IoT Architecture for Smart Grids

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Abstract

The tremendous advances in information and communications technology (ICT), as well as the embedded systems, have been led to the emergence of the novel concept of the internet of things (IoT). Enjoying IoT-based technologies, many objects and components can be connected to each other through the internet or other modern communicational platforms. Embedded systems which are computing machines for special purposes like those utilized in high-tech devices, smart buildings, aircraft, and vehicles including advanced controllers, sensors, and meters with the ability of information exchange using IT infrastructures. The phrase "internet", in this context, does not exclusively refer to the World Wide Web rather than any type of server-based or peer-to-peer networks. In this study, the application of IoT in smart grids is addressed. Hence, at first, an introduction to the necessity of deployment of IoT in smart grids is presented. Afterwards, the applications of IoT in three levels of generation, transmission, and distribution is proposed. The generation level is composed of applications of IoT in renewable energy resources, wind and solar in particular, thermal generation, and energy storage facilities. The deployment of IoT in transmission level deals with congestion management in power system and guarantees the security of the system. In the distribution level, the implications of IoT in active distribution networks, smart cities, microgrids, smart buildings, and industrial sector are evaluated.

1 Introduction

Internet of things (IoT) refers to an informatics network which connects various objects and elements of a system to each other. In smart grid 2.0, the interactions between supply-sides and demand-side will be mounted utilizing advanced smart metering infrastructures. Internet of things (IoT) refers to an informatics network which connects various objects and elements of a system. The plug play capability denotes the ability to deliver energy even by small-scale generation resources. All technical requirements for power system modernization are classified into four layers. Data analysis layer, application layer, communication and control layer and supervisory control and data acquisition (SCADA) Network layer includes AMI connection networks, internetprotocol-aided networks, and bidirectional wired or wireless communication protocols such as TCP/IP.

2 Summary

2.1 IoT in the generation level

Demandside medium-scale or small-scale distributed generation (DG), also known as virtual power plants sources-or micro, will be widely used in the near future. The integration of a few energy resources such as coal, oil, gas, nuclear, hydro, as well as renewable energy sources can improve the performance of the generation sector. Deployment of IoT at this level can lead to a higher level of efficiency and performance bringing tremendous benefits to power systems.

2.2 Renewable energy resources

Wind technologies are evolving rapidly in term of efficiency and scale. IoT technologies along with ICT infrastructures make the wind farm owners able to conduct accurate predictive maintenance schedules, which prevent incurring huge problems. The use of IoT technologies allows making troubleshooting and conducting on-time maintenance.

2.3 IoT and thermal generation

Thermal power plants are a fundamental part of all power systems at present. These types of units ensure the reliability and resiliency of the grid's operation. In future, it is tried to replace conventional thermal power plants with renewable resources due to environmental concerns. The state of each one must be automatically be recorded and monitored using advanced IoTbased sensors.

2.4 IoT and energy storage facilities

The main obstacle to more deployment of renewable energy resources is their uncertain and intermittent nature. IoT infrastructure can actualize this condition to facilitate the collaborative operation of wind farms or solar parks with gridscale energy storage facilities. Energy storage units can be divided into categories of bulk energy time-shifting, frequency regulation in small-scale, frequency stability in large-scale and power reliability.

2.5 IoT in transmission level

Transmission level is the connector between the generation level and distribution level. Phasor measurement units (PMU) can determine the magnitude and angle of voltage and current at a specific point of the line taking advantage of GPS system for time synchronization. PMU is able to report measurements with a high temporal resolution of about 30-60 measurements per second. These devices can help to have enhanced real-time monitoring on the conductor, insulations, and towers.

2.6 IoT in active distribution networks

The communications network is counted as one of the most crucial parts in AMI systems. It provides a bidirectional, consistent, and secure connection between the servers and data collectors, counters, customers and beneficiary companies. Incorporation of IoT in distribution layer yields tangible benefits such as online supervision on consumption pattern of consumers and intelligent control of generation and consumption of energy.

2.7 IoT in microgrids

IoT-oriented technologies make the operator able to maintain the security of interconnected microgrids. By the implementation of IoT infrastructure, the data corresponded with all microgrid's internal components and microsources can be shared with the upstream grid's operator. This matter will be led to the improvement of power system performance as well as more penetration of renewable energy resources.

2.8 IoT in smart cities, buildings, and homes

Smart city refers to an urban area that takes advantages of different types of IoT sensors and ICT infrastructures to share information which is employed to manage resources and assets efficiently. By incorporating IoT-based communication infrastructure, end-users are able to have more convenient control over many devices and equipment using computer-based interfaces or HMIs such as mobiles and tablets.

2.9 Industrial internet of things (IIoT)

Industries are classified as sensitive loads which demand more reliable electricity supply than residential, commercial, or agricultural consumptions. Various types of loads such as powerelectronic-based devices, induction machines, synchronous motors are vastly used in this sector. The third revolutions imply the incorporation of automation systems in the industries. This terminology refers to the era of digitalization of theenergy sector which represents the deployment of IoT infrastructure in the energy sector.

3 Highlights

- Internet of things (IoT) refers to an informatics network which connects various objects and elements of a system to each other using advanced information and communications technology (ICT) and advanced embedded systems including digitalized sensors, meters, and controllers
- The IoT technologies in generation level deal with the integration of a couple of energy resources such as coal, oil, gas, nuclear, hydro as well as renewable energy sources such as wind, solar, geothermal, and marine-based energies in order to improve the performance of the generation sector and maintain the dynamic and static security of power system
- IoT infrastructure can actualize this condition to facilitate the collaborative operation of wind farms or solar parks with gridscale energy storage facilities, which can boost the profitability of both types of units
- The first section dealt with the implication of IoT in the generation layer
- The incorporation of IoT improves the observability of lines which results in better monitoring of the transmission grid
- The third layer dealt with distribution level

4 Conclusion

IoT helps to conduct better preventive maintenance and fault detection in the generation section. In the transmission layer, the incorporation of IoT improves the observability of lines which results in better monitoring of the transmission grid. This matter results in a more secure operation along with better congestion management in emergencies through automatic IoT-equipped controllers.