CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION

The smart grid delivers the electricity from suppliers to consumers using digital technology with two way communications to control appliances at consumers home to save energy, to reduce cost and increase reliability and transparency. Smart grid integrates the traditionally used power hardware with sensing and monitoring technological issues and communications to improve the grid performance to the utmost level and gives the better services to the consumers.

In this connection, power grid infrastructure is very critical and made with heterogeneous interconnected combination of elements like power transformers, generators and distribution feeders that are geographically spread.

The increasing complexity of demand gives the huge number of geographically spread generators and the side effects caused by variable nature and penetration of renewable energy systems makes it vulnerable and requires specific security mechanism. The current power system does not give better quality of experience and also a centralized system with unidirectional power flows from the power plants.
So the complete handling mechanism was done by central stations and some partial substations when required there it may be mentioned that all the loads are almost passive. So if distributed intelligence is to be provided in local electricity generation, it is reliable, efficient, flexible and economic and also it provides secure power supply and usage.

At this point, some other issues related to the power issues need consideration. Generally, the depletion of fossil fuels increases the cost of energy to extreme level, and worsens the environmental conditions. So an upgrade in the current electrical power system is indispensable to incorporate more distributed energy resources units, such as distributed generation and distributed storage units.

The distributed generation units utilize renewable energy resources such as wind turbines, photo voltaic panels combined heat and power systems. As the distributed energy resource units typically operate at the distributed voltage level and are geographically close to loads, micro grids are developed to interconnect the energy sources and loads in a relatively small area such as a university or industrial area and so on.

Despite the potential benefits of micro grids, monitoring a large number of plug and play distributed energy resource units and loads is a challenging issue. The next generation power grid called as smart grid is an ideal choice that can face this specific challenge.

It is possible to use both wired and wireless networks for the communication infrastructure of the micro grid. If a comparison is made between these two alternatives, the wireless network is better because of the benefits it offers such as higher flexibility and lower deployment cost.
So the smart grid technology is a proven choice for intelligent control of the power consumption with two way wireless communication networks. The performance of the smart grid is relatively based on the customer or consumer satisfaction and it can be variable as Quality of Experience.

The overall benefits can be stated sequentially it enhances improving reliability; improves quality like stable voltages; proves to be more energy efficient, allows two way flow of power and provides dynamic pricing and demand side control. Besides these benefits, an important feature of the smart grid technology is its greater consumer choices.

Under the Energy Independence and Security Act (EISA) of 2007, the National Institute of Standards and Technology (NIST) has introduced a conceptual reference model Bletsas et al (2006). The NIST Conceptual Reference Model is descriptive and is intended to be high-level.

The NIST conceptual Model can serve as a tool for identifying actors and possible communication paths in the Smart Grid. Figure 2.1 below provides a high-level grouping of what the NIST has deemed as the smart grid domain.

The seven domains in the Smart Grid Conceptual Model include: customers, markets, service providers, operations, bulk generation, transmission and distribution. Here QoE driven power scheduling is the most important for smart grid.
All these requirements may maintain the clear analysis and good quality of service. Along with these aspects, the customer satisfaction is also important for the control centers. Otherwise they may quit the system and it can leads to revenue loss. More number of customers also need to be satisfied and should maintain good quality of service here is a question that how to define a specific model in the clear context of smart grid.

Communication is also one of the important key factors for smart grid communication technology. Generally are may find so many wireless technologies with different kinds of complexity and flexibility in regard to the users.
There is an imperative need to study the wireless communication systems because of their importance in the smart grid power management system. Some of the mainly used wireless techniques in today’s world are GSM, GPRS, 3G, WI-Max, PLC and ZigBee. The performance analysis of these networks also should remind one of the most familiar and flexible usage of the service.

In detail explanation and analysis of these communication networks are actually beyond the scope of work. In the next section, a relevant system model with smart meters and related equipment is clearly defined for customer satisfaction and good quality of experience. To begin with, the basic literature surveys of various authors and their proposed experiments needs to be presented.

2.2 LITERATURE SURVEY

Lightner et al (2010) “An Orderly Transition to a Transformed Electricity System,” in September 2001, the U.S. Department of Energy (DOE) sponsored a workshop to develop a roadmap on communication and control technologies for distributed energy resources. From this and subsequent activities with industry, academia, and other research institutions, the concepts and vision of an interactive and adaptable electricity system emerged. A vision is now commonly referred to as smart grid.

Supported by significant federal investment announced in 2009, the DOE, its national laboratories, and industry partners are now making significant strides in smart grid deployments, demonstrations, and research. An imperative underlying these activities is that they contribute to ensuring the steps taken in transitioning toward a smart to grid retain a system with
dependable performance to the economy and society it services. This paper summarizes the status of current smart grid related efforts, explains smart grid priorities, and describes the direction of research and development activities supported by the DOE.

Bose et al (2010) "Smart Transmission Grid Applications and Their Supporting Infrastructure", in this paper the author assumed that the time synchronized measurements will be ubiquitously available at all high-voltage substations at very high rates. The author examined how this information can be utilized more efficiently for real time operation as well as for subsequent decision making. This new information available in real time is different, both in quality and in quantity, from the real time measurements available today.

The promise of new and improved applications to operate the power system more reliably and efficiently has been recognized but it is still in conceptual stages. Also, the present system has been recognized to be inadequate to this real-time data. But even conceptual designs of such infrastructure needed to store and communicate the data are in their infancy. In this paper, the author first suggested the requirements for an information infrastructure to handle ubiquitous phasor measurements recognizing that the quantity and rate of data would make it impossible to store all the data centrally as done today.

De La Ree et al 2010 proposed entitled “Synchronized Phasor Measurement Applications in Power Systems,” Synchronized phasor measurements have become a mature technology with several international manufacturers offering commercial Phasor Measurement Units (PMUs) which meet the prevailing industry standard for synchrophasors.
Installation of PMUs on power transmission networks of most major power systems has become an important current activity. This paper provides a brief introduction to the PMUs and Wide Area Measurement System (WAMS) technology. It discussed the uses of these measurements for improved monitoring, protection and control of power networks.

Rogers et al (2010) "An Authenticated Control Framework for Distributed Voltage Support on the Smart Grid," Existing and forthcoming devices at the residential level have the ability to provide reactive power support. Inverters which connect distributed generation such as solar panels and Pluggable Hybrid Electric Vehicles (PHEVs) to the grid are a few example, such devices are not currently utilized by the power system. The authors have investigated the integration of these end-user reactive-power-capable devices to provide voltage support to the grid via a secure communication infrastructure.

Russell et al (2010) “Intelligent Systems for Improved Reliability and Failure Diagnosis in Distribution Systems," Certain smart grid technologies can reduce the number of customers affected by prolonged outages and thereby increase reliability through automated switching to restore service. Such technologies are useful, but reactive in nature, performing their function only after a fault occurs and an outage has been detected. They must presume that non faulted feeder sections and alternative feeders are healthy and capable of carrying increased power flow.

Requirements for data and computation are substantially greater than for devices like digital relays and power-quality meters, but feasible with modern electronics. This paper provides selected examples of failures that have been predicted by intelligent Distribution Fault Anticipation (DFA)
algorithms. The data requirements and processing analysis to detect these failures are discussed. The problems related to full-scale deployment of the proposed system in a utility-wide application are presented. The authors use experience gained from their long-term research to propose concepts for overcoming these impediments.

Moslehi and Kumar et al (2010) “A Reliability Perspective of the Smart Grid”, increasing complexity of power grids, growing demand, and requirement for greater reliability, security and efficiency as well as environmental and energy sustainability concerns continue to highlight the need for a quantum leap in harnessing communication and information technologies. This leap is widely referred to a smart grid. A framework for cohesive integration of these technologies facilitates convergence of acutely needed standards, and implementation of necessary analytical capabilities. This paper critically reviews the reliability impacts of major smart grid resources such as renewable, demand response, and storage. The authors argue that an ideal mix of these resources leads to a flatter net demand that eventually accentuates reliability challenges further. A grid wide IT architectural framework is presented to meet these challenges while facilitating modern cyber security measures. This architecture supports a multitude of geographically and temporally coordinated hierarchical monitoring and control actions over time scales from milliseconds and upwards.

Armenia et al (2010), A Flexible Phasor Data Concentrator Design Leveraging Existing Software Technologies, Recently, many utility companies have been adding synchrophasor measurement capability to their systems. Synchrophasors can provide operators with additional information about current system state, and they can be used to improve the accuracy of
state estimation. Currently, many transmission operators do not have the ability to process, store, and utilize the data from their own PMUs locally. Instead, they rely on larger data concentrators located elsewhere.

The authors presented a design for a phasor system, called the Flexible Integrated Phasor System (FIPS), to enable a more flexible, lower cost alternative to provide independent system operators and transmission owners ready access to their phasor data. This provides a robust foundation for a variety of smart applications.

Rahimi et al (2010) "Demand Response as a Market Resource under the Smart Grid Paradigm", Demand Response (DR), Distributed Generation (DG) and Distributed Energy Storage (DES) are important ingredients of the emerging smart grid paradigm. For ease of reference, these resources are collectively known as Distributed Energy Resources (DER).

Although some of the DER, emerging under smart grid is targeted at the distribution level, DER and more specifically DR resources, is considered important elements for reliable and economic operation of the transmission system and the wholesale markets.

In fact, viewed from transmission and wholesale operations, sometimes the term virtual power plant is used to refer to these resources. In the context of energy and ancillary service markets facilitated by the Independent System Operators (ISOs) / Regional Transmission Organizations (RTOs), the market products DER/DR can offer may include energy, ancillary services, and/or capacity, depending on the ISO/RTO market design and applicable operational standards. In this paper the authors first explored the
main industry drivers of smart grid and the different facets of DER under the smart grid paradigm.

Metke and Ek (2010) “Security Technology for Smart Grid Networks”, there is virtually universal agreement that it is necessary to upgrade the electric grid to increase the overall system efficiency and reliability. Much of the technology currently in use by the grid is outdated and in many cases unreliable. There have been three major blackouts in the past ten years. The reliance on old technology leads to inefficient systems, costing unnecessary money to the utilities, consumers, and tax payers. The authors in this paper discussed key security technologies for a smart grid system, including public key infrastructures and trusted computing.

Molderink et al (2010) “Management and Control of Domestic Smart Grid Technology”, Emerging new technologies like distributed generation, distributed storage, and demand-side load management will change the way in which is consume and produced. These techniques enable the possibility of reducing the greenhouse effect and improving grid stability by optimizing energy streams. In this paper the authors put forward a three-step control methodology to manage the cooperation among these technologies, focused on domestic energy streams. In this approach, (global) objectives like peak shaving or forming a virtual power plant can be achieved without harming the comfort of residents. As shown in this work, by using good predictions, in advance planning and real-time control of domestic appliances, a better matching of demand and supply can be achieved.

Mohsenian Rad et al “Optimal Residential Load Control with Price Prediction in Real-Time Electricity Pricing Environments”, real-time electricity pricing models can potentially lead to economic and environmental
advantages compared to the current common flat rates. In particular, they can provide end users with the opportunity to reduce their electricity expenditure by responding to pricing that varies with different times of the day.

However, recent studies have revealed that the lack of knowledge among users about how to respond to time-varying prices as well as the lack of effective building automation systems is two major barriers for fully utilizing the potential benefits of real-time pricing tariff. The authors tackled these problems by proposing an optimal and automatic residential energy consumption scheduling framework.

It attempts to achieve a desired trade-off between minimizing the electricity payment and minimizing the waiting time for the operation of each appliance in household in the presence of a real-time pricing tariff combined with inclining block rates. The authors’ design requires minimum effort from the users and is based on simple linear programming computation. Moreover, they argued that any residential load control strategy in real-time electricity pricing environments requires price prediction capabilities.

Pedrasa et al (2011) “Coordinated Scheduling of Residential Distributed Energy Resources to Optimize Smart Home Energy Services”, the authors described algorithmic enhancements to a decision-support tool that residential consumers can utilize to optimize their acquisition of electrical energy services. The decision-support tool optimizes energy services provision by enabling end users to first assign values to desired energy services, and then scheduling their available DER to maximize net benefits.

They had chosen Particle Swarm Optimization (PSO) to solve the corresponding optimization problem because of its straightforward
implementation and demonstrated ability to generate near-optimal schedules within manageable computation times. They improved the basic formulation of cooperative PSO by introducing stochastic repulsion among the particles. The improved DERs schedules are then used to investigate the potential consumer value added by coordinated DERs scheduling.

Yingchen Zhang et al (2005) “Wide Area Frequency monitoring NETwork (FNET) Architecture and Applications”, recent developments in smart grid technology have spawned interest in the use of phasor measurement units to help create a reliable power system transmission and distribution infrastructure. WAMSs utilizing synchrophasor measurements can help with understanding, forecasting, or even controlling the status of power grid stability in real-time. A power system FNET was first proposed in 2001 and was established in 2004. This paper presented some of the latest implementations of FNET applications, which add significant capacities to this system for observing power system problems.

Fangxing Li et al (2010) Smart Transmission Grid: Vision and Framework a modern power grid needs to become smarter in order to provide an affordable, reliable, and sustainable supply of electricity. For these reasons, considerable activity has been carried out in the United States and Europe to formulate and promote a vision for the development of future smart power grids. However, the majority of these activities emphasized only the distribution grid and demand side leaving the big picture of the transmission grid in the context of smart grids unclear. In this paper, the authors presented a unique vision for the future of smart transmission grids in which their major features are identified. In this vision, each smart transmission grid is regarded as an integrated system that functionally consists of three interactive, smart
components, i.e., smart control centers, smart transmission networks, and smart substations.

Ginot et al (2010) “Application of Power Line Communication for Data Transmission over Pulse Width Modulation (PWM) Network”, in industrial applications, a feedback loop is used in order to transmit control and diagnostic information from the motor back to the inverter. The implementation of such feedback loop requires the use of extra cabling between both sides and that may have length exceeding a few hundred meters. In this paper, the motor feeder cable is used for data transmission instead of the separated extra cable by using the Power Line Communication (PLC) technology.

However, besides the fact that feeder cables are not designed for data transmission, they are also polluted by the inverter's outcome. Therefore, PLC modems developed for domestic applications may not be suitable. The aim of this study is to underline the possibility of communicating in such an environment. Limitations and difficulties that obstruct transmission are revealed. Also, possible solutions are discussed such as the use of a pulse width modulation filter in mean to overcome those limitations.

Pei Zhang et al (2010) “Next-Generation Monitoring, Analysis, and Control for the Future Smart Control Center,” this paper proposed a vision of next-generation monitoring, analysis, and control functions for tomorrow's smart power system control centers. It first reviewed the present control center technology and then presents the vision of the next-generation monitoring, analysis, and control functions.
The paper also identified the technology and infrastructure gaps that must be filled, and developed a roadmap to realize the proposed vision. This smart control center vision is expected to be a critical part of the future smart transmission grid.

Podmore et al (2010) “The Role of Simulators for Smart Grid Development”, the implementation of highly realistic real-time, massive, online, multi-time frame simulations is proposed as a means for building a common vision of smart grid functions among politicians, regulators, managers, operators, engineers, and technicians. These massive simulations will include hundreds of participants that play roles of reliability coordinators, transmission operators, distribution operators, power plant operators, and substation operators.

Direct load control of millions of customer appliances is identified as a silver bullet to build self-healing and maximal flow smart grids that can accommodate large penetrations of intermittent wind and solar generation and rapid load growth due to plug-in electric vehicles. The paper recommended that up to 50% of load be controlled with minimal inconvenience to customers to potentially enhance angle, voltage, frequency, and thermal stability. An expert operator decision model is described with a view to helping system developers build operator-centered and friendly smart grid control systems.

Heydt et al (2010) The Next Generation of Power Distribution Systems”, this paper summarizes diverse concepts for the next generation of power distribution system. The objective is to bring distribution engineering more closely aligned to smart grid philosophy. Issues of design, operation, and control are discussed with regard to new system theoretic as well as component/materials advances.
In particular, two transmission engineering techniques are modified for use in distribution engineering: state estimation, and location marginal pricing. The impact of electronic control in distribution systems is discussed. Because education and training have a great impact on distribution engineering, these topics are discussed as well.

Conejo et al (2010) “Real-Time Demand Response Model”, this paper the authors described an optimization model to adjust the hourly load level of a given consumer in response to hourly electricity prices. The objective of the model is to maximize the utility of the consumer subject to a minimum daily energy-consumption level, maximum and minimum hourly load levels, and ramping limits on such load levels. Price uncertainty is modeled through robust optimization techniques. The model materializes into a simple linear programming algorithm that can be easily integrated in the Energy Management System of a household or a small business.

Crider et al (2010) “Reducing Impact of Pulsed Power Loads on Microgrid Power Systems”, Micro grid power systems are becoming increasingly common in a host of applications. In this work, the mitigation of the adverse affects of pulsed-power loads on these systems is considered. In micro grid power systems, pulsed loads are particularly problematic since the total system inertia is finite. Examples include ships and aircraft with high-power radars, pulsed weapons, and electromagnetic launch and recovery systems. In these systems, energy is collected from the system over a finite time period, locally stored, and then rapidly utilized. Herein, a new strategy to accommodate these loads is presented. This strategy is based on identifying the optimal charging profile. Using simulation and experiment, it is shown that the proposed strategy is highly effective in reducing the adverse impact of pulsed-power loads.
Tongdan Jin et al (2010) “Ordering Electricity via Internet and its Potentials for Smart Grid Systems”, the internet has evolved into a ubiquitous communication medium for information exchanges, services requests, and commodity purchasing. This paper proposed the concept, architecture, and the customer incentives for implementing a new demand-side management system called Online Purchase Electricity Now (OPEN). The new system allows customers directly to order electricity via the Internet as if purchasing a book online.

Utility companies, after consolidating the customers' orders, decide an optimal generation and distribution scheme to satisfy customers' demands. The time epoch between the customers' order and the actual generation acts as the lead time during which virtual energy is scheduled for production. Such a virtual energy provisioning system can improve the reliability and stability of the electric grid which is increasingly integrated with distributed energy resources. Bayesian theory, hypothesis testing, and dynamic pricing are employed to justify the feasibility and applicability of the OPEN system.

Wilsun Xu et al (2010) “Power Electronic (PE) Signaling Technology-A New Class of Power Electronics Applications”, the application of power electronics to facilitate the transmission or conversion of electric energy has been well known. This paper presented a different class of power electronic applications and the power electronic circuits are deployed to create small but discernible signals online. The signals are utilized for monitoring power line communication and other information-oriented purposes.

The authors used the term “PE signaling technology” to designate the technologies involved in these applications. The objective of this paper is to survey and review the developments in this fascinating field. Several highly
successful PE signaling technologies and their applications are illustrated. It is believed that signaling-oriented power electronic techniques have many potential applications in power systems and they can be a major source of innovation for the smart grid initiative.

Xian Liu et al (2010) “Economic Load Dispatch Constrained by Wind Power Availability: A Wait-and-See Approach”, in this paper a load dispatch model for the system consisting of both thermal generators and wind turbines is developed. The stochastic wind power is included in the model as a constraint. It is shown that, under certain conditions, the presented model has a set of closed-form solutions. The availability of closed-form solutions is helpful to gain more fundamental insights, such as the impact of a particular parameter on the optimal solution.

Moreover, the feasible ranges of optimal solutions are given in the case that the output power of thermal turbines is restricted. Furthermore, the probability distribution and the average of solutions are derived. This is called the wait-and-see approach in the discipline of stochastic programming. The present work shows that the effects of random wind speed on the generated power can be readily assessed.

Rieken et al (2011) “Ultra Low Frequency Power-Line Communications Using a Resonator Circuit” novel device for the transmission of digital information over power lines is introduced. The transmission circuit is passive, using a resonator circuit to create a narrowband disturbance in the system. This disturbance can be detected over great distances and, in many cases, through distribution transformers.
This makes it a promising solution to power-line communication problems in distribution systems that are sparsely populated over large geographical expanses. Modulation algorithms are introduced. The results obtained are discussed using a prototype to transmit signals on a real distribution system.

Chakrabortty et al (2011) A Measurement-Based Framework for Dynamic Equivalence of Large Power Systems Using Wide-Area Phasor Measurements,” Wide-area analysis and control of large-scale electric power systems are highly dependent on the idea of aggregation. For example, one often hears power system operators mentioning how northern Washington oscillates against southern California in response to various disturbance events. The main question here is whether dynamic electromechanical models can be constructed analytically for these conceptual, aggregated generators representing Washington and California.

These models in reality are some hypothetical combinations of thousands of actual generators. In this paper, the authors addressed this problem, and presented a concise overview of several new results on how to construct simplified inter area models of large power networks by using dynamic measurements available from PMUs installed at specific points on the transmission line.

Borghetti et al (2010) “Synchronized Phasors Monitoring during the Islanding Maneuver of an Active Distribution Network”, the paper describes the performance of a PMU prototype based on a synchrophasor estimation algorithm. It is conceived for the monitoring of active distribution networks, as well as experimental application during some intentional islanding and reconnection tests of an urban medium voltage power network.
With respect to typical applications in transmission networks, the use of PMUs in distribution networks requires very low values of Total Vector Error (TVE), which involves particular low values of phase errors of the synchrophasor estimates.

These requirements are met by a specifically developed PMU, the characteristics and experimental characterization of which are illustrated in the paper. Three of these PMUs have been then used to monitor experimental tests carried out to assess the capability of an urban distribution network to operate autonomously when fed by a local 80 MW combined-cycle power plant. The information provided by the installed PMUs significantly facilitates the operator maneuvers and appears to be useful for the development of an improved control and management system of the active distribution network.

Saele and Grande et al (2011) “Demand Response from Household Customers: Experiences from a Pilot Study in Norway”, this paper presented experiences from a pilot study focusing on daily demand response from households. It utilizes smart metering, remote load control, pricing based on the hourly spot price combined with a time of day network tariff. A token is provided to the customers indicating peak hours. The observed demand response was 1 kWh/h for customers with standard electrical water heaters.

By aggregating this response, the potential for demand response from 50% of Norwegian households can be estimated at 1000 MWh/h (4.2% of registered peak load demand in Norway). A cost-effective realization of this potential should have high focus when considering smart metering technology. From a market perspective, a potential load reduction of this size should be into the day a head market. Demand response to price (the day
after) will not affect the price, but might create imbalances and the need for activating balancing resources, creating additional costs.

Peizhong Yi et al (2011) “Developing ZigBee Deployment Guideline under WiFi Interference for Smart Grid Applications”, Smart grid is an intelligent power generation, distribution, and control system. ZigBee, as a wireless mesh networking scheme is low in cost, power, data rate, and complexity. It is ideal for smart grid applications, e. g. real-time system monitoring, load control, and building automation. Unfortunately, almost all ZigBee channels overlap with Wireless Local Area Network (WLAN) channels, resulting in severe performance degradation due to interference. In this paper, the authors aimed to develop practical ZigBee deployment guideline under the interference of WLAN.

Their proposed scheme is implemented with a Meshnetics ZigBit development kit and its performance is empirically evaluated in terms of the Packet Error Rate (PER) using a ZigBee and Wi-Fi coexistence test bed. It is shown that the empirical results agree with the analytical results. The measurements demonstrate that the design guideline can efficiently mitigate the effect of WiFi interference and enhance the performance of ZigBee networks.

Yinliang Xu et al (2011) “Novel Multiagent Based Load Restoration Algorithm for Microgrids”, once a fault in microgrids has been cleared, it is necessary to restore the un-faulted but out-of-service loads as much as possible in a timely manner. This paper proposed a novel fully distributed multi agent based load restoration algorithm. According to the algorithm, each agent makes synchronized load restoration decision according to discovered information. During the information discovery process, agents
only communicate with their direct neighbors, and the global information is discovered based on the average-consensus theorem.

In this way, the total net power, indexes and demands of loads that are ready for restoration can be obtained. Then the load restoration problem can be modeled and solved using existing algorithms for the 0-1 Knapsack problem. To achieve adaptively and stability, a distributed algorithm for coefficient setting is proposed and compared against existing algorithms and a particle swarm optimization based algorithm. Theoretically, the proposed load restoration algorithm can be applied to systems of any size and structure. Simulation studies with power systems of different scale demonstrate the effectiveness of the proposed algorithm.

Shahraeini et al (2011) “Comparison between Communication Infrastructures of Centralized and Decentralized Wide Area Measurement Systems”, restructuring in power systems has introduced new complexities and difficulties in controlling these systems. Therefore, new control strategies should be investigated during the operation of power systems. On the other hand, Communication Infrastructure (CI) is responsible for establishing any control strategy. The purposes of this study are twofold: firstly, to design a communication infrastructure for any given power network with determined measurements; secondly, to compare communication infrastructures for centralized and decentralized control strategies in power grids.

The comparison criteria are communication network cost, delay (latency), and reliability. In this study, Hybrid State Estimation (HSE), as one of the most important WAMS is opted. Communication infrastructures are designed for two different control strategies: centralized and decentralized (multi-area) HSE. These strategies have been investigated in IEEE 118-bus
test network. Some new concepts that help to compare any two given communication infrastructures with each other, are introduced.

Finally, two designed communication infrastructures for these two strategies are compared with each other. The results show that although communication infrastructure investments are almost the same in both cases, decentralizing, as a cause of decentralized control strategy, results in improvement of latency and reliability of CI.

Dallinger et al (2011) “Vehicle-to-Grid Regulation Reserves based on a Dynamic Simulation of Mobility Behavior”, this study establishes a new approach to analyze the economic impact of Vehicle-to-Grid (V2G) regulation reserves by simulating the restrictions arising from unpredictable mobility requests by vehicle users. A case study for Germany using average daily values (in the following also called the “static” approach) and a dynamic simulation including different mobility patterns are presented.

Comparing the dynamic approach with the static approach reveals a significant difference in the power a vehicle can offer for ancillary services and provides insights into the necessary size of vehicle pools and possible adaptations required in the regulation market to render V2G feasible. In the static approach it is shown that negative secondary control is economically the most beneficial for electric vehicles because it offers the highest potential for charging with “low-priced” energy from negative regulation reserves. A Monte Carlo simulation using stochastic mobility behavior results in a 40% reduction of the power available for regulation compared to the static approach.
Erol Kantarci et al (2011) “Wireless Sensor Networks for Cost-Efficient Residential Energy Management in the Smart Grid”, wireless sensor networks (WSNs) play a key role in the extension of the smart grid towards residential premises, and enable various demand and energy management applications. An efficient demand-supply balance, a reduction in electricity expenses and carbon emissions will be the immediate benefits of these applications. In this paper, the authors evaluated the performance of an in-Home Energy Management (iHEM) application.

The performance of iHEM is compared with an Optimization-based Residential Energy Management (OREM) scheme whose objective is to minimize the energy expenses of the consumers. It is shown that iHEM decreases energy expenses, reduces the contribution of the consumers to the peak load, and reduces the carbon emissions of the household and its savings are close to OREM. On the other hand, iHEM application is more flexible as it allows communication between the controller and the consumer utilizing the Wireless Sensor Home Area Network (WSHAN).

Abe et al (2010) “Digital Grid: Communicative Electrical Grids of the Future”, to support a high penetration of intermittent solar and wind power generation, many regions are planning to add new high capacity transmission lines. These additional transmission lines strengthen grid synchronization, but they will also increase the grid's short circuit capacity. Furthermore they will be very costly. With a highly interconnected grid and variable renewable generation, a small grid failure can easily start cascading outages, resulting in a large scale blackout.

The authors introduced the ‘digital grid,’ where large synchronous grids are divided into smaller segmented grids which are connected
asynchronously, via multiple IP addressed ac/dc/ac converters called digital grid routers. These routers communicate with each other and send power among the segmented grids through existing transmission lines. These lines have been repurposed as digital grid transmission lines. The digital grid can accept high penetration of renewable power, prevent cascading outages, accommodate identifiable tagged electricity flows, record those transactions, and trade electricity as a commodity.

Husheng Li et al (2011) “Communication Requirement for Reliable and Secure State Estimation and Control in Smart Grid”, System state estimation and control are important issues to ensure the stability and reliability of the smart grid system. In this paper, the problem of how to securely estimate the system state and control the smart grid is studied. In the set up studied, the sensor(s) and the controller communicate with each other through a wireless channel subjected to monitoring by an eavesdropper.

The channel capacity requirement that ensures a negligible information leakage to the eavesdropper about the system state and control messages is studied from the information theoretic perspective. Two scenarios with single sensor or multiple sensors are studied. Numerical simulations are used to evaluate the capacity requirement in typical configurations of the smart grid.

Giuliano Andrea Pagani et al (2011) “Towards Decentralization: A Topological Investigation of the Medium and Low Voltage Grids”, the traditional power grid has been designed in a hierarchical fashion, with energy being pushed from the large scale production factories towards the end users. With the increasing availability of micro and medium scale generating facilities, the situation is changing. Many end users can now produce energy
and share it over the power grid. Of course, end users need incentives to do so and want to act in an open decentralized energy market.

In the present work, the authors offered a novel analysis of the medium and low voltage power grids of the North Netherlands using statistical tools from the complex network analysis field. They used a weighted model based on actual grid data and proposed a set of statistical measures to evaluate the adequacy of the current infrastructure for a decentralized energy market.

SuK young Lee et al (2009) “Vertical Handoff Decision Algorithms for Providing Optimized Performance in Heterogeneous Wireless Networks”, there are currently a large variety of wireless access networks, including the emerging Vehicular Ad hoc NETworks (VANETs). A large variety of applications utilizing these networks demand features such as real-time, high-availability, and even instantaneous high-bandwidth in some cases.

Therefore, it is imperative for network service providers to make the best possible use of the combined resources of available heterogeneous networks, (namely WLANs, Universal Mobile Telecommunication Systems, VANETs, Worldwide interoperability for Microwave Access (WiMAX), etc.) for connection support. When connections need to migrate between heterogeneous networks for performance and high-availability reasons, seamless Vertical Hand Off (VHO) is a necessary first step. In the near future, vehicular and other mobile applications will be expected to have seamless VHO among heterogeneous access networks.

Ruonan Zhang et al (2010), Discussed a hybrid reservation/contention-based MAC for video streaming over wireless
networks. To reserve or not for bursty video traffic over wireless access networks has been a long-debated issue. For uplink transmissions in infrastructure-based wireless networks and peer-to-peer transmissions in mesh or ad-hoc networks, reservation can ensure the QoS provisioning at the cost of a lower degree of resource utilization. Contention based MAC protocols are more flexible and efficient in sharing resources by bursty traffic to achieve a higher multiplexing gain. But the performance may degrade severely when the network is congested and collisions occur frequently.

More and more wireless standards adopt a hybrid approach, which allows the coexistence of resource reservation and contention based MAC protocols. However, how to cost-effectively support video traffic using hybrid MAC protocols is still an open issue. In this paper, first we propose how to use hybrid MAC protocols to support video streaming over wireless networks. Then, quantify the performance of video traffic over wireless networks with contention-only, reservation-only, and hybrid MAC protocols, respectively. Admission regions for video streams with these three approaches are obtained.

Sakarindr and Ansari discussed Security services in group communications over wireless infrastructure, mobile ad hoc and wireless sensor networks. Group communication in wireless networks has been facilitating many emerging applications that require packet delivery from one or more sender(s) to multiple receivers. Due to insecure wireless channels, group communications are susceptible to various kinds of attacks. Although a number of proposals have been reported to secure group communication, provisioning security in group communication in wireless networks remains a critical and challenging issue.
This article presented a survey of recent advances in security requirements and services in group communications in three types of wireless networks. It also discussed challenges in designing secure group communication in these networks: wireless infrastructure networks, mobile ad hoc networks, and wireless sensor networks.

Niati et al (2012) “Throughput and Energy Optimization in Wireless Networks: Joint MAC Scheduling and Network Coding”, this paper studied joint scheduling and network coding in wireless multicast networks with independent sources. Designing a network coding solution for wireless networks involves scheduling interference-free transmissions and optimizing a performance measure for the predetermined scheduling sets, followed by constructing network codes for the specific solution. In such a design process, the results of prior steps need to provide enough information to the subsequent steps.

In this paper, the authors formulated a linear optimization problem whose results can be used to design a coding solution. They built their work on previous works and presented statistics that showed the importance of incorporating unequal timeshares in designing network codes. In particular, the authors’ statistics indicated a throughput improvement of about 35% in maximum flow problems and energy savings between 13% and 30%, depending on the network size, in minimum energy problems. They also presented the requirements of code construction algorithms for wireless networks that captured the broadcast property of these networks. They could design proper codes when timeshares are unequal.

Qingwen Liu et al (2006) “A cross-layer scheduling algorithm with QoS support in wireless networks”, scheduling plays an important role in
providing QoS support to multimedia communications in various kinds of wireless networks, including cellular networks, mobile ad hoc networks, and wireless sensor networks. The authors proposed a scheduling algorithm at the MAC layer for multiple connections with diverse QoS requirements. This is where each connection employs an Adaptive Modulation and Coding (AMC) scheme at the physical (PHY) layer over wireless fading channels.

Each connection is assigned a priority, which is updated dynamically based on its channel and service status and the connection with the highest priority is scheduled each time. The authors' scheduler provides diverse QoS guarantee, uses the wireless bandwidth efficiently, and enjoys flexibility, scalability and low implementation complexity. Its performance is evaluated via simulations.

Hamdaoui et al (2010) “Maximum Achievable Throughput in Multiband Multi antenna Wireless Mesh Networks”, recently, a rapidly increasing demand has been witnessed for, and hence, a shortage of, wireless network bandwidth due to rapidly growing wireless services and applications. It is, therefore, important to develop an efficient way of utilizing this limited bandwidth resource. Fortunately, recent technological advances have enabled Software Defined Radios (SDRs) to switch from one frequency band to another at minimum cost, thereby making dynamic multiband access and sharing possible.

On the other hand, recent advances in signal processing combined with those in antenna technology have provided Multiple-Input Multiple-Output (MIMO) capabilities, thereby creating opportunities for enhancing the throughput of wireless networks. Both SDRs and MIMO together enable next-generation wireless networks, such as mesh networks, to support
dynamic and adaptive bandwidth sharing along time, frequency, and space. In this paper, a new framework has been developed which

1. Identifies the limits and potential of SDRs and MIMO in terms of achievable network throughput.

2. Provides guidelines for designers to determine the optimal parameters of wireless mesh networks equipped with multiband and multi antenna capabilities.

Yang Song et al (2010), discussed Minimum energy scheduling in multi-hop wireless networks with retransmissions,” MaxWeight algorithm, aka. Back-pressure algorithm has received much attention as a viable solution for dynamic link scheduling in multi-hop wireless networks. The basic principle of the MaxWeight algorithm is to select a set of interference-free links with the maximum overall link weights in the network, where the link weight is determined by the queue difference between the transmitter and the receiver.

While the throughput-optimality of the MaxWeight algorithm is well-understood in the literature, the energy consumption induced by the MaxWeight algorithm is less studied, which is of great interest in energy-constrained wireless networks such as wireless sensor networks. In this paper, authors put forth a Minimum Energy Scheduling (MES) algorithm for multi-hop wireless networks with stochastic traffic arrivals and time-varying channel conditions. This algorithm is energy optimal in the sense that the proposed MES algorithm can achieve an energy consumption which is arbitrarily close to the global minimum solution.
Moreover, the energy efficiency of the MES algorithm is achieved without losing the throughput-optimality. In other words, the MES algorithm is still throughput optimal whereas the average consumed energy in the network is significantly reduced, as compared to the traditional MaxWeight algorithm. The theoretical results are substantiated via simulations.

Weihong Hu et al (2011) Load Adaptive MAC: A Hybrid MAC Protocol for MIMO, SDR, MANETs. The performance of prevalent wireless MAC protocols is a function of network contention level and the capabilities of the underlying network nodes. While contention based MAC protocols such as Carrier Sense Multiple Access (CSMA) experience significant performance degradation under high contention levels, slot-based MAC protocols such as Time Division Multiple Access (TDMA) perform in the opposite way. In this paper, the authors mooted a hybrid MAC protocol which is referred as Load-Adaptive MAC (LA-MAC) protocol for MANETs formed by a collection of MIMO equipped nodes.

The design of LA-MAC protocol is described and reported on its implementation in a MANET test bed formed by a collection of MIMO Universal Software Radio Peripheral (USRP) Software Defined Radio (SDR) nodes. Through analytical and experimental studies, they compared the performance of LA-MAC with that of CSMA and TDMA under different traffic conditions. The results showed the improvements achieved by LA-MAC in comparison with other alternatives.

detecting unusual events in real time. To provide an alarm signal about an incoming car to a pedestrian using sound or to notify a driver about a pedestrian using infrastructure-to-vehicle communication, the deployed sensor system collects the sensed data from multimodality sensor nodes, performs data fusion, and conducts reactions to avoid the imminent accident.

To evaluate App-MAC, simulation and empirical have been conducted through the TOSSIM simulator using Berkeley TelosB motes with synthesized target recognition events. App-MAC is compared with three state-of-the-art MAC protocols, i.e., Sensor MAC (S-MAC), TDMA, and traffic-adaptive medium access (TRAMA), in terms of the proposed performance metrics, namely, average event delivery latency, event fairness index, channel utilization efficiency, and energy consumption efficiency. The authors found that App-MAC tremendously outperforms the other protocols in this application scenario.

Sangman Moh et al (2011) “A Cooperative Diversity-Based Robust MAC Protocol in Wireless Ad Hoc Networks”, in interference-rich and noisy environment, wireless communication is often hampered by unreliable communication links. Recently, there has been active research on cooperative communication that improves the communication reliability it has a collection of radio terminals transmitting signals in a cooperative way. This paper proposed a MAC algorithm, called Cooperative Diversity MAC (CD-MAC), which exploits the cooperative communication capability of the physical (PHY) layer to improve robustness in wireless ad hoc networks.

For accurate evaluation, this study presents and uses a realistic reception model by taking Bit Error Rate (BER), derived from Intersil HFA3861B radio hardware, and the corresponding Frame Error Rate (FER)
into consideration. System-level simulation study shows that CD-MAC significantly outperforms the original IEEE 802.11 MAC in terms of packet delivery ratio and end-to-end delay.

Wen Tsuen Chen et al (2010) TAMMAC: An Adaptive Multi-Channel MAC Protocol for MANETs, the use of multiple channels in wireless networks could provide performance advantages in reducing collisions and enabling more concurrent transmissions. The authors proposed a multi-channel MAC protocol, which uses a single transceiver and divides the beacon interval into two parts: channel negotiation and data transmission.

However, the fixed length of channel negotiation interval limits the channel utilization. The authors designed a new single transceiver MAC protocol, named Traffic Aware Multichannel Medium Access Control (TAMMAC) that can exploit multiple channels with smart window increase and decrease rules to adjust the contention window size dynamically and properly. The simulation results show that the proposed protocol achieves higher aggregate network throughput than the other schemes under various traffic loads.

Calafate et al (2009) “QoS Support in MANETs: a Modular Architecture Based on the IEEE 802.11e Technology”, providing QoS in wireless ad hoc networks is an intrinsically complex task due to node mobility, distributed channel access, and fading radio signal effects. This goal can be successfully accomplished only through the cooperation of the different protocol layers involved. In this paper authors recommended a novel QoS architecture that is able to support applications with the bandwidth, delay, and jitter requirements in MANET environments.
The architecture is modular, allowing the plugging in of different protocols, which offer great flexibility. Despite its modularity, optimizations have been proposed based on interactions between the MAC, routing, and admission control layers which offer important performance improvements. The proposal is validated in scenarios where different network loads, node mobility degrees, and routing algorithms are tested in order to quantify the benefits offered by the QoS proposal.

In particular, real H.264/AVC video traces have been used to simulate video sources in order to measure the quality in terms of peak signal to noise ratio of the received video, so that the benefits of applying the QoS scheme to video sources can be assessed in terms of user satisfaction.

Ghaboosi et al (2009) “eMAC - A Medium Access Control Protocol for the Next-Generation Ad Hoc Networks”, the standard IEEE 802.11 has been shown to be quite inefficient in multi hop networks. In addition to the hidden-terminal and exposed-terminal problems, there is also an unreachability problem, which may result in link/routing failures and unfairness among multiple traffic flows. In this paper, a MAC protocol, called eMAC, is proposed. Under the proposed scheme, stations maintain Double-Hop Neighborhood (DHN) graphs while exchanging designated e MAC tables to share their knowledge about their neighborhood topology.

The performance of the proposed schemes is evaluated and compared with that of earlier schemes through simulations. Their results showed a performance enhancement due to better handling of unreachability, possible heterogeneous power distributions among contending stations, and mobility issues.
Menouar et al. (2006) “A survey and qualitative analysis of MAC protocols for vehicular ad hoc networks”, in order to avoid transmission collisions in MANET, a reliable and efficient MAC protocol is needed. VANETs have vehicles as network nodes and their main characteristics are high mobility and speed.

Active safety applications for MANETs need to establish reliable communications with minimal transmission collisions. Only a few MAC protocols designed for MANETs can be adapted to efficiently work in MANETs. In this article a short overview is provided on some MANETs and MAC protocols.

Jiawei Xie et al. (2005) “Improving the reliability of IEEE 802.11 broadcast scheme for multicasting in mobile ad hoc networks”, broadcasting is one of the essential communication models of MANETs. Many MANETs multicast routing protocols rely heavily upon MAC layer's broadcast service for data delivery, multicast architecture construction and maintenance.

However, the broadcast mechanism of the IEEE 802.11 standards cannot provide reliable broadcasting support, and therefore, satisfactory performance of the multicast protocols cannot be guaranteed. An extension to IEEE 802.11 broadcast mechanisms, called round-robin acknowledge and retransmit, to address this shortcoming is proposed.

Since it is a different from other mechanisms, a simple and effective acknowledge mechanism is employed in which the lost frames are reported by neighboring nodes in a round-robin style to avoid the notorious ack explosion problem. A MAC layer retransmission scheme is then provided for the lost frames. By varying the traffic load and group size, under the On
Demand Multicast Routing Protocol (ODMRP), extensive simulations show that the proposed scheme provides a highly reliable broadcast service to the routing layer, and ODMRP performance is improved significantly.

Hui Xu et al (2010) “A unified analysis of routing protocols in MANETs”, this paper presented a mathematical framework for the evaluation of the performance of proactive and reactive routing protocols in MANETs. This unified framework provides a parametric view of protocol performance, which in turn provides a deeper insight into protocol operations and reveals the compounding and interacting effects of protocol logic and network parameters.

The parametric model comes from a combinatorial model, where the routing logic is synthesized along with the characterization of MAC performance. Each wireless node is seen independently as a two-customer queue without priority, where the two types of customers are unicast and broadcast packets. The model captures the essential behavior and scalability limits in network size of both classes of routing protocols, and provides valuable guidance on the performance of reactive or proactive routing protocols under various network configurations and mobility conditions.

The analytical results obtained with the proposed model are in close agreement with simulation results obtained from discrete-event Qualnet simulations.

Lili Zhang et al (2004) “Two-phase coding multichannel MAC protocol with MAI mitigation for mobile ad hoc networks”, this introduces a novel multichannel MAC protocol for MANETs based on a scalable two-
phase coding scheme. It eliminates the Hidden Terminal Problem (HTP) without the exchange of neighborhood information.

Furthermore, power control is incorporated to mitigate MAI. Simulation results show that a significant improvement can be achieved by the proposed protocol over IEEE 802.11 DCF.