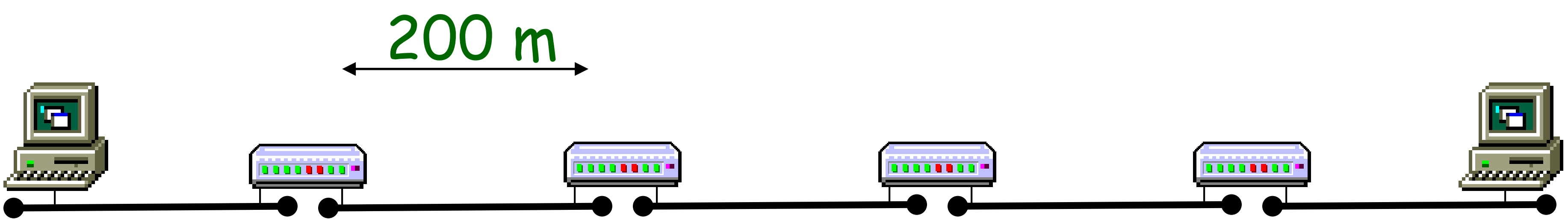
CE3005
Computer Networks

Part I - Tutorial 3

Q1: Ethernet: Minimum Frame Size Requirement

A round trip signal propagation time + the processing time is the minimum transmission requirement for a frame transmission to ensure a proper detection of a collision.

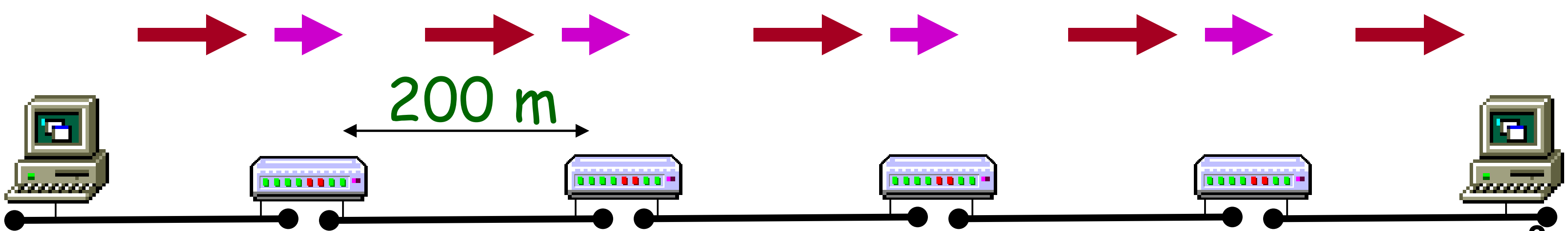


We must consider the "worst" case.

Q1: Minimum Frame Size

Minimum frame size (tx. time)
= 2 x end-to-end signal propagation time
+ processing time (negligible)

End-to-end signal propagation time
= 5 x delay in segment + 4 x delay in each repeater



Q1: Minimum Frame Size

Minimum frame size (tx. time)
= 2 x end-to-end signal propagation time
+ processing time (negligible)

36us

8us

End-to-end signal propagation time
= 5 x delay in segment + 4 x delay in each repeater

10us

2us

2us

- Given that signal prop. time is 1us for every 100m
  Delay per segment = 200 / 100 = 2 us
- Given that the delay in each repeater = 2 us

Q1: Minimum Frame Size

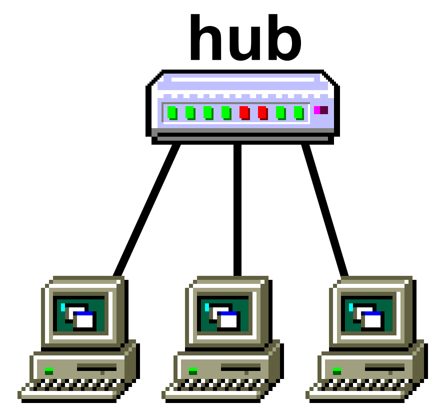
Minimum frame size (tx. time) = 36 us

at 20Mb/s, for a time period of 36 us, the number of bits can be transmitted is:

36us x 20Mb/s = 720 bits

Q2:Binary Exponential Backoff (BEB)

PROBLEM:
Three stations involved in a collision in an attempt to access an Ethernet LAN. Calculate the probability that the next event on the channel is also a collision.

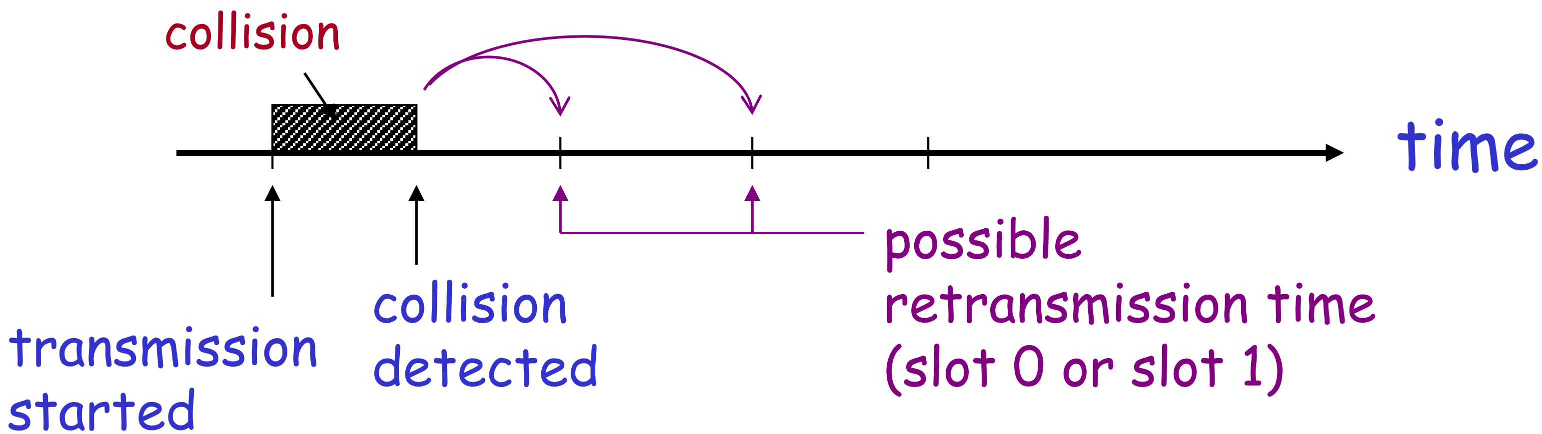


Next event can be either:
- a successful transmission

or

- a collision.

Q2:Binary Exponential Backoff (BEB)



Probability that the next event is also a collision:

= Prob (All choose slot 0 or 1) + Prob (Two choose slot 0)

= Prob (A=0, B=0, C=0) + Prob (A=1, B=1, C=1)

+ Prob (A=1, B=0, C=0) + Prob (A=0, B=1, C=0)

+ Prob (A=0, B=0, C=1)

= (0.5 x 0.5 x 0.5) x 5 (since A, B, & C are independent)

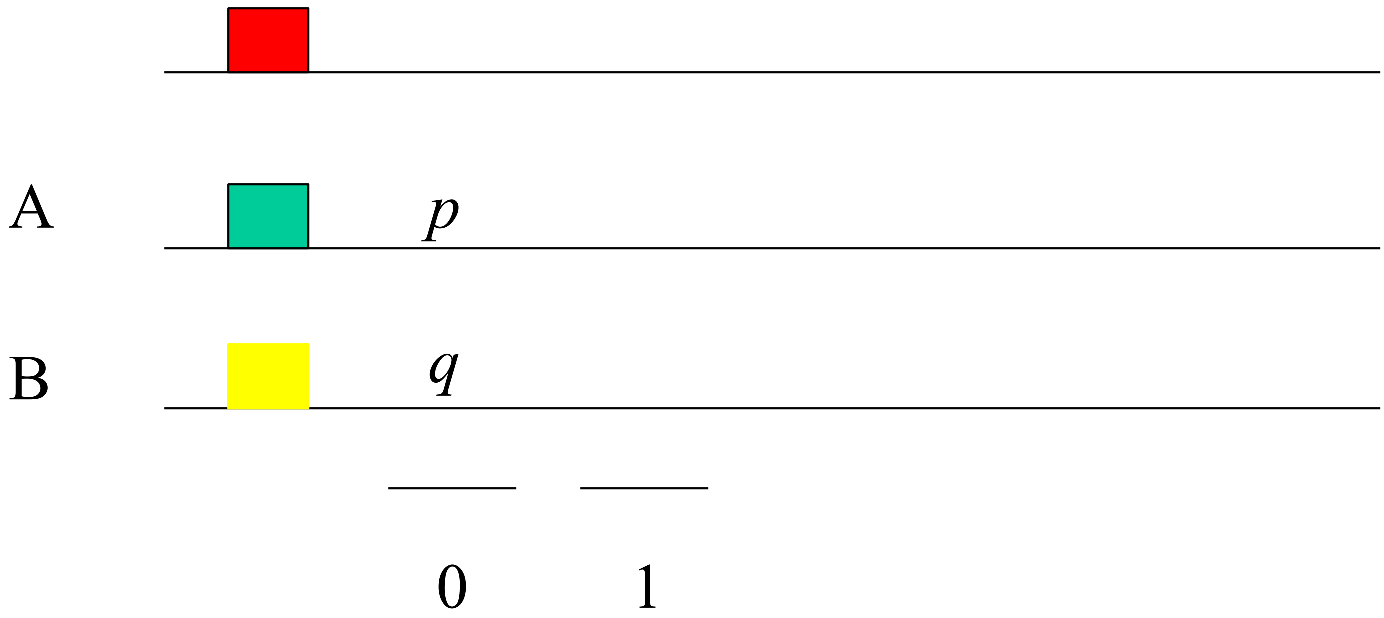
= 0.625

Question 3

In a local area network using the CSMA/CD protocol, a modified Binary Exponential Backoff scheme is used if a collision is detected in the channel. Assume that two stations (A and B) are transmitting and their frames collide in one time slot. Each of them will retransmit its data frame over a window of size 2 slots. Station A retransmits in slot 0 with probability of p and station B retransmits in slot 0 with probability of q.

- If $p = 1/3$ and $q = 2/3$, what is the probability that the first event in the channel will be a success?
- How would you maximize the probability that the first event in the channel will be a success, by choosing proper values for p and q?

Q3 answer



Q3(i) answer

	A	B	Probability	Success?
	0	0	pq	
	0	1	$p(1\text{-}q)$	Yes
	1	0	$(1\text{-}p)q$	Yes
	1	1	$(1\text{-}p)(1\text{-}q)$	

$p = 1/3$, $q = 2/3$

Pr(first event is success) = p(1-q)+(1-p)q
= 1/3*1/3 + 2/3 *2/3
= 5/9

Q3(ii) answer

	A	B	Probability	Success?
	0	0	pq	
	0	1	$p(1\text{-}q)$	Yes
	1	0	$(1\text{-}p)q$	Yes
	1	1	$(1\text{-}p)(1\text{-}q)$	

Pr(first event is success) = p(1-q)+(1-p)q

To maximize the throughput, one can choose
(i) $P = 0$, $q = 1$, or
(ii) $P = 1$, $q = 0$

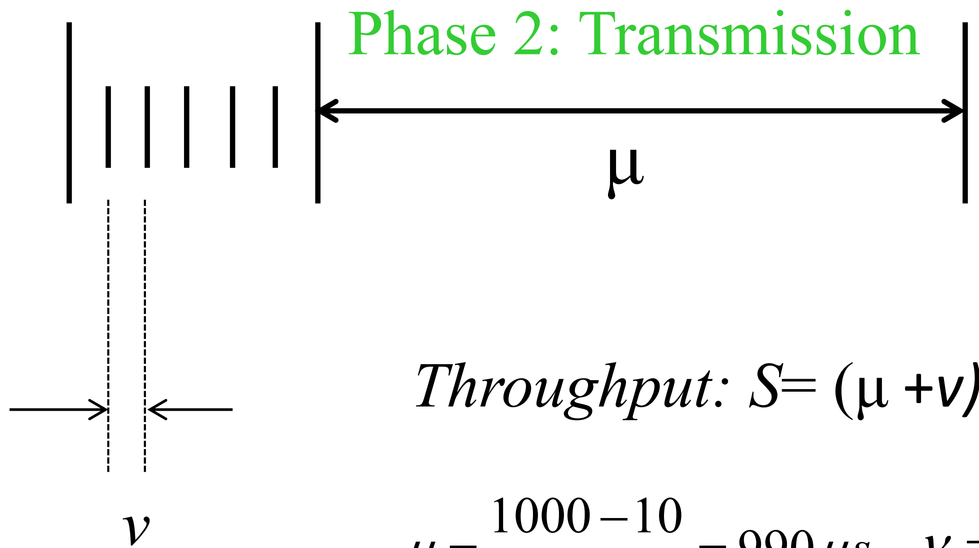
Question 4

You are commissioned to design an experimental Wi-Fi network for CCDS; it the multi-access reservation protocol (MARP) for data link layer. Each transmission cycle of MARP consists of two phases: a reservation phase and a transmission phase. In the reservation phase, a chosen MAC protocol is used for transmission stations to reserve the channel; and in the transmission phase, the station that successfully reserves the channel transmits one frame. The data rate in the Wi-Fi channel is 1 Mbps. The length of the data frame is 1000 bits, among which the reservation frame carries 10 information bits.

Q4(i) Answer

(i) If the MAC protocol used in the reservation phase has a utilization of 0.8, what will be the throughput of the Wi-Fi?

Phase 1: Reservation



S_r=0.8

Throughput: $S = (\mu + v)/(\mu + v/S_r)$

$$\mu = \frac{1000-10}{1mbps} = 990\mu s \qquad v = \frac{10}{1mbps} = 10\mu s$$

$$S = \frac{1000}{990 + 10/0.8} = \frac{1000}{1002.5} = 99.75\%$$

Q4(ii) Answer

(ii) What is the maximum throughput of your Wi-Fi network if the slotted Aloha is used as the MAC??

In order to maximize the utilization, it is equivalent to maximize $S_r = Ge^{-G}$.

$$\frac{dS_r}{dG} = e^{-G} - Ge^{-G} = 0 \Rightarrow G^* = 1$$

In this case,

$$S_{r,\max} = 1/e$$

The maximum utilization is derived as

$$S_{\max} = \frac{\mu}{(\mu - v) + v/S_{r,\max}} = \frac{1000}{(1000 - 10) + 10e} = 98.31\%$$