An Examination of Energy-Efficient Routing Protocols for Wireless Sensor Networks

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Abstract— A wireless sensor network is made up of multiple tiny scattered sensor nodes that monitor in a variety of situations such as armed forces, forests, civil applications, and animals. The restricted amount of energy in sensor nodes is a major bottleneck in the data collection system. We can extend the life of a wireless sensor network by saving as much energy as possible on sensor nodes. To and fro communication is the most energy-consuming activity in WSN, hence lowering it can assist save energy on the nodes. The primary goal of this study is to investigate the numerous challenges linked to WSNs. This paper also demonstrated the performance of energy-efficient routing protocols, which can be further evaluated in WSNs.

Index Terms- WSNs, Applications, Energy Efficient Routing Protocols, Clustering.

I. INTRODUCTION

Wireless Sensor Network is a combination of hundreds or numerous little scattered sensors to monitor an area which can be some physical thing or related to environment such as forests, animals, laboratory etc. These sensors work together and send data to one system for calculation to perform further operations. Every central node is connected to a single or a couple sensor. The sensor centre points are very small in size and are used for transmitting and receiving information. Sensor frameworks have a wide arrangement of employments and systems with incomprehensibly fluctuating necessities and qualities. The sensor systems can be utilized as a part of an unfathomable assortment of fields like military environment, catastrophe administration, living space observing, medicinal and social insurance, mechanical fields, home systems, distinguishing concoction, natural, radiological, atomic, and unstable material and so on. Structure and topology of WSN can differ from straightforward star system to a progressed multi-hop wireless mesh network. Power requirements, restricted equipment, diminished dependability, and a normally higher thickness and a number of disappointment hubs are few of the issues that must be considered when creating conventions for use in sensor systems [2].

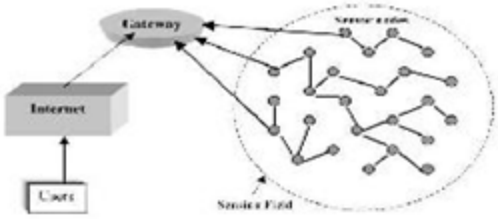

Fig 1: A Simple Wireless Sensor Networks [2]

1.2 APPLICATIONS OF WIRELESS SENSOR NETWORKS (WSN)

1. Military Application: Wireless sensor networks are also an important part of military command, whether its communications, intelligence, control in military, surveillance over restricted areas, reconnaissance etc. One of the most important applications in military is the security and the main function of WSN is to monitor the movement of enemy and army units coordination. Other areas where WSN come into consideration are intrusion detection, surveillance of battlefield where sensitive areas of border are to be monitored for any activity, Sea mine detection, detection of Biological and Chemical attack. Military vehicle tracking is another important application where it is necessary to measure the position of other vehicles to the tanks and for this sensors are equipped with magnetometers.

2. Environmental Application: In environment application we can track movements of animals on ground whether large animals like tiger, bear or elephant and small animals like rabbit, ants etc.

And also the movement of birds of sensor networks include tracking the movements of birds and even insects;; keeping track environmental elements that affect crops and livestock; monitoring of irrigation to fulfil the adequate need of water for crops; the devices used for monitoring the earth and exploring planet; detection of chemicals and biological elements in lab or given facility; and environmental monitoring in sea, soil, and atmosphere; detection of forest in fire; research in meteorological or geophysical fields; detection of danger of flood; the mapping of the environment; and study of pollution in cities.

3. Health Application: Application for health include providing interactive environment to disabled, every second monitoring of patients in critical condition; diagnostics and tests of patient; monitoring and management of medicines; check of insects and other small animals which can be dangerous, monitoring the internal parts of a person; physio data monitoring; and also monitoring of the staff which includes doctors and nurses in the hospitals.

4. Home Application: Smart sensor for microwave ovens to prevent leakage of power, sensors are used in vacuum cleaners to detect dust particles automatically and one of examples is Roomba computerized vaccum cleaner that automatically roams in house to clean off the dust, sensors are used in refrigerators to determine the cool temperature according to the season or weather. The wireless sensors in home appliances can be installed to work collectively and send data which we can manage through internet remotely.

5. Commercial Application: WSN is used nowadays in commercial world too and some of these are in monitoring of expired material; inventory management in large stores like Wallmart or Metro where large amount of input and output is performed in a day; to keep track of the quality of product; for effective usage of space for office construction, controlling temperature in large building providing heat or air conditioning ; used in automatic manufacturing machines such as in automotive industries where every part is built up in a chain; WSN are used in factory to assess the process quality process of production; smart structures with wireless sensor nodes; finding problems in machines; sensor nodes used in transportation and its tracking, largely used in supply and chain management nowadays; sensors for prevention of theft of vehicles and vehicle tracking.

II. ENERGY EFFICIENT ROUTING PROTOCOLS IN WSN

1. Low Energy Adaptive Clustering Hierarchy (LEACH)

LEACH or low energy adaptive clustering Hierarchy is protocol in wireless sensor network to determine the way in which the information is to be sent to the base station while saving the energy as much as possible. LEACH is based on clustering where various clusters are formed randomly and cluster heads are chosen for each cluster where information is collected and forwarded from. The selection of cluster heads in done randomly and after every round the cluster head is changed so that energy load is distributed among all the nodes in the network. The data is compressed at the cluster heads arriving from other sensor nodes in the same cluster, the cluster heads then forward an data collectively to the base station. LEACH is a TDMA/CDMA MAC protocol which helps in decreasing inter-cluster and intra-cluster communications. The data is centrally collected and analyzed regularly at the base station. So this protocol is efficient when regular monitoring of an area needs to be done. The cluster heads are changed in every round because if the previous node would be made cluster head again and again then it would die eventually and other nodes would still be having power so the change of cluster head in each round is required to distribute the communication load.

2. Hybrid Energy-Efficient Distributed clustering (HEED)

HEED is an clustering protocol which takes into consideration the cost of communication and energy usage at the same time. The formation of cluster head is based on the residual energy, that means in every round the node with highest remaining energy will become cluster head and the energy used in communication is reduced by selecting the cluster head and the nodes associated with it in a cluster. The

protocol aims for four main targets i.e. increasing the network lifetime by energy distribution, closing the cluster process by continuous iterations, decreasing the energy used in controlling the network, constructing compressed clusters and the deserving cluster head for high efficiency.

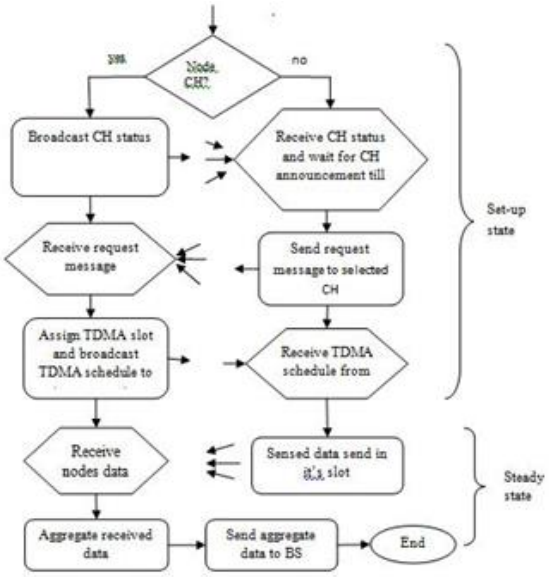

Fig 2: Flowchart of LEACH

3. Distributed Weight-based Energy-efficient Hierarchical Clustering protocol (DWEHC)

DWEHC as HEED is also a distributed clustering protocol.

It brings improvement in HEED by giving even balance to the sizes of clusters by improving the communication within the clusters by using location of sensor nodes. The cluster head is selected on basis of remaining energy levels similar to that in HEED. Every node works under DWEHC after various rounds and implementation in distributed manner the iterations end. Unlike other protocols a multi level structure for communication within the cluster is constructed in DWEHC and the no. of child nodes are limited and for the cluster head selection the comparison of energy levels is done within the cluster nodes rather than all the nodes in the network

4. Power Efficient Gathering in Sensor Information System (PEGASIS)

In PEGASIS each node communicates with its closest neighbours becomes cluster head to transit data to the base station. With this method the energy load is distributed within all the sensor nodes. For example first we randomly deploy the nodes in the field, and suppose the nth node is at a random part in the filed. The organization of sensor nodes will form a chain, by either using a greedy algorithm beginning from some node. So the base station will know the organization of the chain and inform to all the sensor nodes so in this way all nodes will know which node to transfer data to.

III. RELATED WORK

Stephanie Lindsey et al. [1] represent “Power-effective social occasion in sensor data frameworks" proposed a strategy titled PEGASIS. In the proposed strategy each and every detecting unit hub sends which has a nearby neighbor solely in addition to sends information to the BS around turns, thus little measure of vitality is certainly placed in each and every round. PEGASIS is dependent on avaricious chain calculation which is ideal for information gathering in detecting unit systems. B. Krishnamachari et al. [2] attributes data-centric routing in addition to when compared its operation along with conventional end-to-end routing schemes. They will evaluated the affect regarding source-destination position in addition to connection network concentration on the energy spending in addition to hold up related with information aggregation. S. Bandyopadhyay et al. [3] planned any sent out, randomized clustering criteria to be able to organize a sensors around a wireless sensor network directly into clusters. Then they extensive this particular criteria to manufacture a hierarchy of cluster heads plus noticed this facility benefits increased with the number of stages in hierarchy. Huseyln Ozgur Tan et al. [4] in paper "Force effective information social occasion and conglomeration in remote sensor systems"; proposed two calculations named PEDAP (Power Efficient Data get-together and AggregationProtocol) which are in close vicinity to ideal least spreading over tree subordinate directing methodologies, where one too is the force mindful variety of the other. Y.Xu et al. [5] exploited the localized conjecture paradigm pertaining to power-efficient item keeping track of sensor network. Localized conjecture was comprised of localized

network architecture as well as a conjecture apparatus named combined conjecture, which will accomplished power saving by permitting much of the sensor nodes stayed in get to sleep mode through decreased the exact amount of long-range transmissions. O. Younis et al. [6] prescribed new vitality productive methodology for bunching hubs in impromptu sensor systems. Fixated on this strategy, some kind of standard convention are introduced, HEED (Hybrid Energy-Efficient Distributed bunching), that frequently select group heads in understanding to half and half of their aggregate left over vitality furthermore was extra parameter, such as concerning occasion hub region to its companions or possibly hub degree. O. Younis et al. [7] presented a new protocol, HEED (Hybrid Energy-Efficient Distributed clustering), which regularly every so often pick bunch heads in view of a half breed of the hub remaining vitality alongside the second parameter, similar to hub vicinity to its neighbors furthermore hub degree. It has demonstrated that making use of the appropriate bounds on node denseness along with intra-cluster transmitting stages, HEED might asymptotically practically certainly guaranteed connections of clustered networks. F. Nawaz et al. [11] prescribed a Wireless Sensor Network (WSN) information accumulation and steering convention that is to a great extent perfect to have the capacity to sensor systems which are conveyed generally. This suggested procedure packaged an angle organized heading discovering structure with progressive structure of the LEACH convention. V. Kumar et al. [12] displayed advanced questionnaire upon clustering algorithms described in literary works of WSNs. They displayed a classification of one's productive clustering algorithms in WSNs. They had learned that energy-efficient algorithms increased this network life span. They had interviewed the state-of-art of numerous clustering algorithms in WSN in addition to LEACH and child described in literary works involving WSNs right up until currently and displayed this contrast of numerous LEACH descendants. B. S. Mathapati et al. [16] designed a new power efficient routing protocol known as An Energy Efficient Reliable Routing Protocol for Wireless Sensor Networks (WSN) that often be group based i.e cluster based. Data aggregation seemed to be primarily utilized to collect and also aggregate info in a power efficient manner so that duration of network seemed to be enhanced. J.Peng et al. [17] Energy saving and energy consumption is one of the most crucial concerns associated with wireless sensor network (WSN). Since energy mainly dissipates when data is broadcasting, it has become the most important concern associated with WSN recently. Normally, data accuracy and reliability is the one other main factor of data transmission.

TABLE 1: COMPARION OF ENERGY EFFICIENT ROUTING PROTOCOLS

Name of author	Title of the paper	Protocol	Compression	Metaheuristic	Tree Based	Mobile Sink
Stephanie Lindsey	Power-efficient gathering in sensor info systems.	PEGASIS protocol	Yes	No	No	Yes
Huseyln Ozgur	Force effective information	LEACH protocol	Yes	No	No	Yes

Tan	social occasion and conglomeration in remote sensor systems					
Younis, Ossama	Distributed clustering in ad-hoc sensor networks: A hybrid,energy-efficient approach.	HEED protocol	No	Yes	Yes	No
Gedik, Bugra	An adaptive sampling approach to data collection in sensor networks.	EEPSC protocol	Yes	Yes	Yes	Yes
T. Alkhdour	Energy efficient clustering algorithms in wireless sensor networks:	EEDS protocol	No	Yes	Yes	Yes
Ji, Peng, Yupeng Li	A Clustering Protocol for Data Aggregation in Wireless Sensor Network	DWEHC protocol	Yes	Yes	Yes	No

CONCLUSION

Many energy-efficient routing protocols were employed in this work to join nodes and the base sink, as well as to transmit data over multiple hops. However, due to a limited power source, the lifetime of nodes was not as effective, as several nodes died prematurely. The use of compressive sensing has also been overlooked in the majority of current research. As a result, in the near future, we will propose overcoming the constraints of present energy-efficient procedures through compressive sensing and evolutionary optimization-based tree construction. Various criteria will also be utilized to assess how the proposed technique outperforms existing energy-efficient protocols.

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