ABSTRACT

A power grid is a network that carries electricity from power plants to customer premises. An existing power grid is passive in terms of remote monitoring, control, consumer participation, demand side management, fault diagnosis, security and real time statistics for stake holders. Moreover, it has failed to eradicate some of the challenges such as theft losses and distribution losses. Aging of coal based power plants and scarcity of primary energy sources are the major challenges to overcome. There is an ample amount of renewable energy resources but intermittent and non-dispatchable nature of energy sources are the major challenges for full-fledged utilization of renewable energy sources.

An existing grid is going through a massive transformation through design and deployment of Smart grid. Smart grid technology is an integration of electrical and ICT infrastructure with bidirectional flow of energy and information. It facilitates real time management of grid statistics for active participation of all stake holders. Smart grid communication infrastructure comprises of hierarchical and heterogeneous standards and technologies for its operation. Diverse set of wireline and wireless technologies can be used for design and implementation of Smart grid networks. Choice of specific standard depends upon various factors such as coverage area, data throughput, interoperability, scalability, bandwidth etc.

Wireless Sensor Network (WSN) is the most fundamental network to implement sensing and communication in Smart grid hierarchical networks. Internet of Things (IoT) is an integral component of Smart grid communication infrastructure as real time management of various hierarchical networks and devices necessitates an interconnection and information exchange between different components of networks. Smart grid communication infrastructure is designed, implemented and validated for home area network. It is designed for Personal Area Network (PAN), Local Area Network (LAN) And Wide Area Network (WAN). A dedicated website is developed for realization of IoT application for Smart grid network.

Advancement in technology also imposes numerous challenges. Smart grid integrates various electrical equipment, electronics devices, power electronics converters,

communication transceivers, renewable energy components etc. which are vulnerable to electromagnetic threats as well as generation of EMI.

Furthermore, Cyber security of Smart grid communication infrastructure is the key challenge for secured and reliable operation of an entire system. WSN security is to be implemented with a paradigm shift as an existing Internet security solutions cannot survive against WSN security threats and vulnerabilities. Smart grid design and deployment requires rigorous design and research endeavors as it is the most challenging and ingenious technology of present era.

The research work includes detailed analysis of architecture and protocols for Smart grid communication network. A comparative analysis of various communication protocols is presented for different Smart grid applications. It is apparent from the results that WLAN is a suitable choice for HAN. WLAN is compatible with wired and wireless backbone technologies such as cellular and Ethernet networks. A local server is created using WLAN. The data on the local server is forwarded to website using port forwarding method. The research work validates the fact that IoT is inevitable for Smart grid communication infrastructure. IEEE 802.11 standard can also be used for NAN applications.

An importance of cross layer optimization for network performance is illustrated and validated using simulation results. Joint parameter optimization has significant impact on network performance as depicted in simulation results.

Cyber security and EMI are the major challenges and threats against reliable operation of Smart grid. These issues must be addressed during deployment and testing of Smart grid network to avoid catastrophic events.