COMPARSION BETWEEN CBR PROTOCOL AND LEACH PROTOCOL USING NS2 AND TDMA

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Abstract: **Technological advances in communications and computation have enabled the development of low-cost, low-power, small in size, and multifunctional sensor nodes in a wireless sensor network. Since the radio transmission and reception consumes a lot of energy, one of the important issues in wireless sensor network (WSN) is the inherent limited battery power within network sensor nodes. In addition to maximizing the lifespan of sensor nodes, it is preferable to distribute the energy dissipated throughout the wireless sensor network in order to maximize overall network performance. Packet loss that occurs due to mobility of the sensor nodes is one of main challenge in Wireless Sensor Network (WSN) and it comes in parallel with energy consumption. CBRP can change TDMA scheduling adaptively according to traffic and mobility characteristics. In this protocol the cluster head receive data from not only its member during the TDMA allocated time slot but also other sensor nodes that just enter the cluster when it has free timeslots, each cluster head takes turn to be the free cluster head in the network. The performance of proposed CBR protocol is evaluated using NS-2 and compared with LEACH protocol.**

Keywords: Cluster based routing, LEACH, mobility WSN, Routing.

1. INTRODUCTION

A general conception of wireless sensor network (WSN) nodes is static and it remains fixed in their position. It has been deployed in dominant

manner for a long period of time. Many researches mostly focus on energy consumption in WSN sensor nodes. However, some applications like habitat monitoring, animals tracking, search and rescue, Robo Mote, parasitic-mobility, medical care, and disaster response applications are requesting mobility in WSN components. Selection of a routing protocol for a wireless sensor network depends on various factors like the network lifetime, success rate and the number of nodes in the network. Due to the severe energy constraints of large number of densely deployed sensor nodes, it requires a suite of network protocols to implement various network control and management functions such as synchronization, node localization, and network security. The traditional routing protocols have several shortcomings when applied to WSNs, which are mainly due to the energy-constrained nature of such networks.[11] A routing protocol is required when a source node cannot send its packets directly to its destination node but has to rely on the assistance of intermediate nodes to forward these packets on its behalf. Although many protocols exist for traditional ad hoc wireless networks, none of them are suitable to the unique requirements of wireless sensor networks. Routing in wireless sensor networks differs from conventional routing in fixed networks in various ways. There is no infrastructure, wireless links are unreliable, sensor nodes may fail, and routing protocols have to meet strict energy saving requirements. All major routing protocols proposed for WSNs may be divided into seven categories as Location-based Protocols, Data-centric Protocols, Hierarchical Protocols, Mobility-based Protocols, Multipath-based Protocols, Heterogeneity-based Protocols, QoS-based protocols. The main challenge in WSN is to minimize energy consumption in each sensor node. Many researchers concentrate on the routing protocol that would consume less power and hence prolong network's life span. Wireless ad hoc network routing protocols have been proposed for routing protocols in WSN. Some of them were proactive and designed for static network like Destination Sequenced Distance Vector (DSDV). Some were reactive and designed for mobile network like Dynamic Source Routing (DSR) and some was hybrid protocol like Ad hoc On Demand Distance Vector (AODV). However, these protocols are not suitable for WSN because they require higher power consumption and not suitable for tiny, low capacity and battery operated sensor nodes. [4]

Cluster based routing protocol (CBRP) define new algorithm for cluster head election that can better handle heterogeneous energy circumstances than existing clustering algorithms which elect the cluster head only based on a node's own residual energy. The clustering routing algorithm is used to find out intra cluster and inter cluster link in wireless sensor network clusters are acted as a router, which maintain and distribute of the routing information. After node is selected as cluster head, it will broadcast information that is the cluster head to the rest of the nodes in the same cluster. The remaining nodes decide to join the cluster according to the size of the received signal. Low-Energy Adaptive Clustering Hierarchy (LEACH) Mobile protocol was proposed for mobile nodes to continue the data transmission for a specific wireless sensor cluster head basic idea in LEACH is to confirm whether a mobile sensor node is able to communicate with a specific cluster head. [11] LEACH support mobility in WSN and outperform LEACH in mobility centric environment, LEACH has high packet loss and high power consumption.[7]

2.WIRELESS SENSOR NETWORK (WSN)

The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer application, such as industrial process monitoring and control, machine health monitoring, environment and habitat monitoring, healthcare applications, home automation, and traffic control.

Nodes in other traditional wireless networks are free to move, which results in unpredictable and frequent topological changes. The task of finding and maintaining routes in WSN's is nontrivial since energy restrictions and sudden changes in node status (e.g., failure) cause frequent and unpredictable topological changes. In typical applications of wireless sensor networks, fixed sensor nodes are mixed with mobile sensor nodes in 'hot areas', and fixed sensor nodes are placed in specific locations with power supply, but mobile sensor nodes are not so ever. Mobile sensor nodes are severely constrained by the amount of battery power available, limiting the lifetime and quality of the network. The sensor nodes and routing the sensed information has to be done in an energy efficient way to ensure good lifetime for the

network. Hence, data transfer protocols play an important role in wireless sensor networks major part of the research work concentrates on extending life time of networks by designing energy efficient protocols.[6]battery power available, limiting the lifetime and quality of the network. The sensor nodes and routing the sensed information has to be done in an energy efficient way to ensure good lifetime for the network. Hence, data transfer protocols play an important role in wireless sensor networks major part of the research work concentrates on extending life time of networks by designing energy efficient

protocols.[6]

i. Routing Challenges and Design Issues in WSN

One of the main design goals of WSNs is to carry out data communication while trying to prolong the lifetime of the network and prevent connectivity degradation by employing aggressive energy management techniques. The design of routing protocols in WSNs is influenced by many challenging factors. Some of the routing challenges and design issues that affect routing process in WSNs are as given below. [9]

1. Node deployment: Node deployment in WSNs is application dependent and affects the performance of the routing protocol.

2. Energy consumption without losing accuracy: Sensor nodes can use their limited supply of energy performing computations and transmitting information in a wireless environment. The malfunctioning of some sensor nodes due

to power failure can cause significant topological changes and might require rerouting of packets and reorganization of the network.

3. Data Reporting Model: Data sensing and reporting in WSNs is dependent on the application and the time criticality of the data reporting. Data reporting can be categorized as either time-driven (continuous), event-driven, query-driven, and hybrid. The routing protocol is highly influenced by the data reporting model with regard to energy consumption and route stability.

4. Node/Link Heterogeneity: All sensor nodes were assumed to be homogeneous, i.e., having equal capacity in terms of computation, communication, and power. However, depending on the application a sensor node can have different

role or capability. The existence of heterogeneous set of sensors raises many technical issues related to data routing.

5. Fault Tolerance: Some sensor nodes may fail or be blocked due to lack of power, physical damage, or environmental interference. The failure of sensor nodes should not affect the overall task of the sensor network. If many nodes fail, MAC and routing protocols must accommodate formation of new links and routes to the data collection base stations.

6. Scalability: The number of sensor nodes deployed in the sensing area may be in the order of hundreds or thousands, or more. Any routing scheme must be able to work with this huge number of sensor nodes. In addition, sensor network routing protocols should be scalable enough to respond to events in the environment. Until an event occurs, most of the sensors can remain in the sleep state, with data from the few remaining sensors providing a coarse quality.

7. Network Dynamics: Most of the network architectures assume that sensor nodes are stationary. However, mobility of both BS's and sensor nodes is sometimes necessary in many applications. Routing messages from or to moving nodes is more challenging since route stability becomes an important issue, in addition to energy, bandwidth etc.

8. Transmission Media: In a multi-hop sensor network, communicating nodes are linked by a wireless medium. The traditional problems associated with a wireless channel (e.g., fading, high error rate) may also affect the operation of the sensor network. In general, the required bandwidth of sensor data will be low, on the order of 1-100 kb/s.

9. Connectivity: High node density in sensor networks precludes them from being completely isolated from each other. Therefore, sensor nodes are expected to be highly connected. Connectivity depends on the, possibly random, distribution of nodes.

10. Coverage: In WSNs, each sensor node obtains a certain view of the environment. A given sensor's view of the environment is limited both in range and in accuracy; it can only cover a limited

physical area of the environment. Hence, area coverage is also an important design parameter in WSNs

11. Quality of Service: In some applications, data should be delivered within a certain period of time from the moment it is sensed otherwise the data will be useless. Therefore bounded latency for data delivery is another condition for time-constrained applications. [1]

2.1 Clustering and Routing in WSN

Clustering is the method by which sensor nodes in a network organize themselves into groups according to specific requirements or metrics. Each group or cluster has a leader referred to as cluster head (CH) and other ordinary member nodes (MNs). The cluster heads can be organized into further hierarchical levels. In fact, member nodes are only allowed to communicate with their respective cluster head, which is responsible for relaying the data to the sink with possible aggregation and fusion operations. [2] The fact is that most of the sensing, data processing and communication activities can be performed within clusters. In hierarchical-based routing, nodes play different roles in the network and typically are

organized into clusters. Clustering topology is shown in fig. 1.below. Clustering allows intra-cluster (within a cluster) and inter-cluster (between cluster heads and every cluster head and the sink) routing which reduces the number of nodes taking part in a long distance communication, thus allowing significant energy saving in addition to smaller dissemination latency. Clustering techniques are expected to achieve better scalability since most of the topology changes within a cluster are hidden from the rest of the network [9].
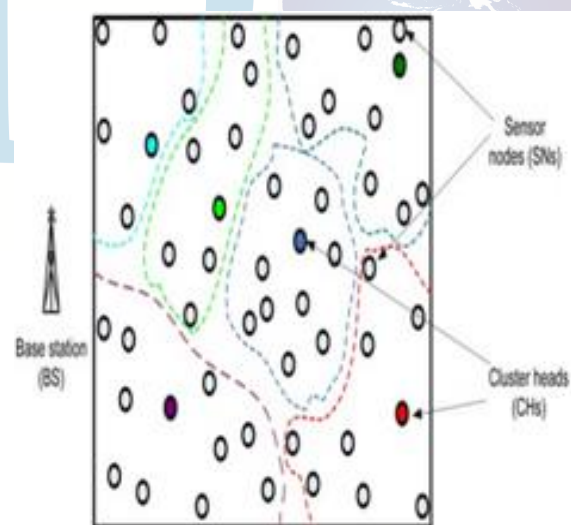

Fig 1: Cluster Based Topology

3. LEACH

LEACH is a Low-Energy Adaptive Clustering Hierarchy uses cluster-formation to

sense data and forwards it to the base station. It supports sensor nodes mobility in WSN by adding membership declaration to LEACH protocol. However, the packet loss and power consumption in this protocol were high. It has been designed to support mobility for applications where fixed sensor nodes are mixed with mobile sensor nodes. It declares the membership of a cluster as they move, and confirms whether sensor nodes are able to communicate with a specific cluster head. The protocol consists of two phases shown in fig.2, one is setup phase and other is steady state phase. In setup phase each sensor node chooses most appropriate cluster head according to received signals strength and then sends the join message to that cluster head. After the cluster head receives the join message from the sensor nodes, it will create a time division multiple access (TDMA) schedule and broadcast to its members. [3]

Since LEACH has fixed TDMA timeslot schedule, each node keep its allocated timeslot even if it has no data to send or move out of the cluster. When sensor nodes from other cluster enter a new cluster, it cannot join the cluster because all the time slots are reserved. Sensor nodes in LEACH wait for two consecutive failure frames in

receiving data request message from its cluster head to decide that it has moved out of its cluster.
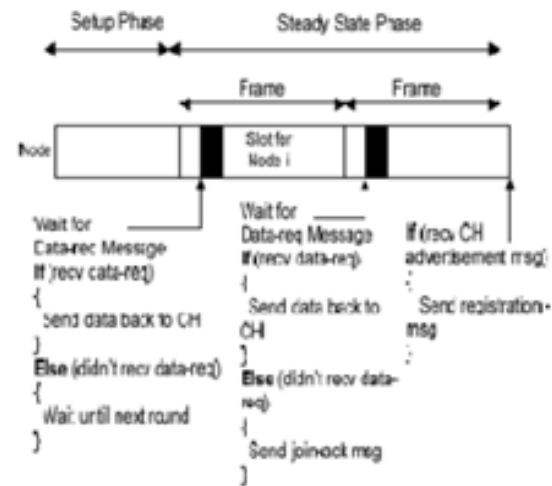

Fig 2: LEACH TimeLine

4. CLUSTER BASED ROUTING PROTOCOL (CBRP)

The energy consumption is one of main challenges in Wireless Sensor Network (WSN).Also packet loss that occur due to mobility of the sensor nodes as well as effective bandwidth utilization are at the concern in wireless sensor network applications. So CBRP is proposed for the same.

In CBRP, routing is done using source routing. It also uses route shortening that is on receiving a source route packet, the node tries to find the farthest node in the route that is its neighbor (this could have happened due to a topology change) and sends the packet to that node

thus reducing the route. While forwarding the packet if a node detects a broken link it sends back an error message to the source and then uses local repair mechanism. [10] Cluster based routing protocol (CBRP) define new algorithm for cluster head election that can better handle heterogeneous energy circumstances than existing clustering algorithms which elect the cluster head only based on a node's own residual energy.

4.1 Cluster Based Routing Algorithm

1. Clustering routing algorithm is used to find out intra cluster and inter cluster link in wireless sensor network clusters are acted as a router, which maintain and distribute of the routing information.

2. After node is selected as cluster head, it will broadcast information that he is the cluster head to the rest of the nodes in the same cluster. The remaining nodes decide to join the cluster according to the size of the received signal.

3. On the other hand, when the sensor node does not receive data request message from the cluster head it will try to establish new membership with new cluster to avoid packet loss.

4. When the sensor node receives data request message from cluster head but it has no data to send, the node will not occupy any time slot. Thus, the timeslot will be assigned to another member who has data to send. It will create a time division multiple access (TDMA) schedule and broadcast to its members.

5. This adaptive protocol can avoid wastage of timeslot, hence ensure efficient bandwidth utilization. Each cluster head keep some free timeslot to enable other incoming nodes from other cluster to join its cluster.

6. Overall implementation of CBRP consists of two phases:

a) Setup phase - It includes cluster head election, advertisement, decision and schedule creation.

b) Steady phase -Sending data to cluster head takes place. [8,11]

4.2 TDMA Scheduling in CBRP

In this protocol, cluster head receives the data not only from its members during TDMA allocated time slot but also from other lost sensor nodes during its free time, and each cluster head takes turn to be the free cluster head in the network. If

the sensor node does not receive data request message from its cluster head during TDMA allocated time slot it will send a message to the free cluster head to avoid the loss of message. If the new cluster head receives a join acknowledgement message, it will then add the new sensor nodes to the list and send the TDMA time schedule to them. CBR protocol uses adaptive scheduling algorithm in which timeslots of sensor nodes that have moved out of the cluster (or timeslots of sensor nodes that have no data to send) can be reassigned to sensor nodes that are awake or have recently moved into the cluster.

Adaptive scheme in CBRP for mobile WSN shown in fig. 3 behaves as follows:
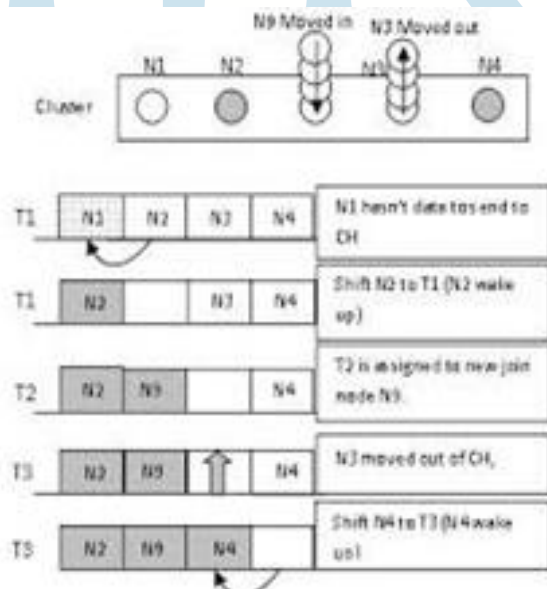

Fig 3: Adaptive TDMA Scheduling in CBRP

a) Enable the sensor nodes that enter the cluster to join the cluster as soon as possible.

b) Achieve efficient bandwidth utilization by avoiding unnecessary wastage of timeslots.

c) Avoid data loss that may happen while the sensor nodes are disconnected from the network for long time.

5. SIMULATION PARAMETERS

In order to evaluate the performance of CBRP we simulate CBRP and LEACH using NS-2 with the various network parameters. Table 1 shows the various simulation parameters. The CBRP achieves significant improvement compared to LEACH. In CBRP the number of packets sent is equal to the number of packets received that means there is no packet loss occurs. Fig. 4 and Fig. 5 shows the total number of packets received successfully as the number of packets send. Adaptive scheduling we can utilize the bandwidth efficiently and round free cluster head in CBRP act as packet loss avoidance technique which enables the sensor nodes to send their data packets to the free cluster head immediately after discovering that they are lost. Registration phase occurs instantly after the sensor nodes receive data request message enable them to join new cluster head as soon as possible and avoid

losing more data messages. From the simulation results we can conclude that the average delay in LEACH is approximately constant because it assumes packets are lost when the sensor node loses its scheduled timeslot, hence does not contribute delay to the network which is shown in Fig. 6 and Fig. 7.

Parameter	Value
Network Size (L*W)	100 * 100 m
Number of Sensor Nodes (N)	100
Sensor nodes deployment	Random
Cluster Head Percentage	5%
Mobile Sensor Nodes Percentage	5 – 100 %
Data Size	2000 bits
Sensing Range R	25 m
Transmission Range	10-20 m
Sensor Speed	1-20 m/s
Mobility Model	Random Way Point Model
Radio Model	First Order Radio Model

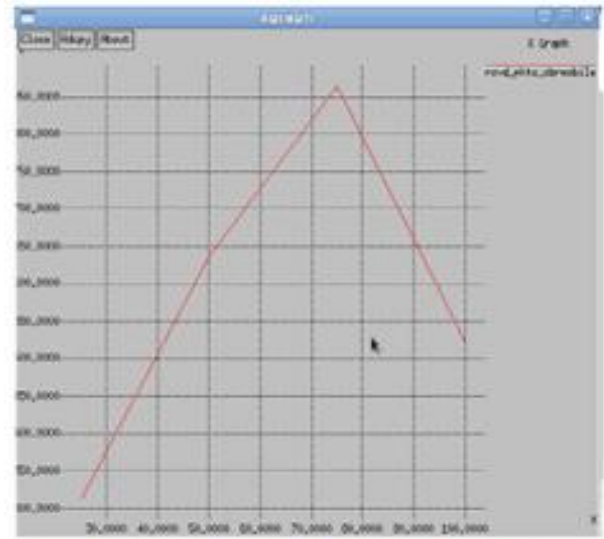**Table 1. Simulation Parameters**
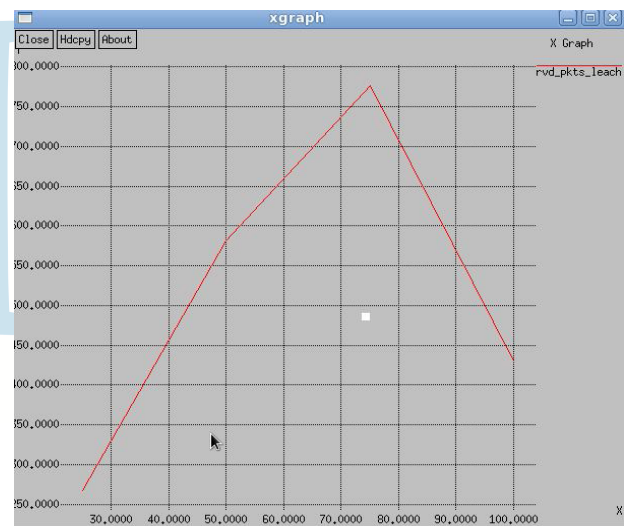

Fig 4: Total Number of Packets in CBR Protocol
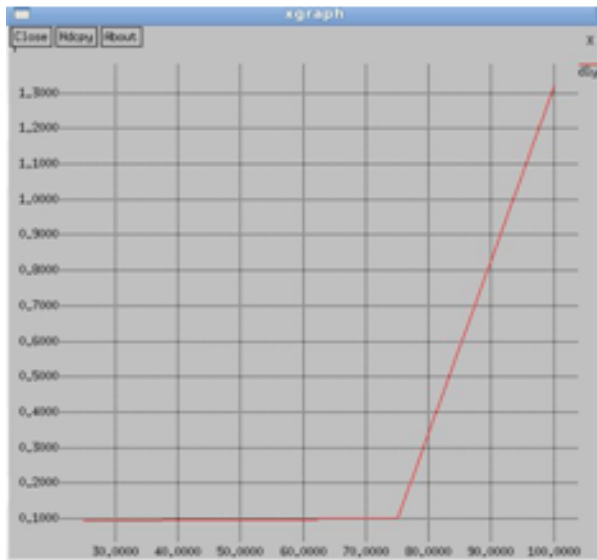

Fig 5: Total Number of Received Packets in

LEACH

Fig 6: Average Delay in CBR Protocol

Fig 7: Average Delay in LEACH

6. CONCLUSION

Integrating mobility in WSN motivates researchers to design and improve routing protocol that can support mobile sensor nodes. In addition to this routing protocol should also be aware of energy consumption limitation in WSN. CBR

protocol reduces the effect of mobility by decreasing packet loss by changing the TDMA scheduling adaptively and using round free cluster head. This protocol is also energy aware, as it reduces the energy consumption by transmitting with low transmission with minimal amount of energy power based on the received signal strength of data request message. The CBRP protocol shows significant improvement in data transfer success rate and energy consumption in mobility environment compared to LEACH protocol.

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AUTHORS PROFILE

She completed her MCA M.Phil.,. Presently she was working as an Assistant Professor in Department of Computer Science, AJK College of Arts and Science. She has nine years of teaching experience. She presented seven papers in National and State Level Conference and one in International Conference. Four papers were published in the reputed International Journal and two in national conference proceedings.