Medium Access Control (MAC)

1) Time Division Multiple Access (TDMA)

   A network employing TDMA uses 50ms time slots. The available slots are split up between 6 stations. During a period of 3 seconds, stations 1, 5 and 6 have data to transmit. Calculate the usage of the available bandwidth for TDMA with and without a reservation access method. Assume that it takes 60us for the reservation frame to be transmitted and that it is negligible in the calculation of the bandwidth usage. Demonstrate the usage in a diagram.

2) Carrier Sense Multiple Access (CSMA)

   Both, CSMA with Collision Detection (CSMA/CD) and CSMA with Collision Avoidance (CSMA/CA) use binary exponential backoff. Assume that four stations 1, 2, 3 and 4 want to send data and the transmission of a frame has just been completed. Show in a diagram how the four stations compete for the medium and the times that are involved, using both CSMA/CD and CSMA/CA.

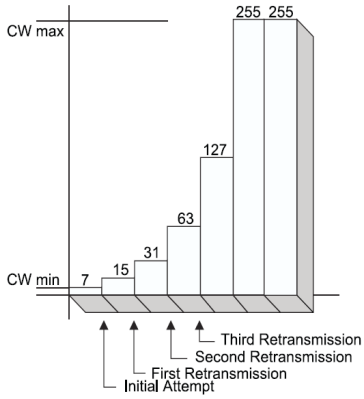

Figure 1: Binary Exponential Backoff

3) Poll

   Assume that a wireless network consists of a wireless access point and a set of 6 mobile stations. The wireless access point polls the individual mobile stations for data to transmit. Stations 1, 3, and 4 have data to transmit; stations 2, 5 and 6 have no data to transmit. Show in a diagram the traffic that is exchanged over the wireless medium between the access points and the stations.

4) Code Division Multiple Access (CDMA)

   Assume a network with three mobile phones, stations 1, 2 and 4, and a base station, station 3. The three mobile phones want to send 011, 101 and 100 respectively; the base station is silent. A 0 is encoded as -1, a 1 is encoded as +1 and silence is represented by 0. Give the signal that the base station receives.

   Chip Sequences:

   Station 1: +1 +1 -1 -1
   Station 2: +1 -1 +1 -1
   Station 3: +1 +1 +1 +1
   Station 4: +1 -1 -1 +1

802.11 Wireless Networking

5) An access point uses the Point Coordination Function (PCF) of 802.11 to communicate with 10 laptops that are associated with it. After the contention free period has been completed, the laptops attempt to communicate with one another directly using the Distributed Coordination Function (DCF) of

802.1 – see figure 2 for a possible topology. Assume that at least a number of transmission attempts lead to collisions.

Describe the frames that are exchanged by the stations and the inter frame spaces that are involved in this exchange. Use diagrams to visualise the chronological exchange of the frames and the inter frame spaces.

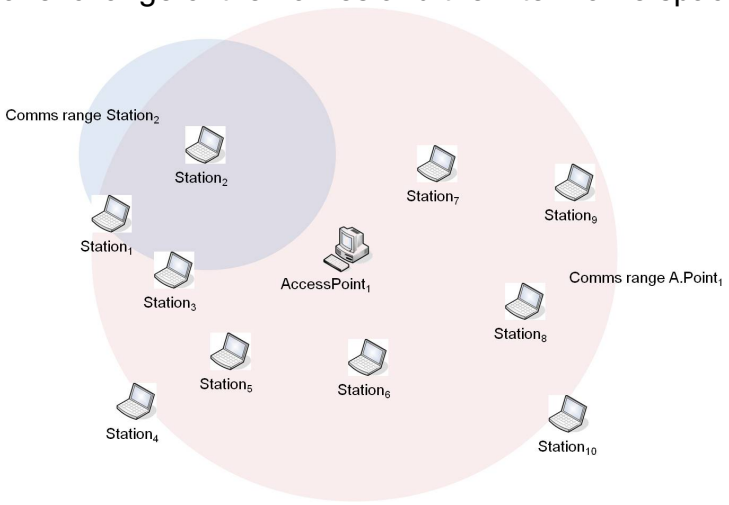

Figure 2: Possible 802.11 topology

6) Three stations using 802.11 intent to transmit each 3 data frames to an access point. The times for the transmission for data frames and the Beacon are 190us, for RTS and Poll 180us, for CTS, ACK and CF-End 132us.

with 802.11a:
slot: 9us
SIFS: 16us
PIFS: 25us
DIFS: 34us
AIFS: >=34us

   i) Calculate the total time for the transmissions if the stations use DCF. Assume that the random numbers for backoff slots received by the stations are different for all the stations ie. that no collisions occur because of the same random numbers received by two or more stations. Indicate the random numbers that you are using for your calculations.
   ii) Calculate the total time for the transmissions if the stations use PCF. Assume that the access point uses only one contention free period for polling each station 3 times.

802.3 Ethernet

7) IEEE 802.3 Ethernet defines a frame format as shown in figure 1 and may include a IEEE 802.2 Link Layer Control (LLC) protocol frame. Figure 2 shows layout of the control field for the types of frames of 802.2 that can be used to implement flow control.

   a) Draw the exchange of the frames in much detail as possible for a Stop-and-Wait approach and for a Selective-Repeat approach. Your diagram should be accompanied by an explanation of the process and of assumptions in case you made any.

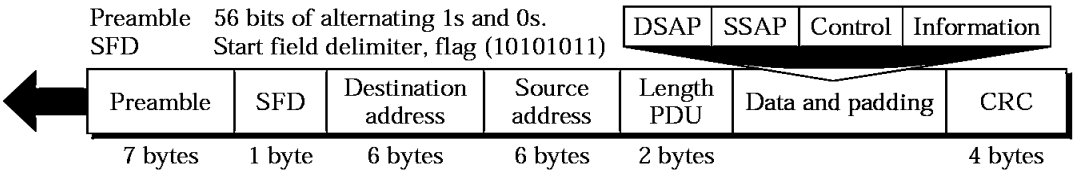

Figure 3: Layout of an 802.3 Ethernet frame

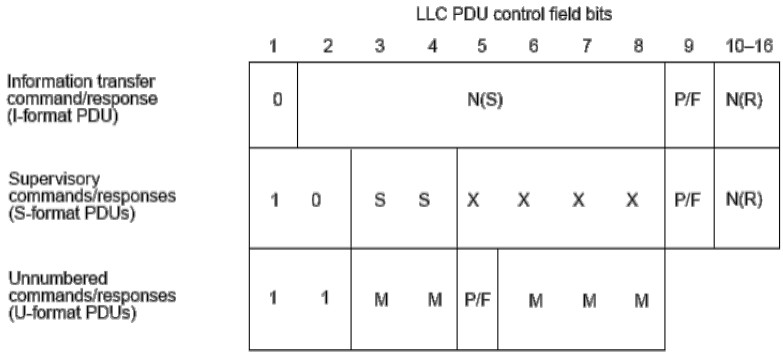

Figure 4: Layout of 802.2 LLC information

8) Assume that you have 2, 20 and 200 stations sharing an Ethernet segment. All stations intent to send frames at some stage during a 5 second window.
   a) Draw a diagram that visualizes the attempts by each station over times to acquire the medium to transmit and how the back-off times for the individual stations develop. Where times etc are not given, use your best judgement and state the assumptions that you are making.
   b) What is the effect of a scenario where stations send large frames e.g.1536 bytes compared against a scenario where stations send very short frames e.g. 64 bytes?

Spanning Tree

The Spanning Tree Algorithm is used to remove loops from local area networks that employ a set of bridges. Apply the algorithm to the following network and give the resulting spanning tree.

Short description of the algorithm:

1. Bridge with smallest ID is selected as root bridge.
2. Mark port on each bridge with least-cost to root bridge as root port.
3. Select designated bridge for each LAN that has root port with least-cost to root bridge – if two bridges have the same cost, select bridge with lowest ID.
4. Mark root ports and designated ports as forwarding ports; other ports as blocking ports.