802.3 Ethernet

1) 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.

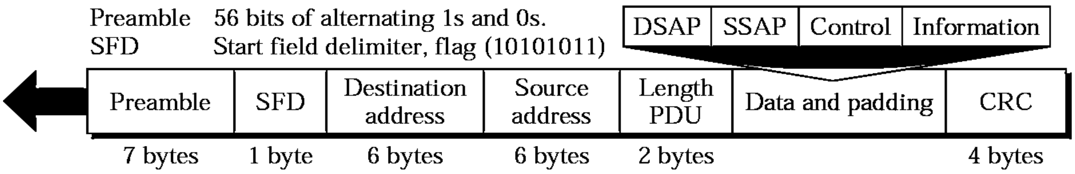


Figure 1: Layout of an 802.3 Ethernet frame

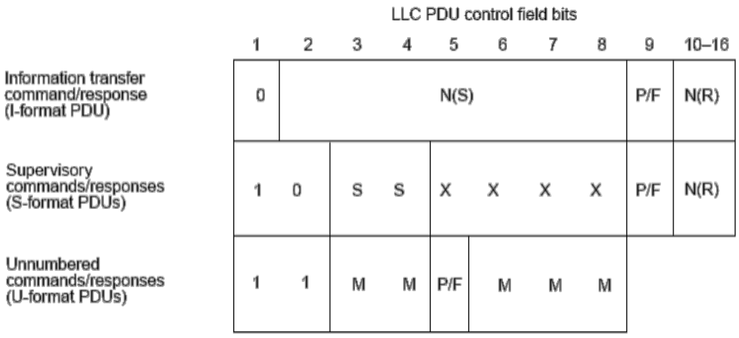


Figure 2: Layout of 802.2 LLC information

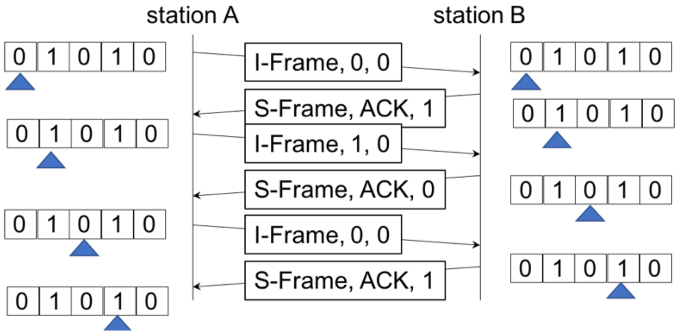
The description of the exchange of frames below has been copied from the HDLC solution ☺ – because in the end, LLC is an updated version of HLDC. In order to adapt this to Ethernet & LLC, the frames will need to be defined:

As addresses for station A and B, I assume random addresses, 0xAABBCC and 0xDDEEFF respectively. The first 7 bytes will be the preamble i.e. 10101010, or 0xAA, followed by the start-field delimiter 10101011, 0xAB. As CRC, I assume a random number, e.g. 0xCCDDBBAA; this would usually be vary with every frame. As Destination and Source Subnet Access Protocol (DSAP and SSAP) I used 0x06 for IPv4. The content of the length, control and information field are dependent on the frame.
Frame from A to B:
Preamble & SFD Dest. Source DSAP SSAP
0xAAAAAAAAAAAAAAAB 0xDDEEFF 0xAABBCC <length> 0x06 0x06
Ctrl bytes Payload. CRC
<control> <information> 0xCCDDBBAA

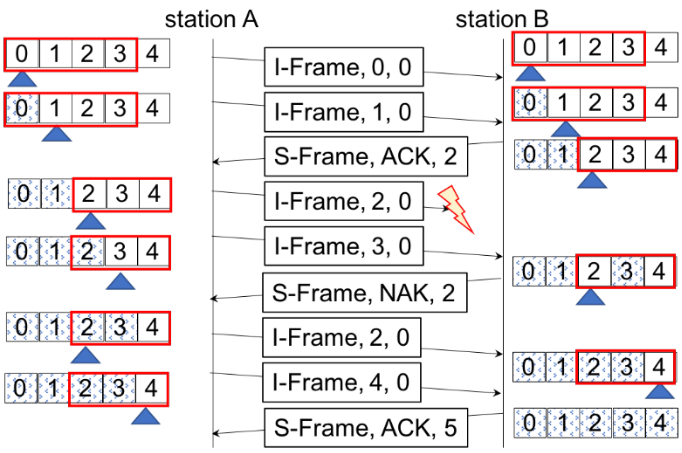
The code in S-Frames for an acknowledgement (RR) is 00 and for a negative acknowledgement (REJ) is 01.

The bit sequences for the control field would look like the following:
IFrame: 0 <7-bit seq#> 0 <7-bit ack#>
SFrame ACK: 10 00 0000 0 <7-bit ack#>
SFrame NAK: 10 01 0000 0 <7-bit ack#>

For Stop&Wait, the sender will send I-frames, carrying the sequence number of the frame, and the receiver will respond to this with an S-frame carrying an acknowledgement.



For Selective Repeat, I-frames will carry sequence numbers of the frame and the receiver will reply with S-frames either as acknowledgements or negative acknowledgements. On the transmission and reception of an acknowledgement, the station A and station B will move their windows forward to the sequence number indicated in the acknowledgement.



802.11 Wireless Networking

2) 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

802.11 – see figure 1 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.

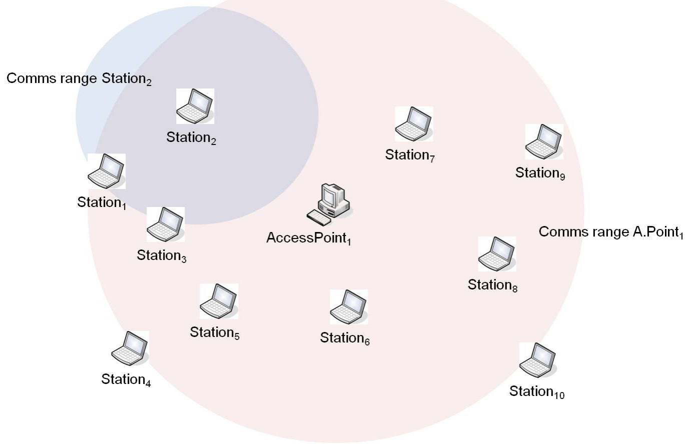


Figure 3: Possible 802.11 topology

Figure 2) and 3) give examples of communication using PCF and DCF; figure 4) presents an example of DCF extended to 10 nodes.

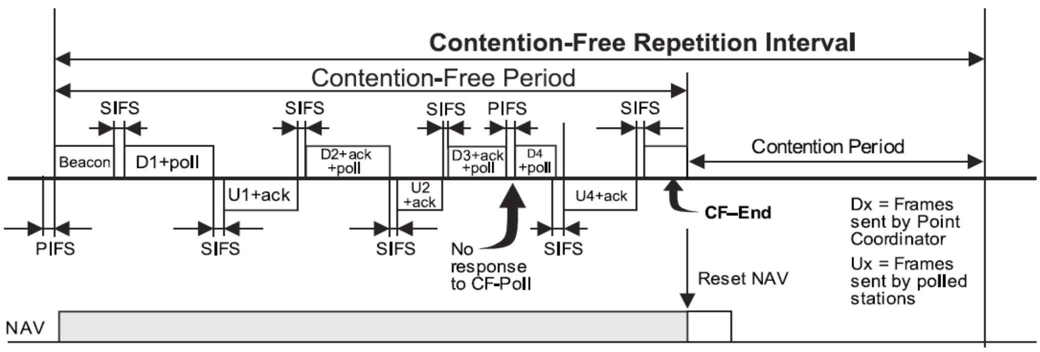


Figure 4: Example for a Contention-Free Period using PCF

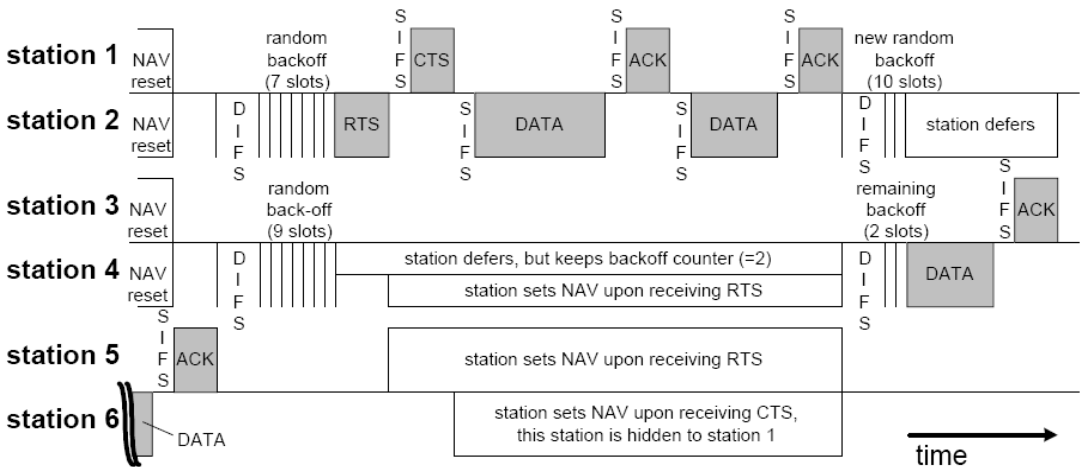


Figure 5: Example for a Contention Period using DCF

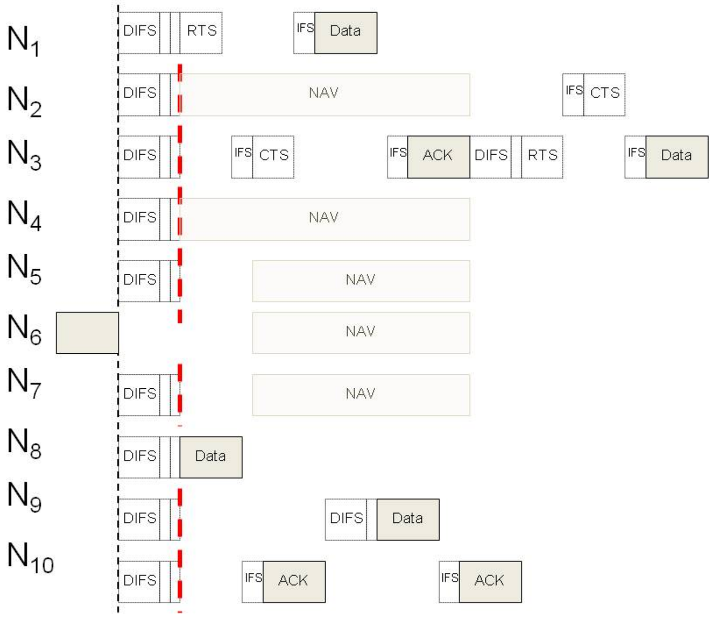


Figure 6: A possible arrangement of communication between 10 nodes using DCF

3) 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.

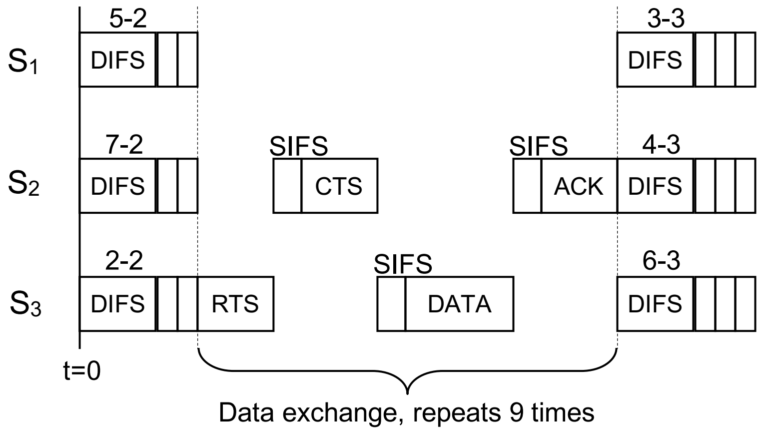
i)

Random back-off numbers – chosen as I went through the exercise:

S_1: 5, 4

S_2: 7, 5, 2

S_3: 2, 6,

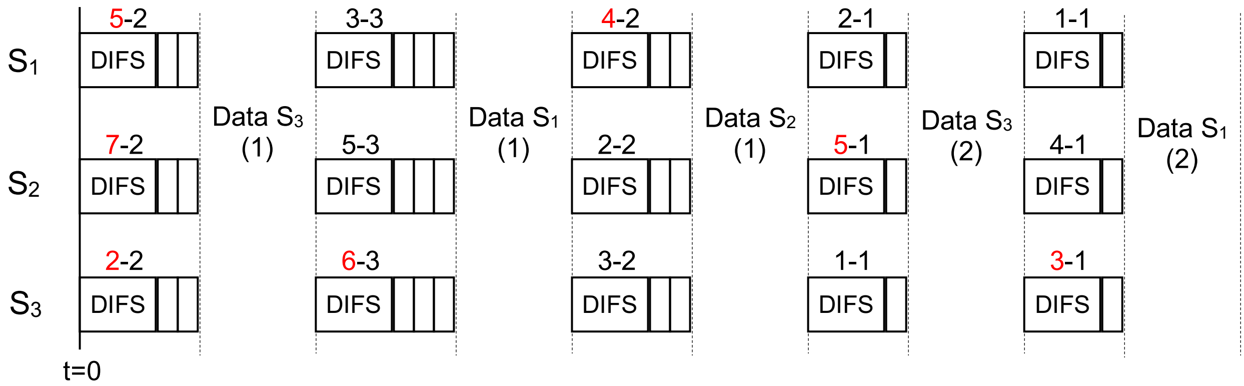


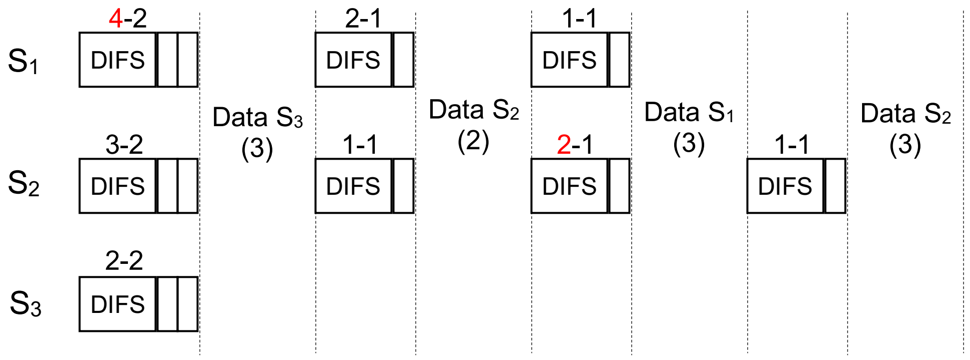
First, all stations wait for the DIFS period; then they pick random numbers for their back-off e.g. 5, 7, 2. The station that returns first – in this case S_3 – transmits an RTS frame. The addressed station – in this case I randomly picked S_2 – waits an SIFS period to be sure that the previous transmission has ended and no one is using the medium; then it transmits a CTS frame. S3 then waits an SIFS period and transmits the data. S2 waits another SIFS period and responds with an acknowledgement.

So every data exchange will consist at least of a DIFS period, an RTS and a CTS frame, a data frame and an acknowledgement and 3 SIFS periods.
Dx= DIFS+RTS+CTS+data+ack+3*SIFS
= 34us+180us+132us+190us+132us+3*16us
= 716us

Now, because whoever sat this questions, said each station would transmit 3 data frames, we'll have to play through this scenario 9 times in order to determine the number of slots that stations wait before transmission.

In the following, I've indicated a random back-off number in red, followed by the number of slots that the stations waited before a transmission by one of them e.g. 3-2 indicates that the station picked 3 as a random number of slots and that the station waited 2 slots before a transmission took place. The data exchanges show the station that is transmitting and the number of the transmission e.g. Data S3 (2) indicates the 2nd transmission of a data frame by station 3.

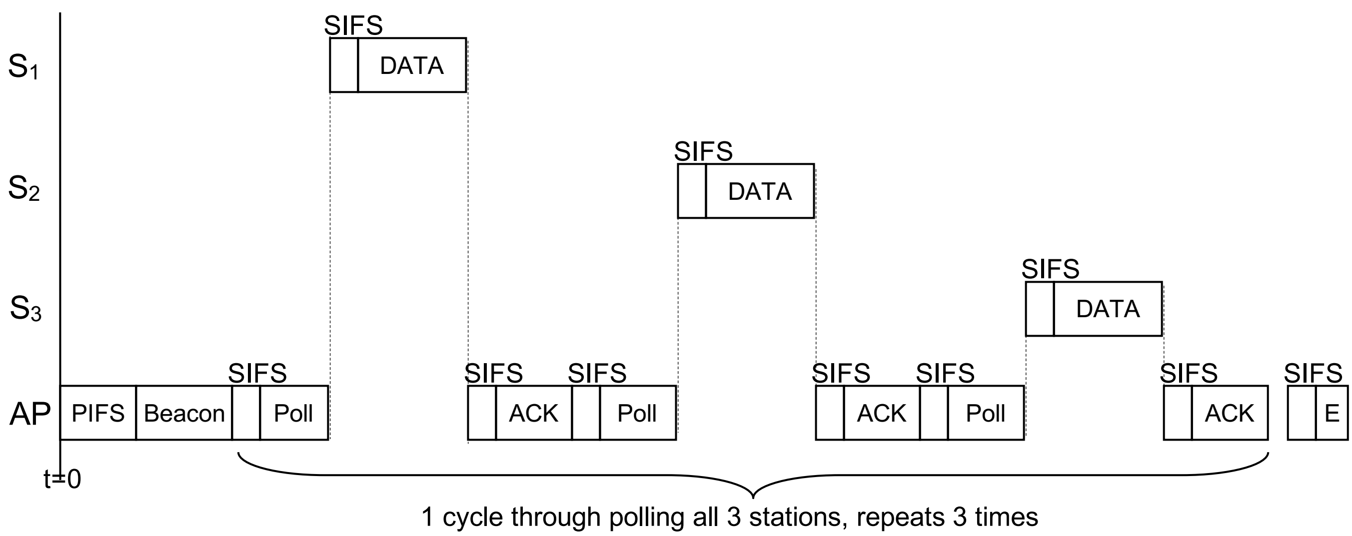




This means that 2+3+2+1+1+2+1+1+1 = 14 slots were used before a transmission took place.

So, the total time for the transmission of the 9 data frames is:
Tx= 9*Dx + 14*slots
= 9*716 + 14*9us
= 6,570us = ~0.006ms

ii)



In the PCF mode, the access point AP initially waits a PIFS period after the last transmission and then transmits a beacon frame. Following that, it waits SIFS time and then transmits a frame to poll a station – in this case S_1. S_1 waits an SIFS period and then transmits a data frame. The access points waits SIFS time, transmits an acknowledgement and then polls the next station e.g. S_2 and then the next, S_3. So, every cycle of polling all stations consists of 9 SIFS periods, 3 poll frames, 3 data frames and 3 acknowledgements:

Dx= 9*SIFS + 3*poll + 3*data + 3*ack
    = 9*16us + 3*180us + 3*190us + 3*132us
    = 1,650us