Reliable Energy Efficient Clustering Scheme Analysis Using Mobile Sink in Wireless Sensor Networks

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Abstract — Due to non inheritable restriction of sensors, there is always a vital issue on the way to utilize restricted energy effectively. In the proposed work we have focused on the Energy Consumption in WSN Using Mobile Sink and Hierarchal Clustering. There is concept of bringing mobile sinks to sensing field to save energy of cluster heads while sending data to mobile sinks instead of fixed sink on base station. In this, we will divide the sensing field into two equal grid levels. These areas are independent to each other for communication and sensing of data by sensor nodes. Mobile sinks have been placed in these grid areas for saving energy by fetching data from heads only. The results show the performance of the proposed scheme for saving resources in wireless sensor network. Traditional AODV process scheme provide good solution for communication but proposed scheme have much better performance in saving resources and to reduce energy consumption. The energy consumption is less in case of mobile sinks communication in wireless sensor network as compared to the normal AODV process. The purpose of mobile sink is very helpful in saving energy in wireless sensor network.

***Keywords*—Wireless Sensor Network, Clusters, Energy Consumption, Mobile sink.**

I. INTRODUCTION

A Wireless Sensor Network (WSN) consists of a large number of tiny wireless sensor nodes (often referred to as sensor nodes or, simply, nodes) that are, typically, densely deployed. Mobile communications and wireless networking technology has seen a thriving development in recent years. Driven by technological advancements as well as application demands various classes of communication networks have emerged such as Cellular networks, Ad hoc Networks, Sensor Networks and Mesh Networks. Cellular Networks are the infrastructure dependent networks. Ad hoc networks are defined as the category of wireless networks that utilize multi hop radio relaying since the nodes are dynamically and arbitrarily located. Ad hoc networks are infrastructure independent networks. [10]

Nodes measure the ambient conditions in the environment surrounding them. These measurements are, then, transformed into signals that can be processed to reveal some characteristics about the phenomenon. The data collected is routed to special node, called sink node (also called Base Station) [1]. Then, typically, the sink node sends data to the user via Internet or satellite, through a gateway. Combining the advantages of wireless communication with some computational capabilities, WSNs have an endless array of potential applications in both military and civilian applications, including robotic land-mine detection, battlefield surveillance, target tracking, environmental monitoring, wildfire detection, catastrophe monitoring, structural monitoring, security, industry, agriculture, home, traffic monitoring, for monitoring natural phenomena etc.[1]

In order to support data aggregation through efficient network organization, nodes can be partitioned into a number of small groups called clusters. Each cluster has a coordinator, referred to as a cluster head, and a number of member nodes. Clustering results in a two-tier hierarchy in which cluster heads (CHs) form the higher tier while member nodes form the lower tier. Figure 5 illustrates data flow in a clustered network. The member nodes report their data to the respective CHs. The CHs aggregate the data and send them to the base station either directly or through other CHs [2]. Because CHs often transmit data over longer distances, they lose more energy compared to member nodes. The network may be reclustered periodically in order to select energy-abundant nodes to serve as CHs, thus distributing the load uniformly on all the nodes. Besides achieving energy efficiency, clustering reduces channel contention and packet collisions, resulting in better network throughput under high load. Clustering has been shown to improve network lifetime, a primary metric for evaluating the performance of a sensor network. Although there is no unified definition of “network lifetime,” as this concept depends on the objective of an application, common definitions include the time until the first/last node in the network depletes its energy and the time until a node is disconnected from the base station [2].

The important components of wireless sensor network are discussed below:

• **Sensor Node:** A sensor node is the core component of a WSN. Sensor nodes can take on multiple roles in a network, such as simple sensing; data storage; routing; and data processing.

• **Clusters:** Clusters are the organizational unit for WSNs. The dense nature of these networks requires the need for them to be broken down into clusters to simplify tasks such a communication [2].

• **Cluster heads:** Cluster heads are the organization leader of a cluster. They often are required to organize activities in the cluster. These tasks include but are not limited to data-aggregation and organizing the communication schedule of a cluster [3].

• **Base Station:** The base station is at the upper level of the hierarchical WSN. It provides the communication link between the sensor network and the end-user.

• **End User:** The data in a sensor network can be used for a wide-range of applications [1]. Therefore, a particular application may make use of the network data over the internet, using a PDA, or even a desktop computer.

II. REVIEW OF RELATED WORK

In this paper akyildiz et al.[4] describes the concept of sensor networks which has been made viable by the convergence of wireless communications. A sensor network is composed of a large number of sensor nodes. Sensor nodes mainly use broadcast communication paradigm. Sensor nodes are limited in power, computational capacities and memory. Sensor nodes may not have global identification because of the large amount of overhead and large number of sensors. They also discuss the various factors influencing the sensor network design. These factors are fault tolerance; scalability; production costs; operating environment; sensor network topology; hardware constraints; transmission media, and power consumption. They also discuss the protocol stack for sensor network. The protocol stack consists of the application layer, transport layer, network layer, data link layer, physical layer.

In this paper romer et al.[9] discussed the design space of wireless sensor networks. The deployment of sensor nodes in the physical environment may take several forms. Nodes may be deployed at random or installed at deliberately chosen spots. Deployment may be a one- time activity, where the installation and use of a sensor network are strictly separate activities. However, deployment may also be a continuous process, with more nodes being deployed at any time during the use of the network. Sensor nodes may change their location after initial deployment. Mobility can result from environmental influences such as wind or water. Mobility has a large impact on the expected degree of network dynamics and hence influences the design of networking protocols. Sensor networks consist of a variety of different devices. Nodes may differ in the type and number of attached sensors. One important property of a sensor network is its diameter, that is, the maximum number of hops between any two nodes in the network. In its simplest form, a sensor network forms a single-hop network, with every sensor node being able to directly communicate with every other node. An infrastructure-based network with a single base station forms a star network with a diameter of two. A multi-hop network may form an arbitrary graph, but often an overlay network with a simpler structure is constructed such as a tree or a set of connected stars.

In this paper younis et al.[6] discussed the flow of data in a clustered network. They describe the concept of Data Aggregation. In order to support data aggregation through efficient network organization, nodes can be partitioned into a number of small groups called clusters. Each cluster has a coordinator, referred to as a cluster head, and a number of member nodes. Nodes in WSNs operate on battery power with limited energy. Periodic reclustering is necessary in order to heal disconnected regions and distribute energy consumption across all nodes. Periodic reclustering is also necessary, as the parameters used for clustering are dynamic. They also describe node synchronization. Node synchronization ensures that the clustering process starts simultaneously throughout the network. Lack of synchronization may result in a suboptimal choice of cluster heads.

In this paper pathan et al.[1] describes the various Security Threats and Issues in Wireless Sensor Networks. Wireless networks are usually more vulnerable to various security threats.
The broadcast nature of the wireless communication is a simple candidate for eavesdropping.
Denial of Service is produced by the unintentional failure of nodes or malicious action. The simplest DoS attack tries to exhaust the resources available to the node, by sending extra unnecessary packets. At Physical Layer the DoS attacks could be jamming and tampering, at Link Layer, collision, at Network Layer, misdirection and at Transport Layer this attack could be performed by malicious flooding and resynchronization. In a sensor network, sensors monitor the changes of specific parameters or values and report to the sink according to the requirement. While sending the report, the information in transit may be altered, vanished.

In this paper johansson et al.[2] compare the energy efficiency of single hop and multi hop4 taking into account circuit energy consumption as well as transmission energy. Initial purpose of finding a fundamental limit of multi-hop energy efficiency it success to compare single-hop with two-hop.

In this paper yassein et al.[5] discussed clustering based protocol for wireless sensor network.
A cluster based routing protocol groups sensor nodes where each group of nodes has a CH or a gateway. Sensed data is sent to the CH rather than send it to the BS, CH performs some aggregation function on data it receives then send it to the BS where these data is needed.
They discuss LEACH protocol 5 Phases of LEACH protocol. Different phases of LEACH are
Set-up Phase
(1) Advertisement Phase
(2) Cluster Set-up Phase
Steady Phase
(1) Schedule Creation
(2) Data Transmission
They also discuss another cluster based protocol V-LEACH. In V-LEACH the cluster contains, CH (responsible only for sending data that is received from the cluster members to the BS), vice-CH (the node that will become a CH of the cluster in case of CH dies), cluster nodes (gathering data from environment and send it to the CH).

In this paper atiyar et al. [12] discussed sensor network can be made scalable by assembling the sensor nodes into groups i.e. clusters. Every cluster has a leader, often referred to as the cluster head. A CH may be elected by the sensors in a cluster or pre-assigned by the network designer. The cluster membership may be fixed or variable. Clustering is a key technique used to extend the lifetime of a sensor network by reducing the energy consumption. They also discussed the Distributed Energy Balance Clustering Protocol for heterogeneous wireless sensor networks. DEBC elects cluster heads based on the knowledge of the ratio between remaining energy of node and the average energy of the network. They also discussed Stability oriented Clustering protocols for heterogeneous wireless sensor networks. It increases the stability period of wireless sensor networks. Stability period is actually the time interval before the death of the first node.

In this paper pesovic et al.[11] describes that Overall WSN node power consumption depends on processors, transceiver's power consumption and on the operation regime of these components (switching between idle and operating mode). Most of the node energy is consumed by radio transmission. Power savings in radio transmission are usually achieved by use of energy efficient medium access and routing protocols. They also described that single hop routing is much more energy efficient than multi-hop routing, using real world WSN transceivers. Besides energy efficiency, single-hop routing can also have advantages for other network parameters.
The compression process is carried out by employing the Human coding algorithm and data of a particular node is obtained from the sink node.

In this paper sharma et al. [8] describes an a improved redundant cluster head selection mechanism for SEP-E has been proposed to balance the network load and to extend the network life time. In order to select reasonable cluster heads, first select an initial cluster head and a redundant cluster head in every cluster at each round. The node which has higher remaining energy and minimum mean distance is elected as cluster head of current round. SEP-E assigns a weight to the optimal probability .This weight must be equal to the initial energy of each node divided by the initial energy of the normal node. In order to select the initial redundant cluster head SEP select a node in the cluster that has more energy than other nodes except the initial cluster head in the cluster, that node becomes the initial redundant cluster head. Initial cluster head and initial redundant cluster head both have chance to be cluster head. After selecting initial cluster head (ICH) and redundant cluster head (RCH), SEP should determine which node is elected as cluster head. The specific steps are as follows:
1) ICH and RCH both use flooding way to broadcast status information.
2) When ordinary nodes receive the status information they broadcast their own status information and forward the other nodes status information which they received.
3) ICH and RCH calculates mean distance to all other nodes in the cluster. Both of the nodes send their minimum mean distance to the base station.
4) Base station receives the information and calculates the weight. Which node has more energy selects as cluster head.

III. PROPOSED METHODOLOGY

In the proposed work we have focused on the Energy Consumption in WSN Using Mobile Sink and Hierarchal Clustering. There is concept of bringing mobile sinks to sensing field to save energy of cluster heads while sending data to mobile sinks instead of fixed sink on base station. In our research we will divide the sensing field into two equal grid levels. These areas are independent to each other for communication and sensing of data by sensor nodes. Mobile sinks have been placed in these grid areas for saving energy by fetching data from heads only. Number of mobile sinks is based on the density of the clusters in particular grid area. Cluster heads have been decided on the base of residual energy which should be better then threshold energy decided by average residual energy. Data travelled from cluster heads to nearest mobile sink in associated with their grid area only.

3.1 Proposed Model

The proposed work MSAODV(Mobile Sink Ad-hoc On-Demand Vector Routing Protocol) proceeded with implementation of mobile sink concept to obtain the better

results. Some of the milestones which need to be fulfilling to simulate research proposed concept is given below:

- Find the solution for better communication in between sensor and sink.
- To minimize the latency for communication.
- Increase packet delivery ratio.
- Increase network lifetime while communication by saving resources.

A proposed concept of mobile sink is used to avoid the battery drain of the wireless sensor network. For experimentation we have used network simulator version 2 with animation for the concept of mobile sinks. Various parameters used for experimentation is below table 1:

Table 1: Parameters used for the experimentation

Parameters	Value
Simulator	NS2
Simulation Time	900
No of nodes	20
Routing Protocol	AODV
Traffic Model	CBR
Pause Time	100 sec
Speed	11 mps
Mobile Sinks	5
Number of sources	6
Sub-packet size	256 bytes
Transmit Power	15mW
Receiving Power	13 mW
Initial battery power	100j
MAC layer	802.11

3.2 Proposed Methodology

The proposed work use to simulate sensor network implementation and proceeded with saving energy for sensors. At initial phase basic functionality and collection of information (simulator, basic sensor functions etc) has been done. Network simulator has been used to provide the simulation and results of the proposed work. Fig 1 shows he concept approach for experimentation. Sensing area consider as 670 × 670 meters with variation of nodes around 20 nodes. Various parameters for experimentation is shown in table 1. The transmitting and receiving power has been configured with basic energy carried by sensor nodes. The initial state is for selecting cluster heads based on the residual energy of the nodes. Further we have implemented a simple scenario for sensor nodes and divided the grid area into equal parts. Sensing process starts with computation and communication later on. After this we have implemented the technique for mobile sink into grid area. Number of mobile sinks is based on the density of the clusters available in particular field. Further we have implemented the complete communication process for sensor network which works in different sense fields with mobile sink in very close to various cluster heads. Finally we have done comparison for AODV and MSAODV process with packet delivery ratio and energy consumption as base parameters.

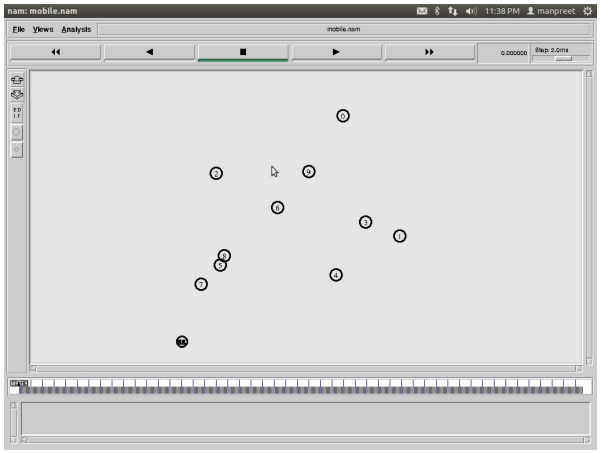

Fig 1: Simulation scenario for experimentation

IV. RESULTS

The results are based on the simulation of mobile sink concept in sensing field for wireless sensor network. Fig 2 shows the energy consumption comparison for the proposed work and normal AODV protocol in sensor network. The comparison shows the energy consumption in case of mobile sink is less as compared to the energy consumption by the normal AODV.

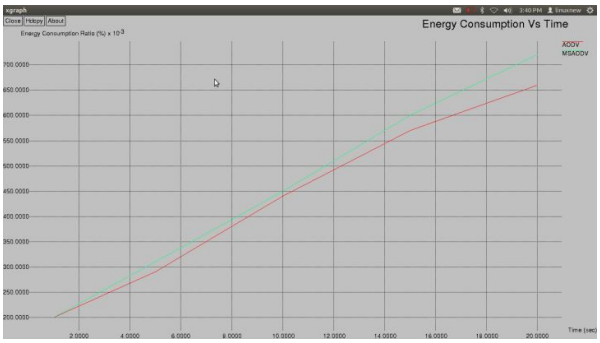

Fig 2: Comparison of AODV and MSAODV in term of energy consumption

The communication of sensor nodes is done with routing process and according to the parameters defined in the network various cluster heads. Normally the wireless sensor nodes are limited with energy and during communication by sensing area, energy consumption by the nodes occurred. This energy consumption is directly proportional the task performed by the sensor nodes. In normal communication while sending data to sink resources consumption goes up but in case of mobile sink consumption is quite low.

Figure 3 shows the packet delivery ratio comparison for the proposed work and normal AODV protocol in sensor network. The comparison shows the number of packets is more in case of mobile sink scenario as compared to normal AODV.

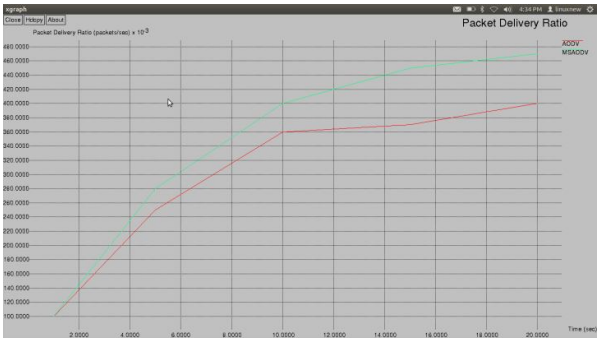

Fig 3: Comparison of AODV and MSAODV in term of Packet Delivery Ratio

Fig 3 shows the packet delivery ratio for both scenarios. In particularly clustering, RSSI value for distance calculation and increased number of packet delivered. As discussed earlier, packet delivery is done to mobile sink not to the main sink so the increase of packet delivery occurred. The results shown above summarized the performance of the proposed scheme for saving resources in wireless sensor network. Traditional AODV process scheme provide good solution for communication but proposed scheme have much better performance in saving resources and to reduce energy consumption. The energy consumption is less in case of mobile sink communication in wireless sensor network as compared to the normal AODV process. The purpose of mobile sink is very helpful in saving energy in wireless sensor network.

V. CONCLUSION

This proposed work is based on the concept of saving of resources in the wireless sensor network area by bringing concept of mobility in the sink nodes. This research is very useful in saving resources and in process to improve the lifetime of the wireless sensor network. This particular research has considered clustering of the nodes and various mobile sinks for collecting data from the nodes. Cluster heads has been selected by counting on the highest residual energy carried by a wireless sensor node. Mobility of the sink nodes has been defined and number of sink used is five and number of sink is decided on the basis of density in the sensing network area. Moreover lifetime of wireless sensor network is improved with implementation of mobile sinks in the network. Further the congestion in the network has also been improved as compared to the previous scenarios.

REFERENCES

[1] Rudranath Mitra1 and Diya Nandy, "A Survey on Clustering Techniques for Wireless Sensor Network", International Journal of Research in Computer Science, 2012.

[2] Avinash Srinivasan and Jie Wu, "A Survey on Secure Localization in Wireless Sensor Networks", Journal Of Networks, 2012.

[3] Prerana Shrivastava, Dr. S. B. Pokle, " A Hybrid Sink Positioning Technique for Data Gathering in Wireless Sensor Networks", International Journal of Engineering and Innovative Technology, 2012..

[4] Jukka Kohonen, “Data Gathering in Sensor Networks”, Helsinki Institute for Information Technology, 2004.

[5] Manoussos Athanassoulis, Ioannis Alagiannis and Stathes Hadjiefthymiades,” Energy Efficiency in Wireless Sensor Networks: A Utility-Based Architecture”, in proceeding of 13th European Wireless Conference, April 1 to 4, Paris, France, 2007.

[6] Xiaobing Wu, Guihai Chen and Sajal.K.Das, “On the Energy Hole Problem of Non-uniform Node Distribution in Wireless Sensor Networks”, the IEEE International Conference on Mobile Adhoc and Sensor Systems, 2006.

[7] Jian Li and Prasant Mohapatra, “Analytical Modeling and Mitigation Techniques for the

Energy Hole Problem in Sensor Networks", Pervasive and Mobile Computing, 2007.

[8] Hung-Yu Shiue, Gwo-Jong Yu, and Jang-Ping Sheu, "Energy Hole Healing Protocol for Surveillance Sensor Networks", In Workshop on WASN 2005.

[9] Zoltan Vincze, Rolland Vida and Attila Vidacs, "Deploying Multiple Sinks in Multi-hop Wireless Sensor Networks", Pervasive Services, IEEE, 15-20 July, 2007.

[10] E.M.Royer, C.K.Toh, "A Review of Current Routing Protocols for Ad hoc Wireless Mobile Networks", IEEE Personal Communications, April 1999.

[11] Gowrishankar, T.G.Basavaraju, Manjaiah D.H, Subir Kumar Sarkar, " Issues in Wireless Sensor Networks", Proceedings of the World Congress on Engineering, 2008.

[12] H. Sivasankari, K. Shaila, K. R. Venugopal, and L. M. Patnaik," Multiple Dynamic Sinks to Maximize the Lifetime and Conservation of Energy in Wireless Sensor Networks", International Journal of Computer Theory and Engineering, February 2012.

[13] H. Sivasankari, M. Vallabh, K. Shaila, K. R. Venugopal, and L M Patnaik, " Multiple mobile synchronized sinks(MMSS) for energy efficiency and lifetime maximization in wireless sensor networks," in Proc. 13th ICIES-2011, June 2011.

[14] Z. Maria Wang, Stefano Basagni, Emanuel Melachrinoudis and Chiara Petrioli, "Exploiting Sink Mobility for Maximizing Sensor Networks Lifetime", Proceedings of the 38th Hawaii International Conference on System Sciences - 2005.

[15] E. H. Callaway, Jr.," Wireless Sensor Networks: Architectures and Protocols", Boca Raton, FL: Auerbach Publications, August 2003.

[16] J. Al-Karaki and A. Kamal, "Routing Techniques in Wireless Sensor Networks: A Survey," IEEE Wireless Communications, 2004.

[17] S. Singh, M. Singh and D. Singh, "Routing Protocols in Wireless Sensor Networks: A Survey," International Journal of Computer Science and Engineering Surveys, 2010, doi:10.5121/ijcses.2010.1206.

[18] Fahed Awad, Eyad Taqieddin, Asmaa Seyam, "Energy-Efficient and Coverage-Aware Clustering in Wireless Sensor Networks", Wireless Engineering and Technology, 2012, doi:10.4236/wet.2012.33021.

[19] Wendi Rabiner Heinzelman, Anantha Chandrakasan and Hari Balakrishnan, "Energy-Efficient Communication Protocol for Wireless Microsensor Networks", IEEE, 2000.

[20] K.Ramesh and Dr. K.Somasundaram, "A comparative Study of Clusterhead Selection Algorithms in Wireless Sensor Networks", International Journal of Computer Science & Engineering Survey (IJCSES) Vol.2, No.4, November 2011.

[21] Joongjin Kook 1, Young-Choong Park 1, Byoung-Ha Park 1, and Jiman Hong, "An Adaptive Clustering Scheme Related to the Sink Position for Sensor Networks", 2012 International Conference on Intelligent Information and Networks (ICIIN 2012), IPCSIT vol. 23 (2012) © (2012) IACSIT Press, Singapore.

[22] Hongyang Chen1, Kaoru Sezaki2, Ping Deng3, Hing Cheung So4, "An Improved DV-Hop Localization Algorithm for Wireless Sensor Networks", 978-1-4244-1718-6/08/$25.00 ©2008 IEEE.