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The Performance Analysis of Optimized Integrated Framework for Smart Grid

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Abstract: ***Supervisory Control and Data Acquisition system are monitoring and controlling system. It focuses on the supervisory level, not the full control permissions. It is gathering real-time data with the help of several kinds of sensors. Internet of Things (IoT) is a three-dimension any time, any place anything connectivity for anything. This paper performing the comparison between the SCADA and optimization framework for smart grid. A power quality model is integrated with the optimization framework. Moreover, this paper focused on the comparison of optimized framework with SCADA.***

Keywords: Automation, IoT, Vulnerability, Data Acquisition, Smart Grid

I. INTRODUCTION

SCADA stands for Supervisory Control and Data Acquisition. The concept of SCADA was introduced in the 20th century. Industries needed to control and monitoring equipment which was installed in remote locations. They would send people to remote locations to operate their equipment. When the computer was introduced and used for industrial control purposes. Supervisory control began very popularly among the utility. The primary objective of the paper is as following: "To analyze the performance of proposed optimized framework for Smart Grid."

II. RELATED WORK

Various research papers and articles are studied keep in mind the comparison between the SCADA and IoT. Some of them are listed below:

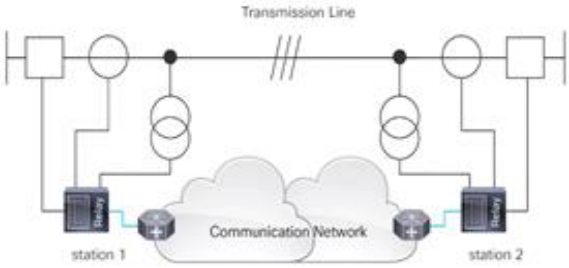

Figure 1: Communication Network [33]

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[1],[2] have performing a comparative analysis and describe their communication protocols. They also pointed out the vulnerabilities of SCADA and IoT. [3] have emphasize on dynamic control and power management. They also try to determine the drawback of the existing system. They also pointed out programming execution, testing and correction of output status of system.

III. SCADA SYSTEM

The term SCADA was introduced firstly in the 1970s. The SCADA was initialized with Remote Terminal Units (RTUs) and Programmable Logic Controllers (PLCs). PLCs and RTUs are microcomputers that could communicate with many same type objects at the same time. It is a system that is able to control, monitor operation and create a log file of all events. SCADA consist of sensors [4],[5],[6],[24],[27] motors, valve, etc. It is widely used in industrial organization. It helps to increase efficiency and process data in smart decisions. This system is used in the Public-Sector Undertakings (PSUs) i.e., energy, oil and gas, transportation, manufacturing, etc. SCADA is not a specific technology; it is a type of pure software or application package which are interacted via hardware and PLCs.

- **Data Acquisition system**

Data Acquisition is the process of retrieves information of equipment which is out of the specified order. In other words, Data Acquisition is a process of measuring a physical quantity or electrical quantity i.e., temperature, current, voltage, sound, etc. using a computer. For measuring such quantity computer needs other hardware/sensors. A computer with software controls the various operations and used for measurement of data, transforming data and processing data. There is various type of application software which offer facilities i.e., analyzing, acquiring, measurement parameter of data. SCADA provides a facility to collect data from various sensors and send them back to the control action [7],[8],[16],[17],[23].

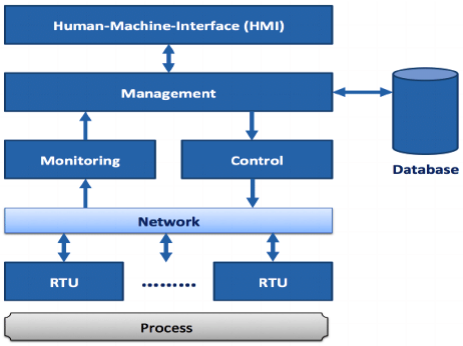

Figure: 2 Architecture of SCADA

Sensors are enlisted below:

Table 1: Sensors used by SCADA

Sr. No	Sensors	Measure Quantity
1.	Strain Gage, Piezoelectric Transducer	Force and Pressure
2.	Potentiometer, LVDT, Optical Encoder	Position and Displacement
3.	Thermocouple, RTD, Thermistor	Temperature
4.	Photo Sensor	Light
5.	Microphone	Sound
6.	pH Electrode	pH

- **Control Mechanism of SCADA**

SCADA system controls the devices with the help of switches. It is controlling automatically but, in some situation, need to handle by human or manual. The SCADA provides the Human-Machine Interface (HMI). HMI display the information which is requested by a human.

IV. INTERNET OF THINGS

The IoT is a collection of various objects/things/modern technologies and working together in the form of a network of devices. The IoT is next industrial revolution which are also known as industry 4.0 [9] [10] [11] [12] [13].

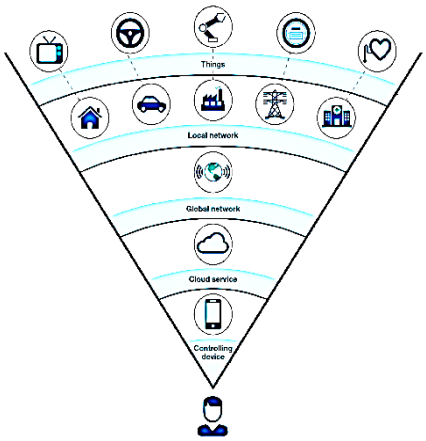

Figure 3: Internet of Things

Sensors and their measuring quantity:

Table: 2 common sensors used by IoT

Sr. No	Sensors	Description
1.	Proximity	Presence of object
2.	Infrared	Detect infrared radiation.
3.	Gyroscope	Angular velocity or angular rate.
4.	Optical	Measure physical quantity of light rays.
5.	Accelerometer	Measurable acceleration

The IoT have also various type of sensors contain the sensing elements. And these sensors are sense the quantity and send them to requested node [14] [15] [16] [17] [18] [19] [20] [21] [22].

- **IoT Energy Monitoring System**

Software: data analysis, prediction, monitoring/reporting, optimization, decision support, event management, remote control, reference semantic model, calculation and analysis of energy performance indicators

Hardware: Meter, DCS/SCADA, data collection and storage, network and IT infrastructure

Platform technology: MES-EMIS interface, wired/wireless field-bus, Demand Management protocol.

Measurement: Energy and production data related to EMU and energy performance indicators should be measured and collected. Since it is important to collect energy data linked to production information, it should be possible to measure energy related to production conditions and operating conditions of facilities.

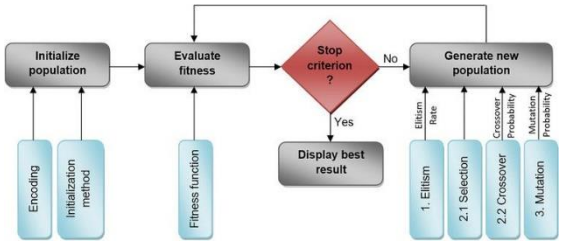

Figure 4: Genetic Algorithm Evaluation Process

Figure 5: Performance Analysis

V. PERFORMANCE ANALYSIS

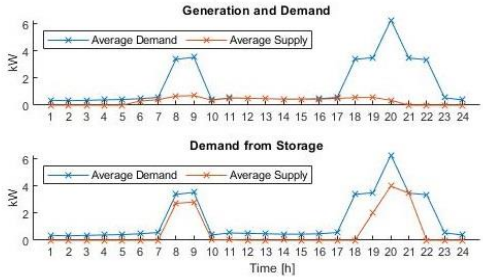

Figure 6: Demand vs Storage with proposed work

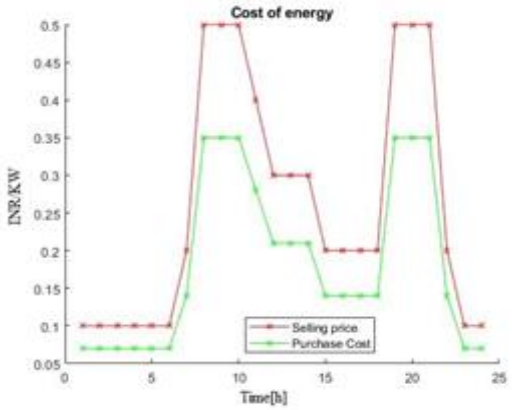

Figure 7: Cost of Energy

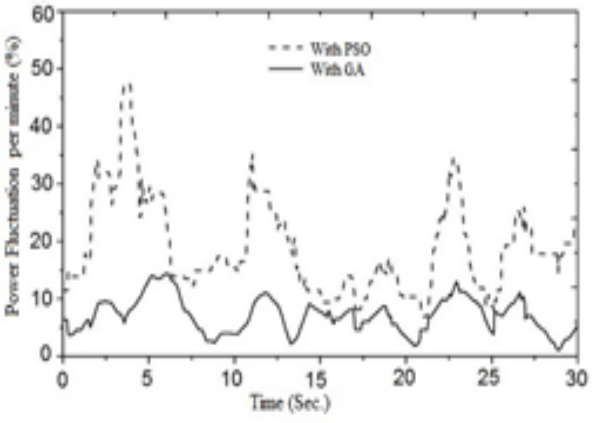

Figure 8: Power Fluctuations

VI. DISCUSSION

The section is analyzed the performance of optimized integrated framework [15]. The cost function is monitoring the cost of energy at different time frame while power fluctuation describes the fluctuation of power w.r.t. algorithm. The overall waveforms already describe the demand, cost, and required compensation task or not.

VII. COMPARISON ANALYSIS

The SCADA and IoT are need to sensors for communication with real time equipment's for data acquisition [7],[22]. The internet of Things is a network of physical devices connected via electronically, software setup, sensors and network connectivity. Both platforms offer an abundance advantage and some vulnerabilities.

Table 3: Required values for Completion compensation task

Node	C in µF	Node	C in µF	Node	C in µF	Node	C in µF
1	0.857962	9	0.185016	17	0.068021	25	0.007005
2	0.858027	10	0.178036	18	0.055893	26	0.007005
3	0.85822	11	0.173218	19	0.043703	27	0.003185
4	0.782009	12	0.130239	20	0.043749	28	0.020772
5	0.61495	13	0.081348	21	0.043541	29	0.014852
6	0.625967	14	0.080126	22	0.015216	30	0.008924
7	0.627969	15	0.078306	23	0.013996	31	0.008926
8	0.619435	16	0.078478	24	0.014007	32	0.00893

Table 4: Comparative Analysis Technology

Sr. No.	Features	IoT	Existing Technology
1.	Scalability	Ability to process any amount of data,	Traditional architecture, Limited users, longer to run reports
2.	Data Analysis	Long term data and supported by machine learning module.	Amount of data is less and no historical data.
3.	Standardization	OPC-UA is used for collect data.	For Data gathering OPC is used.
4.	Interoperability	MQTT protocol for enable communication across devices.	Devices from different manufacturer or different version of software is No supports

For Communication, IoT communicate through internet and another device communicate with each other. The protocol used for communication is MQTT, XMPP, DDS, AMQP. The MQTT protocol is used for collecting devices and communicate with server. SCAD A have many vulnerabilitiesi. Eslow updates, lack of knowledge of devices etc [25] [26] [27] [28] [29] [30] [31] [32] [33] [34].

VIII. CONCLUSION AND FUTURE SCOPE

The study discusses the Supervisory Control and Data Acquisition system and Internet of Things. The study is performed the analysis of performance of optimized framework. The IoT is much faster than SCADA. Moreover, discuss the communication protocol followed by the IoT. The Smart Grid is still in its nascent stage. The whole power community is busy now in understanding and developing smart power grid systems which is a theme of future needs. This paper has written kept in mind, to reveal the vulnerability of SCADA and post implementation reviews of framework, and overcome them to integrate with IoT. If the existing technology is integrated with IoT, the industry is going to the next revolution industry 4.0

REFERENCES

1. Data Acquision, last accessed on 15 june 2019, http://www.ni.com/data-acquisition/what-is/
2. R. Dhobley and A. Chopde, "Comparative Analysis of Traditional SCADA Systems and IOT Implemented SCADA", International Journal of Advance Research, Ideas and Innovations in Technology, volume 3, issue 6, 2017.
3. R. Bhaiswar et al , "Power Management using PLC and SCADA", International Journal of Engineering Innovation &Research Volume 1, Issue 1, ISSN : 2277 – 5668,2012.
4. Last Accessed on 12 july 2021 link: https://www.softwebsolutions.com/resources/scada-system-vs-iot.html
5. Last Accessed on 10 july 2021 link: https://www.softwebsolutions.com/resources/scada-system-vs-iot.html
6. Last Accessed on 11 july 2021 link: https://www.iotnxt.com/2018/07/18/iot-or-scada/
7. Last Accessed on 11 july 2021 link: https://www.finoit.com/blog/sensor-types-used-iot/
8. ASHRAE, "Ventilation for acceptable indoor air quality," Amer. Soc. Heating, Refrigerating Air-Conditioning Eng. Inc, Atlanta, GA, USA, Standard 62.1-2004, 2004.
9. S. Paudyal, C. A. Cañizares, and K. Bhattacharya, "Three-phase distribution OPF in smart grids: Optimality versus computational burden," in Proc. Innov. Smart Grid Technol. Europe, Manchester, U.K., Dec. 2011, pp. 1–7. [CrossRef]

10. S. H. Low, “Convex relaxation of optimal powr flow—Part I: Formulations and equivalence,” IEEE Trans. Control Netw. Syst., vol. 1, no. 1, pp. 15–27, Mar. 2014. [CrossRef]
11. T. Kuruganti and M. Brambley, “Building-to- grid technical opportunity: From the information and communications technology perspective,” DOE Energy Efficiency &Renew. Energy, Washington, DC, USA, Tech. Rep. DOE/EE-1054, Feb. 2016.
12. Ameren. Power Smart Pricing; A Smart Electricity Rate From Ameren Illinois. Accessed on Jun. 3, 2015. [Online]. Available: https://www.powersmartpricing.org/
13. The COMED Residential Real-Time Pricing Program Guide, Commonwealth Edison (ComEd), Chicago, IL, USA. Accessed on Jun. 3, 2015. [Online]. Available: https://www.comed.com/documents/customer-service/ rates-pricing/real-time-pricing/rrtpprogramguide.pdf
14. Z. Wang, “Compensation methods for demand response,” M.S. thesis, Dept. Elect. Comput. Eng., Univ. Kentucky, Lexington, KY, USA, 2015.
15. N. Kumar and G. Singh, “A Novel Algorithm to Improve the Power Quality for the Smart Grid and Integration with the Optimization Framework”. International Journal of Engineering Trends and Technology, 69(9),272-280. DOI: https://ijettjournal.org/archive/ijett-v69i9p233 [CrossRef]
16. Kumar, N., & Singh, G. (2019). Energy Efficient Load Optimization Techniques for Smart Grid with Futuristic Ideas. International Journal of Engineering and Advanced Technology, 9(1), 4327–4331. https://doi.org/10.35940/ijeat.a1778.109119. [CrossRef]
17. Kumar, N., & Singh, G. (2020). [PDF] Load Optimization Framework for Smart Grid: A Systematic Review | Semantic Scholar. http://Www.Ijcstjournal.Org/Volume-8/Issue-5/IJCSTV8I5P7.Pdf
18. Singh, G., Rohil, H., Rishi, R., & Ranga, V. (2019). LETSRP: A Secure Routing Protocol for Manets. International Journal of Engineering and Advanced Technology, 9(1),498–504.https://doi.org/10.35940/ijeat.a9630.109119. [CrossRef]
19. Singh, R., & Gill, N. S. (2020). View of Use of IoT and Machine Learning for Efficient Power Management Through Smart Grid: A Review. IJAST. http://sersc.org/journals/index.php/IJAST/article/view/30681/17037.
20. S. Mohagheghi and N. Raji, "Managing industrial energy intelligently: Demand response scheme," IEEE Industry Applications Magazine, vol. 20, pp. 53-62, 2014. [CrossRef]
21. A. Brooks, E.Lu, D.Reicher, C.Spirakis, and B.Weihl, "Demand dispatch," IEEE Power and Energy Magazine, vol. 8, pp. 20-29, 2010. [CrossRef]
22. Y. M. Ding, S. H. Hong, and X. H. Li, "A demand response energy management scheme for industrial facilities in smart grid," IEEE Transactions on Industrial Informatics, vol. 10, pp. 2257-2269, 2014. [CrossRef]
23. HATTAM, L., & GREETHAM, D. V. (2016). Green neighbourhoods in low voltage networks: measuring impact of electric vehicles and photovoltaics on load profiles. Journal of Modern Power Systems and Clean Energy, 5(1), 105–116. https://doi.org/10.1007/s40565-016-0253-0. [CrossRef]
24. Poghosyan A, Greetham DV, Haben S et al (2015) Long term individual load forecast under different electrical vehicles uptake scenarios. Appl Energy 157:699–709. [CrossRef]
25. Building Energy Data Book. [Online]. Available: http://buildingsdatabook.eren.doe.gov.in(Dec. 10, 2014)
26. M. Maasoumy, M. Razmara, M. Shahbakhti, and A. S. Vincentelli, “Handling model uncertainty in model predictive control for energy efficient buildings,” J. Energy Build., vol. 77, pp. 377–392, Jul. 2014. [CrossRef]
27. S. Privara et al., “Building modeling as a crucial part for building predictive control,” J. Energy Build., vol. 56, pp. 8–22, Jan. 2013. [CrossRef]
28. J. Ma, S. J. Qin, B. Li, and T. Salsbury, “Economic model predictive control for building energy systems,” in Proc. IEEE PES Innov. Smart Grid Technol., 2011, pp. 1–6.
29. M. Pcolka, E. Žá ˇ ceková, R. Robinett, S. ˇ Celikovský, and M. Šebek, ˇ “Economical nonlinear model predictive control for building climate control,” in Proc. Amer. Control Conf. (ACC), Portland, OR, USA, 2014, pp. 418–423. [CrossRef]
30. A. Brooks, E. Lu, D. Reicher, C. Spirakis, and B. Weihl, “Demand dispatch,” IEEE Power Energy Mag., vol. 8, no. 3, pp. 20–29, May/Jun. 2010. [CrossRef]
31. M. C. Bozchalui, S. A. Hashmi, H. Hassen, C. A. Cañizares, and K. Bhattacharya, “Optimal operation of residential energy hubs in smart grids,” IEEE Trans. Smart Grid, vol. 3, no. 4, pp. 1755–1766, Dec. 2012. [CrossRef]
32. S. Shao, M. Pipattanasomporn, and S. Rahman, “Demand response as a load shaping tool in an intelligent grid with electric vehicles,” IEEE Trans. Smart Grid, vol. 2, no. 4, pp. 624–631, Dec. 2011. [CrossRef]
33. Available at https://www.cisco.com/c/dam/en/us/products/collateral/routers/asr-903-series-aggregation-services-routers/datasheet-c78-738338.docx/_jcr_content/renditions/datasheet-c78-738338_7.jpg
34. https://content.iospress.com/openurl.asp?genre=article&issn=1872-4981&volume=13&issue=4&spage=395

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