

# CS 455 - Introduction to Computer Networks

## Homework 4

Due: See class webpage.

- **Question 1 (20 pts)**

- Prove that the **Stop-and-Wait** protocol will operate **correctly** using **only 2 different sequence number**

I.e.: you **only** need to **label** the **frame** in **Stop-and-Wait** using **sequence numbers**:

■ **0** and **1**

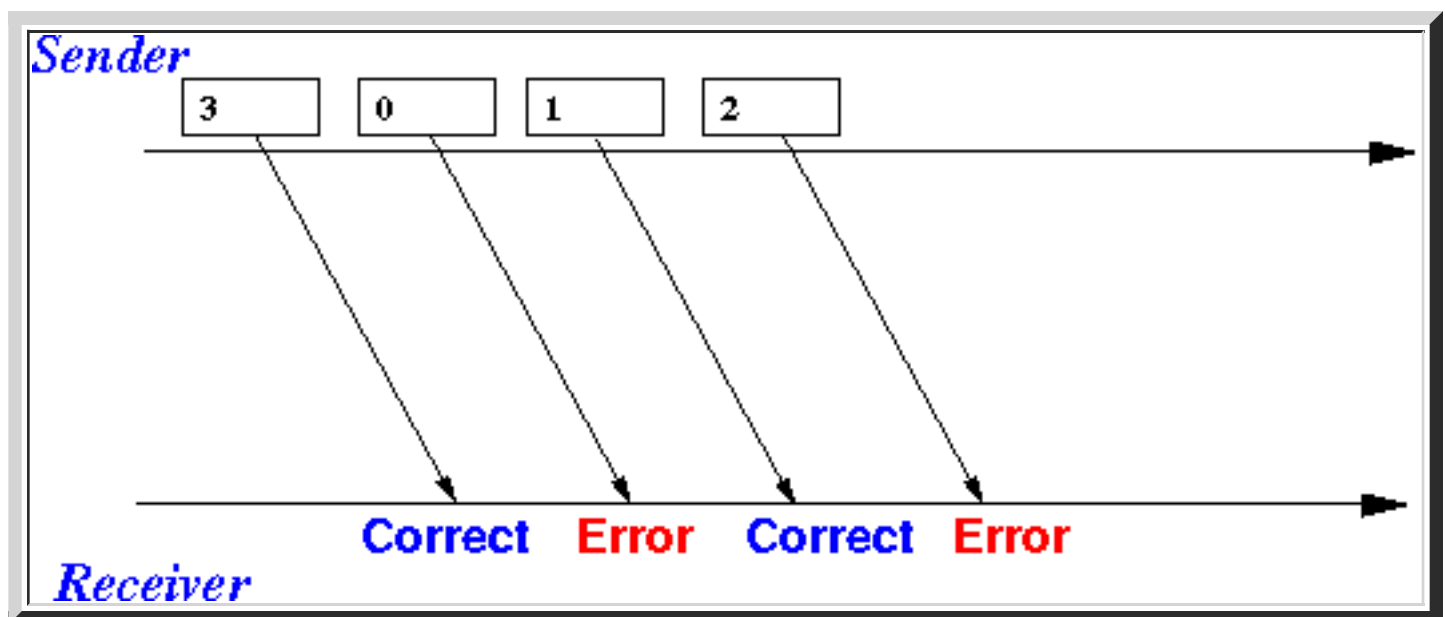
- **Question 2 (20 pts)**

- A sender and a receiver is using the **Sliding Window protocol** using a **send window size = 4** and **receive window size = 4**

The **ACK scheme** used is **cumulative ACK** where **ACK N** acknowledges all **frames** upto (but not including) frame **N**

The **sender** transmits **4 frames** to the **receiver** and **2 of the frames** are received in **error**.  
(**Recall** that the **receiver** can use the **CRC code** in a **frame** to **check** if the **frame** is in **error**)

The following **diagram** show the **transmitted frames**:



Questions: what is the **response** of the **receiver** for these **frames**:

■ **Frame 3**  
■ **Frame 0**

- **Frame 1**
- **Frame 2**

- **Question 3 (20 pts)**

- Suppose you are designing a **Sliding Window** protocol for a **1 Mbps** point-to-point link to the moon.

The a **one-way propagation delay** between earth and moon is **1 sec**.

Assume that the **frame size** is fixed and is equal to **1 KBytes**, you can assume that **1 KBytes = 8000 bits**.

You can assume the **ACK frame** is **negligible**.

**Questions:**

- Assuming there is **no transmission errors**, and **Sliding Window** uses a **send/receive window size** of **100**, what is the **link utilization (= channel utilization)** ?

In other words: **what fraction** of the **1 Mbps link capacity** is **used** to **transmit data frames** (10 pts)

- You **cannot** simply apply the **Stop-and-Wait** utilization formula.
- Take a look at **how** the **utilization** in **Stop-and-Wait** is **calculated**
- Apply the **logic** to compute the **utilization** in **Sliding Window**

- Assuming there are **no transmission errors**, what is the **minimum number of bits** you need for the **sequence number** in the **frame** that will allow you to use the **entire capacity** of the link ? (10 pts)

**Hint:** find the **smallest send window size** that will allow the **sender node** to transmit **continuously (i.e., without stopping)**

- **Question 4 (20 pts)**

- A sliding window protocol uses the **cumulative ACK** scheme.

We will use a *slightly different Acknowledgement scheme*:

- **ACK  $n$**  will **acknowledge** the reception of **all frames upto and including frame  $n$** .

(So you must **adjust** what you have learned to the **above scheme** !!!)

The **number of bits** in the sequence number field is **3** (**8** different sequence numbers).

A **receive windows size** and **send window** size is **5**.

The initial send and receiver windows are **{0,1,2,3,4}**.

The following events occurs at the receiver in the given sequence:

1. The **receiver** first receives the frame numbered with **seq. no. 3**. What ACK message (give sequence number) will the receiver send back to the sender ? (2 pts)
2. The **receiver** next receives the frames numbered with **seq. no. 0 and 2**. What ACK message (give sequence number) will the receiver send back to the sender ? (2 pts)
3. The **receiver** next receives the frame numbered with **seq. no. 1**. What ACK message (give sequence number) will the receiver send back to the sender ? (2 pts)
4. The **receiver** next receives the frame numbered with **seq. no. 0**. What ACK message (give sequence number) will the receiver send back to the sender ? (2 pts)

- Is this frame **always** a retransmission or can this frame be a new frame ?

Show your reason (with a diagram with frame receive/loss events) to get full credit. (5 pts)

5. The **receiver** next receives the frame numbered with **seq. no. 1**. What ACK message (give sequence number) will the receiver send back to the sender ? (2 pts)

- Is this frame **always** a retransmission or can this frame be a new frame ?

Show your reason (with a diagram with frame receive/loss events) to get full credit. (5 pts)

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- **Question 5 (20 pts)**

- Repeat **Question 4** using the following changes in the **sender** and **receiver**:

- **Sender window size** = and **Receiver window size** = **4**
  - The **initial sender/receiver window** = **{0,1,2,3}**
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