EXECUTIVE SUMMARY

Smart grid is the most revolutionary technology of present era. It is aimed to transform an existing passive grid through integration of electrical and communication infrastructure. This research work includes design, optimization and implementation of secured wireless communication infrastructure for Smart microgrid technology.

Chapter 1 deals with introduction, overview, motivation, research methodology and contribution of this research work. Ageing of coal based power plants and their efficiency issues have become a huge challenge to overcome. Smart grid can effectively address this issue by modernization of power plants. It also expedites the use of renewable energy resources to provide clean energy. Moreover, the problems such as transmission and distribution losses, theft losses, scarcity of primary energy resources etc. can be efficiently solved by deployment of Smart grid technology. High penetration of communication technologies in India is a motivational factor for establishment of Smart grid technology. Theoretical framework of this research work includes analysis of communication standards, architecture of Smart grid technology, challenges, network optimization, EMI hazards and cyber security issues. Experimental work includes development of IoT based monitoring and control of smart power system. The prototype is developed for PAN, LAN and WAN. Network optimization is carried out using Riverbed-OPNET simulation software.

Chapter 2 covers literature review. It includes some of the advanced research endeavors in the field of Smart grid. The gap areas are depicted from literature review.

Chapter 3 covers architecture of Smart grid technology. Smart grid communication infrastructure can be envisioned as a hierarchical network using heterogeneous protocols. It is a layered architecture consisting of HAN, NAN and WAN. Smart grid technology involves an active participation of consumers as they have some decision making privileges such as time of the day usage, use of renewable energy resources, selling an extra energy to grid and taking active part in billing cycle through monitoring and control of home area network. Chapter 3 also includes analysis and comparison of various wired and wireless communication standards. Choice of a specific communication standard

depends on various factors such as bandwidth requirement, type of network, coverage area, type of application etc.

Bandwidth is a scarce resource. Smart grid communication infrastructure requires massive data communication for various applications such as AMI, fault diagnosis and management, security, real time monitoring and control, SCADA, disaster management and recovery, management of renewable energy resources, load management etc. Cognitive radio technology can be used for efficient usage of available spectrum. It facilitates the use of unoccupied spectrum owned by primary users to secondary users.

Chapter 4 covers cross layer optimization of the network. It consists of joint optimization of various network parameters of IEEE 802.11 standard. Cross layer optimization violates the traditional layered approach in which each layer is independent of rest of the layers. Cross layer approach can enhance the network performance through joint optimization. This thesis includes optimization of HAN and NAN using Riverbed-OPNET software.

Chapter 5 covers design and implementation of real time monitoring and control of smart power system. The prototype is developed to validate the concept. It works on IEEE 802.15.1, IEEE 802.11 and IEEE 802.3 standards. The developed prototype works in personal, local and wide area network. The IP address of local server is set as **''192.168.1.177''**. The IoT implementation can be observed on **''smartenergy.dlinkddns.com''.**

Chapter 6 covers issues and challenges of Smart grid operation. Smart grid is a gigantic network comprising of communication transceivers, power electronic devices, high power electrical equipment, renewable energy resources, sensors, actuators etc. Thus it is susceptible to EMI threats. The span of hazardous EMI effects is from malfunction of devices to a catastrophic event. There are diverse causes of EMI such as high power EMI, conducted EMI, radiated EMI and ESD. Electromagnetic compatibility of devices can be assessed to ensure the safe and reliable operation of Smart grid network. ICT infrastructure of Smart grid comprises of various hierarchical networks. These networks are vulnerable to cyber-attacks. Moreover, it comprises of WSNs which are the most vulnerable components of Smart grid network. WSN has limited computational and

storage capabilities. They are located at random places in massive quantity. So, the sensor nodes are highly vulnerable to cyber-attacks. This chapter also presents a brief illustration of standardization activities.

Chapter 7 includes a concluding part. A suggestive framework for future research is also depicted in this chapter.