ITS323 – Assignment Feedback

This document provides some feedback on the assignment. In particular, the equations for flow and error control are presented. Then an example of how to plot the results is given (this may be helpful for future assignments). Finally, some comments about the marking scheme are given, and then my notes and your scores are given for each group.

1 Flow Control Equations

Here I present one approach to deriving the equations for flow control throughput.

First consider stop-and-wait flow control on a perfect link, that is, no errors. The transfer of each frame requires that DATA frame to be transmitted, the DATA frame to propagate to the destination, an ACK frame to be transmitted, and the ACK frame to propagate to the source. For a DATA frame consisting of f_{data} bits of original data and f_{hdr} bits of header, an ACK frame consisting of f_{ack} bits, an uplink data rate of r_u bits per second, an uplink propagation delay of d_u seconds, a downlink data rate of r_d bits per second, and a downlink propagation delay of d_d seconds, the time to transfer a DATA frame in the normal case is:

$$T_{normal} = \frac{f_{data} + f_{hdr}}{r_u} + d_u + \frac{f_{ack}}{r_d} + d_d \tag{1}$$

Equation 1 ignores any processing delay at devices.

With stop-and-wait flow control in this normal case, f_{data} bits of data are delivered every T_{normal} seconds, giving a throughput:

$$\rho_{stopwait} = \frac{f_{data}}{T_{normal}} \tag{2}$$

Now consider stop-and-wait ARQ across an imperfect link, that is, errors are possible. Lets assume that there are two possible cases for each successful frame transfer:

1. The DATA frame is transferred successfully (no errors). In this case the time to transfer each DATA frame is the same as stop-and-wait flow control, i.e. T_{normal}.

2. The original DATA frame transmitted is not successfully received. After a timeout of $T_{timeout}$ seconds, the DATA frame is retransmitted and that retransmitted frame is successfully received. In this case, the time for the complete data transfer is the time to transmit the original DATA frame, the timeout, and then the normal time to transmit a retransmitted frame:

$$T_{error} = \frac{f_{data} + f_{hdr}}{r_u} + T_{timeout} + T_{normal} \tag{3}$$

We do not consider the case that a retransmitted DATA frame is in error (although in theory it is possible, for low error rates, it is very unlikely). Given that there are two cases, the average time transmit depends on the probability of each case. With an error rate of e:

$$T_{ave} = (1 - e) \times T_{normal} + e \times T_{error} \tag{4}$$

The throughput of stop-and-wait ARQ is:

$$\rho_{stopwaiterror} = \frac{f_{data}}{T_{ave}} \tag{5}$$

Finally, consider sliding-window flow control (no errors). The problem with stop-and-wait flow control (which is really just sliding window with a window size of 1) is that the source must wait for the ACK of the first DATA frame to arrive back before it can move on to the next DATA frame. In sliding-window with a window size of W frames, the source can transmit W frames before having to wait for the ACK of the first DATA frame to arrive back. If W is large enough, then the source will not have to spend any time waiting as the ACK will arrive while it is still transmitting the original window of frames. This leads to two cases:

1. If the time to transmit W frames is less than the time to get an ACK back (which is T_{normal}), then every T_{normal} seconds, W frames with f_{data} bits can be transmitted.
2. If the time to transmit W frames is greater than or equal to the time to get an ACK back, then no time is spent waiting. The only overhead is header, and hence throughput depends on the ratio of original data, f_{data}, to the total frame size, $f_{data} + f_{hdr}$.

From these two cases, the throughput of sliding-window flow control is:

$$\rho_{slidwin} = \begin{cases} \frac{W \times f_{data}}{T_{normal}} & \text{if } W \times \frac{f_{data}+f_{ack}}{r_u} < T_{normal} \\ \frac{f_{data}}{f_{data}+f_{hdr}} \times r_u & \text{otherwise} \end{cases} \tag{6}$$

2 Plotting Results

How should you plot your results? Figure 1 is an example I created (using fake data) to illustrate the typical elements expected in the plot. Look at the plot and then read on about those elements.

Data sets This plot contains two data sets: expected values which are calculated from an equation and the discrete measured values. In this example I plot the expected values as a solid blue line and the expected values as red crosses. A continuous line (without markers) is acceptable for a data set obtained from an equation. However for a data set obtained from measurements you should either use only markers (like the red crosses in my example) or markers plus a continuous line. Using only a continous line (with no markers) is incorrect, as it doesn't identify which points you obtained measurements for.

Axis Labels The labels for the x-axis and y-axis should name the metric. In the example the labels are *Data Rate [Mb/s]* and *Efficiency*. Where relevant the unit should be given (in the example, effieciency really should have the unit of %, but in the context of this assignment, that may be omitted).

Legend The legend identified which data set is the expected results and which is the measured results.

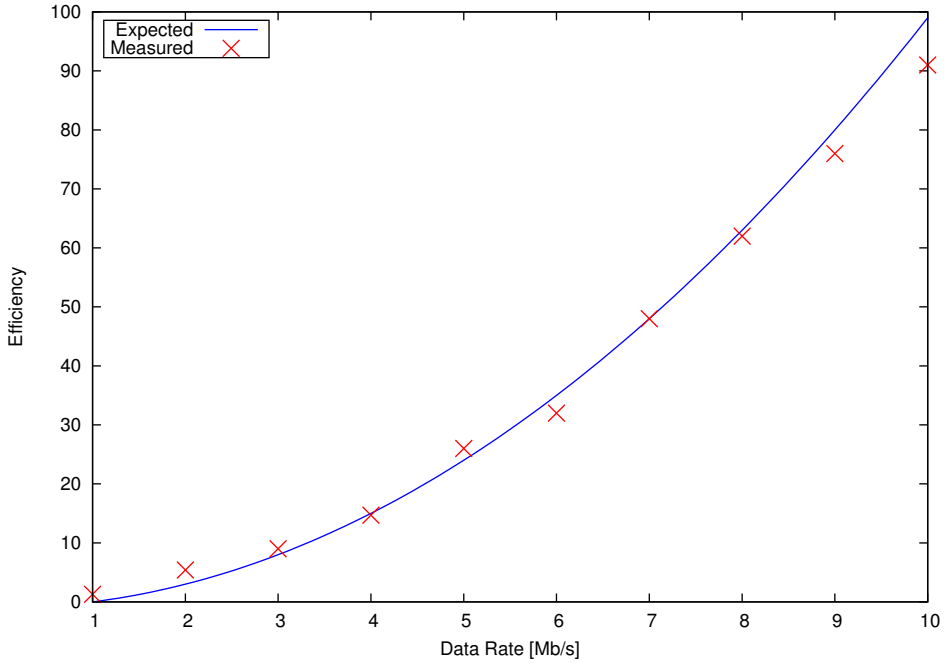

Figure 1: Stop-and-wait Flow Control Efficiency vs Data Rate

Axis Scales The scales are the numbers along each axis. In this example the y-axis ranges from 0 to 100, which is expected for efficiency. Sometimes a different scale is used, but often it can be confusing. For example if you "zoom in" and show only from 80 to 85, then the results may look like a large change, but in fact relative to the entire scale (0 to 100) they may be only small, insignificant changes. Another mistake, is having an efficiency going about 100.

Caption Include a caption with the plot (or at least a title of the plot) so the reader can identify this plot in the set of plots.

3 Marking Scheme

When marking each assignment I looked for the following content. The number in brackets is the weight of this item for the entire assignment (out of a total of 15). In the table of marks you will see these in column headings. Each item I gave a score out of 10.

Presentation (1) Formatting of report. In most cases everyone received full marks.

Mathematical Model (5) I looked for the use of variables and a well presentation equation, and for the correct equations for stop-and-wait (without and with errors) and sliding-window. Basic stop-and-wait was worth 2 marks, sliding-window 2 marks and stop-and-wait with errors 1 mark.

Plots (2) I looked for nice looking plots (see Section 2 for an example).

Results (5) I made a record of the number of experiments for the cases of "no errors" and "errors" (it doesn't matter if my record in the spreadsheet is exactly the same

as the number of experiments you performed; the number was just to serve as a reminder for myself when comparing groups). I then gave a score based on how many experiments, the values you used for parameters and the accuracy of the results. Some students received a bonus of up to 2 marks (meaning they may have received 12 out of 10) if I thought they had outstanding results and approaches to data collection.

Conclusions (2) A score out of 10 based on your textual descriptions of the results.

The total score was the weighted sum of the above components, and is out of 15. Some groups that received a bonus may have a score higher then 15. This will count towards their final grade.

The comments in the spreadsheet are mainly for my own notes, but may explain why you got a lower score for that component. The best way to know why you didn't get full marks is to compare your report with the reports of the top mark students (available on the course website).

Some groups received a penalty (either for incorrect/late submission or too much text similar to other groups). The following spreadsheet does NOT include that penalty. Intead your score in Moodle will include the penalty and a comment explaining it.

Assignment

	Presentation	*1*	*Mathematical Model*		*2*		*2*		*1*	*Plots*		*2*	*No errors*					*Errors*			*Comment*	*5*	*Conclusions*	*2*	***Total***
Group	*Formatting*	*10*	*Equation Variables*	*Stop-and-Wait Equation*	*10*	*Sliding-Window Equations*	*10*	*ARQ Equations*	*10*	*Plot Axis*	*Plot Scale*	*10*	*Rate*	*Delay*	*Size*	*Win*	*Other*	*Error*	*TO*	*Other*		*10*		*10*	***15***
1	Did not remove “Students:”	9	rate and others; used constants instead of variables	Ok	7	Same as stop-and-wait	0	Did not define total time or total time w	0	Not labelled	Window size to 4000?	4	2	2	2	3	0	2	2	0	Not enough values	6	Poor	5	**7.1**
2	Ok	10	No variables for data size	total time or original data size	0	Not included	0	Not included	0	y-axis not labelled, data rate in reverse order	Timeout from 0 to 6	5	7	7	5	7	0	5	5	0	Ok	10	Ok	8	**8.6**
3	Ok	10	rate and others; used constants instead of variables	Ok	7	Same as stop-and-wait	0	Did not define total time or total time w	0	Ok	Ok	10	3	3	2	4	0	6	4	0	Ok	10	Poor	6	**10.6**
4	Ok	10	Defined variables but didnt use them in equations	Ok	8	Hard to read the cases	8	t1 should include 2 data transmissions	7	Ok	Ok	10	4	4	5	6	0	5	5	0	Ok	10	Good	9	**13.7**
5	Ok	10	Ok	Ok	10	Doesnt consider case of large window	7	Ok	10	Ok	Ok	10	7	8	7	7	0	7	7	0	Ok	10	Good	10	**14.4**
6	Did not remove “Students:”	9	Some variables not defined	Ok	8	Ok	10	Ok	10	Ok	Ok	10	11	11	10	6	0	10	7	0	Ok	10	Good	10	**14.5**
7	Ok	10	Did not used variables	No equation (2nd e??)	5	Doesnt consider case of large window	6	Doesnt cover both cases of with and without errors	5	Ok	Ok	10	5	5	2	4	0	5	3	0	Ok, varied multiple parameters, window size results not clear	9	Ok	8	**11.8**
8	Ok	10	Ok	Ok	10	Doesnt consider case of large window	6	t error should include 2 data transmissions	7	Ok	Ok	10	3	3	3	4	1	4	4	0	Ok, include C++ code	12	Ok	9	**14.7**
9	Ok	10	Ok, but RTT equation is wrong	size divided by time	0	Wrong	0	Almost correct, but some brackets are in wrong place	5	Ok	Expected efficiency goes above 100% ??	8	10	10	10	10	0	10	10	0	Excellent	10	Ok	8	**9.7**
10	Ok	10	Ok.	No equation for stop and wait	0	No equation for sliding window	0	No equation for error case	0	Ok	Zoom in too much on one plot	9	4	6	7	4	0	7	7	0	Ok	10	Fair	7	**9.2**
11	Ok	10	Ok.	No equation for stop and wait	0	No equation for sliding window	0	No equation for error case	0	Only single plot; should have plots for each param	-	0	3	3	2	3	0	2	2	0	Considered with and without error separately	10	Fair	7	**7.4**
12																									**0**
13	Ok	10	Did not used variables in equations	Ok	10	Not included	0	Not correct equations for average time	2	Not labelled	Plot throughput, not efficiency	5	6	6	4	5	0	6	7	0	Ok	10	Poor	6	**10.4**
14	Ok	10	Ok	Ok	10	Ok	10	Ok	10	Ok	Ok	10	9	19	12	20	0	98	9	0	Excellent	12	Good	10	**16**
15	Ok	10	Not clear what “time” and “delay” represent	No equation (2nd e??)	5	Small errors, hard to read	7	No equation	0	Not labelled	Ok	6	19	30	11	5	0	11	3	0	Excellent	12	Fair	7	**12**
16	Ok	10	rate and others; used constants instead of variables	Ok	10	Same as stop-and-wait	0	Did not define total time or total time w	0	Ok	Ok	10	2	2	2	3	0	2	2	0	Not enough values	6	Ok	8	**9.6**
17	Ok	10	Ok	Ok	10	No equation for sliding window	0	Ok	10	Ok	Ok	10	3	3	3	3	0	4	3	0	Ok	10	Good	10	**13**
18	Ok	10	p = lambda / u is not relevant	No equation (2nd e??)	5	Incorrect logic and errors in sliding window	5	No equation	0	Not labelled	Did not show actual values	4	10	10	2	5	0	6	7	0	Ok	10	Ok	8	**10.4**
19	Ok	10	Good	Ok	10	Ok	10	results in plot is going up (incorrect)	7	Ok	Ok	10	4	4	5	3	0	5	6	0	Different configs for different protocols	12	None	0	**13.7**
20	Ok	10	Ok	Ok	10	Ok	10	Ok	10	Ok	Ok	10	19	30	51	7	0	42	14	0	Excellent	12	Good	10	**16**
21	Ok	10	None	No equation	0	No equation	0	No equation	0	No units	Ok	8	10	10	10	6	0	10	10	0	Good	10	Ok	8	**9.2**
22	Ok	10	Ok	Ok	10	Ok	10	Correct	10	Ok	Ok	10	10	10	10	9	0	10	7	0	Excellent	12	Good	10	**16**
23	Ok	10	Ok	Ok (included in error)	10	Ok	10	Ok	10	Ok	Ok	10	16	16	8	4	0	6	6	0	Good	10	Good	10	**15**
24	Many pages of calculations??	9	Do not use variables, data transmission not defined	Ok	9	Ok	10	Ok	10	Ok	Ok	10	3	8	3	3	0	6	2	0	Ok	10	Ok	8	**14.3**
25	Ok	10	Ok	Wrong	0	No equation	0	No equation	0	No labels	Ok	6	6	5	5	3	0	5	5	0	Ok	10	None	0	**7.2**
26	Ok	10	Ok	Ok	10	Da should not included headers	6	With errors should not be 2*RTT, but 1*RTT.	6	Ok	Ok	10	5	6	2	4	0	4	3	0	Ok	10	Ok	8	**13.4**
27	Ok	10	Ok	Do not consider header	7	Doesnt consider case of large window	6	Average time wrong	5	Ok	Ok	10	1	4	4	4	0	4	4	0	Ok	10	Ok	8	**12.7**
28	Ok	10	Did not use variables	Ok	8	No equation	0	No equation	0	No labels, plot throughput not efficiecny	Ok	5	10	10	2	8	0	85	7	0	Ok	10	Fair	7	**10**
29	Ok	10	Ok	Ok	10	Doesnt consider case of large window	6	Error rate not considered	0	Ok	Ok	10	10	10	10	9	0	5	7	0	Ok	10	Ok	8	**12.8**
30	Ok	10	Did not use variables	Header not considered	6	Doesnt consider case of large window	6	Incorrect	3	No labels	Ok	6	3	3	3	3	0	3	3	0	Ok, but results not labelled	5	None	0	**7.4**
31	Ok	10	No equations	No equations	0	No equations	0	No equations	0	Ok	Ok	10	3	3	2	3	0	3	3	0	No plots, just tables of data (bad); include Bsah scripts (good)	7	Fair	6	**7.7**
32	Ok	10	Did not use variables	Header not considered	6	Doesnt consider case of large window	6	Incorrect	3	Ok	Ok	10	3	0	0	0	0	3	3	0	No results for window size or delay	5	None	0	**8.2**