IJIREEICE
ISSN (O) 2321-2004, ISSN (P) 2321-5526
International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
Impact Factor 8.414 ⫘ Peer-reviewed & Refereed journal ⫘ Vol. 14, Issue 5, May 2026
DOI: 10.17148/IJIREEICE.2026.14504

IoT and SCADA Technology in Power Systems

Badal Vishwakarma[1], Saish Gaikwad[2], Rajitha T.B.[3], Lovely Gaur[4]

Student, Dept. of Electrical Engineering, BVIT, Navi Mumbai, Maharashtra, India[1]

Student, Dept. of Electrical Engineering, BVIT, Navi Mumbai, Maharashtra, India[2]

HOD, Dept. of Electrical Engineering, BVIT, Navi Mumbai, Maharashtra, India[3]

Lecturer, Dept. of Electrical Engineering, BVIT, Navi Mumbai, Maharashtra, India[4]

Abstract: The rapid advancement of digital technologies has transformed traditional power systems into smart grids. IoT and SCADA play a key role by enabling real-time monitoring, automated control, and efficient decision-making. IoT uses connected sensors to collect data, while SCADA provides centralized control and visualization. Together, they improve power system efficiency, reliability, and support sustainable energy management.

Keywords: Internet of Things (IoT), SCADA Systems, Smart Grid, Power System Automation, Real-Time Monitoring, Remote Control Systems, Data Acquisition, Wireless Sensors, Energy Management, Predictive Maintenance, Grid Modernization

1. INTRODUCTION

Power systems form the backbone of modern infrastructure, yet traditional methods suffer from manual monitoring, delayed fault detection, and energy inefficiencies. With growing renewable integration and demand, advanced automation is crucial. SCADA has long enabled remote substation control, while IoT connects devices like smart meters for real-time data exchange. Their synergy creates robust systems for smart grids, supporting predictive maintenance and remote operations—essential for an electrical engineering student targeting power sector roles.

2. STUDY OF IOT & SCADA TECHNOLOGY IN THE POWER SYSTEM

2.1. Overview of IoT and SCADA:- IoT (Internet of Things) refers to a system of connected devices and sensors that communicate with each other through the internet. These devices collect real-time data such as voltage, current, temperature, and energy usage. In power systems, IoT helps in continuous monitoring, smart metering, fault detection, and data analysis. It mainly focuses on data collection and connectivity, making systems smarter and more efficient. SCADA is a centralised system used to monitor and control power systems and industrial processes. It collects data from field devices like sensors and displays it on a control panel (HMI). Operators can use SCADA to analyze data, detect faults, and take corrective actions remotely. It mainly focuses on control, supervision, and decision-making. IoT and SCADA together improve the performance of power systems. IoT collects real-time data from various devices, while SCADA processes and displays this data for monitoring and control. This combination helps in automation, improved efficiency, quick fault detection, and a reliable power supply.

2.2. Need for Smart Grid Technology: - Traditional grids operate in a one-way flow of electricity and lack communication between consumers and suppliers. This leads to energy wastage and poor fault management. Smart grids, on the other hand, use digital communication and automation to manage electricity more efficiently. They allow two-way communication, real-time monitoring, and quick response to faults. Smart grids also help in integrating renewable energy sources like solar, wind, and hydro power, making the system more sustainable and environmentally friendly.

2.3 Components of SCADA. :- SCADA systems consist of several important components:

- **Sensors and Transducers:** These devices measure electrical parameters such as voltage, current, frequency, temperature, and power factor.
- **RTUs (Remote Terminal Units) and PLCs (Programmable Logic Controllers):** These devices collect data from sensors and execute control commands like switching circuit breakers.
- **Communication Networks:** Data is transmitted through wired (fiber optics, Ethernet) or wireless (GSM, microwave) communication systems.
- **HMI (Human Machine Interface):** It provides a visual display of system data, alarms, and trends, allowing operators to make decisions.

DOI: 10.17148/IJIREEICE.2026.14504

These components work together to ensure efficient monitoring and control.

2.4 Working of SCADA in Power Systems:- In a SCADA system, sensors installed in the field collect data continuously. This data is sent to RTUs or PLCs, which process and transmit it to the central control station through communication networks. The HMI displays the data in graphical form, allowing operators to monitor system performance. If any abnormal condition occurs, such as overload or fault, alarms are generated. Operators can then take immediate action, such as isolating faulty sections or restoring power supply. This improves system reliability and reduces downtime.

2.5 Architecture of IoT:- IoT architecture consists of three main layers:

- Perception Layer: This layer includes sensors and devices that collect data from the environment, such as voltage, current, and temperature.
- Network Layer: It is responsible for transmitting data using communication technologies like Wi-Fi, Bluetooth, LoRa, and 5G.
- Application Layer: This layer processes data using cloud computing and analytics tools and presents it in the form of dashboards and reports.

2.6 Human Role of IoT in Power Systems :- IoT plays a significant role in modern power systems by enabling:

- Smart Metering: Helps in real-time monitoring of electricity consumption and billing.
- Fault Detection: Identifies faults quickly and reduces downtime.
- Load Forecasting: Predicts future energy demand using data analytics.
- Renewable Energy Integration: Monitors and manages energy from solar, wind, and hydro sources.

This improves system efficiency and reliability.

2.7 Integration of IoT and SCADA :- The integration of IoT and SCADA creates a powerful system for power system management. IoT devices collect large amounts of real-time data, while SCADA systems process and display this data for decision-making. This integration enables better monitoring, automation, and control of power systems. It also allows remote operation of substations and improves overall system performance.

2.8 Data Flow in IoT-SCADA System:- The data flow process includes:

- Sensors collect real-time data
- RTUs/gateways process the data
- Communication networks transmit the data
- SCADA system receives and displays the data
- Operators analyse the data and take action

This structured data flow ensures quick response and efficient system management.

2.9 Evolution of IoT and SCADA :- Initially, power systems were manually controlled using analog instruments. In the 1960s, SCADA systems were introduced to enable remote monitoring and control. With the advancement of digital technology in the 1980s and 1990s, SCADA systems became more reliable and efficient. In the 2000s, IoT technology emerged with the development of low-cost sensors and internet connectivity. Today, the combination of IoT and SCADA has led to the development of smart grids with advanced automation and analytics.

2.10 Applications in Power Systems :- IoT and SCADA are widely used in:

- Smart Grid Monitoring: Real-time monitoring of power flow and voltage.
- Substation Automation: Remote control of circuit breakers and transformers.
- Renewable Energy Forecasting: Predicting solar and wind energy output.

Fault Detection and Diagnosis: Identifying and resolving faults quickly.

- Energy Management Systems (EMS): Optimizing power generation and consumption.

These applications help in improving efficiency and reducing power losses.

2.11 Advantages of IoT-SCADA: - The integration of IoT and SCADA provides several benefits:

- Improved reliability and system performance.
- Reduction in operational and maintenance costs.
- Real-time monitoring and quick decision-making.
- Predictive maintenance to avoid failures.
- Efficient energy management and reduced power losses.

DOI: 10.17148/IJIREEICE.2026.14504

- Remote access and control of power systems.

3. CHALLENGES AND FUTURE SCOPE

3.1 Challenges:
- Cybersecurity risks due to increased connectivity.
- High initial installation cost.
- Handling large volumes of data.
- Dependence on reliable communication networks.
- Compatibility issues with old system.

3.2 Future Scope:
- Development of fully automated smart grids.
- Better integration of renewable energy sources.
- Advanced predictive maintenance using AI.
- Improved cybersecurity measures.

4. CONCLUSION

The integration of Supervisory Control and Data Acquisition (SCADA), the Internet of Things (IoT), and digitalization technologies in modern power systems, highlights their role in improving operational efficiency, grid reliability and real time decision making

REFERENCES

[1]. G. Clarke, *Practical Modern SCADA Protocols*, Elsevier, 2004.
[2]. S.M.S. Hussain et al., "IoT-based Smart Grid Systems," IEEE Trans. Ind. Inform.
[3]. NPTEL, "SCADA in Power Systems."
[4]. Ahsan Iqbal et al., "IoT-Based SCADA for Generation Forecasting," IJSET, 2025.
[5]. IEEE Power & Energy Society, Smart Grid Overview.