An Efficient Data Gathering Routing Protocol In Sensor Network Using the Integrated Gateway Node

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Abstract: The sensor nodes are typically battery powered. It is difficult to replace and recharge the battery at regular intervals. A major concern of energy constrained of WSN (Wireless Sensor Network) is to design energy efficient communication protocol. Clustering the whole network is an efficient solution to increase its life time. It is in this direction that a cluster based algorithm for procedural data gathering in WSN is proposed was divided into two classes: the primary class was to set a gateway-selection level and the secondary class was to propose an offer of a home automation using a routing technique centered on a sensor network to set a flooding level. This scheme is to increase the life time of the sensor network with the integrated gateway node. It uses the scheduled rotation of cluster heads, which eliminates the problem with the variability of the number of clusters generated in the dynamic, distributed and randomized protocol This approach achieves energy efficiency by triggering the cluster formation, when the cluster heads energy level falls below a certain level. Also the throughput, data aggregation is improved and end to end delay, packet loss are minimized

***IndexTerms*- sleep wake scheduling algorithm, WSN, LEACH, PEACH**

I. INTRODUCTION

A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance.

In addition to one or more sensors, each node in a sensor network is typically equipped with a radio transceiver or other wireless communications device, a small microcontroller, and an energy source, usually a battery. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from hundreds of dollars to a few pennies, depending on the size of the sensor network and the complexity required of individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and bandwidth. A sensor network normally constitutes a wireless ad-hoc network, meaning that each sensor supports a multi-hop routing algorithm.

II. EXISTING SYSTEM

Previous research works carried out in the area of data gathering protocol in sensor networks is analyzed and surveyed some of the works done by the author are discussed in the following paragraphs.

A) Chain based protocols for data broadcasting and gathering in sensor networks

Kemei Du, Jie Wu and Dan Zhou describes that in wireless sensor networks, the sensor nodes gather information and send the information to a base station periodically. Some important messages need to be broadcasted to all nodes. Data gathering and broadcasting are important operations that consume significant amounts of battery power. Due to the limited battery life, energy efficiency is becoming a major challenging problem in these power-constrained networks. They first review several existing chain-based protocols then present the multiple-chain scheme which outperforms the existing ones in the sparse-node distribution case. Furthermore, they develop an energy-efficient chain construction algorithm which uses a sequence of insertions to add the least amount of energy consumption to the whole chain.

In this method they proposed a new chain protocol, multiple-chain protocol for all-to-all broadcasting in wireless sensor networks. A new chain-construction algorithm, which establishes a chain with a minimum total energy, is also presented. They have evaluated different chain based protocols through simulations: linear-chain, binary combining-chain and newly proposed multiple-chain. Due to various network topologies and applications, it is impossible that one optimal approach exists which is suitable for all situations. Binary combining scheme works efficiently in sensor networks to balance transmission energy cost and latency. For all-to-all broadcasting, linear-chain consumes less energy per round in the dense case, while multiple-chain wins in relatively sparse networks. However, the bottleneck problem occurs in the multiple-chain scheme.

B) Energy efficient communication protocols for wireless microsensor networks

Wendi Rabiner Heinzelman, Anantha Chandrakasan, and Hari Balakrishnan were described that Wireless distributed micro sensor systems will enable the reliable monitoring of a variety of environments for both civil and military applications. In this method they focused at communication protocols, which can have significant impact on the overall energy dissipation of these networks. LEACH uses localized coordination to enable scalability and robustness for dynamic networks, and incorporates data fusion into the routing protocol to reduce the amount of information that must be transmitted to the base station. Simulations show that LEACH can achieve as much as a factor of 8 reductions in energy dissipation compared with conventional routing protocols. In addition, LEACH is able to distribute energy dissipation evenly throughout the sensors, doubling the useful system life time of the networks they simulated.

Finally they concluded that LEACH, a clustering-based routing protocol that minimizes global energy usage by distributing the load to all the nodes at different points in time. LEACH outperforms static clustering algorithms by requiring nodes to volunteer to be high-energy cluster-heads and adapting the corresponding clusters based on the nodes that choose to be cluster-heads at a given time. At different times, each node has the burden of acquiring data from the nodes in the cluster, fusing the data to obtain an aggregate signal, and transmitting this aggregate signal to the base station. LEACH is completely distributed, requiring no control information from the base station, and the nodes do not require knowledge of the global network in order for LEACH to operate. Distributing the energy among the nodes in the network is effective in reducing energy dissipation from a global perspective and enhancing system lifetime.

C) Apteen: a hybrid protocol for efficient routing and comprehensive information retrieval in wireless sensor networks

Arati Manjeshwar and Dharma P. Agrawal were said that wireless sensor networks with thousands of tiny sensor nodes are expected to find wide applicability and increasing deployment in coming years, as they enable reliable monitoring and analysis of the environment. In this method they intended a hybrid routing protocol (APTEEN) which allows for comprehensive information retrieval. The nodes in such a network not only react to time-critical situations, but also give an overall picture of the network at periodic intervals in a very energy efficient manner. Such a network enables the user to request past, present and future data from the network in the form of historical, one-time and persistent queries respectively. They evaluated the performance of these protocols and observe that these protocols are observed to outperform existing protocols in terms of energy consumption and longevity of the network.

So finally they have concluded that introduced Hybrid protocol APTEEN which combines the best features of both proactive and reactive networks and to provide periodic data collection as well as near real-time warnings about critical events. We have also demonstrated implementation of a query which is versatile enough to respond to a variety of queries. This method is suitable for only a network with evenly distributed nodes. This method is not extended extended further to sensor networks with uneven node distributions.

III. PROPOSED SYSTEM

With the rapid advance in semiconductor production and communications technologies, the variety of consumer electronics used at home has been and continues to become digital. Developers of these digital home appliances have pursued providing their users with better services in the manner of interworking based on data communications, rather than having these devices operate independently. In this context, home networking plays a key role in these evolutionary processes. Wireless home networking is coming into the spotlight, as a consequence of the inconvenience of in-home hard wiring, and the convenience of wireless' innate mobility, in spite of the presence of several proposed home networking techniques. Technologies intended to implement wireless home networking include: IEEE 802.11 wireless local area network (LAN), Bluetooth, IEEE 1394, UWB (Ultra Wideband)-based wireless network, and ZigBee used primarily to control all kinds of home appliances. However, we expect that wireless home networking based on the IEEE 802.11 wireless LAN and Bluetooth, which have been adopted almost universally due to their technical maturity, will be predominant in the foreseeable future.

Algorithms

- LEACH(Low-Energy Adaptive Clustering Hierarchy)

- PEACH(Power Efficient Gathering in Sensor Information Systems)

Low-Energy Adaptive Clustering Hierarchy Algorithm

The operation of LEACH is organized in rounds where each round consists of a setup phase and a transmission phase. During the setup phase, the nodes organize themselves into clusters with one node serving as the cluster head in each cluster. The decision to become a cluster head is made locally within each node, and a predetermined percentage of the nodes serve as local cluster heads in each round, on average. During the transmission phase, the self elected cluster heads collect data from nodes within their respective clusters and apply data fusion before forwarding them directly to the base station. At the end of a given round, a new set of nodes becomes cluster heads for the subsequent round.

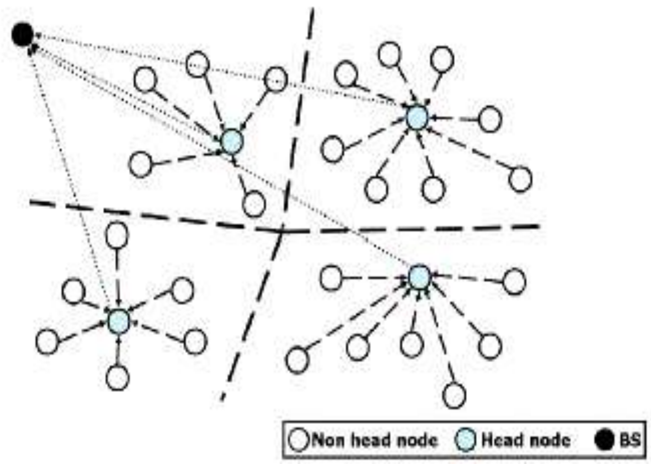

Fig. 1 LEACH structure

Therefore, there is the possibility that the elected CHs will be concentrated in one part of the network; hence, some nodes will not have any CHs in their vicinity. Furthermore, the idea of dynamic clustering brings extra overhead (head changes, advertisements, etc.), which may diminish the gain in energy consumption. Finally, the protocol assumes that all nodes begin with the same amount of energy capacity in each election round, assuming that being a CH consumes approximately the same amount of energy for each node.

Power Efficient Gathering In Sensor Information Systems Algorithm

In PEGASIS, nodes are organized into a chain using a greedy algorithm so that each node transmits to and receives from only one of its neighbors. In each round, a randomly chosen node from the chain will transmit the aggregated data to the base station, thus reducing the per round energy expenditure compared to LEACH. It has the following properties. The BS is fixed at far distance from sensor nodes. The sensor nodes are homogeneous and energy constrained with uniform energy. The energy cost for transmitting a packet depends on the distance of transmission.

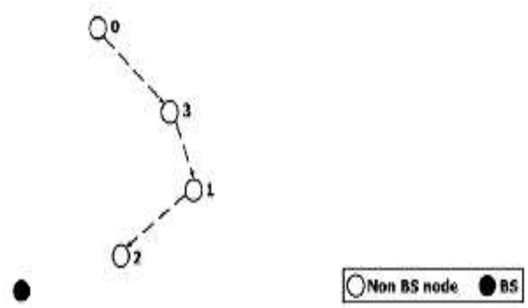

Fig. 2 PEGASIS structure

IV. THE SYSTEM MODEL

In most cases, it is reasonable to assume that the sensor nodes have fixed and relatively short transmission range. In this case, an energy-efficient multi-hop routing mechanism is essential, and cluster organization becomes more complex than in the single-hop condition stated above. Efficient clustering algorithms for WSN have to satisfy several requirements, such as:

1. Clusters should cover entire sensor field.

2. Average cluster size should be as large as possible to maximize data aggregation efficiency.
3. The clusters should be repeatedly reorganized to balance Energy consumption among the nodes.
4. Clustering overhead should be small.
5. It should be simple enough to be performed by low performance processor with small available memory space.

Clustered structure of a network is very beneficial to energy conservation as shown in figure. The benefit comes from the data aggregation of cluster heads. Aggregation efficiency increases as more data packets are aggregated. This benefit, however, is limited in multi-hop networks since cluster size is limited by the radio transmission range of the nodes. On the other hand, clustering overhead increases since clustering becomes more complex. The complexity comes mainly from the following two reasons: First, in multi-hop networks, it is difficult to re- cluster in a synchronized way as in single-hop networks. Second, when one cluster is reorganized, i.e. the role of a cluster head shift from one node to another, physical region the cluster head covers is also changed. These two requirements are for efficiency of the clusters.

In single-hop networks node mobility does not affect any network operation as long as the node does not move out of the transmission range of any other node. Clustering complexities in multi-hop networks can be one explanation for this research trend in sensor networks. We consider for the following network and application model.

1. A lot of sensor nodes are dispersed randomly on an interested region.
2. Sink nodes are placed at some convenient places in or near the sensor field.
3. The sensor nodes have limited processing and communication capabilities in order to satisfy the low-cost condition.
4. All the sensor nodes have the same constant transmission ranges.
5. Users request data from the sensor network by disseminating query packets through the sink nodes.

IGCP-A Integrated Gateway Node Control Algorithm

Although the hierarchical structure is energy-efficient and great in data-aggregation as well as in-network processing is easy, the hierarchical-structure cannot be maintained for a long time and needs to be created again because of intense energy use in nodes like cluster head. The flat-structure has easier multi-hop communication that the hierarchical-structure and allows even energy use of each node. This study suggests the IGN (Integrated Gateway Node) Algorithm to compensate the vulnerability of two structures. It is an Algorithm in which virtual gateway nodes consisting of several nodes like the cluster of hierarchical-structure routing protocol and allows the flat-structure routing protocols between virtual nodes.

Gateway Selection

One cluster head has one gateway node to a sink node. A gateway node is selected by cluster head among the nodes which are one hop closer to the sink node right after the cluster head is elected. The gateway node may be or not be a cluster member of the cluster head which selects it as a gateway. A cluster head sends a gateway selection (GWS) message to a selected gateway node, and thus the selected node can know whose gateway it is. Query dissemination from a sink node and data gathering to a sink node is performed through cluster heads and gateway nodes.

Link setting

Cluster head advertisement (CHAD) is largely classified into the busy Status and static status. The busy status is a status in which IGN is operating as IGNH (Integrated Gateway Node Head) and the static status is a status in which IGN is operating as IGNM (Integrated Gateway Node Member) because there is no need of the IGNH role. The busy status occurs when different IGN's are created, adjacent IGN's are newly created, or the routing table of adjacent IGN's is changed. It also becomes the busy status when it is short of IGNM nodes and needs to borrow IGNM nodes from IGN with many IGNM nodes. In the busy status, IGNM does not play the role of IGNM node but plays the IGN role only and always stays awaken.

Flooding level

Above all, once cluster formation has been completed, the flooding process is not executed. Based on the level acquired through flooding, nodes piggyback their own levels in the data transmitted to update them. This level-updating process is seen in Fig.3.

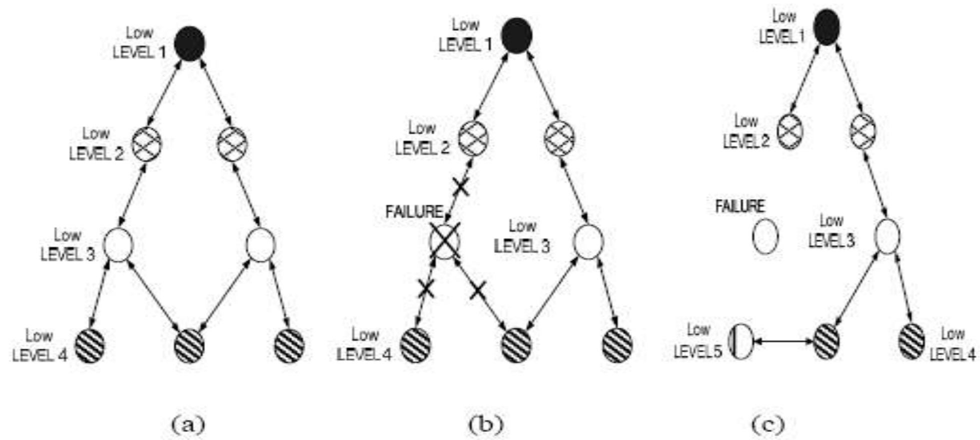

Fig. 3 The level updating procedure

Implementation Of Sleep Wakeup Scheduling Algorithm

The MAC data plane architecture (i.e., processes that involve transport of all or part of an MSDU) is shown in Figure 3. During transmission, an MSDU goes through some or all of the following processes: frame delivery deferral during power save (PS) mode, sequence number assignment, fragmentation, encryption, integrity protection, and frame formatting. IEEE 802.1X may block the MSDU at the Controlled Port. At some point, the data frames that contain all or part of the MSDU are queued per AC/TS. This queuing may be at any of the three points indicated in Figure 3.

During reception, a received data frame goes through processes of MAC protocol data unit (MPDU) header + cyclic redundancy code (CRC) validation, duplicate removal, possible reordering if the Block Ack mechanism is used, decryption, defragmentation, integrity checking, and replay detection. After replay detection (or defragmentation if security is used), the MSDU is delivered to the MAC_SAP or to the DS. The IEEE 802.1X Controlled/Uncontrolled Ports discard the MSDU if the Controlled Port is not enabled or if the MSDU does not represent an IEEE 802.1X frame. Temporal Key Integrity Protocol (TKIP) and Counter.

TRAMA Protocols

TRAMA protocols are based on scheduling In scheduling based protocols, data transmissions are scheduled in advance to avoid contention. However, in such protocols, besides data transmission, nodes exchange neighbor information periodically to schedule the transmission. In TRAMA, contention-free “scheduled access” and contention-based “random access” are performed alternatively, as shown in Figure 4.1. Data transmission is performed in “scheduled access” slot and neighbor information exchange is performed in “random access” slot. The main advantage of TRAMA over S-MAC is improvement in channel utilization. Another more natural approach is to let the guests knock at the door upon their arrival. This way the host can sense their arrivals and open the door at the right time. Since the sensor activities are usually triggered by events, it is also natural to let traffic transmission triggered by events. As the traffic rate in sensor network is relatively low, we can have fix timings for door knocking for each node.

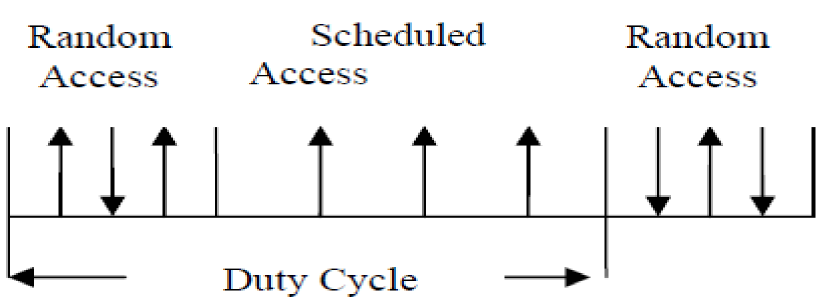

Fig. 4 TRAMA

Advantages Of Contention Free Mac Protocols

The medium access protocol consists of a fully distributed and self-organizing TDMA scheme, in which each active node periodically Listens to the channel and broadcasts a short console message. This control message is needed for medium access operation and is also used to piggy bag various types of information at low energy costs. Information in the control message is used to create a maximal independent set of nodes. This set of nodes creates the set are active, while other nodes are passive and save energy by exploiting the infrastructure created by the connected network. The presented approach is compared in simulation with the SMAC protocol (a medium access protocol with coordinated adaptive sleeping) in B realistic multi-hop network setup where sensor reading are transported to a specific node are established using the dynamic source routing protocol.

Methodology

Unicast data exchange between nodes can be performed as follows:

1) Each node turns on its radio during its own wakeup slot and sleeps during all the other wakeup slots.

2) Each sender randomly picks up a data slot and announces the data slot number along with the receiver's node identifier via a "WAKEUP" message in the receiver's wakeup slot.

3) Upon reception of a "WAKEUP" message, a node checks the embedded node identifier in the "WAKEUP" message. If it is the intended receiver, then the node turns on its radio for the incoming data packet in the specified data slot; otherwise, it just sleeps.

4) If any collision occurs in a node's wakeup slot, then the node turns on its radio for duration long enough to receive an RTS packet at the beginning of each data slot for a possible incoming data packet. This way, a node can minimize the extra energy cost under such a situation.

5) In each data slot, uncast data transmission must follow the well-known RTS/CTS/DATA/ACK scheme in IEEE802.11 to avoid the "hidden terminal problem".

HMAC also provides support for one-hop broadcast operation. When a node has data to broadcast, it sends out a "WAKEUP" message containing a broadcast address and a data slot in each wakeup slot. After receiving such "WAKEUP" messages, all neighbors will wake up in the same data slot to receive.

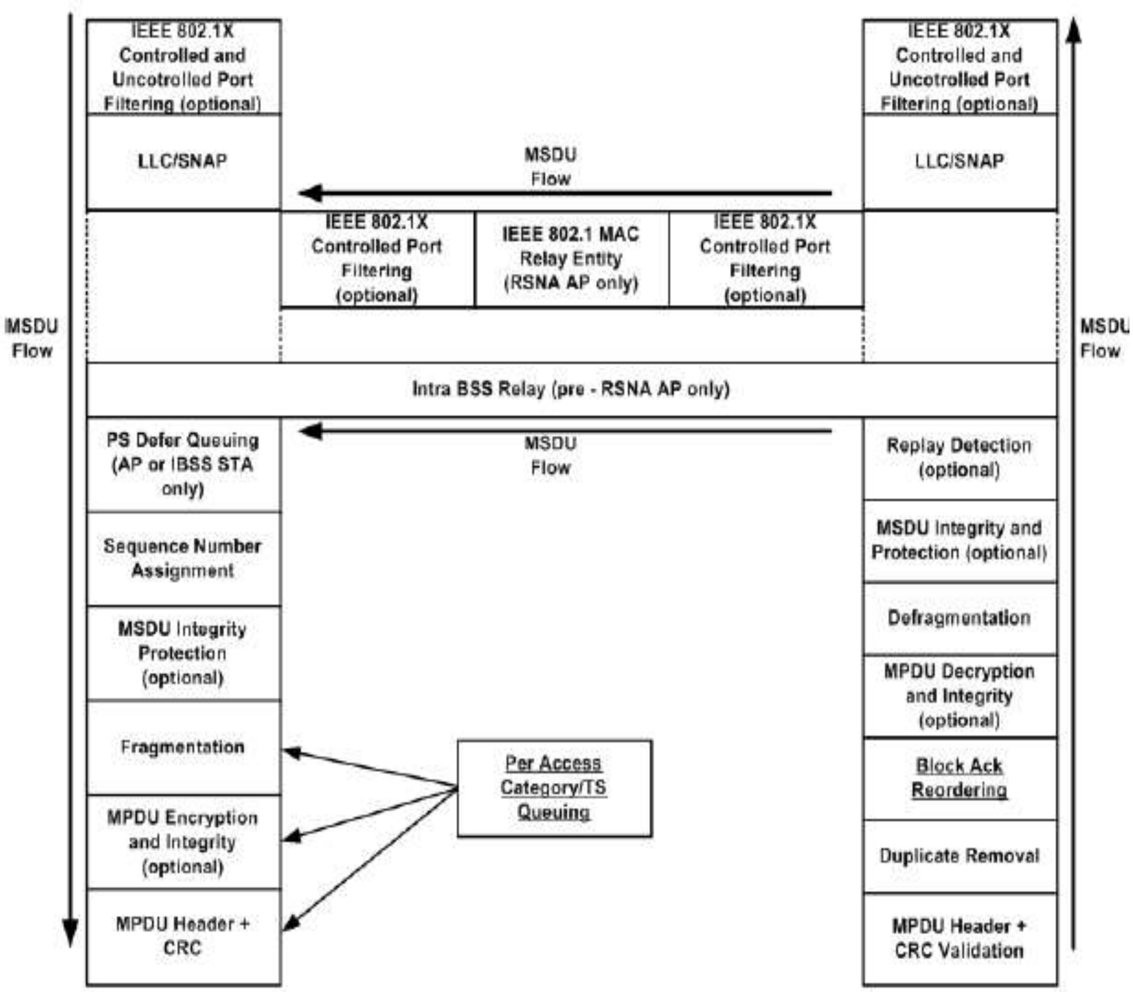

Fig. 4MAC data plane architecture

V. Results and Discussion

It is analyzed that by implementing the integrated gateway node in the cluster the network energy is consumed comparing with the previous algorithms. It is simulated by NS-2.

It is concluded that the energy amount used when existing routing protocols are operating and the energy amount used after the algorithm is analysed.This simulation does not consider the energy amount used in the initialization level to create virtual nodes. It is because it is a very small energy amount comparing to the total energy amount used. In this simulation transmission between nodes, throughput, and end to end delay were analyzed.

Network Setup Scenario and Transmission Between Nodes

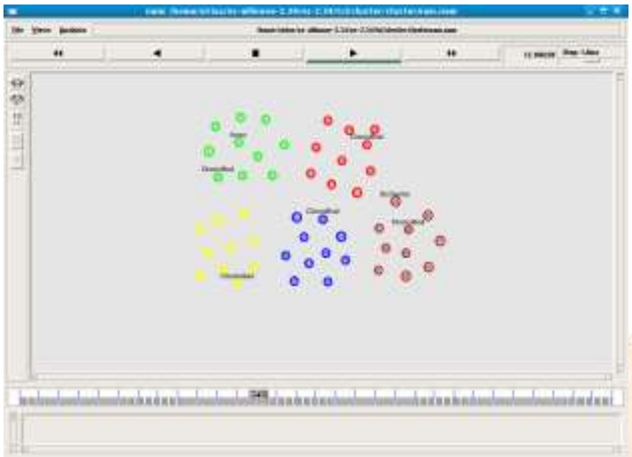

Fig. 5 Network Setup Scenario

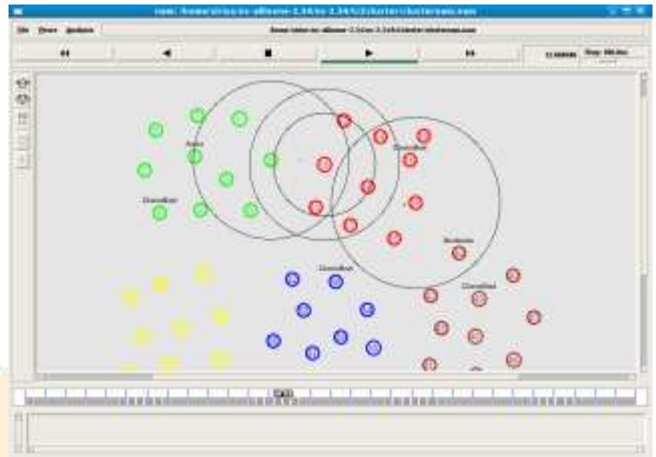

Fig. 6 Transmission of data between nodes

In the above figure 5 It has been seen that the initial network setup scenario of this simulation. Here, totally 50 nodes that have been classified into 5 clusters and each cluster having one cluster head. Once the simulation is started the nodes will have mobility.

In the above figure 6 It has been seen that the transmission of data between clusters in the output Network animator (NAM) window. The total simulation time is 160 seconds. The data rate is set to 1 Mbps.

Throughput Analysis and Routing Overhead Analysis

Throughput is defined as the amount of data moved successfully from one place to another in a given time period.

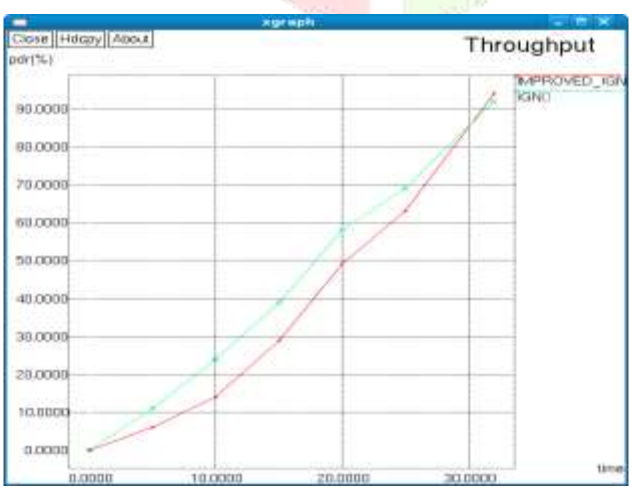

Fig. 7 Throughput of cluster head

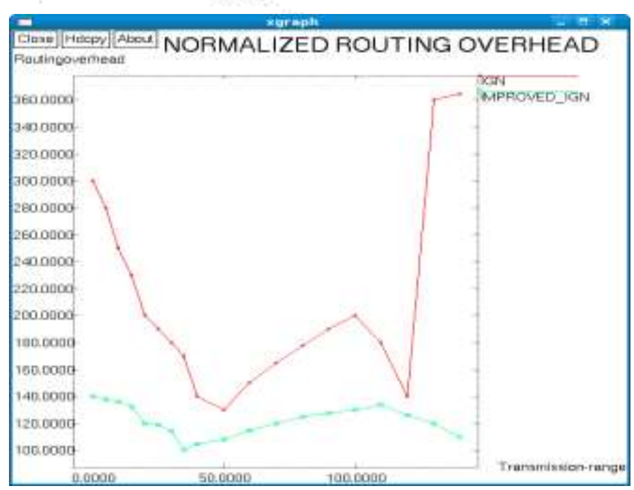

Fig. 8 Routing load

In the above figure 7 It has been seen that the throughput plot for one cluster head. It is high when comparing with previous IGN algorithm.

The above figure 8 shows that the routing load that means cluster over head in this sensor network.

Packet Drop Rate and end to end delay

End-to-end delay refers to the time taken for a packet to be transmitted across a network from source to destination.

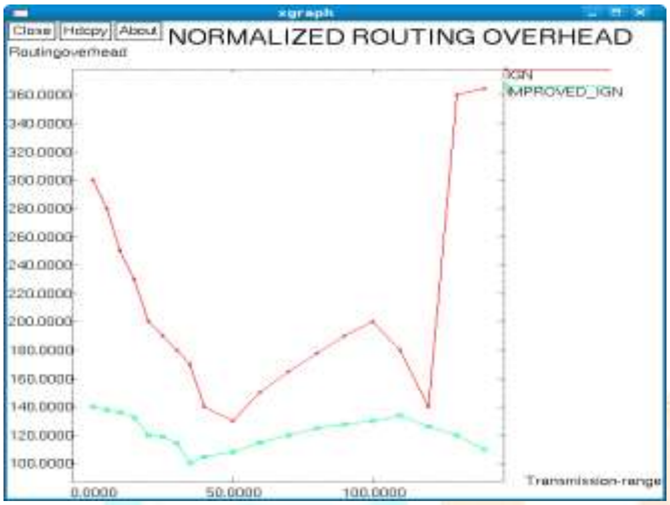

Fig. 9 Normalized Routing Overhead

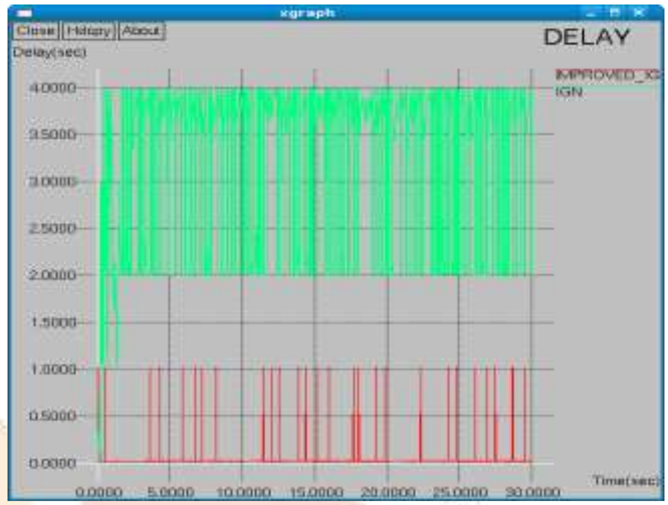

Fig. 10 End to End Delay

The above figure 9 shows that the end to end delay of the source to destination nodes that describes the data transmission between source node and destination node is very less when comparing with previous IGN algorithm. The End to End delay is nothing but the time taken to transmit the packet from source to destination.

The above figure 10 shows that the End to End delay comparisons of IGN and improved IGN algorithms. It also shows that the End to End delay is minimized in improved IGN when comparing with the IGN algorithm.

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