AN-X Technical Note

Measuring Response Time in the AN-X2-MOD-MAS

This technical note describes how we measured response time and processing time when using the AN-X2-MOD-MAS with a ControlLogix to control Modicon I/O.

Response time is the time from when an output is turned on in the ControlLogix controller to when it appears at the output terminal, or the time from when an input terminal changes until the new value appears in the ControlLogix controller.

Processing time is the time consumed by devices such as the AN-X and the ENBT in transferring data.

Introduction

When a ControlLogix processor uses an AN-X-MOD-MAS to scan a Modicon S908 remote I/O network, response time depends on the following factors:

- ControlLogix scan time
- connection RPI
- propagation time over Ethernet (cables, switches, etc.)
- processing time in ENBT and AN-X, depends on the number of connections and traffic
- Modicon remote I/O scan time
- processing time in the Modicon remote I/O adapter and in the output and input modules

Other factors to consider

- The ControlLogix logic scan and the I/O scan are asynchronous. When the logic turns on an output, there can be a delay of up to one RPI before the ENBT sends the output data on Ethernet.
- Ethernet inputs and outputs are asynchronous. The AN-X sends its data when its RPI timer expires. The ENBT does the same. But the two are not synchronized.

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- Similarly, the update from the ControlLogix to the AN-X and the AN-X scan on the S908 remote I/O network are asynchronous. There can be a delay of up to one remote I/O scan time before the AN-X sends the output data on the I/O network.
- The Modicon I/O scan cycles through the configured drops, reading the inputs and then writing the outputs for each drop, and proceeding to the next drop. When the ControlLogix processor sets an output for a drop and the output is wired to an input on the same drop, there will be a minimum of one I/O scan before the input is sent to the ControlLogix.
- The Modicon I/O S908 network scan time depends on the number of drops and the contents of each drop.
- There is some variation in the scheduled data transfer from the ControlLogix; transfer does not happen at precisely the RPI interval

Method

To measure the response time, we used a QTS Modicon drop emulator that turned on an input when an output in the same drop came on, and measured the time from when the output was turned on in the ControlLogix to when the input came on in the ControlLogix. We recorded the minimum, maximum and average times for the round trip of the data.

We tested with networks that ranged from 2 to 32 drops.

To measure the S908 remote I/O scan times, we used the scan time from the AN-X2-MOD-MAS web interface.

All tests were done with one connection from the ControlLogix to the AN-X, with an RPI of 5 ms and 248 words of outputs and 250 words of inputs.

Results

The table summarizes the results of the measurements. Minimum, maximum and average times are for the round trip of the data, from turning on the output in the ControlLogix to receiving the input in the ControlLogix. All times are in milliseconds.

Number of Drops	Minimum time	Maximum time	Average time	I/O scan time
2	5	19	11.97	4.2
4	9	27	18.29	8.5
8	18	44	31.04	16.9
16	35	78	56.39	33.9
32	69	146	107.2	67.8

The average times were calculated over a minimum of 10000 updates.

Analysis

Processing Time

We can obtain an estimate of the AN-X processing delay from either the maximum or minimum time.

Minimum Time

The minimum time represents the case where the ControlLogix just catches the outgoing RPI from the ENBT to the ANX, and the AN-X just catches the I/O scan. The input is returned on the next I/O scan and just catches the Ethernet update from the AN-X to the ENBT. The total delay is therefore one I/O scan time plus 2 processing delay times, one for the output path and one for the input path.

From the table we can estimate the processing delay (ENBT + AN-X + everything else) by subtracting the I/O scan time from the minimum time and dividing by 2

Maximum Time

The maximum time represents the case where the output just misses the outgoing RPI to the AN-X and then just misses going out on the S908 I/O scan. It waits a full I/O scan before it is sent out on the S908 network. The input comes back on the next I/O scan, and then just misses the RPI from the AN-X to the ENBT. The total delay is therefore 2 I/O scans plus 2 processing delay times plus 2 RPIs, one for the output path and one for the input path.

From the table we can estimate the processing delay (ENBT + AN-X + everything else) by subtracting (2 * I/O scan time + 2 * RPI) from the maximum time and dividing by 2.

To test the validity of the analysis of the worst case, we changed the RPI from 5 to 10 ms. We would expect that the minimum time would be unaffected and the maximum time would increase by twice the change in the RPI. The times measured from 6000 samples were 70 (minimum), 155 (maximum) and 112.79 (average), as expected.

Average Time

Assuming that the values are uniformly distributed between the minimum and maximum times, we calculate that the average time would be one RPI plus 1.5 I/O scan times plus two processing times.

Processing Times

The table shows the processing times calculated from the minimum, maximum and average response times.

Drops	Pmin	Pmax	Paverage
2	0.4	0.3	0.34
4	0.3	0.0	0.27
8	0.6	0.1	0.35
16	0.6	0.1	0.27
32	0.6	0.2	0.25
Average	0.5	0.1	0.29

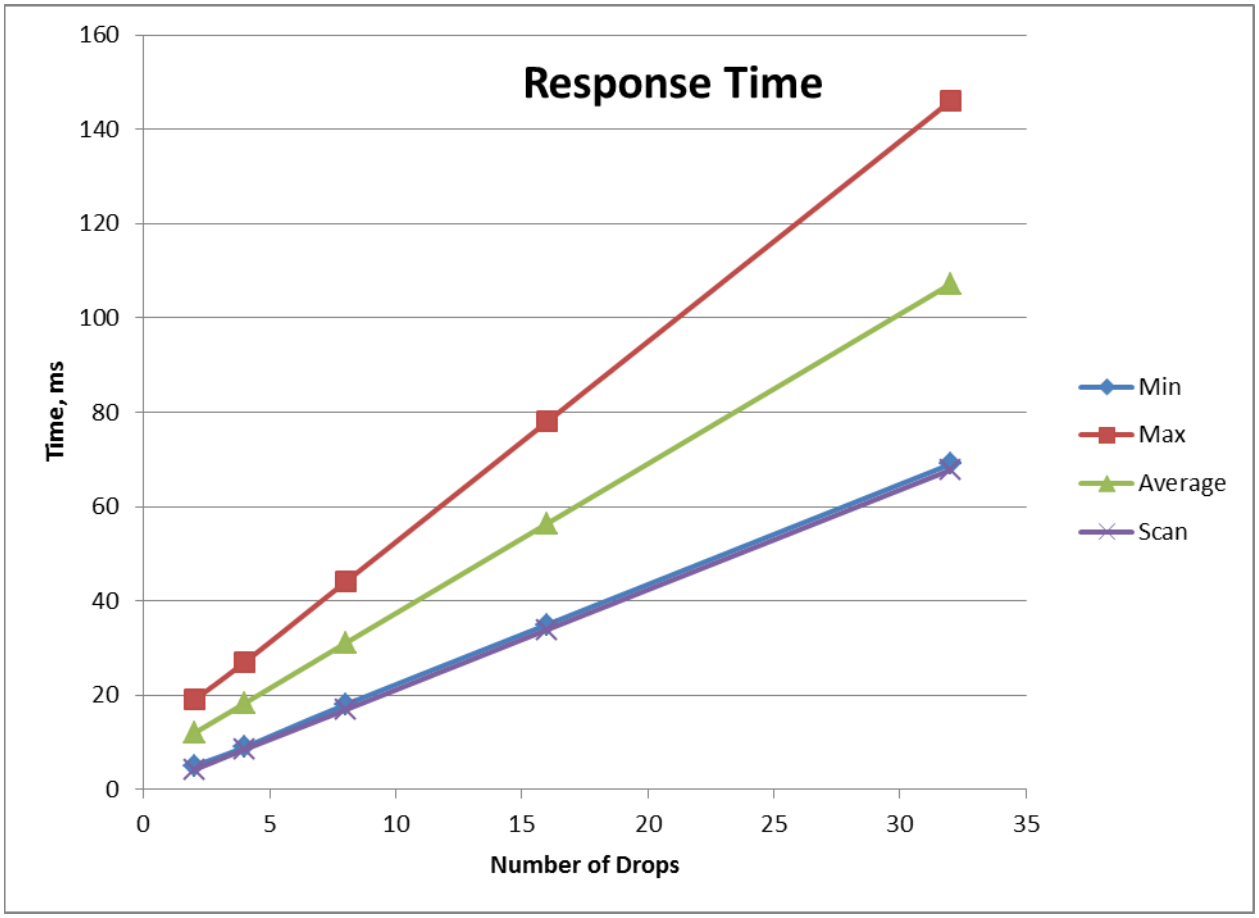
Conclusions

The estimated total data processing time in the AN-X, ENBT and so on is 0.5 ms or less.

All other variations in the delivery time of data are the result of the asynchronous nature of communication between the ENBT and the AN-X and the communication on the S908 remote I/O network.

Response Time

The graph shows the I/O scan time, minimum, maximum and average response times as a function of the number of drops.



In each case, the minimum time is just a little greater than the I/O scan time.