15-441/641: Computer Networks

Midterm Review

15-441 Fall 2019

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Carnegie Mellon University

Brought to you by…

Don’t come within 5 feet of me unless you want to get sick before the exam

But I want you all to rock this test so here I am!

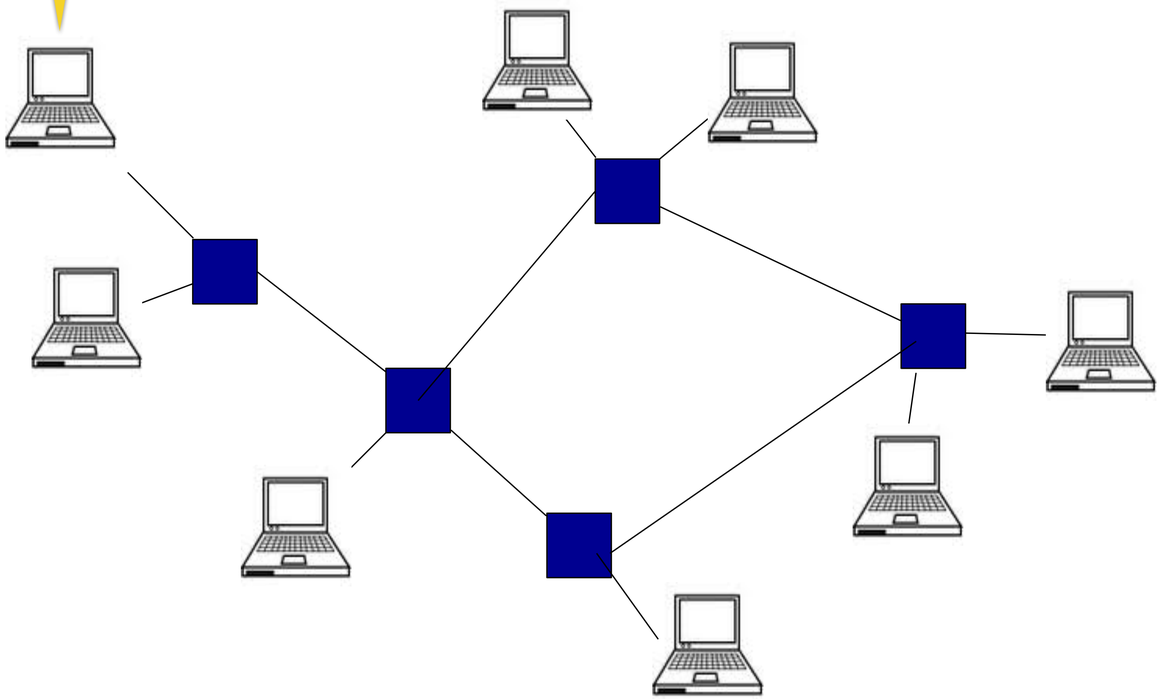
Today's Agenda

- Piazza Questions
  - Answers to your questions
- Math
  - A tough question from last year's midterm
- Internet Scavenger Hunt
  - <u>You need to know how all the pieces fit together</u>

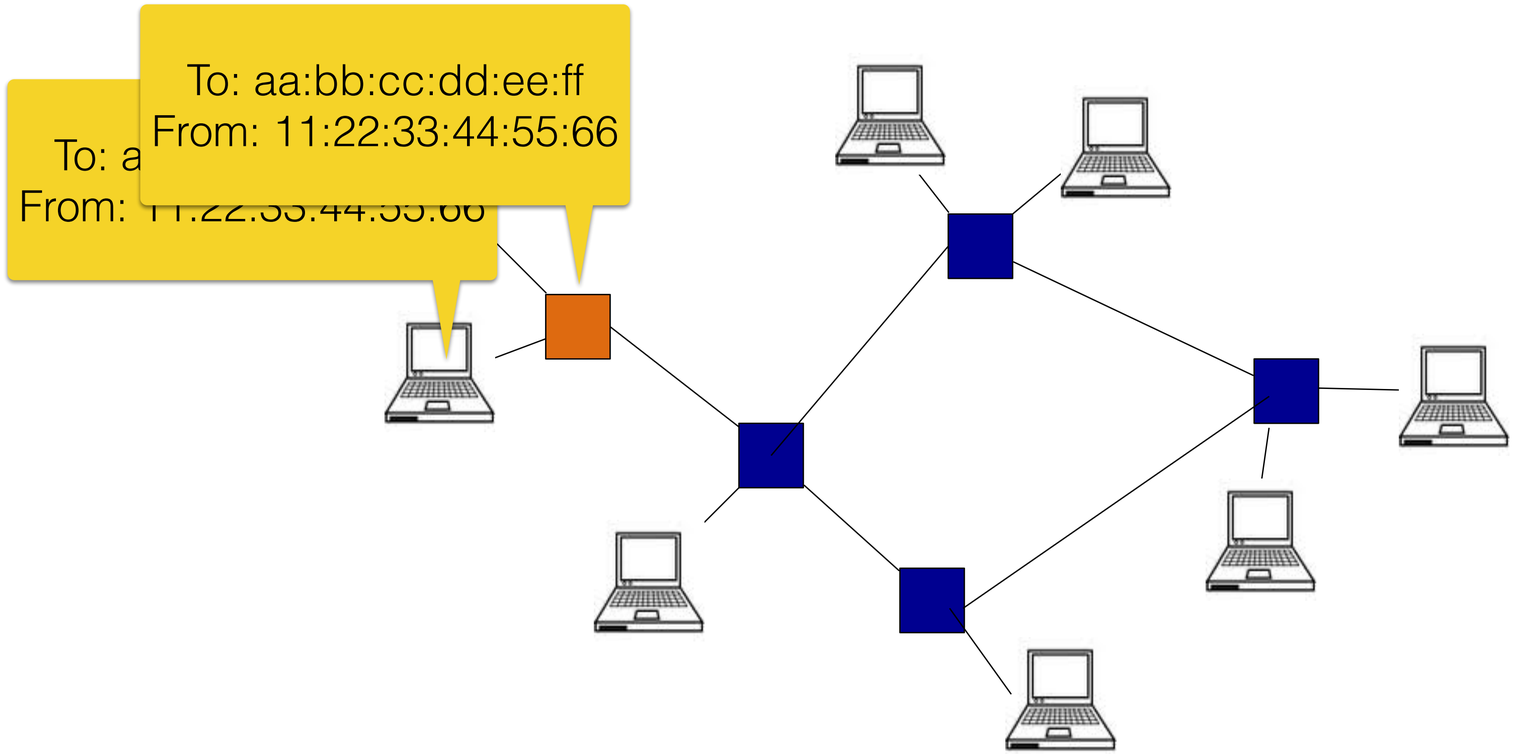
After running the spanning tree algorithm in LAN and finding the shortest path from every node to root node, how do 2 non-root nodes find path to reach each other?

Routing, Generation 1: Broadcast

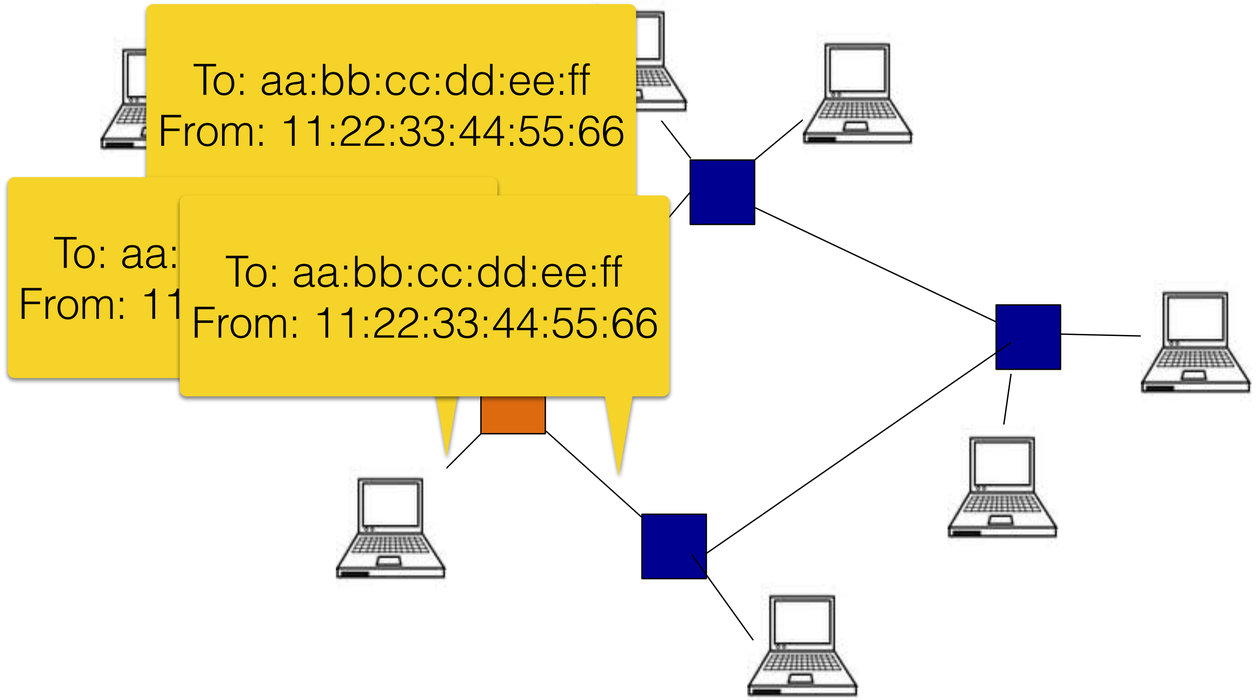
To: aa:bb:cc:dd:ee:ff
From: 11:22:33:44:55:66



Routing, Generation 1: Broadcast



Routing, Generation 1: Broadcast



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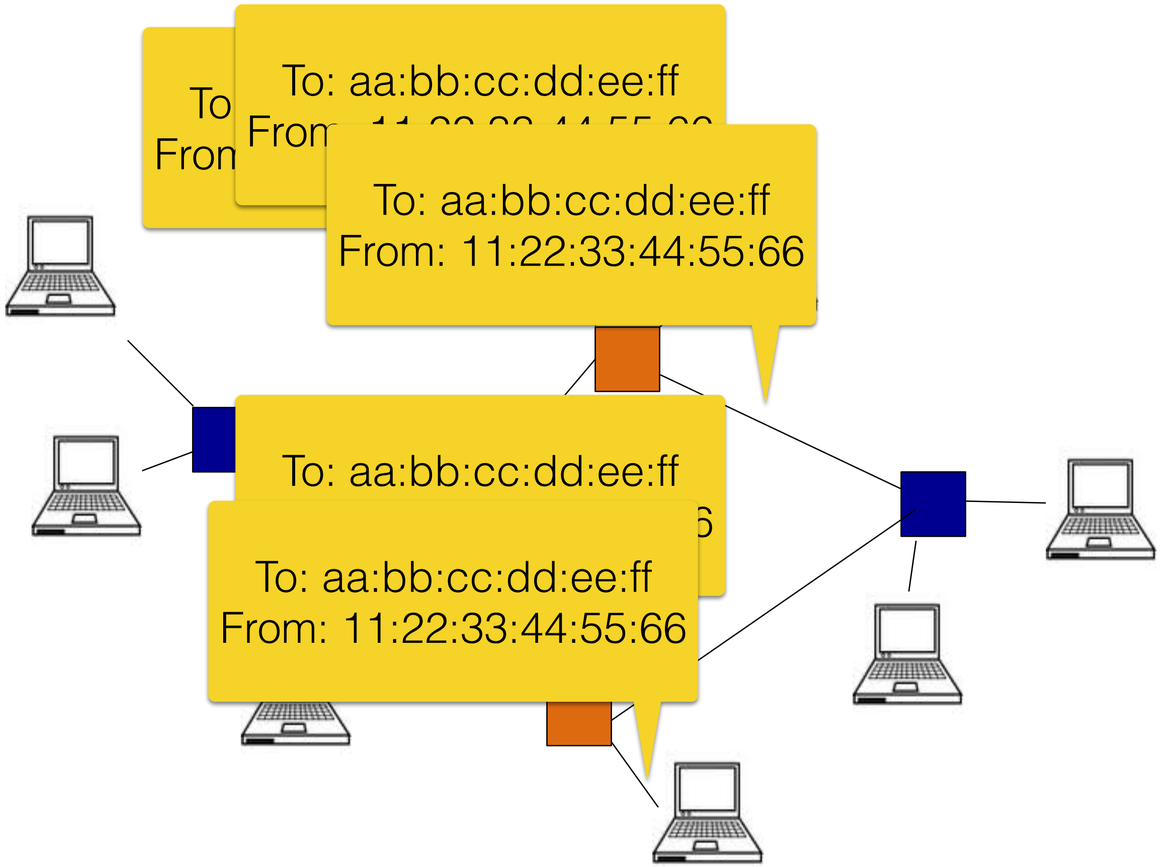

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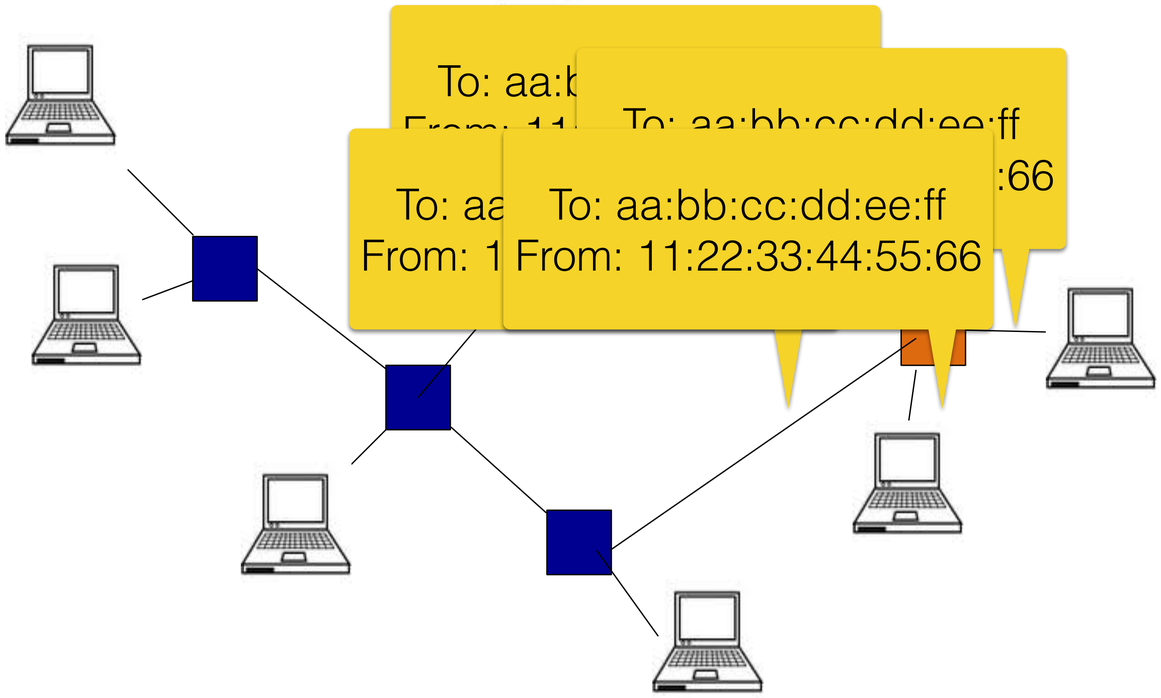
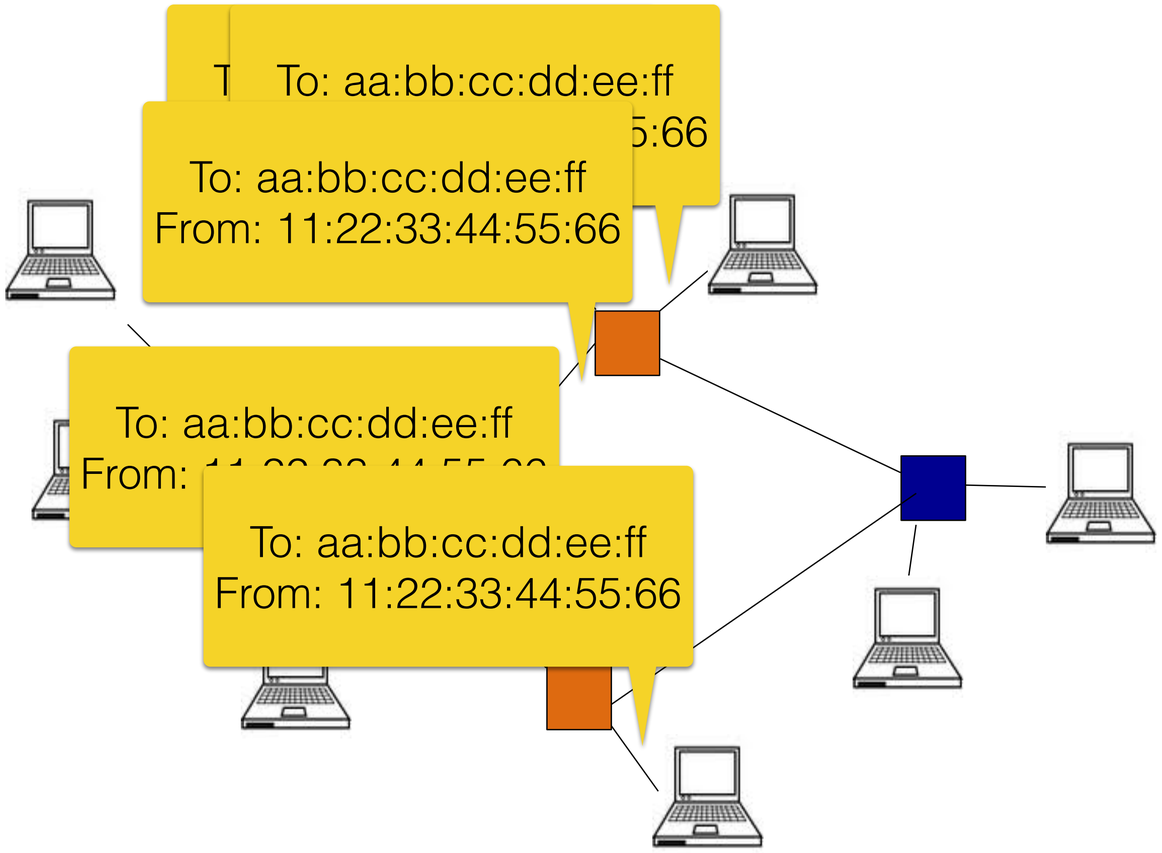
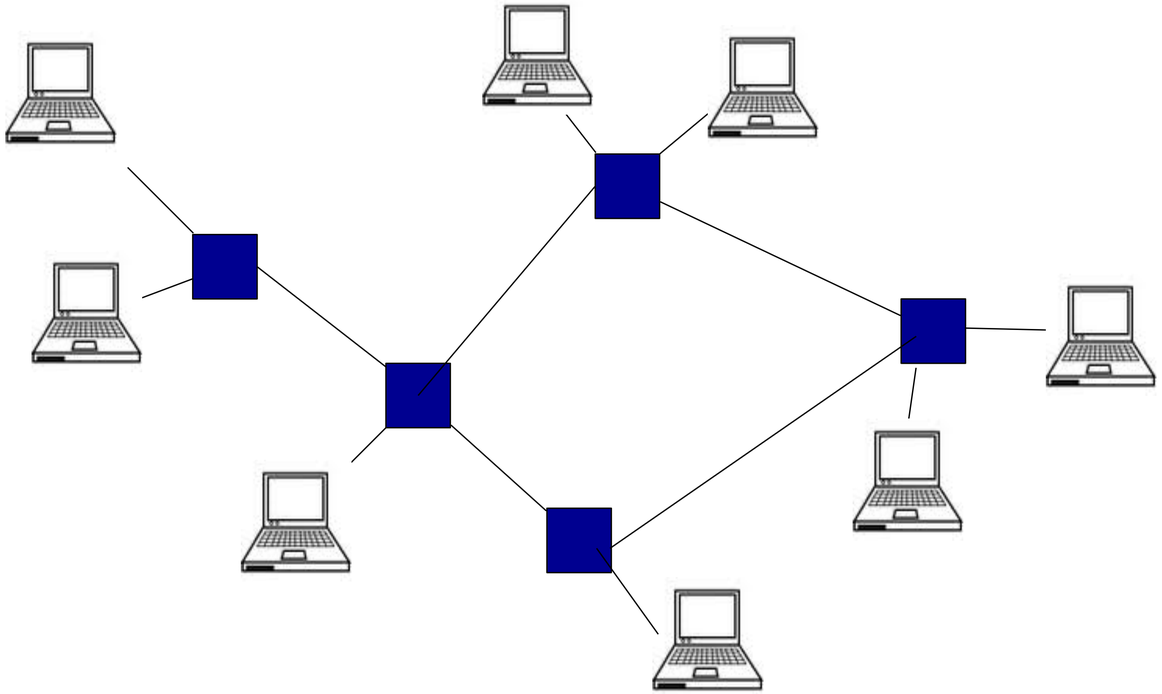


Routing, Generation 1: Broadcast

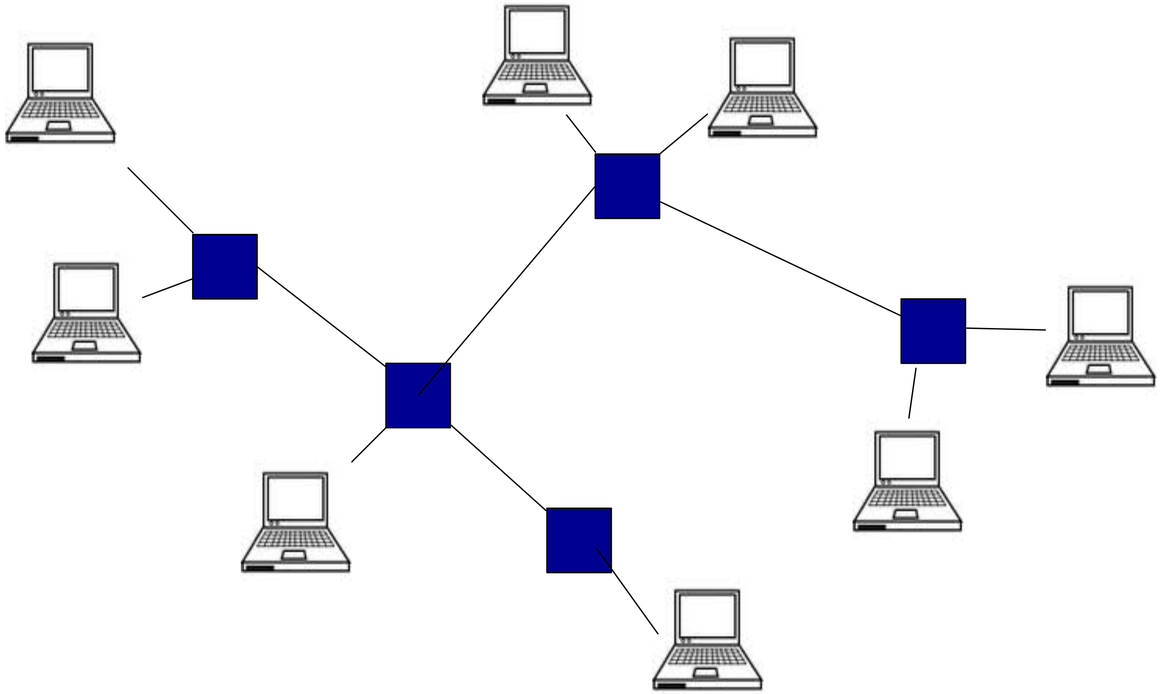


Just make your network be a tree.

How do we turn this…

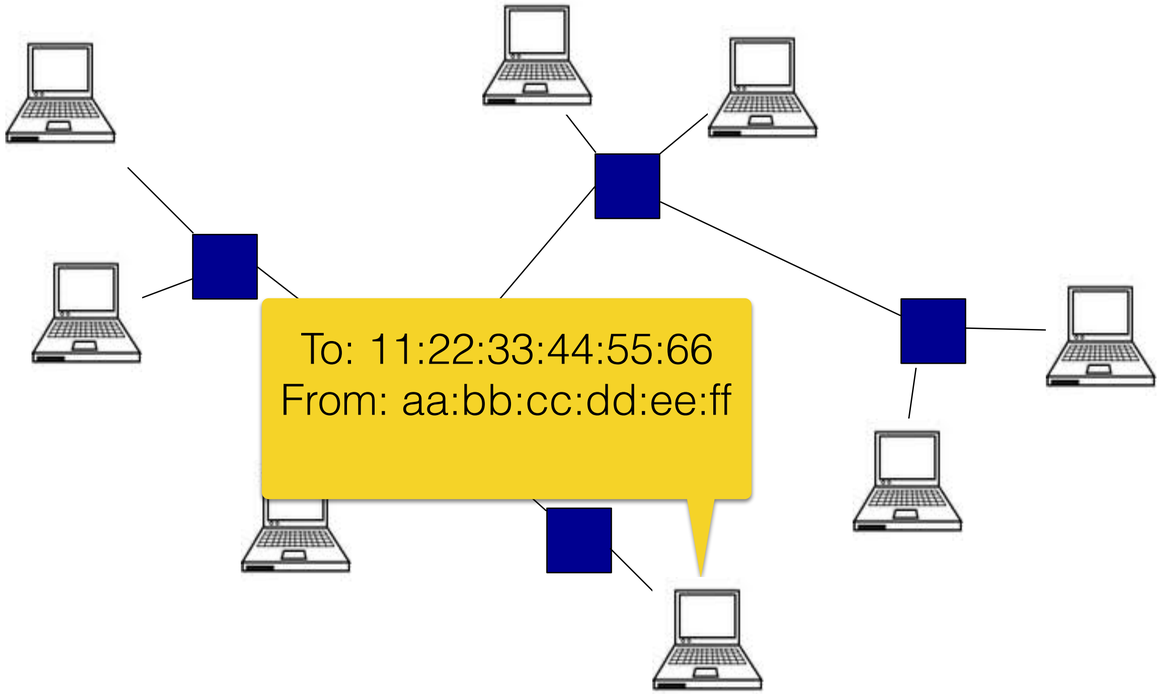


…into this?



Spanning Tree Protocol (STP) turns the network into a tree and therefore prevents broadcast storms.

The Only Smart Thing In Gen 1: Learning Bridges

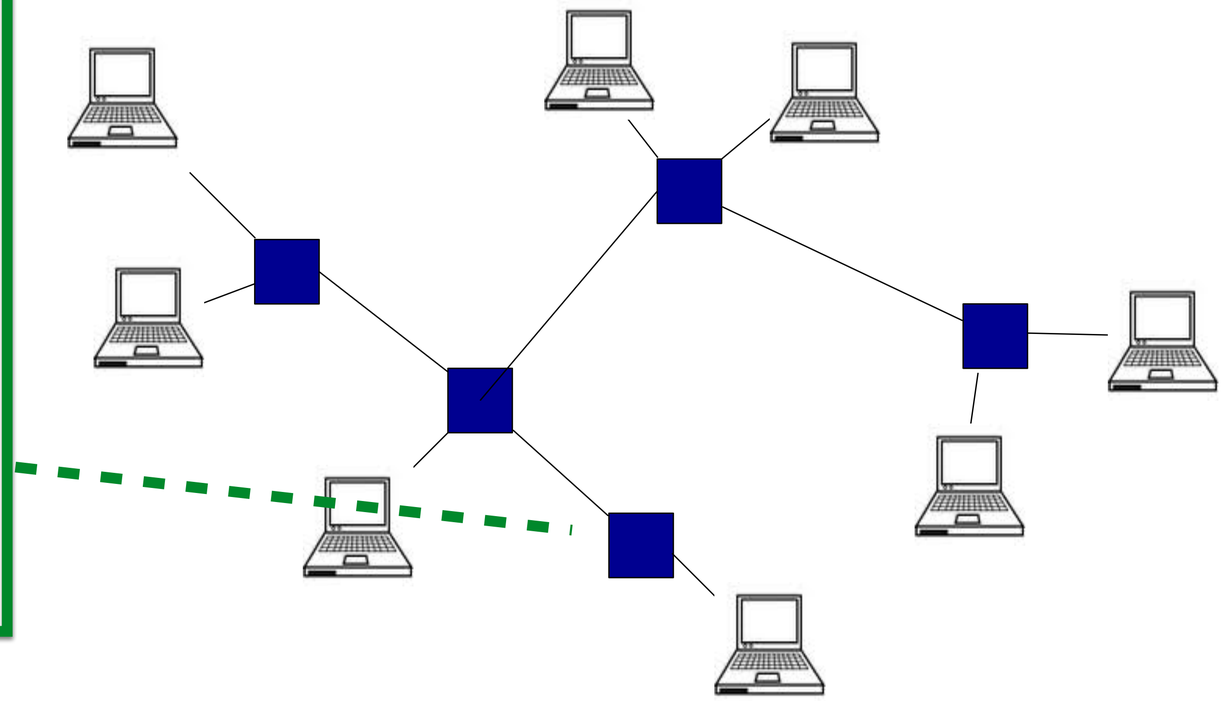


What Happens When aa:bb:cc:dd:ee:ff replies? Does everyone hear it again?

The Only Smart Thing In Gen 1: Learning Bridges

Every switch maintains a table: “If you want to send a packet to this MAC address, send it on this port.”

MAC Address	Port	Age
A21032C9A591	1	36
99A323C90842	2	01
112233445566	2	15
301B2369011C	2	16
AABBCCDDEEFF	1	11



Learning Switch Algorithm

Receive_Packet (packet, ingress_port, time_now):
  Is Source MAC Address in Table?
    If no, insert source (address, ingress_port, time) into table

  Is Destination MAC address in Table?
    If no, send out all ports (except the one it came in on)!!
      (except ingress_port)
    If yes, just send out the port from table

Clean_Up(time_now):
  foreach entry:
    if (time_now - entry.time) is big
      delete entry

MAC Address	Port	Age
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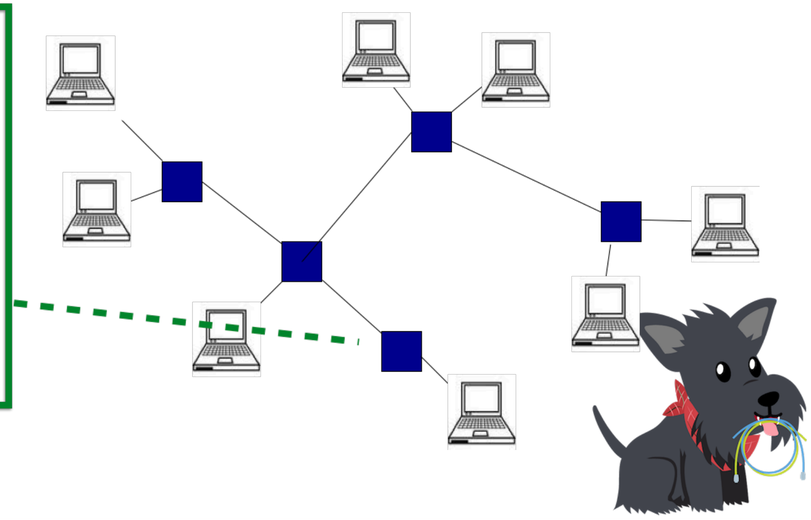


The TCP Reno graph on the first page of sample question shows vertical line between detecting a loss of packet and fast-recovery, isn't that supposed to be a slope?

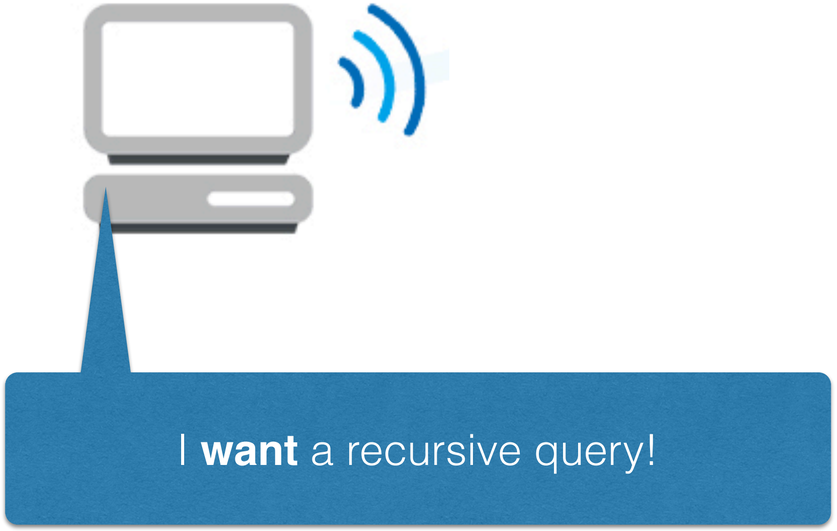
A: Sort of? It drops by 1/2 all at once. Technically there is a tiny tiny slope because time is continuous.

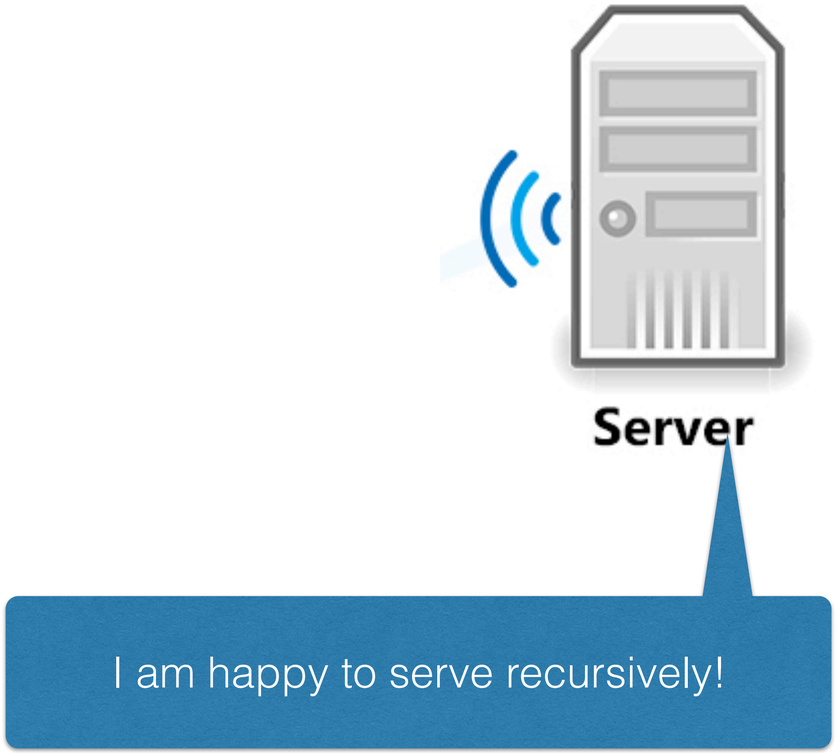
When timeout / packet loss is detected, will the cwnd and ssthresh change at exactly that time or the next RTT?

A: The values are updated immediately. Remember that time, in the real world, is continuous, not discrete…

How can we determine whether a DNS server will resolve a query iteratively versus recursively?

Do you want a recursive query?





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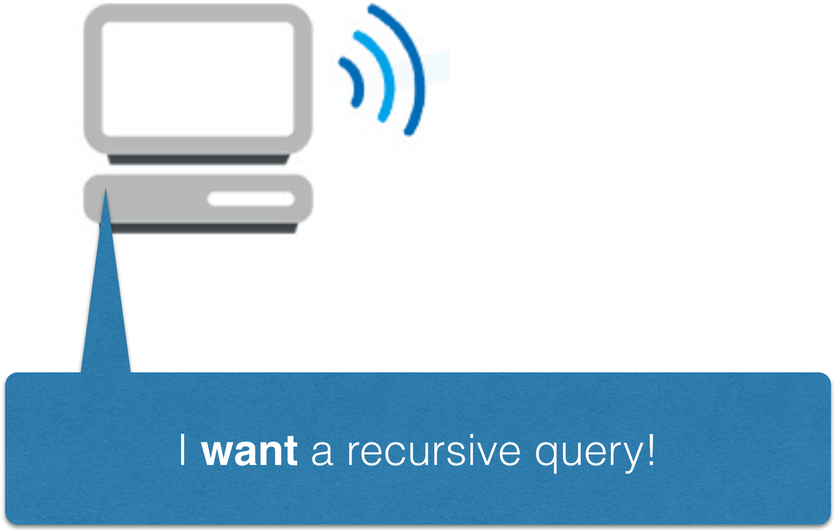

I **want** a recursive query!

I don’t want to serve recursive queries!

Do you want a recursive query?

I **do not want** a recursive query!

I am happy to serve recursively!

Do you want a recursive query?

Header flags format

Field	Description	Length (bits)
QR	Indicates if the message is a query (0) or a reply (1)	1
OPCODE	The type can be QUERY (standard query, 0), IQUERY (inverse query, 1), or STATUS (server status request, 2)	4
AA	Authoritative Answer, in a response, indicates if the DNS server is authoritative for the queried hostname	1
TC	TrunCation, indicates that this message was truncated due to excessive length	1
RD	Recursion Desired, indicates if the client means a recursive query	1
RA	Recursion Available, in a response, indicates if the replying DNS server supports recursion	1
Z	Zero, reserved for future use	3
RCODE	Response code, can be NOERROR (0), FORMERR(1, Format error), SERVFAIL (2), NXDOMAIN (3, Non existent domain), etc.[31]	4

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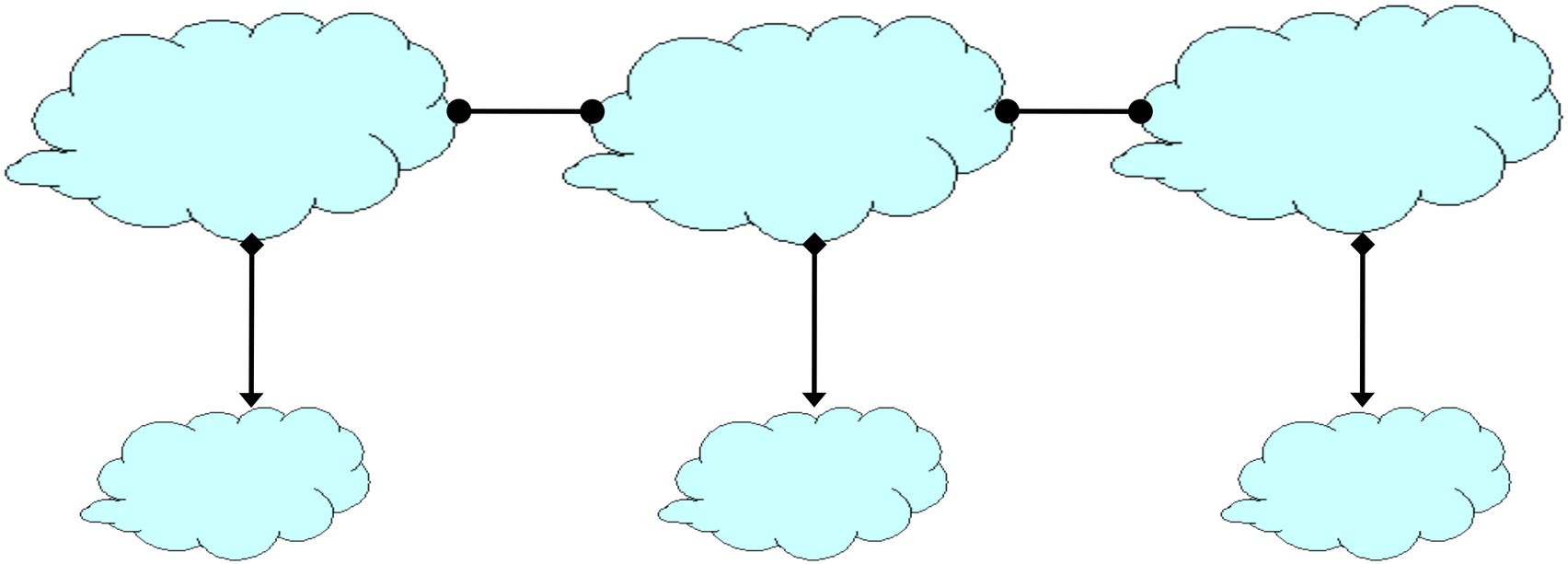
Will an AS advertise its customer's customers to its providers, customers and peers?

A: Yes! A network will always announce routes that can *earn it money*. In this case, if the customer forwarded the route to the network, the network will earn money forwarding traffic to its customer (and its customer will earn more forwarding to the customer's customer!)

Business Relationships



Relations between ASes

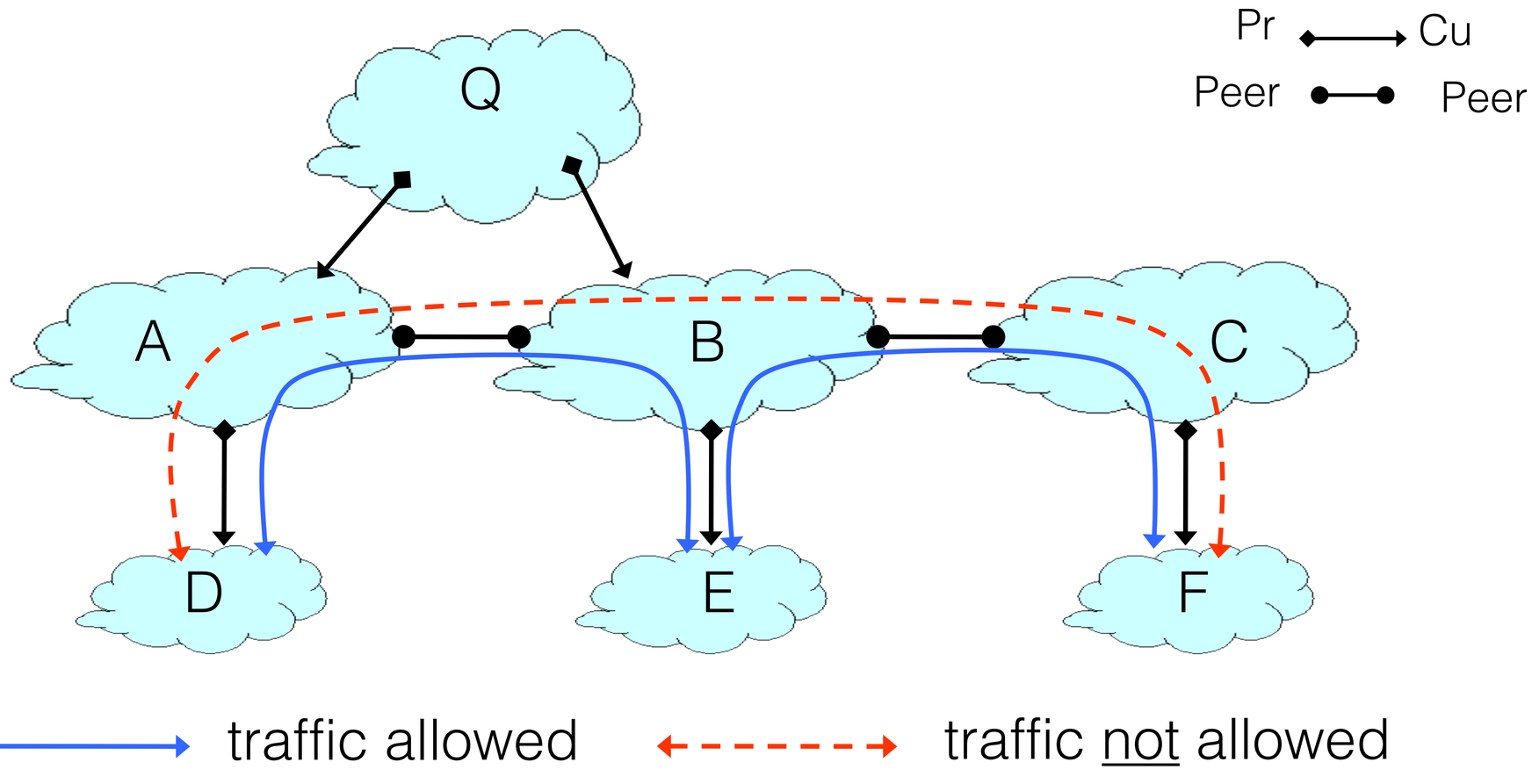
provider ⟶ customer

peer ⟷ peer

Business Implications

- **Customers pay provider**
- Peers don’t pay each other

Routing Follows the Money!

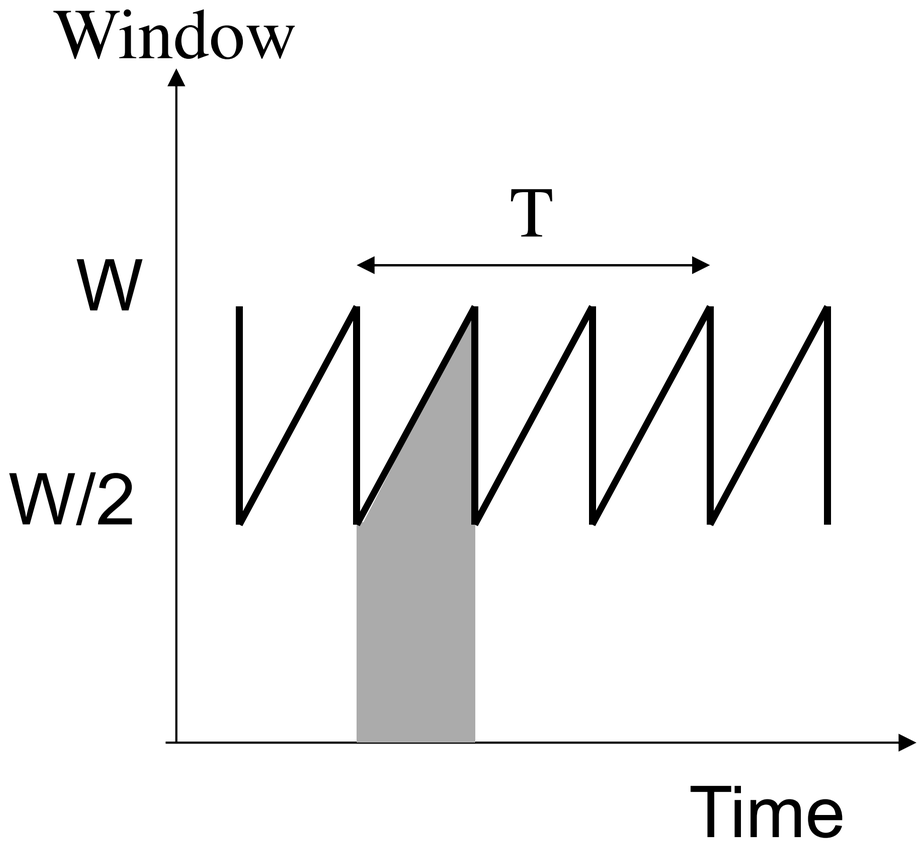


- ASes provide “transit” between their customers
- Peers do not provide transit between other peers

Math!

Deriving the Mathis Equation

1. (16 points) In class, we presented a formula that represents the throughput of TCP as a function of the MTU, roundtrip time, and packet loss rate, assuming there are no timeouts. In this question we will derive this formula. You should assume the RTT is fixed.



From the Mathis Paper

Solving for W we get:

$$W = \sqrt{\frac{8}{3p}} \tag{1}$$

Substitute W into the bandwidth equation below:

$$BW = \frac{data\ per\ cycle}{time\ per\ cycle} = \frac{MSS * \frac{3}{8}W^2}{RTT * \frac{W}{2}} = \frac{MSS/p}{RTT\sqrt{\frac{2}{3p}}} \tag{2}$$

Collect the constants in one term, $C = \sqrt{3/2}$, then we arrive at:

$$BW = \frac{MSS}{RTT}\frac{C}{\sqrt{p}} \tag{3}$$

(Blank slide for you to take notes)

(Blank slide for you to take notes)

And now: An Internet Scavenger Hunt

- Many students have a hard time trying to “connect” all of the layers of the Internet we have discussed.
  - What is L2? What is L3? Where does a packet go?
- This Scavenger Hunt is a fun way to get a “feel” for where all the pieces go.

And now: An Internet Scavenger Hunt

- Form teams of at most 4 people.
- Navigate to: https://github.com/computer-networks/scavenger-hunt
- There are 8 clues, 7 of which are encrypted.
  - The answer to each clue is the key to decrypt the next clue.
- There will be **two** winning teams:
  - (a) The team that finds the answer to clue 8 first.
  - (b) The team that provides the most first “hints” to other teams on the chalkboard.