

EECS 489 - Winter 2024

Discussion 2

Reminders

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- Assignment 1 is due **Monday, January 29th @ 11:59 pm EST**
- Please make sure to, if not done already:
 - Register your GitHub username: <https://forms.gle/BqSfeEdf7RhYWZyu9>
 - Join our GitHub organization (from invite)
 - Use your private p1-username repo to submit and upload your work
 - Fill out the Group Form: <https://forms.gle/Ydmwn92yB13m1zDC9>
 - Please make sure the usernames are correct, and use SPACES
- Autograder: <https://eecs489.eecs.umich.edu/>

Today

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- Performance Metrics
 - Delay
 - Throughput
- Examples

Performance Metrics: Delay

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- Delay: How much time passes between sending and receiving some data across a network
- Link Properties:
 - Transmission Delay
 - Propagation Delay
- Traffic Mix and Switch Internals:
 - Processing Delay
 - Queueing Delay (usually negligible)

Performance Metrics: Throughput

- $\text{Throughput} = \text{Data Transferred} / \text{Time to Transfer}$
- $\text{Time to Transfer} = \text{Transmission Delay} + \text{Propagation Delay}$

Performance Metrics: Q1

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- Suppose a 100-Mbps point-to-point link is being set up between Earth and a new lunar colony on the Moon.
- The distance between this colony and Earth is approximately 385,000 km and data travels over the link at the speed of light (3×10^8 m/s)

1. Calculate the minimum RTT (Round Trip Time) for the link

Performance Metrics: Q1

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1. Calculate the minimum RTT (Round Trip Time) for the link

$$\text{Propagation Delay} = 385,000\text{km} / (3 \times 10^5 \text{ km/s}) = 1.283333 \text{ seconds}$$

$$\text{RTT} = 2 * \text{propagation delay} = 2 * 1.283333 \text{ s} = 2.566666 \text{ seconds}$$

Performance Metrics: Q1

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- Suppose a 100-Mbps point-to-point link is being set up between Earth and a new lunar colony on the Moon.
 - The distance between this colony and Earth is approximately 385,000 km and data travels over the link at the speed of light (3×10^8 m/s)
2. **Suppose Mission Control on Earth wishes to download a 25 MB ($1\text{MB} = 10^6$ B) image from a camera on the lunar colony. What is the minimum time that will elapse between when the request for the data goes out and the transfer is finished? What is the throughput?**

Performance Metrics: Q1

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 - The distance between this colony and Earth is approximately 385,000 km and data travels over the link at the speed of light (3×10^8 m/s)
- 2. Suppose Mission Control on Earth wishes to download a 25 MB (1MB = 10^6 B) image from a camera on the lunar colony. What is the minimum time that will elapse between when the request for the data goes out and the transfer is finished? What is the throughput?**

Transmission Delay = $25 \text{ MB} / 100 \text{ Mbps} = 25 \times 8 / 100 = 2 \text{ seconds}$

Delay = RTT + Transmission Delay = $2.56666 + 2 = 4.56666 \text{ seconds}$

Throughput = $25 \text{ MB} \times 8 / (2 + 1.283333) = 60.9 \text{ Mbps}$

Performance Metrics: Q1

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- Suppose a 100-Mbps point-to-point link is being set up between Earth and a new lunar colony on the Moon.
- The distance between this colony and Earth is approximately 385,000 km and data travels over the link at the speed of light ($3 * 10^8$ m/s)

3. What is the maximum number of flying bits on the link

Performance Metrics: Q1

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- The distance between this colony and Earth is approximately 385,000 km and data travels over the link at the speed of light (3×10^8 m/s)

3. What is the maximum number of flying bits on the link

bits = Propagation Delay * Bandwidth = $1.283333\text{s} \times 100 \text{ Mbps} = 1.2833 \times 10^8$ bits

Performance Metrics Q2

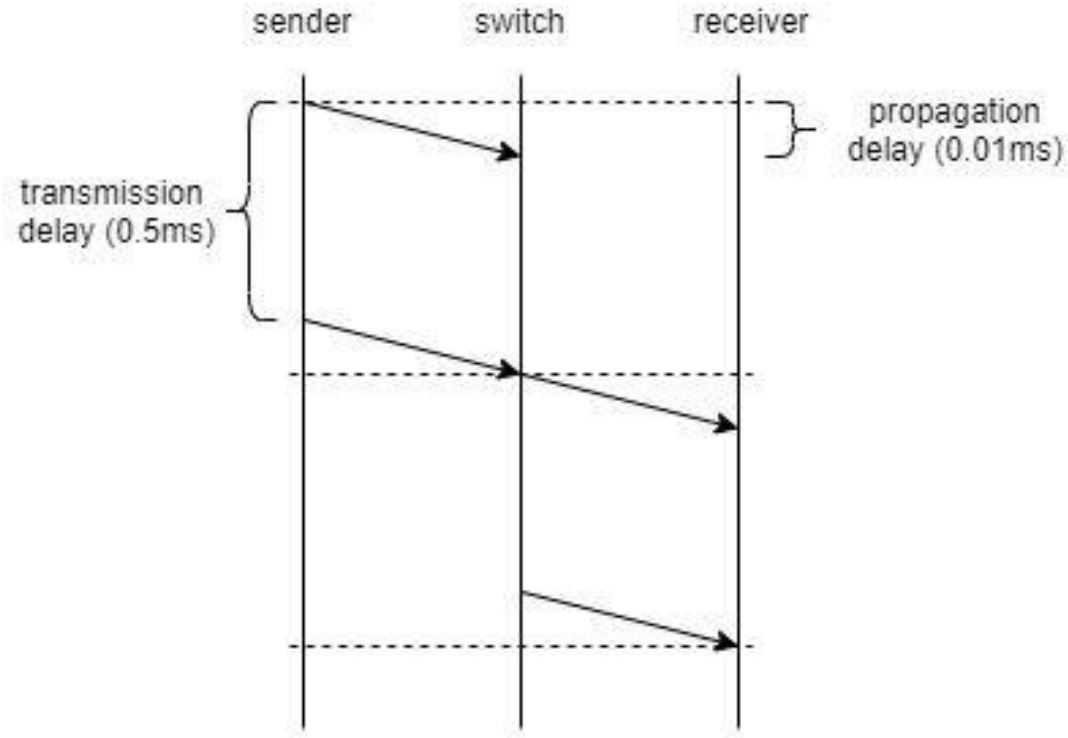
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- Calculate the latency (from first bit sent to last bit received) for the following problems
1. **A 10-Mbps link with a single store-and-forward switch in the path, and a packet size of 5,000 bits. Assume that each section of the link introduces a propagation delay of 10 microseconds, and that the switch begins retransmitting immediately after it has finished receiving the packet.**

Performance Metrics Q2

$$((5000b / 10Mbps) + 10\mu s) * 2$$

$$= 1.02ms$$



Performance Metrics Q2

- — —
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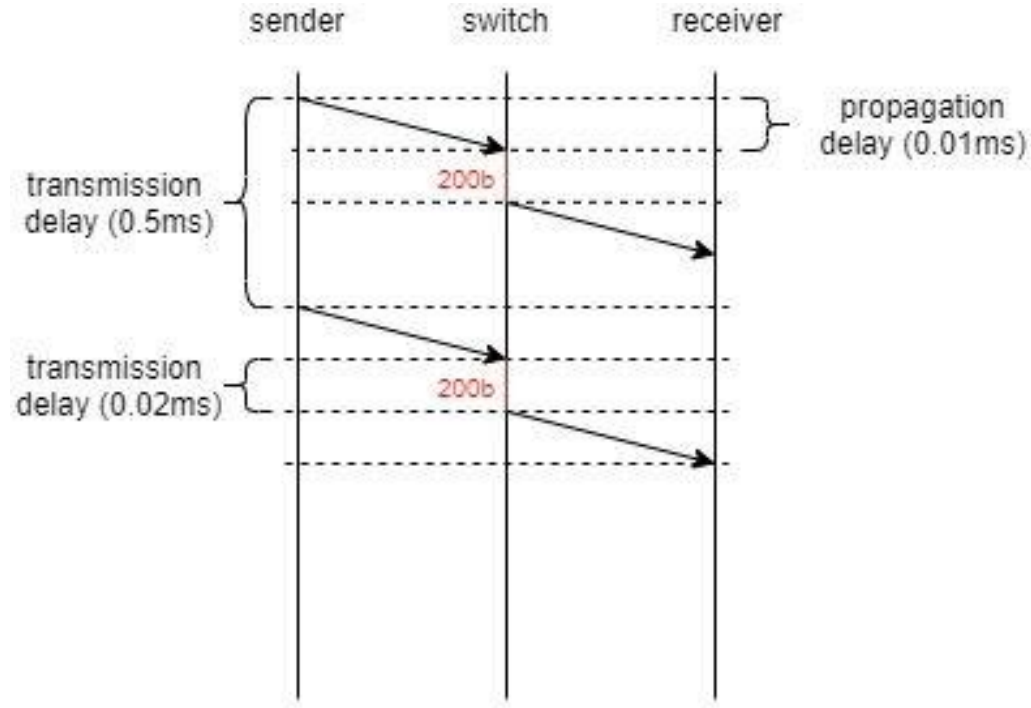
Performance Metrics Q2

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- Calculate the latency (from first bit sent to last bit received) for the following problems
2. **A 10-Mbps link with a single cut-off switch in the path, and a packet size of 5,000 bits. Assume that each section of the link introduces a propagation delay of 10 microseconds, and that the switch begins retransmitting immediately after the first 200 bits have been received.**

Performance Metrics Q2

 $0.51\text{ms} + (200\text{ b} / 10\text{ Mbps})$
 $+ 10\mu\text{s} = 0.54\text{ms}$



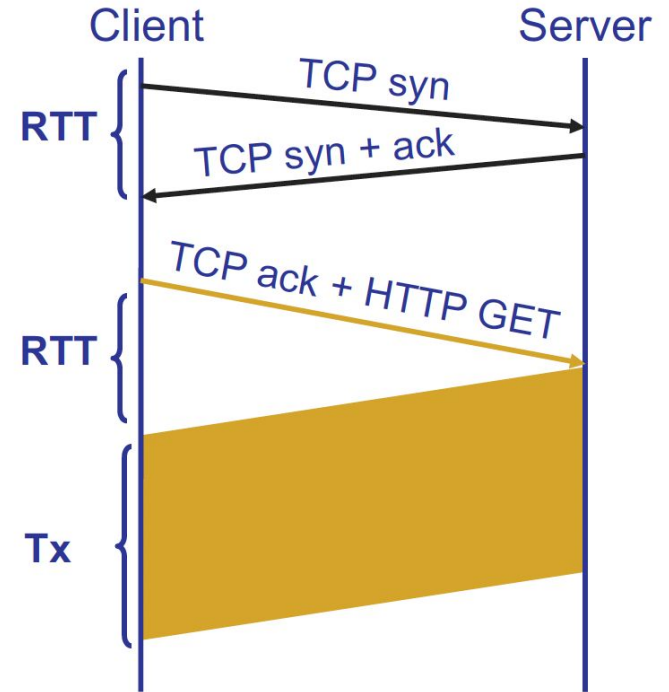
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$$0.51\text{ms} + (200 \text{ b} / 10 \text{ Mbps}) + 10\mu\text{s} = 0.54\text{ms}$$

Performance Metrics Q3

- What is the object request response time if propagation delay is 0.15ms and transmission delay is 0.5ms?

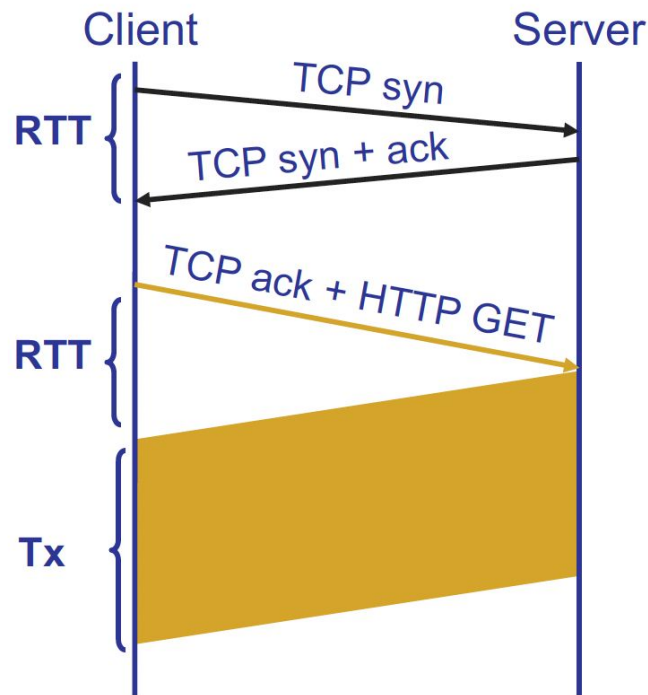


Performance Metrics Q3

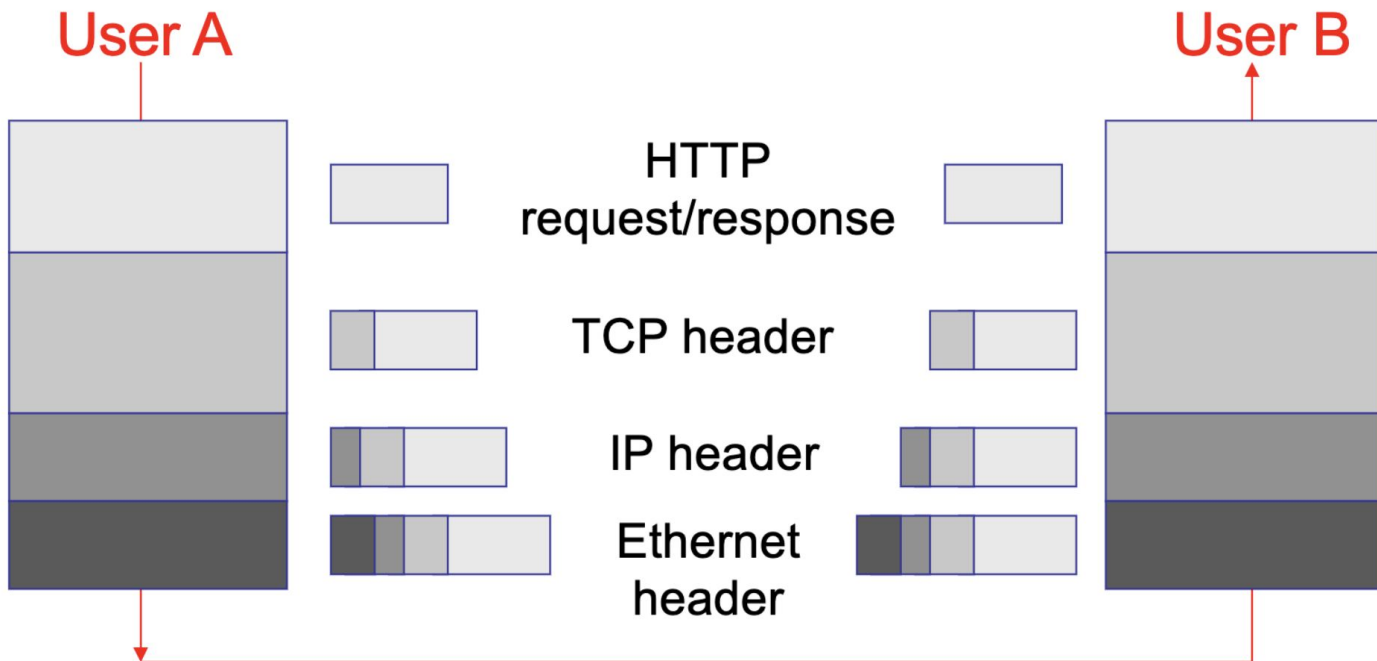
- What is the object request response time if propagation delay is 0.15ms and transmission delay is 0.5ms?

$RTT = 2 * \text{propagation delay} = 0.3\text{ms}$

$\text{Total} = 2 * RTT + \text{Transmission Delay}$
 $= 0.6\text{ms} + 0.5\text{ms} = 1.1\text{ms}$



Network Layer



Wrap-Up

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- Thanks for coming!
- Continue (or please start) working on Assignment 1!