ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

An Energy Efficient and QoS Aware Routing Protocol for Wireless Sensor Network

Kalyani Khanke[1], Mamta Sarde[2]

P.G Student, Dept. of Electronics Communication Engg., AGPCET, Nagpur, India[1]

Faculty, Dept. of Electronics Communication Engg., AGPCET, Nagpur, India[2]

Abstract: A wireless sensor network (WSN) is a collection of nodes organized into a cooperative network, which are small energy constrained devices The efficient use of energy source in a sensor node is most desirable criteria for prolong the life time of wireless sensor network. In WSN, sensors near the static sink have to relay the data of the nodes away from the sink and as a result they drain their energy very quickly. It result in network partitioning and can significantly limit the network lifetime, problem is termed as hotspot problem. So designing efficient routing for reducing energy consumption is the important factor. Recently, mobile sink approach has been used to address the hotspot problem but it increase end to end delay which is not acceptable for delay sensitive application. In this paper, to solve the above problem the consumption of energy during the transmission of data from sensor nodes to the sink has been calculated. Routing protocols in WSNs along with the most energy efficient protocol named LEACH (low energy adaptive clustering hierarchy) and AODV protocol is used. the proposed protocol incurs less end to end delay and is energy efficient. Intensive Simulations are carried out to evaluate the performance of the proposed strategy.

Keywords: Wireless sensor network, clustering, energy efficiency, data gathering, mobile sink, static sink, LEACH, Shortest path routing.

1. INTRODUCTION

The collection of large number of sensor nodes densely deployed in an area to detect some physical phenomenon is termed as Wireless Sensor Network (WSN). A classic architecture of WSN includes randomly deployed sensor nodes near to which Base Station (BS)/sink is placed. Sink is connected to internet through any other wired or wireless network. Sink gives instructions to sensor nodes and gathers sensed data from them. As per the application requirement, sensor nodes sense the desirable physical phenomenon and locally do the data aggregation to avoid communication of redundant data. It sends aggregated data to sink using hop-byhop communication. In contrast to traditional wireless networks, a WSN has its own design and resource constraints. Resource constraints include limited battery power (energy), low sensing power, limited processing power, limited memory and storage space, low communication range and low bandwidth. Design constraints are application dependent and may include random deployment, hundreds or thousands of sensor nodes and environment inaccessible by humans. All these constraints make protocol design in WSN a challenging task. Generally, sensor node does not have power and communication range to directly forward the sensed data to the BS. Hence, a sensor node does not only sense and send its own data but also act as router and propagate the data of its neighbors. In a typical WSN architecture, the sink is static and nodes use multi-hop communication to forward their data to the sink. Consequently, nodes near to the sink deplete their battery power quickly causing a problem termed as hot spot problem. Hotspot problem refer to the phenomenon when the nodes near to the sink quickly drain their energy on account of relaying the data of the nodes farther from the sink. As a result, though the nodes farther from the sink has significant energy left but their energy cannot be utilized as the nodes near to the sink have depleted their energy and hence, it cannot send their data to the sink across hot spot causing energy hole near the sink. This can significantly minimize network lifetime. Static nature of the sink is the main reason behind the hot spot problem, as most of the time same nodes near the sink have to forward the data. Main advantage of the static sink approach is that it involves less end to end delay.

In recent years, contrary to static sink, mobile sink approach has attracted much research interest because of its potential to improve network performance such as energy efficiency and throughput. But main disadvantage of mobile sink approach is that it encounters long end to end delay.

In this paper, the static and mobile sink approaches are combined. It gives advantage of low end to end delay of static approach and energy efficiency of mobile sink approach which minimize the hotspot problem. In proposed model, mobile sink moves in the clustered WSN to collect sensed data from the Cluster heads within its vicinity. At a particular instance of time Cluster heads in the neighborhood of the mobile sink forward their data to the sink. The rest of the cluster heads in the network; wait for their turn to come in to mobile sink vicinity. In this way, during sink movement, all the nodes in the network forward their data to the mobile sink, when mobile sink comes in their neighborhood. Similarly, delay sensitive data is forwarded to the static sink. During data gathering mobile sink also maintains information about the queue length and residual energy of the nodes. Mobile sink neighboring nodes forward their data to the sink using multi-hop or single hop super node Communication. In this way, due to the mobility of the mobile sink, nodes

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

near to the sink change after some time. Hence, no hotspot is created because during sink movement, responsibility of relaying the data is alternatively share by different high energy CHs near the sink. It results in a balanced use of WSN energy and improves network life time. Similarly, delay sensitive is send to the static sink, which helps in achieving the QoS requirements of the delay sensitive traffic. Consequently, hotspot is not formed around the sink as the sink move in the network and as the result the nodes in the network are able to use their energy in balanced manner.

The remainder of this paper is organized as follows: Section 2 presents the related works .Section 3 describes the proposed protocol in details. In section 4 we make analysis and simulation results. Finally, section 5 draws conclusions and shows the future works.

2. RELATED WORK

Data gathering in WSN is usually performed by sensor nodes relaying data towards a static control centre using multi hop communication. In static sink, to deliver a single packet to the BS, by virtue of multi-hop communication involves many sensor nodes on the way to BS. It results in early depletion of energy of some nodes, thus forming energy hole. Since, sensors near the sink have to participate in relaying data on behalf of other sensors. Thus will drain their energy very quickly, resulting in network partitioning and limitation of the network lifetime. Consequently, formation of energy holes near the sink is emerged as critical issue for limiting network lifetime in WSN.

In WSN, recently a novel approach of using mobile sink in WSN is catching momentum. Approach involves movement of sink inside the network area to collect the data and minimize cost [3-9]. Approach getting popularity by emergence of its important application (mostly associated with pervasive sensing and ubiquitous computing). Factors contributing to use of mobile sink is motivated by the imminent growth in increasing number of event-based user-centric network applications like ambient intelligence applications, remote monitoring, smart buildings/rooms, rescue missions, intrusion detection and other pervasive computing applications.

In [10] New advancements in Wireless Sensor Networks (WSN), lead to many novel routing protocols specifically designed by considering QoS and energy efficiency as the main objective, to maximize the whole network efficiency and lifetime.

In [14], Multipath routing protocols improve the load balancing and quality of service in WSN and also provide reliable communication. This investigates various multi-path routing protocols of the WSN in the literature and illustrates its benefits. The main elements of these schemes and their classifications based on their attributes have been also discussed. A comparison of these protocols which are of great help to understand the properties and limitations of existing solutions have been done in the following study.

In [15], Sensor nodes in WMSNs should be able to collect various forms of sensing data, prioritize each form of data based on the application service request conditions, and provide a certain degree of Quality of Service (QoS) guarantee. We propose a routing protocol that can provide QoS that appropriately reflects changes in network status regarding reliability and delay, even in circumstances with a deficiency in sensor node resources. Our algorithm has the advantage of minimizing the routing control messages and therefore can safely operate from an energy-efficient perspective, as the algorithm utilizes broadcast messages regularly transmitted by the sink node.

3. PROPOSED PROTOCOL

Data gathering in mobile sink based Clustered WSN can be divided in to two main phases: Setup Phase and Steady Phase. Explanation of proposed protocol is based on these phases. Following are the description of key responsibilities of these phases:

A. Setup Phase

During this phase, each node determines its residual energy and its location. Clustering is done and route to the static/mobile sink is also formed in this phase. Setup phase is further divided into three sub-phases Initialization and Clustering

1) Initialization:

In this phase, after random deployment, each node determines its residual energy (i.e., battery power left) and its location in which it lies. The information like residual energy and distance to a BS is later used in decision making, such as Cluster-Head (CH) selection, and sink movement.

2) Clustering:

In this phase, clustering of nodes is done. All the nodes in a particular cluster choose a leader node, known as cluster head (CH). The sensor nodes must associate themselves with some of these CHs and become members of a local group (cluster). Each group of nodes sends their data to the CH and then to the static/mobile sink. The following protocol is used for clustering.

The proposed model is on LEACH. LEACH is one of the first hierarchical routing protocols for WSNs. The idea proposed in LEACH has inspired many other hierarchical routing protocols. Clustering is the method by which sensor nodes in a network organize themselves into hierarchical structures. By doing this, sensor nodes can use the scarce network resources such as radio resource, battery power more efficiently. Within a particular cluster, data aggregation and fusion are performed at cluster- head to reduce the amount of data transmitting to the base station. Cluster formation is usually based on remaining energy of sensor nodes and sensor's proximity to cluster-head. Non cluster-head nodes choose their cluster-head right after deployment and transmit data to the cluster-head. The role of cluster-head is to forward these data and its own data to the base station after performing data aggregation and fusion.

B. Steady Phase

In steady phase, proposed protocol performs the actual data gathering task. Steady phase can be further divided into subphases:

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

1) Forwarding data to CH/super node:
When a data is sensed by the sensor node, it needs to be propagated to the BS. It is buffered in the queue of the sensor node. Data forwarding decision is taken at CH node sensor based on delay constraint of the data.
During this phase, each sensor node sends sensed data to their respective elected CH. Each CH sends collected sensed data to their respective super node. As data have already been accumulated by super node from its CH, super node will calculate its Queue Weight (QW). It is the calculation of the weight of the queue, which is sum of the number of packet in the queue. Super node sends the delay constraint data to the static sink along the route already been made in route update phase and forwards delay tolerant data to the mobile sink.
2) Forwarding data to the static sink:
Main shortcoming of the mobile sink approach is that, it maximizes end-to-end delay. As each sensor have to wait for mobile sink to comes in its vicinity to forward data. To avoid this drawback in addition to mobile sink, a static sink is used. Important data as dictated by its priority is send to the static sink to minimize its end-to-end delay. Delay tolerant data is send through the mobile sink, when it comes in its vicinity.
3) Sink Movement Decision:
In this phase mobile sink takes the decision to move to the next place. Movement of the mobile sink in first movement cycle is according to predefined position. But to ensure balance used of energy movement of mobile sink in second and subsequent cycles are dictated by the residual energy and queue weight of the nodes in the network. Mobile sink gets this residual energy and queue weight information from the sensor nodes while getting sensed data from them in previous phase. After completion of every cycle, sink node sort the queue weight and residual energy of the super nodes and take the decision about movement plan. It is to make sure the heavily loaded node and nodes with high energy visited first. It helps in increasing the network lifetime and minimizing the delay. Furthermore, with regular sink movement nodes near to the sink changes with each movement. Thus, chances of formation of hop spot problem or energy hole is minimized.

4. SIMULATION

For analysation we used NS2 and tested our protocols. For performance evaluations following parameters are taken into account: Energy, Delay.

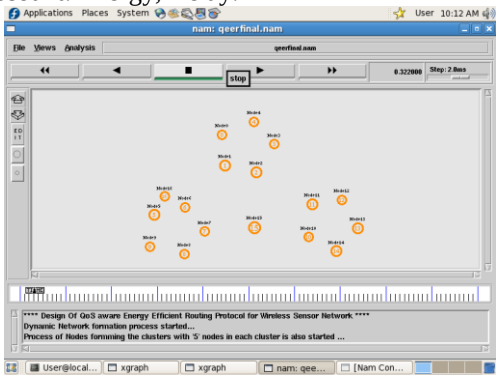

Fig.1 . Wireless Sensor Network formation

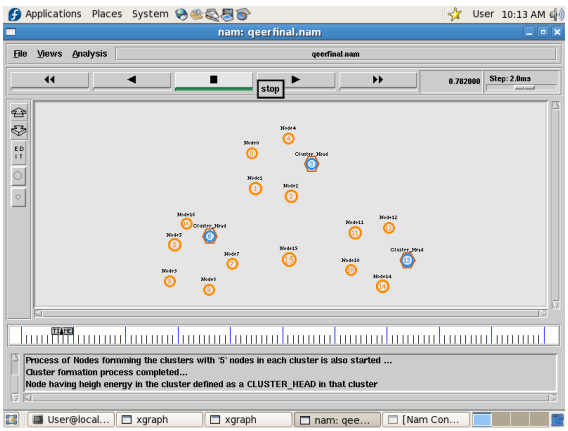

Fig.2 Cluster head defining

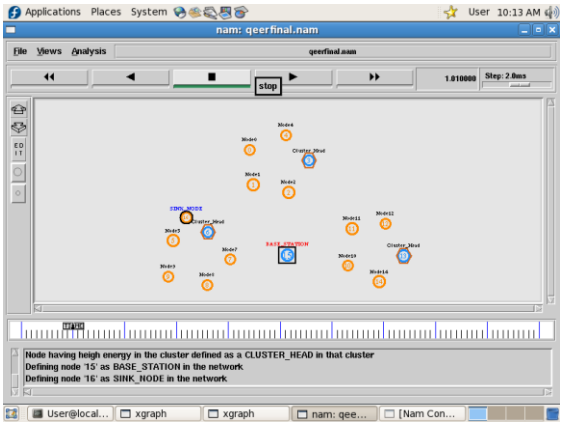

Fig.3 Mobile sink defining

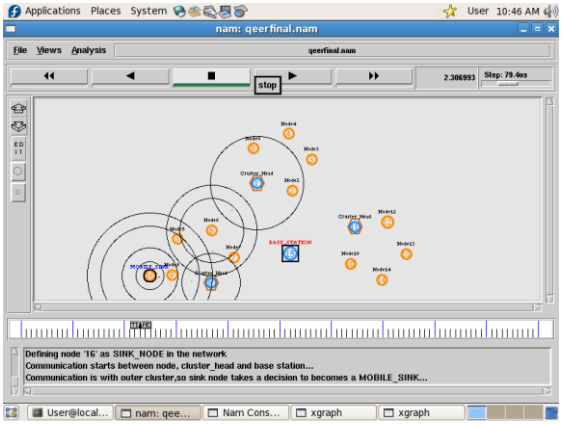

Fig. 4 Data Transmission Using Mobile Sink

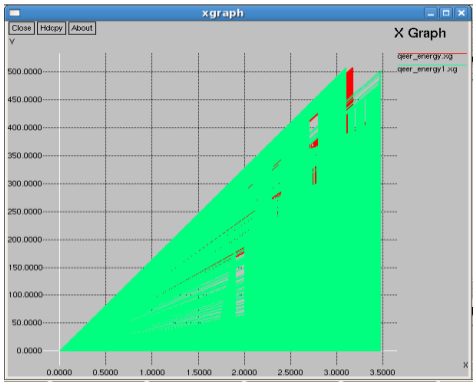

Fig.5 Comparison between energy for Normal protocol and proposed protocol

DOI 10.17148/IJARCCE.2015.4781

ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 7, July 2015

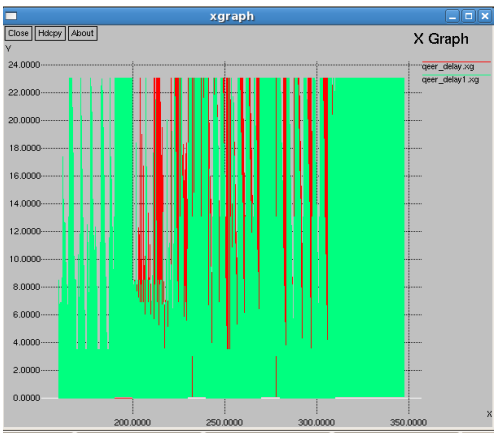

Fig.6 Comparison between delay for Normal protocol and proposed protocol

In the given graphs, green color indicates normal network, red color indicates proposed protocol.

5. CONCLUSION

In this paper, Energy Efficient and QoS aware Energy Efficient Routing protocol for Clustered Wireless Sensor Network is proposed. To evaluate the performance of the proposed strategy, intensive simulation is carried out using NS-2. Performance of the proposed strategy is compared to the normal network using metrics such as energy per packet and delay. The simulation results demonstrated that mobile sink strategy outperforms both static sink and mobile sink strategies in terms of energy per packet and delay. It suggests that performance improvement can be made by using mobile sink in clustered WSN.

REFERENCES

[1] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam, E. Cayirci, "A survey on sensor networks", IEEE Communications Magazine 40(8) (2002) pp.104–112.

[2] Jennifer Yick, Biswanath Mukherjee, Dipak Ghosal, "Wireless sensor network survey", Computer Networks Computer Networks 52 (2008) 2292–2330.

[3] Saad, E.M., M.H. Awadalla,, R.R. Darwish, "A Data Gathering Algorithm for a Mobile Sink in Large-Scale Sensor Networks", The Fourth International Conference on. Wireless and Mobile Communications, 2008. ICWMC '08, 2008.

[4] Bin, W., et al. "Employing Mobile Sink in Event-Driven Wireless Sensor Networks. in Vehicular Technology Conference", 2008. VTC Spring 2008. IEEE. 2008.

[5] Bin, W., et al. "Deploying Multiple Mobile Sinks in Event-Driven WSNs. in Communications", 2008. ICC '08. IEEE International Conference on. 2008.

[6] Vincze, Z., R. Vida, and A. Vidacs, "Deploying Multiple Sinks in Multi-hop Wireless Sensor Networks" in Pervasive Services, IEEE International Conference on. 2007

[7] Trinh, T.H. and H.Y. Youn. "On Mobile Sink Node for Target Tracking in Wireless Sensor Networks". in Pervasive Computing and Communications Workshops, 2007. PerCom Workshops '07. Fifth Annual IEEE International Conference on. 2007.

[8] Song, L. and D. Hatzinakos, "Architecture of Wireless Sensor Networks With Mobile Sinks: Sparsely Deployed Sensors". Vehicular Technology, IEEE Transactions on, 2007. 56(4): p. 1826-1836.

[9] Khalid, Z., G. Ahmed, and N.M. Khan, "Impact of Mobile Sink Speed on the Performance of Wireless Sensor Networks". Journal of Information & Communication Technology, 2007. 1(2): p. 49-55.

[10] Mansoor-uz-ZafarDawood, Noor Zaman, Abdul RaoufKhan,MohammadSalih,"Designing of Energy aware Quality of Service (QoS) based routing protocol for Efficiency Improvement in Wireless Sensor Network (WSN)" Journal of Information & Communication Technology Vol. 4, No. 1, (Spring 2010)

[11] Long Cheng, JianweiNiu, Jiannong Cao, Sajal K. Das, Yu Gu," QoS Aware Geographic Opportunistic Routing in Wireless Sensor Networks" IEEE 2010.

[12] Babar Nazir1, Halabi Hasbullah2," QoS aware Energy Efficient Routing Protocol for Wireless Sensor Network" IEEE 2011

[13] R.Sumathi and M.G.Srinivas," A Survey of QoS Based Routing Protocols for Wireless Sensor Networks" J Inf Process Syst, Vol.8, No.4, December 2012

[14] Mohammad Masdari1 and Maryam Tanabi2, " Multipath Routing protocols in Wireless Sensor Networks: A Survey and Analysis" International Journal of Future Generation Communication and Networking Vol.6, No.6 (2013)

[15] Sung-Keun Lee1, Jin-Gwang Koh2 and Chang-Ryul Jung2 ," An Energy-Efficient QoS-aware Routing Algorithm for Wireless Multimedia Sensor Networks" International Journal of Multimedia and Ubiquitous Engineering Vol.9, No.2 (2014), pp.245-252