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# A NOVEL FRAMEWORK FOR EFFICIENT CONGESTION CONTROL PROTOCOL AND QoS ENHANCEMENT IN ADHOC WIRELESS NETWORKS

**[1]K. MANIKANDAN, [2]M. A. SALEEM DURAI**
[1]Asst Professor (Senior), School of Computing Science & Engg VIT University,Vellore,TN
[2]Associate Professor, School of Computing Science & Engg VIT University,Vellore,TN
E-mail: kmanikandan@vit.ac.in, masaleemdurai@vit.ac.in

**ABSTRACT**

Internet with its wide application has contributed a lot to the fast growth of the world and there are many limitations in ad hoc networks. There are two main failures that occur in the network namely wireless packet loss and congestion. The performance of SCTP in wireless network is considered the active research area. The detection of failure in the wireless network is very important for analysing the performance of networks. In this research work, the route is established by demand routing technique in which many features like the energy of the node, location and bandwidth of the packet are analysed. So when the packet needs to be sent, it analyses all the features and establishes the route with the efficient node that has one hop count by using the SCTP transport protocol. On transmitting the packets some energy from the node gets reduced. So there is a high vulnerability of congestion, since the capacity of the node is reduced. This can be avoided by the proactive approach ECCP by reducing the traffic, send by the source, when the node level reaches threshold. By using the multi-homing technique in the SCTP approach, the packets can be sent till the alternative route is re-established. Thus, the packet loss rate and end to end delay is reduced and QoS is increased in adhoc networks.

***Keywords:*** *Adhoc Networks, Congestion Control, Bandwidth, Qos, Packet Loss*

## 1. INTRODUCTION

A mobile ad hoc network (MANET) is a self-configuring network of mobile devices connected by wireless links. Each device in a MANET is free to move independently in any direction, and will , therefore, change its links to other devices frequently. In ad-hoc networks, every device has a build in router set up so that it communicates with other devices which are reachable. The primary challenge in building a MANET equips each device to continuously maintain the information required to properly route traffic. The control and management of mobile ad-hoc network are distributed among the participating nodes. Each node is responsible for forwarding packet to other nodes in the network. Nodes in mobile ad hoc network are highly mobile that causes network topology to change rapidly and unpredictably. Moreover, the connectivity among the hosts varies with time. In most cases, mobile ad-hoc networks operate on low power devices. Normally these devices have low CPU process capability and small memory sizes, thus affecting the capability of the mobile ad hoc network to reach other devices [5].

The mobile devices can freely move irrespective of the base station and it can establish the connection with the available network. Because of the limited transmission range of wireless multiple networks to forward packets from source to destination. The main criterion that needs to be taken care is the information that should be properly transmitted in the network. The mobile nodes in ad hoc network keep moving and because of the movement of the nodes, link breakage occurs and so, several routing algorithms are introduced in order to increase the efficiency and to transmit the data. Several routing algorithms are present proactive and on demand, in proactive protocol the link between the source and destination is established and the information is transmitted and it has a constant network design and disadvantage is the change in network topology. On demand routing protocol is reactive protocol in which it establishes the link only when it needs to send the packet. The route discovery is done till it reaches the destination. The protocol is considered to be efficient , because the route is discovered only when the data need to be transmitted. We are dealing with the link breakage, which occurs due to mobility of nodes and congestion of packets. In high speed wireless

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network a fast data transfer is required nowadays[5].

In this paper, all the concepts involved in Congestion control and routing have been studied, and how different solutions could be combined to realize such applications have been shown. such as various transport protocols, congestion avoidance algorithms, routing techniques for successful packet delivery concepts are analysed and performance analysis is made and proven successfully.

### 1.1 Research Challenges In Adhoc Networks

The congestion happens in the network layer. Because of congestion , many problems arise in the system. Some of the problems that occur in the network because of congestion are:

**Delay**: When more number of packets are sent because of the control packets in the network traffic arise and large number of packets are dropped. So in-order to maintain the global synchronization, the packets are resent and so it causes delay in the network.

**Collision**: In the network many transactions are performed. So while using the same nodes collision occurs.

**Energy Wastage**: Some amount of energy is required for sending the packets. On resending the packets again energy of the node is wasted and conserving the energy properly is very important for the wireless network.

The network bandwidth should be properly utilized in-order to maintain the good network. So when we reduce the energy conservation and use the bandwidth properly, the system is effectively allocated. This congestion control mechanism is done along with routing.

### 1.2 Problem Statement

Network plays the major role in day to day life. When one wants to send the data over network connection established. Many protocols like TCP (Transmission Control Protocol), SCTP (Stream Control Transmission Protocol) are used in data communications. In the wireless network, two types of data are sent one is the data packets and the control packets. Because of this, traffic occurs in the network and collision also takes place. Nowadays multimedia is very much used in the real time applications due to high bandwidth congestion occurs. But the retransmission in multimedia has an easy access but when data gets lost, identifying is very difficult and the problem like global synchronization occurs. Mobility and low bandwidth are the main disadvantage in the wireless. Due to this, packets get lost and the energy of the nodes gets reduced and wasted unnecessarily. In many existing networks, the congestion control is not properly given. So in this paper, we are proposing a layered approach on the network layer congestion control is introduced with proper energy utilization which is maintained by the transport layer. SCTP approach is used for its efficiency while compared with the other protocols, bandwidth usage is considered and improve the quality of service of the system.

## 2. ADHOC NETWORKS-SYSTEM MODEL

Ad hoc network refers to a network connection established for a single session and does not require a router or a wireless station. It is also defined as the collection of mobile nodes connected through wireless link. Information is exchanged between the nodes in the form radio signals. In wireless network 'Air' acts as the transmission medium. In this research work congestion control protocol simulated and tested in adhoc networks. Ad hoc networks system model has been shown in Fig 2.1

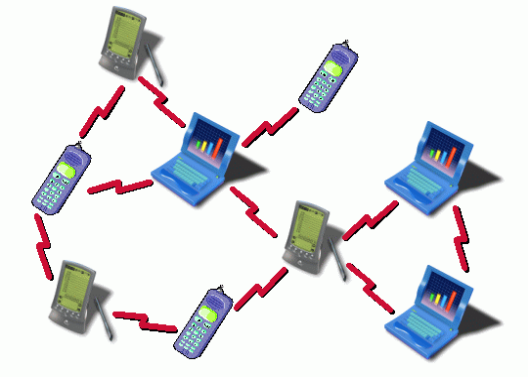

*Fig 2.1: Adhoc Networks*

## 3. LITERATURE REVIEW & RELATED WORKS

### 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 in real time approach the minimum amount of message needs to be

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delivered on time retransmissions for the wireless links is mainly considered. In networks, all the nodes have common physical channel, even when 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 derived from the success rate of communication the startup, The EDF is a framework where reliability and timeliness are adopted. So this paper analyses the efficient use of bandwidth [1].

### 3.2 Ts/Tdma Energy Efficient Congestion Control

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

### 3.3 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. The ECN configured at the router , 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 an 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].

### 3.4 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 .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 and 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 buffer capacity and reduces the packet loss rate. So it mainly considers the traffic rate and avoids congestion [4].

### 3.5 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 sender needs to wait and calculate the window size to transmit the data So it greatly reduces the throughput. RACC the receiver does the flow control in which the receiver has the timer set if the timeout happens then it considers it packet loss and informs the source to retransmit the lost packet. But it can be because of network collision also. So, in our work,

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we are going to consider and differentiate both that rectify the problem accordingly[5].

### 3.6 Congestion And Peak Power Control

The admission of the packets to the network, power control, and congestion are the main aspects of the paper. The admission control is done in order to maintain the packet delivery ratio to be high. So control algorithms are introduced in order to maintain the QoS of the system the host channel adapters (HCA) and network interface cards (NIC) are used to find the effectiveness of the system. The admission and congestion control is done by probing method on getting the request the router compares the available bandwidth with the bandwidth of the packet that is going to be sent. If it is accepted, the destination node is checked whether the packet is sent to proper destination or not. Thus by this method, it initially checks the bandwidth available and then sends the packet. So we are adapting this mechanism in our system[6]. Cross layer hop by hop congestion control scheme is proposed to improve TCP performance in multi hop wireless networks which coordinates the congestion response across the transport, network, and transport layer protocols. The method determines the main reason of the packet loss and coordinates the layers of Mac layer, transport and network layer. The congestion control mechanism is done when the alternative route is also chosen in order to avoid the congestion in future[7].

## 4. PROPOSED FRAMEWORK

The proposed ECCP (Efficient Congestion Control Protocol) flowchart has shown in the Fig 4.1

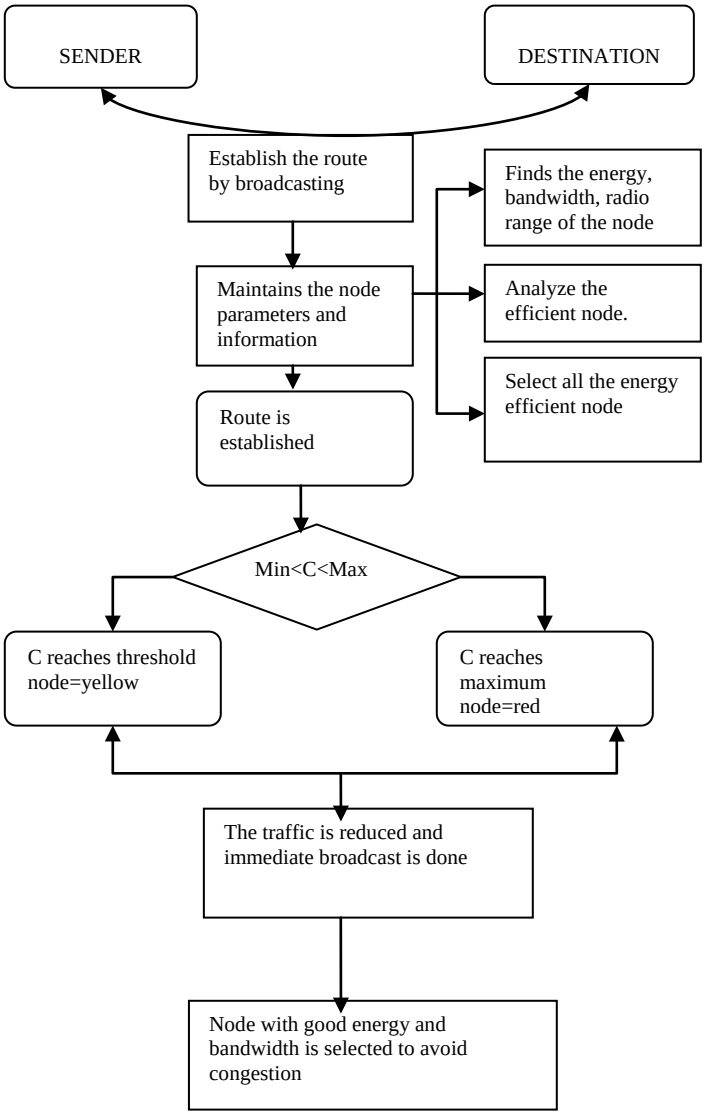


*Fig 4.1.ECCP Protocol design*

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 Fig 4.1, 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. Route is established with the energy efficient node. After establishing the route source sends the packet. Instantaneous queue is maintained in every node.

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The nodes accept the packet when the capacity of node is minimum and till it reaches the threshold 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 has 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 and delay is reduced.

### 4.1 ECCP Algorithmic Approach

The Proposed ECCP is divided into 4 phases. The algorithmic representation of the approach is given:

1. Network formation
2. Establish the route
3. Energy Drains
4. Alternate route

#### 4.1.1 Network formation

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 to facilitate the movement of mobile nodes . 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”.

In the wireless network, the nodes are not stable and they are free to move anywhere out of base station also. When the connection needs to be established, every node in the network starts to broadcast to know the energy capacity and node list is maintained which furnishes 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, bandwidth
        Save in the node_list;
END
```

#### 4.1.2 Establish the route

After identifying the node capacity by using (STDMA) the bandwidth of the packet is identified and energy is compared. A path is chosen with a good radio range and node that has more bandwidth is chosen and the link is established in SCTP. In this scenario after broadcasting and obtaining the information the node list is generated and all one hop neighbor is 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

```
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
```

#### 4.1.3 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 maintained. 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 of 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 alternative route from the node list.

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

Journal of Theoretical and Applied Information Technology
30th November 2012. Vol. 45 No.2

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Elseif(C=Max)
Choose alternate path;
Node=red;
END;

**4.1.4 Alternate route**

When the node turns red then it means unsafe to send the packets. Alternative 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 close to the location is chosen that has good radio range and bandwidth capacity and establish the route with the node. In order to avoid the global synchronization before dropping of packets immediately a new route is determined with the most efficient path.

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;
Repair_node that can repair the link break respond to curr_node;
New path is established through (intermediate_node);
End if;
END;

**4.1.5 Energy Constraint**

The congestion is avoided in this system in which it is done by using this ECCP (Efficient Congestion Control Protocol) in which the energy and the bandwidth are considered and an overall algorithm is developed and given below:

Begin
N number of nodes in the network;
Broadcast the RREQ, initialize timer;
Analyze the location, energy, hop count, bandwidth of all node;
If (BW of packet is high)
Choose node with more energy;
Else (BW of packet is low)
Node with less energy;
Energy analysis;
$E(i) = \sum^{BW}$ (Energy/ Total energy (E(o))
Energy of nodes gets consumed
E(u) = E(o) – E(a);
E(u) = T (threshold);
If (E(i) < T <= E(i))
Slow down the source node;
Choose alternate route before congestion;
Stop;

In this the method is analyzed in which E (i) initial energy analysis of all the nodes. The energy of every node is analyzed and determined. The E (u) is the consumed energy of all the nodes it is determined by the overall energy (o) of the network and the amount of energy E (a) used by each node in the network. This is given as the threshold value if the energy of the node is less than T then the packet is free to send. If the energy exceeds T then it informs the source node to slow down the process. And in the mean while it starts discovering the alternate route.

## 5. SIMULATION SETUP

The evaluation is carried out with network simulator (NS-2.34) by performing several experiments that illustrate the performance of the system. The simulation parameters like number of nodes, traffic model simulation time is given in this approach. Our simulation settings and parameters are summarized in Table 5.1

We use NS2.34 to simulate our proposed protocol. We use the distributed coordination function (DCF) of IEEE 802.11 for wireless LANs as the MAC layer protocol. It has the functionality to notify the network layer about link breakage.

| Network Parameter | Value |
|---|---|
| No. of Nodes | 30 |
| Simulation time | 20 |
| Area Size | 1000 X 1000 |
| MAC | 802.11 |
| Routing Protocol | AODV |
| Layer | Link Layer |
| Performance parameter | Energy consumption |
| Initial energy | 10 |
| Rx power | 3 |
| Tx power | 6 |
| Transmission protocol | SCTP node 1 and node 12 |
| Network simulator | NS 2.34 |

*Fig 5.1. Simulation Parameters*

Journal of Theoretical and Applied Information Technology
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In our simulation, mobile nodes move in a 1000 meter x 1000 meter region for 20 seconds simulation time. We assume that each node moves independently with the same average speed. All nodes have the same transmission range. The network size is fixed as 30 nodes and the pause time of the mobile node is 10 seconds. The initial energy capacity of the node is given as 10 joules. The transmission power of the node is 6 watts. The receiving power of the node is given as 3 Watts. Energy consumption is the main module in the system. The routing protocol used is the AODV and the transport layer used is the SCTP approach.

### 5.1 Network Formation

The Research paper is implemented in network simulator version 2. First the scenario and traffic files are created according to our requirements and included in the TCL file. According to our specification, initially the number of nodes is displayed in the network animator in which the network is the wireless network as given in the Fig 5.2 and that broadcasting takes place to all the nodes in the network.

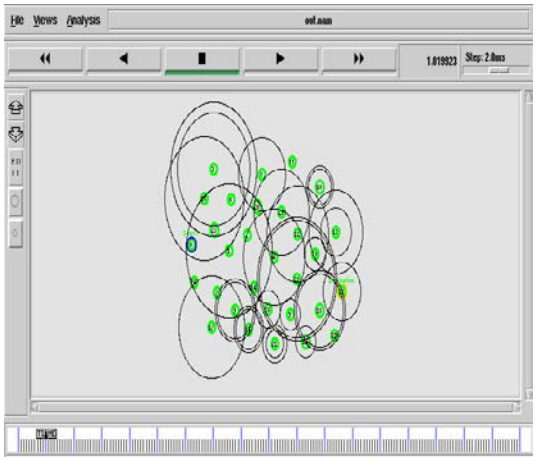

*Fig 5.2: Network formation*

### 5.2 Route Discovery

After the source and destination is selected in the network , the route is discovered while broadcasting the network. The energy of every node in the network, location of the node, hop count between nodes, bandwidth of the packet that has to be send is analyzed. From the analysis the efficient nodes are selected and route is established as given in the Fig 5.3

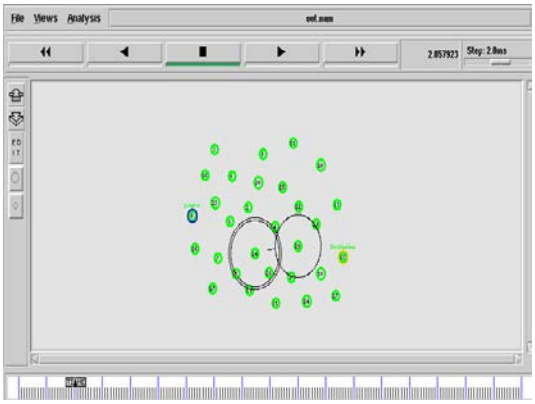

*Fig 5.3: Route Discovery*

### 5.3 Energy Utilization

When the packets are transmitted over the network some amount of energy gets used in the node and the energy capacity decreases. If the capacity of the node is from minimum to threshold value then transmit the packets. When the node capacity reaches threshold node becomes yellow as shown in the Fig 5.4.

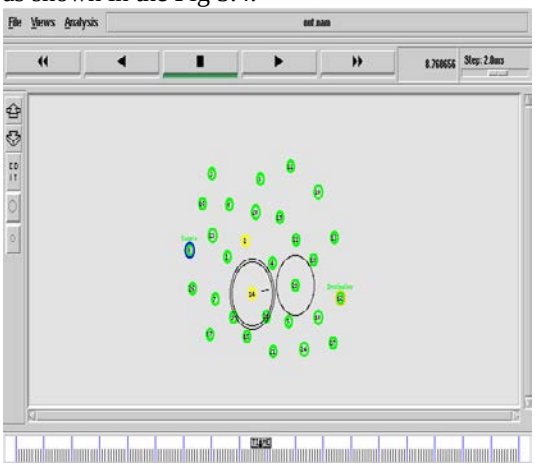

*Fig 5.4: Energy Utilization*

### 5.4 Congestion Avaoidance With Energy

On continuous transmission of packets the capacity of the node reduces drastically, And the value when exceeds the threshold and comes to maximum the control packets that are send from the destination are dropped as shown in the Fig 5.5. So source send the control packet and checks the status of network.

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30th November 2012. Vol. 45 No.2

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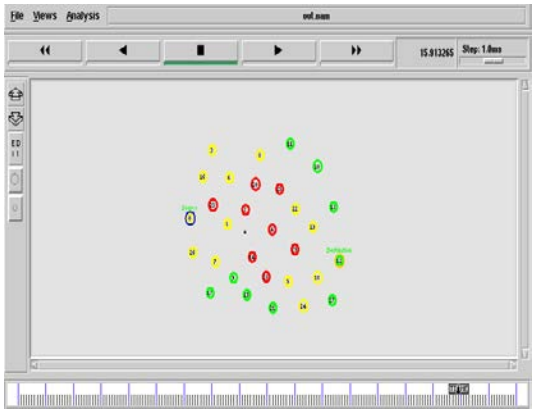

*Fig 5.5: Complete Energy Drain*

### 5.5 Alternate Route

In this method the SCTP transport protocol is used so if one port fails it will be able to send with the alternate port. When it exceeds the threshold value alternate route broadcast is done as shown in the Fig 5.6. Thus it avoids the congestion control that causes in the future by finding the alternate path as soon as possible.

*Fig 5.6: Alternate Route Broadcast*

### 5.6 Alternate Path

After broadcasting to the network again the efficient node is selected from the available nodes. In which the energy of the node will be very much reduced since it is alive when the other operation was taking place. So packets with low bandwidth are selected for transmission since the energy is also reduced to avoid further congestion in the network because of the overflow in the network as shown in the Fig 5.7.

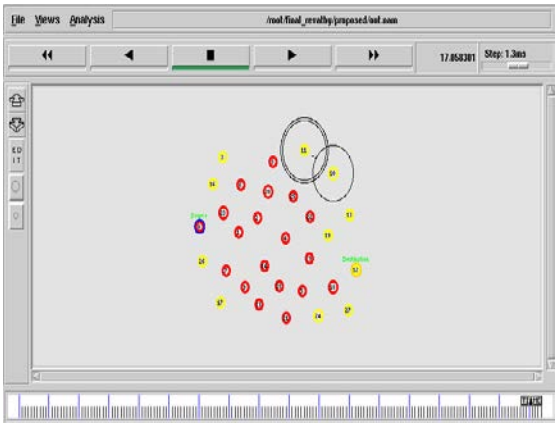

*Fig 5.7: Alternate Route*

## 6. PERFORMANCE ANALYSIS

### 6.1 Energy Consumption

It compares the energy that is consumed by the nodes in the network with the initial energy that is present in the network. Based on the energy of the available node the bandwidth is chosen. For the node that has lower energy low bandwidth is chosen and vise versa. So it avoids from large amount of bandwidth getting wasted as shown in the Fig 6.1

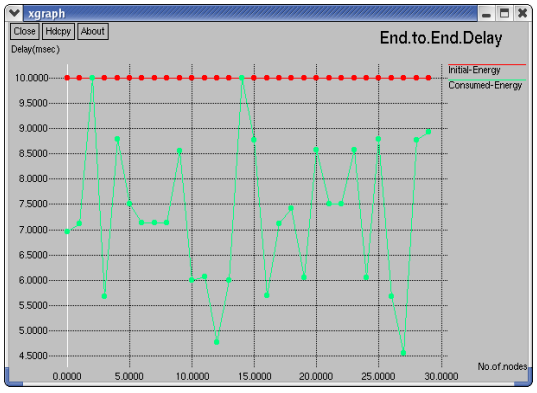


*Fig 6.1: Energy Consumption*

Based on the energy that is utilized in the network the route is chosen. In the initial transmission the nodes 2, 4, 12, 16, 24, 27 are involved so the energy of the nodes are reduced. So on choosing the alternate route the efficient nodes are selected based on the analysis of all the nodes.

### 6.2 Packet Delivery

Compares the packet delivery ratio of the existing methodology with the efficient

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methodology where the bandwidth is maximum when the energy of the node is more. It informs the source and automatically chooses a node that has more bandwidth so the packet delivery ratio is also very high. The loss of the packet is less because it initially analysis the capacity of the node so the packet delivery is more as given in the Fig 6.2.

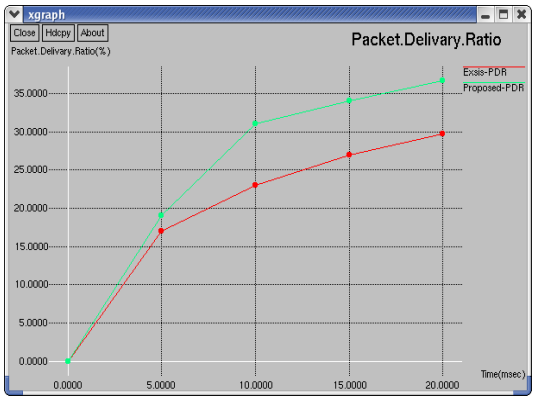


*Fig 6.2: Packet Delivery Ratio*

### 6.3 Throughput

Throughput or network throughput is the average rate of successful message delivery over a communication channel. The amount of data that is moved successfully over the network with the time limit is the throughput. Thus the throughput of the system is also increased as shown in the Fig 6.3.

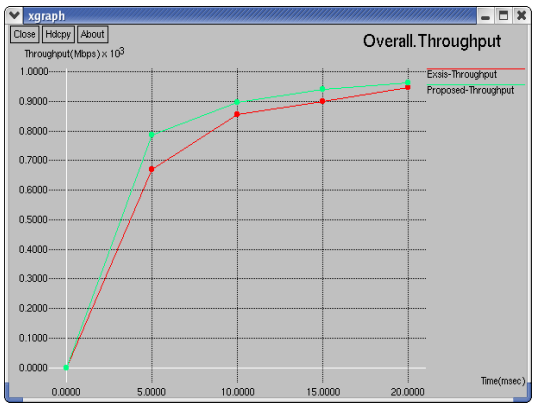


*Fig 6.3: Throughput Analysis*

## 7. CONCLUSION

The congestion control in the layered approach is done by involving the transport, network and data link layer as the cooperative approach. The main metrics considered in this paper is the initial bandwidth of the packet, energy capacity of the node and location. So in-order to avoid the congestion, node with one hop count is selected. To avoid congestion because of the control packets the SCTP transport protocol is chosen.So that, with the alternate socket in the node it can transfer the packet. 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. The energy is repeatedly analysed because some amount of energy is used while transmitting so till the node reaches the threshold value the nodes are free to send. After it reaches the threshold values which is identified dynamically the information is given to slow down the process. By doing this congestion caused by packet overflow is reduced. So the quality of the network is also in good performance which is proved by the analysis given above. By doing this way congestion is reduced.

## 8. FUTURE WORK

This research work is further extended 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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