IS 370: Review Sheet 5
Chapter 5

Discussion Questions :

1. **Compare between Internet layers in terms of data packets, services provided, protocols, implementation method and locations, and service basis**

Layer	Packets	Services	Protocols
Application	Data	Provide services to Internet users (web, file transfer, email,…)	HTTP, FTP, SMTP, POP3, IMAP, DNS,…..
Transport	Segment	buffering, segmentation, mux, demux, reliability, flow control, congestion control	TCP, UDP
Network	Datagrams	encapsulation to form datagrams, forwarding, routing	IP, RIP, OSPF, BGP, ….
Link	Frames	framing, link access, reliable delivery, error detection & correction, …	Ethernet, 802.11, PPP, ….

Layer	Where is it implemented?	How is it implemented?	Service basis
Application	host	Software as a part of OS	Process-to-process
Transport	host	Software as a part of OS	Process-to-process
Network	Host and routers	Software	Host-to-host
Link	Host (network adaptor) and routers	A combination of hardware and software	Node-to-adjacent node connected with a link

2. **Compare between IP address and MAC address in Internet**

IP address	MAC address
Network layer address	Link layer address
32-bit (4byte)	48-bit (6byte)
Address each host interface and router interface	Address each node (host or router) network adapter
Hierarchical (subnet part, host part) CIDR	flat
Dynamic (change if node moved to another LAN)	Fixed and permanent (do not change if node moved)
Dotted-decimal notation	Hexadecimal notation
Administered by ICANN and assigned to ISP	Administered by IEEE and assigned to manufacture
Determined by DHCP	Determined by ARP

3. **Compare between DNS, NAT and ARP**

DNS	ARP	NAT
Translate from hostname to IP address	Translate from IP address to MAC address	convert local IP addresses of a subnet into one IP address
Translate any where in the Internet	Translate within the subnet only (same LAN)	Translate between internal and external IP addresses

4. **What are the services provided by data link layers?**

- Framing
- Link access
- Reliable delivery between adjacent nodes
- Flow control
- Error detection
- Error correction
- Half-duplex and full-duplex

Reliability, flow control, and error detection services are provided by transport layer and link layer

5. **Explain the problem of multiple access? How can we solve it?**

- single shared broadcast channel.
- two or more simultaneous transmissions by nodes causes interference.
- collision if node receives two or more signals at the same time

Solution: Nodes use multiple access protocol to regulate their transmission into the shared channel. Distributed algorithm that determines how nodes share channel. Communication about channel sharing must use channel itself.

6. **What are the characteristics of an ideal multiple access protocol?**

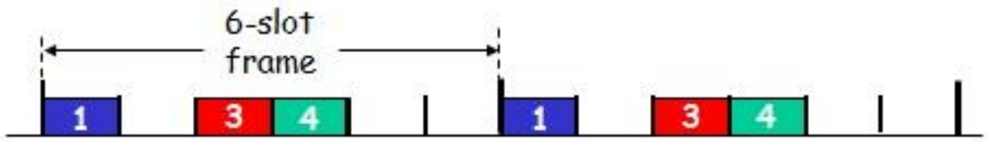
1. when one node wants to transmit, it can send at rate R.
2. when N nodes want to transmit, each can send at average rate R/N
3. fully decentralized:
    - No special node to coordinate transmissions.
    - No synchronization of clocks, slots.
4. Simple so that it is inexpensive to implement.

7. **Differentiate between different classes of multiple access protocol?**

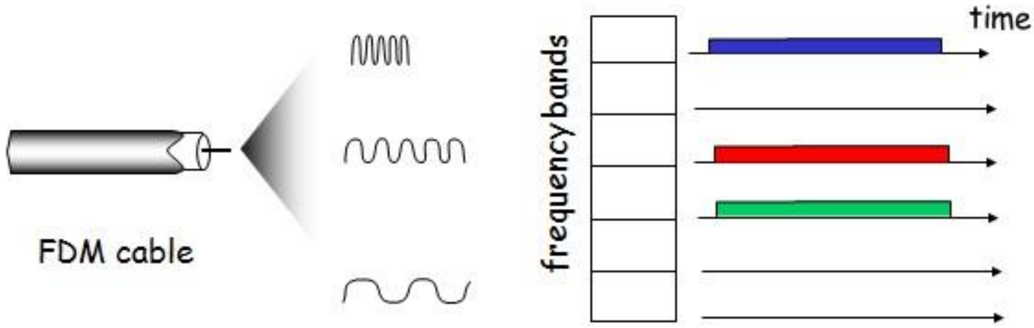
- Channel Partitioning
    - divide channel into smaller “pieces” (time slots, frequency, code)
    - allocate piece to node for exclusive use
- Random Access
    - channel not divided, allow collisions
    - "recover" from collisions
- "Taking turns"
    - nodes take turns, but nodes with more to send can take longer turns

8. Explain briefly with the aid of schematic diagram TDMA and FDMA protocols?

- TDMA: time division multiple access.
  - access to channel in "rounds"
  - each node gets fixed length slot (length = pkt trans time L/R) in each round
  - each node is assigned R/N bandwidth
  - unused slots go idle
  - example: 6-nodes LAN, 1,3,4 have pkt, slots 2,5,6 idle



- FDMA: frequency division multiple access.
  - channel spectrum divided into frequency bands
  - each node assigned fixed frequency band (R/N)
  - unused transmission time in frequency bands go idle
  - example: 6-nodes LAN, 1,3,4 have pkt, frequency bands 2,5,6 idle



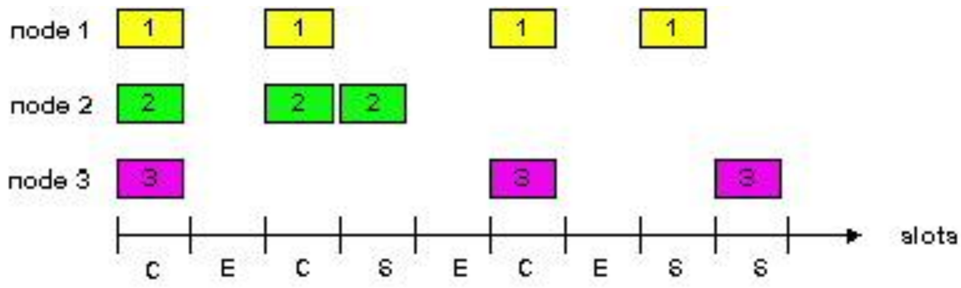
9. Explain briefly with the aid of schematic diagram slotted ALOHA and CSMA protocols?

- Slotted ALOHA:
  <u>Assumptions:</u>
  - all frames same size (L)
  - time divided into equal size slots (time to transmit 1 frame L/R s)

- nodes start to transmit only when slot beginning
- nodes are synchronized
- if 2 or more nodes transmit in slot, all nodes detect collision

<u>Operation:</u>

- when node obtains fresh frame, transmits in next slot
  - ➢ if no collision: node can send new frame in next slot
  - ➢ if collision: node retransmits frame in each subsequent slot with prob. p until success



<u>Pros</u>

- single active node can continuously transmit at full rate of channel
- highly decentralized: only slots in nodes need to be in sync
- simple

<u>Cons</u>

- collisions, wasting slots
- idle slots
- nodes may be able to detect collision in less than time to transmit packet
- clock synchronization

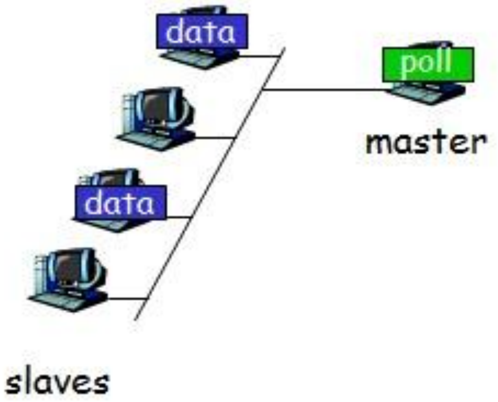
مادري اذا المطلوب الـ(Pros و Cons) او الـ(Assumptions و Operations) !!!

- CSMA: Carrier Sense Multiple Access: listen to channel before transmit:
  - If channel sensed idle: transmit entire frame
  - If channel sensed busy, defer transmission
  - human analogy: don't interrupt others!

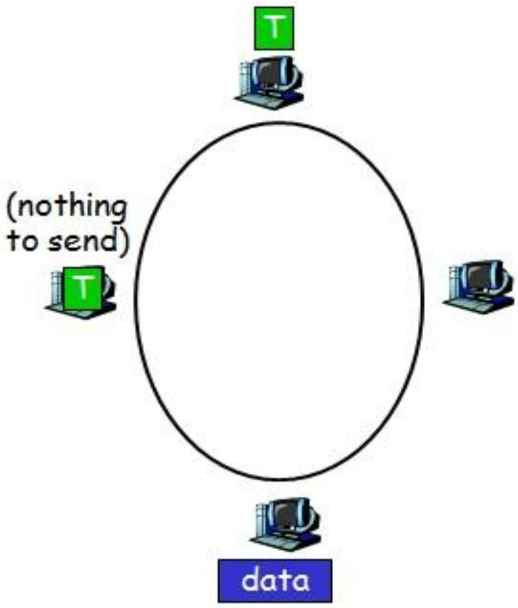
ما لقيت الرسمة لـ CSMA

10. Explain briefly with the aid of schematic diagram slotted polling and token-passing MAC protocols?

- Polling protocol:
  - master node "invites" slave nodes to transmit <u>in turn</u>
  - typically used with "dumb" slave devices
  - each node is assigned R/N bandwidth
  - Concerns:
    - ➢ polling overhead (latency)
    - ➢ single point of failure (master)
  - Examples: Bluetooth and 802.15



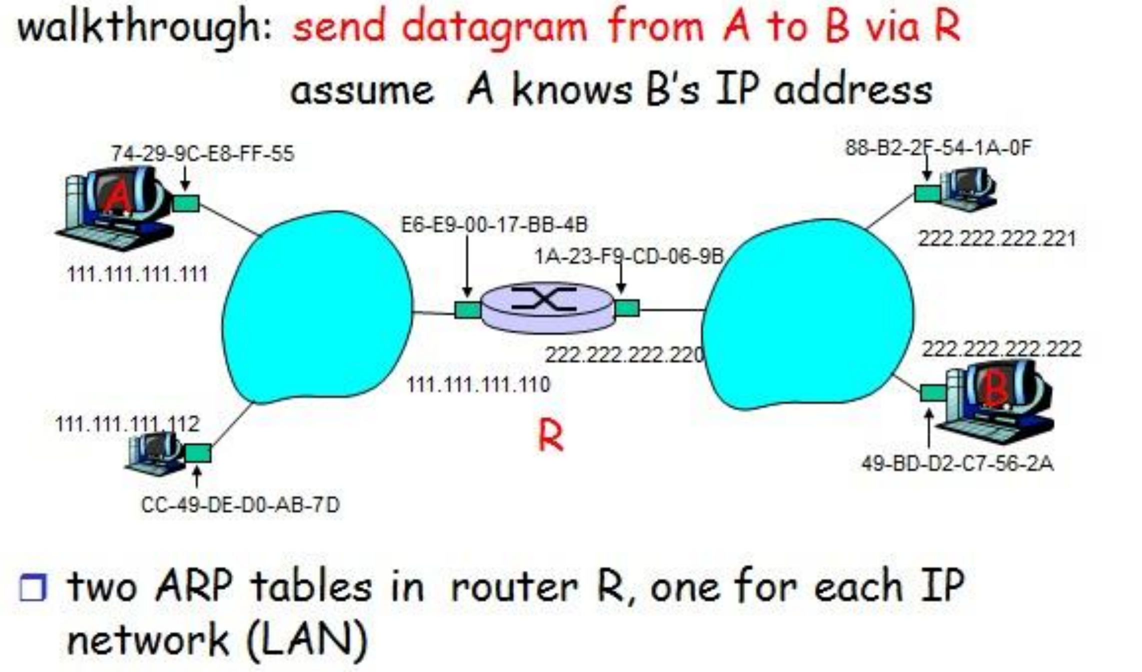
- Token-passing protocol
  - Control**token** passed from one node to next sequentially.
  - When a node receives the token, it holds onto it only when it has frames to send otherwise it immediately passes the token to the next node



11. What is the function of ARP? What is the condition of its operation?

To find the MAC address of the destination node by ARP table. The condition that the sender has the destination MAC address in its ARP table. If not, sender broadcasts ARP query packet, containing destination's IP address.

12. **Explain briefly with the aid of schematic diagram the process of routing a data frame from host A to host B in a different LAN?**



- A creates IP datagram with source A, destination B
- A uses ARP to get R’s MAC address for 111.111.111.110
- A creates link-layer frame with R's MAC address as dest, frame contains A-to-B IP datagram
- A’s NIC sends frame
- R’s NIC receives frame
- R removes IP datagram from Ethernet frame, sees its destined to B
- R uses its forwarding table to place the datagram on the correct interface
- R uses ARP to get B’s MAC address
- R creates frame containing A-to-B IP datagram sends to B

This is a really important example – make sure you understand!

13. **Why is ALOHA not efficient? How does CSMA solve the problem?**

Because Aloha is simple, no synchronization, when frame first arrivestransmit immediately, andcollision probability increases.

CSMA solve it by collision detection:

- if another node transmits at the same time, defer transmit.
- collisions detected within short time.
- colliding transmissions aborted, reducing channel wastage.
- human analogy: if someone else begins talking at the same time, stop talking.

Put T in front of the true statement and F in front of the false statement:

14. Link layer is mostly software implemented .F
15. Link layer protocols are implemented in the network adepter .T
16. The link layer is responsible for data transfer from host-to-host .T
17. Data packets in network layers are called datagrams .T
18. The link layer protocols are called medium access protocol .F
19. Slotted ALOHA is more efficient than pure ALOHA .T
20. FDMA is not efficient in case of low load .T
21. In random access MAC protocol a single node transmitting can fully utilized the channel .T

22. TDMA does not prevent collision .F
23. CSMA avoid collision by sensing the channel before transmit .F
24. Take-turn MAC protocols are highly efficient .F
25. MAC address changes when a node moves to another LAN .T
26. In Internet all links employ the same MAC protocol .F

Fill in the space in the following sentences:

27. MAC address is **48** bit represented in **Hexadecimal** notation .
28. Hosts and routers are called **nodes**.
29. Communication channels that connect adjacent nodes are called **links** .
30. Link layer packet is called **frame**.
31. Ethernet, 802.11 and PPP are examples of **link layer** protocols .
32. **Controller** is a special purpose chip that implements most of link layer services .
33. SW and HW meet at **Link** Layer .
34. In TDMA, each node is assigned **R/N** bandwidth .
35. **Parity Check** is widely used for error detection and correction in link layer .

Problems :

36. Drive a formula to compute slotted ALLOH max. efficiency?

$Np(1-p)^{N-1}$

37. Drive a formula to compute pure ALLOH max. efficiency?

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

38. Suppose the information content of a packet is the bit pattern 1010 1010 1010 1011 andan even parity scheme is being used.
a) What would the value of the field containing the parity bits be for the case of 2-dimension parity scheme?

Even parity means that you must have an even number of "ones" bits (including the parity bit). We have nine ones. So, parity bit = 1

b) Using the matrix produced in (a) show that a single-bit error can be detected andcorrected and a double-bit error can be detected but not corrected

Correct	1–bit error	2–bit error	2–bit error	2–bit error
1 0 1 0 | 0	1 0 1 0 | 0	1 0 1 0 | 0	1 0 1 0 | 0	1 0 1 0 | 0
1 0 1 0 | 0	1 0 1 0 | **1**	1 **1** 1 **1** | 0	1 **1** 1 0 | 0	1 0 1 **1** | 0
1 0 1 0 | 0	1 0 1 0 | 0	1 0 1 0 | 0	1 0 1 0 | 0	1 0 1 0 | 0
1 0 1 1 | 1	1 0 1 1 | 1	1 0 1 1 | 1	1 0 1 **0** | 1	1 **1** 1 1 | 1
0 0 0 1 | 1	0 0 0 1 | 1	0 0 0 1 | 1	0 0 0 1 | 1	0 0 0 1 | 1

In the one–bit error, we see that the row 2 parity does not add up and that the parity column parity does not add up. The error must be in the parity column of row 2; the data are OK.

In the first 2–error variant, we see that two columns have bad checksums, but that no row has a bad checksum. We know that one of the rows has bits 2 and 4 bad, but cannot say which.

In the last two 2–bit error scenarios, be have ideas as to the bad rows and columns. The difficulty is that the last two scenarios present identically.

39. Suppose a datagram contains 10 bytes consisting of the 8-bit unsigned binaryrepresentation of the numbers 1 through 10. Compute the checksum for this data.

40. Consider the 5-bit generator, G=10011, and D=1010101010, find R.
If we divide 10011 into 1010101010 0000, we get 1011011100, with a remainder of R=0100.

41. Suppose that 4 active nodes A,B,C, and D are competing for access to a channel using slotted ALOHA. Assume infinite number of packets transmitted by each node and that each node attempts to transmit in each slot by probability (p).
a) What is the probability that node A succeeds for the first time in slot 4?
b) What is the probability that some node succeeded in slot 2?
c) What is the probability that the first success occurs in slot 4?
d) what is the efficiency of the system?

a) $(1 - p(a))^3\, p(A)$
where,
$p(A)$ = probability that A succeeds in a slot

$p(A) = p(A\ \textit{transmits and B does not and C does not})$
$= p(A\ \textit{transmits})\ p(B\ \textit{does not transmit})\ p(C\ \textit{does not transmit})$
$= p(1-p)\,(1-p) = p(1-p)^2$

Hence, $p(A\ \textit{succeeds for first time in slot 4}) = (1 - p(a))^3\, p(A) = (1 - p(1-p)^2)^3$
$p(1-p)^2$

b) $p(A\ \textit{succeeds in slot 2}) = p(1\text{-}p)^2$
$p(B\ \textit{succeeds in slot 2}) = p(1\text{-}p)^2$
$p(C\ \textit{succeeds in slot 2}) = p(1\text{-}p)^2$

$p(\textit{either A or B or C succeeds in slot 2}) = 3\, p(1\text{-}p)^2$
(because these events are mutually exclusive)

c) $p(\textit{some node succeeds in a slot}) = 3\, p(1\text{-}p)^2$
$p(\textit{no node succeeds in a slot}) = 1 - 3\, p(1\text{-}p)^2$

Hence, $p(\textit{first success occurs in slot 4}) = p(\textit{no node succeeds in first 3 slots})\ p(\textit{some node succeeds in } 4^{th}\ \textit{slot}) = (1 - 3\, p(1\text{-}p)^2)^3\ 3\, p(1\text{-}p)^2$

d) efficiency = $p(\textit{success in a slot}) = 3\, p(1\text{-}p)^2$