COMP90007 Internet Technologies Workshop

Week 5

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Slides

https://github.com/SiaHuo/COMP90007Workshops

If there is any error in slides, please point it out.
Please refer to solution on LMS for standard answers

Question 1

What is the minimum overhead in bytes to send an IP packet using PPP?

Review

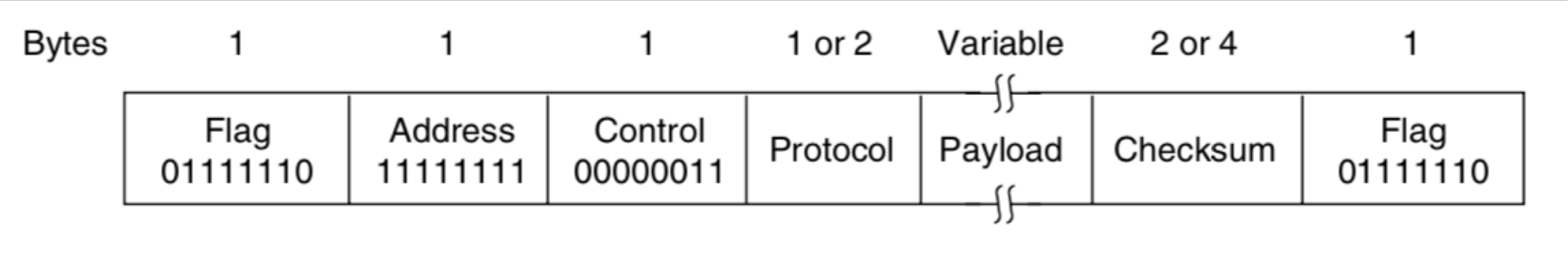
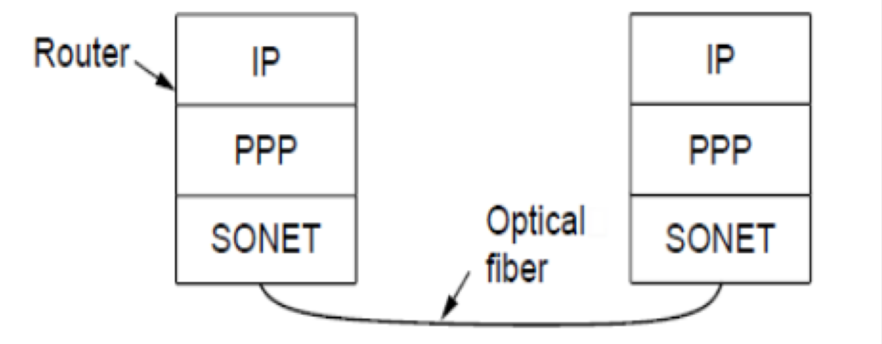


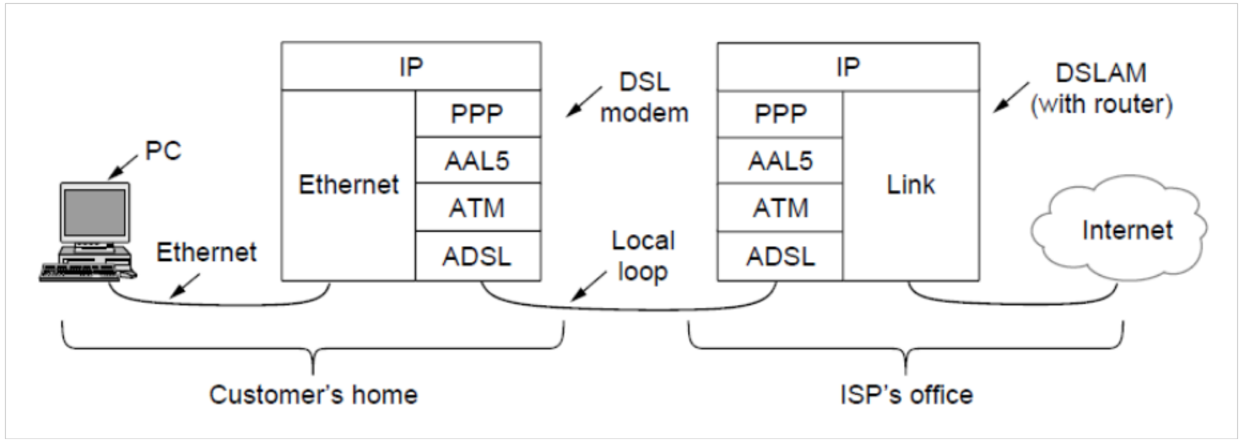
Figure 3-24. The PPP full frame format for unnumbered mode operation.

Point to Point Protocol (PPP)

- Data-link layer
- Controls transmitting data across two nodes(any devices in the network)
- Both SONET (Synchronous Optical Networking) and ADSL (Asymmetric Digital Subscriber Loop) use PPP in different ways



Protocol stacks



Question 1

What is the minimum overhead in bytes to send an IP packet using PPP?

Bytes	1	1	1	1 or 2	Variable	2 or 4	1
	Flag 01111110	Address 11111111	Control 00000011	Protocol	Payload	Checksum	Flag 01111110

Figure 3-24. The PPP full frame format for unnumbered mode operation.

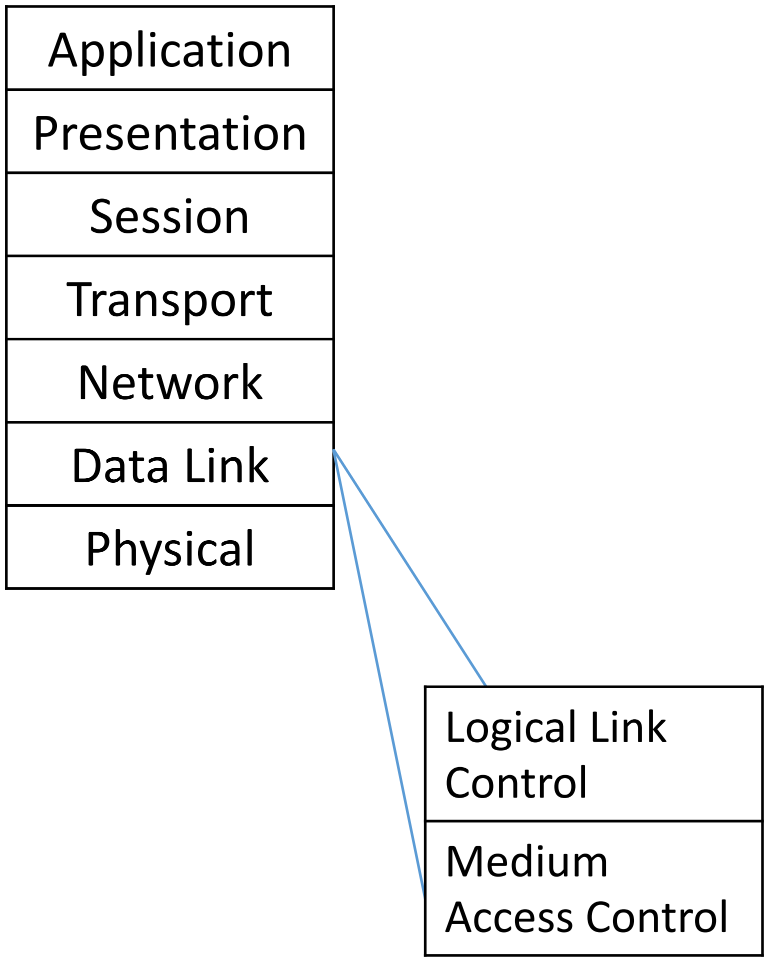
Answer:
Note that you do not need to consider the length of the IP packet or its header.

Minimum bytes in PPP frame: 1 byte for leading flag, 0 bytes for address and control, 1 byte for protocol, 2 bytes for checksum, 1 byte for trailing flag, giving a total of 5 bytes.

The address and control fields can be omitted via LCP negotiation when the connection begins. (See Ch 3.5.1 Tanenbaum)

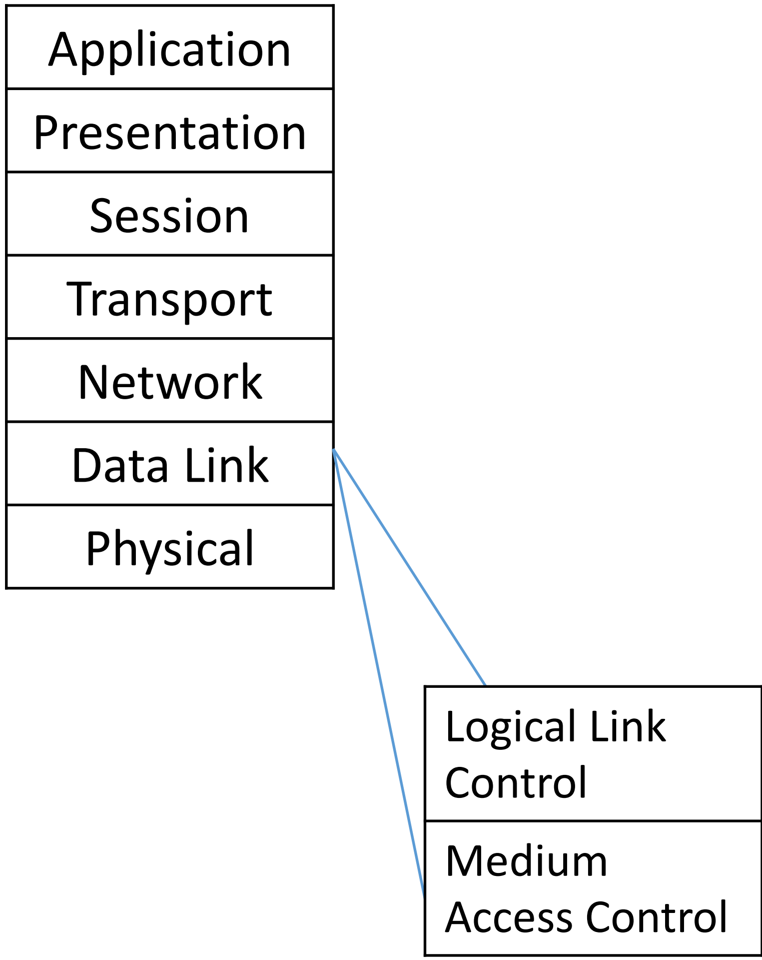
MAC

- On point to point networks, there are only singular sender and receiver pairs, eliminating transmission contention
- On broadcast networks, determining right to transmit is a complex problem
- Medium Access Control (MAC) sub-layer is used to assist in resolving transmission conflicts



Sub-Layer: MAC

- Lives near the bottom of the data link layer
- Controls how we can allocate multiple users over a single shared channel in a broadcast network.



Multiple Access Protocols

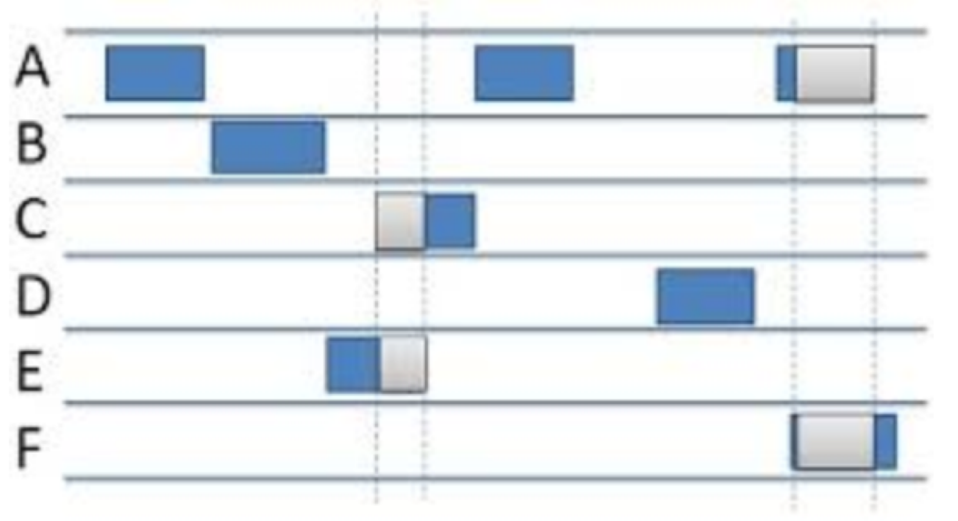
1. ALOHA
    - Pure
    - slotted
2. CSMA
    - 1-persistent
    - non-persistent
    - p-persistent
3. CSMA/CD
    - Bit-map
    - Binary Countdown

4. Limited Contention Protocol

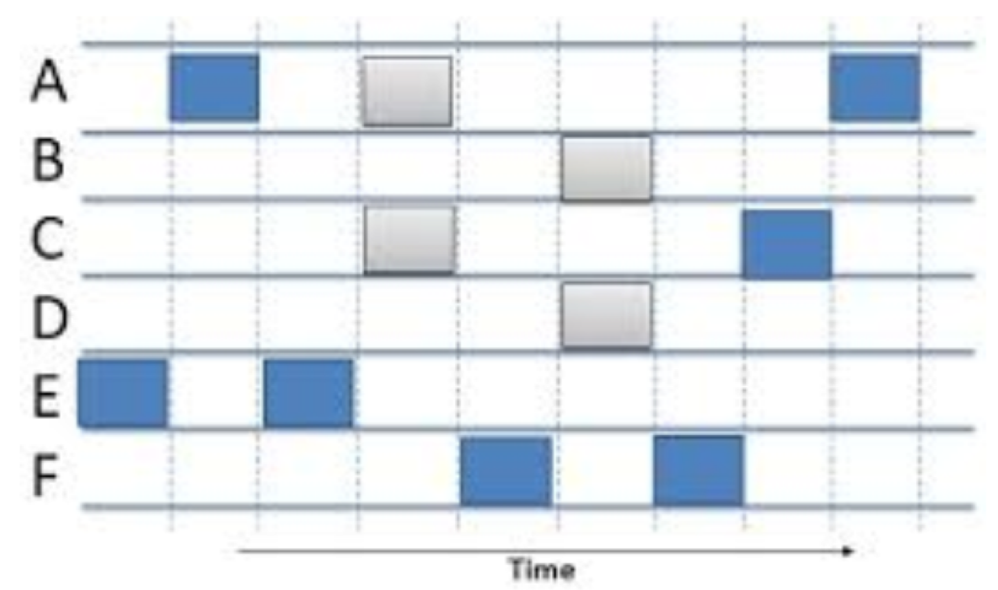
- The Adaptive Tree Walk Protocol

1.ALOHA

The basic idea of an ALOHA system is simple: let users transmit whenever they have data to be sent.
2 versions: pure and slotted.



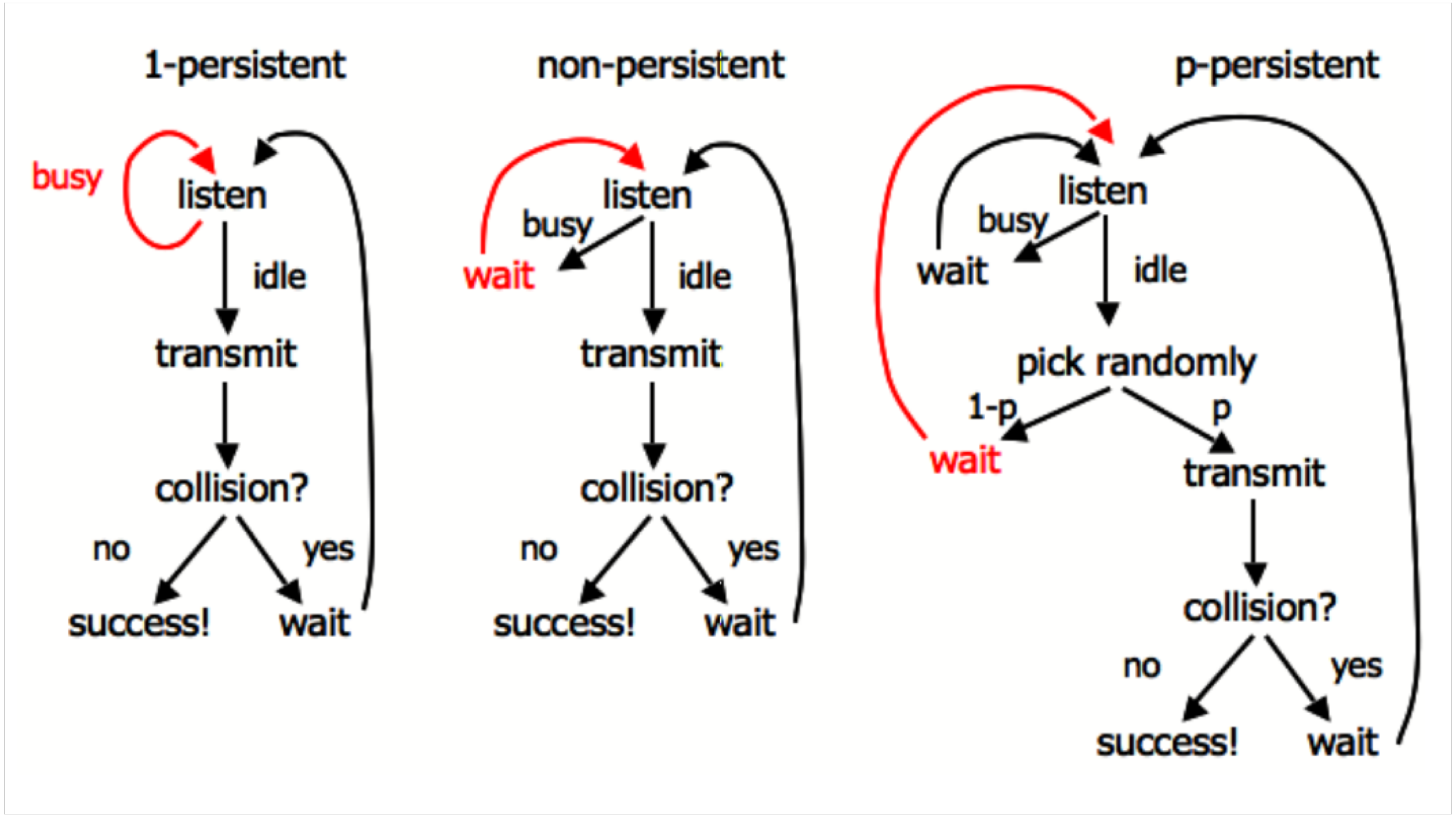
Pure ALOHA



Slotted ALOHA

2.CSMA(Carrier Sense Multiple Access)

- Stations listen for a carrier and act accordingly are called carrier sense protocol.



However, if two stations sense the channel to be idle and begin transmitting simultaneously, their signals will still collide.

Another improvement is for the stations to quickly detect the collision and abruptly stop transmitting, (rather than finishing them) since they are irretrievably garbled anyway. This strategy saves time and bandwidth.

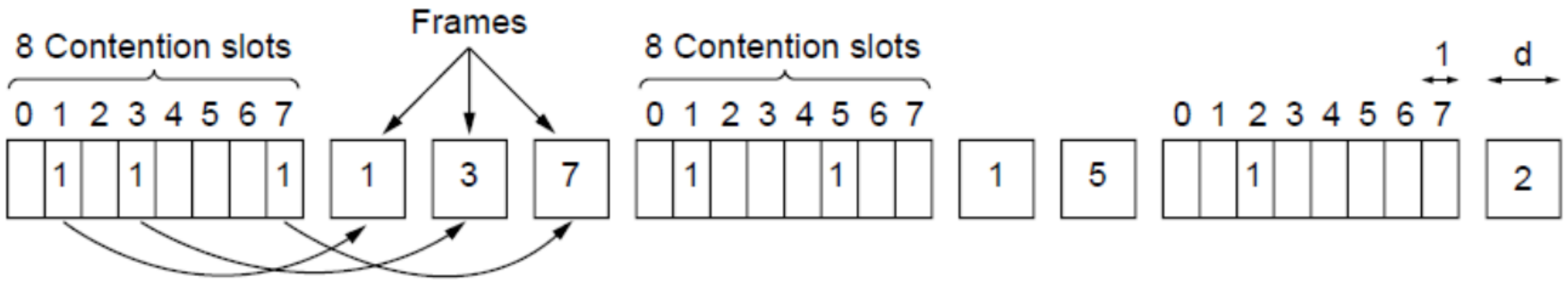
CSMA/CD

CSMA with Collision Detection

- Bit-Map Protocol
- Binary Countdown

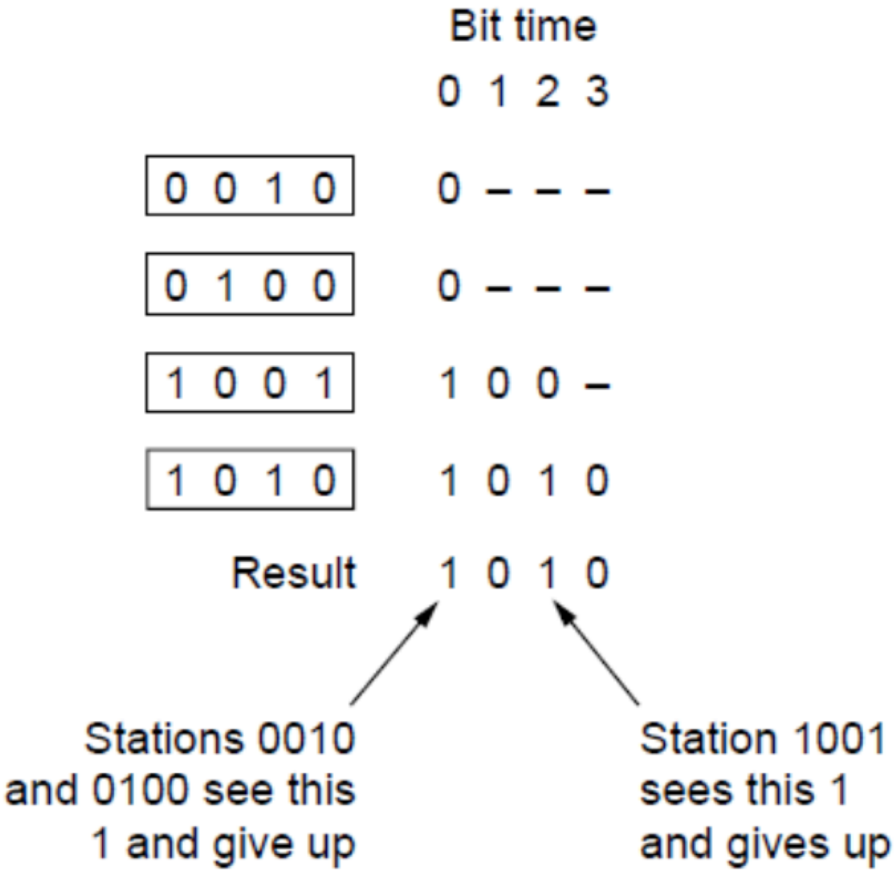
3. Collision Free Protocols

- Bit Map Protocol
  - Reservation-based protocol
  - 1 bit per station overhead
  - Division of transmission right, and transmission event - no collisions as this is a reservation based protocol



Binary Countdown Protocol

- Stations send their address in contention slot (log N bits instead of N bits)
- Channel medium ORs bits; stations give up when they send a “0” but see a “1”
- Station that sees its full address is next to send



Comparison

- **ALOHA, CSMA protocols – potential collisions**

  No need to reserve, send once the conditions are satisfied.

- **CSMA/CD – collision free (bit map and binary countdown)**

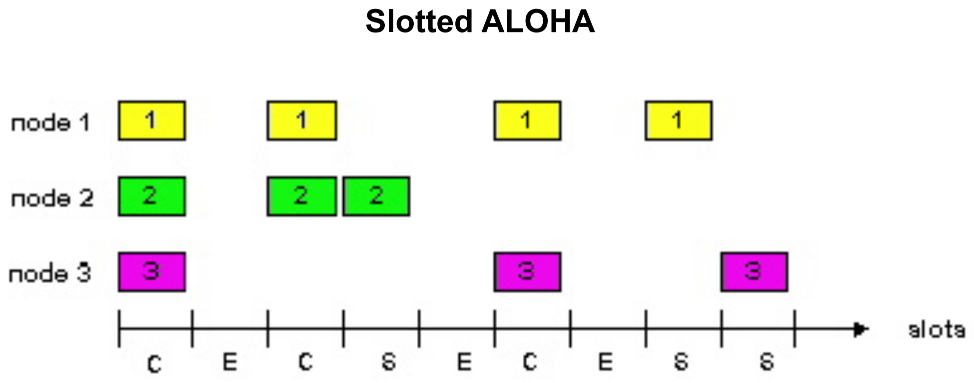
  Need to reserve

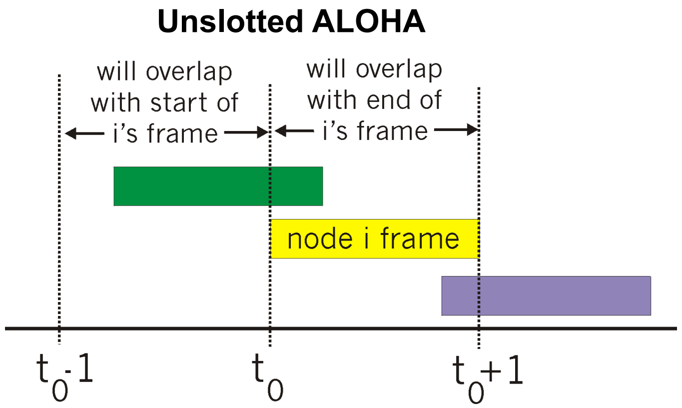
  With a low load, the reservation-based protocols may incur unnecessary overhead.

  With the load increases, they become more and more attractive.

Question 2

Consider the delay of pure ALOHA versus slotted ALOHA at low load. Which one is less? Explain your answer.





Answer:
With slotted ALOHA, it has to wait for the next slot. This introduces half a slot time of delay. With pure ALOHA, transmission can start instantly.

At low load with minimal collisions, pure ALOHA will have less delay.

However, at higher loads, there is more probability for collisions in pure ALOHA compared to slotted ALOHA. This is because frames can collide in midway. By enforcing synchronisation, slotted ALOHA is able to achieve much greater efficiency.

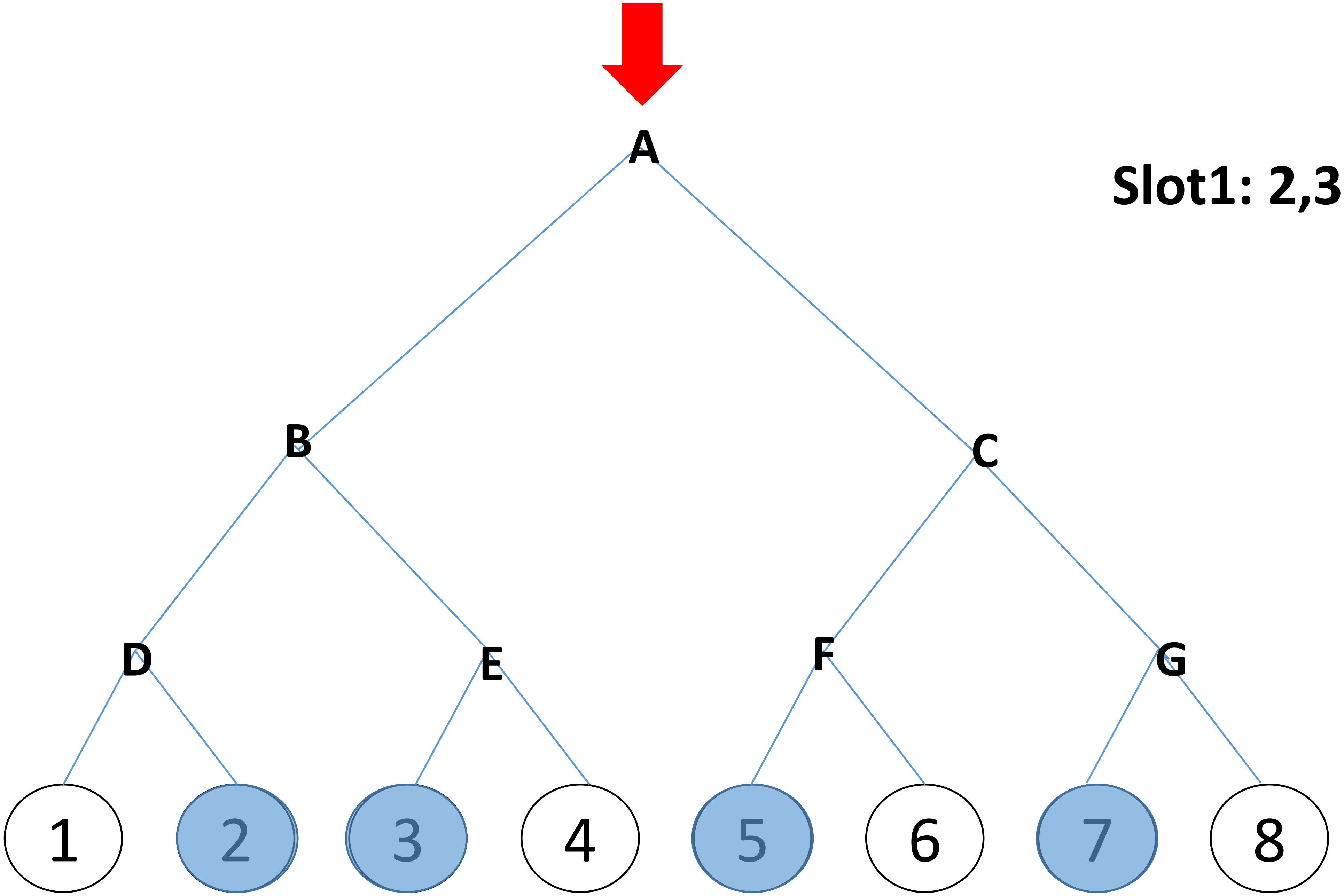
Question 4

Eight stations, numbered 1 through 8, are contending for the use of a shared channel by using the adaptive tree walk protocol. If all the stations whose addresses are prime numbers suddenly became ready at once, how many bit slots are needed to resolve the contention?

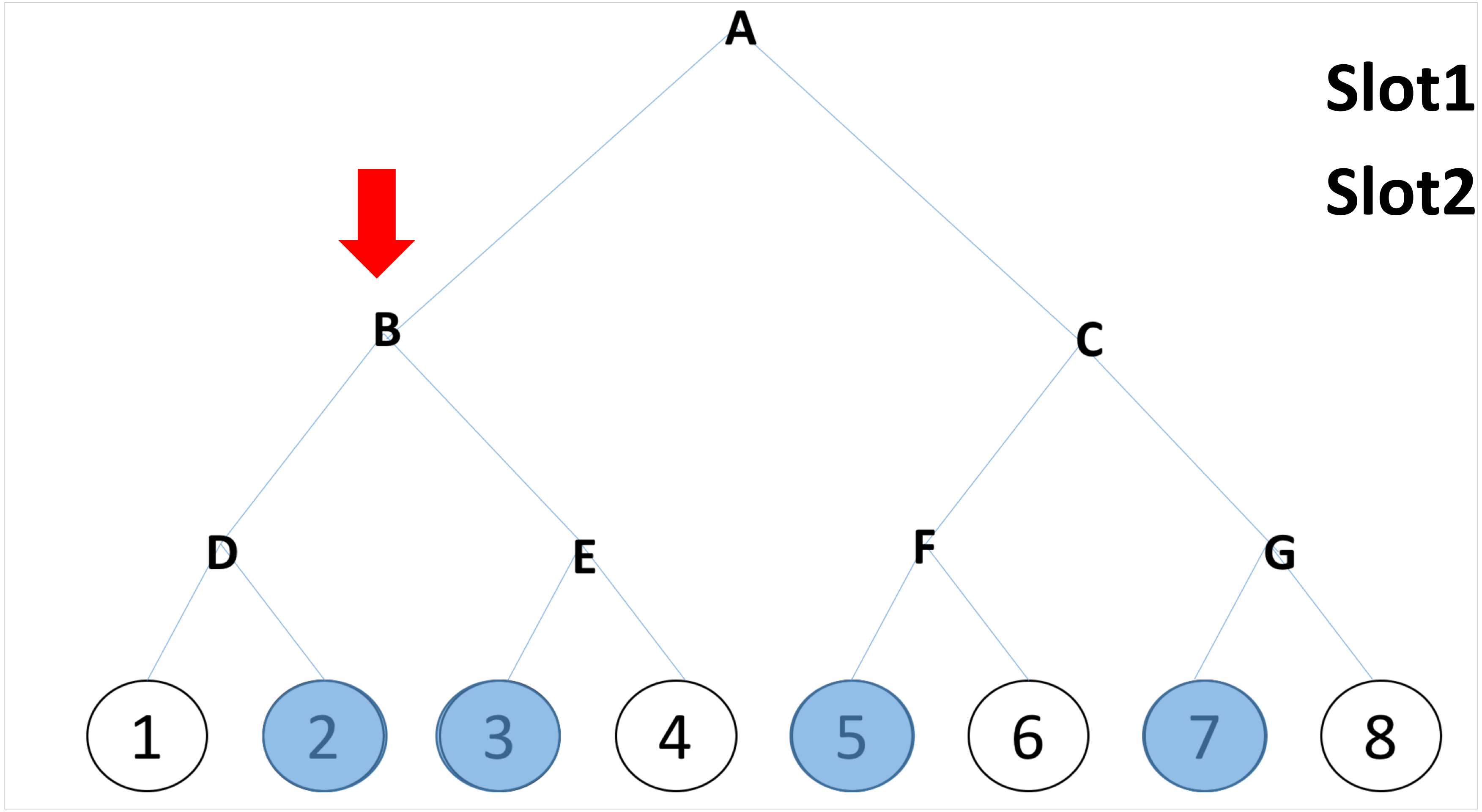
4.Limited-contention protocols

Adaptive tree walk protocol
Evenly distribute the resource (depth first search)

We combine the best properties of the contention and collision-free protocols, arriving at a new protocol that used contention at low load to provide low delay, but used a collision-free technique at high load to provide good channel efficiency.

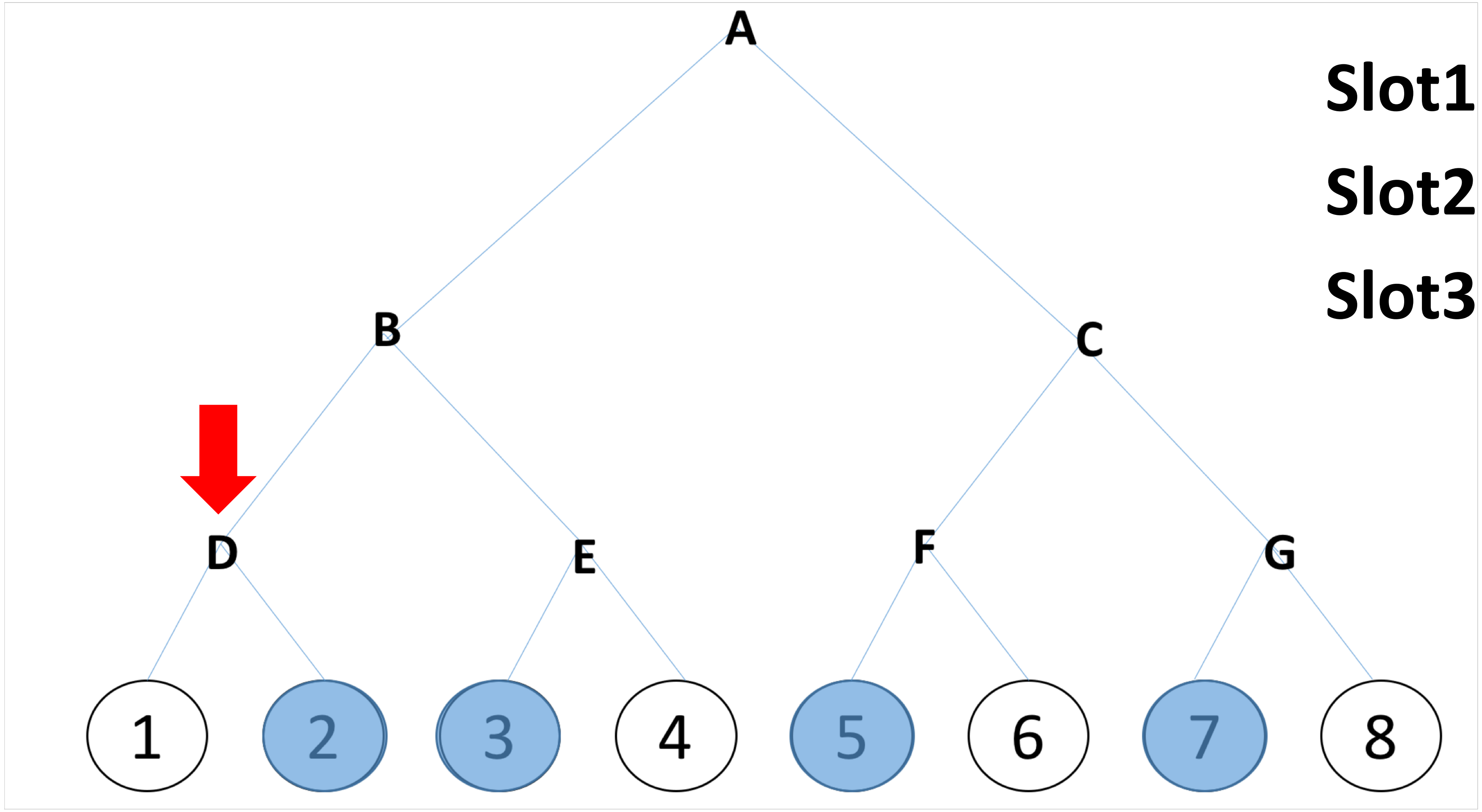


Slot1: 2,3,5,7



Slot1: 2, 3, 5, 7

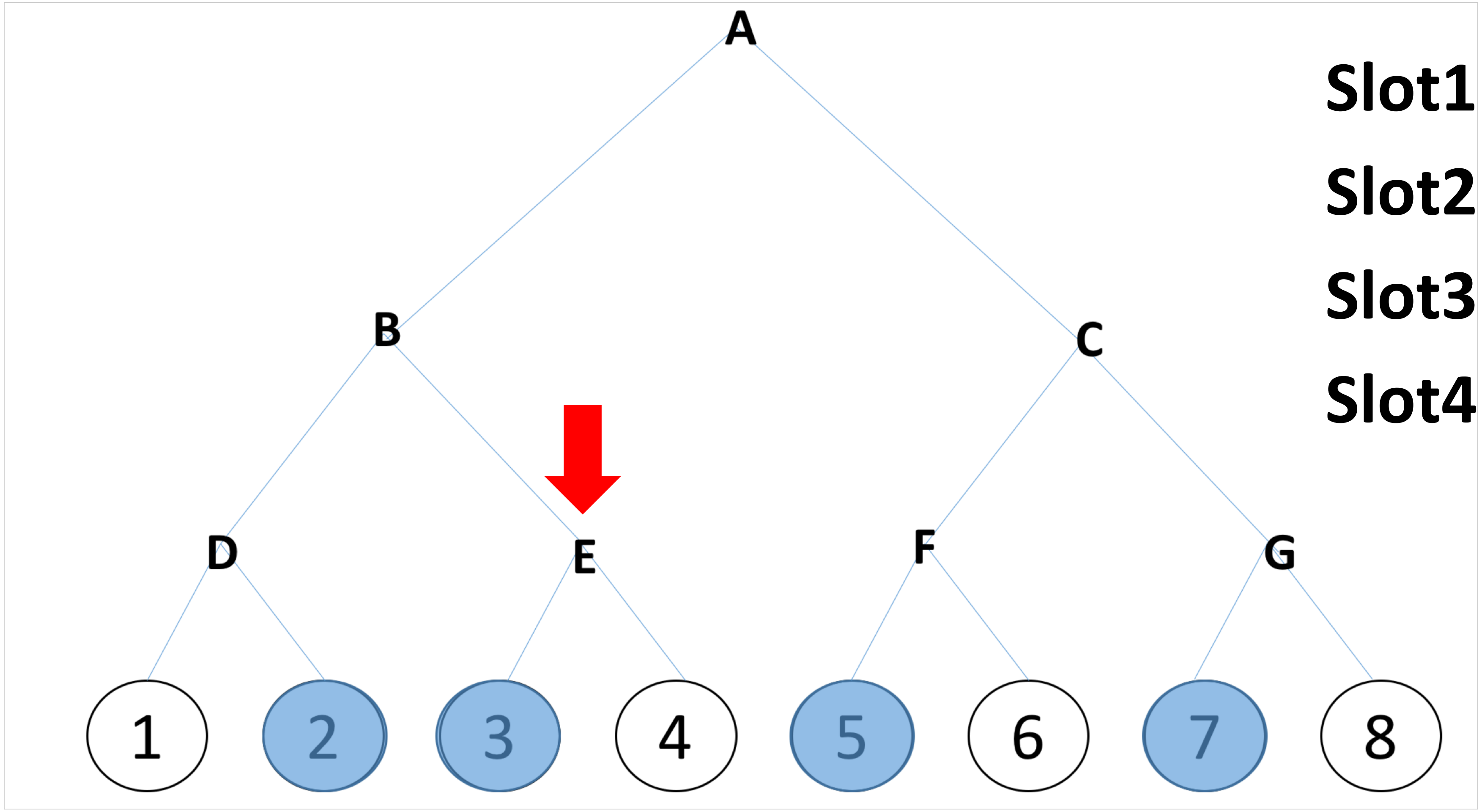
Slot2: 2, 3



Slot1: 2, 3, 5, 7

Slot2: 2, 3

Slot3: 2

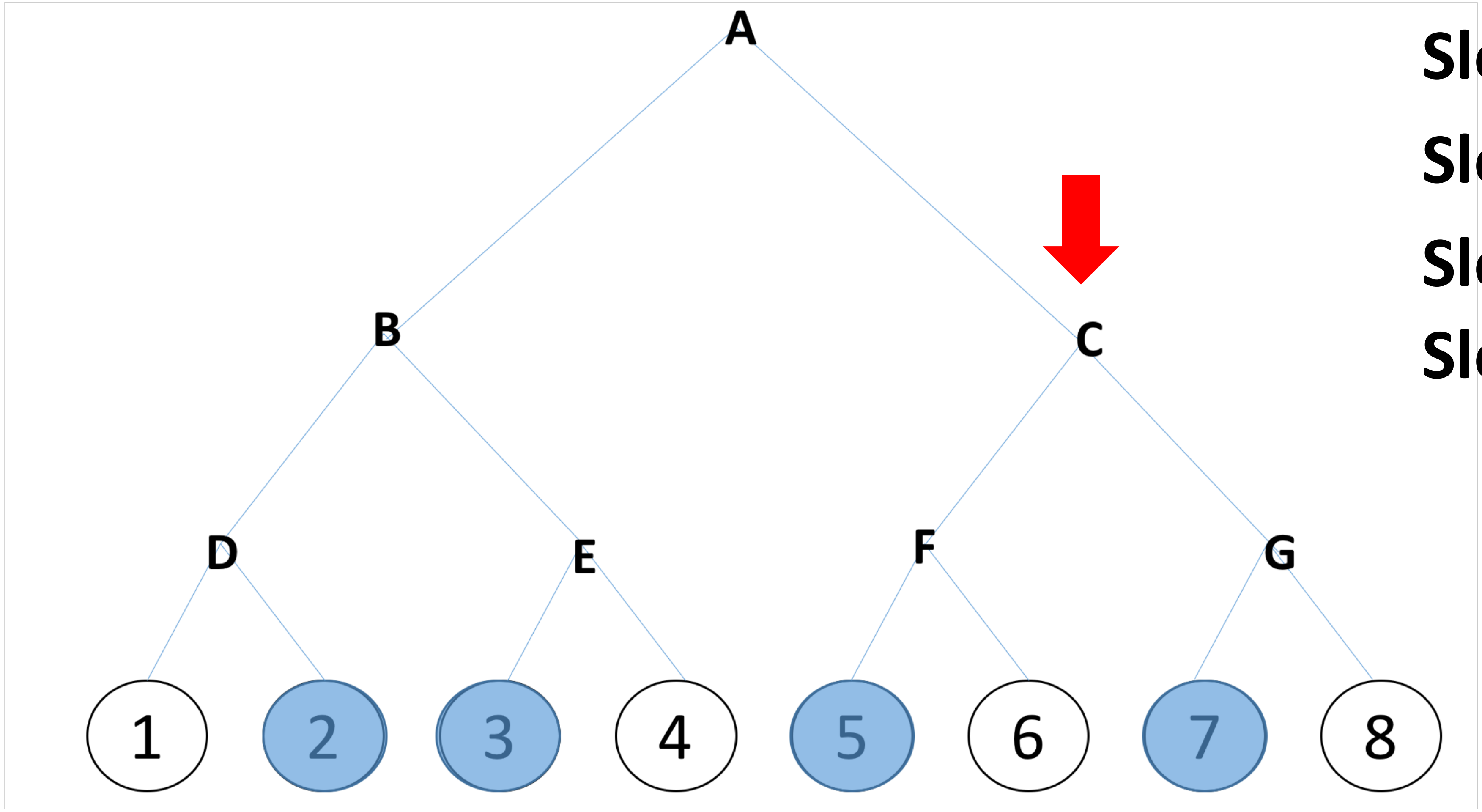


Slot1: 2, 3, 5, 7

Slot2: 2, 3

Slot3: 2

Slot4: 3



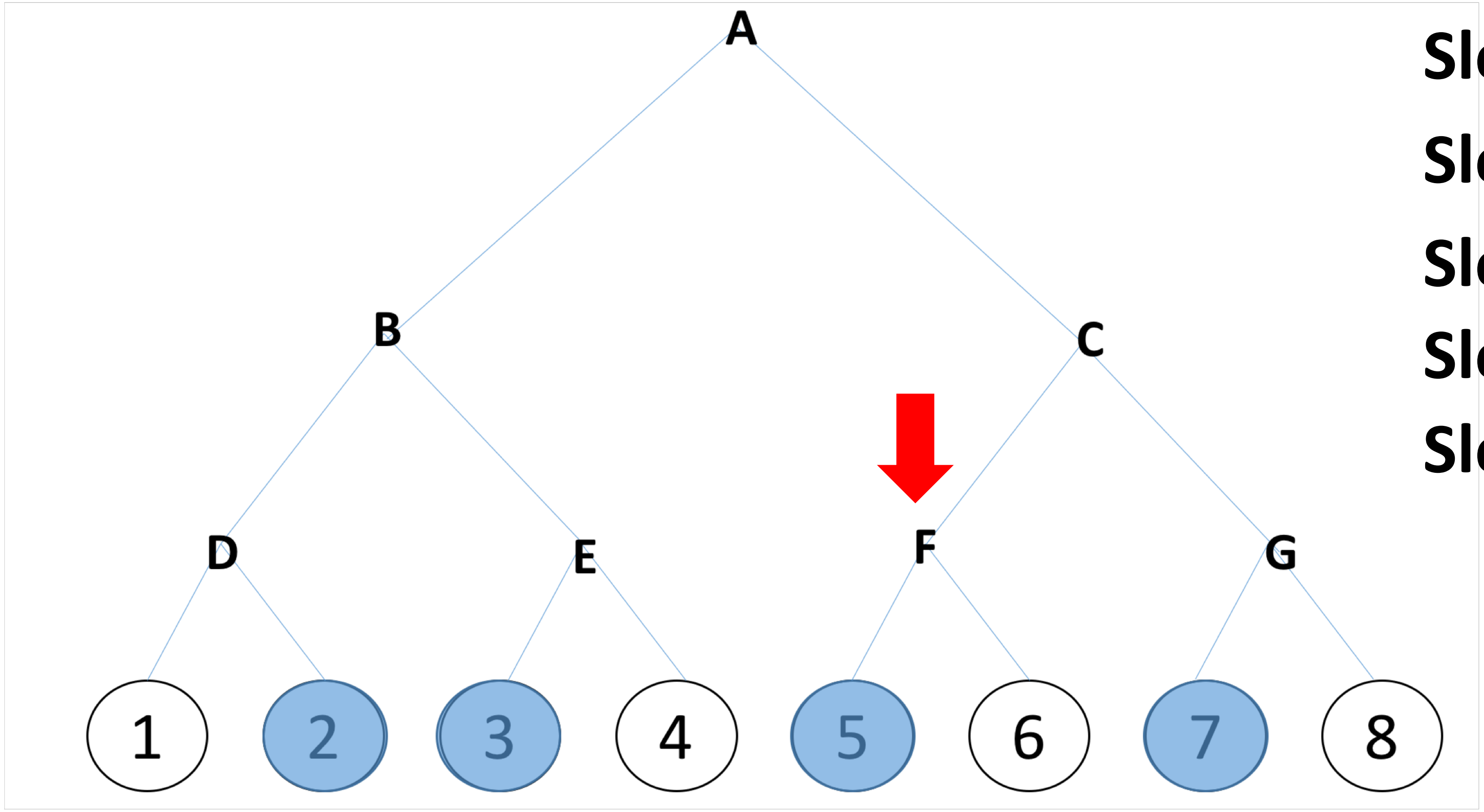
Slot1: 2, 3, 5, 7

Slot2: 2, 3

Slot3: 2

Slot4: 3

Slot5: 5, 7



Slot1: 2, 3, 5, 7

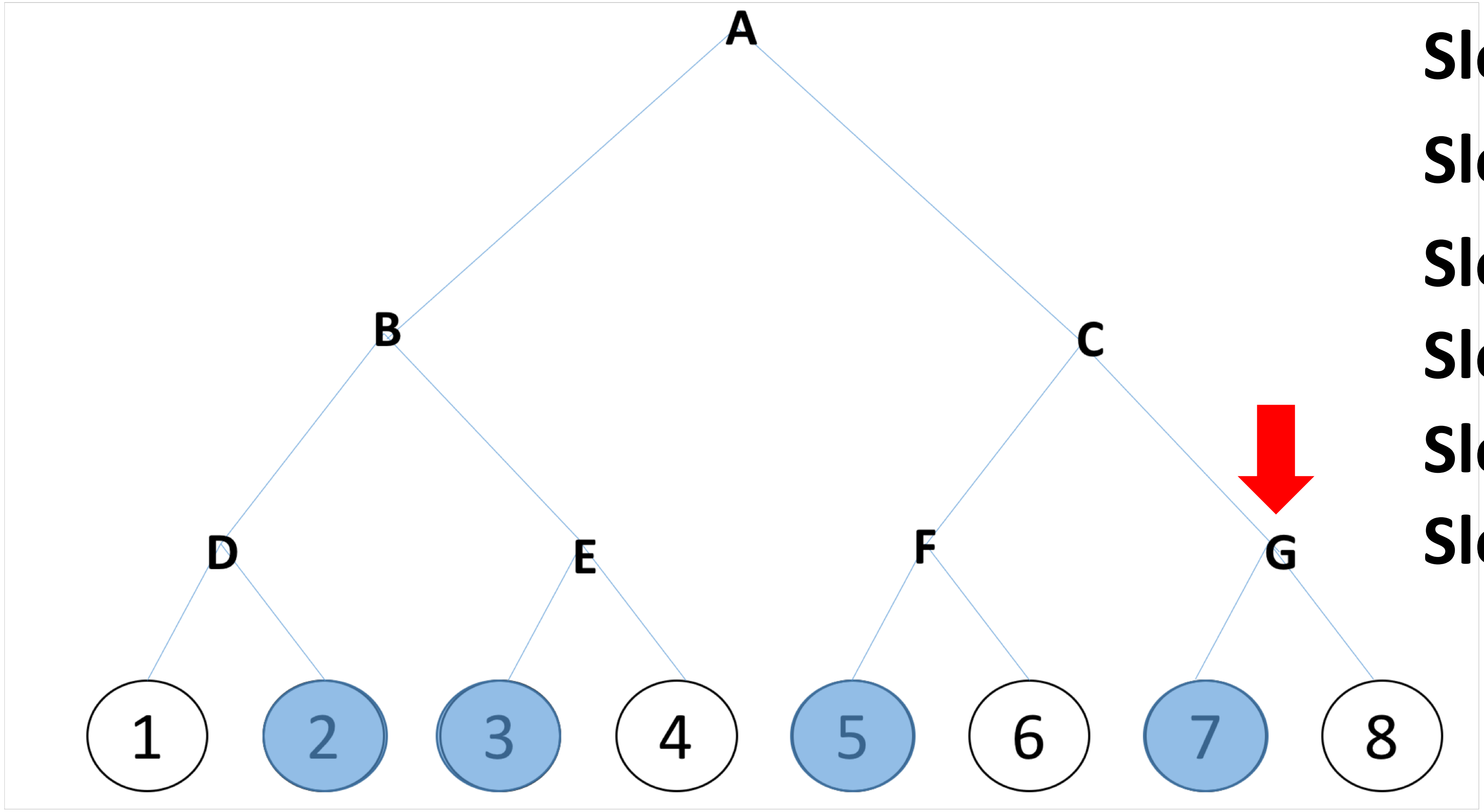
Slot2: 2, 3

Slot3: 2

Slot4: 3

Slot5: 5, 7

Slot6: 5



Slot1: 2, 3, 5, 7

Slot2: 2, 3

Slot3: 2

Slot4: 3

Slot5: 5, 7

Slot6: 5

Slot7: 7

Question 4

Eight stations, numbered 1 through 8, are contending for the use of a shared channel by using the adaptive tree walk protocol. If all the stations whose addresses are prime numbers suddenly became ready at once, how many bit slots are needed to resolve the contention?

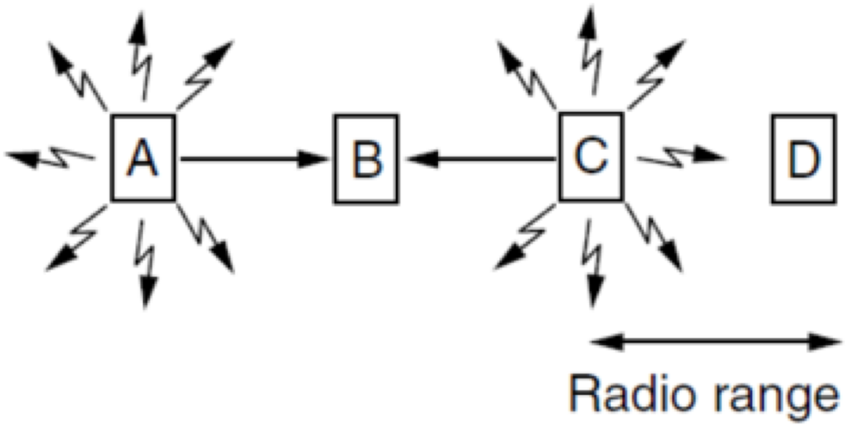
Answer:
Stations 2,3,5,7 want to send. 7 slots are needed, with the contents of each slot being as follows:
slot 1: 2, 3, 5, 7 (collision)
slot 2: 2, 3 (collision)
slot 3: 2 (success)
slot 4: 3 (success)
slot 5: 5, 7 (collision)
slot 6: 5 (success)
slot 7: 7 (success)

Wireless LAN Protocols

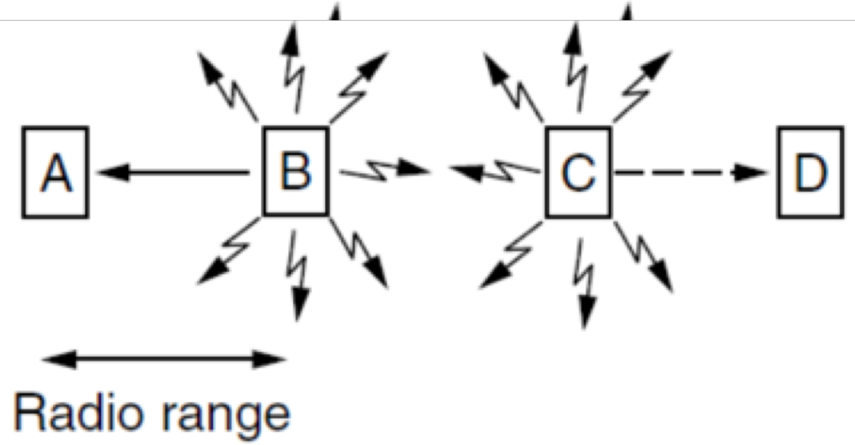
- Wireless Complications: when a station is in the range of two transmitters or relays, interference affects signal reception
- Leads to hidden and exposed terminal problems
- Require detection of transmissions to receiver, not just carrier sensing

Hidden and Exposed terminals

- **Hidden terminals** are senders that cannot sense each other but nonetheless collide at intended receiver
- Want to prevent; loss of efficiency
- A and C are hidden terminals when sending to B



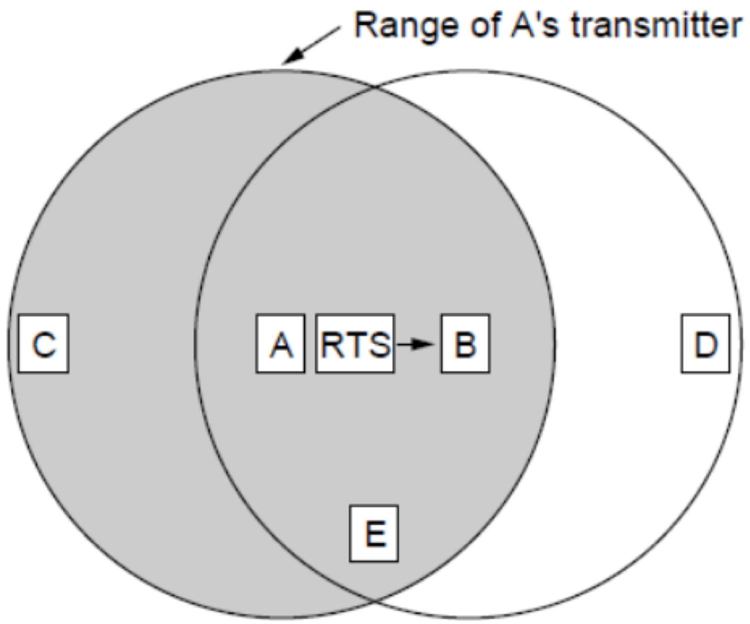
- **Exposed terminals** are senders who can sense each other but still transmit safely (to different receivers)
  - Desirably concurrency; improves performance
  - B → A and C → D are exposed terminals



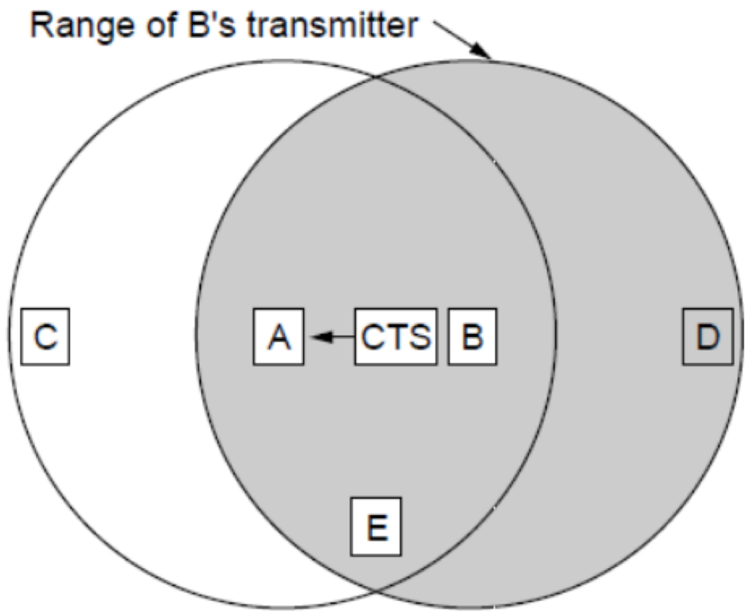
MACA

MACA protocol grants access for A to send to B:

- A sends RTS to B [left]; B replies with CTS [right]
- A can send with exposed but no hidden terminals



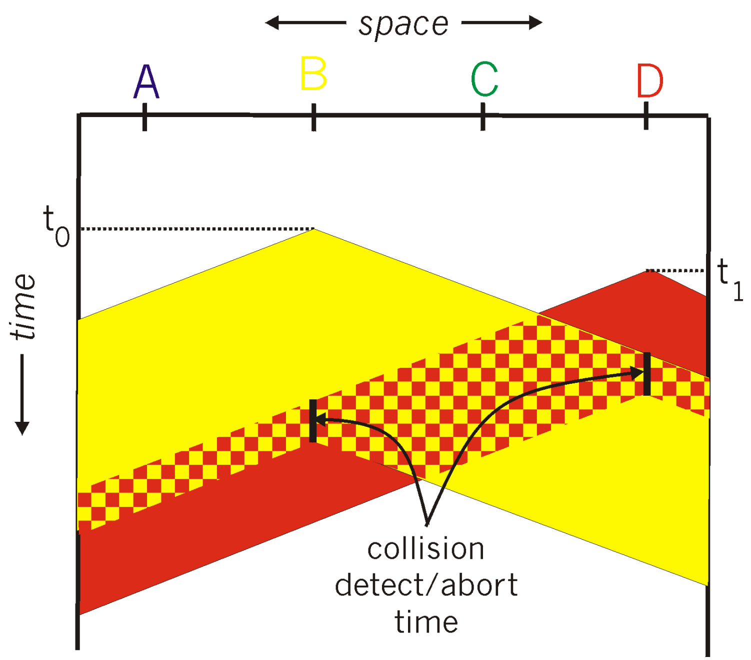
A sends RTS to B; C and E hear and defer for CTS



B replies with CTS; D and E hear and defer for data

Question 3

The wireless LANs that we studied used protocols such as MACA instead of using CSMA/CD. Under what conditions, if any, would it be possible to use CSMA/CD instead?



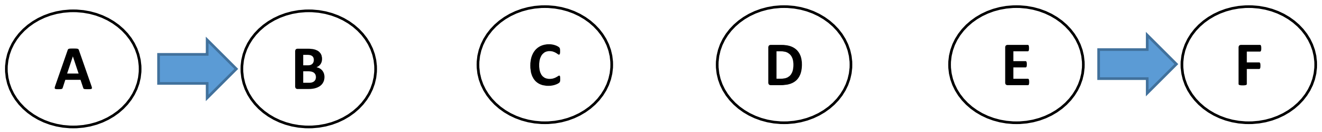
Answer:
Radios cannot receive and transmit on the same frequency at the same time. In wireless systems, the received signal can be 1,000,000 smaller than the transmitting signal. Therefore detecting the received signal superimposed on the transmitted signal is near impossible.

There is also the problem of not all stations being within radio range of each other, and therefore will not detect the collision.

Question 5

Six stations, A through F, communicate using the MACA protocol. Is it possible that two transmissions take place simultaneously? Explain your answer.

Answer:
Yes. Imagine that they are in a straight line and that each station can reach only its nearest neighbours. Then A can send to B while E is sending to F.

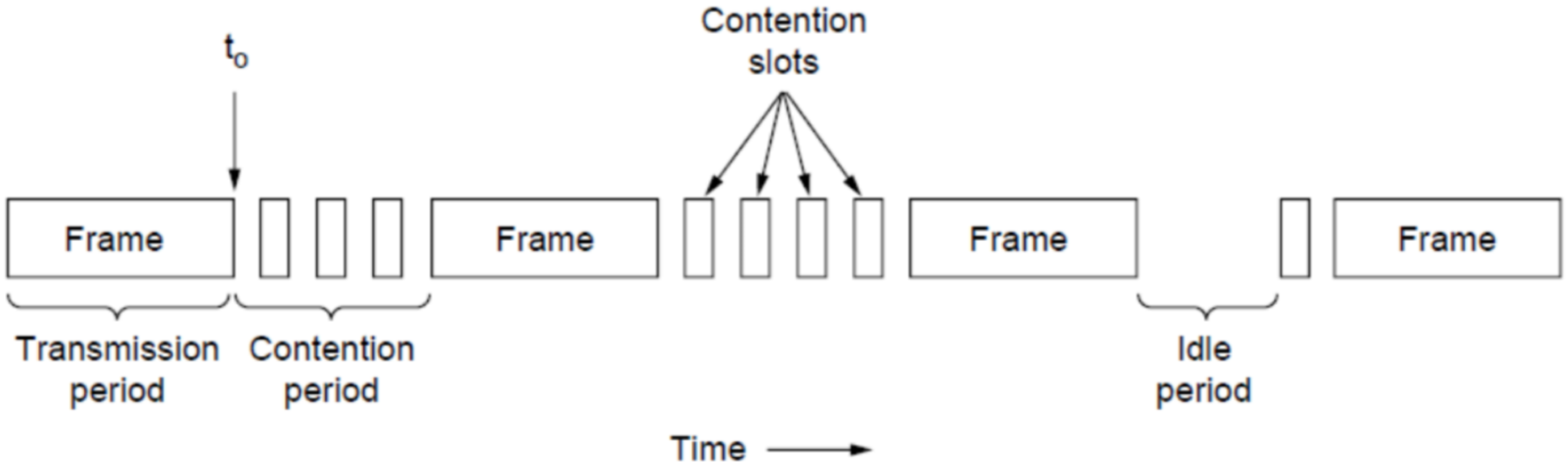


Question 6

Give two reasons why networks might use an error-correcting code instead of error detection and retransmission.

Answer:
One reason is the need for real-time quality of service. If an error is discovered, there is no time to get a retransmission. The show must go on. Forward error correction can be used here. Another reason is that on very low quality lines (e.g. wireless channels), the error rate can be so high that practically all frames would have to be retransmitted, and the retransmissions would probably be damaged as well. To avoid this, forward error correction is used to increase the fraction of frames that arrive correctly.

Q3[5 marks] Consider the CSMA/CD model shown below for collision free protocols.



Now consider the Binary Countdown protocol involving stations 0 to N-1 with each station represented by equal length binary digits. Stations with data ready to send broadcast their addresses during a contention period simultaneously. An arbitration rule is applied so that only one station wins the right to send the frame after the contention period.

a. Now consider the situation when N is 16. What is the length of the contention period in bits? **log16 to the base2=4**

b. Briefly explain the arbitration rule used in the Binary Countdown protocol.

In the contention period stations transmit their addresses bit by bit starting from the most significant bit. The bits from all stations are ORed in the channel. At any point of time, if a station with "0" bit in its address detects "1" in the channel, it backs out. Others continue to transmit. Only the channel that does not see any conflict with its address will win the right to send its frame at the end of the contention period.

c. Suppose at time t_0, stations 3, 5, 11 and 12 became ready to transmit. Which station will win the right to transmit after the contention period? **12**

d. If d is size of the frame and there are N stations, what is the channel efficiency of the method? **d/(d+log n)**

e. What is the main advantage of Binary Countdown protocol over Bit-Map protocol?

Lesser overhead