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Comparison of LEACH Protocol with DSR, Bellman Ford and LAR Protocols

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Abstract

A wireless network which consists of spatially distributed autonomous devices using sensors is called as Wireless sensor network. There are many number of routing protocols supported by Wireless sensor network. One of the protocols is LEACH protocol, which balances and manages the energy load. LEACH is the first network protocol that uses hierarchical routing for wireless sensor networks to increase the life time of network. We have used QualNet 7.3 Network Simulator to create the scenarios and coding language as VC++ to implement LEACH protocol. An attempt is also made to compare efficiency of LEACH protocol with other routing protocols such as DSR, LAR and Bellman Ford. Better accuracy is obtained for LEACH protocol, when compared to other routing protocols.

Keywords: *Wireless sensor network, LEACH, QualNet 7.3, DSR, LAR, Bellman Ford.*

I. INTRODUCTION

Wireless Sensor Network (WSN) is a very large array of diverse sensor nodes that are interconnected by a communication network. The elementary components of a sensor node are sensing unit, a processing unit, a transceiver unit and a power unit. The sensor node senses the physical quantity being measured and coverts it into an electrical signal. Then, the signal is fed to an A/D converter and is ready to be used by the processor. The processor will convert the signal into data depending on how it is programmed and it sends the information to the network by using a transceiver. The sensing data are shared between the sensor nodes and are used as input for a distributed estimation system.

The fundamental objectives for WSN are reliability, accuracy, flexibility, cost effectiveness, and ease of deployment. WSN is made up of individual multifunctional sensor nodes. As we know that wireless sensor network mainly consists of tiny sensor node which is equipped with a limited power source. The lifespan of an energy-constrained sensor is determined by how fast the sensor consumes energy. A node in the network is no longer useful when its battery dies. Researchers are now developing new routing mechanisms for sensor networks to save energy and pro-long the sensor lifespan. The dynamic clustering protocol allows us to space out the lifespan of the nodes, allowing it to do only the minimum work it needs to transmit data. The WSN can be applied to a wide range of applications, such as environment management, environmental monitoring, industrial sensing, infrastructure protection, battlefield awareness and temperature sensing. So, it is essential to improve the energy efficiency to enhance the quality of application service.

In this paper, LEACH (Low Energy Adaptive Clustering Hierarchy) Protocol is analysed in detail and compared with other routing protocols. LEACH is a cluster-based hierarchical protocol which creates an energy balance in the network, saves the node energy and hence increases the lifetime of the network. The rest of the paper is organized as follows. Section II briefs about the literature survey. Section III gives brief introduction of LEACH. Necessary routing protocols are briefed out in Section IV. In Section V, LEACH is compared with other protocols. Conclusion is given in Section VI.

II. LITERATURE SURVEY

Ms. Mandakini Dihingia et al have analysed the implementation of Leach Protocol [1]. This paper presents LEACH protocol and other variants of LEACH protocol such as V-LEACH protocol. Meena Malik et al analyzed the LEACH Protocol in Wireless Sensor Networks [2]. This paper presents a detailed review and analysis of LEACH protocol. Comparison of various network parameters is done in the form of tables and graphs. Sandeep Gangane et al have analyzed the LEACH Protocol in Wireless Sensor Network [3]. This paper surveys working of LEACH protocol, its limitations and advancements done in LEACH to improve its performance. Amandeep Kaur et al reviews of LEACH Protocol and Its Types [4]. This paper we have given a brief review of these techniques and compared it. SEEMA RAHUL et al gives the Performance Analysis of AODV, DYMO and Bellman Routing Protocols in Mobile Ad-HO Network [5]. This paper present performance comparison of four mobile ad-hoc network routing protocols i.e. Ad-hoc On Demand Distance Vector (AODV), (DYMO), Bellman using Qualnet 5.0.2 The performance analysis is based on different network metrics such as End-to-End delay(s), Average Jitter(s), Total packet received and

Throughput. Sangita Vishwakarma has done a survey on LEACH protocol [6]. This paper a detailed view and analysis of LEACH Protocol has been discussed. Qing Wu1 et al has analyzed LEACH Routing Protocol [7]**.** The performances of LEACH simulation algorithms were analyzed through MATLAB simulation. Hence, in this paper, we are implementing the LEACH protocol using QualNet 7.3 and also compare the LEACH protocol with other routing protocols.

III. LEACH PROTOCOL

As we all know that all the networks have a certain lifetime during which nodes have limited energy by using that, the nodes gather, process, and transmit information. This means that all aspects of the node, from the sensor module to the hardware and protocols, must be designed to be extremely energy-efficient. Decreasing energy usage by a factor of two can double system lifetime, resulting in a large increase in the overall usefulness of the system. In addition, to reduce energy dissipation, protocols should be robust to node failures, fault-tolerant and scalable in order to maximize system lifetime.

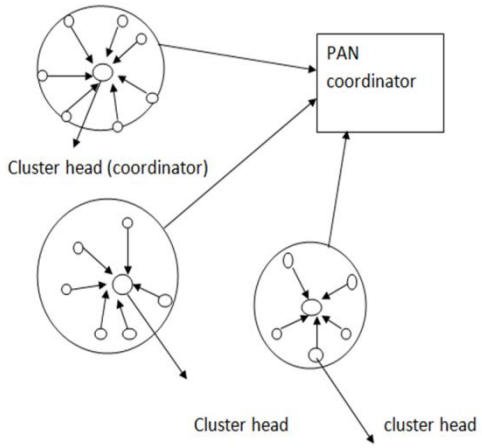

Fig.1: Scenario of LEACH

LEACH is the first network protocol that uses hierarchical routing for wireless sensor networks to increase the life time of network. A simple scenario of Leach protocol is shown in fig.1. All the nodes in a network organize themselves into local clusters, with one node acting as the cluster-head. All non-cluster-head nodes transmit their data to the cluster-head, while the cluster-head node receive data from all the cluster members, perform signal processing functions on the data (e.g., data aggregation), and transmit data to the remote base station. Therefore, being a cluster-head node is much more energy-intensive than being a non-cluster-head node. Thus, when a cluster-head node dies all the nodes that belong to the cluster lose communication ability.

LEACH incorporates randomized rotation of the high-energy cluster-head position such that it rotates among the sensors in order to avoid draining the battery of any one sensor in the network. In this way, the energy load associated with being a cluster-head is evenly distributed among the nodes. Since the cluster-head node knows all the cluster members, it can create a TDMA schedule that tells each node exactly when to transmit its data. In addition, using a TDMA schedule for data transfer prevents intra-cluster collisions.

There are two phases in LEACH protocol.

- Set-up phase
- Steady-state phase

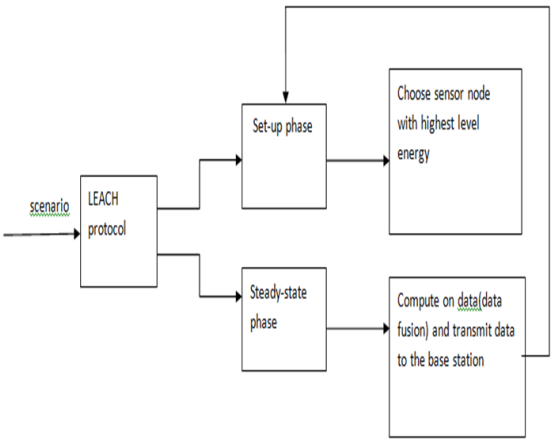

Fig. 2. Phases of LEACH

A. Set-up phase

In set-up phase, the cluster head is selected and then it forms a group. So after some time the corresponding cluster head to be reduced and to rotate the cluster head selection process. In the selection of cluster head each node decides whether to turn into cluster head or not average residual energy. Some nodes with more residual energy turns into cluster heads and send cluster head information to inform other nodes. The other nodes with less residual energy turn into common nodes, and send information about joining cluster to cluster head.

B. Steady-state phase

In this phase, clusters are created and the corresponding cluster head is selected. After the cluster head receives the data it can be aggregated and the data can be transmitted to the base station. The base station computes average node energy, and determines which nodes have energy high or below this average, some nodes having higher energy compare to average energy choose as cluster head for current round. During this phase, all CH nodes must keep their receivers on. The CH node receives all the messages for nodes that would like to be included in the cluster. Based on the number of nodes in the cluster, the CH node creates a TDMA schedule telling each node when it can transmit. once the clusters are created and the TDMA schedule is fixed, data transmission can begin. In the next round, the associate cluster head should be made as a lead while selection of cluster head for the first round, so no need to select the cluster head for next round. Then associate CH node that will become a CH of the cluster.

IV. OTHER ROUTING PROTOCOLS

A. Dynamic Source Routing (DSR)

One of the routing protocols is Dynamic Source Routing (DSR) available in wireless mesh networks. It uses a route on-demand when a transmitting node requests as similar to AODV. But, it uses source routing instead of relying on the routing table at each intermediate device.

In DSR, determining source routes requires accumulating the address of each device between the source and destination during route discovery. This accumulated path information is cached by nodes processing the route discovery packets.

Advantages

- DSR uses a reactive approach which eliminates the need to periodically flood the network.
- In DSR, a route is established only when it is required and hence the need to find routes to all other nodes in the network.

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Disadvantages

- The disadvantage of DSR protocol is that the route maintenance mechanism does not locally repair a broken link.
- Stale route cache information could also result in inconsistencies during the route reconstruction phase.

B. Bellman Ford

Bellman-Ford Routing Algorithm, also known as Ford Fulkerson Algorithm, is used as an algorithm by distance vector routing protocols such as RIP, BGP, ISO IDRP, NOVELL IPX. Routers that use this algorithm have to maintain the distance tables (which is a one-dimension array - "a vector"), which tell the distances and shortest path to sending packets to each node in the network. The information in the distance table is always updated by exchanging information with the neighbouring nodes.

Advantages

- Cost is minimized.
- Maximizes the performance.

Disadvantages

- It does not scale well.
- Changes in network topology are not reflected quickly since updates are spread node-by-node.
- Count to infinity

C. Location-Aided Routing (LAR)

Location-Aided Routing (LAR) utilizes the location information for improving the efficiency of routing by reducing the control overhead. LAR designates two geographical regions for selective forwarding of control packets, such as expected zone and request zone. The expected zone is the region in which the destination node is expected to be present. The request zone is a geographical region within which the path finding control packets are permitted to be propagated. The objective is to provide a qualitative analysis of the LAR protocol in different city scenarios in Vehicular Ad hoc Networks.

Advantages

- LAR reduces the control overhead by limiting the search area for finding the path.
- LAR increases the utilization of its bandwidth.

Disadvantages

- The applicability of this protocol depends heavily on the availability of GPS infrastructure or similar sources of location information.
- This protocol cannot be used in situations where there is no access to such information.

V. EXPERIMENTAL RESULTS

Wireless sensor networks are an active topic in networking. There are many number of routing protocols available as discussed in the survey. We have analyzed and implemented LEACH protocol. We have used QualNet 7.3 Network Simulator to create the scenarios and VC++ for coding purpose. The main advantage of LEACH protocol is balancing and managing the energy load which has been proved practically. An attempt is also made to compare efficiency of LEACH protocol with other routing protocols such as DSR, LAR and Bellman Ford. For comparison purpose, we have used the parameters such as average unicast end-to-end delay and average unicast jitter. Figure 3 and figure 4 shows the comparison between DSR and LEACH. Figure 5 and figure 6 shows the comparison between LEACH and Bellman Ford. Figure 7 and figure 8 shows the comparison between LAR and LEACH. The highest statistics shown in figure 3 to figure 8 depicts LEACH performance. Table I shows the parameters and settings done in QualNet 7.3. Table II shows the comparison of LEACH protocol with DSR, Bellman ford and LAR. From Table II, it can be shown that LEACH is better in performance, when compared with other protocols.

TABLE I. PARAMETERS IN QUALNET 7.3

PARAMETER	VALUE
Simulation Time	300
Terrain size	500*500
No. of nodes	20
Channel type	Wireless Channel
Traffic Type	CBR
Routing protocols	LEACH,BELLMAN,DSR,LAR

TABLE II. COMPARITIVE RESULT

Routing protocol	**Average unicast end-to-end delay(seconds)**	**Average unicast Jitter**
LEACH	0.200462	242
DSR	0.14871	209
Bellman ford	0.0913152	81
LAR	0.190552	135.003

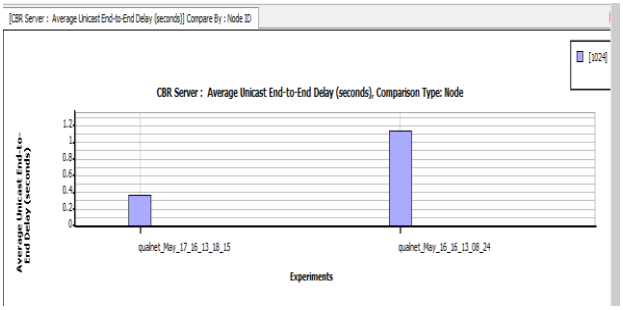

Fig.3 comparision between DSR and LEACH

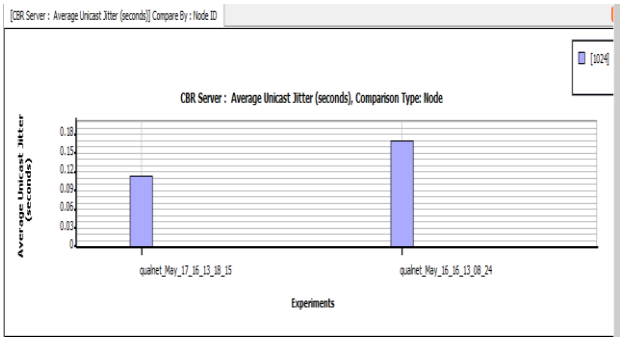

Fig.4 comparision between DSR and LEACH

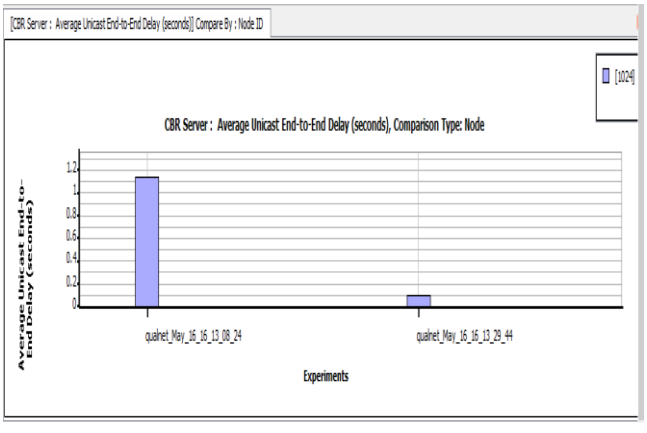

Fig.5. Comparision between LEACH and BELLMAN FORD

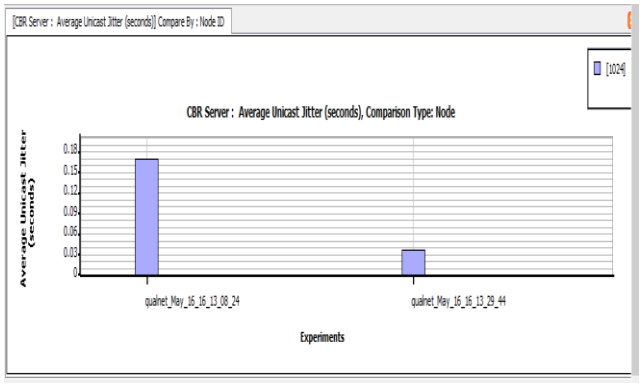

Fig.6. Comparision between LEACH and BELLMAN FORD

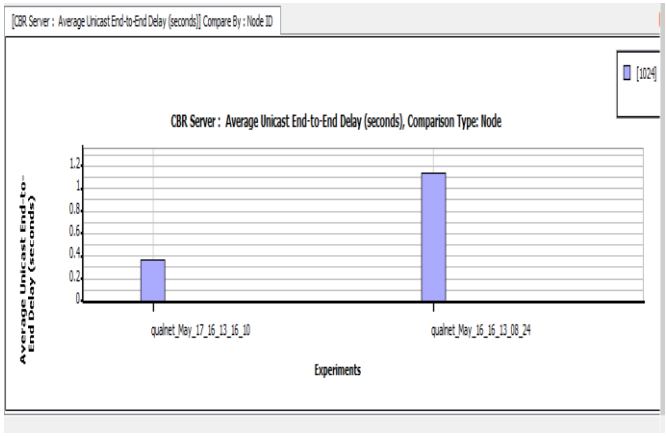

Fig.7. Comparision between LAR and LEACH

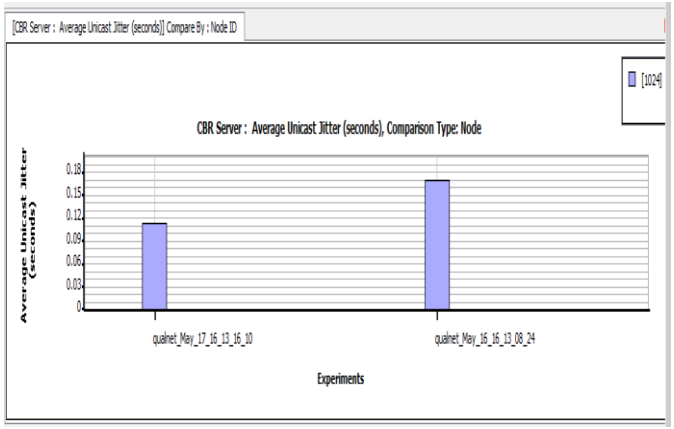

Fig.8. Comparision between LAR and LEACH

VI. CONCLUSION

Wireless sensor network supports different number of routing protocols. LEACH protocol uses hierarchical routing for wireless sensor networks to increase the life time of network. LEACH protocol is implemented using QualNet 7.3 Network Simulator and VC++. Efficiency of LEACH protocol is compared with the other routing protocols such as DSR, LAR and Bellman Ford. Better accuracy is obtained for LEACH protocol, when compared to other routing protocols.

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