Optimize the Cluster-head Election Technique in Wireless Sensor Network

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NIRMA UNIVERSITY

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Optimize the Cluster-head Election Technique in Wireless Sensor Network

Major Project

Submitted in partial fulfillment of the requirements

For the degree of

Master of Technology in Computer Science and Engineering in Networking Technology

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Guided By

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Certificate

This is to certify that the Major Project Report entitled “”**Optimize the Cluster-head Election Technique in Wireless Sensor Network”** submitted by **Amit Parmar (Roll No: 12MICT13)**, towards the partial fulfillment of the requirements for the degree of Master of Technology in Computer Science and Engineering in Networking Technology of Nirma University, Ahmedabad is the record of work carried out by him under my supervision and guidance. In my opinion, the submitted work has reached a level required for being accepted for examination. The results embodied in this major project part-I, to the best of my knowledge, haven't been submitted to any other university or institution for award of any degree or diploma.

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Undertaking for Originality of the Work

I, **Amit Parmar**, Roll. No. **12MICT13**, give undertaking that the Major Project entitled "**Optimize the Cluster-head Election Technique in Wireless Sensor Network**" submitted by me, towards the partial fulfillment of the requirements for the degree of Master of Technology in **Computer Science & Engineering in Networking Technology** of Nirma University, Ahmedabad, is the original work carried out by me and I give assurance that no attempt of plagiarism has been made. I understand that in the event of any similarity found subsequently with any published work or any dissertation work elsewhere; it will result in severe disciplinary action.

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- Amit Parmar
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Abstract

Wireless Sensor Networks (WSN) is mainly characterized by it's limited power supply. Hence the need for energy efficient infrastructure is becoming increasingly more important since it impacts to network lifetime. Here the focus of this thesis on Hierarchy clustering because Multi-hop short range communication between wireless sensor node is energy efficient compared to Single-hop long range communication. In Hierarchy clustering there are many Protocol but this paper talk about the well known Low-Energy Adaptive Clustering Hierarchy (LEACH)[1].Centralized Low-Energy Adaptive Clustering Hierarchy (LEACH-C) and Advanced Low-Energy Adaptive Clustering Hierarchy(ALEACH) are energy efficient clustering routing protocol and they are belongs to hierarchy routing. In this thesis we proposed Modified LEACH-C to upgraded the execution of existing Leach-C in such sort of Topology where Leach-C perform not all that well. By Applying Method of Distance calculation between CH (cluster-head) to Member node and BS(base-station) to Member node. Making non-overlapping cluster using assigning proper ID while creating cluster. Which makes the routing protocol more energy effective and delays life time of a wireless sensor network. Simulation results demonstrate that Modified LEACH-C enhances network life time contrasted with LEACH-C algorithm.

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Chapter 1

Introduction

1.1 Research Area

Wireless sensor systems are a combination of micro electro mechanical frameworks (MEM-S), low-control hardware and low-power radio recurrence (RF) outline. A remote sensor organize for the most part comprises of three principle parts: (i) Numerous sensor hubs. Sensor hubs are equipped for article sensing, information handling, putting away, and steering exercises. (ii) A base station (Bs).the base station may be a settled or versatile hub which can interface the sensor system to a current correspondences foundation or to the web with the clients to disperse the information sensed for further transforming.in remote sensor radio recurrence (RF) transceiver and a force source. Furthermore, the hubs suit sensors and actuators [1].In numerous WSN provisions, the organization of sensor hubs is performed in an adhoc design without cautious preplanning and designing.The open framework interconnection reference model built by the worldwide principles association (ISO) tags the relationship between messages transmitted in a correspondence system and requisitions projects run by the users.hence, we can utilize a comparable model to order WSN into diverse capacities which intimate correspondence layers.[2]

The applications layer represents programs run by users. The transport layer maintains the flow of data and provides error detection and correction. Routing is performed in the network layer. The data link layer implements media access control (MAC) protocol to resist fading, filter noise and reduce message collision. The physical layer provides the actual hardware communication link interconnections.

The research work in this thesis focuses on routing schemes in WSNs. In network con-

cepts, routing is the act of directing and delivering network traffic across a network from sources to a destination, whose kernel is path determination.
Routing in sensor networks is very challenging due to several characteristics that distinguish them from contemporary communication and wireless ad-hoc networks. [3]

1.2 Research Problem

The objective of this thesis is:

To study energy-efficient routing schemes in a distributed wireless environment subject to limited transmission range and check their cluster head election technique in each routing algorithm and then optimize that cluster-head election technique and device a modified algorithm which is perform better in such scenario where some of the existing protocol not perform so well.

1.3 Types Of Routing Scheme

- HIERACHICAL
- LOCATION BASED
- NAGOTIATION
- MULTIPATH
- QOS BASED
- MOBILITY [3][4]

This thesis work mainly focused on hierarchical routing and in which LEACH and their variant.

Chapter 2

Literature Survey

2.1 TEEN

TEEN is a clustering protocol that focuses on a receptive network and empowers cluster heads to force requirement on when the sensor hubs ought to report their sensed information. Each one group head telecasts to its parts a worth, called hard threshold (HT), for the sensed characteristic past which a sensor ought to turn its transmitter on to report its sensed information to group head. Group head additionally shows an alternate quality, called delicate threshold (ST), which demonstrates a little change in the worth of the sensed characteristic, making sensor turn on its transmitter and send information to the group head. Youngster is a hierarchical protocol intended to be receptive to sudden changes in the sensed traits, for example, temperature. Teenager seeks after a hierarchical approach alongside the utilization of an information driven instrument.[3] than all sensor nodes.

Working of LEACH is partitioned into rounds. Every hub is fit to end up bunch head just once in a 1/p rounds, where p is the coveted rate of bunch heads throughout each one round. A hub will select an arbitrary number between 0 and 1. In the event that esteem of chose irregular number is not exactly the threshold T(n), the hub turns into a group head for the present round.

2.2 APTEEN

In this segment, we present another protocol created for crossover networks, called APTEEN (Adaptive Periodic Threshold-touchy Energy Efficient Sensor Network Protocol). In APTEEN once the CHs are chosen, in each one cluster period, the cluster head first telecasts the accompanying parameters: Attributes(a): This is a situated of physical parameters which the client is intrigued by getting information about. Thresholds : This parameter comprises of a hard threshold and a delicate threshold is a specific worth of a characteristic past which a hub might be activated to transmit information. ST is a little change in the worth of a trait which can trigger a hub to transmit information once more. Plan This is a TDMA plan like the one utilized within allocating an opening to every node.[3] count Time It is the most extreme time period between two progressive reports sent by a node. It might be a numerous of the TDMA plan length and it represents the proactive segment. In a sensor network, close-by hubs fall in the same cluster, sense comparable information and attempt to send their information all the while, creating conceivable crashes. We present a TDMA timetable such that every hub in the cluster is doled out a transmission opening. In the accompanying segment, we allude to information qualities surpassing the threshold esteem as discriminating data.

2.3 LEACH

Low-energy adaptive clustering hierarchy (LEACH) is a standout amongst the most prevalent various leveled directing calculations for sensor systems. The thought is to structure groups of the sensor nodes focused around the gained indicator quality and use nearby bunch heads as switches to the sink. This will spare energy since the transmissions might be carried out by such group heads rather than all sensor nodes.

Heinzelman [1]designed the hierarchical clustering in WSN and device a protocol Low-Energy Adaptive Clustering Hierarchy (LEACH). LEACH protocol organize the sensor nodes in the network into clusters and pick-out one of them as the cluster-head.LEACH protocol has following properties. (1)Base Station is not mobile. (2)All sensor nodes are having limited and same energy , storage capacity and computational capability is also the same in every nodes. Because of the limited energy protocol impose the energy constraint.

This bellow figure(2.1) is redrawn from[5]

LEACH is a self-organizing ,adaptive clustering protocol that uses randomization to

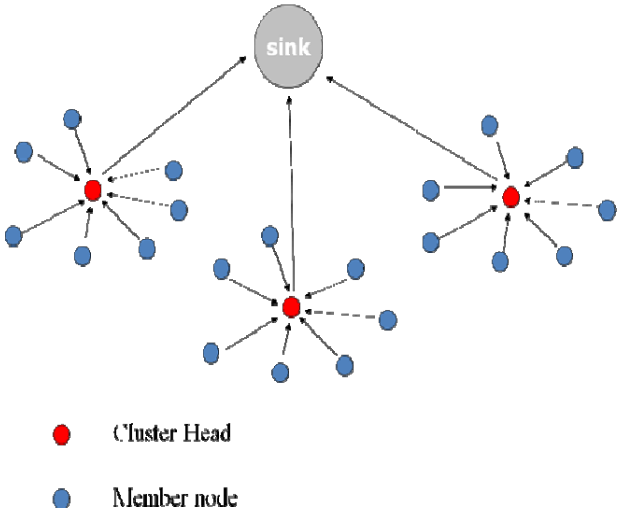

Figure 2.1: Network Model with Clustering in Leach

distribute the energy load evenly among the sensors in the network. In LEACH , the nodes compose themselves into local clusters.with one node going about as cluster-head.if unluckily the same sensor node elect as cluster-head than it would die quickly. we have been made some assumptions while implementing or simulating LEACH protocol.

-Every last hub is sensing at settled time rate and in the wake of sensing its having information to send to the cluster-head and cluster-head send to the BS(base-station).

-All nodes can achieve Base Station.

-Cluster-Head are uniformly distributed.

-Symmetric propagation channel.[6]

How LEACH is work? There two phase of working (1)Setup phase (2)Steady phase first we go through setup phase During the setup phase, a predefined desired percentage of nodes, p, choose themselves as cluster-head. How it can be done? Every node wanting to be the cluster-head so they have to chooses a random number, between 0 and 1. If this random number is less than the threshold value, T(n), then the node becomes the cluster- head for the current round. The threshold value is calculate by the equation is given bellow.

$$T(n) = \begin{cases} \frac{p}{1 - p(r mod \frac{1}{p})}, & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases} \quad [6]$$

Where G is the accumulation of nodes which are not chosen as cluster-head in last r rounds. LEACH algorithm is distributed. Moreover LEACH protocol perform information combination to layer the information that needs to send from CHs to BS(base statio). It is not guarantee that throughout each one round just p% of all nodes ought to chose as cluster-head. Furthermore additionally the location of cluster-head is not characterized.[1].

2.4 ALEACH

Advanced LEACH (ALEACH) is amplification of LEACH, which is enhances the life time of the network and lessening likelihood of disappointment nodes utilizing the characteristic parameter of heterogeneity. Same Like LEACH , ALEACH is likewise work in two phase(a)setup Phase and (b)steady state stage. Lets make a supposition that in the network percentage of the population of sensor nodes which has more energy resource then the other nodes. Let say m be the part number of aggregate number of nodes n which has **a** times more energy than whatever remains of alternate nodes. We allude that these m nodes are influential nodes called CAG nodes (gateways or cluster-head) and the rest (1-m)*n as standard nodes[5]. The procedure of electing cluster-head is same as LEACH Algorithm procedure for electing cluster-head. After decided about the cluster-head then we will see that how many CAG nodes becomes cluster-head now and how many still as CAG node it self. Where remaining nodes choose a cluster to join according to the highest RSSI. After member nodes send to request message to CHs then CHs send confirmation messages to their members nodes. And after all data transmitted to their respective CHs , CHs will aggregate their data and transmit to Base Station. If Cluster-head (CH) is a ordinary node seek a node choose its nearest CAG node chosen as gateway and gateway will route the data to the Base Station. If Cluster-head it-self CAG node then data will directly transmit to the Base Station.
Bellow figure(2.2) is redrawn from[5]

How energy is consume per round in LEACH and ALEACH is given by bellow equation.

$$E_{round} = M * E_{CH} + (N - M) * E_{BS} \text{ [6]}$$

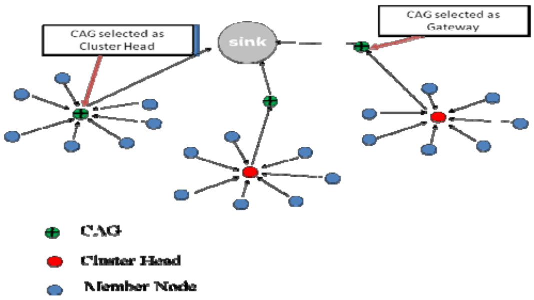

Figure 2.2: The ALEACH network model

Here M is the total member nodes of the clusters during the round and N is total number sensor nodes deployed in a region to be simulated.

2.5 LEACH-C

The placement of the cluster-head is a problem in LEACH but the LEACH-C will overcome that problem.[7] The working of LEACH-C algorithm is every hub needs to send their coordinates (location) and energy data to Bs(base-station) and after this Base Station will figure average energy of the energy data accepted from all nodes. which nodes are having energy level higher than the average energy figured will be the probable cluster-head for the present round. Then Base Station will select the desired optimal percentage of cluster-head from the set of probable cluster-heads by using simulated annealing algorithm and, to find an optimal cluster is NP-hard problem.[8] This LEACH-C algorithm is attempting to minimize the amount of energy for the member nodes to cluster-head. By minimizing the total summation of squared Euclidean distance between all the member node and cluster head. Once all the cluster-head nodes and their associated cluster are identified, then the time of broadcasting the cluster-head ID from BS(base station) to every node. If probable cluster-head ID is matches with the broadcasted IDs then that probable cluster-head becomes cluster-head. There are nodes who does not get to be a cluster-head they will figure out their TDMA schedule throughout which they can transmit their information to cluster-head or base station. Nodes are in slumber until their turn comes. It serves to spare energy of nodes. The suppositions in LEACH and LEACH-C is that cluster head are uniformly distributed. The following figures show that how dynamically cluster formation is change. Bellow figure(2.3) and figure(2.4) are taken from[1].

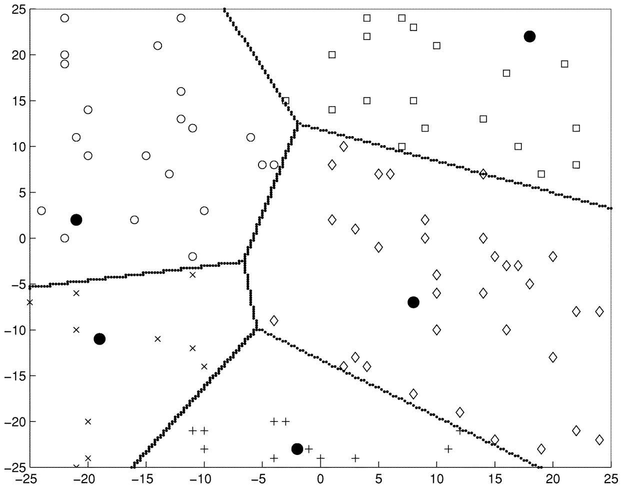

Figure 2.3: Dynamic cluster At time T

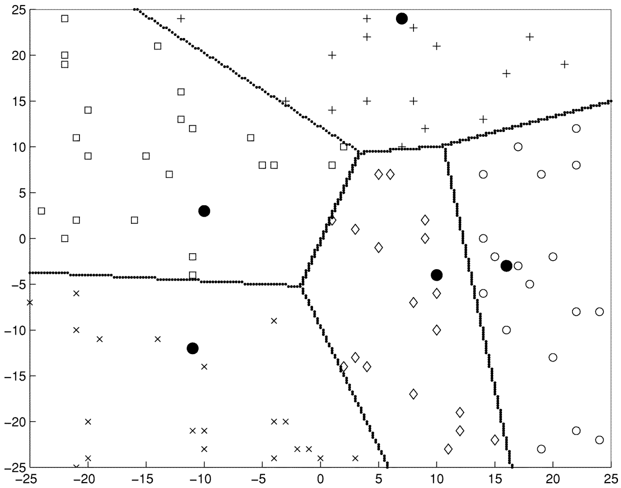

Figure 2.4: Dynamic cluster At time T'

2.6 WALEACH

ALEACH has acknowledged energy level of a node to choose a node will turn into a CH throughout a specific round or not. Significant detriment of ALEACH is fitting vitality (weights) is not given to general probability and current state probability[9]. Principle point of our algorithm -WALEACH is to increment the lifetime of a WSN and expansion the PRR by allotting fitting weights to the general probability and current state probability.

WALEACH partitions rounds into Cluster Set up stage and Steady Setup stage. Cluster Setup stage is utilized to choose cluster heads. Throughout cluster setup stage every hub chooses an arbitrary number between 0 and 1. On the off chance that chose number is short of what threshold esteem T(n), a hub chooses itself as a cluster head for the present round, where T(n) is given by mathematical statement 2. The general probability what's more present state probability is given by comparison 5 and mathematical statement 6 individually. In these comparisons w is utilized to appoint weight (significance) to general probability and current state probability.

$$T(n) = G_p + CS_p$$

$$G_p = \frac{k}{N - k(rmod\frac{N}{k})}$$

$$CS_p = \frac{E_{current}}{E_{max}} * \frac{k}{N}$$

$$G_p = \frac{N - (w - k)}{N} * \frac{k}{N - k * (rmod\frac{N}{k})}$$

$$CS_p = \frac{w * k}{N} * \frac{E_{current}}{E_{max}}$$

All the equation are taken from [9]

2.7 CVLEACH

On the off chance that we accept that energy use of a node to speak with cluster head and base station is ECH and EBS separately, where ECH ¡¡¡ EBS. Further we can accept that there might be C hubs which could be chosen as cluster head throughout each one round and every hub might be chosen as cluster head just once in 1/p rounds, where p is wanted rate of cluster heads throughout each one round.For LEACH and ALEACH algorithms, energy consumption per round Eround is given in bellow Equation.

$$E_{rand} = M * E_{cH} + (N - M) * E_{Bs}$$

where M is the total member nodes of the clusters during the round and N is the total number of nodes deployed in a region to be monitored.[6]

Energy needed to correspond with the cluster head by the part node is less contrasted with vitality needed by the cluster heads or non part nodes to correspond with the base station. From comparison 5, if we will build number of part hubs, with craved number of cluster headsc, then general vitality consumption throughout a round is lessened. This could be conceivable by making non-covering clusters. CVLEACH is the scope based vitality efficient.
Filter calculation which builds the amount of part hubs of a cluster by making non covering clusters. CVLEACH likewise works in round which is settled measure of time throughout which chose hub can go about as a cluster head. Like LEACH, at the start of each one adjust every hub chooses an irregular number between 0 and 1 and computes threshold esteem T(n), where T(n) is given by comparison in LEACH calculation. In the event that chose arbitrary number is short of what the threshold esteem T(n), hub chooses itself as a cluster head. In any case, before a hub can declare itself as a cluster-head to other nodes,if it accepts cluster head publication from other cluster head then the hub withdraws itself as a cluster head throughout that adjust and chooses to join to one of the clusters. A node will join to one of the clusters, from where it has accepted cluster head publication. A hub will send join message to one of the clusters for which least vitality is needed for correspondence with the cluster head. [6]

2.8 WCVALEACH

ALEACH has acknowledged energy level of a node to choose a node will turn into a CH throughout a specific round or not. Significant weakness of ALEACH is legitimate criticalness (weight) is not given to general probability and current state probability. WALEACH appoints essentialness to general probability and current state probability. Fundamental point of our calculation - WCVALEACH is to increment the lifetime of a WSN and to build PRR by allocating legitimate weights to the general probability and current state probability. It likewise makes non-covering cluster locales as does in CVLEACH to further build the lifetime of WSN.

WCVALEACH partitions rounds into Cluster Set up stage and Steady Setup stage. Cluster Setup stage is utilized to choose cluster heads. Throughout cluster setup stage every hub chooses an arbitrary number between 0 and 1. In the event that chose number is short of what threshold esteem T(n), a hub chooses itself as a cluster head for the present round. The general probability what's more present state probability is given by comparisons in WALEACH calculation. In these comparisons w is utilized to allocate weight (significance) to general probability and current state probability.when any hub accepts Cluster Head publication, it withdraws its investment to be chosen as a cluster head for the present round. This serves to make non-covering cluster areas, and blankets more number of part hubs. Cluster Set up period of WCVALEACH calculation is indicated in Algorithm 1 and Steady Set up stage is demonstrated in Algorithm 2 which is utilized by part hubs to send information to their cluster heads. [10]

Chapter 3

Proposed Approach

Proposed Approach call it Modified LEACH-C. In LEACH-C we saw how we make cluster and CH (cluster head). Each and every node has to send their coordinate value and energy information to the BS (base station) and the BS will calculate the average energy and whichever nodes energy is greater than average energy those nodes are eligible for cluster-head (CHs). And after using simulated annealing algorithm LEACH-C find desired number of cluster-head from set of eligible cluster-head.[7]

In proposed Scheme we do same thing for deciding cluster-head and formation of cluster. BS (base station) takes the information about coordinates and energy information from all nodes and Calculate the average energy and whichever nodes energy is more than average energy that nodes are eligible cluster-heads. And after using simulated annealing algorithm we find the optimal cluster-heads. In proposed approach when each sensor node send their coordinate value and energy information to BS (base-station) that time each sensor calculate the Euclidean distance between themselves and BS (base-station) and that distance saved in sensor node memory. A sensor node have three different sections (i) sensing (ii) computing (iii) communication. And all three connected with two way bus connection. In computing section memory is there. After cluster formation and deciding about CH (cluster-head) is done, when all CHs (cluster-heads) transmit their IDs to the member nodes to join them that time each node again calculate the Euclidean distance between transmitted CHs and member nodes. Then each node will compare their both distance (i) BS to member node and (ii) CHs to member node. The member node will transmit its data which has least distance. In some type of topology BS is located centrally and it is possible that BS to member node is less compare to CHs to member node. Energy Consumption in proposed scheme is calculating by bellow formula.

$$E_{rand} = M * E_{cH} + (N - M) * E_{Bs}$$

Here the M are the member nodes who transmit their data to their respective cluster-head(CHs).N is total nodes that presented in network in that particular round. (N-M) nodes are transmit their data to Base Station(BS) and those node have minimum distance with BS as compare to with CHs(cluster-head).

This proposed scheme is extension of LEACH-C protocol and basic rules that in LEACH protocol that rules are also have to follow, so we used the same desired percentage (p%) of cluster-head thats in LEACH and if desired percentage cluster-head is float then it will transfer into integer. For example 5% CHs of 50 nodes is 2.5 so it will take 3 CHs. We adopt the same strategy that is used in LEACH when float value come on, we do not convert in to ceiling value of its float value,but we convert in to floor value of its float but up to 20 nodes. When we have less than 20 nodes alive that time we select ceiling value of its float value. For example I have 50 nodes and 5% of 50 nodes is 2.5 but we take 2. In other case suppose I have 19 node and 5% of 19 nodes is 0.95 in this case we take ceiling value of its float value. And this algorithm additionally guarantees that a node can turns into a cluster-head just once in 1/p rounds. Each one round starts with the cluster setup stage. cluster setup stage is known as algorithm part-1 and steady state phase is known as algorithm part-2.

Chapter 4

Simulation Results

This chapter covers the details of the tool used for implementation of the project and other relevant details. The chapter also presents the snapshots of the simulated algorithms and explains the significance of some steps on the final output.

4.1 Simulation Result of LEACH-C and Proposed Approach Modified LEACH-C

Assumption

Leach is the protocol that is used for selection cluster-head from network area. 1.All the nodes are in communication range to each other.

2.Topology is same throughout the simulation or throughout data transfer.

3.We taken results of different topologies (standard) that are used by mit university when the are simulating. 4.in this protocol Probability calculated by internal RAND() function which is all ready in programming.

Here i present the resulted graph of data transfer rate,Energy consumption and node dies in time interval and we took results in every 10 seconds. Bellow the table is simulation parameter which defines the units of every entity that are used in simulation.

Assumption and Simulation parameter are the same as we taken in leach-c and conditions are same as in Modified leach-c.

Bellow graphs shows Average Data Transfer per Node,Average energy consumption and Average node dies means End of simulation every node has transfer their data to CHs

Node Deployment Area	100m X 100m
Types of Topology	50,100,200
Rate of taken Readings	Every 10 seconds
Round Duration	20 seconds
Simulation Time	3600 seconds
Expected percentage os CH per Round	5%
Initial Energy (FND,HND,LND)	2 joule

(cluster head) or (and) BS (base station),energy consume by each node by end of simulation and Average node died Reaspectively.we took the average of each and every node.

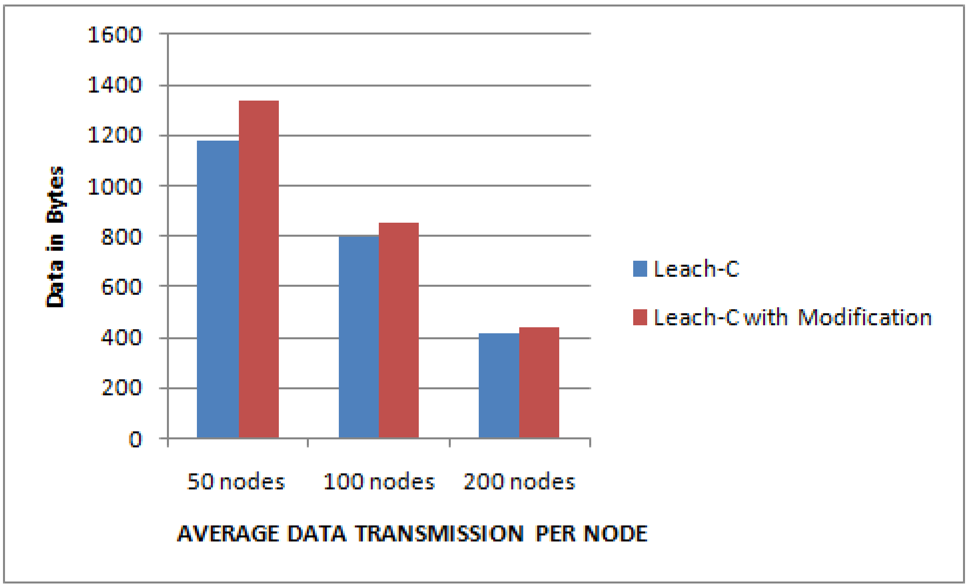

Figure 4.1: Average data transfer per node in time 10=1.

Bellow Graphs shows total energy consumption in all three topology 50 nodes , 100 nodes and 200 nodes.

Bellow graphs shows Total data received at BS(base station) in all three topologies 50 nodes , 100 nodes and 200 nodes.

Bellow graphs shows Nodes died in in all three topologies.

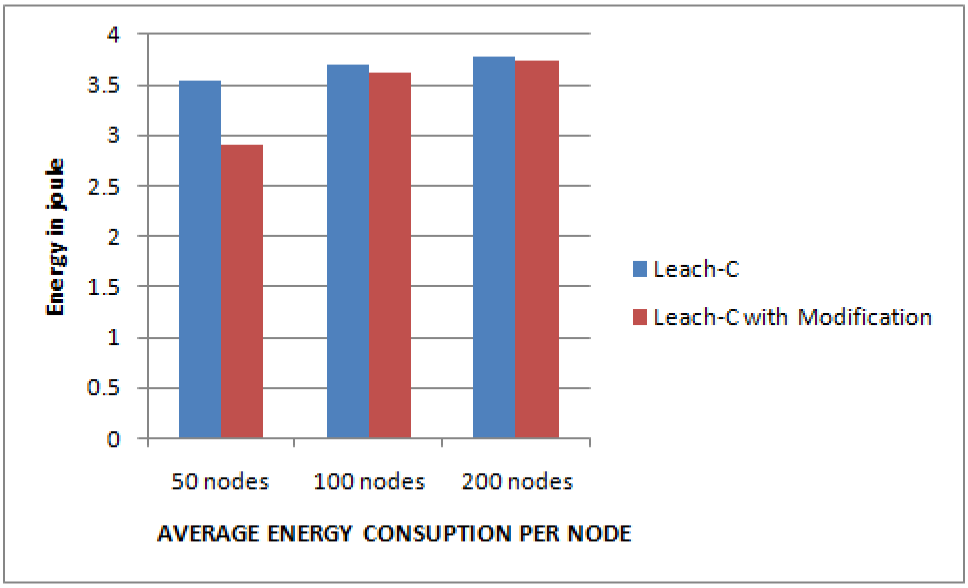

Figure 4.2: Average Energy consumption per node in here time 10=1.

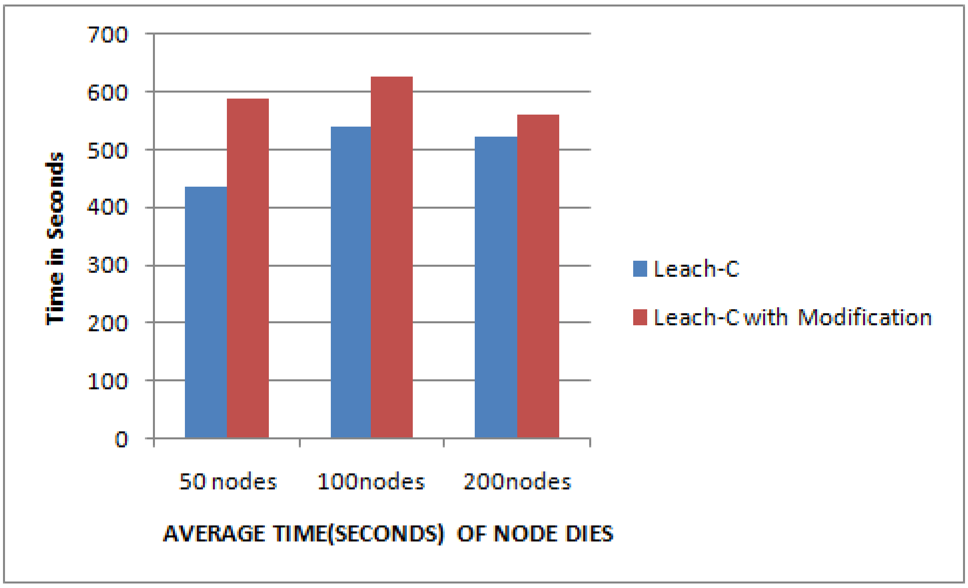

Figure 4.3: Average Node dies time 10=1.

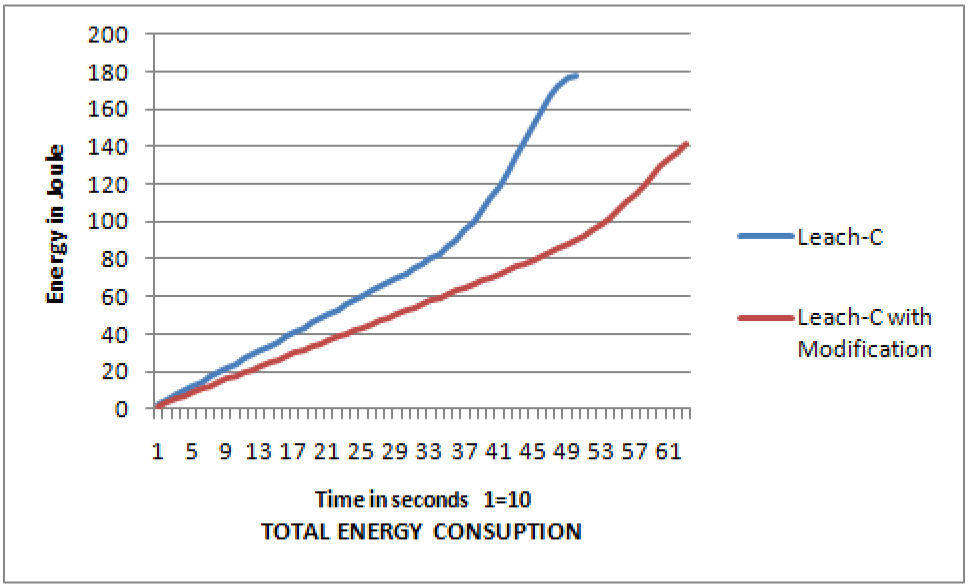

Figure 4.4: Total energy consumption in 50 nodes, time 10=1.

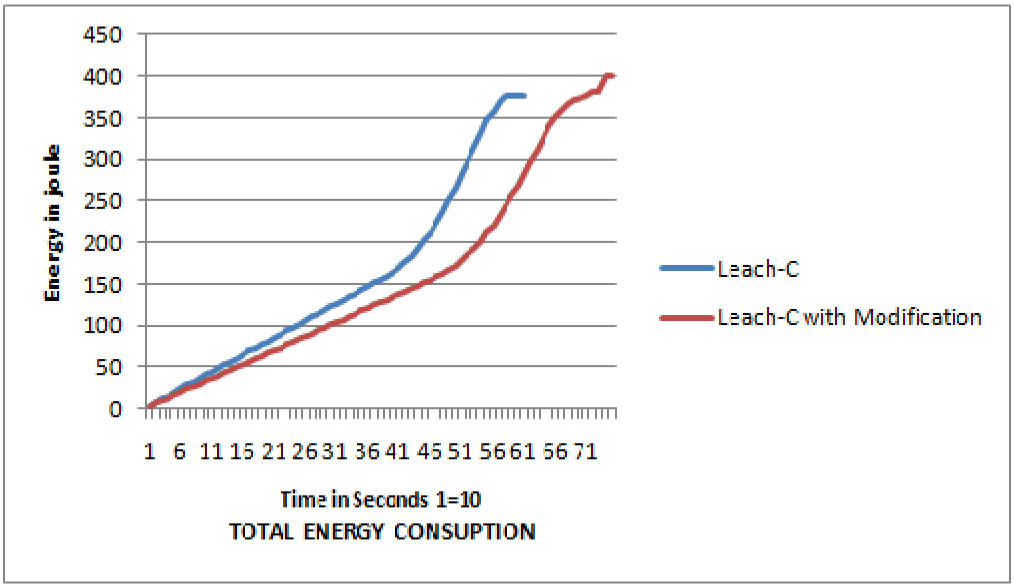

Figure 4.5: Total Energy consumption in 100 nodes, time 10=1.

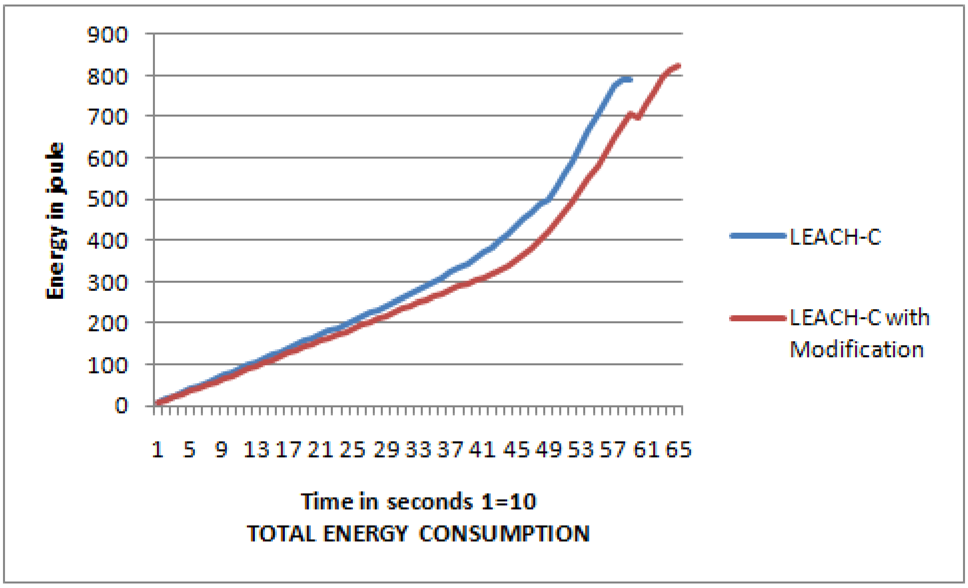

Figure 4.6: Total Energy consumption in 200, time 10=1.

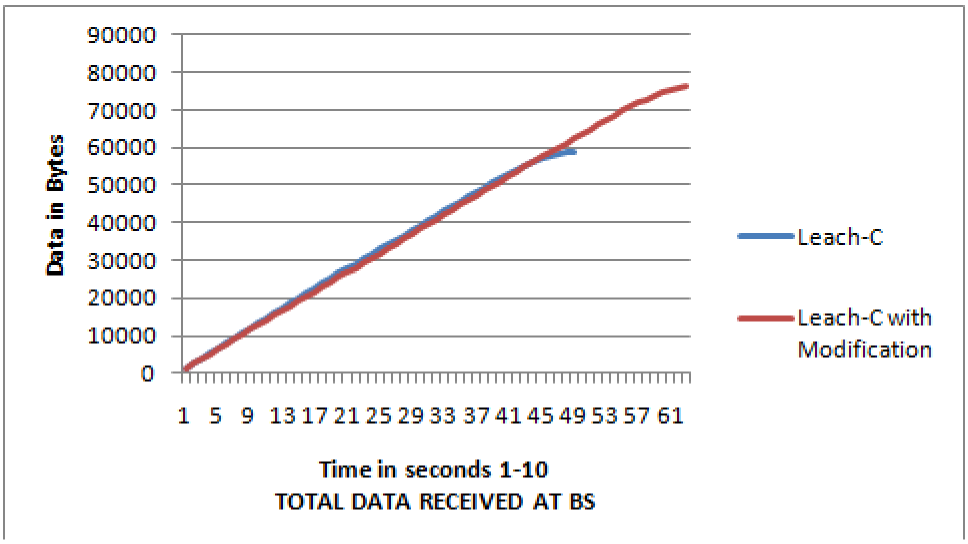

Figure 4.7: Total Data received at BS(base station) in 50, time 10=1.

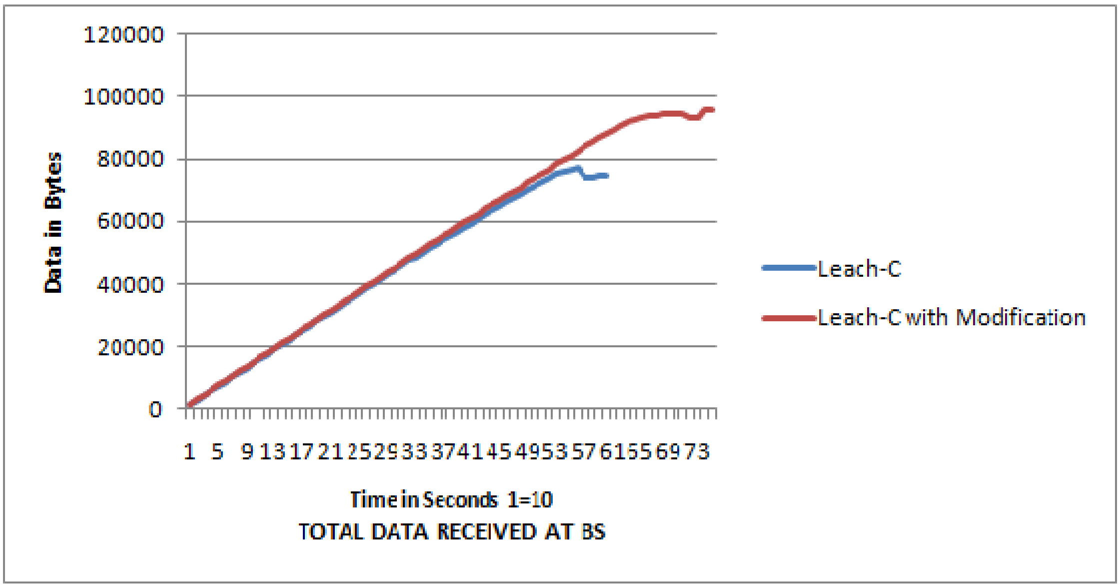

Figure 4.8: Total Data received at BS(base station) in 100, time 10=1.

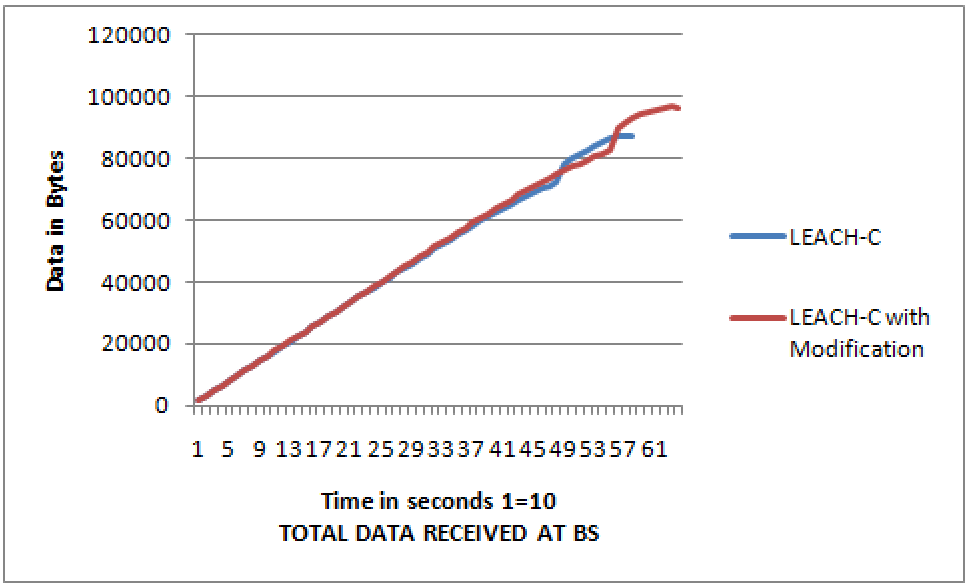

Figure 4.9: Total Data received at BS(base station) in 200, time 10=1.

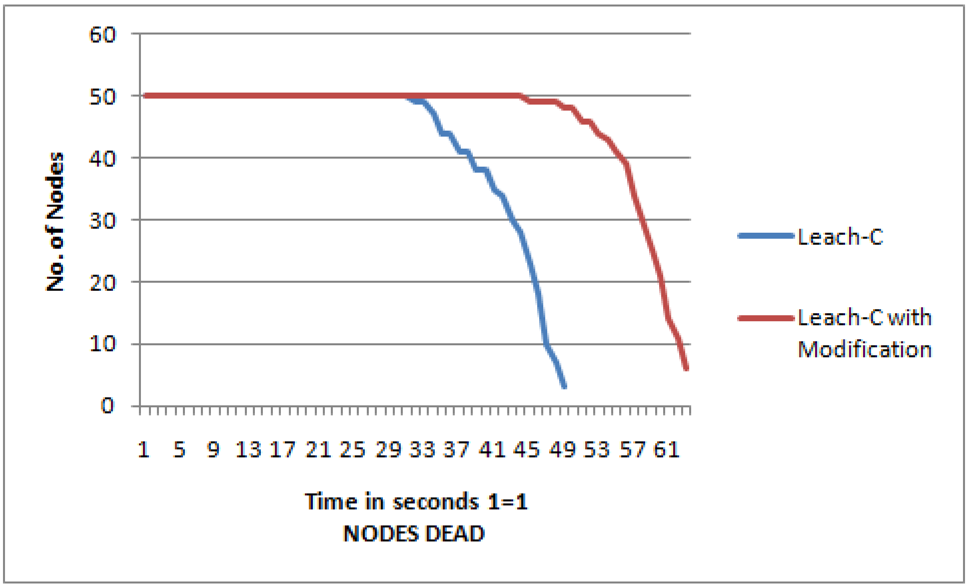

Figure 4.10: Nodes dies in 50 nodes, time 10=1.

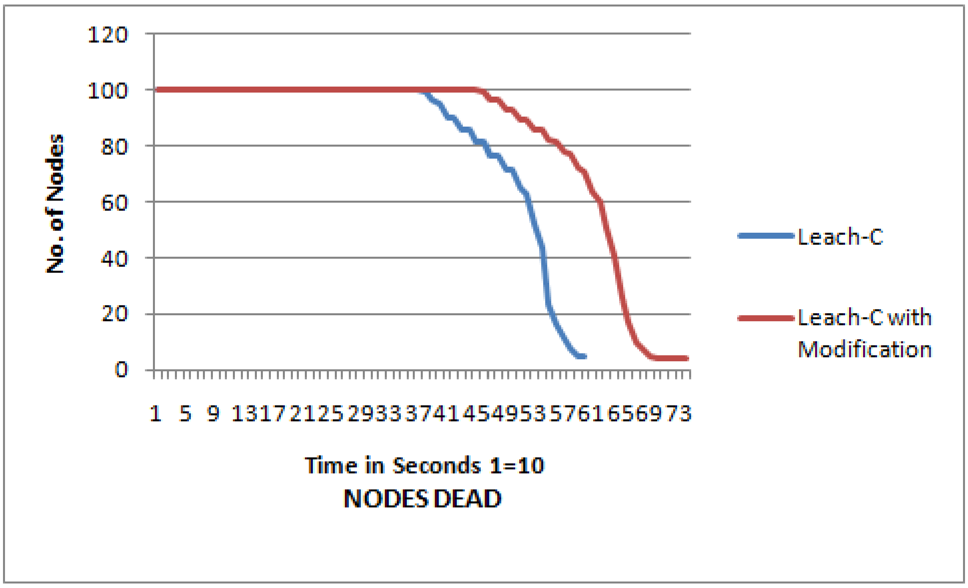

Figure 4.11: Nodes dies in 100 nodes, time 10=1.

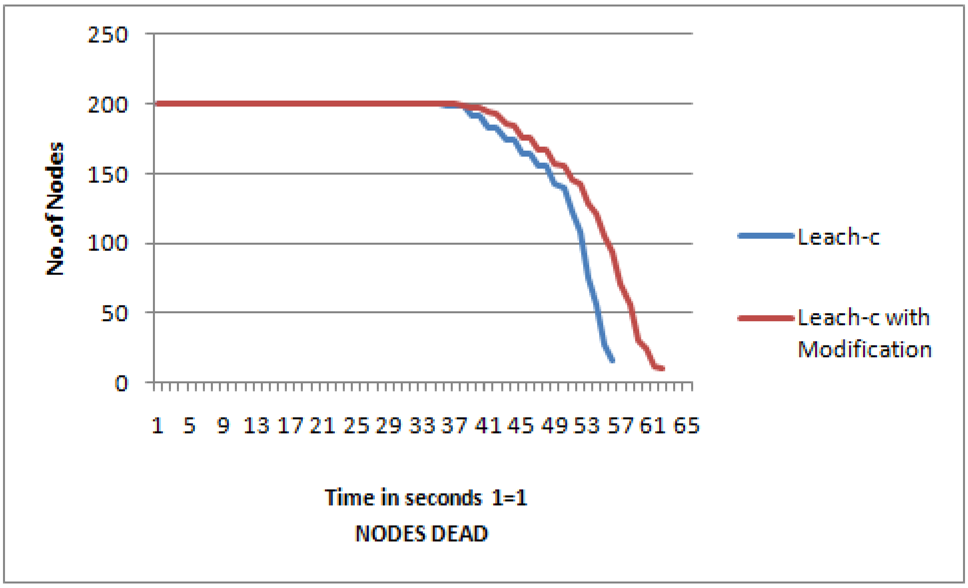

Figure 4.12: Nodes dies in 200 nodes, time 10=1.

Chapter 5

Conclusion

Modified LEACH-C algorithm is an extension of existing LEACH-C algorithm and by examined their simulation results we can conclude that Modified LEACH-C is energy efficient than LEACH-C. It is also guaranteed that a node can become a cluster-head only in 1/p round,where p is expected or desired percentage of cluster-heads. It is also increases the life time of the sensor network which we have confirmed using FND , HND and LND matrices.Modified LEACH-C is better than LEACH-C in terms of packet reception at BS (base station).

FND means first node died in sensor network at what time the first sensor node died that time we need to take and plot the accordingly and same for half of the nodes and same for the last node.

Following figure shows the life time of network by using three metric (1)First Node Dies (FND) (2)Half Node Dies (HNF) (3)Last Node Dies (LND

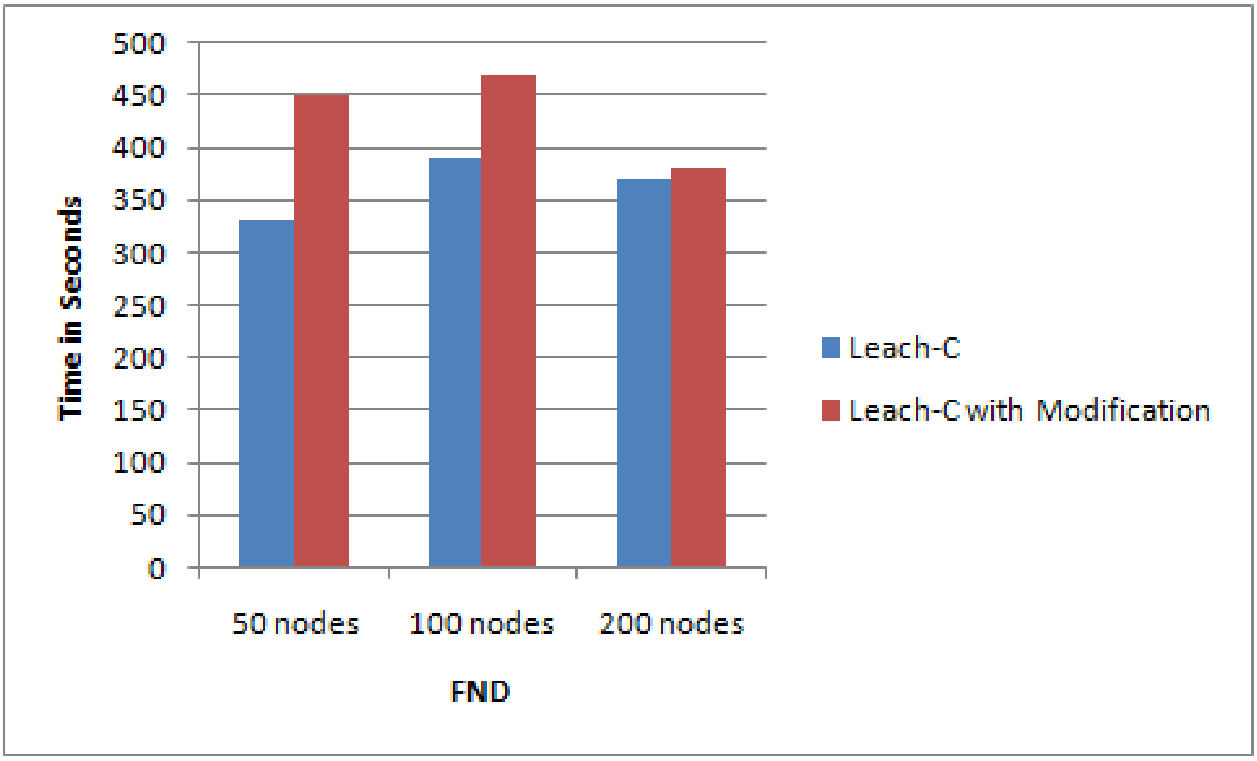

Figure 5.1: First node died, time 10=1.

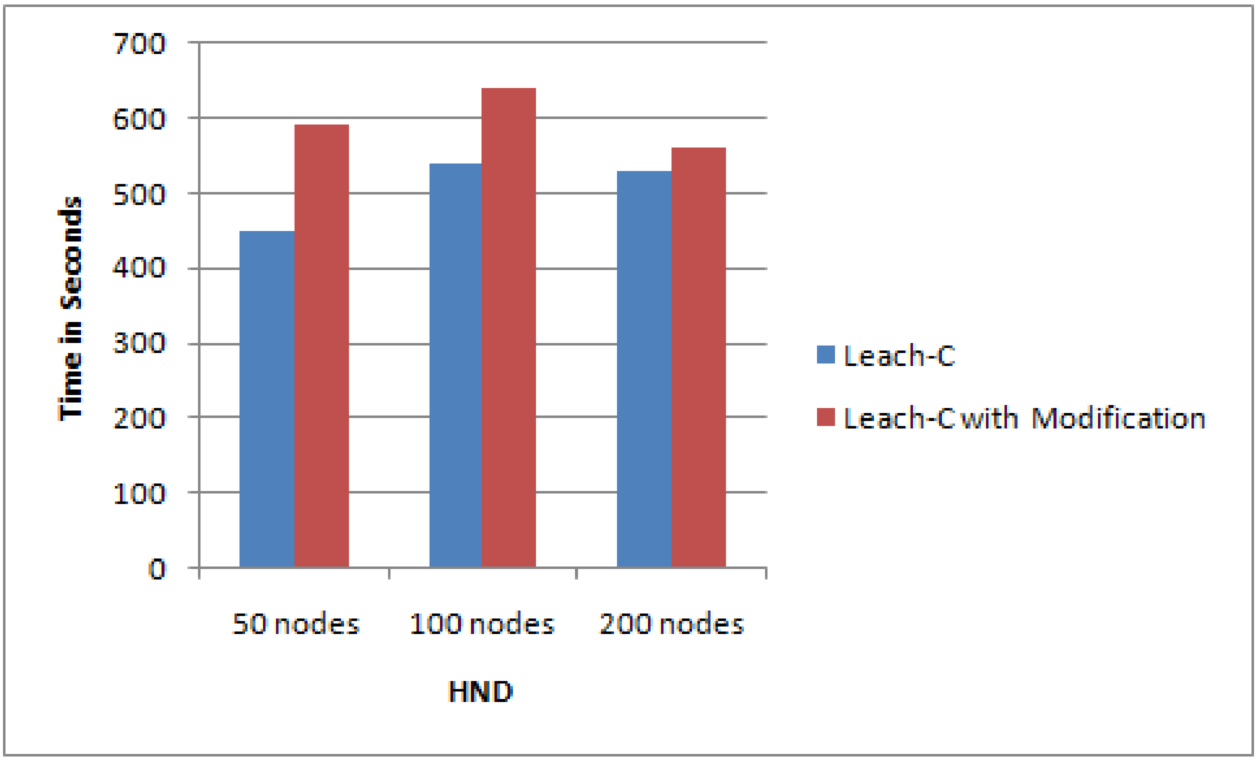

Figure 5.2: Half node died, time 10=1.

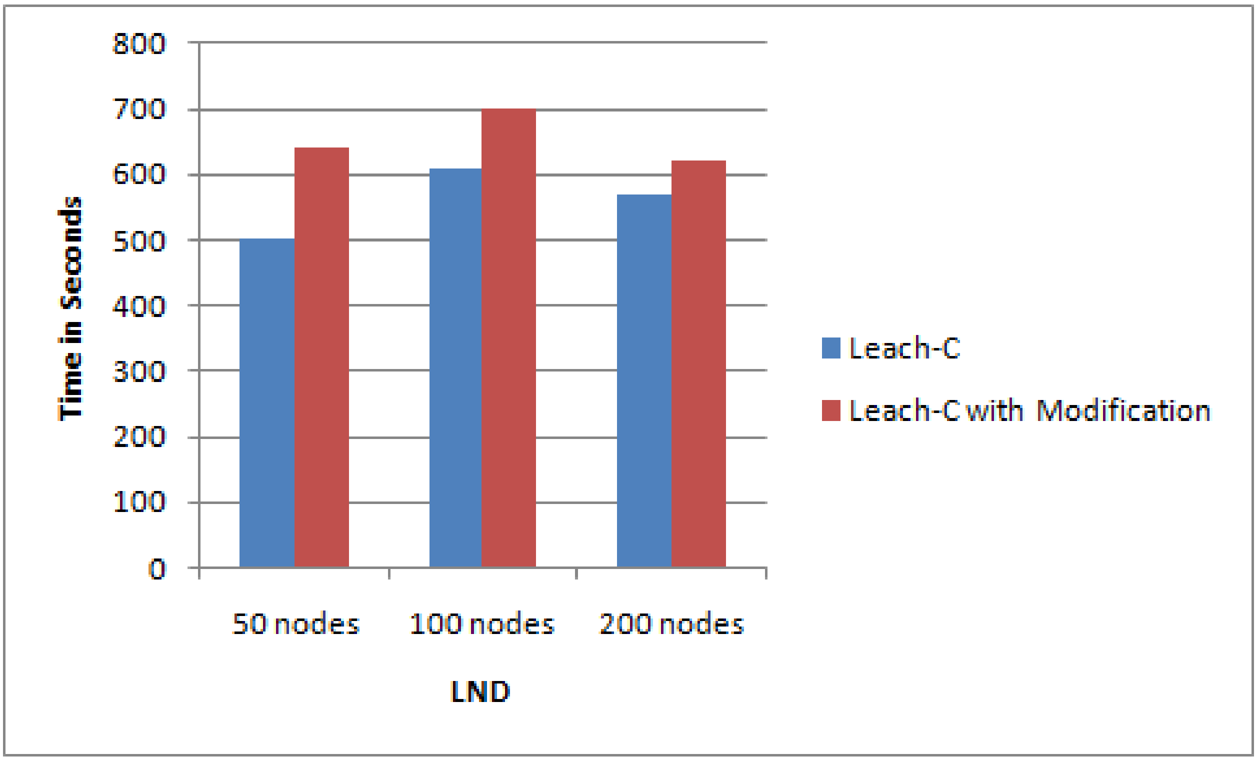

Figure 5.3: Last node died, time 10=1.

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