

CS447 – Networks and Data Communications

Summer 2026

Homework #6 Questions (SOLUTIONS)

Your last-three-digits: _____

Submission Due: (each student is required to submit (by email as attached file) your solutions for this homework by 11:00AM on July 28 (Tuesday))

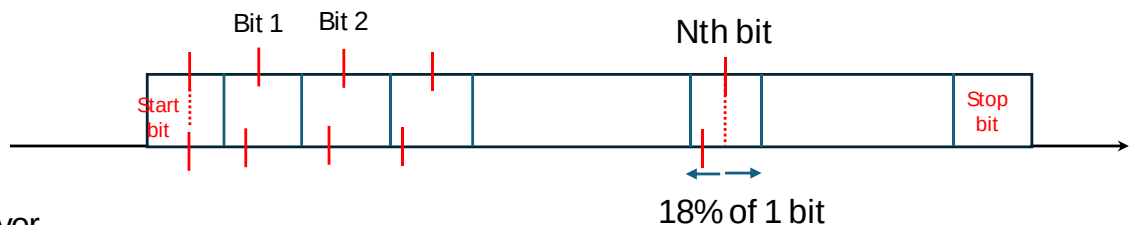
QUESTION #1:

Suppose that asynchronous serial data transmission is clocked by two clocks (one at the sender and the one at the receiver) that each has a drift of 3 minutes in one year. How long a sequence of bits can be sent before possible clock could cause a problem? Assume that a bit waveform will be good if it is sampled within 18% from the center. Assume that the bit samples are taken at the middle of the clock period. Also assume that at the beginning of the start bit the clock and incoming bits are in phase.

Show all your work for full credit.

- The worst case clock-drift between the sender and the receiver in each year = $(3 \times 2) = 6$ minutes between them.
- Assume that a bit waveform will be good if it is sampled within 18% from the center

Sender



- How long a sequence of bits can be sent before possible clock could cause a problem?

Question: What is 'N'?

Solution:

$$((6 \text{ min}/1\text{year}) \times (N \text{ bits})) \leq ((0.18) \times (1 \text{ bit}))$$

$$((6 \text{ min}/(365 \times 24 \times 60)\text{min}) \times (N \text{ bits})) \leq ((0.18) \times (1 \text{ bit}))$$

$$((6/(365 \times 24 \times 60)) \times (N)) \leq ((0.18) \times (1))$$

$$((6/(52560)) \times (N)) \leq (0.18)$$

$$6 \times N \leq (0.18) \times 52560$$

$$N \leq 15768.03$$

$$N \leq 15768 \text{ (it needs to round down)}$$

QUESTION #2:

Although TCP slow-start is an effective technique for dynamically adjusting the window size under various situations, it can result in long recovery times in high-speed networks.

Assume a round trip-time of 15ms and a link with an available bandwidth of 2 Gbps ($1\text{G} = 10^9$) and a packet size of 230 octets (1 octet = 1 byte = 8 bits). How long will it take to reach the window size that is just large enough for full (= 100%) utilization of this link?

Assume that no error will happen during the packet transmissions.

Show all your work (most of the credit is for showing a correct procedure to find the solution, instead of the solution itself).

Solution:

In each second, a transmitting host computer has $((1 \text{ sec})/(50\text{ms})) = 1,000/15 = 66.7$ transmission rounds.

If a transmitting host can transmit as many as (2×10^9) , each transmission round has $(2 \times 10^9/66.7) \text{ bits} = (29,985,007) \text{ bits}$.

If the transmission host transmits $(29,985,007)$ in each transmission round, the transmitting host computer reaches the fill-throttle on the 2 Gbps connection.

The TCP slow-start always requires each new session of transmission begins with window-size = 1). This means that a transmitting host computer must stop after it transmits only one packet (because its window size is 1) at its first transmission round (it will be 2 at the next round, 4 at the third round, and so on)..

At the full-throttle, each transmitting host computer should transmit as many as $(29,985,007)/(230 \times 8) = (29,985,007)/(1840) = 16,296.2$ packets.

For a transmitting host computer to transmit 16,297 packets, the open window-size at a transmitting host computer should be:

ceiling ($\log_2(16297)$) = 18 (at least 18 rounds).

$$2^{13} = 8,192$$

$$2^{14} = 16,834$$

Since each round can happen at a 15ms time-interval, the time for a transmitting host computer to have the window-size of 16,297 (or more), it takes each transmitting host computer ($15\text{ms} \times 14$) = 210ms (= 0.21 second).

Answer: 270ms (or 0.27 second)

QUESTION #3:

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 = 2.5 Gbps ($G = 10^9$)
- Segment length of a LAN: 300 meters
- Signal propagation speed: 150 m/ μs

Solution:

The round-trip distance: (300 meters) $\times$ 2 = 600 meters

The 1-bit signal transmission-delay: (1 second)/((2.5×10^9) bits/second)

$$= (1/2.5) \times (1 \text{ bit}/(10^9 \text{ bits/second}))$$

$$= ((1/2.5) \times 1) \text{ ns}$$

$$0.4 \text{ ns}$$

The round-trip signal propagation delay: (600 meter)/(150 meter/ μs) = 4 μs

Then, a transmitting host computer should sustain its transmission for 4 μs (= 4,000ns)

The minimum packet size: (4,000/(0.4)) bits = 10,000 bits (= 1,250 bytes)