Course: Communication Networks

Date: 12/12

Topics Covered: HW # 6

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1. Short answer questions:

   (a) Briefly describe the responsibilities and differences of the network layer's control plane and data plane.

   (b) What are the four desirable characteristics of an 'ideal' multiple access protocol that we discussed?

   (c) Assume there are N=5 active nodes, each of which has an infinite supply of frames that they want to transmit. If two or more frames collide, then all nodes will detect the collision. Given the probability that a node transmits is p=0.25, what is the maximum efficiency for (i) pure ALOHA (ii) slotted ALOHA? *(Hint: Looking for the probability that any node has success. See equations for P(success by any of N nodes) in Lec-21)*

a) Data Plane

- per-router functions for handling packets
- Focuses on forwarding packets arriving on input links to the appropriate output links
- operates at a high speed
- involves data processing tasks

Control planes

- executes routing protocols
- responds to network events
- performs management functions (ex. policy enforcements)
- coordinates with remote controllers for network-wide decisions
- operates at slower pace
- involves decision making rather than data processing

b) 1. simplicity
2. Decentralized - doesn't rely on central coordinator
3. Throughput for single node - throughput of R bps
4. Fair sharing - when M nodes contain data to send, avg throughput is R/M bps

c) Pure ALOHA

$P_{success}: N \cdot p(1-p)^{2(N-1)}$

$N=5$

$p=0.25$

$5(0.25(0.75)^8) = 0.12514$

Slotted ALOHA

$P_{success} = N \cdot p(1-p)^{N-1}$

$N=5$

$p=0.25$

$5(0.25(0.75)^4) = 0.39551$

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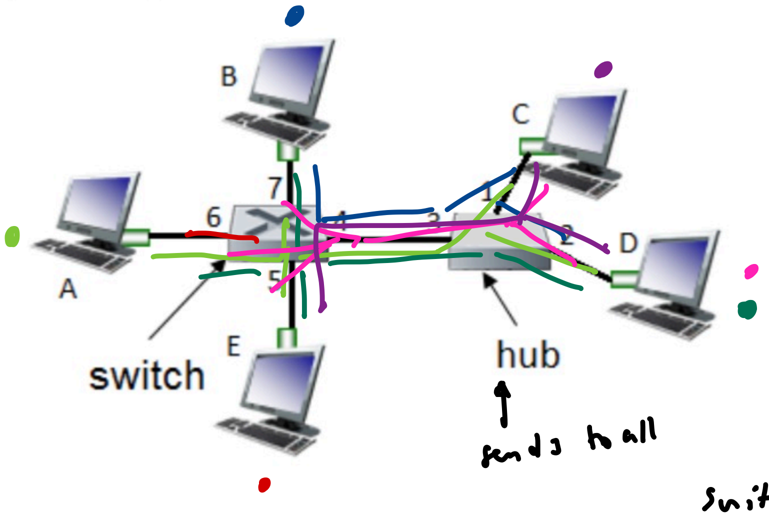
2. An Ethernet LAN consists of one **switch** and one **hub**. Suppose that initially the switch table is empty. For each of the following frame transmissions, list every port on to which the frame is forwarded (see 6.4.3).



switch table

- (a) A sends a frame to C. : 7, 5, 4, 2, 1 UPDATED: A | 6
- (b) D sends a frame to B. : 3, 4, 7, 5, 6 UPDATED: D | 4
- (c) B sends a frame to D. : 4, 1, 2 UPDATED: B | 2
- (d) E sends a frame to A. : 6 UPDATED: E | 5
- (e) D sends a frame to C. : 1, 3, 7, 5, 6
- (f) C sends a frame to E. : 2, 3, 5 UPDATED: C | 4

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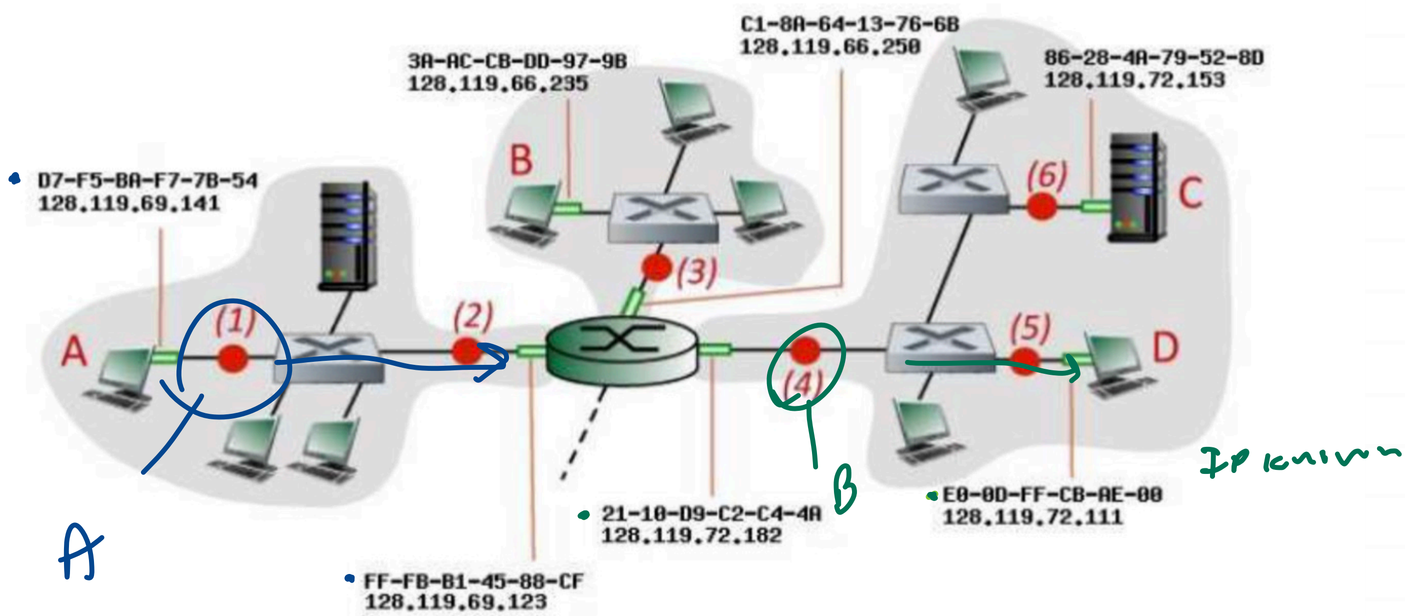
3. Suppose that in the network below the IP address of each subnet's router interface is known by all of the subnet's hosts, **all ARP tables are empty**, and D's IP address is known to A.



(a) In a table of the form shown below, list the content (ARP or IP), MAC source and destination addresses, and the IP source and destination addresses of all frames that pass point (1) as a result of the transmission of a single UDP segment from host A to host D *(hint: see 6.4.1, specifically on ARP and Sending a Datagram off the Subnet)*.

Frame #	Content (ARP or IP)	MAC src addr	MAC dst addr	IP src addr	IP dst addr
1	...	...	...	...	...

(b) Repeat (a) but now at point (4) on the figure.

Hint: A related (but not identically set up) interactive practice problem can be found here.

a)

Frame #	Content (ARP or IP)	MAC src addr	MAC dst addr	IP src addr	IP dst addr
1	ARP	D7-F5-BA-F7-7B-54	Broadcast. FF-FF-FF-FF-FF	128.119.69.141	128.119.69.123
2	ARP	FF-FB-B1-45-88-CF	E0-0D-FF-CB-AE-00	128.119.69.123	128.119.69.141
3	IP	D7-F5-BA-F7-7B-54	FF-FB-B1-45-88-CF	128.119.69.141	128.111.72.111

b)

Frame #	Content (ARP or IP)	MAC src addr	MAC dst addr	IP src addr	IP dst addr
1	ARP	21-10-D9-C2-C4-4A	Broadcast. FF-FF-FF-FF-FF	128.119.72.182	128.119.72.111
2	ARP	E0-0D-FF-CB-AE-00	21-10-D9-C2-C4-4A	128.119.72.111	128.119.72.182
3	IP	21-10-D9-C2-C4-4A	E0-0D-FF-CB-AE-00	128.119.69.141	128.119.72.111

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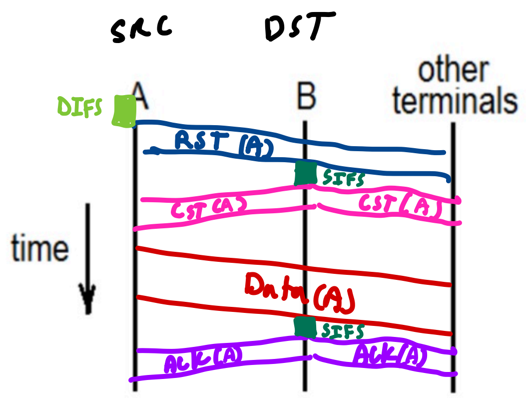
4. Questions re: 802.11 MAC (Sec. 7.3.2)

(a) Briefly describe the hidden node problem associated with wireless networks.

(b) The 802.11 MAC protocol includes a scheme to help avoid collisions and the hidden node problem. What two special control frames are introduced by this scheme and what is their purpose?

(c) Briefly explain / show how the above scheme is implemented in the 802.11 CSMA/CA protocol using a timing diagram like the one shown below. Assume that A is transmitting to node B.



a) Hidden node problem: two nodes cannot hear each others transmissions due to physical obstructions

This is an issue because they may send data simultaneously, which can lead to collisions at a common destination

b) 1. Request to Send (RTS)
- sent by a station to the AP to reserve access to communication channel
- signals the intent to transmit data

2. Clear to send (CTS)
- sent by the AP after receiving the RTS
- grants sender permission to transmit & informs all others to wait

c) 1. RTS frame: A → B RTS
2. CTS frame: B responds with CTS
3. Data transmission: A → B transmission
4. ACK: B sends Ack frame to indicate that transmission was successful

SEE DRAWING

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5. Your company uses connection and filter tables to implement a **stateful** firewall. Your company's network address is 142.241.0.0/16. Construct a filter table of the form given in Table 8.8 to realize a firewall that:

   (a) permits internal users to make DNS queries to external DNS servers

   (b) permits internal users to set up Telnet (port 23) sessions with external hosts

   (c) permits external users to visit the internal web server at 142.241.56.13

   (d) blocks all other in-bound and out-bound traffic

   Hint: you should have 7 rows, 2 each for (a)-(c) and one for (d). For each two entry pair in (a)-(c), one rule will establish outgoing behavior and another incoming behavior. Again, please see Table 8.8.

	Action	Src Addr	Dst Addr	protocol	Src Port	Dst Port	Flag Bit	check conn
a	allow	142.241.0.0/16	outside	UDP	> 1023	53	–	–
a	allow	outside	142.241.0.0/16	UDP	53	> 1023	–	×
b	allow	142.241.0.0/16	outside	TCP	>1023	23	any	–
b	allow	outside	142.241.0.0/16	TCP	23	>1023	ACK	×
c	allow	outside	142.241.56.13	TCP	>1023	80	any	–
c	allow	142.241.56.13	outside	TCP	80	>1023	ACK	×
d	deny	all	all	all	all	all	all	all