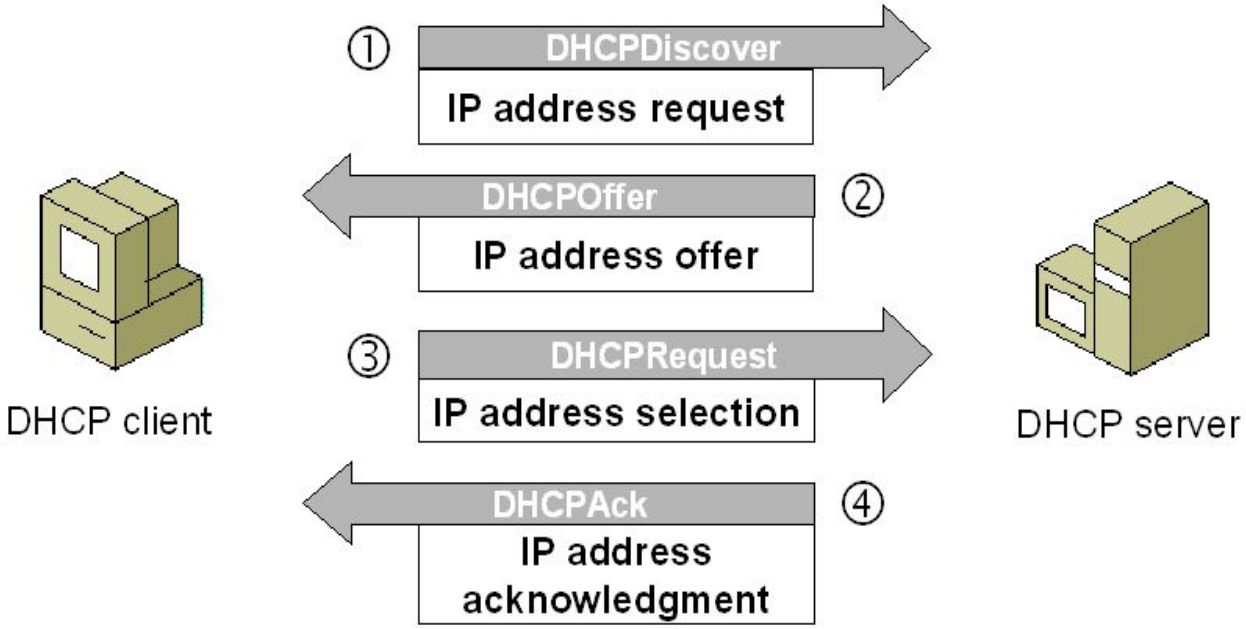
DHCP (Dynamic Host Configuration Protocol)

Function: DHCP automatically assigns IP addresses and other network configuration parameters to devices on a network, allowing them to communicate effectively.

Key Roles:

- Dynamic IP Address Assignment
- Configuration Management
- Lease Management

Roles Of DNS & DHCP In Networking



Pop Quiz

Q. Which protocol automatically assigns IP addresses to devices on a network?

A

DHCP

B

DNS

Pop Quiz

Q. Which protocol automatically assigns IP addresses to devices on a network?

A

DHCP

B

DNS

HTTP/S & FTP as common protocols

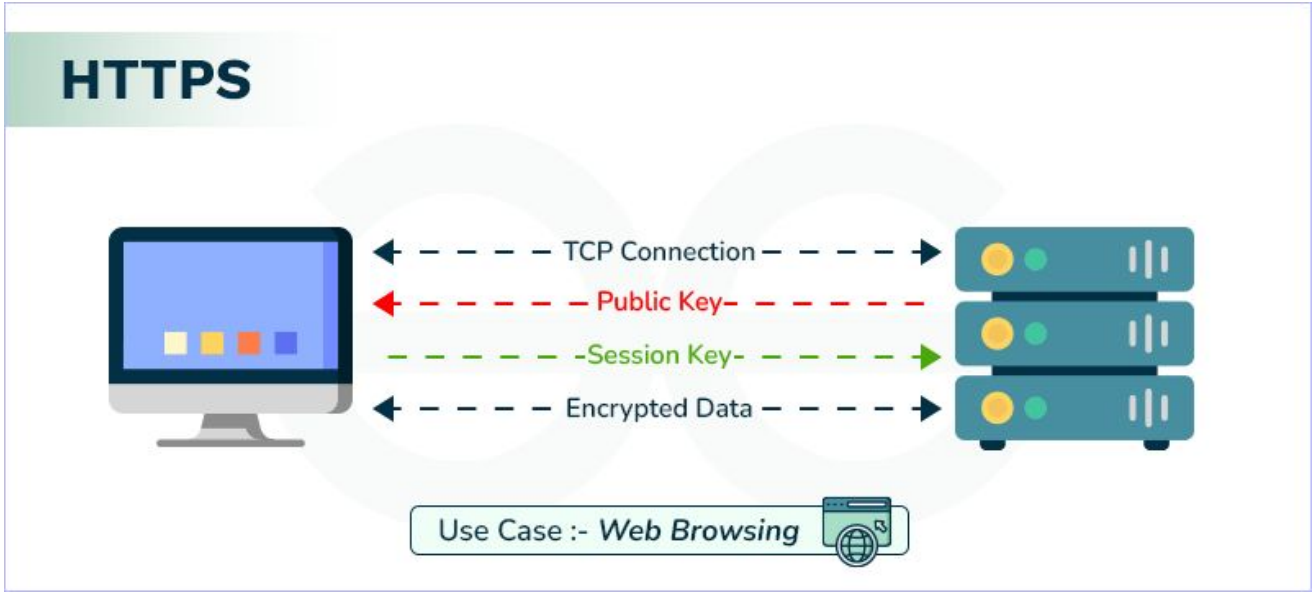
HTTP/S (Hypertext Transfer Protocol/Secure)

Overview: HTTP is the protocol that governs how web pages are transmitted from servers to clients (web browsers).

Practical Uses:

- Web Browsing
- E-Commerce
- APIs

HTTP/S & FTP as common protocols



HTTP/S & FTP as common protocols

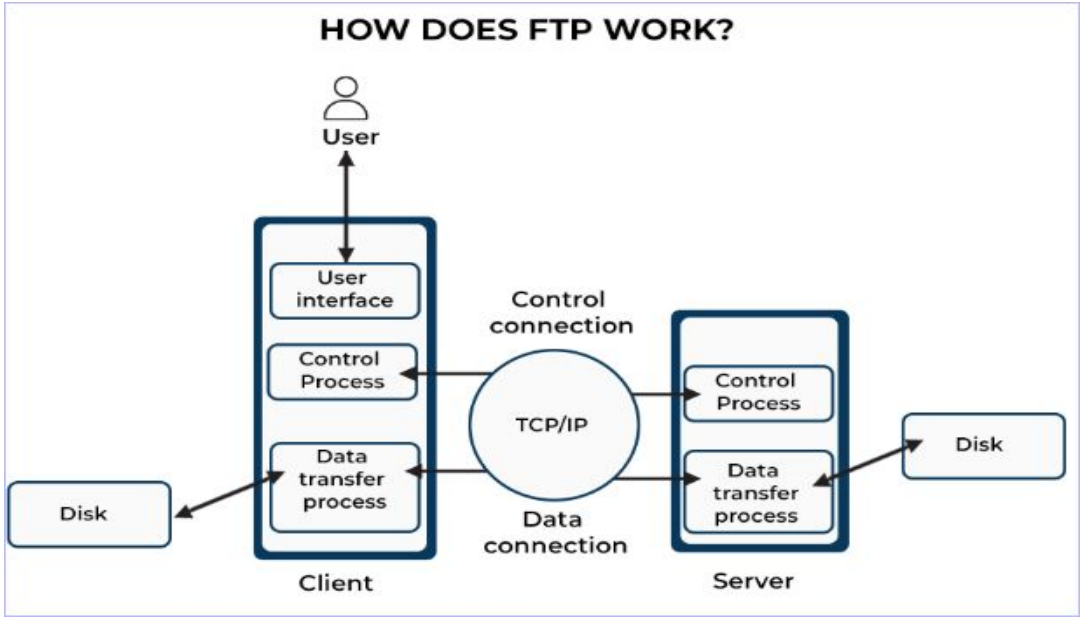
FTP (File Transfer Protocol)

Overview: FTP is designed specifically for transferring files between a client and a server. It allows users to upload, download, and manage files on remote servers.

Practical Uses:

- File Management
- Backup Solutions
- Web Development

HTTP/S & FTP as common protocols



Pop Quiz

Q. Which protocol is specifically designed for transferring files between a client and a server?

A

FTP

B

HTTP

Pop Quiz

Q. Which protocol is specifically designed for transferring files between a client and a server?

A

FTP

B

HTTP

Pop Quiz

Q. Which port is commonly used for HTTP traffic?

A

443

B

80

Pop Quiz

Q. Which port is commonly used for HTTP traffic?

A

443

B

80

PW SKILLS

Time for case study!

Important

- Complete the post-class assessment
- Complete assignments (if any)
- Practice the concepts and techniques taught in this session
- Review your lecture notes
- Note down questions and queries regarding this session and consult the teaching assistants

Thanks !