

CS447-001 – Networks and Data Communications

Summer 2026

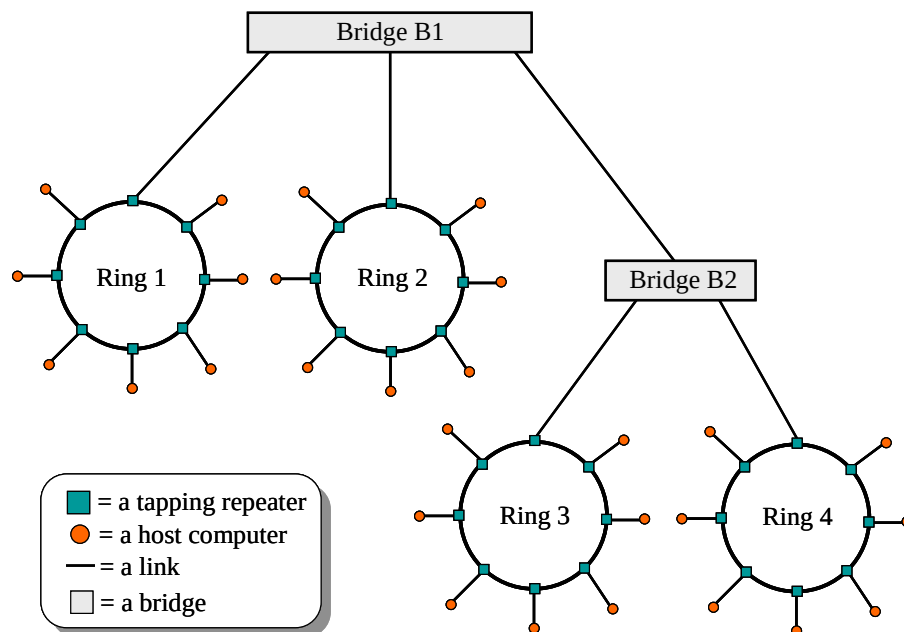
Exercise Questions on July 16th

QUESTION #1:

For a network system that consists of four rings and two bridges as shown below, **find the probability that any two stations, selected at random, will be unable to communicate.**

For this question, you do not have to complete your calculation. Establish a correct formula to calculate the probability with all the necessary correct parameters in it will bring you full credit.

- Each ring consists of **101** tapping repeaters and **101** links (for 100 host computers and 1 connection to a bridge).
- The mean failure rate for a tapping repeater is P_R ($0 < P_R < 1$)
- The mean failure rate for a link is P_L ($0 < P_L < 1$)
- The mean failure rate for a bridge is P_B ($0 < P_B < 1$)
- Wires between a tapping repeater and a bridge will never fail
- Wires between a tapping repeater and a host computer will never fail
- Host computers will never fail



Solution:

STEP #1:

(1) The sender and the receiver are on the same ring network

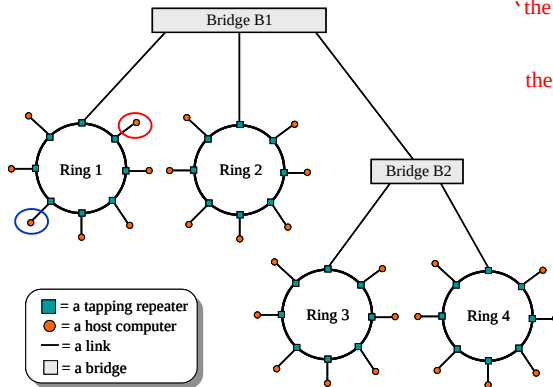
○ - sender
○ - receiver

the probability of you be **unable to communicate** with your receiver

$$= 1 - ((1-P_R)^{101} \times (1-P_L)^{101})$$

the probability of all 101 repeaters on the ring are working

the probability of all 101 links on the ring are working



$$1 - ((1-P_R)^{101} \times (1-P_L)^{101})$$

= the probability of this ring (Ring 1) is not properly working (the sender is unable to communicate with its receiver on the same ring)

STEP #2:

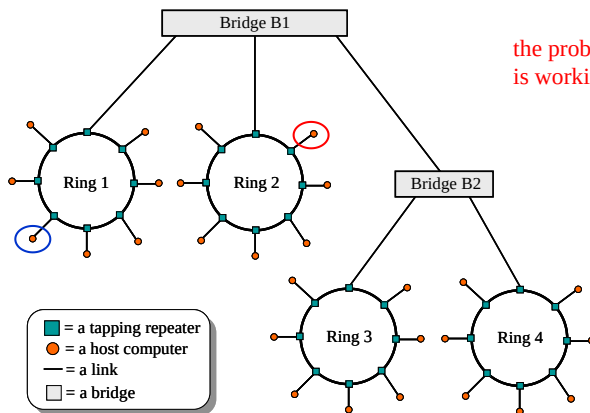
(2) The receiver is on the ring network across one bridge

○ - sender
○ - receiver

the probability of you be **unable to communicate** with your receiver

$$= 1 - ((1-P_R)^{101} \times (1-P_L)^{101} \times (1-P_B))$$

the probability of the bridge between the sender and the receiver is working



$$1 - ((1-P_R)^{101} \times (1-P_L)^{101} \times (1-P_B))$$

STEP #3:

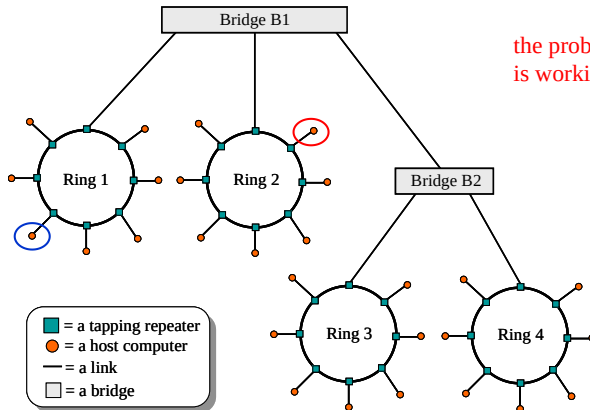
(3) The receiver is on the ring network across two bridges

○ - sender
○ - receiver

the probability of you be **unable to communicate** with your receiver

$$= 1 - ((1-P_R)^{101} \times (1-P_L)^{101} \times (1-P_B)^2)$$

the probability of the bridge between the sender and the receiver is working



$$1 - ((1-P_R)^{101} \times (1-P_L)^{101} \times (1-P_B)^2)$$

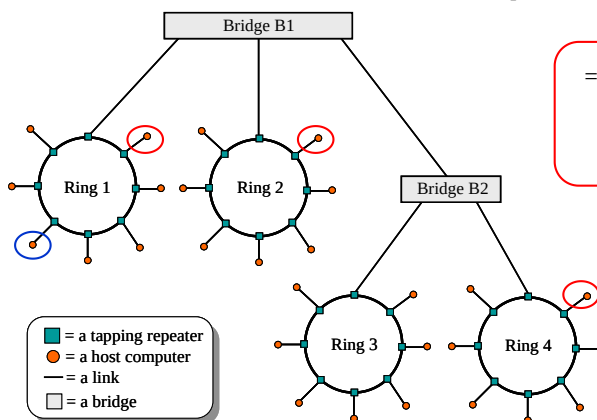
STEP #4 (final solution):

The final solution

○ - sender
○ - receiver

- (a) There are 100 possible destinations (receivers) on the same ring
- (b) There are 101 possible destinations (receivers) on the ring over one bridge
- (c) There are 202 possible destinations (receivers) on the ring over two bridges

A: the probability of you be **unable to communicate** with any receiver



$$= (100/403) \times (1 - ((1-P_R)^{101} \times (1-P_L)^{101})) + (101/403) \times (1 - ((1-P_R)^{101} \times (1-P_L)^{101} \times (1-P_B))) + (202/403) \times (1 - ((1-P_R)^{101} \times (1-P_L)^{101} \times (1-P_B)^2))$$

QUESTION #2:

One of the weaknesses in CSMA/CD is that, if a collision is not detected, CSMA/CD does not take advantage of “CD”. How large the minimum packet size, if any collision will be detected?

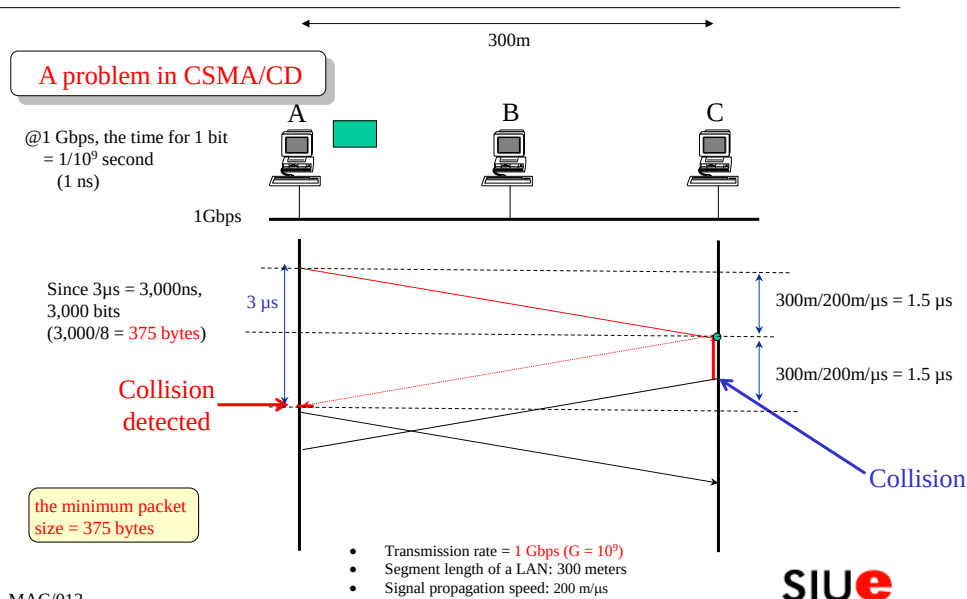
- Transmission rate = 1 Gbps ($G = 10^9$)
- Segment length of a LAN: 300 meters
- Signal propagation speed: 200 m/ μ s

Solution:

- The round-trip propagation distance: $(300 \times 2) = 600$ meters
- The round-trip propagation time: $(600 \text{ meters}) / (200 \text{ meters}/\mu\text{s}) = 3\mu\text{s} (= 3,000\text{ns})$
- At 1 Gbps, transmitting 1 bit at a transmitting host computer = $1/(10^9)$ second = 1ns
- A transmitting host computer transmits $(1 \text{ bit}) \times 3,000\text{ns} = 3,000\text{bits} (= 3000/8 = 375 \text{ bytes})$

A: the minimum packet size should be 375 bytes.

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QUESTION #3:

A disadvantage of the contention-based approach for medium access control, such as CSMA/CD, is the capacity wasted due to multiple stations attempting to access the transmission channel (such as an Ethernet cable) at the same time. Suppose that time is divided into discrete slots, where each discrete slot is one full round-trip time from one end of a LAN segment (using a bus-based LAN) to the other end. In each discrete slot, each of N stations attempts to transmit with a probability of p ($0.0 \leq p \leq 1.0$). What fraction of slots will be wasted due to contentions by multiple simultaneous transmission attempts by N stations? If the transmission rate of the cable used for this CSMA/CD is R bps, what will be the throughput achievable (ignore all other overhead)?

Note: I will try my best to give you partial credit to any meaningful work. However, presenting (or describing) your ideas in such a way that it is easy to follow will increase your partial credit (or it may bring you full credit to do so).

QUESTION #4:

BEB does not completely remove the chances of additional (subsequent) collisions after the first collision is over. Assuming that only two hosts are attempting to transmit, how many additional collisions can happen after the first collision is over?