

THE OPC-BASED SYSTEM AT SNS: AN EPICS SUPPLEMENT*

M. Martinez, R. Wood, ORNL-SNS, Oak Ridge, TN 37830, U.S.A.

Abstract

The Power Monitoring System at the Spallation Neutron Source (SNS) is a Windows-based system using OLE for Process Control (OPC) technology. It is employed as the primary vehicle to monitor the entire SNS Electrical Distribution System. This OPC-based system gathers real-time data, via the system's OPC server, directly from the electrical devices: substations, generators, and Uninterruptible Power Supply (UPS) units. Thereupon, the OPC-EPICS softIOC interface reads and sends the data from the OPC server to EPICS, the primary control system of SNS. This interface provides a scheme for real-time power data to be shared by both systems. Unfortunately, it engenders obscure anomalies that include data inaccuracy and update inconsistency in EPICS. Nevertheless, the OPC system supplements the EPICS system with user-friendly applications—besides the ability to compare real-time and archived data between the two systems—that enable performance monitoring and analysis with ease. The OPC-based system at SNS is a complimentary system to EPICS.

monitoring and engineering tools for analysis of all major components in the SNS electrical distribution system (e.g. substations, emergency generators, UPS units, etc.); and, (2) a single Human Machine Interface (HMI) scheme should be implemented for monitoring each major component and associated subassemblies.

The EPICS system was considered for implementation, but after evaluation, it was determined to require extensive and time-consuming software development for device drivers. With the time constraints on the SNS project, other options were considered. The approved system employed the Cutler-Hammer PowerNet™ system with an OPC-based HMI called ICONICS Genesis.

As SNS moved to the operations phase, the availability of real-time power data at the Central Control Room (CCR) became essential. This motivated the integration of the OPC-based system and the EPICS system. As a result, the OPC-EPICS softIOC was developed and implemented to bridge these two systems.

INTRODUCTION

At the beginning of the SNS project, two baseline requirements were established for the Power Monitoring System: (1) the system should provide real-time

SYSTEM ARCHITECTURE

The Power Monitoring System architecture is illustrated in Fig.1, shown as typical. The Windows server contains the PowerNet and Kepware OPC servers which are the integral part of the system in providing real-time data to OPC clients and to EPICS.

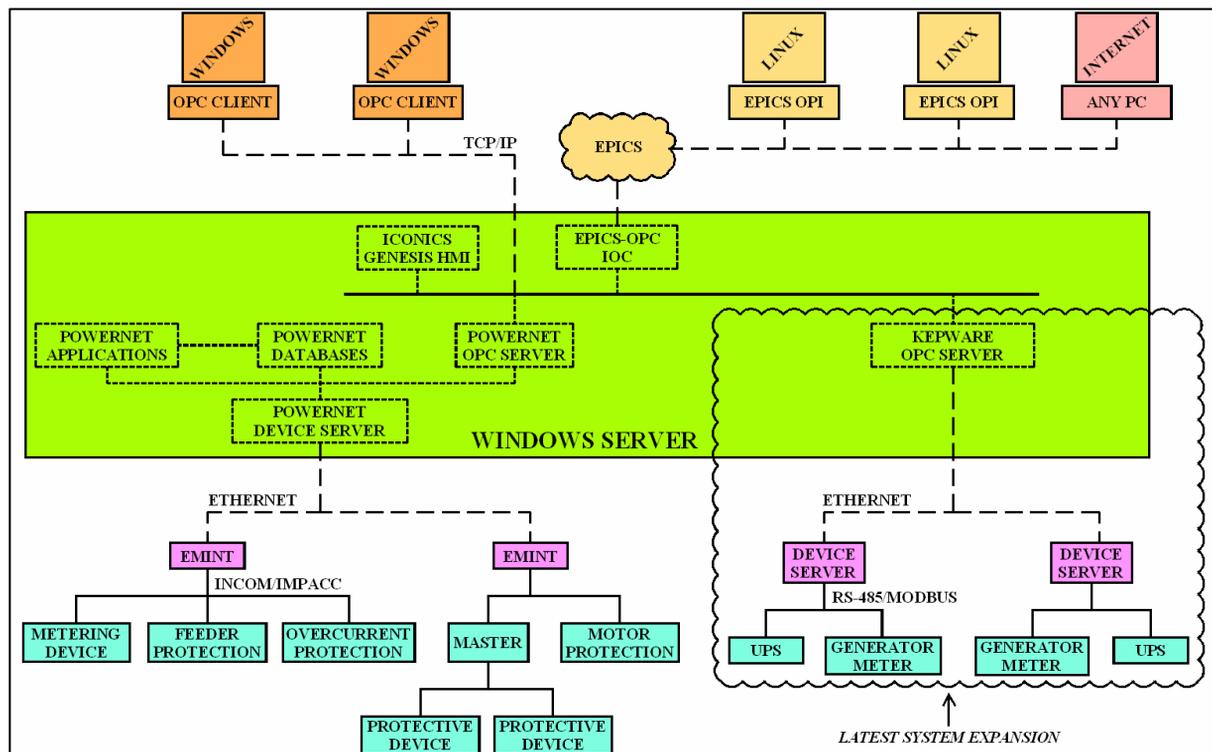


Figure 1: SNS Power Monitoring System Architecture

* Work supported by Oak Ridge National Laboratory for UT-Battelle, LLC, under contract DE-AC05-00OR22725 for the U.S. Department of Energy

The PowerNet/Genesis System

The PowerNet/Genesis system was the original system employed to provide real-time monitoring and analysis tools. It delivered information on electrical distribution devices (e.g. TVA main buses, feeders, substations, and motors). This information could be accessed through Genesis at the server itself or at the OPC clients. The system uses the proprietary PowerNet INCOM (Industrial Communications) network protocol. It is comprised of the following components: IMPACC (Integrated Monitoring Protection and Control Communication) devices which include the metering and protective devices, EMINT (Ethernet master INCOM network translator) as Ethernet interface, PowerNet device server, applications, databases and OPC server, Genesis HMI, and OPC clients [1].

OPC-EPICS Interface

Since EPICS is the primary system for providing data at the CCR, system integrators faced the problem of porting information from the current system into EPICS without any system reconfiguration. With the existence of an OPC-EPICS softIOC already implemented at other facilities, the softIOC was acquired, further developed and customized to meet system requirements and compatibility [2]. After implementation, real-time data on the electrical distribution system became available at the CCR.

UPS and Generators

The UPS units and diesel generators are essential components of the electrical distribution system as they provide emergency power to critical SNS devices during power outages or disturbances. To ensure reliability, these emergency devices had to be monitored as well. The expansion effort to add these devices into the current system started last year. To start monitoring the UPS and generators, the Kepware OPC server was employed to poll real-time data and to make the data available to Genesis and EPICS. The RS-485 network uses Modbus protocol and serial Modbus master/slave operation to access data from the emergency devices where the device server functions as the master, as well as the Ethernet interface. This expansion is ongoing, but there are now nine UPS units and three generators with real-time information at the CCR.

OPC BENEFITS

With the existence of the OPC-based monitoring system, providing real-time electrical data at the CCR with EPICS became possible. The EPICS system could then be integrated without the originally-required extensive development of device drivers for each of the metering and protective devices. The OPC system has been a great benefit in system integration, as well as, monitoring screen development with Genesis GraphWorx™ and historical data plotting with Genesis TrendWorx™. Hence, it is supplementary to EPICS.

System Integration

The use of OPC technology is not only a bridge for EPICS with the proprietary PowerNet system, but also with the recently added subsystem for the UPS and generators. Adding the UPS and generators to the Power Monitoring System was easily integrated into the OPC-based system, although it uses a different communication protocol. Since the expansion conforms with the OPC standard, porting UPS and generator data into EPICS did not require any special effort. The same OPC-EPICS interface was able to be used to connect this subsystem to EPICS.

As the demand for real-time and archived data increases, distinct systems have to be brought together and function as a whole. With the variety of connectivity requirements from one user to another, power monitoring data have been setup to be readily available at the Windows clients, EPICS workstations, and the Internet. Although these data portals have distinct graphical capabilities, the OPC-based Genesis GraphWorx™ application has been used to provide uniform monitoring screens across these portals. Figure 2 shows an Internet monitoring screen with graphics developed in Genesis GraphWorx™.

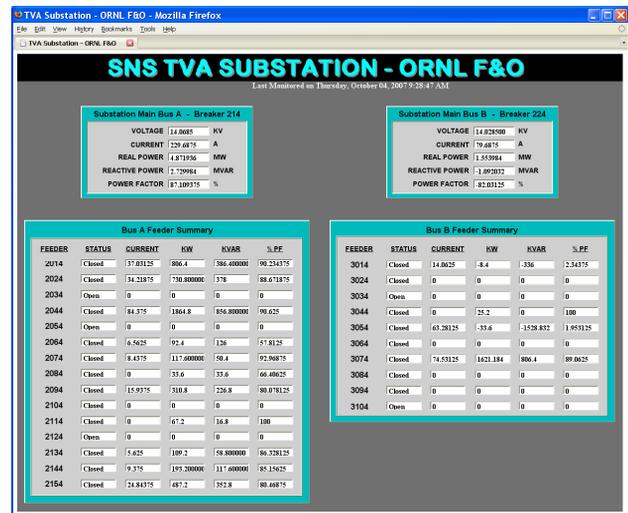


Figure 2: Internet Real-Time Monitoring

Genesis GraphWorx™

GraphWorx is a powerful and user-friendly ICONICS Genesis tool used for the development of excellent graphical interfaces. The Genesis monitoring screens are the primary user interface in accessing real-time data in the OPC-based system. These screens were developed easily and can be reconfigured effortlessly to achieve the best data presentation. Moreover, GraphWorx can readily provide a user-friendly interface.

A sample Genesis monitoring screen is shown in Fig. 3. This recently-developed overview screen will be implemented to monitor all the UPS and generators after all emergency power devices are added to the OPC-based Power Monitoring System.

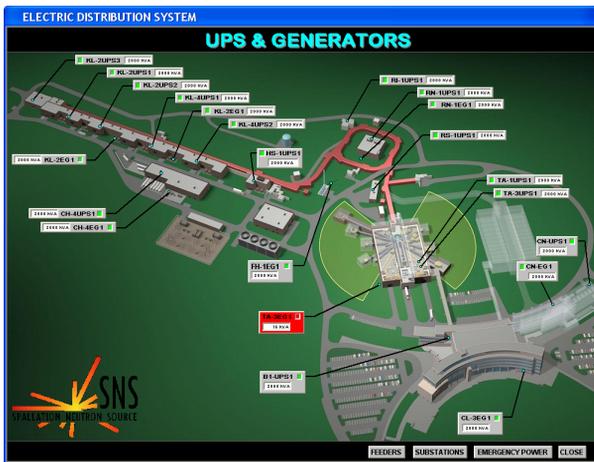


Figure 3: UPS and Generators Overview Screen

Furthermore, the GraphWorx screens were saved to a PNG image format and were utilized in developing the monitoring screens in EPICS and in the Internet. Consequently, monitoring screen development is more efficient while providing uniformity between platforms.

Genesis Trending

The OPC-based system uses the Genesis trending tool, called Genesis TrendWorx™, in plotting both historical and real-time data. The interactive and user-friendly trending screen shown in Fig. 3 was developed and customized using the GraphWorx application with embedded trend view ActiveX control. Plotting is straightforward with the presence of comprehensible menus and buttons located the bottom of the screen. The user is not required to have any prior or current knowledge of the OPC tags associated with any of the pre-determined standard parameters (e.g. current, volts, power, PF, etc.).



Figure 4: Genesis Historical Trending

In EPICS, plotting with the ArchiveViewer requires knowledge of the EPICS process variables (PVs). This is further complicated with the fact that the EPICS power

monitoring PVs do not conform with the SNS naming convention. Hence, the Genesis trending provides satisfaction to users who demand a user-friendly environment.

Aside from delivering user satisfaction, Genesis trending has helped in investigating and solving data inaccuracies and updating inconsistencies in EPICS. For instance, when SNS operators noticed an unexpected instantaneous drop of 3MW on the site total power, the Genesis plots were compared to the EPICS plots during the investigation. As expected, they showed no drop in the site power and instead indicated an error in the EPICS system interface. In other cases, the Genesis plots have been used to help fill the gaps on the ArchiveViewer plots.

CURRENT EFFORTS

The Power Monitoring System requires expansions in different areas. When expansion resumed last year, the emergency power devices were prioritized to be added to the system. Completing the addition of the UPS and generators is one of the current efforts.

Another high priority task is to add accurate alarm specifications to existing PVs in the alarm handler and to add other critical PVs that are now being monitored in the CCR. An alarm system exists in the Windows system, but it is not readily available to operators and the EPICS alarm handler is preferred.

Finally, the SNS operators require better data presentation on the EPICS displays. The current monitoring screens are not very effective in conveying critical information on the electrical distribution system, which sometimes lead to confusion. Hence, providing better monitoring screens at the CCR is another prioritized effort. Genesis GraphWorx™ will be used to create the graphics.

CONCLUSION

The Power Monitoring System will continue to evolve as a useful and reliable system. With the ongoing effort of adding more electrical system devices to EPICS, the OPC-based system will continue to aid in development, testing and event investigations. Aside from providing a more user-friendly environment to Windows users, it is being utilized in making up for current deficiencies in the EPICS power monitoring. Accordingly, the OPC-based system is truly an EPICS supplement.

REFERENCES

- [1] Eaton/Cutler-Hammer, "User's Guide to PowerNet Software Version 3.32 and Greater," <http://www.eaton.com>.
- [2] Personal communication with John Munro Jr., ORNL-SNS, September 2007.