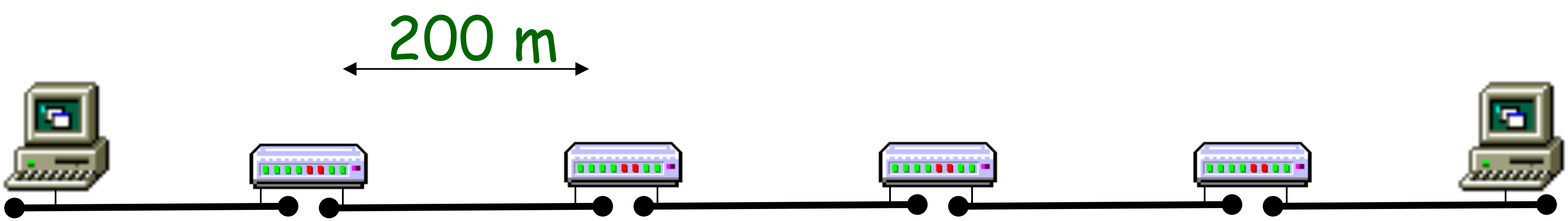
CZ3006

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.

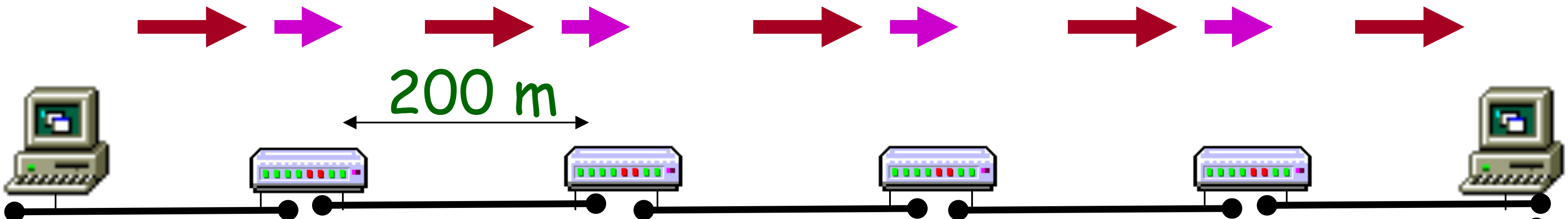


We must consider the "worst" case.

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

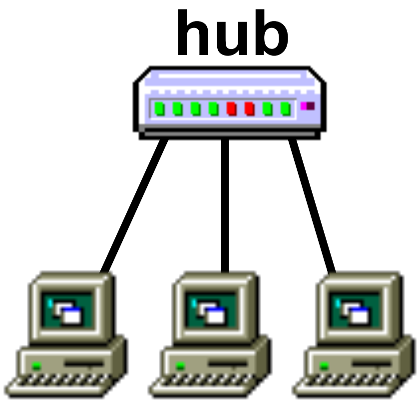
Minimum frame size (tx. time) = 36 us

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)

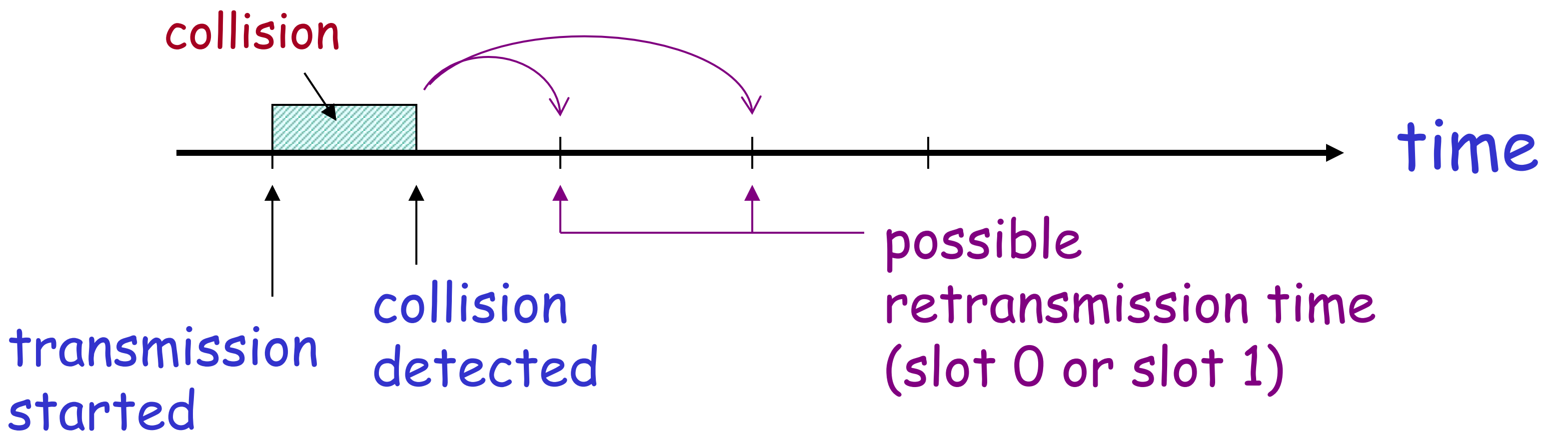
PROBLEM:
Three stations involved in a collision in an attempt to access an Ethernet LAN. Calculate the probability that the next event on the channel is also a collision.



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)

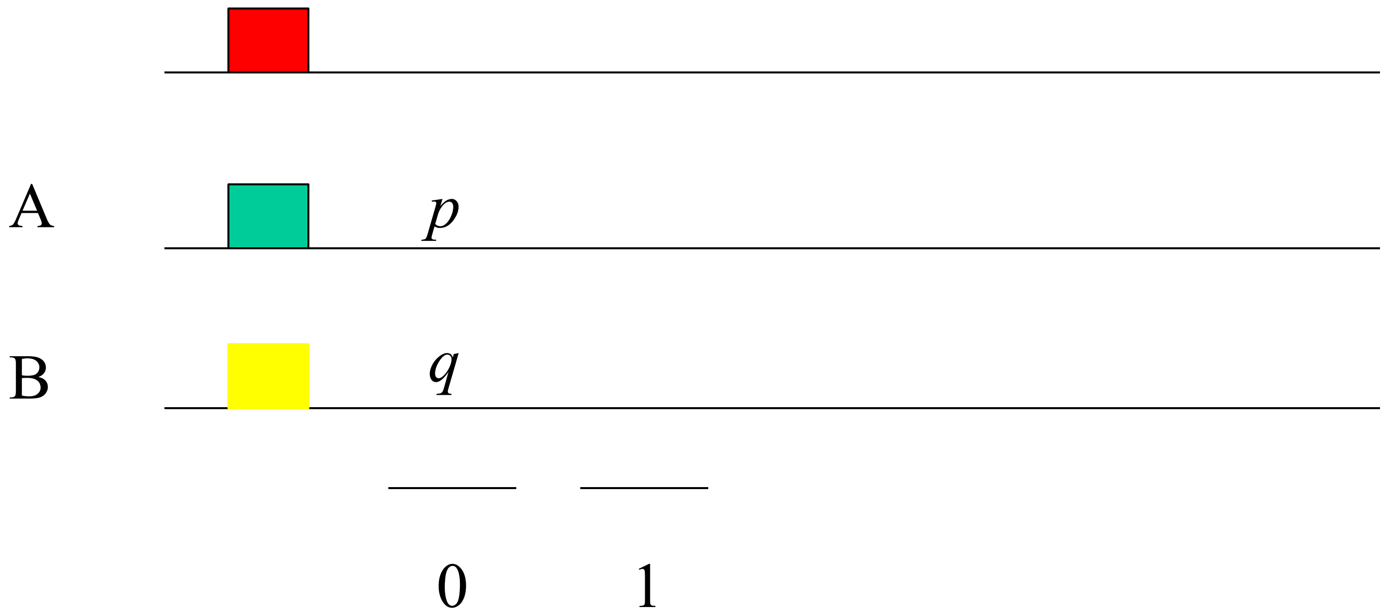
= 0.625

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	$p(1-q)$	Yes
	1	0	$(1-p)q$	Yes
	1	1	$(1-p)(1-q)$	

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

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	$p(1-q)$	Yes
	1	0	$(1-p)q$	Yes
	1	1	$(1-p)(1-q)$	

Pr(first event is success) = p(1-q)+(1-p)q
minimize $pq + (1-p)(1-q)$ is achieved when
$pq = 0$ *and* $(1-p)(1-q) = 0$

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

Question 4

Suppose that an 11-Mbps 802.11b WLAN is transmitting 64-byte frames back-to-back over a radio channel with a bit error rate of 10^{-7}. How many frames per second will be damaged on average?

Q4 Answer

A frame contains 512 bits. The bit error rate is $p = 10^{-7}$. The probability of all 512 of them surviving correctly is $(1 - p)^{512}$, which is about 0.9999488. The fraction damaged is thus about 5×10^{-5}. The number of frames per second is $11 \times 10^6 / 512$ or about 21,484. Multiplying these two numbers together, we get about 1 damaged frame per second.

Taylor expansion:

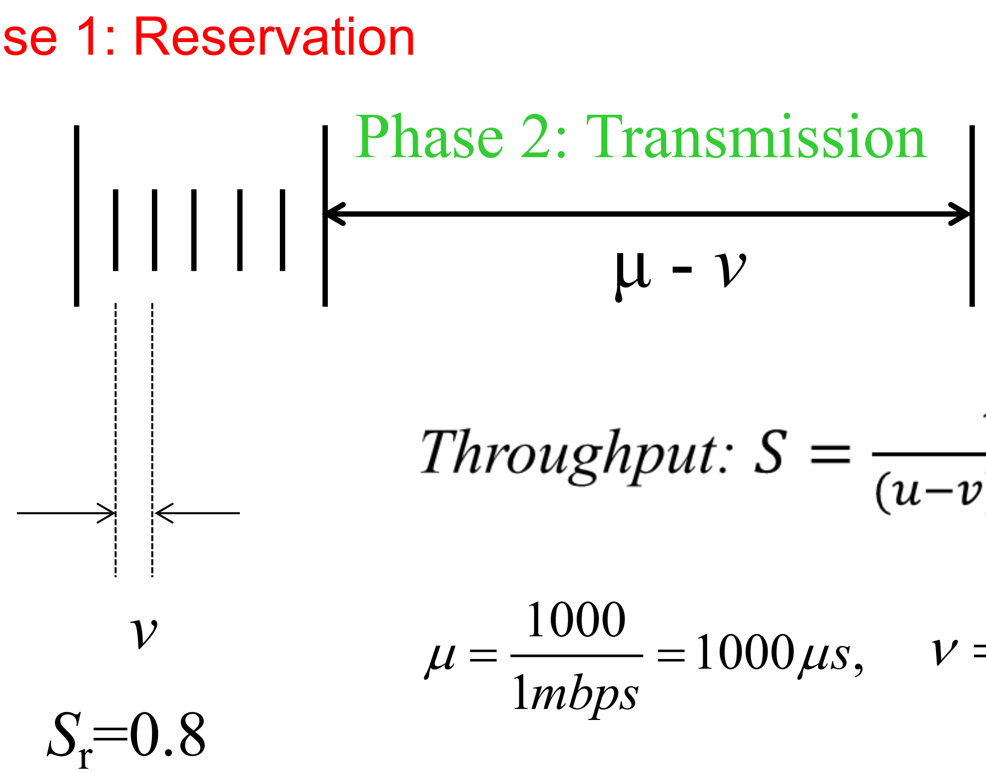
$(1 - p)^{512} \approx$ 1-p*512 = 1- 10^{-7} *512 = 0.9999488

Question 5

You are commissioned to design an experimental wireless network for SCE to support its 100 wireless devices. You have decided to adopt a multi-access reservation protocol (MARP) for frame transmission in the data link layer. Specifically, each transmission cycle 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 wireless channel is 1 *Mbps*. The length of the data frame is 1000 *bits*, among which the reservation frame carries 10 information *bits*.

Q5(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 MARP?



$$Throughput: S = \frac{u}{(u-v) + {}^{v}/_{S_r}}$$

$$\mu = \frac{1000}{1mbps} = 1000\mu s, \qquad \nu = \frac{10}{1mbps} = 10\mu s$$

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

Q5(ii) Answer

(ii) Assume that the slotted Aloha protocol is used in the reservation phase. The utilization for the slotted Aloha protocol is Ge^{-G}, where $G = np$, n is the number of stations, and p is transmission probability. Calculate an optimal transmission probability to maximize the throughput of the MARP, and the corresponding maximum throughput?

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, $p^* = \dfrac{G^*}{n} = 1/100 = 0.01$,

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

The maximum utilization is derived as

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

In addition to the office hours listed in the previous slide, please feel free to contact Assistant Professor Jun ZHAO as follows to schedule appointments to ask questions. Thanks!

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