COMPSCI 314 S2C Assignment 2
2010
Flow Control

Department of Computer Science
The University of Auckland

*This assignment contributes **5%** of your overall course mark. Submit your assignment in **PDF** format to the **Assignment Drop Box**. Include all **workings** and **explanations**. Marks will be deducted for ambiguous solutions. Zero marks are awarded if the answers contain no explanation. Also, refer to the Departmental Policy on Cheating on Assignments.*

Assignment Drop Box (https://adb.ec.auckland.ac.nz/adb/).
Departmental Policy on Cheating on Assignments
(http://www.cs.auckland.ac.nz/administration/policies/CheatingPolicy.php)

[Total: 50 marks]

Q1. Stop and wait. [20 marks]

Consider a data link from Auckland to Sydney, using an undersea optical fibre. Assume the distance is 2100 km (2.1×10^6 m), and that the speed of an optical signal is 2×10^8 m/s. Assume that the transmission capacity of the link is 150 Mb/s, and that the frame size is 1500 bytes.

(*Technical note:* You might have heard of a standard link rate of 155 Mb/s; however, the useable capacity on such a link is very close to 150 Mb/s, so this is a realistic example.)

a) What is the one-way delay for a data frame to travel between Auckland and Sydney? [5 marks]

$(2.1 \times 10^6)/(2 \times 10^8)$ seconds = 1.05×10^{-2} seconds = 10.5 milliseconds.

b) To get an approximate answer, do we also need to consider the time taken for a computer to output a frame at 150 Mb/s? [5 marks]

1500 bytes = 8x1500 bits = 12000 bits / 150 Mb/s = 0.00008 s = 0.08 milliseconds.
This not worth considering by comparison with 10.5 ms.

c) Calculate the bandwidth-delay product for the link, in megabytes. [5 marks]

"Bandwidth" = 150 Mb/s, delay = 1.05×10^{-2} s, BDP = $150 \times 10^6 \times 1.05 \times 10^{-2}$ = 1575000 bits = 1.575 Mbits.

d) Consider a stop-and-wait protocol sending 1500 byte frames and waiting for an ACK after each frame. Assuming no frames or ACKs are lost, calculate the achieved bit rate in b/s. Then calculate the efficiency of the protocol, i.e., what percentage of the transmission capacity is actually used. [5 marks]

10.5 milliseconds to send a frame and 10.5 milliseconds to send back the ACK means that we need 21 milliseconds to send 1500 bytes (12000 bits). Therefore achieved bit rate is 12000/0.021 = 571429 bit/s. Efficiency is 571429/150000000 = 0.0038 = 0.38%.

[Note to markers: some students will not understand that the answer to b) is "not worth considering" and will do an elaborate calculation including the time to output the frame. They should get almost the same answer! Others simply won't believe that the efficiency is so low. Some others might try to copy last year's assignment... that won't work very well, because the numbers were different.

2.5 for getting the correct rate (near to 571429 bit/s) and 2.5 for calculating a correct percentage (near to 0.38%)]

Q2. Fixed window [15 marks]

For the same link, now assume that a "window" of N frames is allowed on the link at one time before waiting for an ACK.

a) What is the efficiency for N=10, N=100, N=1000 [10 marks]

N=10 is just like sending single frames of 10x1500 bytes, so we can send 10 times as much every 21 milliseconds, efficiency is 3.8%. **[3 marks]**

N=100 is similar, efficiency is about 38%. **[3 marks]**

N=1000 frames would be 1.5 MB or 12 Mbits and that would take 80 milliseconds to transmit - much more than the 21 ms round trip time. So the result would be meaningless. **[4 marks: 3 marks for calculation and 1 mark for explaining that the result is meaningless]**

b) For a sliding window protocol to use this link with maximum efficiency, what is a suitable window size (measured as a number of frames)? [5 marks]

The correct answer is a window equal to twice the BDP, which allows the ACK for packet 1 to arrive just as packet N is being sent. With BDP = 1575000 bits and 12000 bits/packet, the answer is N = 2x1575000/12000 = 262.

Another method is that to get efficiency 100%, we need N = 100/0.38 = 263. Good enough.

Q3. Satellite link [15 marks]

Assume that the optical fibre is damaged and temporarily replaced by a satellite link of the same capacity. How will the answers to Q1 and Q2 change?

Q1a. The one-way delay increases from 10.5 msec to 200 ms. [up to 250 ms. also OK. The strictly correct answer is 239 ms.]

[Q1b. No change.]

Q1c. BDP = 150×10^6 x 0.2 = 30,000,000 bits = 30 Mbits. [up to 37.5 Mbits OK]

Q1d. Achieved bit rate is 12000/0.4 = 30000 bit/s. [down to 24000 OK]
Efficiency is 30000/150000000 = 0.0002 = 0.02%. [down to 0.016% OK]

Q2a. N=10, 0.2%; N=100, 2%, N=1000, 20% [same pattern]

Q2b. N = 2x30000000/12000 = 5000. [up to 6250 OK]

[Note to Markers: 2.5 marks for each section
For Q1.a, 200 ms has been calculated in the slides for the first lecture, page 20. Other valid values, up to 250ms, are also acceptable if a trustworthy reference is provided.]
