

National University of Computer and Emerging Sciences (Lahore Campus)

Quiz 2: Application Layer (Chapter 2)

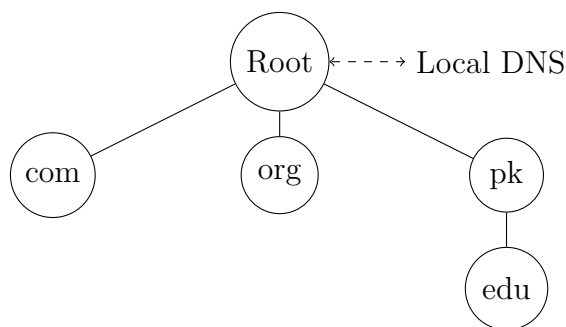
Name: _____ Roll No: _____ Section: BSE-6B1 (Spring 2026)

1. (5 points) DNS Resolution and Latency Calculation

A user requests `www.university.edu.pk`. The local DNS server caches nothing. The delays are:

- Local Host to Local DNS: 2 ms (One way).
- Local DNS to Root Server: 40 ms (RTT).
- Local DNS to .pk TLD Server: 35 ms (RTT).
- Local DNS to .edu.pk Authoritative Server: 20 ms (RTT).
- Local DNS to university.edu.pk Server: 15 ms (RTT).

The DNS resolution is **Iterative**. The RTT between the client and the web server is 50 ms. Assume a new TCP connection is established and requires one RTT for the TCP three-way handshake and one RTT for the HTTP request/response. Calculate the total time from clicking the link to receiving the initial HTTP response, assuming the Local DNS server must contact Root, then TLD, then Authoritative. The local DNS server must also query the final authoritative server for university.edu.pk to obtain the IP address.



Solution:

1. DNS Resolution Time:

$$T_{DNS} = 2 \text{ (Host} \rightarrow \text{DNS)} + 40 \text{ (Root)} + 35 \text{ (TLD)} + 20 \text{ (Auth)} + 15 \text{ (Server)} + 2 \text{ (DNS} \rightarrow \text{Host)}$$

$$T_{DNS} = 114 \text{ ms}$$

2. HTTP Connection & Response:

$$T_{HTTP} = 1 \times RTT_{HTTP} \text{ (TCP Handshake)} + 1 \times RTT_{HTTP} \text{ (HTTP Request)} = 2 \times 50 = 100 \text{ ms}$$

3. Total Time:

$$T_{Total} = 114 \text{ ms} + 100 \text{ ms} = \mathbf{214 \text{ ms}}$$

2. (10 points) **High-Latency HTTP & Parallel Connections**

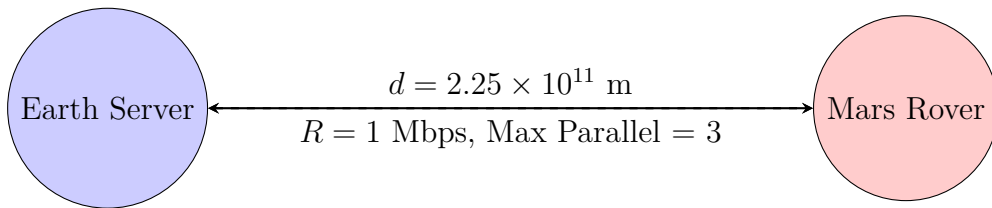
An automated rover on Mars needs to download a firmware update from a server on Earth. The update consists of one base HTML index file (size $L_b = 2$ KB) and 8 referenced binary objects (each size $L_o = 100$ KB).

The link characteristics are:

- Distance Earth-Mars: $d = 2.25 \times 10^{11}$ meters.
- Transmission Rate: $R = 1$ Mbps.
- The rover opens parallel TCP connections but is limited to a maximum of $K = 3$ parallel connections due to memory constraints.

Calculate the total time elapsed from the initial connection request until the last object is fully received. Assume:

- Short control packets (SYN, ACK, HTTP GET) have negligible transmission time compared to propagation delay.
- We are using **Non-Persistent HTTP** over the parallel connections.
- No DNS lookup is required (IP is hardcoded). Speed of light $c = 3 \times 10^8$ m/s.



Solution:

1. Calculations:

$$d_{prop} = \frac{2.25 \times 10^{11}}{3 \times 10^8} = 750 \text{ s} \implies RTT = 2 \times d_{prop} = 1500 \text{ s}$$

$$d_{trans(base)} = \frac{2 \text{ KB} \times 8}{1 \text{ Mbps}} = 0.016 \text{ s}, \quad d_{trans(obj)} = \frac{100 \text{ KB} \times 8}{1 \text{ Mbps}} = 0.8 \text{ s}$$

2. Step 1: Base File Download (Non-Persistent: 2 RTT + Trans)

$$T_{base} = 2 \times RTT + d_{trans(base)} = 3000 + 0.016 = 3000.016 \text{ s}$$

3. Step 2: 8 Objects with K=3 Parallel Connections We download objects in batches. Since $K = 3$, we need $\lceil 8/3 \rceil = 3$ batches. Note: Bandwidth is shared, so transmission time for 3 objects is $3 \times d_{trans(obj)}$.

- **Batch 1 (Obj 1-3):** $2RTT + 3 \times 0.8 = 3000 + 2.4 = 3002.4 \text{ s}$
- **Batch 2 (Obj 4-6):** $2RTT + 3 \times 0.8 = 3000 + 2.4 = 3002.4 \text{ s}$
- **Batch 3 (Obj 7-8):** $2RTT + 2 \times 0.8 = 3000 + 1.6 = 3001.6 \text{ s}$

4. Total Time:

$$T_{total} = 3000.016 + 3002.4 + 3002.4 + 3001.6 = \mathbf{12006.416 \text{ s}}$$