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Multihopped Cooperative Seed Based Data Transfer and TDMA Schduling in WSN

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***Abstract*—Video transmission plays a very vital role in our day to day life. In this paper, improved TDMA based scheduling approach is addressed. The set of nodes can be used to create aggregate cache. The nodes which act as common link can be used between two grids of nodes. Those common links are helpful for reducing the routing table size. Reliable handshaking protocol between two grids is proposed. Multihop video transmission approach in WSN is implemented to transmit video remotely in wirelessly connected nodes. Path history built up algorithm is discussed to decide timeline to active / deactivate path. Prediction of incoming packet algorithm is proposed.**

Keywords*—*WSN, TDMA, SEED, MULTI HOPPING

I. INTRODUCTION

This Video conferencing is used for academic students, to create virtual class. In common forum, community can remotely come together for sharing their knowledge. To achieve video transmission in WSN, one need to know the hardware and peripherals to connect to the hardware. The Raspberry pi 3 is a sensor node as well as a small computer that have several interfaces for establishing connection with external hardware. It has a processor of 1.2 GHz and 1 GB RAM. Raspicam is camera for raspberry pi and it can be directly connected to raspberry pi. ZigBee module can be directly connected using USB to Raspberry pi. For video capturing, Raspicam camera is used. Now the question remains that how multihopping of captured stream can be done. In other word, how to transfer video using multihop. The single path routing is known to us. It has less overhead. It reacts faster. [1]

Multipath routing reduces no of route discoveries. It gives optional paths for data transfer. On demand routing protocols, can be used in conjunction with both. How to build routing table and how to distribute routing table information among other by exchanging messages is the main concern. In Single Path Routing, discovery is done in below given way.

We know if we have got multiple path, we should do optimum use of all of them. It should not happen that only one path get reused or over consumed and another path should remain under consumed. Some important questions arise in front of us.

- How to discover multiple paths.
- Based on which condition, alternate path should be chosen.
- How to consume each of them equally.
- How to carry out path maintenance.
- In In case of failure of any node, how to bypass failure node or set of node or link and select alternate path of set of nodes.

Answer for above questions is to use disjoint path. What is Disjoint means. If two sets have no common element, then those two sets are called as, Disjoint. Two set of nodes can be disjoint. They do not have any common node. Two set of links can be disjoint.[2] They do not have any common link. In case of non-disjoint nodes, they share some common nodes. In case of non-disjoint link, they share some common links. In that common node or common link, if something goes wrong, both sets will become inactive. If there is no common node or link, both set of node or links can continue to work independently. Such independent nodes or links can be proved more robust and can give guarantee of safe working. In other words, fault-tolerance working is guaranteed. We have plenty of nodes available to bypass the failure node or nodes.[3]

II LITERATUR SURVEY

Link is chain of more than one nodes in series. We have two independent chain of nodes in series. It means two links or two paths parallel to each other. If no node is common, it is called as Node disjoint. Here we do not consider Source and Destination If no link is common, it is called as Link disjoint. There could be common node but not link.[4] If something goes wrong in common node, all links which arise from that node will become isolated. If there is a common link, it is called as partial disjoint path. On one side of common link, we have 2 parallel path and on other side, we have two parallel path. On both side, alternate paths become available. Before switching the paths, hop count n, delay, bandwidth, snr is also considered. These should not be broadcasting of duplicate RREQ. There should not be any routing loop.[5] S should discover more than one routes among themselves. We combine multiple signals and while transmitting, we transmit them as one signal. We allow multiple user to use our transmitted signal on a single channel.[6] We send our signal on single channel and multiple users access that channel and extract the signal to their devices. All of them start using our common channel and the signals flowing in that common channel are available for use to them. It is called as multiple access by multiple users. Greater is the packet or block of data, greater is the throughput. In FDMA frequency1 is dedicated for User 1. Frequency 2 is dedicated to user 2. Each user get separate set of frequency number.[7] Data is generated at baseband. Data is modulated at varying frequencies. Say we have five users named as User A, User B, User C, User D and User E. If we provide Frequency 1 for User 1 and similarly other frequencies for each different user, then it will lead to wastage of frequencies since each user may remain idle for some time but his allocated frequency will not be used for others. This happens in case of FDMA. [8]

In TDMA, we follow different approach. We allow A, B, C, D and E to use frequency 1, 2, 3, 4 and 5 for time t1 to t2 and then user F, G, H, I and J for time t2 to t3 and then again turn come for A, B, C, D and E for time t3 to t4, we can manage multiple users in given five frequencies. We just provide them multiple time slots to use the same frequency and their turn comes one after another. We can imagine a chess board. Each block of chess board represents a time slot for each user. Each alternate column represents set of few users repeated to consume specific frequency in given time slots.[9]

FDMA was introduced when there were Analog technology. In Analog technology, we cannot put more than one signal in same frequency band. After that Digital technology came. In Digital technology, we can put multiple signals in same frequency band. It is a single frequency multiple user technology. It is used in GSM for first time.

In TDMA, just like the individual frequency share, on the same line, different times slots are allocated for different user and all users share same frequency spectrum. Each time slot is of T seconds. Each channel get a time slot of T seconds. Transmission interval is maintained as (N * T) seconds. Signals come from each user. These incoming signals are transmitted at interval of (N * T) seconds. Each user get 1 time slot out of 8 TDMA slots. Dynamic resource allocation can be achieved. But channel cannot support more than 8 users at a time.[10]

CDMA uses high frequency orthogonal sequence of bits. Ex- Walsh code or pseudo random code. They spread signals over a large frequency bands. Data signals XOR with pseudo random code to produce transmission ready signals. Signals from different users come. These signals are XOR and composite signal is formed. This composite signal is transmitted on the same frequency bands. At the receiver end, receiver must have same spreading sequence. That spreading sequence is multiplied by composite signal and inverse XOR operation takes place and receiver can retrieve the original signal. This process is called as despreding. It makes CDMA very secure and robust.[11]

OFDMA – One of the feature of OFDM is bandwidth scalability. It means various bandwidths are available. Out of them, specific bandwidth can be chosen for each user. User A get bandwidth A. User B get bandwidth B. It allows multiple users to access separate bandwidth depending upon resource availability. Second feature is Carrier Aggregation. There are primary carriers and secondary carriers. More than one carriers of any types can be used to serve user. These sub carriers are orthogonal and there are no guard bands between them. The OFDMA provide low Inter symbol interference.[12]

III DESIGN

The Algorithm for prediction of incoming packet is given below. The below given assumption is made. Each node should have complete info of one hop neighbor and common link. common link has complete database of both grids.

Algorithm for cooperative streaming of bytes using TDMA approach

Step 1 -

At Seed node S1 -

Take Clock reading (Say r1) and refer Packet arrival chart.
Find out queue identifier (Say q1)
Find its incoming time (r2)
Find out the difference (diff = r1 – r2)
Initialize wakeup time = (r1 + diff) -1
Go to sleep till wakeup time. (Sleeping saves battery life)
Wake up at wakeup time.
S1 will confirm from neighbor, Does the packet arrived?
If Response code is Yes, give token of identification and receive packet from N1.
If Answer is No, then wait for next n second. Again, ask N1.
Once Packet arrived, Neighbor n1 will send alert message to all seeds s1 to s9.
S1 will give the token to neighbor node.
S1 will Receive packets # 1 from neighbor and start processing on it. Ex – decompression. Extract bytes.

At Next seed S2,

Receive packets # 2 from neighbor and start processing on it. Ex – decompression, Extract bytes.
Thus, parallel execution takes place.

Step 2 -

All seed nodes will start processing on their bytes chunks in parallel. When all node done processing, they all send signal of task completion.

Step 3 –

The bytes are now converted to raw format and ready to play by player.

We can modify the above given algorithm. Option 1 is Each node should have complete info of network. Option 2 is each node should contain info of 1 hop nodes and if alternate node not found. It should share common node with the neighboring node. They should create Triangle like structure in case of non-availability of alternate node. Option 3 is Some administrative group node or head node should provide correct info to all node. Nodes can decide and read where is the common or non-common routes. Option s4 is Set of forward path node and Reverse path node is supplied by Head node. Other should actively test and follow it. It would be easy to reach up to Source as well as Destination.

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When Source node and Destination node communicate via intermediate node, intermediate node get reverse path up to S as well as forward path up to D on path1. These info is stored in their cache. Also, it should identify pair of nodes on path1 and path2 up to path n. Hence how many non-common paths exist, is identified by intermediate nodes. On Path1 One node should forward route request as well as route reply only once. Next time on path2, node should get chance to forward route request and route reply. Sometimes routing loops get created. That should be avoided. There are various technics. Set a max limit of how many no of hops RREQ should take to reach up to Source. Set a max limit of delay RREQ should take to reach up to Source. Using a single path or using multiple path, which is the best approach for data transmission?

1. First primary path is used. After primary path, does not work, secondary path should be used.
2. After secondary path exhausted, other alternate paths are used.
3. More number of routes, more routes maintenance is required.
4. Simultaneous path usage and their maintenance of selected path is required.
5. If a node fail, route should select alternate node (using hello packets) and maintain integrity of path.
6. On multiple paths, we can flow data packets by splitting packets or by replicating packets.
7. Different addresses can be used for different paths.
8. Instead of waiting of node failure, we can monitor path and node health after fix rounds of test. It avoids rediscovery of routes.

Network Path logic should maintain path so that nodes having least chances of survival should be prepared. In advance. Alternate node selection should be done for them in advance. We assume, the chain of nodes is already set. We call it as path or link. That link may be a primary path from source to destination or secondary path from source to destination. It may be any common link between two primary paths. When the node is over used, there are chances of it failure. Hence the frequency of traffic should be taken into consideration. Fr a fixed number of iteration, the traffic should flow through the node of the path. All nodes will become drain at once. This should not happen.

Hence all alternate nodes should be used and all paths should be activated. In short, there should be distribution of traffic over all parallel path. Nodes must have a unique id capable to communicate in both directions. There should be a provision of holding value of special variable known as load per neighbor. First a primary path is selected. This primary path is considered as reference path. Primary path should have load density of 50 packet per minute. After primary path, secondary path is selected having load density of less than 50 packets but more than 40 packets per minute.

Here, it is assumed that a grid like structure of 10 x 10 nodes is created. Consider a node having surrounding pairs of 6 nodes in star like fashion having middle node as path selector. All 6 are in communication range of central node. Other 6 surrounding nodes act as 6 alternate nodes. Central node, lower node and upper node are part of primary path. Central node can divert traffic through the alternate nodes based amount of remaining energy. Using any of the 6 nodes, secondary path can be created. Through node, three types of packets flows. Transmitted packet, received packet and relayed packets. Those may be data packets or control packets. This information is used to determine path life for next round of transmission. Path selector node treat neighbour as cache. Each path selector node keep the no of neighbour available to it. Using neighbour, they create primary and secondary and alternate paths. Each packet when transmitted or received, some amount of energy of node is spend. It is directly affect path life. Node should not interfere in working of any other node. Each neighbour node when work, some amount of cache it provides for path. Path selector node act as carrier of control packets or ack packets. Neighbour node act member of primary path or secondary path. For more cache, ↀ shape of path is created in 3 dimension.

In wired network, we know all routers receive some signals from the neighboring in range nodes. These signals are termed as packets. They are generated at node and passed toward router smoothly or continuously. The advantage of wired transmission is these packets or signal do not interfere with each other and wire is physical medium which are totally separated from other. These wires or path act as conveyor for packets. These nodes can simultaneously transmit and receive at a time. But this is not the case in case of wireless network.

In wireless network, when one node transmits, it throws its signal in 360 degree in all direction and all other nodes need to be silent at that time. If they also transmit, it will obviously cause interference. There are various types of interference which occur in case of wireless transmission. Destination can receive only one packet at a time. Aim of our Time Disseminated Routing protocol is to reduce interference, add more paths, more cache, increase Throughput and decrease Latency. Let's have a look at Interference types. These are Self interference, forwarder interference, cross hop interference. There are various interfering channels and their numbers goes on increasing as the number of hops goes on increasing. Can we estimate channels at each node level and at each router level?

If we do so, we can deal with interference channel. Packet goes from Node A to Node B. I call it as B received signal x(t) a channel 1 which start from Node A and end at Node B. Interference which is caused by self-channel is called as Self interference and it is denoted by I_{tself} x(t). From node B packet goes forward to node C. I call it as packet will flow through channel 2 which start from Node B to Node C. Forwarding channel 2 will also cause interference. It is called as Forwarding Channel interference which is $I_{forward}$ x(t). The I_{tself} x(t) is like $I_{forward}$ x(t). I_{tself} x(t) travel in the air. $I_{forward}$ x(t) travel through air as well as toward another node c. Hence timing of both is different. How do we observe these interferences? Observe the jump of received signal from height 1 to Height 2 and from Height 2 to Height 3. These jumps represent that interference that has occurred.

If we narrow self-channel, we can decrease the chance of self-interference occurring. If we narrow forwarding-channel, we can decrease the chance of forward -interference occurring. Thus, we can cancel them one by one.

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Both sender node and receiver node have some fixed frequency. So, there is always difference in their frequencies. That difference is called as frequency offset. Forwarding channel contain **frequency offset.** Superposed self-interference and forwarding interference can be viewed as output of Superposed channel.
Next question is can we narrow superposed channel? If we can do that, we can cancel the effect of forwarding interference. This is because, superposed channel contains forwarding interference. Forwarding interference flow through air as well as toward next node. Forwarding channel contain frequency offset. Hence, superposed channel is changing over the time. Hence channel estimation will not be accurate over the time.
Let us consider following scenario.
Node B work at angular Frequency Omega.
Node C work at angular Frequency Omega.
Node B send out signal x(t).
It introduces frequency offset (Omega - Omega)

Signal Botch = $x(t) * h_{ubs} * e^{(Omega - Omega)}$ (1)
Node C send out signal x(t). It also introduces frequency offset (Omega - Omega)
Signal Cob = $x(t)*Cb*h_{ubs} *e^{(Omega - Omega)} *e^{(Omega - Omega)}$ (2)
It will cancel out frequency offset. $e^{(Omega - Omega)\ cancel}$ out with $e^{(Omega - Omega)}$
Now, the signal received at B contain no frequency offset.
So, the signal received at B will be free from any frequency offset.
Signal Cob = $x(t) * Cb * h_{ubs} * 1$ (3)

That means forwarding channel is free from frequency offset. Now we can assume superposed channel as a single channel.
Using full duplex, we can remove effect of self-interference. Using cancellation in superposed channel, we can remove effect of forwarding interference. Now third interference is cross-Hop interference. Each node when transmit, affect neighboring adjust nodes. In case of A->B->C->D->E, cross hop interference can be seen between B->D, B->C->D, A->C->D. We cannot cancel all of them. Casual cross hop and Non-casual cross hop interferences occur. Casual cross hop interference is like the forwarding interferences as we have seen. Non-casual cross hop interference travel through multiple node. A->C->D. Casual cross hop interference travel through the multiple nodes. B->D, B->C->D. Forwarding interference travel through the single nodes. B->C, C->B. Casual interferences- If we narrow the channel, we can cancel the interferences like self, forwarding and cross hop. Non-casual interference - these are caused by source. Source generate the signal. These are due to multi path components. So, leave them there.

Hierarchical cancelation- Node must do channel estimation once. Ex - A->B->C->D->E. Direction is Dust to sac. D will transmit Test signals for doing self-channel estimation. Signal of D will reach up to node C. Now C received the signals. C will start self-channel estimation. C will start estimating and get the self-superposed channel and forwarding channel. B will receive signals. B will start estimation and get self-channel, forwarding channel and cross hop channel.

Noise accumulation factor is to be considered. When packet is sent, signal is amplified and transmitted. Such amplified signal is received at receiver without any decoding. Received signal contain noise. Noise is getting generated and added or accumulated. It introduces Error. This error in signal is propagated from one node to another node. This noise reduces SNR at destination node. Our protocol suggests to use virtual Hop substation. We can divide big challenge into small challenges. Similarly, long path can be divided into small paths. These smaller paths are called as virtual paths. If we consider 6 hop path, then first 3 hop become our small target. The aim should to achieve 3 hops successfully. After that, all packet counters will be reset to zero. Decoding will take place here. Amplification will also take place here. Packet header will become short. Packet size will also become small since header size is reduced. Packet will contain only payload. Now, next target would be to transmit packet to destination which is at 3 hop.

I. DELAY ANALYSIS OF PRPOSED TDMA APPROACH

In WSN, we have a sender and receiver station. Fixed station as well as intermediate nodes act as transmitter as well as receiver. Each fixed as well as intermediate station need a channel using which they can transmit and receive the data message without collision of packets over the channel. This channel act as a path way for conveying the data or multimedia messages. The channel get utilized by the stations as well as the intermediate nodes. Each intermediate node is a source of packet and to dispatch their packets, these nodes should get a fixed time slot. If time slot is not provided, due to concurrent transmission, packets may tend to collide and no guarantee can be given that packet will reach to destination. If time slot is given, packet will not collide and same channel will get used by multiple intermediate node for sending as well as receiving the packets. Among these intermediate nodes, some may have urgency in term of sending or receiving packets. This is also called as the priority of that specific intermediate node to achieve their goal within a given stipulated time. So, channel assignment and priority assignment for node are two important factor. Size of packet is never same.

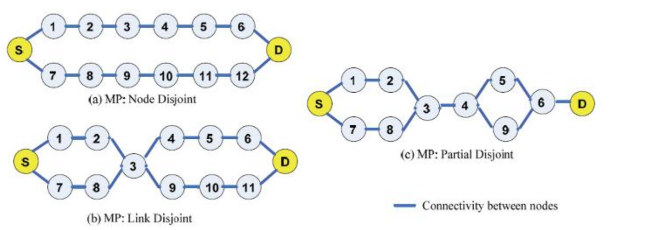

Fig. 1. Common Link between clusters

Each packet contains totally unique bytes based on the sensors data. Sensors generate bytes based on their environment where they are deployed for taking reading or observation of parameter. This observation may include environmental parameters or multimedia parameters. If all of

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them need the same channel, there will be formation of queue of time slot. Some policy will be then required to place a node based on some parameter in queue. Per the index, these nodes will get chance to utilize the channel to deliver the packet.

Given time axis X is subdivided into slots ranging from slot 1 to slot S. Each slot is sub divided into fixed sub slots ranging from 1 to ss. Each of the main slot is now sub divided into 1 to ss slots. Each sub slot is used to carry out functions like send, receive, process assemble and retransmission of packets. Let the duration of sub slots out of ss sub slots is say T seconds. So, each activity is to be carried out in T seconds. (Each sub slot time T / total No of slots S) this much time is required for each activity at each node. Before sending packet in current slot, one should ensure that in previous slot, the required input is obtained. Also in next slot, which output is expected is to be determined.

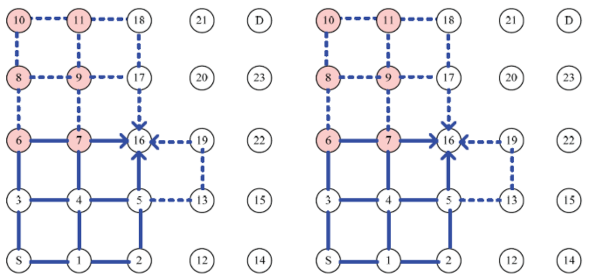

Fig. 2. Cooperative accumulation of byte content from all seeds in each Grid

As it is a queue of packet, it is also a queue of time slots. each slot will get properly utilized if its previous slot is perfectly working and bringing the input. Each next time slot should bring the output.

We can call T/ss as individual activity time within each slot out of S slots.

If we take into consideration all slots out of S, we call T/S as fractional activity time out of S slots.

Each transmitted packet consists of 5 activities. All these 5 activities ideally need 5 sub slots time. Each transmitted packet requires 5 sub slots on each node.

Each received packet consists of 4 activities. All these 4 activities ideally need 4 sub slots time.

Each received packet require 4 sub slots on each node.

We consider single packets. T1 T2 T3 T4 AND T5 are the time slots required for each packet.

R, P, C, V and T are the activities which takes place at receiver side.

- R= Receive packet.
- P= Process & Read packet.
- C=Construct new packet
- V=Validate packet
- T=Transmit packet

Sub slots are shared among several nodes. It is called as spatial reuse or SA conflict (Slot assignment conflict) Say same slot is assigned to pair of nodes at k-hops. Hence, SA conflict occurs at k-hop. It may lead to message collision. Consider k = 2. TDMA may be transmitter driven or Receiver driven. If the TDMA guarantees 2 hop conflict free slot assignment it is called as full frame TDMA. If the TDMA does not guarantees 2 hop conflict free slot assignment it is called as reduced frame TDMA. To decide Which node will be given the slot ownership, we need to consider CSMA protocols which can sense the medium before starting actual transmission. Node need access of channel. For that node experience struggle. It is called as contention for getting access of channel. If node do not have to struggle it is called as pure TDMA and it is simple one. If node need to contend, it requires help of CSMA along with TDMA. It is called as hybrid TDMA. All Node access channel in their given access time slots. In case of Pure TDMA, channel can be accessed without any contention. But in case of hybrid TDMA, node cannot get access to channel in the given time slot. Hence, in the given time slot, node must contend for channel access. After resolving contention node can get access of channel. To resolve contention, there is a separate process. In case of pure TDMA, if node is a transmitter node and he is the slot owner, it will transmit packet. After that, slot owner does not have anything to send. At the receiver side, receiver will do long listening. Receiver will sample channel to detect if there is any incoming message. If no message is coming, receiver will go to sleep. If some message is coming, receiver will wait for message. Receiver will come to know the destination of incoming message from the neighbor node. If the incoming message is for the itself, then the node will listen the media, wait and remain idle. If the message is not intended for itself, node will not wait and it will stop the listening radio. TDMA protocols are node scheduling type or link scheduling types.

IV EXPERIMENAL SET UP

The experiment is performed using python and 50 nodes are deployed. The communication is set up among 50 nodes. These schedule is distributed from Common link node. Once all node schedule is broadcasted to all node, nodes set their wake up and sleep time. At wake-up time, node receive the packet. At sleep time, do not communicate and go to sleep mode. After receiving packet, nodes start parallel processing and decompress the packet in cooperative manner. After that, all nodes provide raw bytes to player node. Player node create queue of clips and merge clips to produce video. The below given chart shows that using delay is minimized. The comparison is done of proposed routing protocol with SPIN, Gossiping, Flooding Routing Protocols based on Delay, hops to reach up to Common Node and Base station. Say N1 and N2 nodes are available. N1 node act as transmitter and N2 node act as receiver. N1 node detect channel and transmit if no other is using the channel. N1 node detect channel and post pond transmission if some other node has already started using the channel and switch to receive mode. Node N2 act as receiver. N2 will wait in receive mode up to Timeout time. As soon as it receives packet, it will produce acknowledgement and send back. If acknowledgement is received, it is indication of no collision occurred. In case of node deployment, the nodes are deployed in a region. It may be either Manual deployment or Random deployment. In manual deployment, node position is known to us. In random deployment, node position is not known to us.

If position is known in advance, it is easy to set the sequence of visit of nodes. Ex- we visit shops in a market where we know each shop location. Sometimes, we dynamically set the path. In some case, we follow pre-determined path. We can calculate the travelling time. We can calculate delay of response. We can determine processing time and speed of each node hardware. We can determine Energy dissipation at each node. We can provide unique identifier to each node.

V RESULT

We provide slots to node for carrying out activities like receive packet, read packet, process packet, create packet, retransmit packet. It is transmitter driven TDMA. In receiver driven TDMA, following activities are carried out. Transmit packet, set counter variable, get another packet, wait for ack of successor packet. retransmit. We provide slots to link for carrying out communication between parts of nodes. Say we have 2 transmitters and both transmit in same slot. Collision occur and messages packets get destroyed. There are three types of collisions. If receiver fall in the range of both transmitter, then it is Type I collision. If both transmitters send packets to single receiver, then it is called as Type II collision. If two transmitters transmit ad receiver is transmitting to another node, then it is called as Type III transmitter. To avoid contention, each transmitter should do resolution procedure at time of start of transmission.

TABLE I. COMPARISION OF DELAY OCCURRED IN ROUTING PROTOCOLS

Protocols	Packet Size	Hops to reach up to Common Link	Hops to reach up to Base station	Retry attempts	Delay
SPIN	280 bytes	6	12	8	4
GOSSPING	280 bytes	8	15	7	4
FLOODING	280 bytes	6	8	7	4
LEACH	280 bytes	5	6	5	2
Proposed Routing Protocol	280 bytes	4	6	2	1

VI CONCLUSION

A central level database can be maintained by extracting info from each cluster or territory at central node. That central node can act as super cluster head. It is responsible to dispatch messages in hierarchical manner. Based on the information available, chances of survival of cluster head and their nodes is decided at super cluster head. Path of communication between nodes can be finalized at super cluster head. Super cluster head become single point of contact instead of contacting each cluster head. Our information can be dispatched to any destination using super cluster head.

What super cluster head do to route message is called as routing. Routing takes place in multihop fashion. End of routing is Cluster head. Routing is done in 4 different ways based on the applications. Event driven routing where when certain event trigger then only the nodes start sharing sensor readings or information and transmitter node come to know about the path as well as sensor readings. Query driven where query is passed up to destination regarding the sensor readings and sensor reply and at the same time the route up to sensors is also discovered. Time driven where each time slot is provided for generating data. In that time slot, data is exchanged from sensor to Cluster node and cluster node to another cluster node and then finally response is given back from receiver node to transmitter node.

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