Calculating the Update Speed in a Group3 Control System

There are two operating speeds that determine the overall polling interval of a particular channel in a system.

1. The speed of the DI processor in servicing the I/O cards in a particular DI.
2. The speed of the message passing around the fiber optic loop, the loop polling interval.

An overview of the Group3 system is necessary;

Within a Device Interface box (DI) there is a processor card, and a number of I/O boards. The DI services that I/O cards, updating them and reading the input values which it then stores. This servicing of the I/O boards occurs continuously with a basic interval of 1ms.
Completely asynchronously to the I/O board servicing, the Loop Controller (LC) polls the DI asking for information about a particular I/O board or group of I/O boards. The DI supplies this information from it's memory. The LC will then ask for information about the next I/O board, and so on around the loop.

1. Considering the DI processor servicing the I/O boards in more detail

Every millisecond the DI processor performs a service call on an I/O board.
The boards are cycled through in a strict rotation, 1ms per board.
Thus if there are three I/O boards in a DI, a particular board will receive a service call once every 3ms.

For certain boards, one service call can read all and update all the channels for that board, so the entire board can be service in 1ms. Other boards will require several service calls to update all channels on the board. The table below outlines the number of service call required to update an entire board.

Type	Nature	Service Calls Required
A	Fast Analog	1
B	Digital	1
C	ADC	8
D	DAC	8
E	DC Motor	4
F	Serial Comms	1
G	Stepper Motor	4
H	Encoder	1
J	16 bit DAC	2
K	GPIB/IEEE-488	1

This table is necessary in working out the channel polling intervals, as described later.

Consider the worst case of a DI loaded with three 8-channel analog boards. One channel is serviced every 1ms, so it will take the DI processor 24ms to work its way around all channels in that DI. So within the DI an individual channels is serviced every 24ms. How long it takes for this information to reach the control computer then depends on how many I/O boards there are on the loop.

2. Loop Speed

In software versions prior to V4.3, one message on the loop would update or read all of the channels of one I/O board.
Version 4.3 introduced a new messaging structure, where one message was able to service nearly all the I/O boards in a DI. This multi-board message is automatically used for board types B, C, D, H, & J. The remaining boards A, E, G, F, & K, all have data strings that are too long to be joined in to one message, and must be serviced by a dedicated message to each board.

So the most popular and common boards - the digital and analog I/O boards can be automatically combined in to one message, and this produces a faster overall network response.
On average, in a large system of mostly analog and digital channels, it takes 0.8 ms to service each board on the loop.

So the simple rule for estimating the polling interval on the loop is:

0.8ms per I/O board on the loop

As stated a the start, there are two intervals to consider - the DI servicing interval, and the loop polling interval. The average and worst case response times must take in to account both of these intervals.

Here are some rules for working out the overall polling interval for a particular channel in a particular DI:

The DI service interval:

a. Take the number of service calls required to service that board: ____
(from the table above)
b. Multiply by the number of I/O boards in the DI x ____

DI Servicing Interval = ____

The Loop polling interval:

a. Take the number of I/O board on the loop: ____
b. Multiply by the loop speed of 0.8ms per I/O board x 0.8

Loop polling Interval = ____

The **effective polling interval** for a particular channel will be the **larger** of the two numbers calculated above.

The second parameter of concern in the response time for a particular channel in a system. Of course on average this will be the polling interval as worked out above.

The worst case response time will be the sum of both the DI service interval and the loop polling interval.

This is the case when the input changes just after a particular channel has been serviced by the DI processor, and then the loop message for that board arrives just before the DI is due to service that channel again, thereby carrying away old data. The control computer must then wait for the loop to cycle around the loop for the new data.

If speed is critical on some channels, then a multi-loop system should be considered; one or more loops for high speed, with the DIs kept a lightly loaded as possible, and another loop used for the remaining channels where speed is less critical.