Evolution in Consumption of High Energy in Smart Grid using Wireless Sensor Network Implementation

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***Abstract*— Energy Efficient Approach for Wireless Sensor Network and its Challenges for Smart Grid Applications. The study of Wireless Sensor Network (WSN) is considered to be one of the most challenging issues of recent research in the field of electronic communication as well as computer application. One of the major problems with the wireless communication sensors reflects an issue related to the high energy consumption against marginal performance in terms of output. A Case Study on Link Reliability and Node Lifetime Evaluations in Power Distribution Systems Recent advances in embedded systems and wireless sensor networks (WSNs) made it possible to realize low-cost monitoring and automation systems for smart grids Sensor networks offer a powerful combination of distributed sensing, computing and communication. They lend themselves to countless applications and, at the same time, offer numerous challenges due to their peculiarities, primarily the stringent energy constraints to which sensing nodes are typically subjected. The distinguishing traits of sensor networks have a direct impact on the hardware design of the nodes at least at four levels: power source, processor, communication hardware, and sensors. In this paper we provide high energy consumption output for smart grids using wireless network.**

Keywords* — WIRELESS SENSOR NETWORK, SMART GRIDE.

I. INTRODUCTION

The complex and nonlinear nature of electric power distribution networks and the increasing electricity consumption in most countries have caused serious network congestion problems in recent years. Existing power distribution networks suffer from the lack of effective fault diagnostics, monitoring, automation, and communications [2]. These factors, together with the overstressed situation, increase the possibility of system breakdowns. As a result of the increasing demands for clean, abundant, and sustainable electric energy together with the above mentioned problems, smart grid concept has emerged. Smart grids are modern electric power grid infrastructures, which provide smooth integration of alternative and renewable energy sources through modern communication and sensing technologies and automated control. The potential benefits of smart grids are numerous and they can be outlined as follows:

1. increased energy consumption information available to consumers,
2. improved physical and operational security and resilience against attacks or disasters,
3. increased energy efficiency,
4. improved reliability and safety,
5. the integration of a higher percentage of renewable energy sources,
6. easy integration of plug-in electric vehicles,
7. a reduction in peak energy demand,
8. Several environmental benefits. Currently, power grids are deployed with a centralized communication infrastructure. All control entities within a utility are directly connected to the energy management system (EMS), which is the main control centre in the power grids. The local control entities cannot communicate with each other directly. In the existing power grids, wide area monitoring and control facilities depend on the data provided by local entities. Hence, flexible
9. Adaptation to new control and automation systems is severely restricted and there is a need for a decentralized and data-centric infrastructure to improve system efficiency.

A Wireless Sensor Networks consists of spatially distributed autonomous sensor nodes to monitor physical, or environment conditions. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance. The more modern networks are bi-directional, also enabling control of sensor activity. The WSN is built of "nodes" – the number of nodes may vary from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery. Sensing, processing and communication are three key elements whose combination in one tiny device gives rise to a vast number of applications [1], [2]. A sensor node might varying size than that of a shoebox to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. Internal power sources In computer networking there is a great value of wireless networking because it has no difficult installation, no more expenditure and has lot of way to save money and time. In the field of wireless networking there is another form of networking, which is called as wireless sensor network. A type of wireless networking which is constructed by number of numerous sensors and they are interlinked or connected with each other for performing the same function collectively or cooperatively for the sake of checking and balancing the environmental factors, this type of networking is called as sensor networking. Basically wireless sensor networking is used for monitoring the physical conditions such as weather conditions, regularity of temperature, different kinds of vibrations and also deals in the field of technology related to sound. Sometimes it is also used in pressure, and also checking the environmental pollutants. These sensors, which are used collectively for performing a function, are distributed spatially otherwise it is difficult for the sensors to perform cooperatively to play a role in monitoring. Scientists develop wireless sensor networking on the bases of inspiration from the application known as battle field surveillance which is completely a military application. As we know that this technology has great importance in the field of computational world and where it has computational importance it also has importance in industry. It is also play an important part in civilian technologies like monitoring of traffic control and many others. A sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument Total working of wireless sensor networking is based on its construction. Sensor network initially consists of small or large nodes called as sensor nodes. These nodes are varying in size and totally depend on the size because different sizes of sensor nodes work efficiently in different fields. Wireless sensor networking have such sensor nodes which are specially designed in such a typical way that they have a micro controller which controls the monitoring, a radio transceiver for generating radio waves, different type of wireless communicating devices and also equipped with an energy source such as battery.

II. DESIGN CHALLENGES OF WSNS IN SMART GRIDS

The major technical challenges for realization of WSN based smart grid applications can be outlined as follows.

1. Resource Limitations of Sensor Nodes. The design and implementation of a WSN is constrained by the hardware resources of sensor nodes due to limited physical size, such as energy, memory, and processing.
2. Harsh Environmental Conditions and Dynamic Topologies. In power distribution environments, the connectivity and topology of the network may vary due to varying wireless link characteristics and node failures. In addition, sensor nodes may be subject to different environmental conditions which may cause sensor nodes to malfunction.
3. QoS Requirements of Smart Grid Applications. Different QoS requirements and specifications in terms of reliability, throughput, and latency are required for different types of existing and envisaged smart grid applications as seen in Table 1.
4. Packet Errors and Variable-Link Capacity. In electric power system environments, due to noisy environment and obstructions, the bandwidth of wireless links depend on the interference level perceived at receivers, and high bit error rates are observed in communication. Therefore, it is very hard to meet QoS requirements in smart grid applications due to the varying characteristics of wireless links. Security. Security is an essential feature in the design of WSN-based smart grid applications in order to provide safe communication by preventing intrusion and denial of service (DoS) attacks.

III. DISCUSSION ON COMMUNICATION PROTOCOLS WITH REGARD TO SMART GRID APPLICATIONS

Considering the requirements of smart grid communications, the communication protocol stack of WSN standards is briefly discussed in this section. The details of these discussions are omitted to comply with the page limitations.

1. Physical Layer. IEEE 802.15.4 operates in the 915 MHz and 2.4 GHz bands with multichannel support. Therefore, it is possible to operate in smart grid environments with heavy interference by selecting the less interfered channel if IEEE-802.15.4 based protocols are preferred. Another advantage of IEEE-802.15.4based protocols over other protocols is better signal to-noise (SNR) ratios due to phase shift keying (PSK) modulations. Additionally, ZigBee avoids the multipath and narrowband interference by using the spread spectrum techniques. ISA-100 networks use channel hopping to increase reliability and minimize interference. All these features help network designers to meet the requirements of WSN-based smart grid applications.
2. Link Layer .Zig Beeand 6LoW PAN use 16-bitchecksums, whereas Z-Wave uses 8-bit checksums to provide reliability. Considering end-to-end delay, ZigBee theoretically provides lower expected latency compared to other protocols. All protocols mentioned in the previous section support acknowledgment and

retransmission mechanisms aiming to improve reliability in harsh environments.

3. Network Layer. Link quality (LQ) metric is an important criterion in smart grid environments with multipath and interference. ZigBee uses the link quality indicator (LQI) offered by IEEE 802.15.4. On the other hand, 6LoWPAN does not require the use of LQI. International Journal of Distributed Sensor Networks Wave is uses a received-signal strength-indicator (RSSI-) based LQ estimator which may not be accurate in some cases due to multipath and interference. Z-Wave does not take into account LQ. In general, LQ-aware routing protocols are preferred to ensure reliability in smart grid.
4. Application Layer. ZigBee, Z-Wave, Wireless HART, and ISA-100 have a set of well-defined attributes, commands for various WSN based smart grid applications. This can be advantageous while deploying WSNs for smart grid applications.

IV. SENSOR NETWORKS AND ITS FEATURES

Now a days WSN are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, habitat monitoring, structural health monitoring, pipeline monitoring, transportation, precision agriculture, supply chain management, and many more. Wireless solutions have other benefits in industrial applications such as enhanced physical mobility, reduced danger of breaking cables, less hassle with connectors and ease of upgrading The WSN is built of "nodes" – the number of nodes may vary from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery. The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding. In flooding method more energy will be consumed by the nodes. This technique is generally used urgent message transfer between the nodes, such as critical failure signals. In routing technique, by adopting proper routing protocol much of the energy of a sensor node can be saved and thus increases the lifetime of a node.

Possible applications of sensor networks are of interest to the most diverse fields. Environmental monitoring, warfare, child education, surveillance, microsurgery, and agriculture are only a few examples. Through joint efforts of the University of California at Berkeley and the College of the Atlantic, environmental monitoring is carried out off the coast of Maine on Great Duck Island by means of a network of Berkeley motes equipped with various sensors [8]. The nodes send their data to a base station which makes them available on the Internet. Since habitat monitoring is rather sensitive to human presence, the deployment of a sensor network provides a noninvasive approach and a remarkable degree of granularity in data acquisition. The same idea lies behind the Pods project at the University of Hawaii at Minoa, where environmental data (air temperature, light, wind, relative humidity and rainfall) are gathered by a network of weather sensors embedded in the communication units deployed in the South-West Rift Zone in Volcanoes National Park on the Big Island of Hawaii. A major concern of the researchers was in this case camouflaging the sensors to make them invisible to curious tourists. Sensor networks can also be used to monitor and study natural phenomena which intrinsically discourage human presence, such as hurricanes and forest fires, to monitor eruptions at an active volcano.

Similarly animal movement can be seen by using a dynamic sensor network has been created by attaching special collars equipped with a low-power GPS system to the necks of animals to monitor their moves and their behavior [10]. Since the network is designed to operate in an infrastructure-free environment, peer-to-peer swaps of information are used to produce redundant databases so that researchers only have to encounter a few desired animals in order to collect the data.

Intel’s Wireless Vineyard is an example of using ubiquitous computing for agricultural monitoring. In this application, the network is expected not only to collect and interpret data, but also to use such data to make decisions aimed at detecting the presence of parasites and enabling the use of the appropriate kind of insecticide. Data collection relies on data mules, small devices carried by people that communicate with the nodes and collect data. In this project, the attention is shifted from reliable information collection to active decision making based on acquired data. Just as they can be used to monitor nature, sensor networks can likewise be used to monitor human behavior. In the Smart Kindergarten project at UCLA, wirelessly-networked, sensor-enhanced toys and other classroom objects supervise the learning process of children and allow unobtrusive monitoring by the teacher. Medical research and healthcare can greatly benefit from sensor networks: vital sign monitoring and accident recognition are the most natural applications. An important issue is the care of the elderly, especially if they are affected by cognitive decline: a network of sensors and actuators could monitor them and even assist them in their daily routine. Smart appliances could help them organize their lives by reminding them of their meals and medications. Sensors can be used to capture vital signs from patients in real-time and relay the data to handheld computers carried by medical personnel, and wearable sensor nodes can store patient data such as identification, history, and treatments. With these ideas in mind, Harvard University is cooperating with the School of Medicine at Boston University to develop Code Blue, an infrastructure designed to support wireless medical sensors, PDAs, PCs, and other devices that may be used to monitor and treat patients in various medical scenario. On the hardware side, the research team has created Vital Dust, a set of devices based on the MICA21 senso node platform (one of the most popular members of the Berkeley motes family), which collect heart rate, oxygen saturation, and

EKG data and relay them over a medium range (100 m) wireless network to a PDA.Interactions between sensor networks and humans are already judged controversial. The US has recently approved the use of a radio-frequency implantable device (VeriChip) on humans, whose intended application is accessing the medical records of a patient in an emergency. Potential future repercussions of this decision have been discussed in the media. An interesting application to civil engineering is the idea of Smart Buildings: wireless sensor and actuator networks integrated within buildings could allow distributed monitoring and control, improving living conditions and reducing the energy consumption, for instance by controlling temperature and air flow,. Military applications are plentiful. An intriguing example is self-healing minefield, a self-organizing sensor network where peer-to-peer communication between anti-tank mines is used to respond to attacks and redistribute the mines in order to heal breaches, complicating the progress of enemy troops. Similarly mine identification can also be done by WSN. Urban warfare is another application that distributed sensing lends itself to. An ensemble of nodes could be deployed in a urban landscape to detect chemical attacks, or track enemy movements. Pint is an ad hoc acoustic sensor network for sniper localization developed at Vanderbilt University. The network detects the muzzle blast and the acoustic shock wave that originate from the sound of gunfire. The arrival times of the acoustic events at different sensor nodes are used to estimate the position of the sniper and send it to the base station with a special data aggregation and routing service.

V. SIMULATION WORK AND RESULTANALYSIS OPNET SIMULATOR

OPNET Modeler accelerates the R&D process for analyzing and designing communication networks, devices, protocols, and applications. We can analyze simulated networks to compare the impact of different technology designs on end-to end behavior. Modeler incorporates a broad suite of protocols and technologies, and includes a development environment to enable modelling of all network types and technologies. OPNET's software environment is called access modeler which is specialized for network research and development. It can be flexibly used to study communication networks, devices, protocols, and applications. Because of the fact of being a commercial software provider, OPNET offers relatively much powerful visual or graphical support for the users. The graphical editor interface can be used to build network topology and entities from the application layer to the physical layer. The parameters can also be adjusted and the experiments can be repeated easily through easy operation through the GUI.

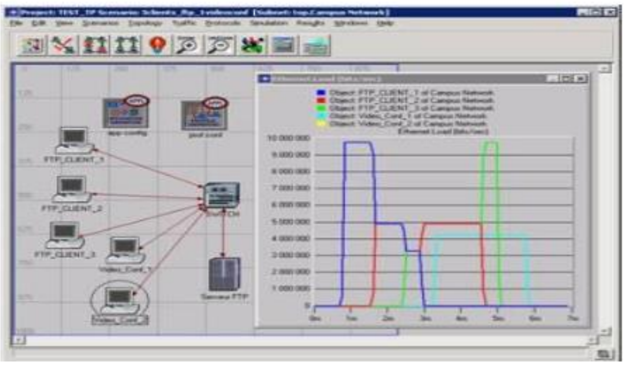

FIGURE 1: OPNET GUI VIEW

OPNET is based on a mechanism called discrete event system which means that the system behavior can simulate by modeling the events in the system in the order of the scenarios the user has set up. Hierarchical structure is used to organize the networks. As other network simulators, OPNET also provides programming tools for users to define the packet format of the protocol. The programming tools are also required to accomplish the tasks of defining the state transition machine, defining network model and the process module. Various result analyses here, we have total 40 mobile nodes dispersed in 100*100 meters area followed by WSN. All the nodes have been supported by mobility feature and there is a Base Station (BS) which is communicated by all nodes to give acknowledgement and take proper response and vice versa.

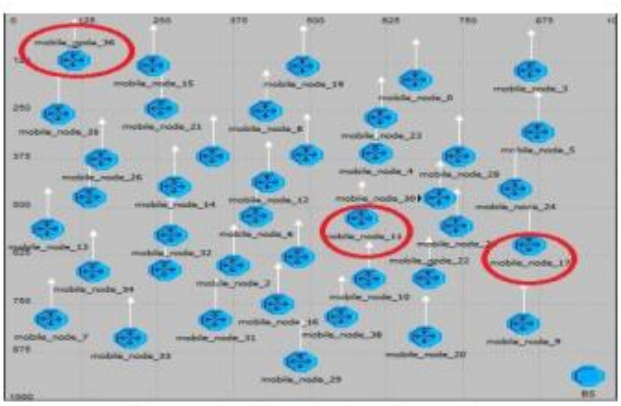

FIGURE 2: SIMULATION SCENARIO

As above we are seeing that node no. 36, 11 and 17 are circled. To observe the energy consumption, we analyze Single and multi-hop for nodes 11, 17, 36 at different distance. We can also view energy consumption of nodes 11, 17 and 36 in single hop by following figure. Where figure 9 for Single hop and figure 10 for multi hop.

VI. CONCLUSION

In this Paper we demonstrate the idea to save the energy in a wireless sensor network for reduction of energy consumption. We are using LEACH protocol on both single and multiple hops (as results shows). OPNET is a good tools to demonstrate our work in fully supported almost feature of IEEE 802.15.4. We are chosen this idea to help in t today's era to reduce global warming like issues. This studied addresses the considerable comparison in single and multi-hop routing strategy for cluster based LEACH protocol. Simulated results are the evidence for multi hop routing strategy is better than single hop routing. Sensor networks offer countless challenges, but their versatility and their broad range of applications are eliciting more and more interest from the research community as well as from industry. Sensor networks have the potential of triggering the next revolution in information technology. The challenges in terms of circuits and systems are numerous: the development of low-power communication hardware, low power microcontrollers, MEMS based sensors and actuators, efficient AD conversion, and energy-scavenging devices is necessary to enhance the potential and the performance of sensor networks. System integration is another major challenge that sensor networks offer to the circuits and systems research community. We believe that CAS can and should have a significant impact in this emerging, exciting area. This paper presents major opportunities and design challenges of WSNs for smart grid applications. WSN-based smart grid applications are introduced, and main WSN standards and communication protocols are discussed for smart grid applications. Importantly, node lifetime and link reliability in wireless sensor networking for smart grid applications have been evaluated through case studies. Overall, this paper explains research challenges resulting from inherent properties of WSNs and smart grid propagation environments. In addition, our experimental studies show that network designers planning to use WSNs for smart grid applications need to consider important sensor node parameters including transmission power, range, and channel parameters. Future work includes the development of cross layer communication protocols to address link-quality variations in smart grid environments, QoS provisioning, and coordinated network management for different application types of smart grid. In addition, in order to prove the advantages of energy harvesting techniques for WSN based smart grid applications, a set of experiments will be conducted and statistical evaluations will be done. A group of field tests will be conducted in a main power room and near a substation. In the same locations, another group of field tests will be conducted to examine the relation between link reliability and node lifetime.

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