Course: Computing Science

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**Part 1**

**The scenario is a metro station of a refugee camp in India for 900 million people.**

**The train only accommodates 1000 people and there are only 4 rails way and 10 trains going, 10 returning**

1. **Explain the computing concepts and the parts to optimize**

In computing terms, the scenarios can be explained as follows:

**900 million people, the data in RAM:**

Represents: Main memory (RAM) capacity

Computing equivalent: This could be likened to a very large amount of data stored in main memory, ranging from several gigabytes to terabytes.

**Train accommodating 1000 people:**

Represents: Data transfer unit size

Computing equivalent: This could be a cache line, data bus width, or network packet size, typically ranging from 64 bytes to a few kilobytes.

**10 trains going, 10 returning**:

Represents: Bidirectional data transfer capacity

Computing equivalent: This represents the number of simultaneous data transfer operations possible in both directions, analogous to concurrent read/write operations in a memory system.

**To optimize this system in computing terms:**

Increase train capacity: Upgrading train capacity from 1000 to 2000 people per train increases the amount of data transferred per operation, thereby enhancing throughput.

Add more railways: Increasing the number of rail lines from 4 to 8 expands the data paths, reducing potential bottlenecks and improving overall data transfer efficiency.

Increase train frequency: Doubling the number of trains running in each direction (from 10 to 20) enhances data transfer rates, thereby boosting system speed and responsiveness.

**Part 2**

**Explain in computing concepts the parts on a phone that determines the efficiency and optimization for data storage, data transfer, connectivity.**

Data Storage

Storage Medium: The type and quality of the storage medium play a crucial role in determining read/write speeds and durability. High-end phones like the iPhone 7 often utilize NAND flash storage, which directly impacts performance. Apple integrates high-quality NAND flash to ensure faster and more reliable operation.

File System: The file system also affects how data is organized and accessed on the storage medium. Modern file systems, such as Apple's introduction of the Apple File System (APFS) with iOS 10.3, are optimized for flash storage. APFS enhances efficiency by reducing fragmentation and improving read/write speeds.

Storage Controller: The storage controller manages data transfer between the CPU and the storage medium. Apple's custom-designed controllers in devices like the iPhone 7 are optimized to achieve high performance and low latency, thereby improving data throughput.

Data Transfer

Memory (RAM): The amount and type of RAM directly influence data access speed and multitasking capability. The iPhone 7 is equipped with 2GB of LPDDR4 RAM, known for fast data access and efficient power usage, essential for handling large applications and multitasking.

CPU and GPU: The processing power of the CPU and GPU significantly impacts data processing speed and graphics rendering. The iPhone 7's A10 Fusion chip features a quad-core CPU with a blend of high-performance and high-efficiency cores, enabling swift handling of complex tasks while conserving energy during lighter activities. Its six-core GPU enhances performance in graphics-intensive applications.

Cache Memory: CPUs and GPUs include multiple levels of cache (e.g., L1, L2) for rapid access to frequently used data, reducing the need to fetch data from main memory and improving overall efficiency.

Connectivity

Modem and Radio Frequency (RF) Chips: These components manage communication with cellular networks (e.g., 4G LTE, 5G), impacting data transfer speed and reliability. The iPhone 7 integrates Qualcomm's X12 LTE modem, supporting download speeds up to 600 Mbps and upload speeds up to 150 Mbps for reliable cellular connectivity.

Wi-Fi and Bluetooth Chips: Wi-Fi (e.g., 802.11a/b/g/n/ac) and Bluetooth (e.g., 4.2) chips facilitate wireless communication, with standards like Wi-Fi 6 and Bluetooth 5.2 enhancing speed and range. The iPhone 7 utilizes Broadcom's BCM4357 chip for fast wireless communication and low-energy Bluetooth connections.

Antenna Design: Advanced antenna design in devices like the iPhone 7 optimizes signal strength and quality for both cellular and Wi-Fi connections, ensuring robust connectivity.

Network Protocols: Optimized software protocols (e.g., TCP/IP, HTTP/2) in iOS streamline data transfer over networks, reducing latency and improving overall efficiency in internet communications and web browsing

**Part 3**

**In computing concepts, explain how the hardware of a server and a phone can process 1 billion transaction and show the metrics**

To understand how the hardware of a server and a Samsung phone can manage 1 billion transactions, we'll break down the processes for three types of transactions: mobile payments, bank card transactions, and internet banking. We'll then compare the capabilities and limitations of server and Samsung phone hardware using performance metrics.

Transactions and Processing Requirements:

For Mobile Payments:

This includes peer-to-peer transfers and bill payments. Processing involves authentication, balance verification, transaction recording, and notifications. Data volume is moderate, with minimal data transfer like user IDs and amounts.

For Bank Card Transactions:

These include point-of-sale transactions and online purchases. Processing requires authentication (PIN/biometric), fraud detection, authorization, and settlement. Data volume ranges from moderate to high, including user data, transaction amounts, and merchant information.

For Internet Banking

Transactions involve fund transfers and account management. Processing includes user authentication (multi-factor), encryption, transaction logging, and notifications. Data volume is high due to detailed account and transfer information.

Server Hardware Capabilities:

Example specifications could include high-performance multi-core processors (like Intel Xeon or AMD EPYC with 64 cores), large RAM capacity (e.g., 1TB DDR4 RAM), fast storage solutions (e.g., NVMe SSDs), and high-bandwidth network connections (e.g., 100 Gbps Ethernet). Specialized hardware like GPUs or FPGAs can be used for tasks such as AI-driven fraud detection.

Metrics for Server Processing:

Servers can handle hundreds of thousands to millions of transactions per second (TPS). For instance, a server with 64 CPU cores might process around 500,000 TPS. Latency is typically low (1-10 milliseconds), and servers can scale horizontally by adding more machines to handle increased loads.

Phone Hardware Capabilities:

Using a Samsung phone as an example, specifications might include a dual-core high-performance CPU (like the Exynos or Snapdragon chips), 6GB of LPDDR4 RAM, up to 512GB of storage, and network connectivity via LTE modem and Wi-Fi 6.

Metrics for Phone Processing:

Phones are limited compared to servers, typically handling around 1,000 TPS locally due to constraints in CPU and memory resources. Latency is higher (50-100 milliseconds) due to network dependencies and lower processing power. Phones cannot scale like servers and are limited to single-device capabilities.

Processing 1 Billion Transactions:

Server Scenario:

A cluster of 10 high-performance servers each handling 500,000 TPS could process 5 million TPS. With considerations like load balancing and redundancy, servers can complete 1 billion transactions in about 200 seconds.

Phone Scenario: Processing locally or through a mobile app, a Samsung phone might handle 1,000 TPS. Offloading heavy processing tasks to cloud servers, optimizing network communication, and ensuring secure transactions are critical. Processing 1 billion transactions on a phone would take significantly longer, around 11.6 days, due to limited processing power and higher latency.

In summary, while both servers and phones can process transactions, servers excel in efficiency and scalability. For handling 1 billion transactions, servers with high-performance clusters are vastly more capable compared to individual phones.