# Computer Facilities and Network Management

# BUS3150

# Tutorial - Week 7

***** FOR TUTORS ONLY *****

*The answers provided here are only brief guides. If you have any comments or suggestions for improvement to this, please let me know so that your improvements may be included in this document.*

**Objective of this tutorial:**
The objective of this tutorial is to strengthen the conceptual understanding of the material covered in the lecture by reflecting on the material in small groups. The tutor will provide feedback to enhance your understanding and diminish misunderstandings, if any.

**How to participate in the tutorial:**
Form groups of four to five students in each and discuss the answers for the following reflective questions with the group members. After spending about ten minutes for each question, discussing with group members, discuss your solutions with the tutor and other groups. The tutor will provide feedback on your solutions.

**ADVANCED:** These types of questions will not be on the exam.

**Question 1 -** Consider the frame transmission shown in Figure 1(a). This diagram shows transmission of fixed sized frames from station **A** to station **B**. It also shows the appropriate acknowledgements transmitted from station **B** to station **A**.

**(a)** What style of flow control and error control does this diagram shown an example of?
*Stop-and-wait flow control and automatic repeat request (ARQ).*

**(b)** How can the receiving station **B** prevent the transmitting station **A** from sending further frames?
*Withhold acknowledgements.*

**(c)** An error has occurred on the fourth frame transmitted (the frame was never received by station **B**). Explain how this error has been detected and corrected.
*Since the receiver, **B**, has not received a frame, it will not send an acknowledgement. Since the transmitter, **A**, has not received an acknowledgement for the frame within a given period of time, the transmitter has timed-out and retransmits the last frame.*

**(d)** What will be the number of the next frame transmitted from station **A** to station **B**?
*Frame 0. The frame numbers alternate 0,1,0,1,0...*

**(e)** How many frames were successfully received by station **B** during the period of time shown? *Four frames.*

**Question 2 -** Consider the frame transmission shown in Figure 1(b). As with Question 1, this diagram shows transmission of fixed sized frames and acknowledgements between stations **A** and **B**.

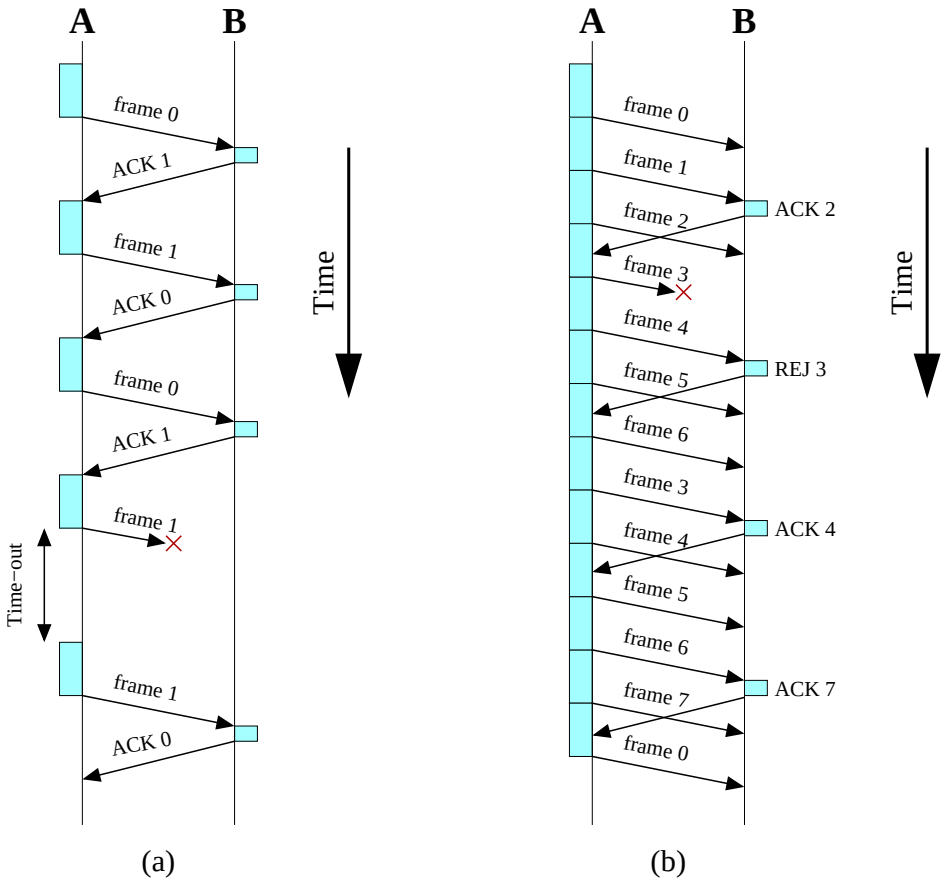


Figure 1: Example transmission of frames for ARQ.

**(a)** What style of flow control and error control does this diagram shown an example of?

*Sliding window flow control with Go-back-N automatic repeat request (ARQ).*

**(b)** How can the receiving station **B** prevent the transmitting station **A** from sending further frames?

*Withhold acknowledgements or using a RNR (receive not ready). Withholding acknowledgements may not stop the flow immediately. It will stop once the buffer (sliding window) has filled. A RNR will stop the flow of frames as soon as it is received by the transmitter. To resume transmission, the transmitter can send an ACK or RR (receiver ready).*

**(c)** An error has occurred on the fourth frame transmitted (the frame was never received by station **B**). Explain how this error has been detected and corrected.

*The receiver (station **B**) has recognised that that frame 3 has gone missing as it has received frame 4 out of order (it has received 0, 1, 2, 4). After the reception of frame 4, the receiver informs the transmitter of this missing frame by sending a reject message indicating that it is still waiting for frame 3 (REJ 3). The receiver then discards frame 4 and all subsequent frames (5 and 6) until it successfully receives frame 3. Once the transmitter has received the REJ 3, it goes back to frame 3 (go-back-N) and retransmits all frames from 3 onwards.*

**(d)** What will be the number of the next frame transmitted from station **A** to station **B**?

*The sliding window must use a 3-bit sequence number to give a counting sequence 0,1,2,...,6,7,0,1,2,... That is, a modulo $2^3 - 1 = 7$ sequence. The following frame will be numbered 1.*

**(e)** How many frames were successfully received by station **B** during the period of time shown?

*Nine frames.*

**(f)** Why is this technique for flow and error control better than that used in Question 1, and how is this demonstrated by the diagram of Figure 1?

*This technique allows for multiple frames to be in transit, rather than a single frame at a time. In the diagram we see that for stop-and-wait, only four frames are sent, while in sliding-window, nine frames are sent for the same given period of time.*

**Question 3 -** The frame transmission examples shown in Figure 1 demonstrate two types of flow and error control. There is a third method for error control not shown in these examples.

**(a)** What is the third method for error control?

*Selective reject automatic repeat request (ARQ).*

**(b)** Explain how this third method for error control would have corrected the missing fourth frame. You may like to draw a diagram similar to those in Figure 1 to help explain.

*Rather than going back and retransmitted frames, selective reject only retransmits errored or missing frames. A selective reject (SREJ 3) is used to indicate which frame needs retransmission. Subsequent frames (i.e. 4, 5 and 6) need to be buffered until the missing frame (frame 3) has been successfully received.*

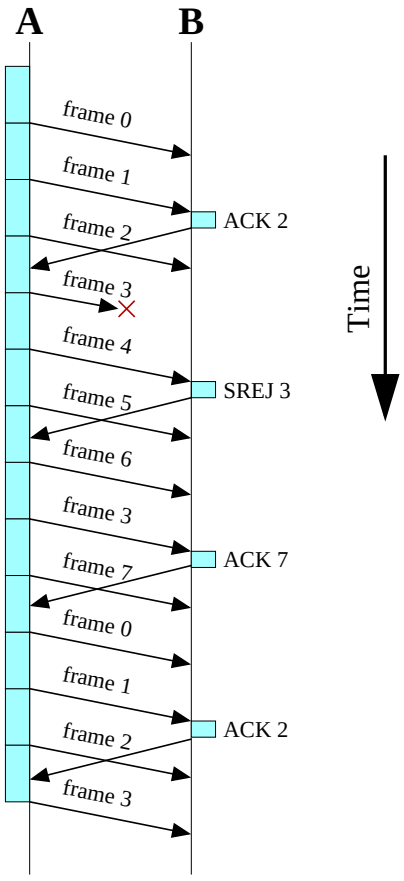


Figure 2: Same example using selective reject.

**(c)** **ADVANCED**: How many frames would be sent in the same period of time using this form of error control? At what cost?

*Frames 4, 5 and 6 that were discarded in go-back-N will be kept in selective reject. Go-back-N transmitted nine frames in the given period of time, therefore, this technique should be able to send 9 + 3 = 12 frames in the same period of time. It will require more complex buffer management hardware.*

**Question 4** - Error detection adds one or more redundant bits to each frame of data.

**(a)** Briefly explain how these redundant bits are created and how they are used by the receiver to check for errors.

*These redundant bits are calculated as a function of the other transmitted bits (data) within a frame. The receiver performs the same calculation and compares with the redundant bits. (Week 6 lecture notes, slide 18).*

**(b)** Using parity as an example of an error detection implementation, show how the bit pattern 01001101 would be sent using odd parity.

*The bit pattern would be sent as 010011011. An additional 1 is added to the end of the bit pattern to create an odd number of ones. (Week 6 lecture notes, slide 19).*

**(c)** What is the problem with parity and briefly describe a technique which fixes this problem.

*The problem with parity is that an even number of bit errors will go undetected (for example, changing 2 bits in* 010011011 $\rightarrow$ 0**0**00111**1**11 *will still leave an odd number of 1's). A solution is to use a more complex function over the bits such as a CRC. (Week 6 lecture notes, slide 19 and 20).*