Vol. 11 (2018) *Acta Physica Polonica B Proceedings Supplement* No 4

PERSPECTIVES OF DCS AND SCADA SYSTEMS IN HIGH-ENERGY PHYSICS EXPERIMENTS*

Sebastian Plamowski

Institute of Control and Computation Engineering
Warsaw University of Technology
Nowowiejska 15/19, 00-665 Warszawa, Poland
S.Plamowski@ia.pw.edu.pl

(Received July 23, 2018)

The article presents DCS (Distributed Control System) and SCADA (Supervisory Control And Data Acquisition) systems and software components in the context of using them in physical experiments. The aspects of usability, performance and system security were discussed. It shows the possibilities of communication with other automation systems and the mechanisms of customization for problems in large industrial facilities.

DOI:10.5506/APhysPolBSupp.11.681

1. Introduction

DCS and SCADA systems are widely and successfully used in a lot of industrial applications [1, 2]. They are applied not only to control continues but also discreet processes, starting from very simple systems to huge complex systems with thousands measuring points (such as nuclear power plants, gas transportation systems and many others). High-energy Physics experiments can be treated as an industrial process with two different types of data. First set of data is Fast Physics Data which has to be recorded with very high resolution. These data can be acquisitioned only by specially dedicated hardware and software. The second type of data is called Slow Control Data and this data describes conditions of process, such as temperature, pressure, gas composition. The Slow Control Process can be treated as an industrial process, where the correctness of these parameters has a very strong impact on the correctness of the physical experiment. It is extremely important, both for safety and the quality of the experiment, to maintain the

* Presented at the II NICA Days 2017 Conference associated with the II Slow Control Warsaw 2017, Warsaw, Poland, November 6–10, 2017.

process values in the required ranges. It is also critical to archive the data accurately in order to properly reconstruct the physical experiment during physical analyses in the future.

The required functionality for control system for Slow Data Process in High-energy Physical experiments fully coincides with the functionality of SCADA systems. This paper shows why commercial SCADA is worth to be considered as a system for High-energy Physics. Author concentrates on the features which can be used to: communicate with other devices, improve system security, reduce the cost of maintenance and improve usability. The new DCS and SCADA system features are presented in the next chapter.

2. SCADA and DCS features

Over the last decade, several new trends can be identified in modern DCS and SCADA systems which have been developed by companies dealing with industrial automation. The main directions are: High Performance HMI, Embedded Simulator, Cybersecurity and Virtualization, Monitoring and Diagnostics as Preventive and Predictive maintenance methods.

2.1. High Performance HMI

Poorly performing HMIs are the main significant factors contributing to major accidents caused by the operator error. A High Performance HMI (HP HMI) is a new technique that defines principles for designing proper process graphics. HP HMI has many advantages, including better abnormal situation detection and response, improved operator situation awareness and reduced training time for new operators [3]. Many industrial companies are working on improving graphics using patterns taken from HP HMI technique.

In contrast to the 80s approach characterized by a large number of colors and strong contrasts, the HP HMI mainly uses shades of gray, and the colors are reserved to inform about abnormal states and are used consistently, effectively and sparingly. Displays are designed in a hierarchy providing progressive exposure of detail. In HP HMI, there are four levels of information. Level 1 provides general view. Level 2 shows part of the process. Level 3 presents process and instrumental diagram details. The last and more detailed is level 4 reserved for details of subsystem and individual sensors. In combination with the consequence of alarming, HP HMI approach makes navigation transparent, which consequently increases the level of security.

2.2. Embedded simulator

One of the company which develops embedded simulator is Emerson, this simulator is embedded in the OVATION DCS system [4]. Ovation-based high-fidelity simulator models are embedded directly into Ovation system *versus* third-party models that run in separate hardware. Single platform for simulation and control provides familiarity with operation, configuration and maintenance activities. Common engineering tools creating simulator models and control system logic eliminate the need for specialized programming knowledge. It establishes a foundation for future technology that enables predictive and prognostic decision making through synchronizing live plant data with simulation. Embedded simulator can be used for: startup and shutdown training, steady-state operation training, control system navigation and familiarization training, malfunctions and abnormal situation training. Basing on the embedded simulator, it is possible to develop procedures for operator and checking "what if" scenario. Embedded simulator enables process optimization, supports knowledge transfer between generations and allows control engineers to develop, test and verify a control system.

2.3. Cyber security and virtualization

Cyber security includes technologies (software and hardware), processes and controls that are designed to protect IT systems, including networks and data from cyber attacks. Cyber security technique reduces the risk of cyber-attacks and protects organization from the unauthorized exploitation of systems, networks and technologies [5]. SCADA and DCS systems can be protected by specialist hardware and software dedicated to protect against cyber-attack.

To improve protection, the hardware can be virtualized. Virtualization is the separation of the operating system from the physical hardware [6]. Virtualization places a thin software layer called the Hypervisor between the operating system and the physical hardware. The Hypervisor presents a complete virtual hardware platform to one or more operating system instances. These are called Virtual Machines. Virtual architecture can be applied to SCADA system, that approach allows to reduce hardware and lifecycle costs, improves deployment and maintenance flexibility and reduces power consumption and heat dissipation.

2.4. Monitoring and diagnostics as preventive and predictive maintenance methods

Monitoring and diagnostics software and hardware are designed to support machinery health management. These specialized modules are developed as an integral part of SCADA systems and deliver information about the state of devices and also support preventive and predictive maintenance methods. It allows to reduce the number of unscheduled downtime, improves availability and performance and provides protection against catastrophic failures. As a result, the protection of people, facilities and the environment is gained. The idea of preventive and predictive maintenance [7] is opposite to the classic approach, where maintenance activity was scheduled basing directly on calendar or runtime hours of machine. As a consequence, the maintenance was scheduled too early or too late, which resulted in losses in the form of unused potential of the machine or an unexpected stoppage. Preventive and predictive maintenance allows to avoid these disadvantages, and schedules the service of the machine more precisely and saves money. Integration with SCADA systems gives full access to SCADA data and tools, and allows to improve efficiently on that solution.

3. Conclusion

The presented possibilities of commercial control systems show a huge potential and also a large disproportion in relation to open source projects [8]. According to the author, the costs related to commercial software licenses will be compensated quite quickly by easier application development and lower costs of maintaining the application and the entire process. An additional advantage is higher security from cyber-attack as well as higher security resulting from lower probability of making a mistake by the operator and the application engineer.

REFERENCES

[1] A. Bagri, R. Netto, D. Jhaveri, *Int. J. Comp. App.* **102**, 1 (2014).
[2] S.A. Boyer, *SCADA Supervisory Control and Data Acquisition*, Instrument Society of America, 2009.
[3] B. Hollifield, E. Habibi, D. Oliver, I. Nimmo, *A Comprehensive Guide to Designing, Implementing and Maintaining Effective HMIs for Industrial Plant Operations*, Plant Automation Services, 2008.
[4] Marketing materials, The Ovation Control System, available at https://www.laurentide.com/wp-content/uploads/2017/09/DCS-Ovation.pdf
[5] E. Colbert, *Cyber-Security of Scada and Other Industrial Control Systems*, Springer International Publishing AG, 2016.
[6] E. Johansson, Virtualization in Control Systems Possibilities and Challenges, available at https://www.sans.org/summit-archives/file/summit-archive-1493741896.pdf
[7] J. Levitt, *Complete Guide to Predictive and Preventive Maintenance*, Industrial Press Inc, 2011.
[8] A. Johnson, Introduction to EPICS, available at https://epics.anl.gov/docs/APS2014/01-Introduction-to-EPICS.pdf