1GUIDELINES TO SELECTING I/O PRODUCTS
For Use with Open Architecture Control Platforms

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An “open architecture controller” means that the controller software/firmware can be run on and with a wide variety of different vendor products. This document will focus on Input and Output systems (I/O) choices. Note that other product selections, such as CPU type/platform, motion controllers, drives, HMI/SCADA systems, and other peripheral equipment are not addressed in this document, but may also be a factor in the I/O selection process.

Additionally, many other I/O systems and products are available than those discussed in this document and may be able to be supported by your open architecture controller choice.

How Controllers Communicate to I/O

Most open architecture control products communicate to I/O devices and I/O networks through drivers. Sometimes, multiple drivers can be used at the same time, to allow you to mix and match a number of different I/O systems. Some vendors allow users to create their own drivers through a Developer Toolkit.

Terminology:

- *Program Scan:* The time it takes the controller to scan the application logic and process communication requests.
- *I/O Scan:* The time it takes the controller to refresh all the inputs and send new data to the outputs, and perform any other I/O tasks, such as forcing or communications to “smart” modules.
- *System Throughput:* Program Scan + I/O Scan
- *I/O Transfer:* The time it takes an I/O interface scanner card to transfer the data to the actual I/O modules from its on-board memory.
- *I/O Response Time:* The time it takes an input module to react to an incoming signal from a device or for an output module to send a signal to the device, including data conversions as in the case of an analog module.
- *I/O Update Time:* The total time it takes from when an input sensor receives data until the I/O interface scanner card receives the data for processing, or for an output device to receive data from the I/O interface scanner card.
- *I/O Throughput:* I/O Transfer + I/O Response Time + I/O Update Time.

TYPES of I/O SYSTEMS

"Traditional" PLC I/O

This category of I/O products are rack mounted, modular I/O systems that provide industrial packaging, reasonable cost and performance for most applications, and easy troubleshooting. The I/O racks and modules are normally mounted in a cabinet and signal wires are run to the cabinet from the sensors.

Tealware: SoftPLC Corporation provides this I/O system with their brand-name Tealware™ I/O. This system provides high-speed local I/O up to 1024 digital points (or up to 32 total modules). The I/O scan for most local systems is 1msec. A remote I/O network which runs at 2.5MBaud allows for up to 16K digital points (64 racks = 512 modules) at a distance of up to 20,000 feet from the CPU. The remote I/O network allows for 4 local racks per remote drop at local I/O speeds, with about a 2msec delay per drop (not per rack), for up to 15 remote drops. Local and Remote Tealware I/O can be used with the SoftPLC In Tealware CPU modules and an interface card that can be installed in any ISA slot of a PC (Cat. No. PCCARD10). Tealware is a cost effective, fast I/O system suitable for most industrial applications.

A-B RIO: Many control vendors support Allen-Bradley Remote I/O (RIO) networks (1771, 1747, Block, Flex, Point, and other compatible I/O systems and devices) via the A-B 1784-KTS/KTX/KTXD interface cards that can be installed in an ISA/PCI slot of a PC. A-B does not allow 3rd parties to support their local I/O. The network speed is 115.2KBaud maximum, and Throughput on the A-B RIO network is the normally the same as that of an A-B PLC-5 or SLC-500 system, including the 7-8msec delay per rack caused by the Remote I/O Adapter (eg: 1771-ASB). If Block Transfer is used for analog or other intelligent I/O modules (and if the control vendor supports Block Transfer in their driver), the same restrictions of one Block Transfer per adapter per scan apply. A-B publishes formulas that can be used to determine the I/O Throughput Time in a RIO system. By using multiple RIO channels, users can improve the Throughput, by setting scan sequences and offloading intelligent modules to 1/rack. The controller, in its I/O Scan simply reads/writes data from its RAM data table over the backplane to the RAM on the KT*x* card(s), therefore, the I/O Scan is normally less than 1 msec. Unless the I/O is already in place, A-B RIO is not normally a recommended solution due to high cost and slow Throughput Time, along with cumbersome programming and delays associated with Block Transfer.

GE 90/30: Controllers can support the GE Series 90/30™ I/O network via a -PCIF interface card, which is available in ISA and PC/104 form factors. The I/O modules must be installed in an expansion rack. The controller, in its I/O Scan simply reads/writes data from its RAM data table over the backplane to the RAM on the PCIF card(s), therefore, the I/O Scan is normally less than 1msec. GE Fanuc publishes formulas to determine the Throughput time of a system. Unless the I/O is already in place, GE 90/30 I/O is not normally a recommended solution since other options are comparable in price and have faster Throughput Time.

Field Bus I/O

This category of I/O products consists of standardized protocols for distributed I/O networks. Many vendors provide sensors and I/O modules for these networks. Field Bus I/O provides a way to distribute the I/O along a machine/process to minimize wiring runs back to the control cabinet, as well as providing intelligence in sensors for better diagnostic information or localized control at the sensor level. A number of papers, pamphlets and comparison charts are available from the product and interface card vendor on the advantages, disadvantages, and differences between these networks, therefore, this information is not provided here.

DeviceNet: A number of vendors manufacture DeviceNet Master interface cards (eg: SST, Synergetic, and A-B), which are available in ISA, PCI and PC/104 form factors. Controller vendors normally support only specific interface cards, but any vendor I/O can be used as slaves on the network. The controller, in its I/O Scan simply reads/writes data from its RAM data table over the backplane to the RAM on the interface card(s), therefore, the I/O Scan is normally less than 1msec. The interface card vendors normally provide network configuration and diagnostics software with each card, and this can be used to also determine the I/O Throughput Time. Network speed is a factor of total distance and number/type of devices on the network. In SoftPLC's experience, DeviceNet performs well when the network load does not exceed the mid-point of the specification. Beyond that, our customers have seen performance problems and have had to divide the I/O onto multiple networks.

Profibus: A number of vendors manufacture Profibus Master interface cards (eg: SST, Synergetic, Siemens), which are available in ISA, PCI and PC/104 form factors. Controller vendors normally support only specific interface cards, but any vendor I/O can be used as slaves on the network. The controller, in its I/O Scan simply reads/writes data from its RAM data table over the backplane to the RAM on the card(s), therefore, the I/O Scan is normally less than 1msec. The interface card vendor normally provides network configuration and diagnostics software with each card, and this can be used to also determine the I/O Throughput Time. Network speed is a factor

of total distance and number/type of devices on the network. In SoftPLC's experience, Profibus networks perform well even at the limits of the specification. Training in network configuration/diagnostics is strongly recommended.

Interbus: A number of vendors manufacture Interbus Master interface cards (eg: Synergetic and Phoenix), which are available in ISA, PCI and PC/104 form factors. Controller vendors normally support only specific interface cards, but any vendor I/O can be used as slaves on the network. The controller, in its I/O Scan simply reads/writes data from its RAM data table over the backplane to the RAM on the card(s), therefore, the I/O Scan is normally less than 1msec. The interface card vendor normally provides network configuration and diagnostics software with each card, and this can be used to also determine the I/O Throughput Time. Network speed is a factor of number of devices on the network. In SoftPLC's experience, Interbus networks perform to specification, but the network is very sensitive to noise and cabling requirements must be strictly adhered to.

Computer I/O

This category of I/O products are I/O boards that install directly on the PC backplane, and may then interface directly to the I/O signals through a termination board or interface to I/O blocks, such as Opto modules installed on a terminal board. Normally, the I/O board is connected to the terminal board(s) via ribbon cables. The advantages of this category I/O are typically lower cost with very high speed and/or high performance specifications. The disadvantage is that with higher I/O count requirements, the system becomes difficult to troubleshoot and cabinet space intensive. Also, extreme care must be taken in these installations to ensure proper isolation from external noise from entering into the controller through the I/O system, as many of these boards and modules do not provide isolation such as typically found in PLC I/O or other industrial I/O products. I/O boards are available for ISA, PC/104, PCI, VME and other PC backplanes. There are hundreds of vendors and thousands of products available in this category.

Since the I/O board is on the PC backplane, the I/O Scan is normally much less than 1 msec. The I/O Throughput is based on the hardware selection.

Other computer I/O interfaces through the PC serial port or parallel port. Typically, these I/O systems are slow due to baud rate limitations as well as the synchronous nature of the I/O driver (each module must be communicated with individually one at a time).

Ethernet I/O

Ethernet I/O is becoming more and more popular due to the low cost of the scanner interface card and the high speed network. A number of protocols are available and controller and I/O vendors may support only one. Therefore you need to be careful if you intend to mix and match products from different vendors. Protocols built on TCP/IP, such as Modbus TCP, tend to have a lot of overhead and therefore I/O Transfer is relatively long (eg: 20 to 100msec). Protocols built on UDP are faster and more in line with PLC or Fieldbus I/O, but the products available using UDP protocols are more limited. Throughput varies widely by controller and I/O system.

I/O costs are the same as most Fieldbus I/O products, and in fact are usually the same modules with a different protocol adapter at the beginning of the I/O drop. The cost savings are in the interface card, and in standard network cabling and switches/hubs.

How to Choose?

There is no “right” answer. The application requirements will help limit the selection, particularly in terms of signals to be interfaced with, electrical requirements, and performance specifications. Following are some questions and criteria that have been used in the past to select I/O products.

How many points of I/O are needed? If there are few points located near the CPU, computer I/O or PLC I/O are good choices. If there are many points, and the application is a single machine/process, PLC I/O is a good choice. If there are many points to be distributed over a long distance, remote PLC I/O or Field Bus I/O is a good choice.

Who will maintain the system? If the system will be maintained by electricians or non-engineering personnel, PLC I/O is simplest and most familiar, followed by Field Bus I/O.

What Throughput is required? If the system needs to be extremely fast, then computer I/O is the fastest choice. (Of course, the actual module specifications will need to be a part of this equation.)

Cost? Once the performance specs are met, then cost can be considered. In general, computer I/O and PLC I/O are the lowest cost options.