International Journal of Engineering Research and Reviews ISSN 2348-697X (Online)
Vol. 10, Issue 2, pp: (10-13), Month: April - June 2022, Available at: www.researchpublish.com

SCADA Systems Outlook amid Industry 4.0

Wed Hussain Al-Sadah

SCADA Systems Specialist, Communications Operations Department, Saudi Aramco

DOI: https://doi.org/10.5281/zenodo.6475168

Published Date: 21-April-2022

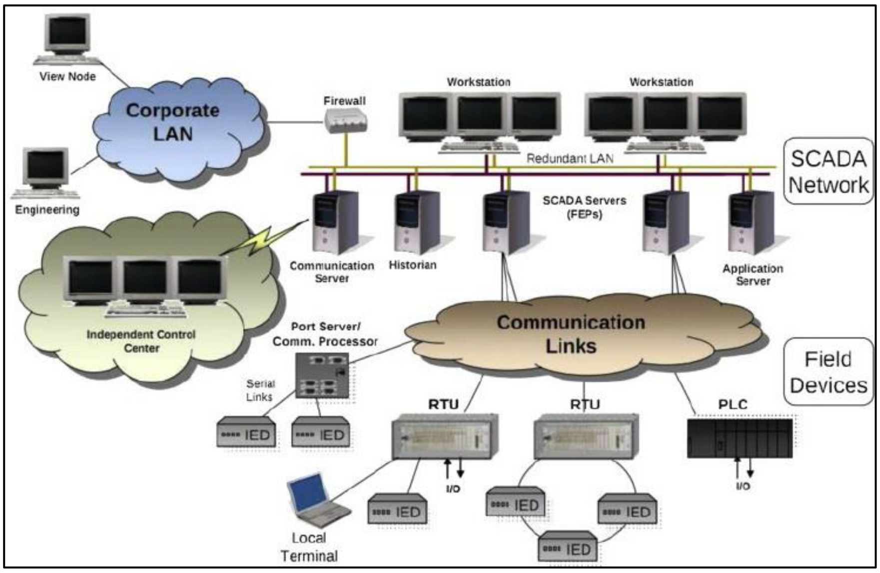
Abstract: **Automation systems are undergoing continuous evolution since their first appearance during Industry 3.0 era. Hardware and software developments are enabling elements for the continuous evolution of both Information Technology and Operations Technology (IT/OT) systems. Several business drivers make such evolution a necessity for the industries to hold a competitive advantage in the marketplace. Industry 4.0 technologies have been emerging at multiple levels of the automation systems, however at slower pace compared to non-industrial IT systems. That is due to the nature and purpose of automation systems, which set these systems at a relatively conservative position. Yet, we have been witnessing several developments in these systems at multiple levels. And the floor is still open for innovative ideas that exploit Industry 4.0 technologies leading to increased efficiency while meeting safety, security and data integrity requirements. The article concludes with a use case study for integrating *Data Analytics*, which is a component of Industry 4.0, in automation systems in order to increase data reliability and to have resilient operation.**

Keywords: **SCADA Systems, Industry 4.0, Data Reliability, Automation Systems.**

1. INTRODUCTION

Background

Supervisory Control And Data Acquisition (SCADA) systems comprise an important element of industrial and manufacturing processes. SCADA is found in industries that vary in applications and physical footprint. Examples are food and beverage and recycling industries, as well as large scale industries, such as oil and gas and electrical power distribution. The SCADA term's first appearance was in the mid-1970s, during the Third Industrial Revolution, where industries witnessed progressive emergence of computer systems and digital technologies, in the context of automation.



Typical SCADA System Architecture. *Picture From: Helge Janicke, "Runtime-Monitoring for Industrial Control Systems," Electronics (ISSN 2079-9292), Vol. 4, 995-1017, 2015.*

Throughout the presence of SCADA systems, they went through several architectural developments. That started with independent systems with no connectivity to other systems, and many of the used technologies were strictly proprietary. As the computer technology evolved, distributed SCADA systems architecture appeared into the picture, where the tasks were distributed among the different components, however with proprietary network protocols. With the use of Networked Architecture, adoption of open and standard LAN and Remote Terminal Unit (RTU) protocols, such as OPC, DNP3, and MODBUS, allowed higher system modularity and cost-effectiveness. The SCADA providers gradually moved from Unix, Linux, and other proprietary platforms into Microsoft Windows platform, which was associated with countless benefits in terms of continuous systems modernization. Web-based SCADA systems established a presence in the early 2000s, which contributed to continuous enhancements to the Graphical User Interface (GUI). Throughout the past 20 years, SCADA system security improvements were a necessity in a world more open to the internet and filled with cybersecurity risks.

Given the aforesaid background about the major architectural developments of SCADA systems, the rest of this article will shed some light on the business drivers influencing future system developments. In addition, it will highlight some of the technology trends shaping the future of automation systems, which result in more and more adoption of Industry 4.0 technologies. Finally, the article will demonstrate some potential developments, via a use case, and highlight some of the implementation challenges.

Business Drivers

Aside from the aforementioned SCADA systems developments; in general, permanent developments are inevitable for industries and manufacturers aiming to hold a competitive advantage and maintain their market share. Today's increased competition is resulting in higher organizations demand towards running at optimal operational levels with less energy and waste. Increasing productivity by reducing manual activities and increasing automation is another objective. Besides increasing profitability, organizations are requiring higher business sustainability via, for example, efficient inventory management and resilient supply-chain. Knowledge preservation is another challenge as the information is one of the organization's assets that needs to be maintained. The rate and magnitude at which data is generated, drives organizations to foster data-centric business models where decisions can be made with higher accuracy and less time.

In light of these business drivers, Industry 4.0 technologies are gaining more importance in industrial organizations, as their implementation and collaboration facilitate meeting these business needs. SCADA system providers are not isolated from this transformation, and have to explore potential use cases and capitalize on the associated benefits of implementing Industry 4.0 technologies.

Technology Trends

Nowadays, various manufacturers producing automation systems, instrumentation, automotive, home security, and household's apparatus are shifting towards manufacturing *digitalized* automation solutions. Those products are equipped with one or more components of Industry 4.0 technologies; such as the *Internet of Things* (IoT), Location Detection, and Smart Sensors.

Industry 4.0 Technologies Components. *Picture From: THE TECHNOLOGY HEADLINES. Industry 4.0 is here: What Should Youth Do to Get Ahead.*

International Journal of Engineering Research and Reviews ISSN 2348-697X (Online)
Vol. 10, Issue 2, pp: (10-13), Month: April - June 2022, Available at: www.researchpublish.com

As mentioned earlier, automation manufacturers are shifting towards manufacturing *digitalized* products, though this shift might be seen as modest by some observers. This slower momentum, compared to that of other less critical industries, is due to several reasons, such as the need to have high product reliability, durability, safety, security, and compatibility with legacy installations and existing infrastructure. Added to those challenges are the need to maintain plant data integrity and confidentiality, where most facilities are conservative when it comes to data sharing with other parties, and as such refrain from accepting remote connections to their systems. As a result, less utilization of the powerful *Cloud Computing* infrastructure, which is one pillar of Industry 4.0 technologies. Another challenge is the handling of the facilities' data, which is often large in size, unstructured, might be of low quality or having missing parts. Exploiting new and innovative business opportunities, and finding feasible use cases are other things that add to the challenges.

During the past few years, we have been observing a tendency in new automation products towards comprising components of Industry 4.0. Virtual Machine (VM) technology was utilized to operate SCADA master servers and operator's Human Machine Interfaces (HMI). And more recently, SCADA solutions over the cloud were commercialized by some automation vendors. In another Industry 4.0 avenue, augmented reality wearables were introduced as a technology that aims to utilize information and expertise in an organization, to help workers perform their tasks safely and more efficiently. Another component is the use of Smart Sensors in manufacturing processes, which paves the road for other Industry 4.0 components, such as the *Industrial Internet of Things* (IIoT) and *Data Analytics*, which are associated with several benefits, such as predictive maintenance, demand forecasting, and lowered maintenance cost. Mobility in SCADA and decentralized control room is another extreme and controversial concept discussed in the automation community; and aside of its pros and cons, it is definitely feasible to implement as far as the technology is concerned.

A Use Case

In the context of exploring the SCADA system capability to adopt *Data Analytics*, which is a component of Industry 4.0, the following question can be raised: Can the SCADA system, by utilizing machine learning techniques, guide the operator during temporary data corruption at some part of the process? To answer this question, a proof of concept was performed in a testing environment in Saudi Aramco OSPAS Operations Coordination Center, in Dhahran. The *test* environment was equipped with a SCADA master station scanning live oil pressure readings from different RTUs along a distance of 640 kilometers of the national network of oil pipelines. Due to the existent correlation among the scanned readings, it was possible to implement a machine learning algorithm, within the SCADA calculation engine, that updates neural network models of each pressure reading. As soon as a fault occurs in a given sensing site, the associated model of the reading can substitute the faulty data with model data estimation. The model data estimation is based on readings received from other relevant parts of the process as well as the model parameter updates prior to the site failure. Those models can, for example, provide guidance to the SCADA operators until the maintenance team restores the failed sensors. This proof of concept, which was patented in the U.S. Patents and Trademarks Office (USPTO) under application number – 16/397344, showed that a SCADA master equipped with *Data Analytics* capabilities can be a game changer in terms of data reliability. With that, the system would either provide actual sensor readings or estimation of those readings, if they are unavailable. Thus, the data reliability would be a function of not only the sensing systems and the communication infrastructure, but also a function of how smart the SCADA master station is.

OSPAS Operations Coordination Center. *Picture From: SAUDI ARAMCO Media Resources.*

2. CONCLUSION

Several use cases can be explored and proofed for validity and implementability. The aforementioned proof of concept is one example of *Data Analytics* use cases that can be explored by SCADA providers, and possibly implemented in new generations of SCADA systems. With the amount of data clustered in control centers, and the progressive development of *Big Data* analytics and algorithms, more opportunities are still available at both the automation and the decision support systems. As the time progresses, more and more Industry 4.0 technologies and services are developing into maturity, and may prove feasibility and acceptance by the end consumer. In the fourth industrial revolution era, modernization of SCADA systems should certainly go beyond increasing the computational throughput and GUI enhancement. New systems are expected to cause a rise in flexibility, efficiency, system intelligence, and the door is always open for new ideas and innovation.

REFERENCES

[1] S. D. Antón, D. Fraunholz, C. Lipps, F. Pohl, M. Zimmermann and H. D. Schotten, "Two decades of SCADA exploitation: A brief history," 2017 IEEE Conference on Application, Information and Network Security (AINS), 2017, pp. 98-104, doi: 10.1109/AINS.2017.8270432.

[2] A. W. Colombo et al., "A 70-Year Industrial Electronics Society Evolution Through Industrial Revolutions: The Rise and Flourishing of Information and Communication Technologies," in IEEE Industrial Electronics Magazine, vol. 15, no. 1, pp. 115-126, March 2021, doi: 10.1109/MIE.2020.3028058.

[3] C. Rameback, "Process automation systems-history and future," EFTA 2003. 2003 IEEE Conference on Emerging Technologies and Factory Automation. Proceedings (Cat. No.03TH8696), 2003, pp. 3-4 vol.1, doi: 10.1109/ETFA.2003.1247680.

[4] L. M. Zawra, H. A. Mansour and N. W. Messiha, "Migration of Legacy Industrial Automation Systems in the Context of Industry 4.0- A Comparative Study," 2019 International Conference on Fourth Industrial Revolution (ICFIR), 2019, pp. 1-7, doi: 10.1109/ICFIR.2019.8894776.

About The Author:

Wed Hussain Al-Sadah is a Systems Specialist in Saudi Aramco's Communications Operations Department, with 20 years of experience in Supervisory Control And Data Acquisition (SCADA) Systems. He holds a Master's degree in Systems Engineering with a focus on Control and Instrumentation from King Fahd University of Petroleum and Minerals (KFUPM). Wed is a member of the Saudi Aramco Process Control Standards Committee and Process Automation Systems Community of Practice. He has participated in several oil and gas and electrical SCADA system projects and system upgrades.