Enhancement in CSMA/CA protocol to avoid packet loss in Wireless Sensor Networks

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***Abstract*— A wireless sensor network consists of a large number of nodes spread over a specific area where we want to look after at the changes going on there. A sensor node generally consists of sensors, actuators, memory, a processor and they do have communication ability. All the sensor nodes are allowed to communicate through a wireless medium. The wireless medium may either of radio frequencies, infrared or any other medium, of course, having no wired connection. Many techniques are proposed for energy saving, Clustering is one of them. In this technique, the clusters are formed by clustering of the grouping nodes.**

***Index Terms*— Sensor Nodes, Clusters, Clusterheads ,Master Node**

I. INTRODUCTION

The recent developments in making energy efficient Wireless Sensor Network is giving new direction to deploy these networks in applications like surveillance, industrial monitoring, traffic monitoring, habitat monitoring, cropping monitoring, crowd counting etc. The growing use of these networks is making engineers to evolve innovative and efficient ideas in this field. A lot of research in data routing, data compression and in-network aggregation has been proposed in recent years .

A wireless sensor network consists of a large number of nodes spread over a specific area where we want to look after at the changes going on there. A sensor node generally consists of sensors, actuators, memory, a processor and they do have communication ability. All the sensor nodes are allowed to communicate through a wireless medium. The wireless medium may either of radio frequencies, infrared or any other medium, of course, having no wired connection. These nodes are deployed in a random fashion and they can communicate among themselves to make an ad-hoc network .

If the node is not able to communicate with other through direct link, i.e. they are out of coverage area of each other, the data can be send to the other node by using the nodes in between them. This property is referred as multi-hoping. All sensor nodes work cooperatively to serve the requests. Generally WSNs are not centralized one as there is peer-to-peer communication between the nodes. So there is no requirement of prior established infrastructure to deploy the network. WSN gives flexibility of adding nodes and removing the nodes as required. But this gives rise to many drastic changes to deal with in the network topology such as updating the path, or the network tree, etc. In a WSN the node that gathers the data information refers to sink. The sink may be connected to the outside world through internet where the information can be utilized within time constraints.

The well known problem in using these networks is limited battery life. This is due to fact that the size of a sensor node is expected to be small and this leads to constraints on size of its components i.e. battery size, processors, data storing memory, all are needed to be small. So any optimization in these networks should focus on optimizing energy consumption. In WSN a lot of sensed data and routing information has to be sent which often have some time constraints so that the information can be utilized before any mishap occurs, e.g. industrial monitoring, machinery monitoring, etc. The energy power consumption is much higher in data communication than internal processing. So energy conservation in WSN is needs to be addressed .

Distributing sensing allows the closer for placements the sensing nodes than a single sensor node would permit. Distributed sensing is done for finding the exact location if the location is unknown. To detect the environmental obstacles like obstructions, line of sight constraints etc here multiple sensors nodes are used. In most cases, the environment to be monitored does not have an existing infrastructure for either energy or communication. It becomes imperative for sensor nodes to survive on small, finite sources of energy and communicate through a wireless communication channel. Distributed processing capability is another requirement of sensor network. This is very important because communication is a major consumer of energy it means due to communication energy is more required than other operations. In centralized systems, some of the sensor nodes are used for communication over long a distance that leads to more energy depletion and some sensor nodes are used for other operations. It would be a good idea to process locally as much information as possible in order to minimize the total number of bits transmitted.

II. CSMA/CA PROTOCOL

Carrier sense multiple access with collision avoidance (**CSMA/CA**), in computer networking, is a wireless network multiple access method in which:

- a carrier sensing scheme is used.
- a node wishing to transmit data has to first listen to the channel for a predetermined amount of time to determine whether or not another node is transmitting on the channel

Manuscript received July 08, 2014.
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within the wireless range. If the channel is sensed "idle," then the node is permitted to begin the transmission process. If the channel is sensed as "busy," the node defers its transmission for a random period of time. Once the transmission process begins, it is still possible for the actual transmission of application data to not occur.[1][2]

CSMA/CA is a modification of carrier sense multiple access.

Collision avoidance is used to improve CSMA performance by not allowing wireless transmission of a node if another node is transmitting, thus reducing the probability of collision due to the use of a random truncated binary exponential backoff time.

Collision avoidance is used to improve the performance of the CSMA method by attempting to divide the channel somewhat equally among all transmitting nodes within the collision domain.

1. **Carrier Sense**: prior to transmitting, a node first listens to the shared medium (such as listening for wireless signals in a wireless network) to determine whether another node is transmitting or not. Note that the hidden node problem means another node may be transmitting which goes undetected at this stage.

2. **Collision Avoidance**: if another node was heard, we wait for a period of time for the node to stop transmitting before listening again for a free communications channel.

- **Request to Send/Clear to Send** (RTS/CTS) may optionally be used at this point to mediate access to the shared medium. This goes some way to alleviating the problem of hidden nodes because, for instance, in a wireless network, the Access Point only issues a *Clear to Send* to one node at a time. However, wireless 802.11 implementations do not typically implement RTS/CTS for all transmissions; they may turn it off completely, or at least not use it for small packets (the overhead of RTS, CTS and transmission is too great for small data transfers).

- **Transmission**: if the medium was identified as being clear *or* the node received a CTS to explicitly indicate it can send, it sends the frame in its entirety. Unlike CSMA/CD, it is very challenging for a wireless node to listen at the same time as it transmits (its transmission will dwarf any attempt to listen). Continuing the wireless example, the node awaits receipt of an acknowledgement packet from the Access Point to indicate the packet was received and check summed correctly. If such acknowledgement does not arrive after a timely manner, it assumes the packet collided with some other transmission, causing the node to enter a period of binary exponential backoff prior to attempting to re-transmit.

Although CSMA/CA has been used in a variety of wired communication systems, it is particularly beneficial in a wireless LAN due to a common problem of multiple stations being able to see the Access Point, but not each other. This is due to differences in transmit power, and receive sensitivity, as well as distance, and location with respect to the AP.[4] This will cause a station to not be able to 'hear' another station's broadcast. This is the so-called 'hidden node', or 'hidden station' problem. Devices utilizing 802.11 based standards can enjoy the benefits of collision avoidance (RTS / CTS handshake, also Point coordination function), although they do not do so by default. By default they use a Carrier sensing mechanism called 'exponential backoff', or (Distributed coordination function) that relies upon a station attempting to 'listen' for another station's broadcast before sending. CA, or PCF relies upon the AP (or the 'receiver' for Ad hoc networks) granting a station the exclusive right to transmit for a given period of time after requesting it (Request to Send / Clear to Send).[

III. RESULTS

The wireless sensor node, being a microelectronic device, can only be equipped with a limited energy. In some application scenarios, the recharge or replacement of energy resources might be impossible. Sensor node lifetime shows a strong dependence on battery lifetime. If the sensor nodes may get die due to limited battery then the chances of network breakage increases and if we want to collect the data (temperature, humidity etc) of that particular area we cannot get that data. Also, in a multihop ad hoc sensor network, each node plays the dual role of data originator and data router. The malfunctioning of a few nodes can cause significant topological changes and might require rerouting of packets and reorganization of the network. Hence, energy conservation takes on additional importance.

Many techniques are proposed for energy saving, Clustering is one of them. In this technique, the clusters are formed by clustering of the grouping nodes. The cluster heads are elected periodically such that members of a cluster can communicate with their cluster heads. These cluster heads send data received from its members to a base station. The multi clustering can also be used. The cluster head should have to be rotated for the balancing of energy and then there will be equal load on every node. The energy consumption can be reduced.

In the present work the whole network is distributed in clusters. The cluster heads can communicate to each other by using the Destination Sequenced Distance Vector (DSDV) routing algorithm. All the members of the cluster give their data to the cluster head and cluster head forward it to the other cluster head until the data do not reach its destination. In the whole network the path between cluster heads is fixed. The path cannot be changed until all the sensor nodes do not die means their battery goes to down. In this case some intermediate nodes will die earlier than other nodes. Then the path is break down between source and destination. Here due to path breakage the packet loss increases, the packet do not reach at the destination. Packet retransmission is also increases the whole network becomes useless. A new network is configured for complete the communication. To configure the new network again become the clusters and cluster heads it takes too much time and consume energy may be the network do not complete the communication. It is totally wastage of network resources like bandwidth, nodes battery, time, etc. figure 3.1 shows the network when intermediate nodes will die earlier than other nodes so it increases the packet loss and packet

retransmission. In this figure all black nodes are the cluster heads of each cluster. Here S and D is source and destination nodes respectively. Between the source and destination a fixed path is established that is cluster 1 to cluster 2 to cluster 4. In this figure the data is transferred from source to cluster head of cluster1 and cluster head 1 forward the data to cluster head 2. Cluster head 2 forward the data to cluster head 4, now data goes to the intermediate node between the cluster head and the destination. The intermediate node sends data to the destination.

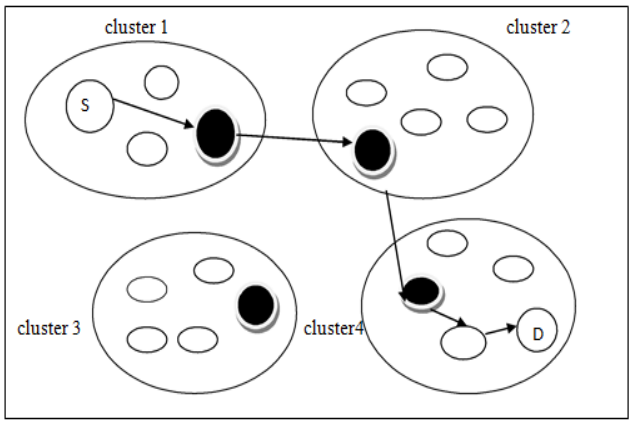

Figure 3.1: simple network with pre-established path

In figure 3.2 shows, that the cluster head 2 goes down, it cannot receive the data from cluster head 1 because its lifetime or battery is not more. Here the packets are losses and it does not reach to its destination because there is no other path is established between source and destination. In this network the further communication cannot take place. We have to need configure the new sensor network with full charged nodes so the communication takes place between source and destination. To configure the new sensor network it is repeats the whole process and it waste the network resources.

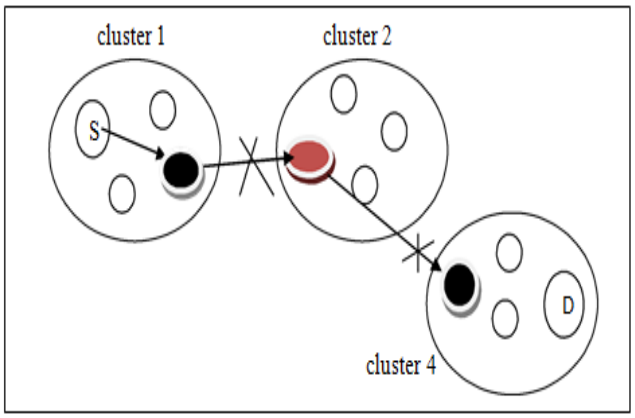

Figure 3.2: a network with die nodes and loss of packets

In the present work the sensor nodes are not synchronous to each other. The packet collision occurs due to the mismatch of timing. Again the packet loss and packets do not reach to their destination. Figure 3.3 shows the whole scenario of sensor network without synchronous of sensor nodes. In this figure here two nodes are the source and two destination, they followed the same path for data transfer. Cluster 1's source send the data to cluster 4's destination and cluster 3's source send the data to cluster 2's destination. Here the clock synchronous is not present between the sensor nodes

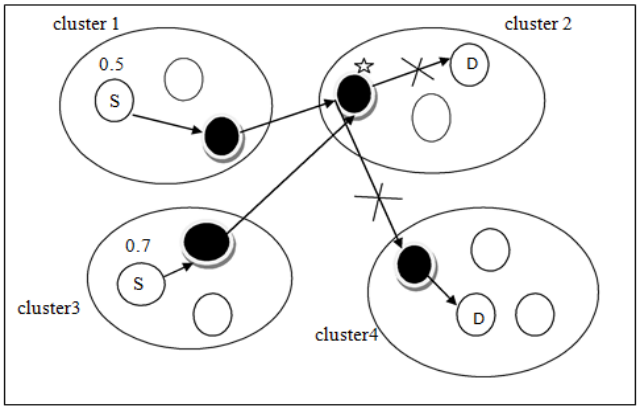

Figure 3.3: A network without synchronous nodes and packet collision

Cluster 1's and cluster 2's source send their data to their respective cluster heads. Now their cluster heads forward the data to next cluster head according to the routes. Here both sources have same route for transfer their data. When the data reaches to the cluster 2's head from both sources at same time here data packets are collide to each other, the data packets are loosed and it do not reach to their respective destinations. The packet retransmission is necessary to complete the communication.

So we have to need a virtual path between the source and destination by using AODV(Ad hoc on demand distance vector). The sensor nodes should be synchronous to each other to avoid the packet collision by using NTP (Network Time Protocol).

In the sensor network the path is established by AODV routing protocol between source and destination. The source node sends the information to the cluster head for their transmission to discover the route between source to destination. Here the whole sensor network is divided into clusters. Figure 3.4 shows the working of AODV. The cluster head broadcast the route request packet in whole sensor network. Route request packet contains the destination address. In the network those nodes have a route to destination node they reply back to the source node. In this a route is discovered between the source node to destination is that cluster 1 to cluster 2 and cluster 4.

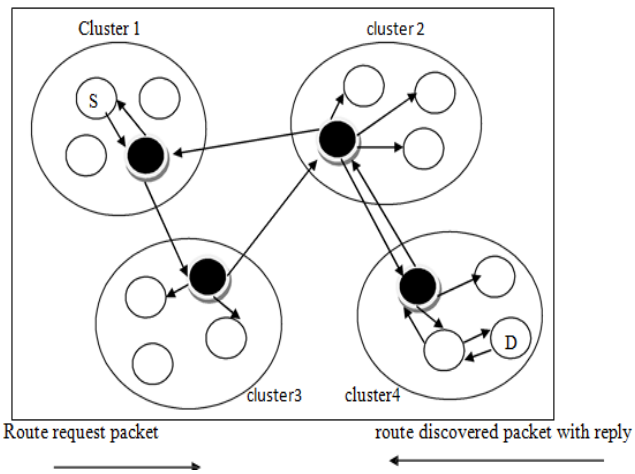

Figure 3.4: AODV routing protocol with route discovery

After the route is discovered the communication start between the source and destination, during the whole communication that path is followed by all the packets. In this approach that path is virtual path if any node is die then other route is chooses for further communication. In our proposed approach packet loss is less because of virtual paths. If packet loss is less then packet retransmission is also less. In this way network consume the less energy because path is not break again and again like pervious techniques here we use the dynamic paths.

In the network all the sensor nodes and cluster heads are synchronous to each other by using the NTP. Figure 3.5 shows the synchronous process. All the sensor nodes match their time with master node which is already deployed in the sensor network. The master node is synchronized with GPS (Global Positioning System), then master node send the information to all the cluster heads and cluster heads distribute this information to all cluster members. Now in the sensor network all the nodes are synchronized and slotted aloha is applied to the network. According to the slotted aloha which nodes want to transmit the data they reserve the time slots. All the nodes get the different slots and they transmit their data according to their tirne. Here packet collision should be less and packet loss also less.

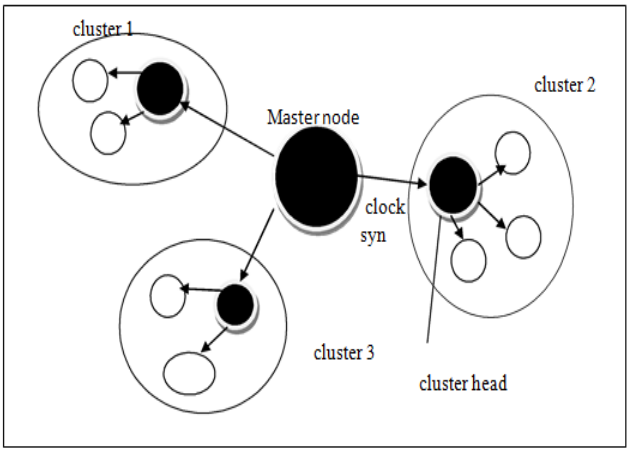

Figure 3.5: Node synchronous process

IV. CONCLUSION

In wireless sensor networks there is a problem of energy consumption. First of all the sensor nodes are deployed in the fixed size area. Then the clustering of the sensor nodes is done. By using the bully algorithm the cluster head is selected means that node which has the highest energy that will be the cluster head. The virtual paths are selected between the cluster heads. The shortest path is selected by using the reactive AODV protocol. Here to avoid the collision the NTP protocol is used the clock is synchronized on each cluster head. RFID(Radio Frequency Identification) is used for the channel sensing to avoid the collisions. The master node synchronizes the clock through the GPS (Global Positioning System). The packet loss is avoided by using this technique.

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