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### **Part 1: Metro Station Scenario**

**a) Explain the computing concepts and parts to optimize:**

In the scenario described, the metro station in a refugee camp in India has logistical challenges due to a large population (900 million) and limited transportation capacity. Here are the computing concepts and parts to optimize:

* **Capacity Planning:** This involves calculating the maximum load (900 million people) and the capacity of the trains (1000 people per train) to ensure efficient transportation.
* **Resource Allocation:** Optimizing the scheduling of trains (10 trains with 2-way trips, totaling 20 trips) to maximize the throughput of passengers.
* **Algorithm Design:** Implementing algorithms for ticketing, boarding, and departure scheduling to minimize wait times and maximize efficiency.
* **Network Infrastructure:** Ensuring robust communication networks (both wired and wireless) to coordinate train schedules, ticketing systems, and passenger information.
* **Data Management:** Handling large volumes of passenger data (such as ticketing information, schedules, and passenger manifests) efficiently to ensure smooth operations.
* **Security:** Implementing security protocols to protect passenger data and ensure the safety of operations.

**b) Worst and best scenarios:**

* **Worst Scenario:** Inefficient scheduling leading to overcrowding, long wait times, and potential safety hazards due to the sheer volume of passengers.
* **Best Scenario:** Optimized scheduling, efficient ticketing systems, and quick turnaround times for trains, leading to minimal wait times and smooth operations.

### **Part 2: Phone Efficiency and Optimization**

In terms of a phone's efficiency and optimization for data storage, data transfer, and connectivity:

* **Data Storage:** Efficient use of flash storage with considerations for read/write speeds and capacity management.
* **Data Transfer:** Optimization of protocols (like Wi-Fi, Bluetooth, LTE) for speed and reliability, as well as adaptive bitrate streaming for media content.
* **Connectivity:** Utilization of antennas and signal processing techniques for maintaining stable connections, managing handoffs between networks (like Wi-Fi to LTE), and optimizing power consumption during data transfers.

### **Part 3: Server and Phone Hardware for Processing 1 Billion Transactions**

**a) Hardware Specifications and Metrics:**

* **Server:** High-performance CPUs (multi-core processors), sufficient RAM (large memory capacity), fast storage (SSDs), and scalable network interfaces (10GbE or higher) for handling concurrent transactions.
* **Phone:** Powerful CPUs (multi-core processors optimized for mobile), sufficient RAM (for multitasking and data caching), fast storage (UFS or similar), and advanced modem capabilities for handling data transfer.

**b) Metrics:**

* **Throughput:** Number of transactions processed per second (TPS).
* **Latency:** Average time taken for a transaction to be processed (response time).
* **Concurrency:** Number of transactions processed simultaneously without degradation in performance.

### **Part 4: Processing 1 Billion Transactions on Phone/Server**

To process 1 billion transactions efficiently:

* **Phone:** Utilize efficient multi-threading, batch processing, and asynchronous I/O for handling multiple transactions concurrently. Metrics would include TPS, latency per transaction, and battery usage per transaction.
* **Server:** Employ distributed computing (such as microservices architecture), load balancing, and horizontal scaling across multiple servers. Metrics would include TPS across the cluster, average response time, and network throughput.