International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-1 Issue-6, August 2012

Dynamic Event Based Energy Efficient Routing Protocol for Wireless Sensor Networks (WSNs)

Ashish Xavier Das, Charlie Eapen, A. Ashok, Sudhanshu Tripathi, Ridha Mabruk Shadi

Abstract—Wireless sensor networks (WSNs) are being increasingly deployed for various applications such as object tracking and monitoring, precision agriculture, controlling nuclear reactors, detecting seismic activities, security and surveillance, navigational activities, industrial automation, and so on. The main purpose of such networks is to gather information from the environments and deliver the same to the applications. The smartness in functioning of smart environments rely primarily on gathering sensory data through WSNs. The sensor nodes are typically resource deficient with energy being the most critical of all the resources. The nodes in a WSN are connected typically to a powerful controlling node called the base station.

Index Terms: Wireless Sensor Network (WSN), EBEERP, LEACH, PEGASIS, Data Gathering Decimation (DGD), Cluster-Head (CH).

I. INTRODUCTION

A wireless sensor network (WSN) consists of spatially distributed autonomous devices called sensors, and one or more base stations to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations. The research in sensor networks received a big boost with a number of funding initiative by US military. Many novel sensor based applications have emerged in recent past. We may classify the sensor applications into following classes Monitoring spaces: This class refers to passive data gathering recognizing occurrence of some events or conditions. The gathered data are typically inputs to a number of target applications. These target applications includes habitat monitoring, monitoring of crops (failure, pest attack), climate control, security surveillance, intelligent alarms (fire, flash flood, volcanic eruption), etc.

Monitoring things: This class refers to gathering data to recognize occurrence of specific states of a system. On occurrence of these states the system may execute a sequence of internal transitions to get into a desirable state. The target applications could be structural monitoring (bridge health monitoring), equipment maintenance, medical diagnostics, etc.

Manuscript published on 30 August 2012.
***** Correspondence Author (s)
Er. Ashish Xavier Das, Department of Electronics & Communication Engineering, SHAITS, Allahabad-211007, India.
Er. Charlie Eapen, Department of Electronics & Communication Engineering, SHIATS, Allahabad-211007, India.
Er. A. Ashok, Department of Electronics & Communication Engineering, SHAITS, Allahabad-211007, India.
Er. Sudhanshu Tripathi, Department of Electrical & Electronics Engineering, SHIATS, Allahabad-211007, India.
Er. Ridha Mabruk Shadi, Department of Electronics & Communication Engineering, SHIATS, Allahabad-211007, India.

Every sensor has three basic units, namely, sensing, radio, and battery. The major constraint being limited energy (small battery unit). Consequently, a large number of sensor nodes can be networked to gather sensory data and each sensor performs two main responsibilities, namely, (i) sensing activities, and (ii) routing the sensed data to the base station or a controller. The base station is a master node which is generally fixed and assumed to have uninterrupted power supply or accessible for maintenance (such as replacement of battery). It acts as an interface of the WSN for complex interactions with other objects. The main responsibility of base station is to collect information from various sensor nodes and process it for further dissemination/actions.

II. RELATED WORK

A. Wireless Sensor Networks:

Wireless Sensor Network is a heterogeneous network composed of a large number of small low-cost devices called nodes and few general-purpose computing devices referred to as base stations. A sensor network is a deployment of massive numbers of small, inexpensive, self powered devices that can sense, compute, and communicate with other devices for the purpose of gathering local information to make global decisions about a physical environment".

B. Components of wireless sensor network:

a. **Sensor Field***:* A sensor field can be considered as the area in which the nodes are placed.
b. **Sensor Nodes***:* Sensors nodes are the heart of the network. They are in charge of collecting data and routing this information back to a sink.
c. **Sink***:* A sink is a sensor node with the specific task of receiving, processing and storing data from the other sensor nodes.
d. **Task Manager***:* The task manager also known as base station is a centralized point of control within the network, which extracts information from the network and disseminates control information back into the network. It also serves as a gateway to other networks, a powerful data processing and storage centre and an access point for a human interface. The base station is either a laptop or a workstation. Data is streamed to these workstations either via the internet, wireless channels, satellite etc. Due to WSNs differing from one network to another, many new algorithms have been proposed for the routing problem in WSNs. These routing mechanisms have considered the characteristics of sensor nodes depending on the type of application and underlying architecture requirements.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

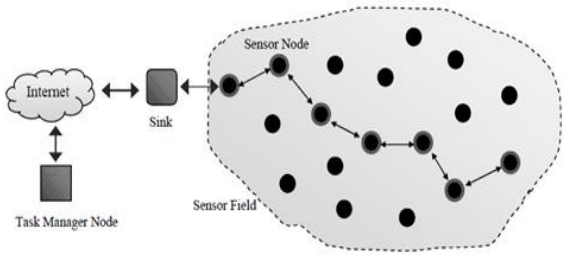

Figure 1: Components of Wireless Sensor Networks

Routing Techniques in Wireless Sensor Networks:

Almost all of the routing protocols can be classified according to the network structure as flat, hierarchical or location-based.

The design of routing protocols for WSN is a subject of intense research as both quality and quantity of information delivered to the end-users is very important for the applications centred on WSN. It has been observed that different protocols work better in different environments/applications. The issue of the effective utilization of energy resource has also been addressed in extensively in the literature. This chapter deals with related work and the underlying concepts which form the basis of energy aware routing protocols for WNSs.

How simple routing ideas could lead to unnecessary wastage of precious energy resources. It deals with some initial thinking done by researchers on the ways to avoid broadcast storm which appear to be the main reason behind excessive energy was a gain routings ideas based on flooding and gossiping. Its describes a number of routing protocols, namely, LEACH , and PEGASIS , which try to eliminate redundant data broadcast and conserve the crucial energy resource by aggregation in some way or other.

The underlying idea of flooding is that each sensor on receiving a data packet broadcasts the same to its every neighbour. This packet is further re-broadcast until it arrives at the destination or the maximum number of hops for the packet is reached. Quite obviously, flooding raises unmanageable broadcast storms as depicted. It may be appropriate for networks which experience quick topology changes. WSN mainly consists of static sensors nodes. So, topology remains more or less static for a considerable period of time. Of course, it is possible to control topology by adjusting transmission power of sensor motes. Batteries, they can ill-afford such associated problems arising out of broadcast storms.

C. LEACH Protocol:

Low-Energy Adaptive Clustering Hierarchy (LEACH) is a clustering based protocol that uses a randomised rotation of local cluster base stations. The nodes in LEACH are divided into clusters and each cluster consists of members called Cluster Members and a coordinator node called the Cluster Head, CH. The cluster heads are not selected in the static manner that leads to quick die of sensor nodes in the network. However, the randomised protocol has been used in order to balance the energy consumption among the nodes by distributing the CH's role to the other nodes in the network. Furthermore, LEACH uses Time Division Multiple Access (TDMA) protocol in order to regulate the channel access within a cluster. It is the responsibility of the CHs to assign TDMA slots to the cluster members. The peer to peer communication between the CH and a member is done just during the time slot that assigned to that member, and the other members will be in their sleep state. Hence, it decreases the energy dissipation;

LEACH has been produced to overcome the disadvantages of the Flat-Architecture Protocols that consume. more energy . The CH aggregates/combines the collected data by the nodes to the smaller size and meaning full data, and then sends the aggregated data to the sink consuming less energy. LEACH tries to send the data over short distances and reduce number of the transmissions, where the energy consumptions depend on the distance and data size. As a result, the main problem with LEACH is the direct sending of CH to the sink, especially when these CHs are located far away from the sink. However, allowing the multi-hop transmission to the sink through other CHs will solve this issue, where the CH just forwards the data to others until it reaches the sink and does not have to re-aggregate the data come from other CHs.

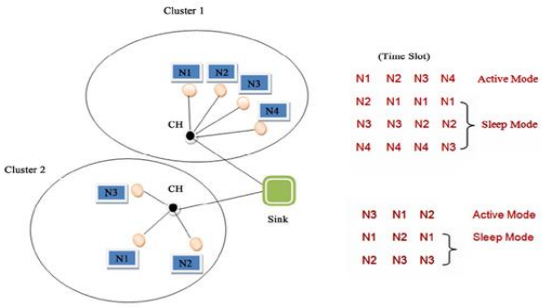

Figure 2: The CH aggregates

D. Energy Efficient System Utilization:

While system design is concerned with selection and organization of system components, the system utilization addresses the question of how those components should be used. Electronic systems often consist of one or more microprocessors and a set of devices with multiple low-power states. Many microprocessors support dynamic clock frequency adjustment, and some newer devices also support dynamic supply voltage setting Thus, at the system level it is possible to reduce energy by transitioning components into low power states (dynamic power management) and by changing the frequency and voltage level of the microprocessor (dynamic voltage scaling).

E. Energy Efficient System Design

Energy efficient system design requires the reduction of energy consumption in all portions of a system. System level design of hardware is concerned with selection and organization of the components. Software design is concerned with definition and selection of operating system, application software and compilers. The interaction between software and hardware components can greatly affect the energy consumption at the system level. Thus it is of critical importance to have a fast and easy way to evaluate energy consumption of the whole system during stages of software and hardware.

F. Definition of Energy Efficiency

For a wireless networks, the devices operating on battery try to pursue the energy efficiency heuristically by reducing the energy they consumed, while maintaining acceptable performance of certain tasks.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

However, for multi-hop routing, which is typical for ad hoc and sensor networks, this is not the optimal strategy. Take the following network as an example. In the energy consumption for transmitting one bit over each link is labelled right beside the link.

Now we want to transmit data from nodes 1, 2, 3, and 4 with rate r1, r2, r3, and r4 respectively to node 5. To minimize the whole power consumed, the routing is shown in Fig. (b). However, we show in Fig.1 (c) another routing strategy, where the numbers adjacent to the link are the fractional data rates going through the route. By simple calculations, the strategy in (c) outperforms (b) because node 1 can function 33% longer time.

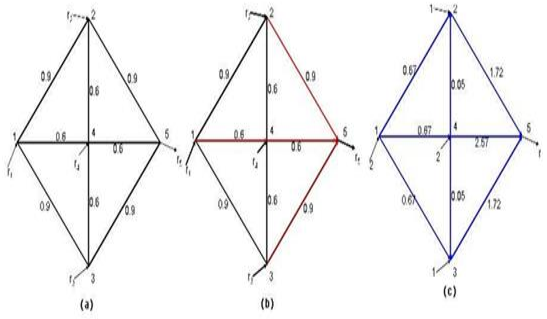

Figure 3: Maximum Lifetime and Minimum Energy Consumption

III. METHODOLOGY

A. Event Based Energy Efficient Routing Protocol (EBEERP):

Our protocol is designed for the event driven scenario, where ever any event occurs in the network, it should be responded. Firstly, we will discuss the Formation of Data Gathering & Dissemination Node, then the Formation of Gateway Node.

B. Formation of Data Gathering & Dissemination Node (DGD):

The formation of Data Gathering & Dissemination Node (DGD Node) is based on the power level factor of the sensor nodes. The sensor nodes in each tier whose power level will be greater than the neighbouring sensor nodes in radius R will be elected as the DGD Nodes.

C. Formation of Gateway Node:

The formation of the Gateway Node is based on the overlapping area of the two Data Gathering & Dissemination Node's communication radius of adjacent Tiers. The regular sensor nodes (falling in the overlapping area of two DGD Node's DTC Range of adjacent Tiers) in this area whose power level will be maximum will be elected as the Gateway Node.

IV. RESULTS AND DISCUSSIONS

A. EBEERP Description:

Our protocol works in the situation when an event occurs in the Network field. Initially, all the sensor nodes are in the sleep state. When any activity or event occurs, the sensor nodes in that area will wake up, listen the event and transmit their data to their nearby Data Gathering & Dissemination Node. All the data will be sending by regular sensor nodes and will be used by the DGD Node along with its sensed data.

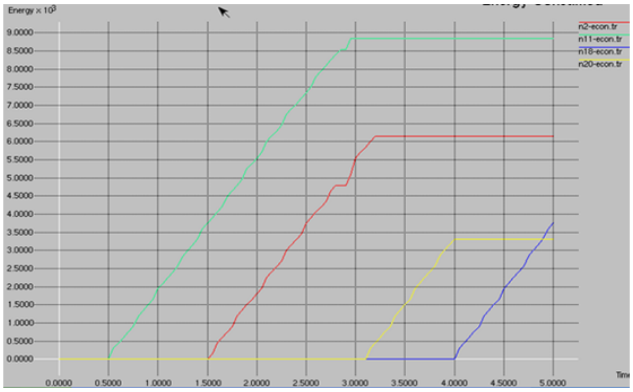

Figure 4: Energy Consumed

The above graph shows the energy dissipation at 1.5th seconds to 3.2th seconds. During this time most amount of power is consumed. As it can be seen in the graph that as the time

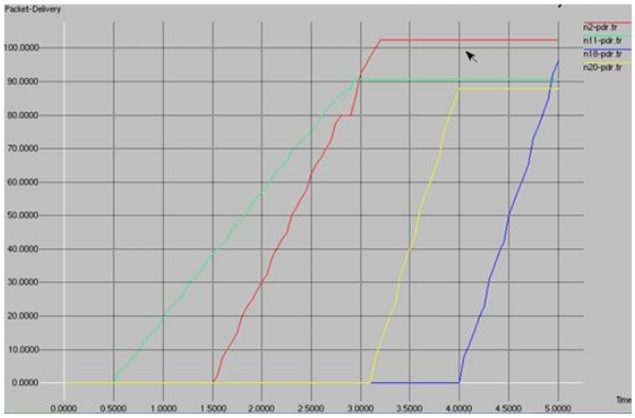

Figure 5: Cluster Packet Delivery Ratio

As the energy consumption is increased for overall network, therefore the clustered packed delivery ratio is also increased. In the above graph it is shown that, Energy started to drain at 1.5th seconds and ends at 3.2sec during this period the red CH has spend this energy for his event.

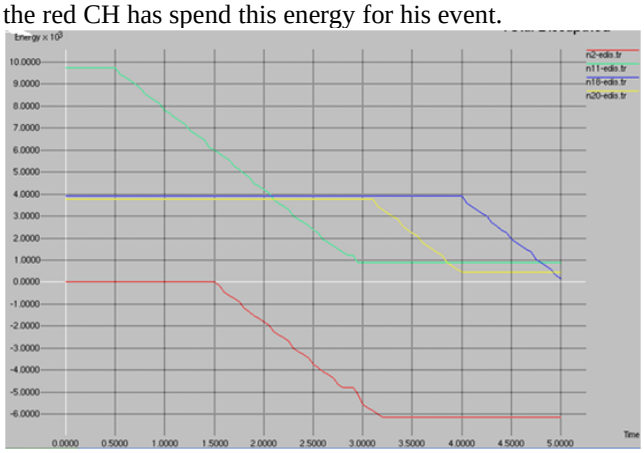

Figure 5 : Total Dissipated

According to our research, we have randomly deployment of 24 sensor nodes in the network field. To evaluate the performance of our proposed model EBEERP, we have simulated its results with LEACH and PEGASIS protocols in 24 sensor nodes network. The Base Station Controller (BSC) is located at the center of the 100m X 100m field.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

We have simulated our experimental result to determine the number of rounds of communication when 1%, 25%, 50%, 75% and 100% of the nodes die using LEACH, PEGASIS and EBEERP with each sensor node having the same initial energy level. Figure 3 shows the number of rounds until 1%, 25%, 50%, 75%, 100% nodes die for 800 X 800m network with 100 J initial energy per node, 0.5 J per node in Figure 4 and 1.0 J per node shows the simulation results for the total energy consumption over simulation time. shows that in the beginning, the total energy consumption of our proposed model EBEERP is somehow similar to the LEACH and PEGASIS. However, as the simulation time increases, EBEERP consumes less energy as compared to the other conventional routing protocols. The simulated result shows that our proposed model EBEERP is 7.5 times better than the LEACH and 2 times better than the PEGASIS respectively system which is highly dense and non-uniform. EBEERP scheme is an energy efficient, reliable and robust protocol which has minimum delay and achieves highly reliable data dissemination in WSN.

V. CONCLUSION

It is now been propose that EBEERP scheme is one of the best for energy efficient and reliable routing in WSN. In experimental and simulation, it is also been achieved that the proposed EBEERP scheme is 7.5 times better than LEACH and 2 times better than PEGASIS.

The main concern of analysing such a protocol is to run this in a disaster management and surveillance system which is highly dense and non-uniform. EBEERP scheme is an energy efficient, reliable and robust protocol which has minimum delay and achieves highly reliable data dissemination in WSN.

V. FUTURE SCOPE OF WORK

According to the result it has been observed that EBEERP is a better protocol for energy efficient wireless sensor network. Still the proposed protocol does not guarantee a uniform distribution of cluster-heads and the number of cluster-heads selected. The protocol constructs clusters without inefficient sensor-node-broadcast to notify the base station of the information of each sensor node. Therefore the proposed protocol changes the desirable number of cluster-heads when composing optimum clusters. Further study should be conducted to solve the above-mentioned problems for better results.

REFERENCES

[1] F. Akylidiz, W. Su, Y. Sankarasubramaniam and E. Cayirci, ―A Survey on Sensor Networks,‖ IEEE Communication Magazine, pp. 102-114, Aug 2002.

[2] D. Estrin, R Govindan, J. Heidemann, and Satish Kumar. Next Century Challenges: Scalable Coordination in Sensor Networks. In Proceedings of Mobicom ' 99, 1999.

[3] J. Yick, B. Mukherjee, and D. Ghosal. Wireless sensor network survey. Computer Networks, 52(12), 2008.

[4] A.A. Abbasi and M. Younis, A survey on clustering algorithms for wireless sensor networks, Elsevier Computer Communications 30 (14-15) (2007), pp. 2826–2841.

[5] W. Heinzelman, A. Chandrakasan, and H. Balakrishnan, ―Energy efficient communication protocols for wireless microsensor networks,‖Proceedings of the 33rd International Conference on System Sciences, January 2000.

[6] Babu ram, N.Chand, Prateek Gupta, S. Chauhan, ―A New Approach Layered Architecture based Clustering for Prolong Life of WSN‖ International Journal of Computer Applications (0975-8887) Volume 15-No. 1, Feburary 2011.

[7] Khattak, A.U.; Shah, G.A.; Ahsan, M.; Two-Tier Cluster Based Routing Protocol for Wireless Sensor Networks, Embedded and Ubiquitous Computing (EUC), 2010 IEEE/IFIP 8th International Conference on Digital Object Identifier: 10.1109/EUC.2010.68 Publication Year: 2010 , Page(s): 410 – 415

[8] W.Heinzelman, A. Chandrakasan, and H. Balakrishnan, ―An application-specific protocol architecture for wireless microsensor .networks, ―IEEE Transactions on Wireless Communication, vol. 1, No. 4, pp. 660-670, October 2002.

[9] Intanagonwiwat, C., Govindan, R., & Estrin, D. (2000). Directed Diffusion: A scalable and roubst communication paradigm for sensor networks. In Proceedings of the Eighth ACM International Conference on Mobile Computing and Networking (MobiCom 2002)(pp. 56–67), Sep 23–28, 2002, Georgia, USA.

[10] O. Younis, S. Fahmy, ―Distributed Clustering in Ad-hoc Sensor Networks: A Hybrid, Energy-Efficient Approach,‖ in Proc. of IEEE INFOCOM, vol. 1, pp. 629-640, Mar. 2004.

[11] Kulkarni, S.; Iyer, A.; Rosenberg, C.; An address-light, integrated MAC and routing protocol for wireless sensor networks, Networking, IEEE/ACM Transactions on Volume: 14, Issue: 4, Digital Object Identifier: 10.1109/TNET.2006.880163, Publication Year: 2006 , Page(s): 793 – 806.

[12] Lindsey, S., & Raghavendra, C. (2002). PEGASIS: Power-efficient gathering in sensor information systems. In Proceedings of IEEE Aerospace Conference, Vol. 3 (pp. 1125–1130), March 2002.

[13] Agrawal, D. P., & Zeng, Q. A. (2006). *Introduction to wireless and mobile systems* (2nd ed.). UK: Thomson.

[14] Al-Karaki, J. N., Ul-Mustafa, R., & Kamal A. E. (2004). Data aggregation in wireless sensor networks—Exact and approximate algorithms. In *Proceedings of IEEE HPSR'04*, Aug 2004.

[15] Alazzawi, L. K., Elkateeb, A. M., & Ramesh, A. (2008). Scalability analysis for wireless sensor networks routing protocols. In *Proceedings of IEEE AINAW'08*, Apr. 2008.

Ashish.X. Das is working as a Assistant Professor in the Department of Electronics and Communication Engineering SHIATS Allahabad. He received his B.E degree from AAIDU, and M.Tech from SHIATS Allahabad. His research is focus on Minimization of energy in WSN

Charlie Eapen is working as an Assistant Professor in the Department of Electronics and Communication Engineering, SHIATS, Allahabad. He received his B.Tech degree from AAIDU, and M.Tech degree in Communicationystem Engineering, from SHIATS, Allahabad. His present research area is on Signal Processing Techniques in Wireless Sensor Network.

A.Ashok is working as a Assistant professor in the Department of Electronics and Communication Engineering SHIATS Allahabad. He received his B.E degree from Anna University, Chennai and M.Tech from SHIATS Allahabad. His research is focus on Digital Signal Processing & Applications.

Sudhanshu Tripathi is working as an Assistant Professor in the Department of Electrical and Electronics Engineering, SHIATS, Allahabad. He received his B.Tech degree from UPTU, Lucknow, and M.Tech degree in Digital Communication, from MANIT, Bhopal. His present research area is Wireless Communication

Er Ridha Mabruk Shadi is a student in M.Tech in t he Department of Electronics and Communication Engineering, SHIATS, Allahabad. He did his B.Tech from Libyan University, Libya.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)