# National University of Computer and Emerging Sciences (Lahore Campus)

## Quiz 1: Computer Networks and the Internet (Chapter 1)

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

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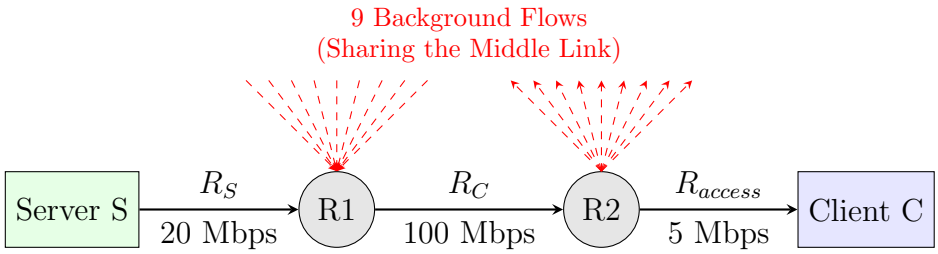
1. (5 points) **Throughput and Bottleneck Analysis**

   Consider the file transfer scenario shown below. Server $S$ sends a file to Client $C$ through two intermediate routers $R1$ and $R2$.

   - Link $S \rightarrow R1$: Rate $R_S = 20$ Mbps.
   - Link $R1 \rightarrow R2$: Shared link, Rate $R_C = 100$ Mbps. This link is shared by 9 other background traffic flows (assume all are working at full capacity).
   - Link $R2 \rightarrow C$: Rate $R_{access} = 5$ Mbps.
   - The 9 background flows consume exactly 10 Mbps each of the middle link ($R1 \rightarrow R2$).

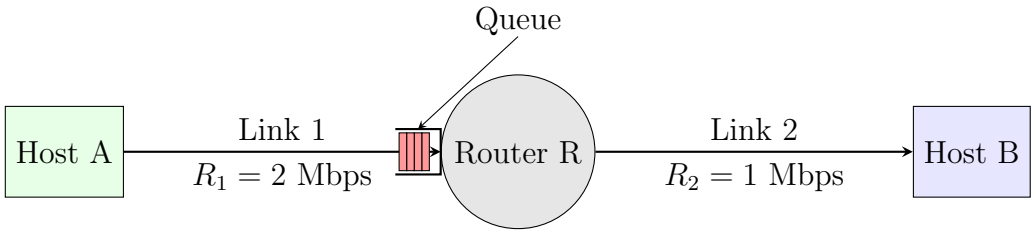
   
   

   Calculate the throughput for the file transfer from $S$ to $C$. Show the available bandwidth for each link and identify the bottleneck link.

2. (10 points) **Nodal Delays and Queuing Dynamics**

Consider a packet-switched network where Host A sends a burst of $N = 10$ packets back-to-back to Host B via a single Router R.

- **Link 1 (A $\rightarrow$ R):** Transmission Rate $R_1 = 2$ Mbps. Propagation Delay $d_{prop1} = 10$ ms.
- **Link 2 (R $\rightarrow$ B):** Transmission Rate $R_2 = 1$ Mbps. Propagation Delay $d_{prop2} = 10$ ms.
- **Packet Size:** All packets have a length $L = 2000$ bits.
- **Processing Delay:** Negligible at Router R ($d_{proc} \approx 0$).
- **Queuing:** Router R has a buffer. Since $R_1 > R_2$, packets arrive at R faster than they can be transmitted to B, causing a queue to build up.




(a) (4 points) Calculate the **Transmission Delay** per packet for Link 1 ($d_{trans1}$) and Link 2 ($d_{trans2}$). Notice that a queue builds up at Router R.

(b) (6 points) Calculate the **Queuing Delay** experienced specifically by the **10th packet** at Router R.