COMPSCI 314 S1C 05 Assignment 1

Department of Computer Science
The University of Auckland

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Due Wednesday 23 March 2005, 4pm
in https://adb.ec.auckland.ac.nz/adb/

- A preliminary version of this assignment was web-posted on 14 March 05. In order to get full credit, you must prepare your answer script from this final version.
- This assignment will contribute 30/300 = 10% to your coursework mark, and 3% to your overall course mark.
- Total possible marks on this assignment: 30.
- To obtain full credit, your script must clearly show *how* you obtained a correct answer.
- If you require additional information in order to answer a problem, you should briefly explain why this information is necessary and why your assumptions about the "missing values" or "missing facts" are reasonable.
- You may submit your assignment either in MS Word format, or in PDF format. The latter format should be used if you are scanning a handwritten script. The filesize should not exceed 2 MB. If you have difficulty meeting these specifications, please contact a tutor **prior to Tuesday 22 March 2005**.
- Your tutors are Li Jihong (jli018@cs.auckland.ac.nz) and Li Li (lli057@ec.auckland.ac.nz).

Q1. The Cassini orbiter is now 8.5 AU (Astronomical Units) from Earth. One AU is approximately 1.5×10^{11} meters. Cassini communicates with its Earth base stations at a raw bitrate of 142 Kb/s.

a. Estimate, to within ±20%, the effective user bandwidth for the Cassini-Earth datalink, under the assumption that this datalink uses the simple ARQ protocol described in the second set of lecture slides. Assume the user message is approximately one kilobyte (this is the variable U in the lecture-slide analysis). Explain any additional assumptions you require to make your estimate. **[3 marks]**

b. Rework your previous estimate, under the revised assumption that the user message length is one megabyte. **[1 mark]**

c. Make some other, more reasonable, set of assumptions about the flow-control protocol and/or the packet length on the Cassini-Earth datalink. Explain your assumptions clearly. Estimate the effective user bandwidth under your new set of assumptions, and indicate why you believe your new assumptions are more reasonable than the ARQ/1KB protocol assumption of Q1a or the ARQ/1MB protocol assumption of Q1b. **[3 marks]**

Q2. In December 2004, the Huygens probe was released from Cassini. The Huygens probe landed on Titan, one of Saturn's moons, in January 2005. During its descent, Huygens sent back a series of digitized images to Cassini. Cassini then relayed these images to Earth. Huygen's uplink to Cassini had a raw bitrate of only 8 kb/s, due to severe power and weight constraints on the spacecraft design.

a. When Cassini was 60,000 km from Huygens, estimate (to within ±20%) its effective bandwidth to Huygens under the assumption that it was using the ARQ protocol of the second set of lecture slides, with a packet length of approximately one kilobyte. **[2 marks]**

b. Cassini sent 250 images to Huygens during its 2.5-hour descent. Compute the average number of kilobytes per image, assuming that its uplink was transmitting images continuously, and assuming that your estimate from Q2a is correct. **[1 mark]**

c. Compare your estimated average image size from Q2b to an average image size computed by taking a randomly-chosen sample of three images from http://esamultimedia.esa.int/docs/titanraw/index.htm. If your estimates are significantly different, give (and briefly explain) two possible reasons for this discrepancy. **[4 marks]**

Q3. At pp. 299-304, your 2nd Edition textbook analyses the effective bandwidth of a protocol it calls "Stop and Wait". The same material appears at pp. 356-360 in the 3rd Edition. The textbook analysis is quite similar to the effective bandwidth analysis of the ARQ protocol that appears at slides 17-22 of the second set of lecture slides for this course.

a. Draw a diagram, in the style of lecture slide 4 of Set 3, for the Stop and Wait (SAW) protocol of the textbook. Your diagram should have the following elements:

- A transmitting station TX (on the left)
- A receiving station RX (on the right)
- A transmitted data message DATA
- A positive acknowledgement message ACK
- A negative acknowledgement message NAK
- A clear indication of what should happen when a valid message (DATA, ACK, or NAK) is received by the TX or RX.
- A clear indication of what should happen when an invalid message is received by the TX or the RX. **[3 marks]**

b. The SAW protocol of the textbook is essentially the same as the ARQ protocol of the second set of lecture slides. However the variables are differently named and, in some cases, differently defined.

Some variables in the ARQ analysis correspond directly to a variable in the SAW analysis. Some variables in the ARQ analysis may correspond to a sum (or difference, or other algebraic combination) of variables in the SAW analysis. There may also be some SAW variables that do **not** appear in the ARQ analysis; or some ARQ variables that do **not** appear in the SAW analysis.

Your answer script for Q3b should present this information in tabular form, with three columns.

- The first column in your table should give a descriptive name to each parameter in the effective bandwidth analysis of either ARQ or SAW. For example, this column might contain the name "raw bit rate".
- The second column should indicate the ARQ variable (or algebraic combination of ARQ variables) for each parameter named in the first column. If this parameter is *not* evaluated in the ARQ analysis of the second set of lecture slides, then write "not modeled" in this position. For example, you might write "*R*" in the second column of your table, in the row for the parameter you named "raw bit rate".
- The third column should give the value of each parameter in the SAW analysis. For example, you might write "R" in the third column of your table, at the row labeled "raw bit rate", because this is the name of the variable used in the textbook's SAW analysis for this parameter.
- Here are the first two rows of your table:

Descriptive Name	**ARQ Variable or Formula**	**SAW Variable or Formula**
Raw bit rate	***R***	***R***

- **[3 marks]**

c. Interpret the information in your table of Q3b by answering the following question. Which of the two analyses (SAW or ARQ) takes into consideration *more* of the reasons why the effective bandwidth of a datalink can be significantly less than its raw bitrate? Explain your answer briefly, with reference to your table. **[2 marks]**

d. Name, and briefly describe, one *additional* reason (not modeled in either the ARQ or SAW analysis!) why the effective bandwidth of a datalink might be significantly less than its raw bitrate. **[1 mark]**

Q4. What octets would be transmitted in a Burroughs TD800 packet, containing the 5-character data message `Hello`, which is sent from a CPU to the data terminal at address #3? Write your characters in hex with parity, following the style of the sample TD800 packet shown in lecture slide 6 of set 3. **[2 marks]**

Q5. Slide 4 of lecture set #3 does not clearly indicate what the polled terminal in a TD800 system should do, if it receives a corrupted packet from the CPU instead of the expected ACK or NAK. Consider the following three possibilities:

a. the polled terminal might send an EOT in response,

b. the polled terminal might resend its data message, or

c. the polled terminal might not send anything in response.

Which of these three possibilities is the most appropriate choice for the TD800 protocol? Explain your reasoning by briefly describing a problematic situation that could arise in each of the other two possibilities. **[3 marks]**

Q6. A Burroughs TD800 CPU might be upgraded with an Ethernet network card, to replace the serial I/O card that handled its original 38,400 bps multi-dropped datalink. The new Ethernet card would require special-purpose "device driver" software. The driver software accepts 7-bit ASCII characters from the Burroughs TD800 link-layer protocol software. These 7-bit characters should be transmitted over the Ethernet to an appropriately-configured Burroughs TD800 terminal (which would also require an Ethernet card and special-purpose driver). The CPU's Ethernet device driver would also have to handle the back-channel: whenever this card receives one or more 7-bit ASCII characters from an Ethernet-equipped TD800 terminal, the CPU's device driver should pass these characters on to the (original, unchanged) Burroughs TD800 link-layer protocol software. After these modifications, the standard Ethernet protocol can be used on the Physical and MAC layers of a Burroughs TD800 system.

We could use a special 8-byte SNAP header to identify this special TD800 traffic on a 10 Mbps Ethernet link. If each Ethernet packet carries a single character of the TD800 protocol, would you expect the upgraded TD800 system to be significantly faster or slower than the original TD800 system? Explain. **[2 marks]**