Name of the Scholar: **IKBAL ALI**

Name of the Supervisor: **Prof. Mini S. Thomas**

Department: Electrical Engineering, Faculty of Engineering & Technology

Title of the Thesis: *"Investigation and Design of the Communication Requirements for SCADA/EMS based Automated Collection and Analysis of IEDs Data"*

Abstract:

The thrust area of research work for this Ph.D. thesis is the investigation and design of the communication requirements for supporting the functions of a substation automation system. These are categorized as operational, administrative and maintenance functions. The real-time and reliable support for these functions in any utility's Substation Automation System (SAS) is a tool to give the utility a competitive edge.

In the deregulated and re-structured environment of the power industry, accurate and timely information is the key to secure operation, profitability, customer retention, market advantage, and growth for the power industry. The operational and commercial needs of the power industry require information systems not only to perform traditional functions but also to support many of the new functions, specifically to meet the needs of competition with deregulation. In recent years, increased emphasis has been given to the reliability of the electric power supply. Major changes in the utility industry, primarily initiated by restructuring and de-regulation, have increased interest in economical and reliable methods to operate the utility and for the transmission of power. With the advancement of Supervisory Control And Data Acquisition (SCADA) & Energy Management System (EMS), a steady stream of operational data in real time is available, which enables the utility to remotely control and fine tune the system performance. Moreover, advanced automation techniques are becoming possible because of Intelligent Electronic Devices (IEDs) in the substation environment. These IEDs have the capability of a large number of operational as well as non-operational data collection. Utilities in the power industries can have the competitive edge by processing this abundance of data and extracting the relevant information

Substations are the strategic node in the whole power network. A substation consists of a large number of switchgears controlled, supervised, and protected by a Substation Automation System (SAS). Substation Communication Network (SCN) Architecture along with communication methods and advanced IT based equipments, used to build SAS, play very crucial role in fast and deterministic

operation of automation functions within substation and hence in maintaining the reliability, availability and survivability of the large, and very complex geographically distributed power network at large.

An extensive literature survey in the thrust area had uncovered the fact that, the existing communication infrastructure being used in electric power substations for the substation automation systems (SAS) are lacking in terms of redundant design, reliability, fault proof architecture and an open and standard framework for communication and application protocols. Hence, much work is required to be done to investigate the communication network infrastructure and communication technologies to be used within the substation. These technologies should support high-speed peer-to-peer data exchange among monitoring, protection and control equipments in a reliable manner.

In this respect, the important contributions of this Ph.D. thesis are as follows:

1. Identification and classification of different substation events data.
2. Evaluation of suitability of Ethernet for SAS applications.
3. Analysis of different possible architectures for Substation communication Network (SCN).
4. Design of a switched Ethernet based fast, reliable and deterministic SCN Architecture.
5. Implementation of the IEC 61850 standards for modeling of the SCN.
6. Demonstration of the use of OPNET modeler as a simulation tool for the performance evaluation of the SCN.
7. Practical implementation and testing of the substation automation schemes using IEC 61850 GOOSE (**G**eneric **O**bject **O**riented **S**ubstation **E**vents) messages.