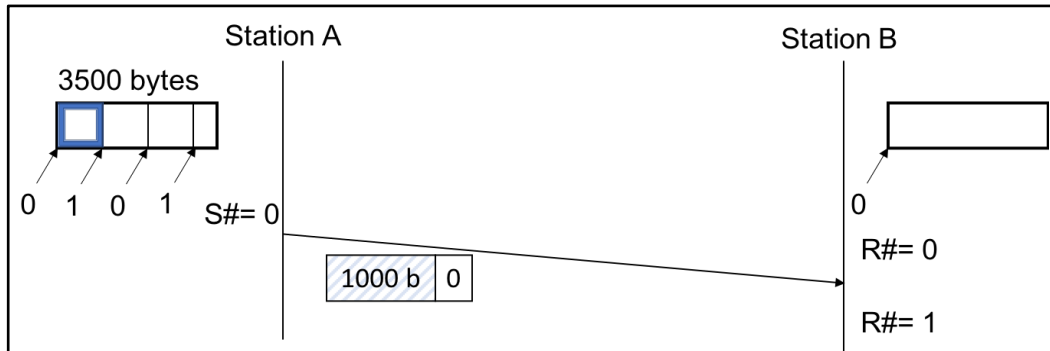


## Flow Control

### 1) Stop-And-Wait ARQ

A sender, station A, has 3500 bytes to send and can transmit a maximum of 1000 bytes in each frame as payload i.e. MTU = 1000 bytes.



**Figure 1:** Start of a transmission of 3500 bytes using Stop&Wait. The header may require additional information.

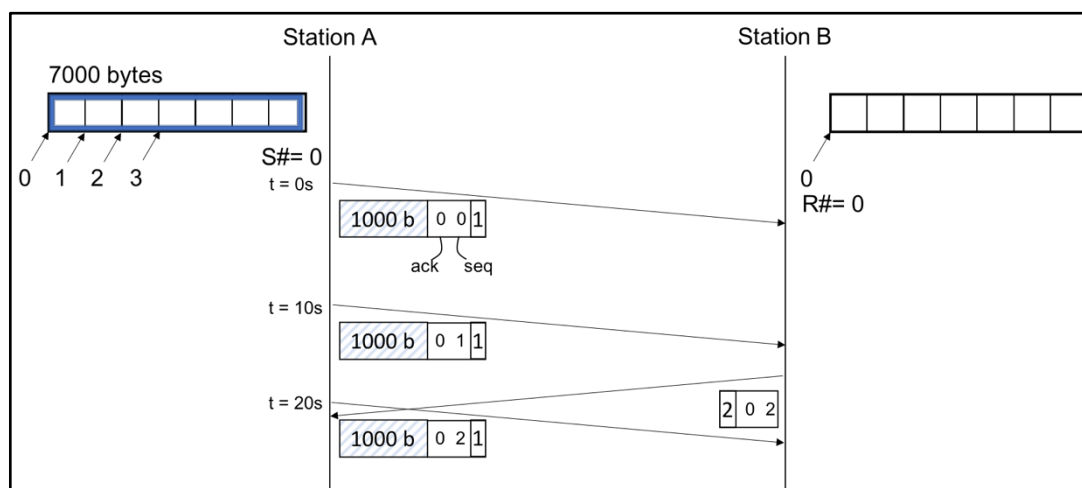
- Complete the picture in figure 1 for a transmission using Stop&Wait ARQ assuming that all transmissions will succeed.
- What happens if the transmission of the 2<sup>nd</sup> frame experiences some interference? Visualise the progress of the transmission with a diagram.
- What information would you include in the header, what size would this header have and how much overhead would be introduced for the transfer of 3500 bytes.

### 2) Go-Back-N ARQ

Assume your header includes 1 byte to identify the protocol, 1 byte to identify the type of the frame, 3 bits for a sequence number of the frame and 3 bits to indicate the sequence number of the next expected frame i.e. the acknowledgement.

prot.	type	seqack
15	1 = data 2 = ack	
1 byte	1 byte	3 bit 3 bit

- Complete the picture in figure 2 using GoBackN ARQ with the sender transmitting a frame every 10ms and the receiver acknowledging every 2<sup>nd</sup> frame, assuming that all transmissions will succeed.
- What happens if the transmission of the 2<sup>nd</sup> frame experiences some interference? Visualise the progress of the transmission with a diagram.
- What information would you include in the header, what size would this header have and how much overhead would be introduced for the transfer of 7000 bytes.
- If you would have used Stop&Wait ARQ, how long would have the transmission of 7000 bytes taken, given that both transmissions of data and acknowledgements would take 10ms?



**Figure 2:** Start of a transmission of 7000 bytes using GoBackN ARQ. The wider frame inside the buffer of available data indicates the window of frames that can be transmitted.

### 3) Selective Repeat ARQ

- I. Complete the picture in figure 2 for a transmission using Selective Repeat ARQ instead of GoBackN ARQ assuming that all transmissions will succeed.
- II. What happens if the transmission of the 2<sup>nd</sup> frame experiences some interference? Visualise the progress of the transmission with a diagram.
- III. What information would you include in the header, what size would this header have and how much overhead would be introduced for the transfer of 7000 bytes.
- IV. What is the maximum window size for a Go-Back-N ARQ protocol and a Selective Repeat ARQ protocol in this scenario?

### 4) Bandwidth-Delay Product

- a) Describe the term “Bandwidth-Delay Product” and calculate it for a connection that has a bandwidth of 2 Mbit/s, uses frames of the size of 1000 bit and a round trip time of 50ms. What is the usage of the total bandwidth? What happens if the bandwidth is changed to 1 Gbit/s and the round trip time to 10ms?

### Sample Exam Question

- (1c) Assume you have a connection between two stations that are limited in processing power and storage capacity. Suggest a flow control mechanism that would be suitable for this connection, explain the details of this mechanism and justify your choice by contrasting the mechanism against an alternative mechanism.