International Journal of Grid Distribution Computing
Vol. 8, No.6, (2015), pp.239-246
http://dx.doi.org/10.14257/ijgdc.2015.8.6.23

Energy Optimization of Hierarchical Wireless Sensor Networks using RFID Algorithm

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Abstract

Wireless Sensor Network is built of more than a few nodes where each node is linked to one sensor. The main challenging task in this network is lifetime and energy consumption. The LEACH protocol is energy efficient protocol to reduce their energy consumption different modes is applied on the sensor nodes. These modes are sleep, Active and ready mode. These modes are applied on LEACH protocol and this enhancement is called RFID protocol. The main problem exists in RFID protocol is of clock synchronization due which packet loss happened in the network which reduce network performance. To overcome this problem, proposed contention Avoidance Algorithm (RTS /CTS). In this technique cluster, head nodes send RTS packets containing a NONCE feed to all its cluster members. The member nodes would adjust their clocks according to the feed and revert back with CTS packets are synchronization their clocks. The proposed technique has been implemented in Network Simulator. The graphical results show that proposed technique performs batter than LEACH, RFID protocol in terms of throughput, energy and packet loss, Delay and control overhead in the network.

Keywords: *Wireless Sensor Network, LEACH protocol, R-LEACH and Contention Avoidance Algorithm*

1. Introduction

The recent developments in making energy efficient Wireless Sensor Network is giving a new direction to deploy WSN in applications like surveillance, industrial monitoring, traffic monitoring, habitat monitoring, cropping monitoring, crowd counting etc. The growing use of these networks is making engineers to evolve innovative and efficient ideas in this field. A lot of research in data routing, data compression and in network aggregation has been proposed in recent years [1]. The WSN has a group of nodes ranging from few to several hundred or even thousands. It consists of small light weighted wireless nodes called sensor nodes. A sensor node varies from the size of a shoebox to a grain of dust. The cost of sensor nodes is ranges from the minority to hundreds of dollars, depending on the complication of the individual sensor nodes. The amount and cost constraints on sensor nodes result in changes in constraints on resources such as energy, memory, computational speed and bandwidth. The topology of the WSN can vary from a simple star network to multihop mesh network. The transmission technique between the hops of the network can either be routing or flooding. Energy, computation, memory and limited communication capabilities are the resource constraints of wireless sensor networks. All sensor nodes in the wireless sensor network are interacting with each other or by intermediate sensor nodes [2].

ISSN: 2005-4262 IJGDC
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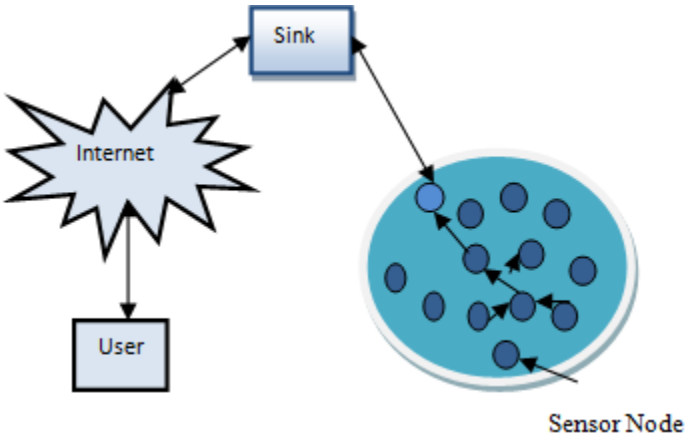

Figure 1. Wireless Sensor Networks

The energy consumption is the main concern in a wireless sensor network. There are many protocols in wireless sensor network to reduce the energy consumption and to increase the network lifetime [3]. The primary hierarchical protocol is the low Energy Adaptive Clustering Hierarchy (LEACH). LEACH is the Energy consumption protocol in wireless sensor network because LEACH randomly selects an only some sensor nodes as cluster heads (CH) and rotates this task to equally allocate the energy load among the sensor in the Network. LEACH protocol is able to enhance the network lifetime. But there are some issues about the LEACH protocol [4]. LEACH is not suitable protocol because data is sending to base station at every round so energy consumption is high, to reduce the energy dissipation number of the protocol was proposed such as R-LEACH, LEACH-C, LEACH-M, LEACH-V *etc.*, R-LEACH (RFID- LEACH) is used to overcome the limitation modifies LEACH protocol by embedding communications modes like Active, Ready and Sleep modes in the network. In Active mode only sensed data, in ready mode sensed as well as transmitting data to the BS. The node in sleep mode used for saving the energy consumption and also balance the energy loads of the Cluster head [2].

The rest of the paper is organized as follow; section II explores the related work while Section III contains the detailed formulation of the problem. The proposed technique has been explained in detail in section IV while its performance has been analyzed in section V. Section VI concludes the present work.

2. Related Work

Lee et al.[2014] purposed Reservation Aloha for No Overhearing that is used to inform the tag of its effective communication for eliminating overhearing problem .large of energy is reduced due to overhearing is many times larger than consumed effective communication .to eliminate this problem author purpose algorithm (RANO). A tag has information about the time and duration of communication advance because it maintain active mode for kept the sleep mode due to other transmission period. RANO Protocol saves the 60 times energy than another protocol [5].

Nayak P. et al. [2014] purposed two important clustering protocols, namely LEACH and LEACH-C (centralized), using NS2 tool for several chosen scenarios, and analysis of simulation results against chosen performance metrics with latency and network lifetime. As a conclusion of observation from results, it can be mentioned that LEACH can be preferred if localized coordination of nodes in clustering without involving BS is of high priority than other factors like assurance over the desired number of clusters etc.; and LEACH-C can be chosen when centralized and deterministic approach covering entire

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network is expected still bringing in increased network lifetime and desired number of clusters [6].

Ramesh R. et al.[2014] purposed modification in LEACH protocol enables an alternative node to get replaced in place of node which loses its energy such that it extends the lifetime of the entire network and avoids data loss. In future a sleep mechanism can be induced among the nodes in clusters which in turn can further increase the network lifetime. The awaken nodes with no data transfer can be taken into sleep mode using ASLEEP (Adaptive Staggered LEEP Protocol) which in turn increase the lifetime of Sensor nodes. The integration of ASLEEP protocol into LEACH can yield a prolonged network lifetime and good data aggregation policy [7].

Alhawat A. et al.[2013] Purposed new version of LEACH protocol called the V-LEACH protocol and the comparison of LEACH protocol with V-LEACH protocol. From the simulation results were, first the number of alive nodes is more than the original LEACH. Second the number of dead nodes is less than the original LEACH protocol. Network life-time is increased by 49.37% then original LEACH [8].

ZHOU H. et al. [2009] purposed new version of LEACH protocol called multihop-LEACH protocol. In LEACH, each CH directly communicates with BS no matter the distances between CH and BS. It will consume a lot of its energy if the distance is far. It selects a most favorable path between the CH and the BS through other CHs and use these CHs as a convey station to transmit data over through them [9].

Yadav S. et al. [2014] proposed two protocols named as Genetic algorithm and optimization of LEACH protocol that are used on LEACH protocol and compare both results on the basis of rounds. This comparison was based on optimal thresholding probability for cluster formation. Finally, after comparison finds LEACH-GA method outperforms MTE,DT and LEACH in terms of network lifetime, use for optimal energy-efficient clustering [10]

Xianging F. et al.[2007] studies LEACH protocol, and puts forward energy-LEACH and multihop-LEACH protocols. Energy-LEACH protocol improves the alternative method of the cluster head, makes some nodes which have more remaining energy as cluster heads in next round. Multihop-LEACH protocol improves communication mode from single hop to multi-hop between cluster head and sink. Simulation results show that energy-LEACH and multihop-LEACH protocols have enhanced presentation than LEACH protocols [11].

3. Problem Formulation

To Enhance, the LEACH energy Efficiency R-LEACH (Radio Frequency Identification) protocols are used by embedding communications modes like Active, Ready and Sleep modes in the network. In Active, the mode only sensed data, in ready mode sensed as well as transmitting data to the Base station. The node in sleep mode used for saving the energy consumption and also balance the energy loads of the CHs. These modes are applied on LEACH protocol and this enhancement is called RFID LEACH protocol. The main problem exists in RFID protocol is of clock synchronization due which packet loss happened in the network which reduce network performance. In this protocol sensor nodes send data to the cluster head at the same time and packet loss problem occurred due to non-Synchronized clocks [12].

Various Algorithm and protocols have been proposed for synchronization the clocks within the network, such as Network Time Protocol (NTP), Precision Time Protocol (PTP), Reference Broadcast Synchronization (RBS) and GPS- based Synchronization etc.

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But all these protocols have their individual drawbacks ranging from low accuracy, high cost, and energy inefficiency to high complexity. In this manner, being a limited-energy system, the efficiency, lifetime and robustness of the WSN is severely compromised. In this work, the further enhancement will be proposed in RFID protocol for clock synchronization. The enhancement will be based on contention Avoidance Algorithm (RTS /CTS) in this technique cluster head nodes send RTS packets containing a NONCE feed to all its cluster members. The member nodes would adjust their clocks according to the feed and revert back with CTS packets are synchronization their clocks. The proposed technique has been implemented in Network Simulator. The graphical results show that proposed technique performs batter than LEACH, RFID protocol in terms of throughput, energy and packet loss, Delay and control overhead in the network.

4. Simulation Setup

In order to evaluate the performance of the proposed algorithm, it has been simulated in the Network Simulator 2 (NS2). The Network Simulator is a discrete event packet-level simulator which consists of tools that simulate the behavior of networks such as creating network topologies, traffic models, load patterns etc.The use of fixed topology, Energy model makes the network highly dynamic. The routing protocol used is the AODV (Ad-hoc On Demand Distance Vector) protocol which supports both unicast and multicast routing over the WSN. For individual identification of the sensor nodes over the network, the RFID technology is used. To enhance the performance of R-LEACH using contention Avoidance Algorithm (RTS/CTS) by using these simulation parameters.

Table 1. NS-2 Simulation Parameter

parameter	Settings
Simulation Area	**500*500 meters**
No of nodes	**41**
Channel Type	**Channel/wireless**
Antennae model	**Antenna/omni antenna**
Energy model	**Battery**
Interface queue Type	**Queue/Droptail /Priqueue**
Link layer type	**LL**
Simulation time	**10s**
Topology	**Fixed**
Routing protocol	**AODV**
Radio –propagation Model	**Two-way Ground**
Proposed Algorithm	**Contention Avoidance Algorithm**
Traffic Source	**CBR**
Type of MAC	**MAC/ 802.11**
Packet size	**1000 bytes**

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5. Results & Discussion

To enhance optimized R- LEACH QoS parameters such as Energy consumption, Packet loss, End to End delay, Throughput and control overhead. In Figure 2 calculates the average energy consumption used by the network per unit time (in joule per second). In the graph shows that the proposed technique, contention Avoidance Algorithm by using RTS/CTS packet is lower energy utility as compared to LEACH and R-LEACH protocol. In the graph LEACH, protocol is more energy consumption because each cluster head directly communicates with base station no matter the distance between cluster head and the base station, it will use a lot of energy [2].

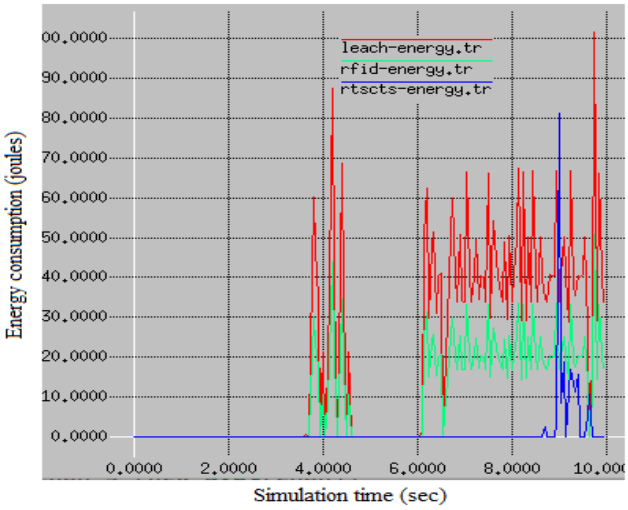

Figure 2. Energy Graph Comparison b/w LEACH, R-LEACH Protocol and Contention Avoidance Algorithm

In Figure 3 calculates the packet loss during in the network per unit time. In the graph packet loss is more in the previous technique. In the previous technique clocks of the cluster, heads are not timely synchronized. This is the reason that the packet loss is higher is more in the previous technique [12]. The packet loss in the new technique is reduced because the clocks of the cluster heads are synchronized with the RTS and CTS.

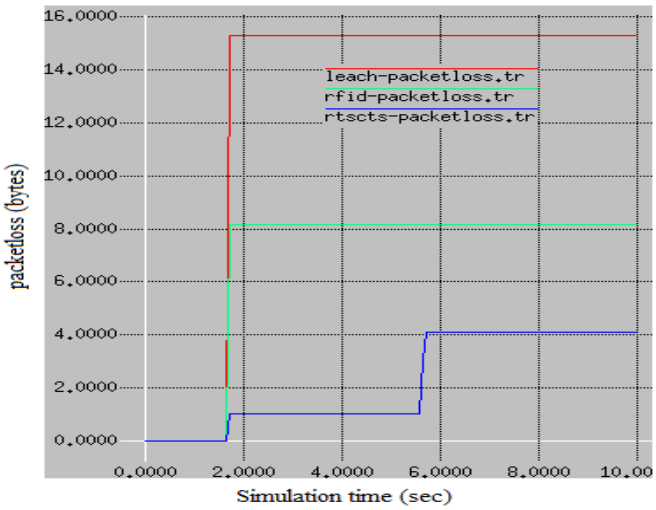

Figure 3. Packet loss Comparison b/w LEACH, R-LEACH Protocol and Contention Avoidance Algorithm

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In Figure 4, calculates Throughput is the average data packets received at the destination. From the graph, In LEACH protocol throughput will decrease due to high energy consumption, packet loss and overhead [13]. The throughput of the network is enhanced in proposed technique with clock synchronization.

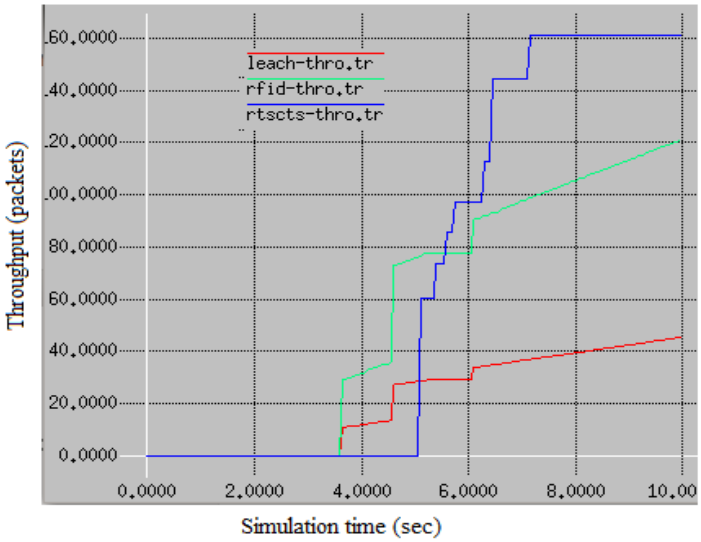

Figure 4. Throughput Comparison b/w LEACH, R-LEACH Protocol and Contention Avoidance Algorithm

In Figure 5 calculates the End to End delay as the time taken for a packet to be transmitted across a network from source to destination. The end to end delay is reduced in the new technique because the clocks of the cluster heads are synchronized with the RTS and CTS. In Previous technique delay is more because energy consumption is high due to this it causes a delay for data transmission [14].

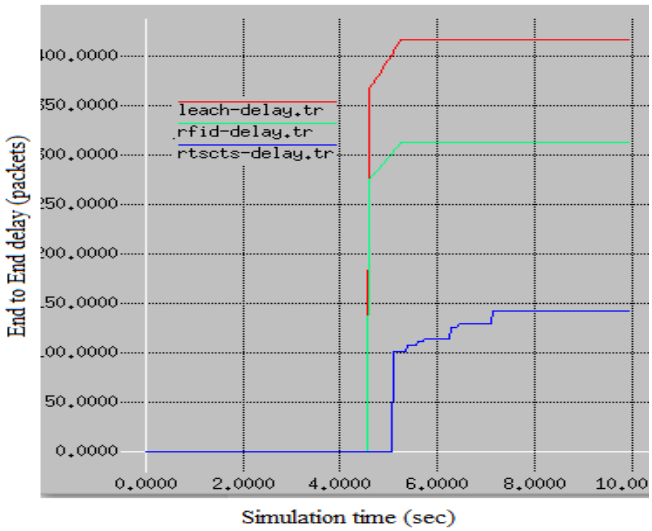

Figure 5. End to End delay Comparison b/w LEACH, R-LEACH Protocol and Contention Avoidance Algorithm

In Figure 6, calculates control overhead is the ratio between a total number of control packets and a total number of packets delivered successfully. From the graph, it is

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observed that LEACH has high overhead due to delay increase [15]. The control overhead is reduced in the contention Avoidance Algorithm because less packet loss in the network.

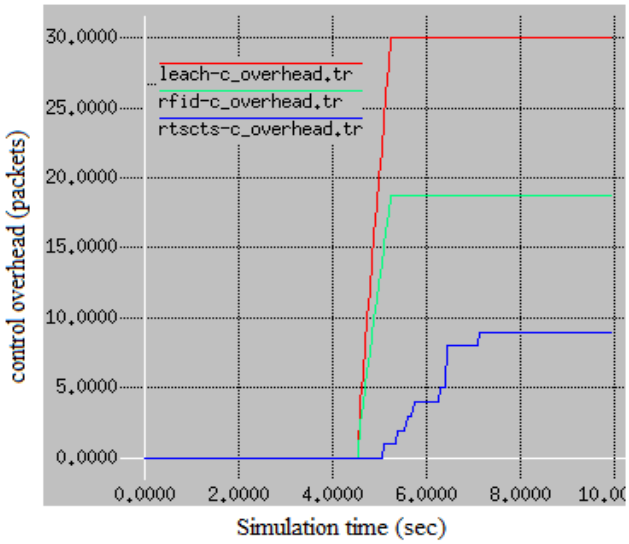

Figure 6. Control overhead Comparison b/w LEACH, R-LEACH Protocol and Contention Avoidance Algorithm

6. Conclusion and Future Scope

The wireless sensor networks are the type of network which is used to sense the environmental conditions like temperature, pressure etc. This type of network is generally deployed on the far places like oceans, forests and deserts in such places it is very difficult to recharge or replace the battery of these sensor nodes. To reduce the energy consumption of these sensor nodes various techniques has been applied so far. Among the various types of techniques, clustering is the most efficient technique to reduce energy consumption of network. In this work, LEACH protocol has been used for clustering in which cluster heads are selected on the basis of distance and energy. The LEACH protocol is energy efficient protocol to reduce their energy consumption different modes is applied on the sensor nodes. These modes are sleep, Active and ready mode. These modes are applied on LEACH protocol and this enhancement is called RFID protocol. The main problem exists in RFID protocol is of clock synchronization due which packet loss happened in the network which reduce network performance. In this work, the further enhancement will be proposed in RFID protocol for clock synchronization. The enhancement will be based on RTS and CTS packets. The proposed technique has been implemented in simulated environmental conditions. The graphical results show that proposed technique performs batter than LEACH, RFID protocol in terms of throughput, energy and packet loss, End to End Delay and control overhead in the network.

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