INTERNATIONAL JOURNAL OF SCIENTIFIC PROGRESS AND RESEARCH (IJSPR) ISSN: 2349-4689
Volume-17, Number - 03, 2015

A Survey on Energy Efficient Routing Techniques in Wireless Sensor Networks

Jahida Bee[1] & Prof. Nitin Choudhary[2]
[1]M-Tech Research Scholar, [2] HOD & Research Guide Department of Computer Science & Engg.
Kopal Institute of Science & Technology, Bhopal

Abstract- The popularity of WSN has increased enormously in recent time due to growth in Micro-Electro-Mechanical Systems (MEMS) technology. WSN has the potentiality to connect the physical world with the virtual world by forming a network of sensor nodes. Sensor nodes are usually battery-operated devices, and therefore energy saving of sensor nodes is a major design issue. To prolong the network's lifetime, minimization of energy consumption must be implemented at all layers of the network protocol stack starting from the physical to the application layer including cross-layer optimization. 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. The WSN is built of "nodes" – 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 or an embedded form of energy harvesting. In this review paper authors have analyzed WSN in order get energy efficient routing in WSN.

Keywords: - Energy, Efficient, Routing, Wireless Sensor Networks (WSNs).

I. INTRODUCTION

Wireless Sensor Networks (WSNs) are networks that comprise of sensors that are distributed in an ad hoc fashion over a defined geographical area, aimed at sensing some predefined information from the surrounding, processing them and transmitting them to the sink station. The sensors work with one another to capture some physical event. The data assembled is then transformed to get important outcomes. Remote sensor systems comprise of protocols and algorithms with self-arranging capabilities. WSNs can be widely divided into two types-Unstructured WSN and Structured WSN. While Unstructured WSN have a large collection of nodes, put up in an ad-hoc fashion; Structured WSN have few, scarcely distributed nodes with pre-planned deployment. The Unstructured WSNs are difficult to maintain, but it is relatively easy to maintain Structured WSNs.

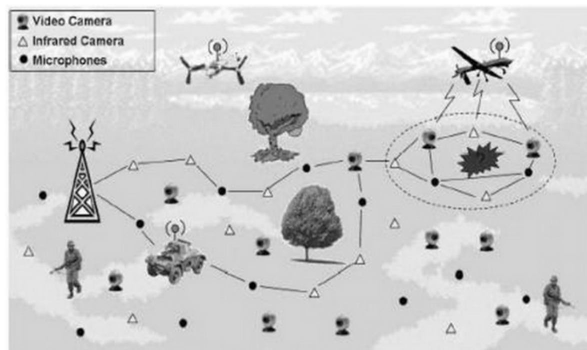

Fig.1. Wireless Sensor Network

Characteristics of a WSN include:

- *Power consumption constraints for nodes using batteries or energy harvesting*
- *Ability to cope with node failures*
- *Mobility of nodes*
- *Heterogeneity of nodes*
- *Scalability to large scale of deployment*
- *Ability to withstand harsh environmental conditions*
- *Ease of use*
- *Cross-layer design*

II. SYSTEM MODEL ARCHITECTURE

The basic block diagram of a wireless sensor node is presented in Fig. 1 It is made up four basic components: a sensing unit, a processing unit, a transceiver unit and a power unit. There can be application dependent additional components such as a location finding system, a power generator and a mobilize.

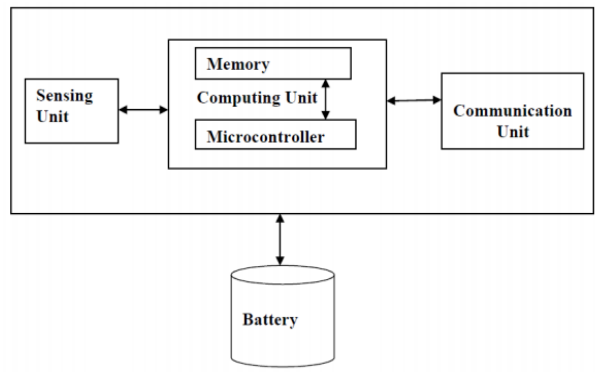

Fig.2. Block diagram of Wireless sensor Network

Sensing Unit – Sensing units are usually composed of two subunits: sensors and analog to digital converters (ADCs). Sensor is a device which is used to translate physical phenomena to electrical signals. Sensors can be classified as either analog or digital devices. There exists a variety of sensors that measure environmental parameters such as temperature, light intensity, sound, magnetic fields, image, etc. The analog signals produced by the sensors based on the observed phenomenon are converted to digital signals by the ADC and then fed into the processing unit.

Processing Unit

The processing unit mainly provides intelligence to the sensor node. The processing unit consists of a microprocessor, which is responsible for control of the sensors, execution of communication protocols and signal processing algorithms on the gathered sensor data. Commonly used microprocessors are Intel's Strong ARM microprocessor, Atmel‘s AVR microcontroller and Texas Instruments' MP430 microprocessor. For example, the processing unit of a smart dust mote prototype is a 4 MHz Atmel AVR8535 microcontroller with 8 KB instruction flash memory, 512 bytes RAM and 512 bytes EEPROM. Tiny OS operating system is used on this processor, which has 3500 bytes OS code space and 4500 bytes available code space. The processing unit of μAMPS wireless sensor node prototype has a 59–206 MHz SA-1110 micro-processor. In general, four main processor states can be identified in a microprocessor: off, sleep, idle and active. In sleep mode, the CPU and most internal peripherals are turned on, and can only be activated by an external event (interrupt). In idle mode, the CPU is still inactive, but other peripherals are active.

Transceiver Unit

The radio enables wireless communication with neighboring nodes and the outside world. It consists of a short range radio which usually has single channel at low data rate and operates at unlicensed bands of 868-870 MHz (Europe), 902-928 MHz (USA) or near 2.4 GHz (global ISM band). For example, the TR1000 family from RF Monolithic works in the 800–900 MHz range can dynamically change its transmission power up to 1.4 mW and transmit up to 115.2 Kbps. The Chipcon‘s CC2420 is included in the MICAZ mote that was built to comply with the IEEE 802.15.4 standard [8] for low data rate and low cost wireless personal area networks.

There are several factors that affect the power consumption characteristics of a radio, which includes the type of modulation scheme used, data rate, transmit power and the operational duty cycle. At transmitted power levels of -10dBm and below, a majority of the transmit mode power is dissipated in the circuitry and not radiated from the antenna. However, at high transmit levels (over 0dBm) the active current drown by the transmitter is high. The transmit power levels for sensor node applications are roughly in the range of -10 to +3 dBm. Similar to microcontrollers, transceivers can operate in Transmit, Receive, Idle and Sleep modes. An important observation in the case of most radios is that, operating in idle mode results in significantly high power consumption, almost equal to the power consumed in the Receive mode. Thus, it is important to completely shut down the radio rather than set it in the idle mode when it is not transmitting or receiving due to the high power consumed. Another influencing factor is that, as the radio's operating mode changes, the transient activity in the radio electronics causes a significant amount of power dissipation. The sleep mode is a very important energy saving feature in WSNs.

Battery

The battery supplies power to the complete sensor node. It plays a vital role in determining sensor node lifetime. The amount of power drawn from a battery should be carefully monitored. Sensor nodes are generally small, light and cheap, the size of the battery is limited. AA batteries normally store 2.2 to 2.5 Ah at 1.5 V. Though, these numbers vary depending on the technology utilized. For example, Zinc–air-based batteries have higher capacity in Joules/cm3 than lithium batteries. Alkaline batteries have the smallest capacity, normally around 1200 J/cm3. Furthermore, sensors must have a lifetime of months to years, since battery replacement is not an option for networks with thousands of physically embedded nodes. This causes energy consumption to be the most important factor in determining sensor node lifetime.

Applications of Wireless Sensor Networks:

Wireless Sensor Networks may consist of many different types of sensors such as seismic, low sampling rate magnetic, thermal, visual, infrared, acoustic and radar. They are able to monitor a wide variety of ambient conditions that include temperature, humidity, vehicular movement, lightning condition, pressure, soil makeup, noise levels, the presence or absence of certain kinds of objects, mechanical stress levels on attached objects, and the current characteristics such as speed, direction and size of an object. WSN applications can be classified into two categories as shown in Figure

1. *Monitoring*
2. *Tracking.*

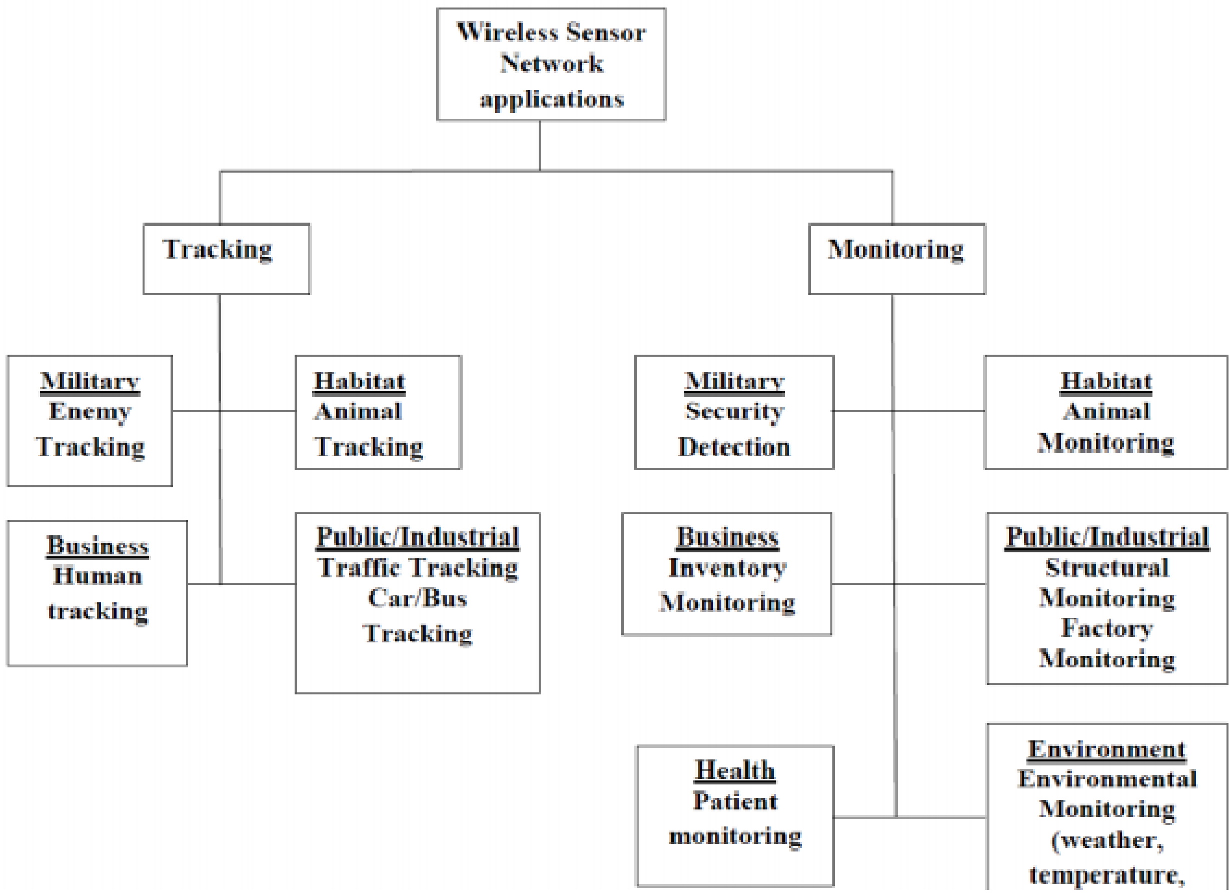

Fig.3. Overview of Wireless sensor networks

The Sensor Node

Wireless Sensor Networks mainly consists of nodes known as sensors. Sensors are devices with low energy as they operate on battery, having limited memory and processing ability and are designed to survive extreme environmental conditions. These are mostly due to their small size. They are also featured with self organizing and self healing power. Three basic parts of a SENSOR NODE can be seen as: A sensing subsystem that is used for data capturing from the real world. A subsystem for processing that is used for local data processing and storage. A subsystem consisting of wireless communication to be used to for data receiving and transmission.

Communication in WSNs

The communication systems in Wireless Sensor Networks consist of three layered architecture. The three layers are:

1. *Transport Layer* - The main concern of the Transport Layer is congestion detection and mitigation. Reliability of the network is also checked in this layer. The direction of data communication and packet recovery are important

measures taken care by this layer. This layer is also concerned with energy conservation.

2. *Network Layer* - The main concern of Network Layer is to route the data-packet in the network. Data aggregation and computational overheads are taken care by this layer. This is also an energy efficient layer.
3. *Data-Link Layer* -The main concern of the Data-link Layer is to transfer data between two nodes that are physically connected, sharing the same link. TDMA/CSMA/CA is carried out by this layer.

Clustering based Protocols for WSNs

Grouping calculations for WSNs could be isolated as Centralized cluster calculations and distributed grouping calculations. Distributed clustering systems are again isolated into their sub segments relying upon the sort of cluster, necessity for clusters and parameters utilized for CH determination.

Applications of Wireless Sensor networks

The applications of WSN can be categorized in 3 parts:

1. *Object Monitoring*
2. *Area Monitoring*
3. *Space and objects Monitoring*

Object monitoring may be structural monitoring, Eco-physiology based monitoring, condition-based handling, medical diagnostics monitoring and urban terrain mapping. For instance in Intel fabrication plants- sensors collect vibration data, monitor any kind of authors, thus conclude facts in real-time.

III. LITERATURE SURVEY

Lots of researches being carried out in the in the wireless sensor network among these the WSN is the hottest trend of research in terms of enhancing the concert and quality of services. Few of the previous research authors studied. These have been discussed here.

A Ahmad, K. Latif, N. Javai &, Z. A. Khan , U. Qasim [1]" proposed a Cluster based routing technique is most popular routing technique in Wireless Sensor Networks(WSNs). Due to varying need of WSN applications efficient energy utilization in routing protocols is still a potential area of research. In this research work authors introduced a new energy efficient cluster based routing technique. In this technique authors tried to overcome the problem of coverage hole and energy hole. In their technique authors controlled these problems by introducing density controlled uniform distribution of nodes and fixing optimum number of Cluster Heads (CHs) in each round. Finally authors verified their technique by experimental results of MATLAB simulations.

Behzad, M. and Javaid, N. ; Sana, A. ; Khan, M.A. [2] presented a Wireless Sensor Networks, efficient energy management is of great importance. In this paper, authors propose a novel routing protocol, Threshold Sensitive Density Controlled Divide and Rule (TSDDR) to prolong network lifetime and stability period. To achieve these targets, authors utilize static clustering with threshold aware transmissions. Simulations are done in MATLAB and the results show that their protocol has 60% longer stability period than LEACH [1] and 36% longer stability period than DDR[2]. Authors also implemented the Uniform Random Model (URM) to find Packet Drop to make their scheme more practical.

Pramanick, M., Basak, P. , Chowdhury, C. Neogy, S.[3] investigated WSN that is one of the fastest growing technologies in wireless domain. The sensor nodes are typically light and with limited battery power they are failure-prone too. So, efficient power saving schemes must be designed and developed to optimize energy consumption and thereby improve overall network lifetime. Clustering technique is one of the time-tested approaches that effectively reduce energy consumption. The lifetime of WSNs is enhanced by uniform clustering that balances network load among the clusters. In this paper, authors have reviewed various energy efficient clustering schemes applicable in wireless sensor networks. The schemes are analyzed thoroughly and some of them are simulated to assess performance.

Ayers, M. [4] presented Quality of Service (QoS) control that is of paramount importance in wireless sensor networks. In this paper authors proposed a new QoS control algorithm, referred to as Gureen Game, for wireless sensor networks. Gureen Game not only improves the Gur Game for QoS control but also significantly addresses the power consumption authors akness of the original Gur Game based QoS control for senor networks. Authors study the logic behaviors of the proposed Gureen Game, and evaluate its QoS performance compared with the original Gur Game and a recent control algorithm called Shuffle for energy-efficient QoS control. Their simulation results demonstrate the merits of the proposed Gureen Game.

De Andrade, I.B.D. , Belo Horizonte, Brazil ; de Oliveira Januario, T. ; Pappa, G.L. ; Mateus, G.R.[5] presented a WSNs these are composed of autonomous and resourceconstrained (power, sensing, radios, and processors) nodes. These networks are conceived to have a large number of nodes working on monitoring phenomena. A major challenge for theses networks is to provide solutions that maximize quality of service (QoS) requirements, such as coverage and data routing, and minimize the energy consumption. This paper presents an evolutionary algorithm (EA) to solve the Density Control, Coverage and Routing Multi-Period Problem (DCCRMP) in WSN. The results are compared to the optimal solutions obtained by an Integer Linear Program model and a GRASP heuristic from the literature. The EA obtains significant improvements in both quality of solutions and computational time

Jannatul Ferdous, M. , Khulna , Ferdous, J. , Dey, T. [6] proposed a centralized routing protocol called Central Base Station Controlled Density Aware Clustering Protocol (CBCDACP) where the base station centrally performs the cluster formation task. In this protocol, an optimum set of cluster heads are selected by using a new cluster head selection algorithm focusing on both the density of the sensor nodes and the minimum distances among the cluster head and its neighbor nodes. The performance of CBCDACP is then compared with some prevalent clustering-based schemes such as Low Energy Adaptive Clustering Hierarchy (LEACH), Centralized LEACH (LEACH-C). Simulation results show that CBCDACP can improve system life time and energy efficiency in terms of different simulation performance metrics over its comparatives.

IV. PROBLEM DESCRIPTION

Wireless sensor Networks are deployed densely in a variety of physical environment for accurate monitoring. In critical condition monitoring like, environmental tracking application, accuracy is critical performance metric. Therefore, order of receiving sensed events is important for correct interpretation and knows what actually happening in the area being monitored. Similarly, in intrusion detection applications (alarm application), response time is the critical performance metric. On detection of intrusion, alarm must be signaled within no time. There should be a mechanism at node for robust communication of high priority messages. This can be achieved by keeping nodes all the time powered up which makes nodes out of energy and degrades network life time

Large number of nodes is being deployed in the wireless sensor network monitoring field. Consequently, the data flow in the network is considerably large which will involve significant energy dissipation for nodes. The problem in clustering technique is the creation of energy holes. In random distribution of nodes CHs which are overloaded cause the creation of energy holes. In multihop data forwarding technique, nodes near the BS consume large energy. These areas of nodes are also called hotspots. Energy depletes quickly in the hotspot areas of network.

V. CONCLUSION AND FUTURE SCOPE

The goal of this research study is to identify the performance challenges of WSN and analyze their impact on the performance of routing methods. For this purpose a thorough literature review study has been performed to identify the issues affecting the routing performance. Then to validate the impact of identified challenges from literature, an empirical study has been conducted by analyzing different routing protocols, taking into consideration these challenges and results are shown. On the basis of achieved results from empirical study and literature review recommendations are made for better selection of protocol regarding to application nature in the presence of considered challenges.

REFERENCES

[1] Ahmad, A.; Latif, K.; Javaid, N.; Khan, A.; Qasim, U., "Density controlled divide-and-rule scheme for energy efficient routing in Wireless Sensor Networks," Electrical and Computer Engineering (CCECE), 2013 26th Annual IEEE Canadian Conference on , vol., no., pp.1,4, 5-8 May 2014.

[2] Kemal Akkaya and Mohamed Younis. A survey on routing protocols for wireless sensor networks. Ad Hoc Networks, 3:325{349, 2005.

[3] Jamal N. Al-karaki and Ahmed E. Kamal. Routing techniques in wireless sensor networks: A survey. IEEE Wireless Communications,11:6{28, 2004.

[4] G. Anastasi, M. Conti, and M. Di Francesco. Extending the life time of wireless sensor networks through adaptive sleep. Industrial Informatics, IEEE Transactions on, 5(3):351 {365, aug. 2009.

[5] A. Bachir and D. Barthel. Localized max-min remaining energy routing for wsn using delay control. In Communications, 2005. ICC 2005.2005 IEEE International Conference on, volume 5, pages 3302 { 3306 Vol. 5, may 2005.

[6] Douglas M. Blough and Paolo Santi. Investigating upper bounds on network lifetime extension for cell-based energy conservation techniques in stationary ad hoc networks. In in Proceedings of the ACM/IEEE International COnference on Mobile Computing and Networking (MOBICOM, pages 183{192. ACM Press, 2002.

[7] Michael Buettner, Gary V. Yee, Eric Anderson, and Richard Han. X-mac: A short preamble mac protocol for duty-cycled wireless sensor networks. In in SenSys, pages 307{320, 2006.

[8] Q. Cao, T. Abdelzaher, T. He, and J. Stankovic. Towards optimal sleep scheduling in sensor networks for rare-event detection. In Information Processing in Sensor Networks, 2005. IPSN 2005. Fourth International Symposium on, pages 20 { 27, april 2005.

[9] Jae-Hwan Chang and L. Tassiulas. Maximum lifetime routing in wireless sensor networks. Networking, IEEE/ACM Transactions on, 12(4):609 { 619, 2004.

[10] M. Cheng, Xuan Gong, and Lin Cai. Joint routing and link rate allocation under bandwidth and energy constraints in sensor networks. Wireless Communications, IEEE Transactions on, 8(7):3770 {3779, july 2009.