Framework for Congestion Control with Efficient Energy and Qos Enhancement for Wireless Network

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ABSTRACT
In the recent days many applications need fast transfer of large amount of data over network. So the performance of TCP and SCTP in wireless network is an active area. After every failure the connection between source and destination gets disconnected. But the failure can be because of congestion packet loss or wireless packet loss. In this paper, a new mechanism is introduced by which it avoids the failure caused by congestion by estimating the energy of each node, bandwidth of the packet, and considering the node that has more radio range. So when the packet need to be send, the route is established by broadcasting to the nearby nodes and the energy of every node in the network is analyzed and maintained statically so the node that has more energy and bandwidth is selected. And some amount of energy gets drained on sending more packets, dynamically the traffic is reduced from the sender and by using the reactive routing protocol link is re-established by broadcasting to the nearby node. Since SCTP has multi-homing technique it prevents link failure by routing with alternate path. So instead of detecting the congestion after it occur this approach gives better results So the packet loss rate and end-end delay will be reduced which in turn improves the QOS of the system.

General Terms
Congestion avoidance, QOS, Energy

Keywords
Energy, Bandwidth, SCTP, TCP, Congestion control, Routing

1. INTRODUCTION
MANET is a type of wireless network that has networking routable environment on the link layer. It connects the mobile devices using wireless links and every node has the router set up in it. And it does not have an infrastructure so the mobile nodes can move. Since it has the limited range many networks are needed. The information should be transmitted securely Sand completely is the main criteria. MANET may have several "characteristics like dynamic topologies, bandwidth constraints, energy constraints, limited physical security, routing protocols and on demand routing protocols" as mentioned in [8]. The mobile nodes in ad hoc network are not stable so they move from one network to another because of this link breaks among nodes and connection disconnects. Hence, several routing algorithms are introduced in order to increase the efficiency and to transmit the data. We are dealing with the link breakage, which occurs due to mobility of nodes and congestion of packets. In high speed wireless network a fast data transfer is required nowadays. The main function of TCP is to equalize the transmitted rate of sender and receiver. TCP is the widely used network protocol in transport layer and it also determines the overall network performance. When TCP starts to send the a timer is also initiated to keep track for acknowledgement from receiver this is called the retransmission timer if the ACK for the segment does not return within the timeout period the sender will retransmit the packet and set the timer value to the maximum of about 64 sec as given in the paper [12]. Many TCP congestion control algorithms are introduced nowadays to avoid congestion. The network capacity is not properly utilized.

On receiving three negative acknowledgements as shown in the Figure 1 and timeout TCP treats it as packet loss and reduces the congestion window but this works well for wired networks. The packet loss in the wireless can be because of mobility also. In this case TCP reduces the congestion window which leads to poor performance. TCP updates its window size in congestion avoiding stage, on retransmission the sender has to wait for a particular duration before sending any new packets which in turn reduces the throughput. SCTP [13] is also a transport layer protocol it satisfies many security deficiencies and has multi streaming feature. Load sharing and balancing are not supported it also uses the ECN method for avoiding congestion. In this a better path for data transmission is selected. Energy also plays the important role in the mobile adhoc network as discussed in the paper[2] where congestion and less energy causes delay in the network proper time allocation, saving energy, congestion control needed to be satisfied. Node level congestion is caused by overflow of the buffer and no capacity to store the packets and sometimes link failure happens because of lot of information packets that are send so in STDMA [2] it statistically measure the load of the data that need to be send and energy of each node using the information from the nodes by using TS-TDMA [2] the time slots of nodes are analysed so it avoids congestion. When packets collide large energy is wasted by retransmitting the packets again and again. When many resources send the packet to single node energy gets drained. So the source need to send again and again energy is wasted unnecessarily.

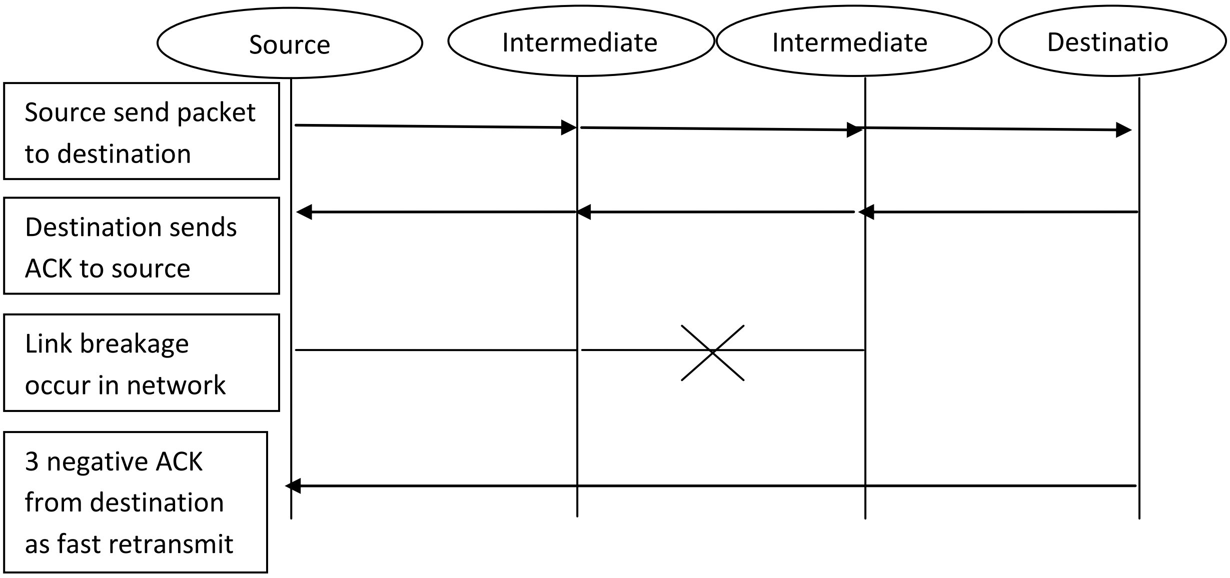

Figure 1: Three duplicate ack for performing the fast recovery or fast retransmit

The main aim of this paper is to design an efficient algorithm for routing with congestion control and to improve the quality of service in a MANET. The algorithm comprises of two parts: a route discovery mechanism that uses reactive protocol in which an extra feature is added by broadcasting to the nearby nodes, energy of the node i.e.(capacity) of the node is analysed based on the statistical approach, nodes that have good radio range is selected by using WCETT[2] approach, packet bandwidth to be send and choosing the same node for another channel is avoided to control the collision among packets, energy gets drained on sending the packets and when the node reaches the critical situation it is informed to the source and packet sending traffic is minimised and alternate route is chosen by analysing the static node list and the node that has good energy capacity is selected as new path by this mechanism global synchronisation is also maintained in which the packet is never dropped and new path is also chosen immediately. By this approach the overall delay in the network is reduced and throughput is increased so the QoS is improved by this method.

2. SYSTEM ARCHITECTURE

2.1 Layered Approach

The TCP is the layered architecture in which each and every node in the network has the 5 layers to transmit the data. The application layer is the front end for the user it has any internet protocols. The data moves to the transport layer in which it transmits from server to client. There are two types of protocols UDP and TCP, in which TCP is connection oriented and it divides the data to segments. After sending the data ACK is received for every packed so it is secure transmission. UDP is connectionless, unsecure but it transmits the data very fast. Some packets may be lost. So TCP is used. In Network layer it is also called as IP layer it is responsible for routing protocols.

2.2 Systematic Approach

The fundamental challenge is to know the bandwidth capacity of the node in advance so that the energy of the node according to the packet will be identified but the bandwidth is not the constant all the time. In this approach as shown in the Figure 2 initially the source and destination is selected and the route is established by on-demand routing approach and by broadcasting to the nearby nodes. Statistically identify the energy capacity of every node present. In which the radio range of the node is identified by using WCETT approach, and the bandwidth of the packet is estimated from which the energy of the node is analyzed value. When the capacity reaches the threshold value or when the link breakage occurs due to mobility it intimates the source node to stop sending the packets and when it does not have enough bandwidth it selects the node that have high capacity from the node list available and establishes the path again instead of broadcasting to the intermediate node again so the overall time is also reduced. Throughput of the approach is increased.

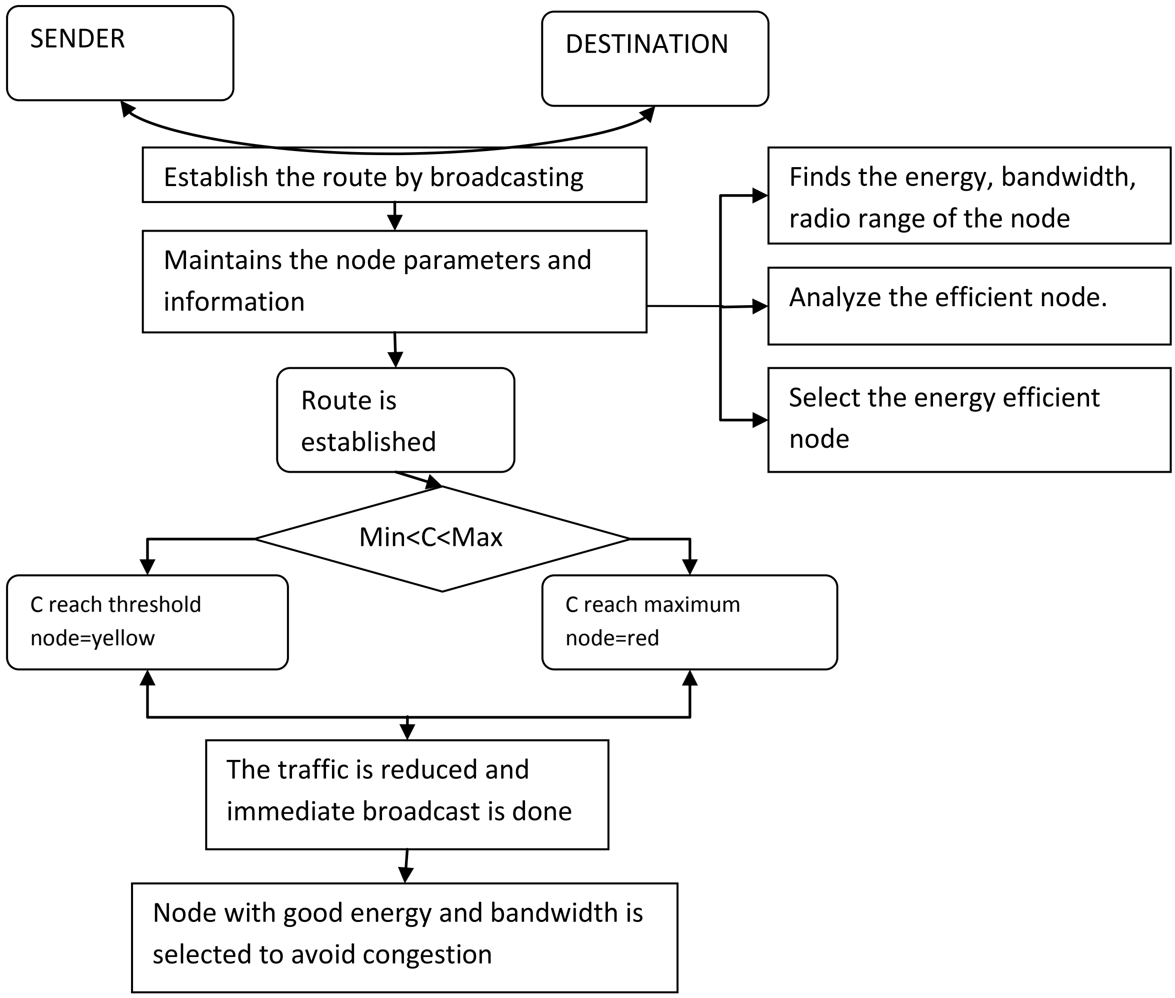

Figure 2: Flow of route discovery and congestion Control

3. RELATED WORK

3.1 Bandwidth Efficient Admission Control

A bandwidth-efficient admission control mechanism addresses the two main issues of industrial communication, reliability, which is affected by behavior of such networks, and timeliness, which depends on the transmission scheduling policy adopted [1], in real time approach the minimum amount of message need to be delivered on time retransmissions for the wireless links is mainly considered. In networks all the nodes will be having common physical channel, even when there is less collision error rate on the packet is different. The message errors and retransmissions are mainly based on flow and size of packets. The special admission control test is combined. The communication period is not decreased from the success rate of communication the startup, The EDF is a framework where reliability and timeliness is adopted. So in this paper efficient use of bandwidth is analyzed.

3.2 TS/TDMA Energy Efficient Congestion Control

Congestion and limited energy causes delay in network, saving the battery life, time allocation, delay, are the some aspects that need to be considered, in this approach statistical time division is combined with the TDMA to avoid congestion and saves energy as discussed in the paper[2] (TAL) is used so that it manipulates the free time slots that occurs due to the node mobility (LBA) is also used in order to allocate the load of the packets properly. The detail of the node location, battery and memory is obtained initially. When there is no packets to be send free time slots are allocated to the nodes or when same data occurs it is not suppose to send the data. When data needs to be send a new time slot is assigned to the node it can also choose the path which is already established so this will save the time and energy of the network.

3.3 Fast Startup Congestion Control

The main challenge in the flow startup after the node is idle for a long time and after connection setup. The TCP uses the slow start mechanism but it is very time consuming. The main objective of the fast startup is to fully utilize the path and the available bandwidth in the node. So large amount of packets is transmitted and RTT is also reduced. The end systems normally run the end to end congestion control. In addition to speedup, fast startup congestion control can also overcome other problems of the Slow-Start, such as a faster convergence to equal sharing of resources as in the paper [3] end systems can determine an allowed sending rate by querying the routers on the path, using a new Internet Protocol (IP) option, for instance during the connection setup. The fast startup increases the congestion in the network it leads to delay or packet losses this can be avoided by have active queue management. The admission is controlled in the routers by approving the rate request. In the congestion window is increased moderately for selected applications is concluded in the paper.

3.4 New Tcp-Reno on wireless packet loss rate

In the work of Tcp-Reno it is based on monitoring the wireless packet loss rate in real time along with the router configured with explicit congestion notification mechanism. In which it is capable of distinguishing the loss whether it is because of mobility or congestion packet loss. So the sender takes advantage to adjust the segment size. In the paper [4] the ECN configured at the router that marks the packets when the router's buffer occupancy exceeds a threshold. Explicit Congestion Notification (ECN) is an extension of RED. The router configured with the function of ECN can indicate incipient congestion where the notification can sometimes be through marking packets rather than dropping them the TCP sender to effectively differentiate packet losses due to random wireless link errors from those caused by link congestion.

3.5 Fast congestion notification:

The tcp application depends upon the queue management mechanism. Fast congestion notification also controls the packet admission and the congestion control this helps to send congestion avoidance as early as possible even if the queue is almost full or empty the arrival rate is manageable so in this paper [5] it examines the properties by fixed values in queue level and it shows that larger the drain (growth) in the queue, the smaller (larger) is the largest average arrival rate that can be endured before activating the packet drop/mark mechanism, and the larger (smaller) the maximum achievable drop probability.

Queue management manages by dropping packets when necessary in which the packet admission to the queue is done during the mark activation. The drop mechanism is of 2 categories reactive and proactive. In reactive it doesn't prevent the packet drop before the buffer is flooded and in proactive it prevents the packet drop before the buffer gets full. Drop-tail is the reactive queue management method so it has the global synchronization problem. But in active queue management the global synchronization is eliminated which in turn increases the throughput. The fast congestion notification responds to congestion very quickly.

In the work of fast congestion notification it is done before the buffer overflows by considering the instantaneous queue length rather than optimal queue length. In this mechanism if the packet is dropped, congestion avoidance notification is given to the gateway so it considers the buffers capacity and reduces the packet loss rate. So it mainly considers the traffic rate and avoids congestion.

3.6 Receiver-Assisted Congestion Control:

In many applications the fast data transfer is essential but the TCP cannot effectively utilize the network capacity. In TCP when the node continuously receives three negative acknowledgements it considers there is a packet loss and resends the packet but it can be because of mobility also which leads to poor performance. And on retransmission the send need to wait and calculate the window size to transmit the data so it greatly reduces the throughput. In the paper [6] RACC the receiver does the flow control in which the receiver has the timer set if the timeout happens then it considers it as packet loss and informs the source to retransmit the lost packet. But it can be because of network collision also. So, in our work we are going to consider and differentiate both rectify the problem accordingly.

3.7 Congestion control QOS Enhancement

For multimedia applications QoS is very necessary. In the paper[7] GPSR greedy perimeter stateless routing is used in which it is a location-based on demand routing protocol it considers the efficient bandwidth utilization and concurrent transmission among neighbor nodes is considered in concurrent transmission MAC (CTMAC) it inserts additional gap in between control packets and data packets so, in order to safeguard concurrent data transmission, collision avoidance information is included in control packets a special ACK sequence is proposed in this by using the fragmentation algorithm. By considering this paper on demand adhoc routing protocol, concurrent data transmission and congestion avoidance by buffer capacity is considered.

4. METHODOLOGY

In routing and congestion avoidance algorithm, initially connection is established between the neighbor nodes. Initially the first hop neighbor nodes that are the only neighbor of some node are included directly to the route. Then the remaining nodes for the route are selected that has less hop count and durability is more.

4.1 Network formation

In the wireless network the nodes are not stable and free to move anywhere out of base station also. When the connection need to be established every node in the network starts to broadcast to know the energy capacity and node list is maintained which tell the details about the node its location, memory and radio range till what it can communicate

The pseudo code for algorithm is as follows:

```
BEGIN
        If (node has data to send)
Create RREQ with src and dest fields;
Initialize timer Trreq;
                Broadcast_node=node1 (src);
                Send RREQ to Broadcast_node;
        End if;
NODE LIST
        Broadcast_node (details);
        Find energy, radio range, and bandwidth
        Save in the node list;
END
```

4.2 Establish the route

After identifying the node capacity by the using (STDMA) the bandwidth of the packet is identified and energy is compared. A path is chosen which has good radio range and node that has more bandwidth is chosen and the link is established in SCTP. The algorithm is:

```
BEGIN
Route (src)
                Identify X: first hop neighbors of src;
                Select the node as less hop_count &
high_bandwidth;
        If( X has node which is the only neighbor of a node)
                Select the node as Broadcast_node;
END
```

4.3 Energy Drains

When route is established packets are forwarded. On transmitting the packets the energy of the node gets reduced on sending more and more packets. The energy level is maintain by

$$E_U=E_T+E_{(I)}$$

E_U is the amount of energy used by the node on sending packets.

E_T is the overall energy

$E_{(I)}$ is the energy used by all the node. The capacity C is the E_U of every node in the network.

```
BEGIN
Minimum<Capacity<Maximum
For every packet arrival
        Calculate the capacity of the node;
        Mark the packets
        If (min<C)
                Then transmit the packets;
        Else if(C<Max)
                Inform the source to transmit slowly;
                Node=yellow;
        Else if(C=Max)
                Choose alternate path;
                Node=red;
END;
```

4.4 Alternate route

When the node turns red then is means unsafe to send the packets. Alternate route should be chosen as soon as possible. From the node list that is established already the details of the node will be available so a node which is close to the location is choose which has good radio range and bandwidth capacity and establish the route with the node

The pseudo code for Quick Repair and congestion avoidance is as follows:

```
BEGIN
QR (src, dest, curr_node)
        If (curr_node detects a critical bandwidth)
                Slowdown the process of sending
        Check the Node_list;
                Choose node nearby and good radio range;
                Broadcast ( intermediate_node);
Repair_node that can repair the link break respond to curr_node;
New path is established through (intermediate_node);
        End if;
END;
```

5. MODULE DESCRIPTION

The project is implemented in Ns2 2.34. In the simulation we consider the hop taken for every node, its energy, traffic rate, radio range in order to avoid congestion. The simulation is done by using 40 nodes as given in the Table 1. The energy for the node is given as 10 joules. Packet transmission size is 150. The routing protocol is AODV and SCTP transport protocol is used in which it is a reactive approach. In WCETT the radio range of the node is established. We consider 802.11 in the MAC type so that it communicates with the entire node without causing any congestion in the network. Omni directional antenna is used.

Table 1. Ns2 Simulation settings

No. of Nodes	**40**
Area Size	**1000 X 1000**
MAC	**802.11**
Routing Protocol	**AODV**
Layer	**Link Layer**
Initial energy	**10**
Rx power	**3**
Tx power	**6**
Transmission protocol	**SCTP node 1 and node 12**

5.1 Formation of wireless network

In this case as shown in the Figure 3 the nodes are deployed in the random fashion. After selecting the source and destination in the network it starts to broadcast its information. It initially checks whether all the nodes are alive. All the nodes in the network are not stable in nature they move from one location to another since they are not wired. In this scenario a beacon node is selected which acts as a common node for both the sources. After which the node starts broadcasting to the neighboring nodes. The information like range of the node, bandwidth, energy level of the node are identified and obtained as a routing table information before establishing the connection

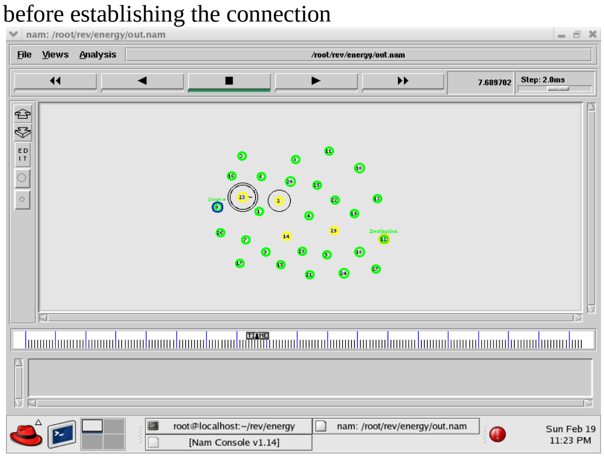

Figure 3: initial sensing and broadcast

5.2 Establishing the route:

In this scenario after broadcasting and obtaining the information the node list is generated and all one hop neighbor are arranged in the routing table. After analyzing the bandwidth of the packet and the energy capacity of the node that can transfer the packet is selected from the list of nodes. And the wireless network is created.

5.3 Draining of the energy

On transmitting the packets initially node will be having full energy. On transmitting the packets the energy gets drained. When the node is unable to receive the packet the congestion occurs because low bandwidth when the node capacity is good enough it signals as yellow or green and when the node energy is completely drained which is red. It informs the source to reduce the traffic and chooses the alternate route from the node list as shown in the Figure 4 since it has the property of multi-homing uses the alternate path.

5.4 Alternate Route

In order to avoid the global synchronization before further dropping of packets immediately a new route is determined with the most efficient path as shown in the diagram Figure 4 an power efficient path is selected

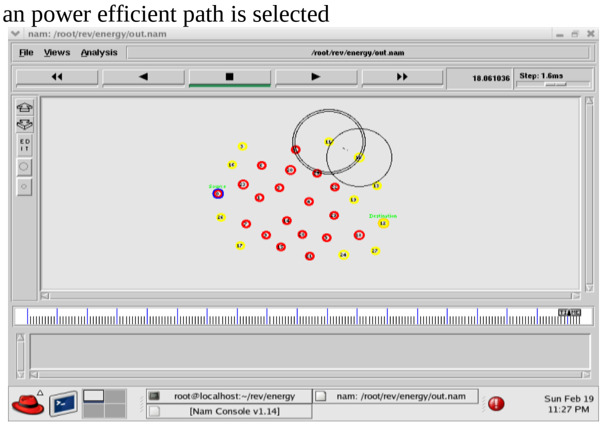

Figure 4: Alternate route with efficient node

6. RESULT ANALYSIS

The graph in the Figure 5 compares the energy and the average delivery ratio of the SCTP protocol without energy consideration and with energy consideration. In the proposed method since the node with high efficiency is selected the average delivery ratio is also high. The transmission rates given to both the system are 100 but the no of packets delivered successfully is when the energy is considered.

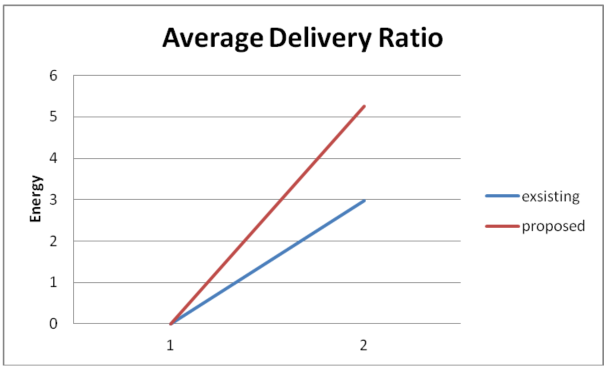

Figure 5: the Average delivery ratio Vs Energy

The graph in the Figure 6 compares the end to end delay experienced in normal routing without considering the energy or the capacity of the node and congestion avoidance method where measures are taken before congestion occurs. When is node goes to the critical position alternate route is established immediately so the overall delay of the network is reduced.

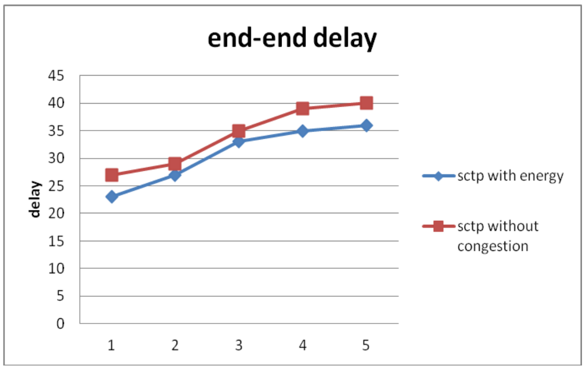

Figure 6: End-End delay Vs Pause time.

In the Figure 7 it compares the packet delivery ratio of the existing methodology where there is no notification of the node failure with congestion avoidance method where before dropping the packets when the strength of the node is less it informs the source and automatically choose a node that has more bandwidth so the packet delivery ratio is also very high.

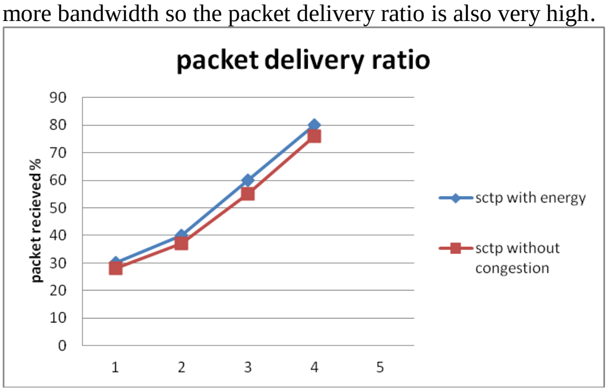

Figure 7: packet delivery (%) Vs Pause time(sec)

7. CONCLUSION

In our paper, the algorithm has been tested for both symmetric and asymmetric networks. In this approach the congestion is mainly reduced and energy is properly consumed among the nodes. The method of WCETT is adapted in this paper for determining the radio range of the node. The energy of every node in the network is analyzed and the amount of packets that are going to be send is also determined initially so according to that the capacity of the node is determined whether it can transmit or not. By doing this way congestion is reduced. When the node moves link breakage occurs so instead of taking a preventive measure after the link breaks or collision occurs the process is done before by alternating the route immediately from the node list by re-broadcasting and analyzing which node has more capacity. The node list will also be maintained to know about the capacity of the previously used nodes. So when the source receives the status of every node in the network congestion can be avoided periodically. The results show that it is not necessary that each and every node in the network must take part in the forwarding activity. If a node has more incoming links, the frequency of its occurrence in the entire forwarding list is more i.e., many nodes consider the particular node as the forwarding node.

Future work in paper is to alter the node list dynamically whenever there is a change in the network. So instead of rebroadcasting to the nearby node it can establish the route immediately by predicting method. And also to implement multi hop technique so the performance can be increased even more.

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