

Communication and Security Technologies for Smart Grid

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ABSTRACT

The smart grid is a new paradigm that aims to modernize the legacy power grid. It is based on the integration of ICT technologies, embedded system, sensors, renewable energy and advanced algorithms for management and optimization. The smart grid is a system of systems in which communication technology plays a vital role. Safe operations of the smart grid need a careful design of the communication protocols, cryptographic schemes, and computing technology. In this article, the authors describe current communication technologies, recently proposed algorithms, protocols, and architectures for securing smart grid communication network. They analyzed in a unifying approach the three principles pillars of smart-grid: Sensors, communication technologies, and security. Finally, the authors elaborate open issues in the smart-grid communication network

KEYWORDS

Cyber Security, Information and Communication Technology, SCADA Systems, Sensors, Smart Grid

1. INTRODUCTION

Smart grid is a new paradigm that aims at making the legacy utility grid, efficient, green, reliable and secure. The term was coined in 2007 by the US congress in a bid to modernize the US power grid system (Energy Independence and Security Act of 2007, 2007). As stated in the 2007 Act on energy Independence and Security, a smart grid should have the following ten features: (1) Wide-scale deployment of ICT (Information and communication technologies) to shape-up performance, reliability, and trustworthiness of the utility grid, (2) dynamic optimization of grid operations and resources, (3) integration of effective renewable energy resources, (4) endorsement of advanced demand response scheme, (5) amalgamation of smart technologies for controlling and monitoring the grid operations, (6) consolidation of intelligent appliances, (7) integration of cutting-edge electricity storage and peak-abatement technologies, (8) purveying consumers with timeous information and control options, (9) development of standards for communication and interoperability of appliances and equipment, and (10) battling barriers and obstacles that prevent the adoption of smart grid technologies, practices, and services.

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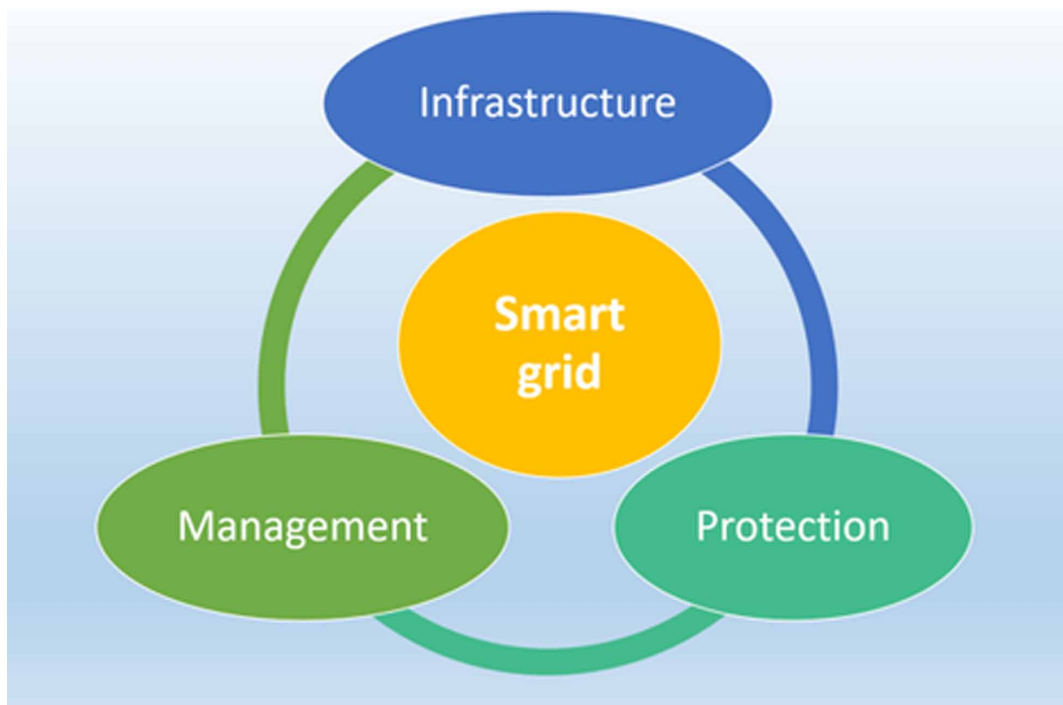
As explained (Korzun & Gurtov, 2015) in (Dutt, Jantsch, & Sarma, 2016) and in (Glesner & Philipp, 2013), smart system should take intelligent decision, has a mechanism for situation awareness, elastic, proactive, etc. The enabling technologies for smart system are determined by the intended functionality. As stated in (Glesner & Philipp, 2013), control and cybersecurity are the cornerstones for smart grid. The recent trend in the process automation is the deployment of sensors for data collection, actuators for control and multi-agent system for solving complex problem.

During recent years, discernible efforts have been put forward to establish a smart grid with the characteristics stated heretofore. A good survey that summarizes the research effort on the permissive technologies for the smart grid until the year 2011 is reported in (Fang, Misra, Xue, & Yang, 2012). The authors reviewed advances in the following three axes: infrastructure, management, and protection. Finally, the researchers digested the omnifarious projects, legislations, programs, standards and trials worldwide in the area of smart grid. Figure 1 elaborates the three essential ingredients in a smart grid.

Communications is a key enabling technology for the smart grid infrastructure. It is believed that the smart grid will integrate multifarious communication technologies like cellular communication, fiber-optic, short-range communication, wireless mesh networks, power-line communication, and satellite communication. The assorted deployment of communication technologies in the smart grid is attributed to factors like the application requirements, the geographic locations, environments, legislations, cost, and so forth. In (Gungor, et al., A Survey on Smart Grid Potential Applications and Communication Requirements, 2013), the authors summarized the communication requirements for fourteen smart grid applications. They further road mapped future smart grid services and applications.

The intensive deployment of communication technologies in the smart grid has precipitated the need for cyber security. The cyber security solution aims to preserve the confidentiality of the consumers, to protect the data against eavesdropping and to prevent embedded systems, used along the smart grid, from running malicious software. The authors of (Yan, Qian, Sharif, & Tipper, 2012)

Figure 1. Smart grid ingredients proposed in (Fang, Misra, Xue, & Yang, 2012)



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