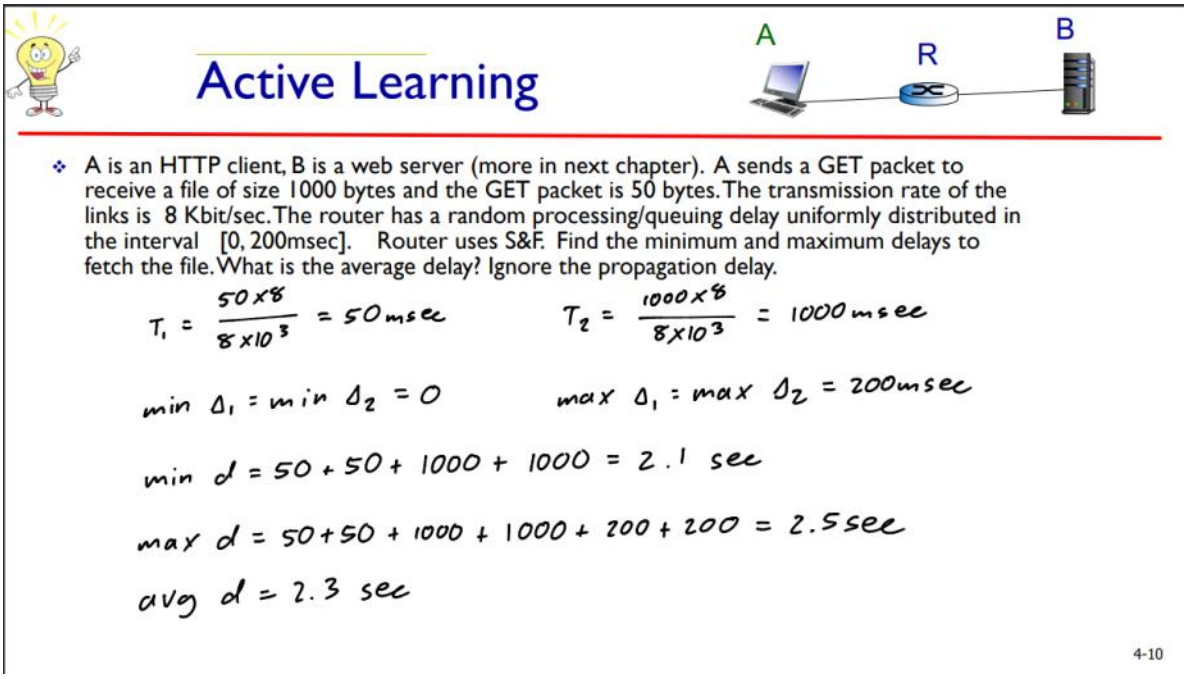
Active Learning

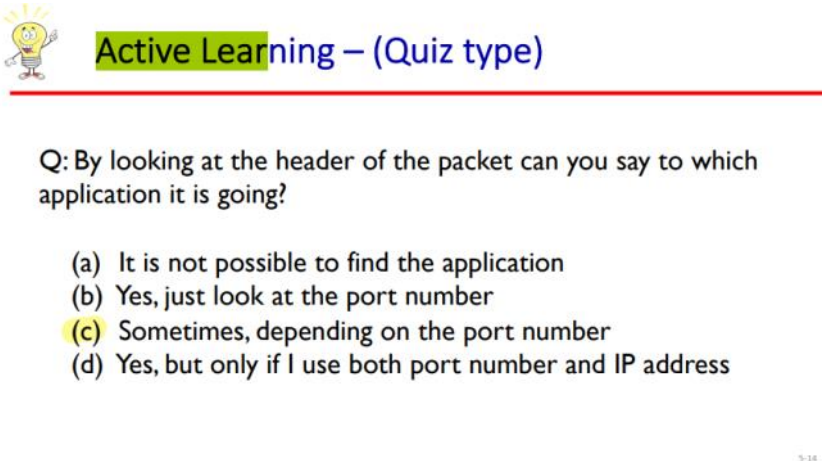
Monday, April 17, 2023 3:39 PM

Interactive Problems, Computer Networking: A Top Down Approach (umass.edu) **???**

Lecture 4:----------



Lecture 5:----------



Active Learning

❖Minion wants to design a new File Transfer Protocol (FTP). Help him find the best transport protocol.

(a) He has to use TCP because it has congestion control.
(b) He has to use TCP because it is a reliable service.
(c) He has to use UDP because FTP is elastic and does not need connection setup.
(d) He has to use UDP because file transfer can tolerate delay and does not need timing.

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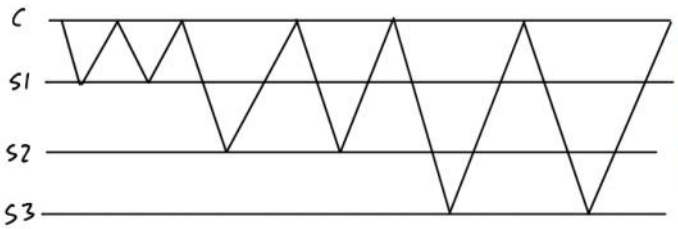
Lecture 6:----------

Active Learning

❖A web page has two pictures.

(a) Find the time (in terms of RTT) it takes to retrieve the web page if the two pictures are on two different servers and non-persistent HTTP is used. (no parallel connections) 6 RTT's

This page has a picture of two lovely birds:



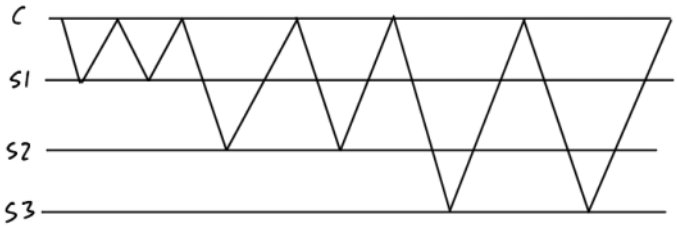
Even lovelier birds here:

6-16

Active Learning

(b) Solve the problem for persistent HTTP.

6 RTT's



6-17

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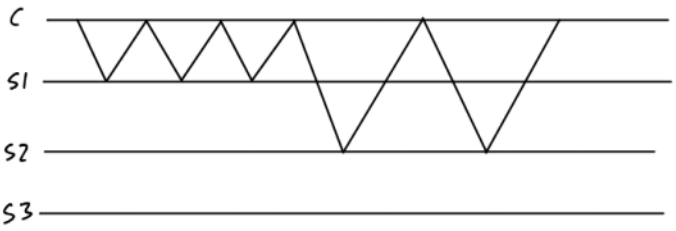
(c) What if only one of the pictures is on a different server.

5 RTT's

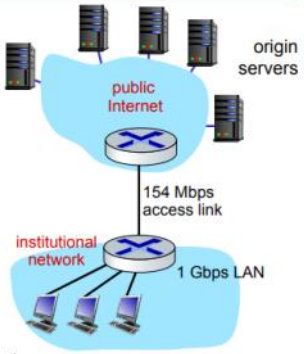


6-18

Lecture 7:----------

Active Learning

- Assume instead of using a cache, we increase the rate of the outgoing link to 154 Mb/s. What would be the average total delay in fetching files?



$LAN = \frac{15 \times 100k}{1G} = \frac{1.5M}{1G} = 0.15\%$

access link utilization $= \frac{1.5M}{154M} = 0.97\%$

∴ delay is restricted to internet delay, i.e. 7 seconds

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Active Learning

If the user is authenticated by using the username and password, do we still need to use cookies?

useful to stay logged in

Lecture 8:----------

Active Learning

- What happens if the mail message has a single dot in a line?

SMTP will add another dot to the single dot.

Active Learning

- Consider the following two statements :
  - (I) Email clients may use either SMTP or POP3 to send and receive emails.
  - (II) SMTP uses 7-bit ASCII messages over a TCP connection to send emails.

Pick the right option among the following:

(a) Both statements are true.

(b) Both statements are false.

(c) Statement I is true but statement II is false.

(d) Statement II is true but statement I is false.

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Lecture 9: ----------

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Active Learning - Typical Exam Question

Suppose within your web browser you click on a link to obtain a web page. The IP address is not cashed and the root, TLD, and authoritative servers should all be visited to resolve the IP address. Assume that the one-way propagation delay between your computer and the local DNS server is 1 msec and the one-way propagation delay in the internet is 5 msec. Assume that the web page you are fetching has one image located on a different server in the same company.

only to resolve IP address

How long does it take to resolve the IP address of the web page and all objects?

time to resolve IP of the main page : 1 + 10 + 10 + 10 + 1 = 32

time to resolve IP of the image : 1 + 10 + 1 = 12

total time : 44 msec.

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Active Learning - Quiz

I. Two DNS requests for the same website that are 1 second apart always have the same address resolution time.

II. DNS uses a client-server paradigm.

(a) Both statements are true.

(b) Both statements are false.

(c) Statement I is true and Statement II is false.

(d) Statement I is false and Statement II is true.

Lecture 10:----------

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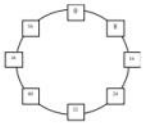
Active Learning - Final 2010

- All keys are distributed uniformly at random in the key range,
- The query for any key is generated with the same probability.
- Each P2P link has a delay of 1 second.
- All 8 peers are responsible for the same number of queries on average



Q: What is the average search time in the system?

$$\frac{1}{8}\cdot 0 + \frac{1}{8}\cdot 7 + \frac{1}{8}\cdot 3 + \frac{1}{8}\cdot 4 + \frac{1}{8}\cdot 5 + \frac{1}{8}\,6 + \frac{1}{8}\cdot 7 + \frac{1}{8}\cdot 8$$

$$= \frac{35}{8}$$

probability of finding the key on each node is 1/8

- if the key is on node 0, delay is 0
- if the key is on node 8, delay is 7
- if the key is on node 16, delay is 3
- if the key is on node 24, delay is 4

⋮

- if the key is on node 56, delay is 8

Lecture 11:----------

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Active Learning

Question: why does TCP need to work with 4-tuples?

Active Learning

Recall: The use of checksum field is optional in UDP.

- Question: how does the receiver know that the transmitter has used checksum? (note no flag in the header)

Lecture 12:----------

Active Learning - Midterm 2010

- A file of size 40,000 Bytes is transmitted on a connection with the bit rate of R=400,000 bit/sec and the one way propagation delay of 5msec. Assume that a header of 50 Bytes is added to each packet and assume that the maximum packet size (including the header) in the network is limited to 450 Bytes. Ignore the processing delay and assume that the size of the ACK packet is 50 Bytes.
- If Stop-and-Wait ARQ is used, how long does it take to transmit the file? Assume an error-free communication.

$F = 40\,000\ B \times 8 = 370\,000$ bits

$R = 400\,000$ bits/sec

$T = \frac{L}{R} = \frac{450 \times 8}{400\,000} = 9$ msec

$T_{ACK} = \frac{50 \cdot 8}{400\,000} = 1$ msec

$D = T + RTT + T_{ACK} = 9 + 5 \times 2 + 1 = 20$ msec

$T_{total} = 20\text{msec} \cdot 100 = 2$ sec. ($100 = \frac{40\,000}{400}$)

Lecture 13:----------

Active Learning

- Assume, 1 Gbps link, 15 ms prop. delay, 8000 bit packet. How long does it take to transmit a file of size 100 KBytes if Go-Back-4 is used. Ignore the header size and assume error-free.

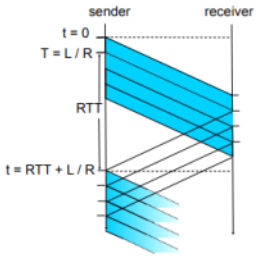
$T = \frac{L}{R} = \frac{8000}{10^9} = 8\,\mu sec$

$M = \frac{800\,000}{8000} = 100$ packets

number of windows $= \frac{100}{4} = 25$

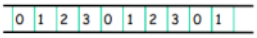
total time $= 25 \times (RTT + T) + 3 \times T$

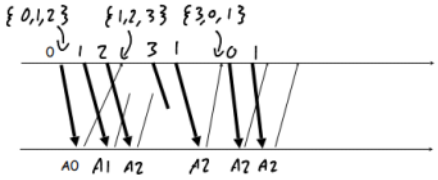
$= 750\,224\,\mu sec$



Active Learning - Midterm 2010

- In the following example assume Go-Back-3 is used, what will be the sequence numbers and the ACK numbers? Assume $m = 2$, where m is the number of bits at the header used for the sequence number.





1

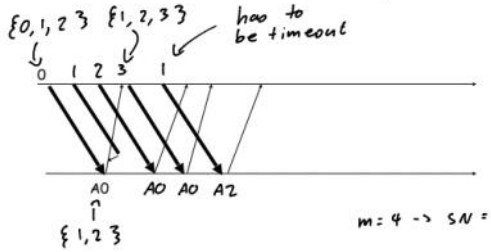
Lecture 14:----------

Active Learning - Midterm 2007

- If Selective-Repeat with N_s=3 and N_r=2 is used, what will be the sequence numbers and the ACK numbers? Use cumulative ACK. Assume $m = 4$.

$N_s + N_r \leq 2^4$

≤ 16



$m = 4 \rightarrow SN = \{0, 1, 2, \ldots, 15\}$

Lecture 15:----------

Active Learning - Midterm 2010

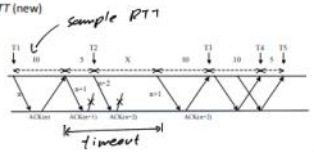
- In the figure below, TCP transmits packet with the given sequence numbers on a 10Mb/sec link. At time T1, *EstimatedRTT* = 16msec, and *DevRTT*= 8msec. All values on the figure are in msec.

EstimatedRTT (new) = 0.875 * *EstimatedRTT* (old) + 0.125 * *SampleRTT*

DevRTT (new) = 0.75 * *DevRTT* (old) + 0.25 * |*SampleRTT* - *EstimatedRTT* (old)|

TimeoutInterval = *EstimatedRTT* (new) + 4 * *DevRTT* (new)

(a) Compute the value of X.



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Estimated RTT (new) = 0.875 × 16 + 0.125 × 10 = 15.75 msec.

Dev RTT (new) = 0.75 × 8 + 0.25 × 6 = 7.5 msec.

Timeout interval = 15.75 + 4 × 7.5 = 45.75 msec.

$y = 45.75 - 5 = 40.75$ msec.

Lecture 17:----------

Active Learning - Exam Question

- A file of size 5000 Bytes is transmitted on a TCP connection with the one way propagation delay of 5msec. Ignore the processing delay and the header size, and assume that the size of the ACK packet is negligible. No packet is lost in the network. Maximum segment size is 250 Bytes. Ignore the TCP connection establishment and tear-down time.
  - What will be the total time required to transmit the whole file after the GET command has been received at the server if the link bandwidth is infinity?

$\frac{5000}{250} = 20$ packets

↳ always use slow start

$1 + 2 + 4 + 8 + 16 > 20$ ⇒ requires 5 RT's

(slow start)

$\therefore 5 \times (2 \times 5\text{msec}) = 50$ msec.

Active Learning

- What is the benefit of moving some responsibilities of TCP (e.g. congestion control and error control) to the application layer?

Lecture 18:----------

Active Learning

- Consider the following two statements:
  - I. The port of a switch is the same as the port used in the transport layer.
  - II. A router might have a queue in the input port as well as another queue in the output port.

(a) Both statements are TRUE.
(b) Statement I is TRUE but statement II is FALSE.
(c) Statement I is FALSE but statement II is TRUE.
(d) Both statements are FALSE.

Active Learning - Quiz 2015

- A router has the following entries in its routing/forwarding table.

Address/mask	Interface
150.12.192.0/19	Interface 1
150.12.0.0/16	Interface 2
150.12.216.0/21	Interface 3
Default	Interface 4

- A packet with the address 150.12.218.51 arrives. Which interface would the packet be forwarded to?

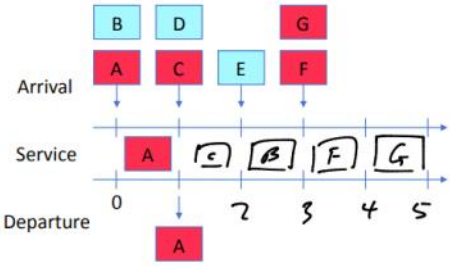
(a) Interface 1.
(b) Interface 2.
(c) Interface 3.
(d) Interface 4.

218.51 = 11011010 00110011
① 192.0 = 11000000 00000000
② 0.0 = 0... 00000000
③ 216.0 = 11011000 00000000

Lecture 19:----------

Active Learning - Priority

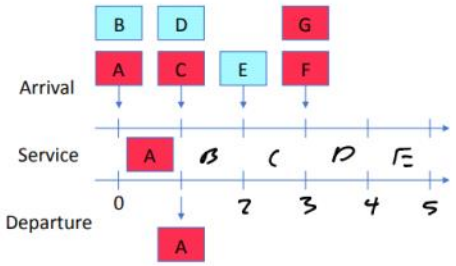
- Consider the figure below where two traffics are using a queue.
- If red packets have high priority, find the time that each packet waits in the queue.
- What is the average waiting delay in the queue? 11/7



Packet (service)	A	B	C	D	E	F	G
Time entering ~~queue~~	0	2	1	5	6	3	4
Waiting delay	0	2	0	4	4	0	1

Active Learning - FCFS

- Consider the figure below where two traffics are using a queue.
- If FCFS is used, find the time that each packet waits in the queue.
- What is the average waiting delay in the queue? 11/7



service

Packet	A	B	C	D	E	F	G
Time entering ~~queue~~	0	1	2	3	4	5	6
Waiting delay	0	1	1	2	2	2	3

Lecture 20:----------

Active Learning - Subnet Addressing

- The University of Toronto owns the Class B IP address 128.100.0.0.
  - Assume that there are 8 faculties at UofT. Distribute the addresses equally among these 8 faculties and find the subnet addresses for each faculty. How many IP addresses each faculty can have? 3 bits for 8 subnets

IP address	Slash notation	No. of addresses
10000000.1100100.000xx...	128.100.0.0/19	8192
= . = .001xx...	128.100.32.0/19	8192
= . = .010xx...	128.100.64.0/19	8192
= . = .011xx...	128.100.96.0/19	8192
⋮	⋮	⋮
= . = .111xx...	128.100.224.0/19	8192

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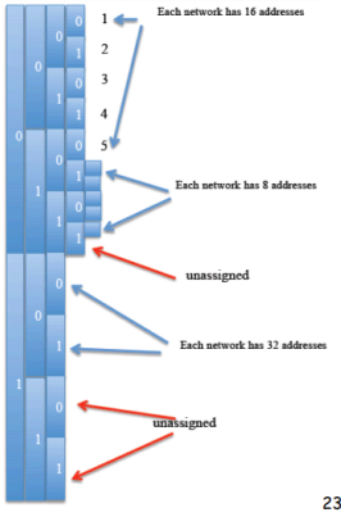
Exam Problem

An ISP is granted a block of addresses starting with 150.100.10.0/24. The ISP wants to distribute these blocks to customers as follows:

- The first group has 5 networks, each needs 12 addresses.
- The second group has 5 networks, each needs 5 addresses.
- The third group has 2 networks, each needs 28 addresses.

Design the subblocks and give the slash notation for each subblock.

Network	IP address range	Network slash notation
1	Min IP: 150.100.10.0/28	150.100.10.0/28
	Max IP: 150.100.10.15/28	
…	…	…
5	Min IP: 150.100.10.64/28	150.100.10.64/28
	Max IP: 150.100.10.79/28	



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150.100.10.XXX...

Active Learning - Subnet Addressing

- The University of Toronto owns the Class B IP address 128.100.0.0.
  - Now assume that the Faculty of Arts and Science needs at least 15000 IP addresses and the Faculties of Music and Law each need about 4000 IP addresses. Distribute the IP addresses among the 8 faculties and find the subnet addresses of those faculties. How many IP addresses each faculty can have?

IP address	Slash notation	No. of addresses	Faculties
10000000.1100100.00xx...	128.100.0.0/18	8192	Arts Sci
= . = .0100xx...	128.100.64.0/20	4096	Music
= . = .0101xx...	128.100.80.0/20	4096	Law
= . = .011xx...	128.100.96.0/19	8192	…
= . = .100xx...	128.100.128.0/19	8192	…
= . = .101xx...	128.100.160.0/19	8192	…
= . = .110xx...	128.100.192.0/19	8192	…
= . = .111xx...	128.100.224.0/19	8192	…

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Lecture 21:----------

Active Learning - Supernet Addressing

- The ACME corporation needs about 1000 IP addresses in their company. They have been offered four consecutive Class C blocks in the 200.23.16.0 range. Suggest a supernet addressing for this company.

One proposed address for the company would be 200.23.16.0/22

11001000 00010111 000100XX XXXXXXXX

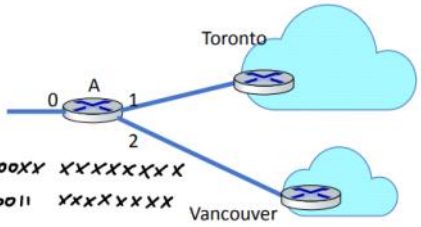
The total number of available addresses will be $2^{10} = 1024$

Active Learning - Supernet Addressing

- The ACME corporation is operating in the cities of Toronto and Vancouver. The Toronto office is the headquarter and has about 750 computers. The Vancouver office has about 250 computers. The company has obtained the address 200.23.16.0/22. What should be the forwarding table in the router A that sends traffic to this company?

One possible solution is

IP address	Interface	
200.23.16.0/22	1	11001000 00010111 000100XX XXXXXXXX
200.23.19.0/24	2	11001000 00010111 00010011 XXXXXXXX

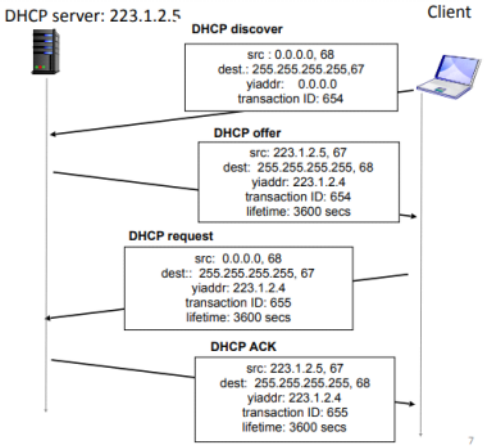


Lecture 22:----------

Active Learning

- Why in the last step the server sends the packet to a broadcast address?
  - Hint: think of multiple DHCP servers on the same network.

All other clients need to know if IP address is now available



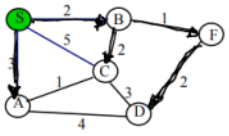
Active Learning

- Perform CIDR aggregation on the following IP addresses: 128.100.214.0/24; 128.100.215.0/24; 128.100.216.0/24; 128.100.217.0/24.

Lecture 24:----------

Active Learning - Link State Routing

- Fill out the first two rows of the following table using the link state routing protocol



Step	N'	A (D,P)	B (D,P)	C (D,P)	D (D,P)	F (D,P)
0	S	3, S	2, S	5, S	∞	∞
1	SB	3, S		4, B	∞	3, B
2	SBF	3, S		4, B	5, F	
3	SBFA			4, B	5, F	
4	SBFAC				5, F	
5	SBFACD					

Lecture 25:----------

Active Learning - Exam 2007

Each node in the following network sends its routing table using a vector of size 6 where each entity of the vector represents the distance to the corresponding node, i.e.

(Dx(A), Dx(B), Dx(C), Dx(D), Dx(E), Dx(F))

The following cost vectors have just arrived at router ~~X~~ A from its neighbours:

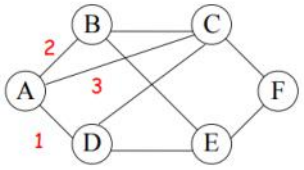
from B: (2,0,2,4,7,1);

from C: (3,2,0,1,3,4);

from D: (1,3,1,0,4,3).

What is the routing table at node A?

(0, 2, 2, 1, 5, 3)

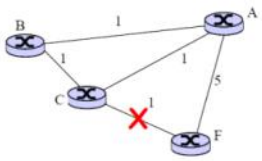


Midterm 2009

In the following network, the distance vector routing protocol has been used to find routes from all nodes to F. Assume the link (F,C) breaks. Fill out the table and find the total time during which packets destined to F go around a loop.

-> assume table is updated every 10 seconds

Iteration	A	B	C
before disconnection	(C,2)	(C,2)	(F,1)
1	(C,2)	(C,2)	(A,3)
2	(B,3)	(A,3)	(A,3)
3	(B,4)	(A,4)	(A,4)
4	(F,5)	(A,5)	(A,5)
5	(F,5)	(A,6)	(A,6)
6	(F,5)	(A,6)	(A,6)
7	(F,5)	(A,6)	(A,6)
8			
9			
10			



Total loop time = 3 x 10 = 30 seconds

Lecture 26:----------

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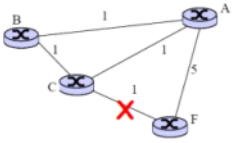
Active Learning - Exam 2009

Use the Poisoned Reverse algorithm to fill out the following table to find the shortest distance from each node to node F.

Iteration	A	B	C
before disconnection	(C,2)	(C,2)	(F,1)
1	(C,2)	(C,2)	(-1,∞)
2	(B,3)	(A,3)	(-1,∞)
3	(F,5)	(-1,∞)	(B,4)
4	(F,5)	(A,6)	(A,6)
5			
6			
7			
8			
9			
10			



If each iteration takes 10 seconds, find the total time during which packets go around around a loop.

1 x 10 = 10 sec

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Active Learning

- True or False:
  - (a) No ICMP error message is generated in response to a datagram carrying an ICMP error message. True
  - (b) An ICMP error message might be generated by a host. True

Lecture 28:----------

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Midterm Exam 2007

- We intend to transmit the bit stream 10011101 over a noisy channel using the standard CRC method with the generator polynomial $x^3 + 1$
  - Find the transmitted bit stream.

$$i(x) = x^7 + x^4 + x^3 + x^2 + 1$$
$$g(x) = x^3 + 1$$
$$x^3 i(x) = x^{10} + x^7 + x^6 + x^5 + x^3$$

$$\begin{array}{r} x^7 + x^3 + x^2 \\ x^3+1 \overline{)\, x^{10} + x^7 + x^6 + x^5 + x^3} \\ \underline{x^{10} + x^7} \\ x^6 + x^5 + x^3 \\ \underline{x^6 + \quad x^3} \\ x^5 \\ \underline{x^5 + x^2} \\ x^2 \end{array}$$

Transmitted bits:

10011101100

data crc

Midterm Example (cont'd)

- Assume that the third bit of data (i.e. the third bit from the left in the above example) arrives in error at the receiver. Can you detect an error if you only see the received sequence? How?

Received bits = 10111101100

$$\begin{array}{r} x^7 + x^5 + x^3 \\ x^3+1 \overline{)\, x^{10} + x^8 + x^7 + x^6 + x^5 + x^3 + x^2} \\ \underline{x^{10} + \quad x^7} \\ x^8 + \quad x^6 + x^5 + x^3 + x^2 \\ \underline{x^8 + \quad\quad x^5} \\ x^6 + \quad x^3 + x^2 \\ \underline{x^6 + \quad x^3} \\ x^2 \end{array}$$

Remainder is nonzero. Hence the error can be detected. →

Midterm Example (cont'd)

- Can a CRC scheme with the generating polynomial $g(x) = x^3 + 1$ detect two-bit errors? If yes, why. If no, give an example.

Solution: No it cannot always detect two-bit errors. See the example

Example

Transmitted bits: 10011101100

Received bits: 10010100100

error

But how did we find this example?

Midterm Example (cont'd)

Systematic approach:

Transmitted bits: b(x)

Received bit: d(x) = b(x) + e(x) where e(x) is the error pattern

An error cannot be detected if e(x) divides g(x), that is

$$e(x) = q(x)\, g(x)$$

In the given example, we have:

Transmitted bits:	$b(x) = x^{10} + x^7 + x^6 + x^5 + x^3 + x^2$	b = 10011101100
Received bits:	$d(x) = x^{10} + x^7 + x^5 + x^2$	d = 10010100100
Error polynomial:	$e(x) = x^6 + x^3 = x^3(x^3 + 1)$	e = 00001001000

Lecture 29:----------

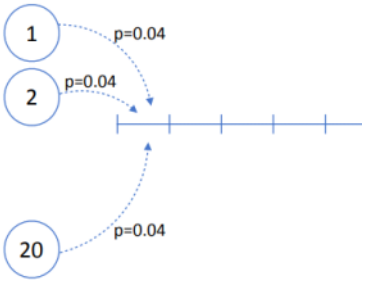
Active Learning - Final Exam 2006

- A Local Area Network (LAN) uses the slotted ALOHA protocol. There are 20 terminals in the network, and each terminal transmits a packet in a given slot with the probability $p = 0.04$. What is the throughput of the system?

$ps = p(1-p)^{N-1} = 0.04(0.96)^{19} = 0.01842$

$20 \cdot ps = 37\%$

$\therefore$ 37% of timeslots are successful



Active Learning - Final Exam 2006

- What is the percentage of the slots that are left idle if $p = 0.04$?

$(1 - 0.04)^{20} = 44\%$

Active Learning - Final Exam 2006

- If the packet transmission is not successful due to a collision, the terminal attempts retransmission in the next slot with probability $p = 0.04$. Determine the expected delay (in time slots) that a packet incurs from the first transmission attempt to the successful reception.

$$\frac{1}{P_s} = \frac{1}{0.01842} = 54.3 \text{ timeslots}$$

$$P_f = 1 - P_s = 0.9816$$

↑ probability of failure of single node

Lecture 30:----------

Active Learning - Final Exam 2011

N computers have been connected to a shared medium (a cable) of length 2 km. The maximum channel rate of the shared medium is 10 Mbps. Each computer generates 10 packets per second with each packet being 1000 bytes. The speed of wave propagation is 2×10^8 meters/second. What is the maximum number of nodes supported in the network if CSMA-CD is used on the shared medium?

$$T = \frac{L}{R} = \frac{1000 \cdot 8}{10 \cdot 10^6} = 0.0008$$

$$\tau = \frac{d}{s} = \frac{2000}{2 \cdot 10^8} = 0.00001$$

$$\text{eff} = \frac{1}{1 + \frac{5\tau}{T}} = 0.941$$

traffic at each node
$10 \times 1000 \times 8 = 80\,000$ bps

0.941×10 Mbps

$$\therefore \text{no. of nodes} = \frac{9.41 \times 10^6}{80\,000} = 117$$

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Active Learning

- Why is there a minimum size (64 bytes) for the frame?

(a) Because we need a minimum sensing interval.
(b) Because 64 is a multiple of 8.
(c) The minimum frame size increases efficiency.
(d) All packets arriving from the network layer are more than 46 bytes.

Lecture

31:----------
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Active Learning

- What would go wrong if we did not have MAC addresses and only used IP addresses inside a LAN?

Lecture 32:----------
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Active Learning

- If switches are transparent and self-learner, can we use them in place of routers in a large campus network?

① the switch table size will be extremely large
② frequent flooding in the network will waste resources

Lecture 34:----------
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Active Learning

- What is the chief difference between MPLS and IP Tunnelling?

we are guaranteed that packets will always pass through the same path in MPLS, but not in IP Tunnelling.

Active Learning

- In the following network, a packet arrives from A with the label 22. What will be the route of the packet?

A -> R1 -> R2 -> R3 -> R4 -> F

Forwarding Table at R1

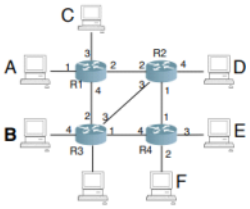
Input (Interface, label)		Output (Interface, label)	
1	22	2	56
4	66	2	75
2	56	3	22

Forwarding Table at R2

Input (Interface, label)		Output (Interface, label)	
1	22	2	56
2	75	4	56
2	56	3	22

Forwarding Table at R3

Input (Interface, label)		Output (Interface, label)	
3	22	1	66
2	75	4	56
2	56	3	22
4	66	2	75



Forwarding Table at R4

Input (Interface, label)		Output (Interface, label)	
1	22	2	56
2	75	4	56
2	56	3	22
4	66	2	75