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Survey on techniques for cluster based communications in WSN

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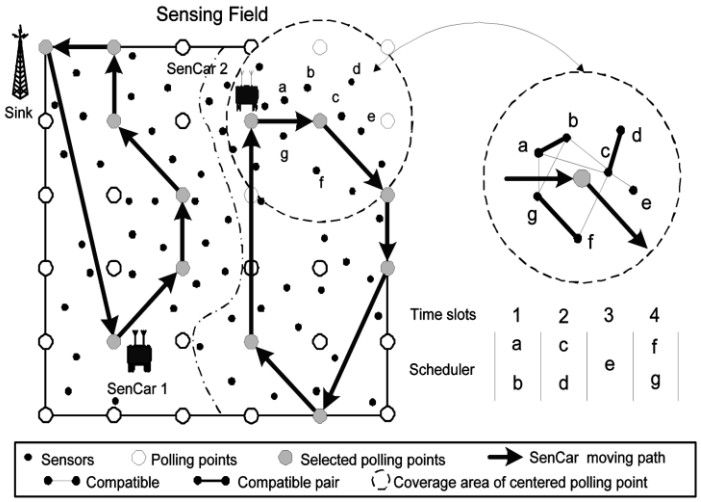
Abstract - *Wireless Sensor Networks basically depends upon the data gathering scheme. In WSN when compared to mobile data gathering time, data uploading takes large amount of time. The time taken for data uploading can be decreased by placing multiple antennas on the mobile collector. Hence for data gathering a three-layer framework has been proposed, which contains Sensor, cluster-head and the mobile collector layer also named as SenCar layer. This three layer framework proposed employs an algorithm called as distributed load balanced clustering and dual data uploading, also termed as LBC-DDU. The aim lies in increasing the network lifetime, low latency for data gathering and good scalability. When compared to the existing schemes, the proposed scheme facilitates dual data uploading and balances the work load by introducing numerous cluster head simultaneously in every cluster. Through inter cluster transmissions, SenCar receives information from the cluster head and in turn SenCar transmits the information to sink node.*

Key Words: Cluster head, Wireless sensor networks (WSNs), Wireless Networks (WNs), Multi-user multi-input and multi-output (MU-MIMO), polling points, dual data uploading, load balanced clustering, data collection.

1. INTRODUCTION

Wireless Sensors Networks composed of dense, low-price, low-power, multifunctional sensor network points have undergone growth as a new information-gathering considering various different examples of applications including medical process, environment monitoring and so on. Considering the increase in the effect for low-power and low-price, various multifunctional sensors have made WNs an important information gathering scheme. At the sensor layer, multiple cluster-heads are produced to make ready balanced work amount and also to make simple uploading of dual data [3]. Focusing on the cluster-head layer, connections among clusters is supported and guaranteed. Within clusters the cluster-heads generated work together to act as energy-saving inter-cluster communications. Further, information from cluster-head is transmitted to SenCar through inter-cluster transmissions. Lastly at the mobile collector layer, SenCar duty is to visit each selected polling point and collect the data provided to it from cluster-head and transfer it to the sink node. There has been several approaches proposed for gathering the data effectively and efficiently in the literature [1] [2] and they are divided in three groups. The initial group is enhanced relay routing. The second group in which the clusters are formed and permit the data to be forwarded to data sink by cluster-heads. The third category is to take the responsibility of data routing from sensors using mobile collectors.



SenCar: Optimizing on data collection tour for mobile collectors and Minimizing relays at the sensors.

Fig 1.1: Example of efficient and reliable data gathering schemes in WSN

Though these approaches have provided various prominent solutions to data gathering mechanisms for WSN, various inadequacies have been took note. In case of cluster based schemes, cluster head greatly consumes large percentage of the energy in comparison to other sensor nodes because of the inter-cluster data forwarding. In the relay routing mechanisms [1], reducing energy which is conserved on their furthering path doesn't improve the network lifetime. Depending upon the observations made, a three-layer framework called load balanced clustering and dual data uploading (LBC-DDU) is proposed. Here the motive is-achieving scalability, employing mobility and achieving low latency by exploiting Multi-User Multi-Input Multi-Output technique. A distributed algorithm is proposed, firstly for forming cluster which consists of multiple cluster-head. Secondly various (say 2) cluster-head within each cluster will collaborate effectively, for performing energy efficient inter-cluster transmission [4]. Also cluster-head doesn't relay the data from its neighboring clusters, instead forwarding way between the clusters are used where they route cluster-head identification (ID) information to mobile collector. Lastly mobile collector called SenCar is equipped with two antennas. Deploying it with antennas is to allow

simultaneous uploading of data using MU-MIMO techniques by cluster-heads. Here the SenCar plays an important role by visiting all the clusters to gather the data from cluster-head. To decrease the time taken for data gathering, it selects the stop locations and prepares the sequence to visit them.
The paper is summarized in following manner. Section II deals with literature review of previous works. Section III describes about routing protocols for data aggregation. Section IV is about comparative analysis and in section V our paper is concluded.

2. RELATED WORK

The paper proposed by H.Hassanein etc. all [1] describes about the deployment strategies of relaying nodes in heterogeneous wireless sensor networks. In WSN, device deployment has become a major issue. In heterogeneous network, relay nodes are meant for transferring data packets to the base station from all sensor nodes. This paper provides information about the effects of deployment of devices on their connectivity and lifetime in a heterogeneous wireless sensor network.

Node failure recognition in the WSN is challenging because at every instant network may not connect and also resources are limited. The paper proposed by Ruofan Jin, etc. all [2], provides information about how to detect node-failure in mobile WN and to detect node failure, two node failure schemes have been proposed that aims to combine- localized monitoring, location estimation and node collaboration for mobile WN.

The authors X.Tang and J.Xu [3] proposed a data gathering strategy for lifetime-constrained WSN. In this, energy consumption has become a primary source of communication which takes place between a group of sensor nodes located within the network. Here focus is made on considering the relative importance of reading rather than sending sensor readings periodically for data collection.

Data gathering is common yet crucial task in the WSN. B.Gedik etc. all [4] proposed a paper which gives the information about the ASAP which is a sampling approach for periodic data gathering in WSN. This approach is used to rise the network lifetime and also to collect the raw sensor readings in the network. To deal more efficiently, data collection tour for mobile collectors, Ma and Yang [6] came out with an algorithm which is efficient moving path algorithm wherein determining few of the turning points along a path would effectively evade obstacles on a path.

3. ROUTING PROTOCOLS FOR THE DATA COLLECTION

Routing protocols are the type of networking protocols which serve every special purpose on the Internet. Aggregating the data seems critical to the network lifetime as network lifetime plays a vital role in WSN. Most of the routing protocol provides information about the routers communication with one another in the network, and also exchanging the information which allows them in choosing routes between any two nodes in a network[5]. The following are some of the routing protocols discussed.

LEACH

It is the most promising energy adequate communication protocol for WSN. It is one among the most popular clustering algorithm which distributes consumption of energy between sensors of the network. Within the network, group of sensors are formed as clusters and within each cluster, cluster head is chosen. According to leach algorithm, all the sensors of a cluster can be chosen as cluster head with a specific probability. However the sensor with the higher energy level is considered as cluster head randomly. LEACH network considers two phases. One is set up phase and second is steady state.

Considering the set-up phase, cluster head has been carefully selected whereas in steady-state phase, cluster head is maintained when there is a transmission of data between nodes.

Cluster head in their respective clusters inform all the sensor nodes about their position and every sensor node responds the cluster head within their communication range. Cluster head provides a schedule for nodes within its communication range so that each node in that particular communication range turns on its radio hardware in specific time for data transmission. This reduces energy consumption of nodes. When cluster head acquires all the information from sensor nodes which are within its transmission range, it will pass the information to a base station. In this method certain nodes are chosen as a cluster head based on their residual energy.

TL-LEACH

It is the extension of Leach algorithm which is two-level hierarchy Leach. Within the cluster, it uses two different cluster levels heads namely Primary and Secondary cluster head.

Primary and secondary cluster-head does following work, Former in its cluster communicates with later & secondary cluster head in turn communicates with nodes in its sub-cluster. Choosing these cluster-head is done using the same mechanism as that of LEACH.

HEED

It is an energy saving distributed clustering approach for adhoc sensors networks. It is a distributive clustering method that considers energy and communication cost simultaneously. Heed makes use of the nodes residual energy and their communication cost to choose cluster-head in their cluster.

For electing cluster head, initially node which has high energy level is selected as tentative cluster-head. It later on transfers

the message to all nodes within its communication range and informs about its new condition. For this purpose, a cost criterion average minimum reachability power (AMRP) is introduced and is used for breaking constraints in process of selection of cluster head.

Heed algorithm aims to improve network lifetime; it considers remaining energy of each sensor node and the inter cluster communication cost. By the use of transmitted power level used in cluster communication and during clustering a cluster range is determined.

PEGASIS

It is one of the cluster based, reactive protocol and is applicable to homogeneous sensor network. It preassumes that all the sensor nodes in its network have same energy level and are likely to terminate at the same time. PEGASIS is the protocol which is an improvement over LEACH protocol. In this approach, only a single node is chosen as head node which sends collected data to the base station. Here each and every sensor node in its network will have the information about its hop neighbors. The data that is sensed will be passed on to its hop neighbors and further the hop neighbors will pass it to its next hop neighbors. To know the nearest neighbor, each node makes use of its signal strength. The main key idea of this protocol PEGASIS is formation of a chain between sensor nodes in the network so that every sensor node receives information from and transmit it to its nearest neighbor. Finally head node is the one which sends all the collected data to base station.

TEEN

Teen is a routing protocol which stands for Threshold Sensitive Energy Efficient Sensor network protocol. It is basically used for reactive networks. Within the network every sensing node tries its best to be a cluster head for certain time period which we call a cluster period. The cluster head selected, broadcasts its hard and soft threshold to the members at every change in its time period.

Hard Threshold is exact value of an attribute where the node senses this value and informs its cluster-head by turning on its transmitter. Soft Threshold is very small change in the value of a sensed element.

The node senses the data continuously in the network. When any one of the parameter from an attribute set matches its hard threshold value then a node turns on its transmitter and passes that data to a cluster-head. Whenever a node transfers the sensed data, its value SV is set equivalent to its current value of the sensed attribute.

4. Comparative Analysis

Data gathering is one among the most fundamental and important issue in Wireless Sensor Network. Collection of the data using mobile nodes has major benefits over static multi-hop routing in the network[7]. Densely located sensor nodes at particular region within the cluster are more probable to transfer redundant data to base station, which results in an increase in communicational overhead and also the lifetime of network is affected. Since conservation of energy is an important criterion in WSN, data collection must be done in order so as to save energy.

Renjith and Baburaj proposed a paper "Data collection analysis in WSN" which provides information about the data collection mechanisms wherein assumption is made that nodes are all pre-programmed to transmit the collected data to sink node for executing query processing offline. In wireless sensor network, an implicit hypothesis has been made regarding the capabilities and nature of sensor node in the network. This approach experiences the drawback of overall lifetime decrement of network due to energy depletion and extensive communication overhead.

This issue can be solved by introducing a mobile collector to collect the data and transfer it to sink node. The paper proposed by M.Zhao et.al provide information about the efficient data collection mechanism by introducing mobile collector called SenCar which collects data from cluster-heads of multiple clusters and transmits collected data to sink node. A distributed algorithm is used which achieves 50% energy saving per node thus increasing the network lifetime.

To enhance the network lifetime of WSN, it is important to develop energy-efficient algorithm. The amount of energy saving per node yields a great impact on lifetime of network. the paper proposed by Ramesh R and Pramod K.V talks about the influence of factors like architecture of a network, data collection schemes and energy efficient routing protocol in context of data aggregation. The paper talks about the bounds provided on lifetime of network with specific network topologies.

This can be overcome by cluster-based sensor network in cluster-based network, where each of the cluster has its cluster-head, which collects most of data from its sensor nodes thereby transmitting it to the data sink. Hence energy of sensor nodes is saved by not relaying the data on its neighboring node to reach data to sink node, where some of the critical sensors carrying data on the forwarding path might run out of energy faster than other sensor nodes. To save energy of sensor nodes and to reduce the time for data collection to increase in network lifetime, the use of mobile collector is helpful. It collects the data from multiple cluster-head within its communication range and transfers collected data to sink node so that time and energy is conserved hence increasing the network lifetime.

Compared to relay routing in the network where data is relayed between sensor nodes, a mobile collector is used called SenCar. Two antennas are introduced at SenCar which allows multiple cluster-head to simultaneously upload its data by using MU-MIMO mechanism. When compare to other data collection mechanisms as discussed, the LBC-DDU algorithm which allows sensors to self-organize themselves into the clusters and every cluster has multiple cluster-heads which achieves 50% energy-saving on each node in the network and 60% energy saving at its cluster-heads and 20% shorter time consumed for collecting data when compared to traditional mobile data collection.

4.1 Summary of comparative Analysis

Sl.no	Title	Author	Remarks
1	Data-Aggregation Techniques in sensor networks.	Ramesh Rajagopalan and Pramod K	1.WSN composes of sensor nodes and base station also called as sink node. 2.The problem faced while gathering the data in energy constrained wireless sensor network is mainly focused. 3.The main motive of data collection technique is gathering the data [6] in most energy efficient way such that the lifetime of network increases. 4.Various data-aggregation protocols have been discussed such as Leach, Heed, Pegasis etc. 5.Existing works on data-aggregation technique have provided the bound on network lifetime with source behavior and specific network topologies. 6.This can be extended further by working with more general network topologies like cluster-based sensor network.
2	Data collection with multiple controlled mobile nodes in wireless sensor network.	Chao Wang and Huadong Ma	1.Data collection is an important paradigm in WSN. 2.In WSN, collecting and carrying the data in the network by mobile nodes can be done in more efficient manner when compared to static multi-hop routing. 3.Existing system focuses on minimizing the number of mobile-nodes used for data gathering in network also focuses improving path of these mobile nodes which is known as global t-scan. 4.To deal with this, two algorithms are being proposed. Considering one among the two is MinMobileGrowth algorithm which reduces the number of mobile nodes used and helps improving the path of these nodes. 5.The other is Mobile node movement scheduling (MNMS) algorithm, which schedules the movement of mobile nodes in network such that all nodes cooperate with one another and transmit that data gathered to base station.
3	An analysis on data aggregation in WSN	P.N.Renjith and E.Baburaj	1.In the WSN, at a specific region densely deployed sensor node tends to transfer the same data to its base station. 2.It leads to rise in the communication overhead and also it greatly affects the network lifetime. 3.Various data-aggregation techniques[8] are addressed where assumption is made that nodes in the network are pre-programmed so that they send their data to sink node for executing offline query processing. 4.Here in wireless sensor network model, there has been implicit assumption made about its nature and the capabilities of all sensor nodes. 5.It leads to various limitations such as pre-programming of the sensor node behavior and hence can't be modified after deployment and the other is overall lifetime of network is decreased. 6.To overcome this problem an effective energy conservation mechanism should be proposed such as cluster-based network for data aggregation etc.
4	Tour planning for mobile data-gathering mechanisms in WSN	Ming Ma and Yuanyuan yang	1.A data-gathering mechanism is proposed by introducing mobility into the network for large-scale WSN [9]. 2.M-collector basically a mobile collector is proposed which acts like or a vehicle with transceiver and battery. 3.The proposed scheme enhances scalability and also solves the intrinsic problems of large-scale networks. 4.Using mobile collector, network lifetime can be prolonged to a major extent when compared to the scheme which has only a static data collector. 5.Furthermore to improve network lifetime as compared to existing ones, cluster-based mechanism can be used with a mobile collector for collecting data from multiple cluster-heads which are within its communication range.

5. CONCLUSIONS

In comparison to the existing methods, proposed method includes a cluster with multiple cluster heads which balances its work load efficiently in the network and also facilitates dual data uploading. The problem with the existing system is that the cluster was having only single cluster-head which was unable to achieve efficient load balancing and there was no improvement in the network lifetime and different altering energy levels of the nodes forms the cluster partition again and again. Thus to overcome such problems, three-layer framework has been proposed as a solution. This three-layer framework introduces a distributed algorithm known as load balanced clustering and dual data uploading. It composes of three layers, each layer with a specific function. The layers are - sensor, cluster-head and lastly the SenCar layer. An algorithm proposed is used for sensor to self-organize, achieve scalability and make use of simultaneous data uploading and also optimize SenCar's mobility for taking advantage of MU-MIMO. Using SenCar to collect data from multiple cluster head simultaneously and more efficiently it proves that energy consumption is less and hence network lifetime increases.

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