COMPUTER COMMUNICATION NETWORK

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IEEE 802.11 Frame and numerical problems

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Frame (numbers indicate field length in bytes):

2	2	6	6	6	2	6	0-2312	4
Frame control	Duration	Address 1	Address 2	Address 3	Seq control	Address 4	Payload	CRC

Frame control field expanded (numbers indicate field length in bits):

2	2	4	1	1	1	1	1	1	1	1
Protocol version	Type	Subtype	To AP	From AP	More frag	Retry	Power mgt	More data	WEP	Rsvd

- Payload :
  - ❖ At the heart of the frame, which typically consists of an IP datagram or an ARP packet.
  - ❖ Although the field is permitted to be as long as 2,312 bytes, it is typically fewer than 1,500 bytes
- CRC
  - ❖ A 32-bit cyclic redundancy check is used

2	2	6	6	6	2	6	0-2312	4
Frame control	Duration	Address 1	Address 2	Address 3	Seq control	Address 4	Payload	CRC

- Sequence Number
  - ❖ sequence numbers allows the receiver to distinguish between a newly transmitted frame and the retransmission of a previous frame
- Duration
  - ❖ 802.11 protocol allows a transmitting station to reserve the channel for a period of time that includes the time to transmit its data frame and the time to transmit an acknowledgment.
- Fame Control
  - ❖ Type and subtype fields are used to distinguish RTS, CTS, ACK, and data frames.
  - ❖ The to and from fields are used to define the meanings of the different address fields

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2	2	6	6	6	2	6	0-2312	4
Frame control	Duration	Address 1	Address 2	Address 3	Seq control	Address 4	Payload	CRC

- Address Fields
  - There are 4 MAC address fields
  - Address 1 is the MAC address of the wireless station that is to **receive** the frame
  - Address 2 is the MAC address of the station that **transmit**s the frame
  - Address 3 is needed for internetworking purposes—specifically, for moving the network-layer datagram from a wireless station through an AP to a router interface
    - We should keep in mind that an AP is a link-layer device, and thus neither "speaks" IP nor understands IP addresses. The router is not aware that there is an AP between it and the station

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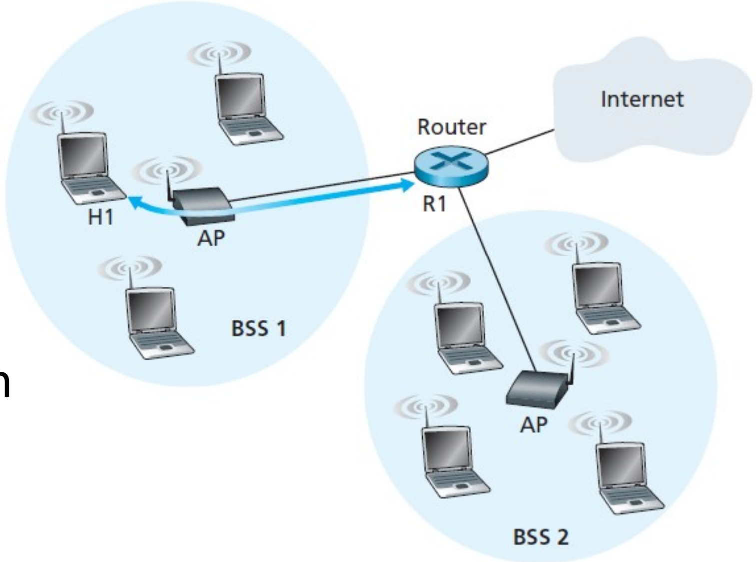
- Router interface R1 encapsulates the datagram within an Ethernet frame with R1's MAC address and H1's MAC address
- AP converts the 802.3 Ethernet frame to an 802.11 frame before transmitting the frame into the wireless channel.
- The AP fills in address 1 with H1's MAC and address 2 with its own MAC address, address 3 with R1's MAC address
- When H1 responds to R1, H1 creates 802.11 frame filling address 1 with AP's MAC , address 2 with H1's MAC and address 3with R1's MAC
- AP converts 802.11 frame to Ethernet frame to send to R1

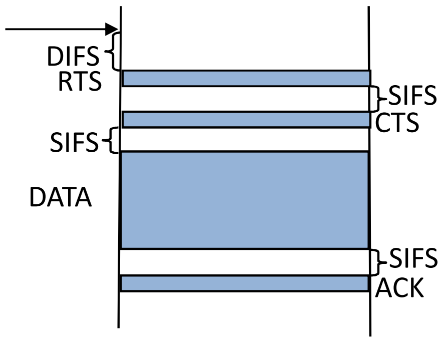


Problem 1

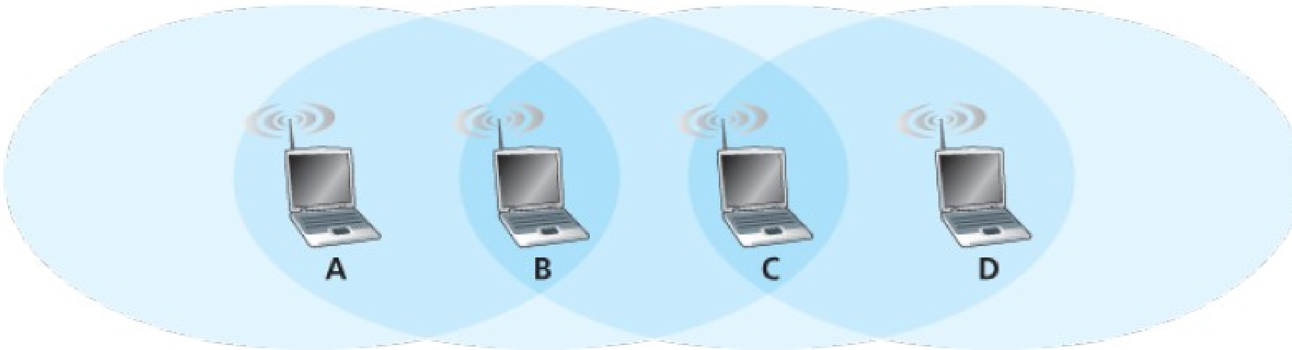
- Suppose an 802.11b station is configured to always reserve the channel with the RTS/CTS sequence. Suppose this station suddenly wants to transmit 1,000 bytes of data, and all other stations are idle at this time. As a function of SIFS and DIFS, and ignoring propagation delay and assuming no bit errors, calculate the time required to transmit the frame and receive the acknowledgment.

Solution of Problem 1

- Number of DIFS = 1
- Number of SIFS =3
- If length of RTS, CTS, ACK packet are L bytes, then total data to be transmitted is 3L+1000 bytes
- If R bps is the transmission rate then total transmission time is T = (3L+1000)*8 /R
- Total Time = T + 3*SIFS + DIFS

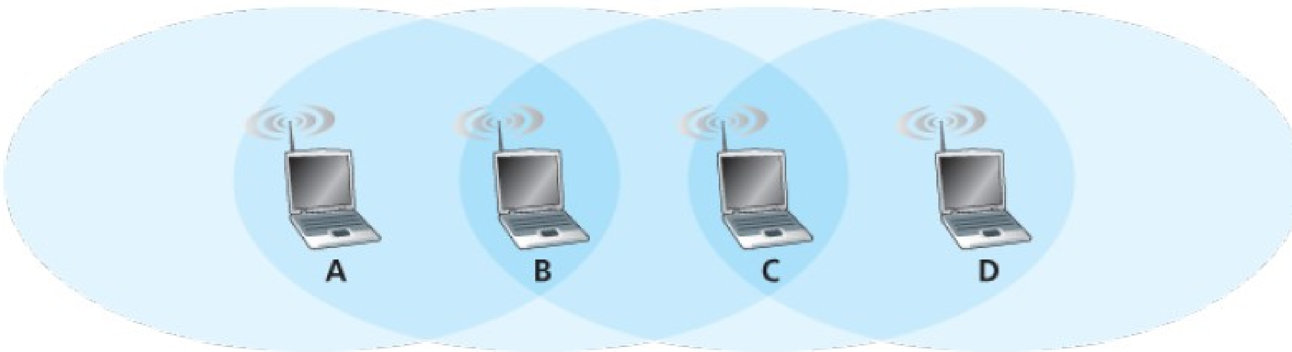


Problem 2



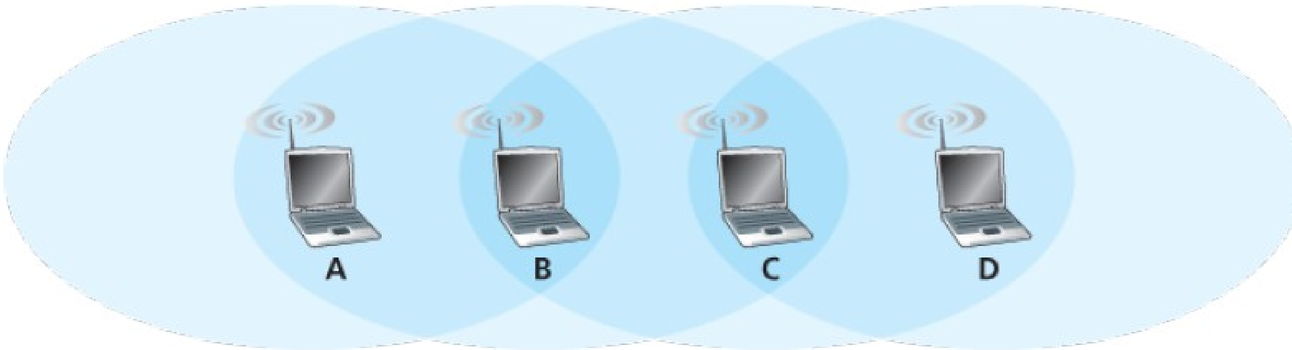
- Consider the scenario shown in Figure, in which there are four wireless nodes, A, B, C, and D.
- Suppose now that each node has an infinite supply of messages that it wants to send to each of the other nodes
- If a message's destination is not an immediate neighbor, then the message must be relayed.
- Time is slotted, with a message transmission time taking exactly one time slot, e.g., as in slotted Aloha

Problem 2



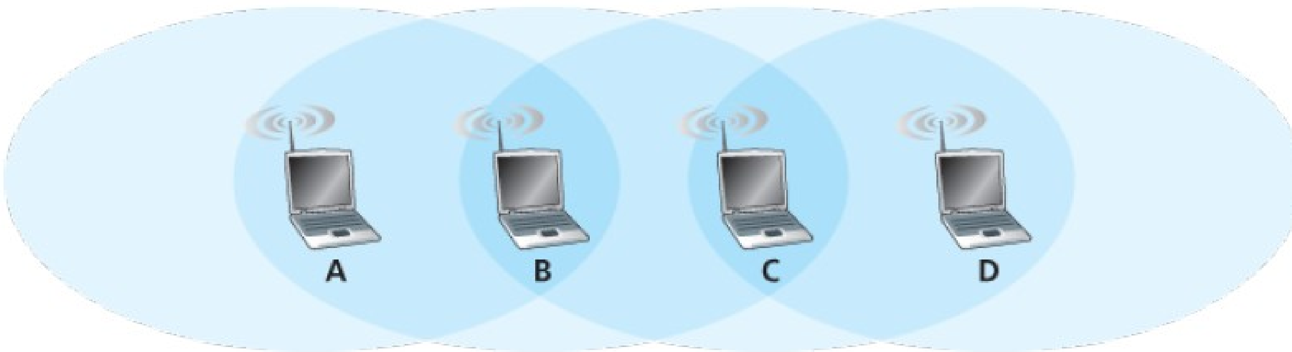
- During a slot, a node can do one of the following: (i) send a message, (ii) receive a message (if exactly one message is being sent to it), (iii) remain silent.
- if a node hears two or more simultaneous transmissions, a collision occurs and none of the transmitted messages are received successfully
- Assume here that there are no bit-level errors

Problem 2



- A) what is the maximum rate at which a data message can be transferred from C to A, given that there are no other messages between any other source/destination pairs?
- B) Suppose now that A sends messages to B, and D sends messages to C. What is the combined maximum rate at which data messages can flow from A to B and from D to C?
- C) Suppose now that A sends messages to B, and C sends messages to D. What is the combined maximum rate at which data messages can flow from A to B and from C to D?

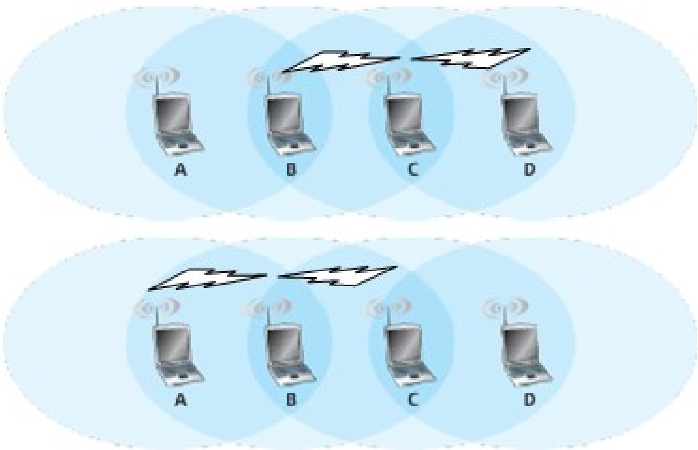
Problem 2



- D) Suppose now that the wireless links are replaced by wired links. Repeat questions (A) through (C) again in this wired scenario.
- E) Now suppose we are again in the wireless scenario, and that for every data message sent from source to destination, the destination will send an ACK message back to the source (e.g., as in TCP). Also suppose that each ACK message takes up one slot. Repeat questions (A)–(C) above for this scenario

Solution of Problem 2

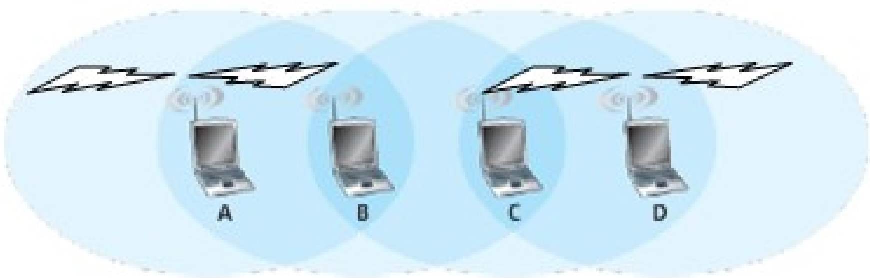
- A)



- 2 slots required to send one packet.
  - ❖ Total 1 messages can be sent in 2 slots

Solution of Problem 2

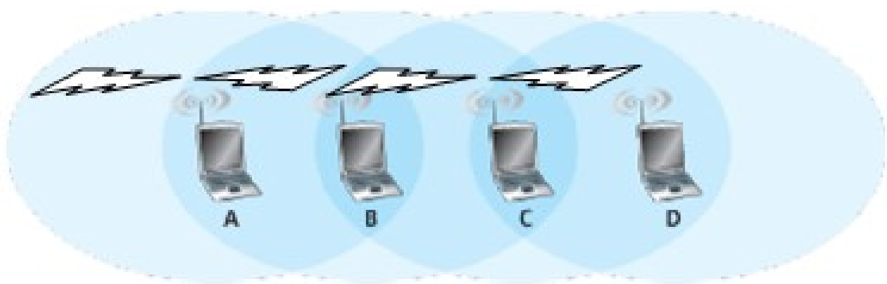
- B)



- A to B and D to C can go simultaneously.
- Together 2 packets can be transferred in a slots.
  - Total 2 messages can be sent in 1 slots

Solution of Problem 2

- C)



- If both A and C transmit simultaneously they will collide at B
- Either A or C can transmit at a slot
  - ❖ Total 1 messages can be sent in 1 slots

Solution of Problem 2

- D)

- i) C to A via one hop of B. On steady flow it is 1 packet per slot
  - Total 1 messages can be sent in 1 slots
- Ii) A to B and D to C are independent. So 2 packet per slot
  - Total 2 messages can be sent in 1 slots
- Iii) A to B and C to D are independent. So 2 packet per slot
  - Total 2 messages can be sent in 1 slots

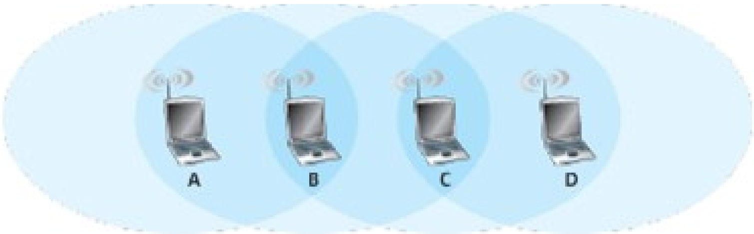
Solution of Problem 2

- E)

- i) C to B 2 slots (messages + Ack) and then B to A 2 slots.
  - ❖ Total 4 slots required to transfer 1 message
- ii) Message from A to B and D to C can go simultaneously. Acknowledgement from B and C can go simultaneously. Ack from C will not reach A and Ack from B will not reach D.
  - ❖ Total 2 messages can be sent in 2 slots

Solution of Problem 2

- E)



- iii) While A is sending message to B , C can not send message to D
- But while in next slot B is sending Ack to A, C can send message to D
- In next slot D can send Ack to C
  - ❖ Total 2 messages can be sent in 3 slots

Solution of Problem 2

- Alternatively :
- C sends to D while A remain silent
- While in next slot D is sending Ack to C, A can send message to B
- In next slot B can send Ack to A
    - ❖ Total 2 messages can be sent in 3 slots

THANK YOU

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