Review on Energy-Awaring Routing Protocols in Wirelesss Sensor Network

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***Abstract*— A Wireless Sensor Network is a network made up of thousands of sensing nodes able to sense, compute and communicate. A node can be either static or mobile in nature. Energy-Efficiency is an important topic in sensor nodes as they are powered by batteries with limited capacity and it is difficult to replace and recharge them. In Wireless Sensor Network, Energy-Efficiency is a noteworthy issue as the lifetime of the whole WSN depends on the sensors with limited energy resource. It directs researchers to search for enhancing energy efficiency in different routing protocols or generate a new one that reduces energy consumption during data transmission, less delay overhead, decrease energy requirement for route maintenance and increase packet delivery ratio.**

***Keywords*—WSN, Sensor node, AODV, DSR, LEACH.**

I. Introduction

A Wireless Sensor Network (WSN) is made up of hundreds or thousands, spatially disseminated, self-organizing, interconnected sensors, to surveil physical and environment conditions like Humidity, Movement, Temperature, etc. and to interactively pass collected data to a main location using the network. It has many application areas such as Area Monitoring, Environmental/Earth sensing, Tracking, Traffic Control, Healthcare Monitoring and Industrial monitoring etc.

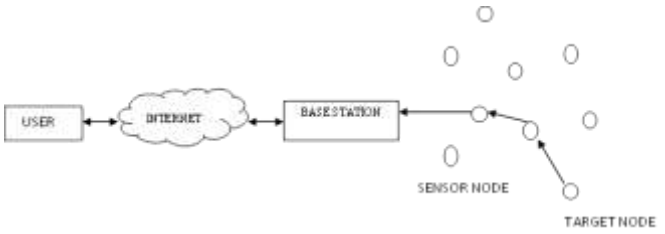

Fig 1. Wireless Sensor Network

Sensor Node:- A sensor node is a low-power, low-cost and either fixed or mobile nodes. Each node is made up of several parts: a radio transceiver with an internal antenna or connection to an external antenna, a CPU, an energy source usually a battery, a microcontroller and an electronic circuit for interfacing with sensor nodes [1]. A sensor node can also be implemented with Global Positioning System (GPS), if required. Size of a sensor nodes vary from size of a grain of dust to size of a shoe box. And similarly, depending on complexity of a sensor node, cost of a sensor node also varies. Resources of a sensor node such as energy, memory, communication bandwidth and processing speed are also limited due to the constraint of size and cost. Life time of a sensor node is also limited as it runs on an energy source, battery.

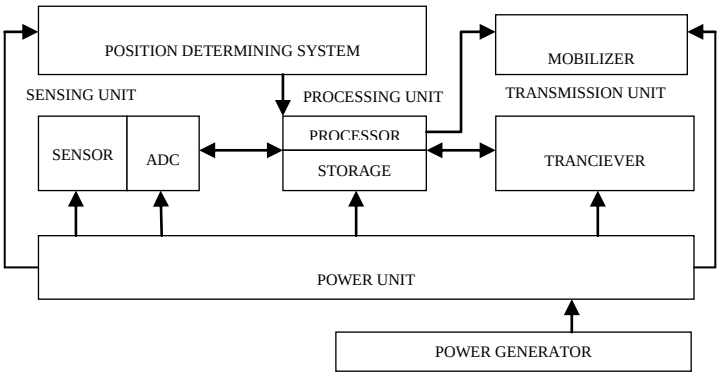

Fig 2. Components of a Sensor node

II. Routing Protocols

In this section, we discussed type of routing protocols for Wireless Sensor Network. Routing protocols are of 3 types: Proactive, Reactive, Hybrid

Proactive Routing Protocol

They are also known as "Table-driven protocols". Basically proactive protocols and connectionless datagram network are alike. They store the routing table all time. Thus proactive protocols have lower latency. DSDV and OLSR are example of proactive routing protocols. Any change in link connection of network is updated in routing table periodically. They provide faster packet delivery because route must be fixed before transferring actual data but it causes more routing overhead. Advantage of this type of protocols is that for determining a route between source node and destination node, source node doesn't need to perform any route discovery procedure for finding a route to the destination and the major disadvantage is that the maintenance of those paths which are not in even use.

Reactive Routing Protocols

They are also known as "On demand routing protocols". They are meant particularly for Ad Hoc networks. They don't maintain a route previously rather they ask for route to their neighbours only when they have any data to send over the network. They search and maintain routes only on demand of route. AODV and DSR [2] lie under these types of protocols. If route is not known, nodes broadcast the route request

messages. Reactive protocols give a best path from source node to destination node through the available network topology and this route is saved permanently whether it'll be used in future or not. Permanently saving routes results in a high traffic control on the network topology, especially in a network with a high number of nodes. Advantage of these types of protocols is that they are more efficient and better than proactive routing protocols as no unused path is maintained in routing table.

Hybrid Routing Protocols

These are the combination of reactive and proactive routing protocols. Routes are found quickly taking advantages of both of these protocols. ZRP is an example of these types of protocols. These protocols are good for those networks that have only small number of sensing nodes. With the increase in no. of sensing nodes in the network, performance of the hybrid protocols also increases. Reactive routing procedures are used at global network level and proactive routing procedures are used at node level for local neighbourhood.

III. Routing Protocols in WSN

Routing in wireless sensor networks is different from conventional routing in static networks. There is no fixed infrastructure, wireless links are untrustworthy, sensor nodes may fail and routing protocols have to meet strict energy saving requirements [3]. Many routing algorithms were developed for wireless networks. All available routing protocols proposed for WSNs, may be divided into seven categories as shown in Table below:

Category	Representative Protocols
Data Centric protocol	SPIN, Directed Diffusion, Rumor Routing, Information-Directed Routing, Gradient-Based Routing, Energy-aware Routing, Information-Directed Routing, Quorum-Based Information Dissemination
Location Based Protocols	MECN, SMECN, GAF, GEAR, Span
Mobility Based protocols	SEAD, TTDD, Joint Mobility and Routing, Data MULES, Dynamic Proxy Tree-Base Data Dissemination
Hierarchical Protocols	LEACH, PEGASIS, HEED, TEEN, APTEEN
QoS Based Protocol	SAR, SPEED, Energy-aware routing
Heterogeneity-based Protocols	IDSQ, CADR, CHR
Multipath Based Protocols	Sensor-Disjoint Multipath, Braided Multipath, N-to-1 Multipath Discovery

IV. Challenges of WSN

WSN is made up of mobile nodes that don't have a predefined infrastructure. To transmit data over the network WSN have to face many challenges. WSN consists of sensor nodes that have limited battery that leads to limited lifetime of network. Similarly, WSN have a number of challenges for its existence. Some of them are described as follows:

A. Node Distribution:- Node distribution determines the path of data transmission. As if the nodes are static, the path is static too. No extra work for path searching. But in WSN, nodes are mobile so their position value determines the path and it changes rapidly. Because of the mobility of nodes network is not easy to handle.

B. Scalability:- A WSN is consists of hundred to thousand number of sensor nodes. Protocols meant for WSN must be capable of handling this large number of nodes and their functionality because lifetime of the network depends on them.

C. Data Combining:- Large data consumes large energy of the network during data transmission. To reduce data over the network, data aggregation is done at specific nodes it requires extra computation at node level.

D. Energy-Efficiency:- As lifetime of the WSN depends on the energy of the nodes. Energy goes down and node becomes dead. As the number of dead nodes increases, life time of WSN decreases. So energy of the nodes must be utilised in a optimized way to increase the lifetime of the whole WSN. Energy consumed is directly proportional to the number of hopes in path. To reduce energy consumption, direct communication is preferable. But as network consist mobile nodes, data has to travel multihop.

E. Unreliable environment:- Environment of the WSN is unreliable it means that Sensor nodes are connected to each other by wireless links. Data may be corrupted during transmission due to noise and other environment factors. Even a node can behave wrong or opposite to its common behaviour.

V. Related Work

In this section, we study a number of different Energy-Efficient Routing Protocols which are proposed in the literature. Various Protocols are available for WSN. All routing protocols have their own advantages, disadvantages and scope for further research. The WSN routing protocols reviewed in this paper are based upon energy efficient routing protocols, which is explained in this section.

Energy efficient mobility support to LEACH (LEACH-M) protocol method is proposed by *Lan Tien Nguyen, Xavier*

Defago and Razvan Beuran [4]. They proposed LEACH support for mobile nodes and reduces the consumption of network resources. They implement their proposed algorithm on ns2 simulator and compared the performance of LEACH-M with LEACH-C [2]. Their algorithm offered significant improvement in performance and also energy efficient in case of mobile nodes.

Aggregate packet stream and more uniform resource utilization introduces DCE (Data Combining Entities) method is proposed by *Curt Schurgers and Mani B. Srivastava* [5]. They proposed that data should be aggregated at DCE, cluster head, before forwarding as it leads to data compaction so that less data to be sent ahead. They also compared the network life time having no DCE, one DCE and more DCE. They conclude that network having one or more DCE will be more energy efficient rather than network with no DCE. Also Uniform distribution of network load leads to uniform resource utilization leading to a uniformly maintained network.

K.Padmanabhan, Dr.P.Kamalakkannan [6] explained the recent developments in sensor networks have made the researchers to find the energy efficient routing protocols. Sensor nodes are energy constrained and can't be replaced in most of cases. They proposed a new model to reduce the energy consumption by the sensor node. They proposed Energy Efficient Dynamic Clustering Protocol (EEDCP) that distributes the energy consumption evenly among all nodes to increase the life time of network overall. Simulation shows that the EEDCP outforms its counterparts.

Gurpreet Singh, Amandeep Kaur in 2013 explained saving energy for sensors in WSN by bringing the concept of clustered AODV (Ad hoc On demand Distance Vector routing protocol). It considered clustering of nodes and various cluster head selection priority. It also deals with link stability issue due to different data transmission frequencies and high energy dissipation of sensor node by calculating average residual energy of cluster head without concern data transmission frequencies and the ratio of transmission to sink node. Network performance was evaluated in terms of number of hopes and packet delivery ratio in network on simulator and better cluster head selection improved better life time. Further less congestion in network was also proved as compared to previous scenarios.

Mehdi Kalantari and Mark Shayman [8] proposed approach when all fixed location aware sensor nodes collect data and send it to a central node. They use a set of partial differential equations similar to Maxwell's equations in electrostatic theory to find the energy efficient routes. They gave a geographical path from each sensor node to destination by utilizing higher residual energy over small residual energy. When energy changes routes need to be revised. For calculating residual energy either subtracts used energy from last stored value or to avoid any error, each sensor node may send their residual energy to central node once after a fixed interval.

Fahed Awad, Eyad Taqieddin, Asmaa Seyam [9] elaborates the concept of Energy efficiency and sensing coverage are essential metrics for enhancing the life time and the utilization of WSN. Their proposed framework is based upon applying the principles of Virtual Field Force on each cluster in order to move the sensor nodes towards proper locations that maximize the sensing coverage and minimizing the transmitted energy. Two types of virtual forces are used: an attractive force that moves the nodes towards the cluster head in order to reduce the energy used for communication and a repulsive force that moves the overlapping nodes away from each other so that their sensing coverage is maximized. The proposed scheme is applied on LEACH clustering algorithm. The simulation results a considerable improvement in performance of LEACH protocol in terms of achieved sensing coverage and network lifetime.

EE-AODV, Energy Efficient Ad hoc ON demand Distance Vector routing protocol was proposed by *Reena Singh and Shilpa Gupta* [10]. The algorithm adopted by EEAODV has enhanced the RREQ and RREP handling process to save the energy in mobile devices. It considers some level of energy as threshold value which should be available in node to be used as an intermediary node. If energy goes down it cannot be used as intermediary node until or unless no alternative path is found. Simulation results showed that lifetime of network increased in EEAODV as compared to AODV.

V Bharathi [11] performed a work, "A Performance Enhancement of an Optimized Power Reactive Routing based on AODV Protocol for Mobile ad-hoc network". In this paper author described that an optimized power reactive routing based AODV protocol by using concept of cognitive function. It ensures that data packets are transferred in the shortest and most reliable mode. In order to improve the scalability of the network management and provide a way of transmission with an energy efficient manner in the path of every node, author proposed a novel way of transmission with stability using a technique called Optimized Power Reactive Routing (OPRR). This proposed protocol avoids new route discovery process in AODV with low power consumption and maintain the stability of node and to improve scalability of the network. Preliminary the simulation using GloMoSim simulator was provided and the result shows the performance enhancements of the Optimized Power Reactive Routing.

Abdul Raouf Khan [12] performed a work, "Energy Efficient Protocol Design Issues in Wireless Sensor Networks". Sensor nodes have a limited power resorce. This paper presents a survey for designing energy efficient Wireless Sensor Network (WSN) Protocols and identifies future trends in designing energy efficient WSN protocols.

Yuping Dong, Hwa Chang et.al [13], "An Energy Conserving Routing Algorithm for Wireless Sensor Networks", proposed an energy efficient routing algorithm for WSN. In this, sensor nodes are divided into several scheduling sets and all sets work alternatively. So sensors need not to be active all the time, which saves a lot of energy. When choosing the next sensor to forward the information to, we consider both the distance from the base station ton the sensor and its current energy level. So the network power consumption will be distributed among the sensors. When the network doesn't have enough sensors that have sufficient energy to run, it generated new scheduling sets automatically. Simulation and comparison demonstrated that this algorithm outperforms the previous work on energy efficient routing algorithm.

Vahid Majid Nezhad1 and Bager Zarei2 [14], proposed a work, "Presenting a New Routing Protocol for Increasing Lifetime of Sensor Network". The concept of "Efficient Energy Consumption" in routing protocol of sensor network, which causes to increase the lifetime of sensor network, has been studied and taxonomy of various techniques foe efficient energy consumption is presented. Also a new routing protocol is presented in a way that proposed protocol uses some special technique to consume energy efficiently. After that they simulate the proposed routing protocol and compared its functions with recent protocols. It is observed that proposed routing protocol increased the lifetime of sensor network.

Mohammed Tarique and Rumana Islam [15] introduced, "Minimum Energy Dynamic Source Routing Protocol (MEDSR) "has done attempts to make DSR more as energy aware routing protocol. The MEDSR approach is based on two mechanisms: Route Discovery and Link Power Adjustment. The route Discovery process is also categorised into two parts: Route Discovery mechanism using low power level and Route discovery mechanism using high power level. The result depicts that when the network size is small the energy saving per data is maximum in MEDSR as compared to DSR, almost 55% high which indeed turning out to be an efficient routing protocol.

VI. CONCLUSION

In the present picture of world, the wireless technology is finding interest in almost all areas. Much work is being done to improve it for practical implementation in real life scenarios. Routing protocols have important and pivotal role in success to practical existence of wireless network and therefore it is one of the main areas of research for researchers in present time.

From the previous work done, it is observed that reactive routing protocols are the one of the best choice for Ad-hoc Networks, because they are fast to establish routes with exchange of lesser number of packet therefore having low routing overhead. In this paper we have observed that a lot of work has been done on different routing protocol for enhancing energy-efficiency in them. By studying all we observed that clustering based routing is more energy efficient than all others as it causes equal energy consumption of nodes by using head election. Load will be distributed to all nodes equally and by this the energy of nodes are utilized efficiently and lifetime of whole network is optimized.

With the knowledge gained and we found that there is still some scope of improving reactive routing protocols of Wireless Sensor Network, in future.

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