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A Study on Energy Efficient Communication Protocol in Wireless Sensor Network

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Abstract-A wireless sensor network (WSN) having less cost, less power, small in size and multifunctional sensor node. Routing protocols in WSNs highlight on limited battery power, limited transmission range as well as processing and storage capabilities. The most important thing of a routing protocol, in order to be efficient for WSNs, is the energy consumption and the extension of the network's life time. Routing protocols in WSNs are also application specific which will led to the development of a verity of protocols. Based on the underlying network structure, routing protocols can be classified into three categories:data-centric, hierarchical and location based routing.WSN has design trade-off between energy and communication over-head which is backbone of the routing technique, Further Cluster Head Routing (CHR) uses clustering, which include partitioning stage and then choosing stage, namely partitions the multi-hop network and then chooses cluster-heads: cluster-head is responsible for receiving, sending and maintaining information in its cluster.Then all cluster forming a rapid spanning tree to prolong network lifetime, save energy and shorten path.

Index Terms-Clustering, energy efficient, wireless sensor networks(WSNs)

1 INTRODUCTION

A WSN is a collection of wireless nodes with limited energy competence that may be mobile or stationary and are located randomly on a dynamically changing environment. The routing strategies selection is an important issue for the competence delivery of the packets to their destination. Moreover, in Such networks, the applied routing strategy should ensure the minimum of energy consumption and hence maximization of the life of network [1]. The first WSN designed was developed in middle 70s by the military and defense industries.it is also used during the Vietnam war in order to support the detection of enemies in remote forest areas. However, that implementation had several drawbacks, they are large in size, consume more energy and limited network capability. The decrease in size and cost of sensors, resulting from such technological advances, has fueled interest in the possible use of large set of disposable unwanted sensors. such interest has motivated intensive research in the past few years addressing the potential collaboration among sensors in data gathering, processing, coordination, management of the sensing activity, data flow to the sink [2]. Now days there is lot of advancement is carried out.WSN are used for military, civilian and for industrial applications. WSNs application in the military field include battle field surveillance, intrusion detection, target field and image. However, are now being used in many civilian application areas too, including environment and habitat monitoring, health applications, home automation and traffic control.

The WSNs may be used in a variety of everyday life activities or services. For example, in a disaster management, a large number of sensors can be dropped by a helicopter. Networking these sensors can assist rescue operations by locating survivors, identifying risk areas and making the rescue crew more aware of the overall situation. Such application of sensor networks not only can increase the efficiency of rescue operations but also ensure the safety of the rescue crew. In addition to the above, an important area of use is the healthcare sector, this area the WSNs may be offer significant cost savings and enable new functionalities that will assist the elder people living along in the house or people with chronic diseases on the daily activities.In wired systems, the installation of enough sensors is also limited by cost of wiring.Previously inaccessible locations, routing machinery, hazardous or restricted area, and mobile assets can now be reached with wireless sensors. Routing in sensor networks is very challenging due to several characteristics that distinguish them from contemporary communication and wireless ad-hoc networks. In sensor node it is not possible to build a global addressing scheme for deployment of sheer number of sensor nodes. Hence IP-based protocols cannot be applied to sensor networks. In adverse to typical communication networks almost all applications of sensor networks require the ow of sensed data from multiple regions(sources)to particular sink. Data generated by these sensors may be redundant due to vicinity of phenomenon. There type of redundancy must be exploited by routing protocols to improve energy and band-width utilization. In this paper we proposed energy efficient routing protocol based on Cluster head routing for wireless sensor network to protect network life time minimizing energy consumption during convergence, topology change and shorten path. Clustering includes partitioning stage and choosing stage namely partition the multi-hop network and then chooses clustered-head. cluster-head is responsible for receiving, sending and maintaining information of its cluster. Routing protocol classified into three main categories, namely data-centric, hierarchical and location based.

2 CHALLENGES IN WIRELESS SENSOR NETWORK

2.1 Network Dynamics

There are three main components in a sensor network i.e sensor node, sink and monitored events.Most of the network architecture assumed that network nodes are static, But it may be dynamic, At that time routing message from

or to moving node becomes challenges.Because stability is important for optimizing energy and bandwidth.

2.2 Node Deployment

Other important issue is topological deployment of sensor nodes. It depends and effects routing protocol. Deployment of sensor node may be deterministic or self-organizing. In deterministic situation, sensor nodes are manually placed and data is route through predetermined paths. However, in self-organizing systems, the sensor nodes are scattered randomly create an infrastructure in ad-hoc manner, In this infra structure, the position of sink or cluster head node is crucial in terms of energy efficiency and performance. When the distribution of sensor nodes is not uniform, then getting optimal clustering is big issue in term of energy efficiency of network.

2.3 Energy Consideration

Sensor nodes may generate redundant bits of data packets; in this case we have to aggregate sensor data so that number of transmission may have reduced. Data aggregation means it takes data from different sources by using function suppression (eliminating duplicates), min, max, average. Some type of function must be executed at the sensor node for energy efficiency and traffic optimization in a number of routing protocols. Data aggregation is also feasible through signal processing techniques.

3 Routing Protocols In Wireless Sensor Networks

3.1 Data Centric Routing Protocols

Data centric protocols are query based and they depend on the naming the desired data. The absolute number of sensor nodes, to which it is difficult to assign global identification to each node. Due to absence of global identification number to each nodes makes it hard to select the set of sensor node for particular query. According to above condition data is transmitted from each and every sensor node suffering from redundancy and significant amount of energy loss. To handle this type of situation we use data centric routing protocol. In this protocol, there is sink queries to certain region and wait for the reply from the sensor nodes to that region. Examples of data-centric routing protocols are SPIN [3], Directed diffusion [4], Rumour routing[5], GBR[6], Shah and Rabaey [7], CADR[8], COUGAR[9] etc. Since data is being requested by sink node through queries, attribute-based naming is used to specify the properties of data.

3.2 Hierarchical routing protocol

Hierarchical routing is the method of arranging the router in hierarchical manner.In this arrangement we have to use powerful router as the backbone and slower router as accessing point.As per access point router are treated as the first tier of the hierarchy, and back-bone router are as second tier of the hierarchy.Data aggregation and fusion is performed in such routing protocols in order to decrease the number of transmitted message to the sink.Examples of hierarchical routing protocols are LEACH(Low Energy Adaptive Clustering Hierarchy)[10],PEGASIS(Power Efficient Gathering in sensor Information System)[11],Subramanian and Kartz [12], GAF[13] etc.

3.3 Location based routing protocol

Location based routing protocol (Geographical routing) gives an idea about geographical position information. The main purpose to using location based routing protocol to calculate the distance between two nodes, so that energy conservation can be known in advance. Actually there is no scheme like IP address in sensor network in the sensor node network, they are spatially deployed on the network. Hence it follows two principle

- It is assuming that every sensor node knows its own principal neighbor's positions.
- The source of message is assumed to be informed about the position of the destination.

The location-based routing technique is very interesting because it operates without any routing tables. furthermore, once the position of the destination is known, all operations are strictly local, i.e every node is required to keep track only of its directed neighbor. Example of Location-Based routing protocols are SPEED [14], kalpakis etal. [15], GAF [13], GEAR[16] etc

4 Energy Efficient Routing Protocols

As most of the attention have been given on the energy factor of the sensor node to be working state. various work has been done in order to minimize the energy consumption of the sensor node. Routing protocol is one of the factor which nuance energy consumption rate of the node in various network topologies. Following subsection discuss the energy efficient routing protocol in wireless sensor network.

4.1 LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY (LEACH)

Low Energy adaptive clustering hierarchy (LEACH) [18]is a popular energy efficient adaptive clustering algorithm that forms node cluster based on receiving signal strength. The cluster head (CH) aggregate the sensed data from all transmits it to the Base Station. LEACH assumes that the base stationis immobile and is located far from sensor network. All the sensor nods are capable of communicating with BS directly. At any point of time, all the nodes have to send and nodes locatedto close to each other co-relate the data. The cluster head(CH) can perform data aggregation and data dissemination as shown in figure. In LEACH the nodes from local clusters with one of the nodes acting as the local sink or cluster head. If the same node would remain as the cluster head throughout the working of the network, it would die quickly because of extensive load from the participating sensors in the cluster. Hence the rotation of the cluster head in every extensive load from the participating sensors in the cluster. Hence the rotation of the cluster head in every

$$T(n) = \begin{cases} \frac{p}{1-p*(rmod1/p)}, & \text{if } n \in G \\ 0, & \text{otherwise} \end{cases}$$

where p is the desired percentage of cluster heads (e.g.0.05),r is the current round, and G is the set of nodes that have not been cluster heads in the last 1/p rounds. Once the CHs have been selected ,they advertise themselves to the remaining nodes.Based on the original strength, the nodes decides which cluster to join. Depend on the number of nodes in the cluster, the CH allocate different time slots for each node to transmit by adopting the basic time division multiple access(TDMA) scheduling. Then CH aggregate the original data to carry meaningful information. The aggregate data then transmitted to the BS by CHs. LEACH enhanced the network lifetime by utilizing the resources efficiently, distributing the load balance uniformly, aggregation data at CH to contain only the meaning information, routing the CH uniformly to achieve balanced energy consumption. But the sensor node does not need to know the location or distance information. So we have some other application such as LEACH-C (Centralize) [17], E-LEACH (Enhanced) can be used.

4.2 POWER EFFICIENT GATHERING IN SENSOR INFORMATION SYSTEM (PE-GASIS)

The PEGASIS [18] routing protocol is an advance version of LEACH. The basic idea of PEGASIS is to form a chain in which every sensor node transmits and receive from its neighbor and one thing is that we have select randomly only one node from the chain to transmit to the Base Station.The chain formation is based on greedy algorithm. As shown in the above figure node A passes its data to node B. Node B aggregate node A data and its own data and pass it to C, Then C aggregate the data getting from A and B with its own data and transfer it to node D. Node E collects data from F and aggregate with its own data and transfer to the node D. Finally, node D aggregate all the data from other nodes with its own data and transmit to Base-Station. In sum, PEGASIS protocol constructs the chain and each node collects and delivers to its nearest neighbor node. As each node selected head node by its turn, PEGASIS protocol saves energy remarkably, But PEGASIS have several drawbacks. Such as since head node is single, it may occur bottleneck. some other drawbacks are when PEGASIS selected as a head node, there is no consideration about the location of the base station.

4.3 THRESHOLD SENSITIVE ENERGY EFFICIENT SENSOR NETWORK PROTO-COL (TEEN)

TEEN [19] is hierarchical protocol which is design to handle sudden changes. As we know LEACH is a pro-active network and TEEN is the reactive network. Pro-Active mean sensor node sends sensed data periodically and send to the BS. But Re-Active means nodes are reacting immediately to the sudden change in sensed data and transmit to the BS. Hence they are sleep mode in most of the time. So the number of transmission is reduced, which results energy consumption also reduced. The sensor node architecture in TEEN follow Hierarchical grouping in which close nodes form cluster, further goes on next level until Base-Station is reached. Since clusters are formed, the cluster head broadcast two threshold i. e hard threshold and soft threshold towards the sensor node. The hard threshold means the minimum possible value beyond which, Sensor node transmit value and report to the cluster head. Thus the hard threshold allow the nodes to transmit only when the sensed attribute is in the range of interest. Hence it reduced the of transmission significantly by minimizing the number of transmissions. But soft threshold responsible for small change in the value of the sensed attribute. A smaller value of the soft threshold gives more accurate picture of the network, in expense of increase energy consumption. Hence user can control the trade-off between energy efficiency and accuracy. The main drawback of this protocol is, if the threshold is not reached, the nodes will not communicate and the user will not get any data form network. Also the user is not able to know even if nodes die.

4.4 ADAPTIVE THRESHOLD SENSITIVE ENERGY EFFICIENT SENSOR NETWORK PROTOCOL (APTEEN)

APTEEN is an improved version of TEEN, which transmit data based on the threshold and also periodically. It works on both pro-active and reactive networks. It adapts itself according to the application requirement. When we once get the cluster head, It broadcast a set of parameters, threshold (this parameter consist of the hard and soft threshold), attributes(the set of physical parameter in which the user is interested),schedule(based on TDMA schedule for assigning a slot for each node), (Tc) Count Time (It is the time period between two successive reports sent by node. It can be multiple of the TDMA schedule length and it accounts for pro-active component). The main advantage of APTEEN with respect to TEEN is that it consumed less energy. But main disadvantage of APTEEN are complexity and that it results in longer delay in time.

5 CONCLUSION

In this paper, I bid to summarize energy efficient routing protocol in wireless sensor network. Growing demand of wireless sensor network accelerate the research and development of routing protocols. Minimize energy of the sensor network using routing protocol is a big threat of WSN. As we have deal with TEEN and APTEEN in this paper which will minimizes the latency and the energy as per their own architecture.

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