Monitoring Commercial Conventional Facilities Control with the APS Control System - The Metasys-to-EPICS Interface

G.J. Nawrocki, C. L. Seaver, J.B. Kowalkowski
Advanced Photon Source
Argonne National Laboratory

ABSTRACT

As controls needs at the Advanced Photon Source matured from an installation phase to an operational phase, the need to monitor the existing conventional facilities control system with the EPICS-based accelerator control system was realized. This existing conventional facilities control network is based on a proprietary system from Johnson Controls called Metasys. Initially read-only monitoring of the Metasys parameters will be provided; however, the ability for possible future expansion to full control is available. This paper describes a method of using commercially available hardware and existing EPICS software as a bridge between the Metasys and EPICS control systems.

THE APS CONVENTIONAL FACILITIES CONTROL SYSTEM

The contractor selected for conventional facilities control was Johnson Controls, an environmental control system contractor familiar to many institutional and industrial facilities. This control system, called Metasys, is installed throughout the APS site.

Metasys is a distributed system of intelligent I/O processors, called network control modules (NCM), for control and monitoring of environmental and HVAC parameters. The data link and physical layer of this distributed system uses ARCNET for I/O processor intercommunication as well as the link to operator workstations for the human interface. This ARCNET-based communication path is called the N1 LAN [1]. As with many industrial control systems, the communication protocol and software for this system are proprietary to the manufacturer.

It should be noted that the NCM modules themselves have a subnet for communication to smaller distributed I/O control processors. This subnet, called the N2 Bus, is for communication between I/O processors only and does not provide an interface to an operator workstation [1].

The software native to the Metasys control system is called the Metasys Facilities Management System (FMS). The FMS is configured via the operator workstation, a PC-compatible computer running the Metasys Person Machine Interface (PMI) software. Physical control parameters, such as an individual temperature sensor or the on/off status of a certain water pump, are mapped to analog or binary Metasys objects. Associated with the Metasys objects are parameters which govern such elements as units (analog objects have single unit parameters, binary objects have two unit parameters, one each for the logical “1” and logical “0” values), display precision (analog only), object status (binary only), and of course the present value of the object [2].

A collection of Metasys objects is referred to as a Metasys system. The entire APS conventional facilities control system can be viewed as a tree of Metasys system directories containing files representing Metasys objects. The current software release of the Metasys File Management System at the APS allows for a maximum of 50 Metasys objects per Metasys system.

THE APS ACCELERATOR CONTROL SYSTEM

The accelerator control system at the APS is a distributed, networked system based upon the standards of EPICS [3]. It provides elaborate control and monitoring of all aspects of accelerator operation. Applications written specifically for EPICS provide facilities for data acquisition, back up and restoration of accelerator parameters, as well as the handling of alarms generated by the control system.

EPICS provides for VME-based input/output controllers (IOCs) to be distributed throughout the facility and interconnected via Ethernet to one another and also to UNIX-based operator interface (OPI) consoles [3]. This control system operates and monitors all functions of accelerator systems such as magnet power supplies, vacuum pumps, and beam position monitors.

Physical I/O points in EPICS are mapped to "process variables." Each of these process variables has parameters associated with it which define display and alarm parameters as well as the actual value of the process variable. These parameters are called fields. A collection of process variables in EPICS is referred to as a "database." The database is loaded into the IOC associated with the physical I/O point hardware. Process variable fields are available to other IOCs and OPIs via a communication protocol called channel access [3].

It is clear that the initial step in interfacing the Johnson Controls Metasys System to EPICS is to provide the requisite hardware and software links so that the Metasys object parameters could be mapped to EPICS process variable fields.

THE METASYS NETWORK PORT

The Metasys network port is a device which allows monitoring and controlling of the Metasys Facilities Management System from a third-party computer system. The network port emulates an Allen-Bradley PLC-5 and will exchange FMS data with a system that communicates with Allen-Bradley PLC-5 Word Range Read, Word Range Write, and Read-Modify-Write commands [2].

The network port must be actively programmed to map Metasys objects to the Allen-Bradley PLC-5 syntax. Up to 800 analog Metasys objects may be assigned to the PLC-5 syntax F8:0 - F8:799. Only the present value parameter of an analog object is available in four-byte analog words. Up to 3200 binary Metasys objects may be assigned to the PLC-5 syntax B3:800 - B3:3999. Binary Metasys object information is available in two-byte binary words. Individual bits of this binary word can be parsed to read such binary object parameters as present value and the status parameters: on-line / off-line, defined / undefined, and reliable / unreliable status. Status parameters for analog objects are available for F8:0 - F8:799 from B3:4000 - B3:4799, respectively. The present values of these binary objects are meaningless [2].

The active programming of the network port is accomplished with the Metasys Person Machine Interface (PMI) software. The process involves copying the existing Metasys objects one wishes to monitor from its location in the FMS directory structure of Metasys systems into a directory structure of Metasys systems native to the network port. This can become quite tedious for a large number of Metasys objects and is bound by the finite number of Metasys objects the network port can translate to PLC-5 syntax.

Physically the network port communicates with the Metasys network via ARCNET and appears much like a network control unit as a N1 LAN node. Communication to the PLC-5 system is accomplished via RS232 using the Allen-Bradley Full-Duplex Data Link Layer Protocol (DF/1) at a data rate of 9600 baud.

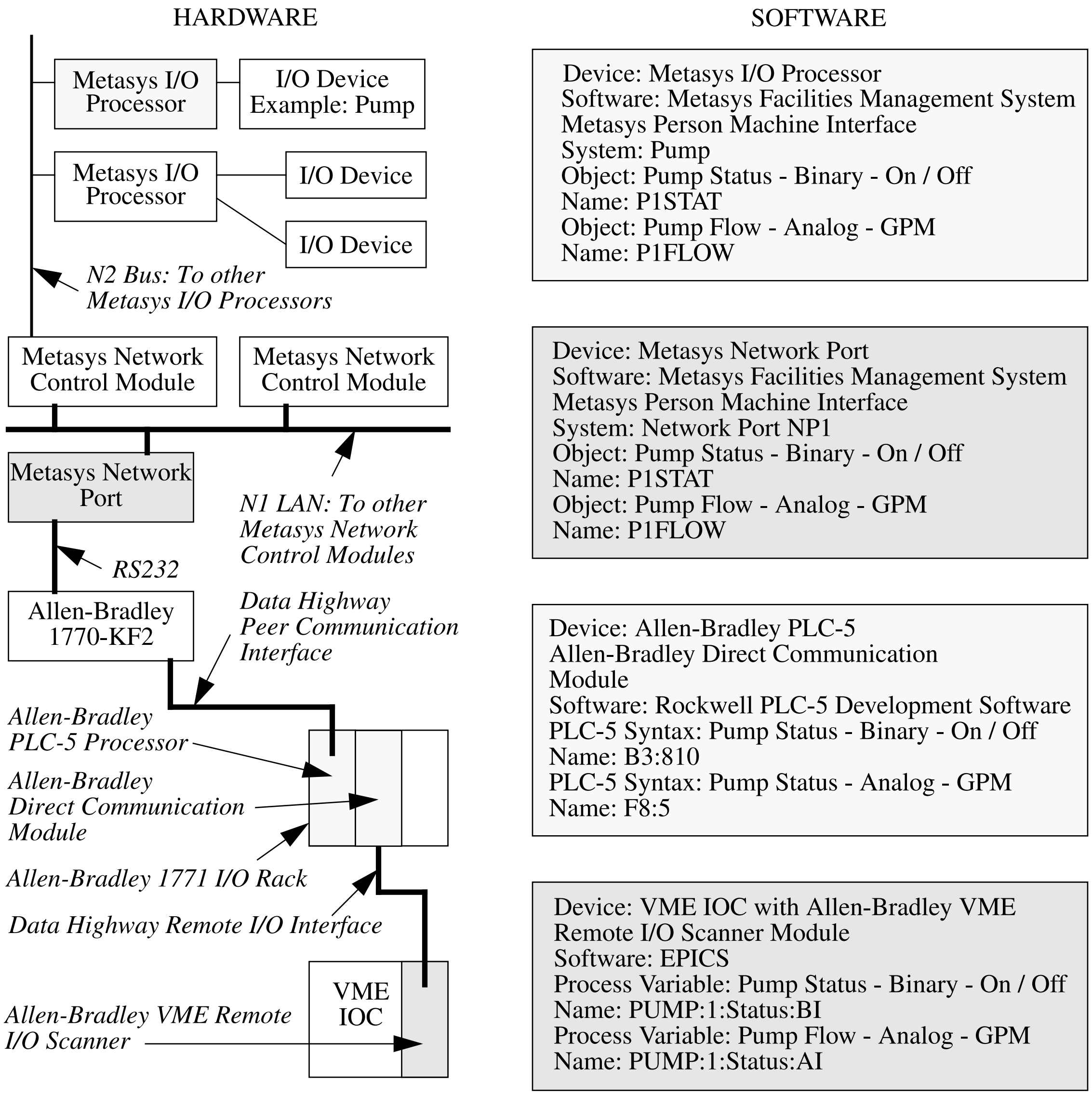
THE PLC-5 LINK TO METASYS

Since the Metasys network port emulates the communication of a PLC-5 and intercommunication between PLC-5 modules is easily accomplished with a Data Highway DF/1 protocol link, a PLC-5 module was programmed so that the data to be monitored from the Metasys network is initially gathered by an Allen-Bradley PLC-5 module. The PLC-5 was placed in a 1771 I/O chassis and connected to the network port. Since the PLC-5 processors communicate via the Allen-Bradley Data Highway and the Metasys network port communicates via an RS232 interface, there was an additional piece of hardware required, the Allen-Bradley 1770 KF2.

THE ALLEN-BRADLEY 1770-KF2

The Allen-Bradley 1770-KF2 module is a passive intelligent device which allows communication between the Allen-Bradley Data Highway and an intelligent asynchronous device programmed to handle the DF/1 communication protocol. Electrically the 1770-KF2 connects to the Allen-Bradley Data Highway in the standard multi-drop configuration, with the Data Highway station number set via DIP switches. Electrical connection to the asynchronous device is via RS232 or RS422, at data rates of up to 9600 baud [4]. The 1770-KF2 was used to electrically connect the Data Highway from the network port to the PLC-5 processor.

FIGURE 1. The METASYS-to-EPICS Link, a Hardware and Software View



THE PLC-5 AS A BRIDGE TO EPICS

In addition to the PLC-5, a 1771-DCM Direct Communication Module also resides in the 1771 I/O chassis. The DCM module provides the communication link to the APS control system with existing EPICS device support [5]. The PLC-5 is programmed with a Rockwell Software PLC-5 Development Software package. This ladder logic program reads the Metasys data which has been syntactically converted to PLC-5 binary (B3) and analog (F8) data representation by the network port via the Data Highway Peer Communication Interface. This data is then block transferred to the 1771-DCM on a time repetitive basis ensuring that the DCM module receives fresh data as read from Metasys. This repetition need only be fast enough to refresh the data every ten seconds. This is due to a time limitation on the N1 LAN data update of the Metasys network port. The DCM is then read over a Data Highway Remote I/O Protocol connection to an EPICS IOC with an Allen-Bradley VMEbus I/O scanner. The data read from the Johnson Controls conventional facilities control system may now be used in EPICS displays, alarm handling applications to warn of impending failures, and data acquisition techniques familiar to operators and accelerator physicists. Currently this interface is configured for read-only access of Metasys data. Modification for the control of

Metasys conventional facilities parameters from EPICS is easily accomplished with changes in the PLC-5 ladder logic program.

SUMMARY

Figure 1 summarizes the network which provides the link between the EPICS-based accelerator control system and the METASYS-based conventional facilities control system at the APS. It is intended that this system will provide a vital link for data acquisition and monitoring so that correlations may be made between accelerator operation and environmental parameters.

ACKNOWEDGMENTS

This work was support by the U.S. Department of Energy, Office of Basic Energy Sciences, under Contract No. W-31-109-ENG-38. Metasys is a registered trademark of Johnson Controls Inc. ARCNET is a registered trademark of Datapoint Corporation. PLC-5 is a registered trademark of Allen-Bradley Corporation.

REFERENCE

[1] Johnson Controls Inc., Metasys Interface Specification, 1994.

[2] Johnson Controls Inc., Metasys Network Technical Manual 636, Network Port Section, Technical Bulletin, 1992.

[3] W. McDowell, M. Knott, F. Lenkszus, M. Kraimer, N. Arnold, R. Daly, “Status and Design of the Advanced Photon Source Control System,” *Proceedings of the 1993 Particle Accelerator Conference,* pp. 1960-1962, 1993.

[4] Allen-Bradley Inc., Allen-Bradley 1770-KF2 Reference Manual, Publication 1784-6.5.3-DU3, 1988.

[5] J. Stein, C. Seaver, G. Nawrocki, M. Kraimer, “Data Exchange from Allen-Bradley PLC-Based Systems to EPICS,” these proceedings.