Tarea Corta 1

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1 Latency Calculation

Given:

- Total data to send: 1024 Mb (megabits)
- Link bandwidth: 16.4 Mbps (megabits per second)
- Packet size: 8 Mb per packet
- Acknowledgment (ACK) size: 8 bytes $\approx$ 64 bits (though negligible in sending time at 16.4 Mbps)
- Packet loss: 2.5%
- Total transfer time: 10 minutes = 600 seconds
- "Stop-and-Wait" behavior: The server sends one packet, *waits* for the ACK, then sends the next.

Step 1: Number of packets

1. **Number of packets:**

$$N_{\text{ideal}} = \frac{1024\,\text{Mb}}{8\,\text{Mb per packet}} = 128 \text{ packets.}$$

2. **With 2.5% loss (Stop-and-Wait):**

   - Probability of a packet successfully arriving: $1 - 0.025 = 0.975$.
   - Expected transmissions per successful packet: $\frac{1}{0.975} \approx 1.0256$.
   - Hence the **expected total transmissions**:

$$N_{\text{actual}} = 128 \times \frac{1}{0.975} \approx 131.3.$$

Step 2: Time to send one data packet

Each 8 Mb packet over a 16.4 Mbps link takes

$$T_{\text{data}} \;=\; \frac{8\,\text{Mb}}{16.4\,\text{Mbps}} \;\approx\; 0.488\,\text{seconds}.$$

Step 3: Incorporating latency (propagation delay)

Let:

$$L = (\text{one-way latency of the link in seconds}).$$

Then the round-trip time (RTT) is approximately $2L$. Because this is a Stop-and-Wait scheme, each packet cycle occupies roughly:

$$T_{\text{cycle}} \;=\; T_{\text{data}} \;+\; (\text{round-trip wait for ACK}) \;=\; T_{\text{data}} + 2L.$$

Step 4: Total Transfer Time

The *total* transfer time is the number of (re)transmissions times the per-transmission cycle time:

$$T_{\text{total}} \;=\; N_{\text{actual}}\,\bigl(T_{\text{data}} + 2L\bigr).$$

We know $T_{\text{total}} = 600\,\text{seconds}$. Substituting:

- $N_{\text{actual}} \approx 131.3$
- $T_{\text{data}} \approx 0.488\,\text{s}$

Hence,

$$600 \;=\; 131.3\,\Bigl(0.488 \;+\; 2L\Bigr).$$

Solve for L:

$$\frac{600}{131.3} \;\approx\; 4.57 \;=\; 0.488 + 2L.$$

$$4.57 \;-\; 0.488 \;=\; 4.082 \;\approx\; 2L.$$

$$L \;=\; \frac{4.082}{2} \;\approx\; 2.04\,\text{seconds (one-way latency)}.$$

Answer: The (one-way) latency of the link is about **2** seconds, which implies a ~ 4 second RTT.

2 "You Can Buy More Bandwidth, but You Cannot Buy Less Delay"

- **Bandwidth** (capacity) can be increased (often literally by paying for a faster connection, upgrading lines, or subscribing to a bigger pipe). In short: paying more can provision more bandwidth.

- **Delay** (latency), however, depends on:
  - Physical distance the signals must travel
  - Speed of propagation (near speed of light in fiber, slower in satellite)
  - Switching/queuing latencies in intermediate nodes

  These factors impose a hard limit that you cannot simply "buy away" if the distance is fixed.

3 Comparing Datagram vs. Virtual-Circuit Networks

Aspect	**Datagram Network**	**Virtual Circuit (VC) Network**
Circuit Setup	No call setup. Each packet is independent.	Requires call setup to establish a path (circuit) before sending.
Addressing Scheme	Each packet carries the full destination address.	Each packet carries a short VC identifier (since path is fixed).
Routing	Routers choose paths *per packet*; routes can vary if the network changes.	Route chosen once (during setup). All packets follow that route.
Router Failure	If a router fails, packets can be rerouted dynamically.	If a router on the path fails, the VC breaks; must re-establish.
Quality of Service	Harder to guarantee, since no fixed path is reserved.	Easier to offer QoS guarantees, as resources can be reserved along the VC.

Table 1: Datagram vs. Virtual-Circuit networks comparison.

Key Takeaways

- **Datagram (IP-like)**: flexible, robust against single-point failures, but no guaranteed QoS.
- **Virtual Circuit (ATM- or MPLS-like)**: set up a path with possible resource reservations, providing more consistent performance but less flexibility if nodes fail.

4 Conclusion

1. The latency of a stop-and-wait transfer is found by balancing the total time, the number of packets, sending time per packet, and round-trip delay. In our case, that yielded about **2** seconds of one-way latency.

2. *"You can buy more bandwidth, but you cannot buy less delay."* The distance and speed of light impose *hard limits* that money alone cannot overcome.

3. Datagram vs. Virtual Circuit networks differ in how they handle setup, addressing, routing, fault tolerance, and QoS.