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**Parallel Computing Exam**

1. The scenario is a metro station of a refugee camp in India for 900 million. The train only accommodates 1000 people. Only 4 railways and there are 10 trains going, and 10 returning.

i) Explain the Computing concepts and the parts to optimise.

Ans:

**Scenario:**

**Storage:** 900 million people (refugees) - analogous to the total data to be processed.

**RAM:** 1000 people per train - analogous to the size of the data chunk that can be processed at one time.

**Bus:** 4 railways - analogous to the data transfer pathways between the storage and the CPU.

**CPU:** Metro stations - analogous to the processing units.

**Processes:** 10 trains going and 10 returning - analogous to the individual tasks being processed.

Here's how the scenario with 900 million people, 20 trains, 4 railway lines, and each train accommodating 1,000 people can be related to transferring files:

Scenario Context

900 million people Represents individual file chunks or packets of data that need to be transferred.

20 trains represent network bandwidth or data transfer channel or connections that can transfer file chunks.

4 railway Lines represents the data transmission paths or network routes available. 4 railway lines are similar to the different network routes or parallel paths that data packets can take to reach their destination.

Train Capacity (1000) represents the capacity of each data channel to transfer a certain number of file chunks simultaneously similar to how many file chunks a data channel can handle at once.

**Problem Breakdown**

**1. Total File Chunks to be Transferred: 900 million**

**2. Total Channel Capacity: 20 channels × 1,000 chunks/channel = 20,000 chunks per transmission cycle**

**3. Network Routes Available: 4 routes**

**4. Transmission Cycles Required:**

**Cycles Required = = 45,000 cycles**

**Operating the System**

**Scheduling and Coordination**

**Network Scheduling:** The scheduling of data packets on the network routes is similar to how trains are scheduled on tracks. Efficient scheduling ensures maximum utilization of available channels and routes. If each data channel operates in parallel, scheduling them efficiently across the 4 routes is crucial to minimizing transfer time and maximizing throughput.

Data Throughput

Throughput in networking is akin to the number of file chunks transferred per unit time.

If each transmission cycle takes 1 second, and all 20 data channels can operate simultaneously, then:

4 routes × 20 channels/4 routes = 5 channels per route.

Each channel transfers 1,000 file chunks per cycle, so:

5 channels/route x 4 routes x 1,000 chunks/channel = 20,000 chunks/second

**This means that we can transfer 20,000 file chunks pe second**

ii) What will be the worst and best scenario?

Ans:

**Worst Scenario:**

**Bottlenecks and Idle Time:** If the railways (data buses) are congested, and there are delays in transferring people (data) to and from the metro stations (CPUs), the process becomes inefficient. This is akin to having limited bandwidth in a computer system, causing delays.

**Insufficient RAM:** If the trains (RAM) are too small to handle the load efficiently, many trips will be required, increasing the overall time.

**Unbalanced Load:** If some trains (processes) are idle while others are overloaded, it leads to inefficient use of resources. This can happen if the scheduling is not optimised

.

**Best Scenario:**

**Optimised Data Transfer:** If the railways (data buses) are fully utilised without congestion, data transfer between storage and processing units is seamless.

**Adequate RAM:** If each train (RAM) can carry a large enough chunk of data, fewer trips are required, reducing the overall processing time.

**Balanced Load:** Efficient scheduling ensures that all trains (processes) are evenly loaded, minimising idle times and maximising resource usage.

**Enhanced Processing Power:** If the metro stations (CPUs) can process data quickly, the overall time to complete the processing is reduced.

2. Explain in Computing concepts the parts on a phone that determines the Efficiency & optimization for data storage, data transfer, Connectivity.

Ans:

**Data Storage:**

**Internal Storage, ROM Capacity (NAND Flash Memory):**

This is the main storage for the phone, used to store the operating system, apps, and user data. NAND flash memory is fast and non-volatile, ensuring quick access and data retention without power

**RAM (Random Access Memory):**

RAM is used for temporary data storage that the CPU needs to access quickly. The amount and speed of RAM directly affect the phone's ability to handle multiple tasks simultaneously and efficiently.

**Storage Controller:**

This chip manages the flow of data between the CPU and the internal storage. A good storage controller optimises read and write speeds and improves overall storage efficiency.

**Data Transfer**

**CPU (Central Processing Unit):**

The CPU processes instructions and handles data transfer tasks. A multi-core, high-speed CPU can process more data simultaneously, improving overall performance.

**Internal Buses:**

UFS (Universal Flash Storage): This is a high-speed interface used for internal data transfer between the CPU, RAM, and NAND flash memory. UFS provides faster data transfer rates compared to older technologies like eMMC.

PCIe (Peripheral Component Interconnect Express): Some high-end phones use PCIe for even faster data transfer rates.

**USB Interface:**

USB-C: This port is used for external data transfer and charging. USB-C supports high-speed data transfer and is reversible, making it more user-friendly.

**Wireless Communication Chips:**

Wi-Fi Chip: Handles connections to Wi-Fi networks. The efficiency of data transfer over Wi-Fi depends on the Wi-Fi version supported by the chip (e.g., Wi-Fi 5, Wi-Fi 6).

Bluetooth Chip: Manages short-range wireless communication with other devices. Bluetooth 5.0 and later versions offer improved data transfer speeds and range.

**Connectivity**

**Modem:**

The modem connects the phone to cellular networks. Modern phones use advanced modems that support multiple generations of network technology (e.g., 4G LTE, 5G) for faster and more reliable connectivity.

**Antenna System:**

The antenna system is crucial for signal reception and transmission. Well-designed antennas enhance connectivity and data transfer speeds by improving signal strength and quality.

**Network Interface Chips:**

These chips handle the phone's connections to various networks, including cellular, Wi-Fi, and Bluetooth. Advanced network interface chips support faster and more efficient data connections.

**SIM Card and eSIM:**

These components manage subscriber identity and connect the phone to the mobile network. An eSIM can switch between carriers without needing a physical SIM card, offering more flexibility and potentially better connectivity.

3. In computing concepts, explain how the hardware of a server and a phone can process 1 billion transactions and show the metrics.

Ans:

Processing 1 billion transactions on a server and a phone involves considering their hardware capabilities, including CPU performance, memory, storage, and network bandwidth. Here's a comparison of how each device might handle such a task, along with the relevant metrics:

### Server

**CPU**:

**Architecture**: Typically, servers use multi-core, high-performance CPUs like Intel Xeon or AMD EPYC.

**Clock Speed**: Around 2.0 - 3.5 GHz per core.

**Core Count**: Often 16 to 64 cores or more.

**Memory (RAM)**:

**Capacity**: Servers can have 128 GB to several TB of RAM.

**Speed**: Generally DDR4 or DDR5 with high bandwidth.

**Storage**:

**Type**: SSDs (NVMe) with high IOPS (Input/Output Operations Per Second).

**Capacity**: Can range from TBs to PBs.

**Network Bandwidth**:

**Speed**: Typically 10 Gbps to 100 Gbps.

**Metrics**:

**Transaction Processing Rate**: A powerful server can process tens of thousands to hundreds of thousands of transactions per second (TPS).

**Latency**: Generally low, measured in milliseconds.

### Phone

**CPU**:

**Architecture**: ARM-based processors, e.g., Qualcomm Snapdragon or Apple A-series.

**Clock Speed**: Around 1.8 - 3.0 GHz per core.

**Core Count**: Typically 4 to 8 cores.

**Memory (RAM)**:

**Capacity**: 4 GB to 16 GB.

**Speed**: LPDDR4 or LPDDR5.

**Storage**:

**Type**: Flash storage.

**Capacity**: Ranges from 64 GB to 1 TB.

**Network Bandwidth**:

**Speed**: Up to 5G speeds (theoretically several Gbps).

**Metrics**:

**ransaction Processing Rate**: A high-end phone can process hundreds to a few thousand TPS.

**Latency**: Higher compared to servers, generally in tens of milliseconds.

### Example Metrics Calculation

To process 1 billion transactions, let's calculate the time required based on hypothetical TPS values:

#### **Server**

* **Assumed TPS**: 100,000 TPS.
* **Total Transactions**: 1,000,000,000 transactions.
* **Time Required**:

Time(seconds)= 1,000,000,000/100,000= 10 000 seconds

Time(hour)= 10 000/3600 = 2.78 hours

Time required for a server is 2.78 hours

#### **Phone**

* **Assumed TPS**: 1,000 TPS.
* **Total Transactions**: 1,000,000,000 transactions.
* **Time Required**:

Time (seconds)= 1,000,000,000/1,000=1,000,000 seconds

Time (hour)= 1,000,000/3600= 277.78 hours

A server, with its higher processing power and superior hardware specifications, can process 1 billion transactions significantly faster than a phone. The exact time required would depend on the specific hardware capabilities and optimization of the processing tasks, but the order of magnitude difference in TPS highlights the performance gap between the two types of devices.