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ERED: ENHANCED RED USING DYNAMIC THRESHOLD AN EFFICIENT CONGESTION CONTROL ALGORITHM

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Abstract—Congestion and load balancing is a key problem in MANET. MANET is a network which operates in the absence of any fixed infrastructure, because it has to work under dynamic conditions. For effective load balancing, congestion control and to improve energy-routing matrices, the authentic capture of the load at various locations of the network is required. In this paper an algorithm is proposed that combine RED with threshold value (MaxTh, MinTh). The basic idea behind RED queue management is to detect incipient congestion early and to convey congestion notification to the end hosts. Our purpose is to design an efficient congestion control algorithm to enhance throughput and packet delivery ratio. Simulation is done in a 2.34 simulator environment. Simulation results show that our new ERED algorithm gives better performance than the existing RED algorithm by solving some problem in RED. The comparison is shown in terms of throughput and packet delivery ratio.

Keyword: ***RED algorithm, URED algorithm, Throughput, Packet delivery ratio, Energy conservation and QoS*.**

I. INTRODUCTION

Mobile Ad hoc Network (MANET) is a self-organizing network of mobile devices which does not depend in any fixed infrastructure. A Mobile Ad hoc Network (MANET) is a collection of mobile nodes relying neither on fixed communication infrastructures nor on any base stations to supply connectivity. Each node in the MANET acts both as a router and a host. If two nodes are not under the transmission the range of each other, other nodes are required to serve as mediate routers for the communication between the two nodes. The hosts are free to move around randomly, and hence the network topology may change dynamically over time [2, 17]. MANET devices can take part in the communication only if they are in the communication range of the network, and can move freely within transmission range of the network, and devices which are outside the transmission range of network cannot take part in communication. As the number of data packets transferring increases, the data traffic increases in the network, as a result congestion will occur. Load balancing and congestion control are difficult task in MANET [3]. Congestion is a state in transmission networks in which too many packets are present in a part of the subnet. Congestion may arise when the load on the network is greater than the capacity of the network. RED (Random early detection) algorithm is used to detect congestion by monitoring the average queue length of the output of the router.

RED is better than tail drop, in the sense it does not have a bias against bursty traffic that uses only a small portion of the bandwidth. RED is congestion avoidance technique. It also avoids global synchronization by randomly selecting packets to be dropped or marked before the queue gets full. RED achieves improved stability with reduced oscillation and higher throughput [1]. The advantage of RED algorithm is simple and easy to implement, it eliminates the global synchronization, and improves the utilization of the physical links very much. [2]. The key feature of RED is to calculate the average queue size, length from the current queue length with the help of EWMA (exponential weighted moving average).

In this paper, we are analyzing the performance of packet delivery ratio, end to end delay and throughput of MANET via enhancing Random early detection (RED) and observe how it affects to QoS of the existing mobile Ad-hoc network.

The remaining part of the paper is organized as follows: Section II presents the related work. Section III represents our proposed working model. Section IV describes the simulation experiment setup and gives the performance evaluation of our proposed strategy. Section V concludes the paper.

II. RELATED WORK

RED algorithm

To avoid congestion in MANET, researchers have proposed the use of Active Queue Management (AQM), in which packets are dropped before the queue gets full. RED is a congestion avoidance algorithm, because it forecast the congestion by examining the average queue size. It avoids global synchronization by randomly choosing packets to mark or drop before the queue gets congested. The performance of RED is known to be delicate to its parameters such as the Maximum threshold (Max_{th}), the Minimum threshold (Min_{th}), the maximum packet marking probability (Maxp) and the weighting factor [3].

There are two steps in RED algorithm:
1) Calculate the packet drop probability. This mechanism is

based on controlling congestion before it occurs.
2) Calculate the average queue length
The average length of queue is calculated by given equation.

$$avg_q = (1-W_q)*avg_a + W_q*q \qquad (1)$$

The formula for packet dropped probability of RED is calculated as:

$$p_b = \begin{cases} 0, & avg_q < min_{th} \\ 1, & avg\ q > max_{th} \\ \dfrac{avg_q - min_{th}}{max_{th} - min_{th}} * max_p & min_{th} <= avg_q <= max_{th} \end{cases}$$

Where max p- largest packet drop probability. Equation 2 shows the packet drop probability that depends upon the value of the average queue length. Fig 1 shows the drop function of RED.

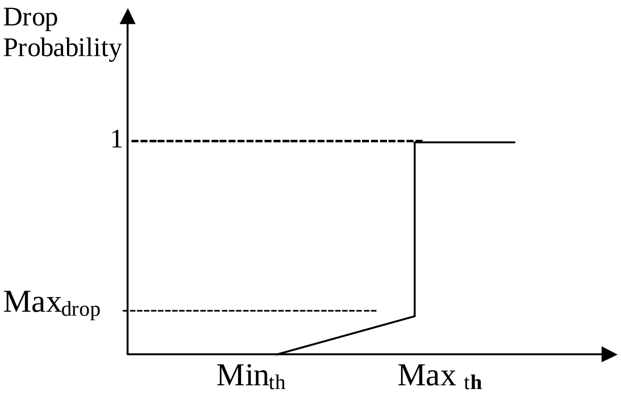

Figure 1. RED Drop Function

Drawback of RED

RED performance is sensitive to the number of competing source/flows. It is highly sensitive to its parameter settings. In RED, at least 4 parameters, namely, a minimum threshold (mint), maximum threshold (math), maximum packet dropping probability (max_p), and weighted factor (w_q), have to be properly set. Performance of RED is sensitive to the packet size.

URED

A new algorithm after RED is URED (upper threshold RED) in which we introduced new extra threshold U_{th} (Upper threshold) for better use of buffer space. In RED algorithm probability of the dropped packet p_a increases linearly up to the packet dropping probability map. When the average queue size is greater than most then p_a is set to 1and all incoming packets are dropped. In URED, by adding Uth probability of dropping packet is slow from max_{th} to $\underline{U}_{th}$ .That means probability of dropped packet is 1 when average queue size reaches to Uth [1].

Problem in URED

Upper threshold is better than RED. For better buffer space.
in Uth additional condition is required for max_{th} to U_{th} when the average queue size is grater than max_{th} to buffer size for maximum utilizing of the buffer size. U_{th} is unnecessary overburden and extra condition Max_{th}<=avg<=U_{th} is not required [1]

III. PROPOSED MECHANISM

Because of some drawback of URED, in our work we will work on max_{th} rather than U_{th}. Whose value is variable, and increased or decreased according to situation. In proposed mechanism there is no need for Uth (upper threshold) for Uth there is some unnecessary condition is to be used, but using this approach there is not any extra condition is required.

```
If
   avg_q >= Max_th
{
   Max_th  =  Max_th +1
   avg_q  < Min_th
   Max_th = Max_th - 1
}
```

In above algorithm Max_{th} is equal to Maxth + 1 that means maxth will be increased to the maximum size of the buffer will be far, and Max – 1 that means maxth will be decreased to the minimum size of the buffer.

Solution approach

Random Early Detection algorithm, measures the average queue size to analyse the degree of network congestion. Average queue size is calculated by Exponential Weighted Moving Average (EWMA) of the original average queue size as:

Avg = (1-w)*Avg + Q*w ……………………. (4.1)

Here
Avg = Average queue size
Q = Instantaneous queue size.
W= is the weighted factor and generally equal to a negative power of two.

The RED algorithm uses the average queue size (Avg) to evaluate the network congestion condition and determine the packet drop probability. The packet drop probability depends upon the relationship between the average queue size and two thresholds, maximum threshold Max_{th} and minimum threshold Max_{th}.
The weighted factor w is a constant that determines the sensitivity of RED gateway to the immediate queue size. It is

often set to slightly small in order to prevent the average queue size (Avg) from varying too dynamically and rapidly.

As the average queue size Avg is under the Min_{th}(minimum threshold) all incoming packets are enqueued serially. As the average queue size Avg is over the maximum threshold Max_{th}, all arriving packets are dropped unconditionally. As the average queue size Avg ranges between the maximum threshold Max_{th} and the minimum threshold Min_{th}, the nominal packet dropping probability P is given by the following equation

$P = Max_p * (Avg - Min_{th}) / (Max_{th} - Min_{th})$………...(4.2)

The Random Early Detection algorithm uses packet dropping probability P to decide whether the packet drop / mark will occur or not. The Early packet drop is used to detect incipient congestion so that action is taken before it become burst.

Proposed Solution for Enhanced RED mechanism:

The proposed Enhanced mechanism is using the basic idea of Random Early Detection with some modification in working is mentioned below:

Random Early Detection algorithm, initialize the threshold parameters (Min_{th}, Max_{th}) to the fixed value when simulation starts, these values cannot change during the simulation. In a MANET, due to the quick diversity of changing the network condition, fixed threshold parameters are not appropriate and can degrade network performance. Proposed Enhanced mechanism works with variable threshold parameters which are changing according to the network congestion condition.
Random Early Detection doesn’t utilize queue space, fully due to setting of Max_{th} to the fixed value, To solve this problem Proposed Enhanced mechanism gradually adjust the maximum threshold value Max_{th} to maximum available queue size, purpose is maximum utilization of available queue space because all the incoming packet are dropped after queue size reached to the maximum threshold (Max_{th}).

Proposed Algorithm for Enhanced mechanism

Algorithm of Enhanced is based on the parameter setting to improve the network performance; pseudo code of this algorithm is given below:

List of variables which contain RED variables used in Enhanced mechanism

Min_{th} = Minimum threshold value

Max_{th} = Max threshold value

P = Packet drop probability

Q = Instantaneous queue size

P_{max} = Maximum packet drop probability

Proposed Enhanced mechanism same functionality of random early detection with some additional functionality as explained in algorithm 3.1, this algorithm is divided in three steps for easy understanding of working procedure.

```
Step 1:  if (v_ave <= th_miSn )
{
max_p = 0;
th_max = th_max - 1;
}

Step 2: if(v_ave > th_min && v_ave <= th_max)
        {
         p = (v_ave - th_min) / (th_max - th_min);
         p *= max_p;
         }

Step 3: if ( v_ave >= th_max)
         {
            th_max = th_max + 1;
            p = (v_ave - th_max) / (th_max - th_min);
            p = (1 - max_p) *p;
          }
            if (p > 1.0)
         {
            p = 1.0;
            return p;
          }
```

Algorithm 3.1 : Proposed algorithm of Enhanced mechanism

IV. SIMULATION EXPERIMENT

4.1 Simulation Parameters

To calculate the performance of the network I have used the following parameters mentioned in table 4.1. I have used these parameters for calculation of results, both for existing mechanism and also for the proposed solution approach of Enhanced mechanism.

Simulator Used	NS-2.34
Number of nodes	30
Number of sources	1-5
Number of destinations	1-5
Dimension of simulated area	500m×500m
Routing Protocol	AODV
Simulation time	60 sec
Packet size	2000 bytes
Node movement at average Speed (m/s)	5 m/s
Transmission range	250m

Table 4.1 Network parameters used in the simulation.

4.2 Scenarios of Enhanced RED mechanism

Scenario of Enhanced RED mechanism consists of details about the scenario used in calculation of results such as no of nodes used, connection establishment mechanism, and packet transmission policy.

4.2.1 Sensing for Connection Establishment and Packet Transferring

In the simulation all nodes are scattered and moving an average speed of 5m/s in predefined area. When source node wants to send data to the destination node, source node initiate route request procedure, till destination node is found with strong connection. This dissertation work is using AODV routing protocol which is reactive routing protocol. First connection is established from source to destination through intermediate node. When strong connection is established, source node starts transferring data packets through establish route to the destination node. When all data packets are reached to destination, connection is closed.

Figure 4.1 shows the relative position of nodes in the network. This contains one source and one destination node. In the above figure node (0) is working as source node and node (5) is working as a destination or sink node. Circle shows the transmission range of respective node.

4.2.2 Connection Establishment and Packet Transmission

Here nodes are scattered in predefined boundary and ready for establishing connections and transmit their data. According to the simulation scenario, each node senses their neighbors which is in radio range 250m then establish a connection. This simulation scenario having two sources and destination pair.

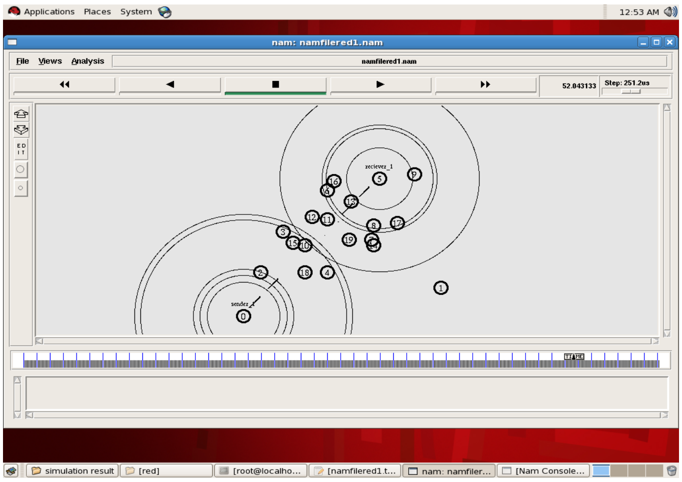

Figure 4.1 Simulation scenario of ad hoc network

When connection is established between any source and destination pair, this will start sending packets to the destination without waiting to other source to establish connection with other destination, both sources and destination pair will work separately. When the established connection will be strong connections between source and destination after that they will start the communication and terminate connection when the processes of packet transmission is completed or path is broken due to node movement.

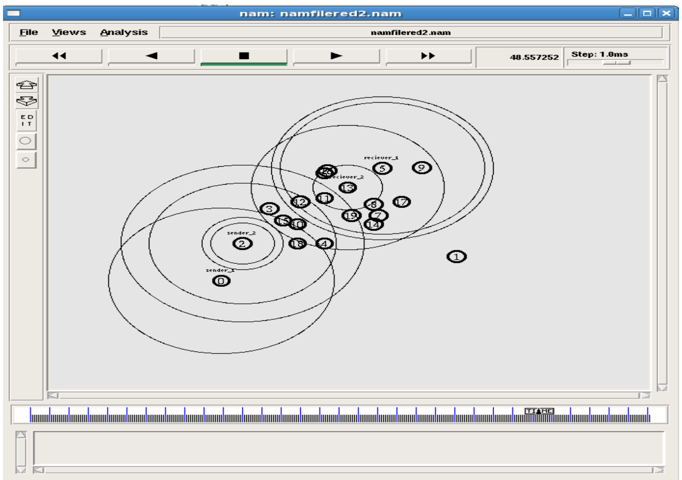

Figure 4.2 Connection establishment and packet transmission.

Figure 4.2 show the relative position of a node in the network, in which some nodes are working as source and some as a destination or sink nodes and rest of other nodes are working as intermediate node. Circle shows the transmission range of respective nodes. [1]

4.3 Packet delivery ratio v/s number of sources

Packet delivery ratio is the ratio of the number of delivered data packet to the destination to the number of packet generated. Mobile wireless Ad hoc networks use packet delivery ratio (PDR) as a metric to choose the best path, transmission rate or power. PDR is normally calculated either by counting the number of received hello/data messages in a small period of time, i.e., less than 1 second, or by taking the history of PDR into account.

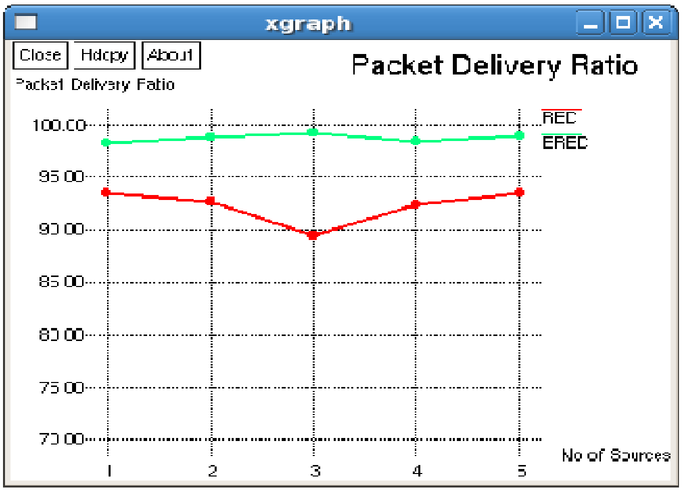

Figure 4.3 Packet delivery ratio v/s number of sources

Figure 4.3 shows the packets delivery ratio of both random Early Detection method and Enhanced Random Early Detection mechanism with respect to number of source. Packets delivery ratio is plotted in y axis, and x axis plots the number of source used in calculation of the packet delivery ratio in the simulation. Graph is drawn between conventional Random Early Detection [RED] mechanism and proposed solution mechanism v/s number of source.

Figure 4.3 shows that packet delivery ratio of ERED is higher than RED. Numerical analysis is done in Table 4.3. Numerical analysis shows that PDR is consistently higher in ERED than RED. Numerical result also shows that PDR has been dropped in both mechanisms by increasing number of source due to increasing of network congestion.

Packet Delivery Ratio		
No.of source	RED	ERED
1	93.56	98.26
2	92.76	98.85
3	89.53	99.25
4	92.35	98.47
5	93.51	99.04

Table 4.3 Packet delivery ratio v/s number of sources

4.4 Network Throughput v/s number of source comparison

Network throughput is the average rate of successful message delivery over a transmission channel. This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is generally calculated in bits per second (bit/s or bps), and sometimes in data packets per time slot or data packets per second.

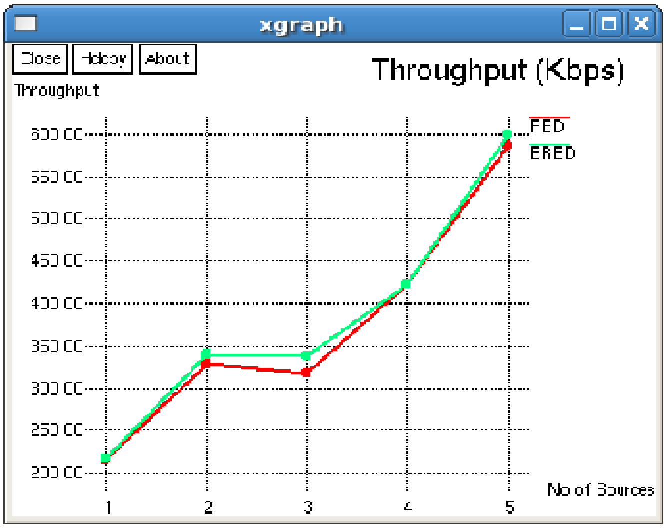

Figure 4.4:- Throughput v/s number of source comparison

Throughput		
No.of source	RED	ERED
1	216.27	217.7
2	329.99	341.03
3	317.86	339.35
4	422.02	422.40
5	587.03	599.56

Table 4.4 Throughput v/s number of source comparison table

Figure 4.4 shows the Throughput of both random Early Detection method and Enhanced Random Early Detection mechanism with respect to a number of sources. Throughput is plotted on the y axis, and x axis plots the number of sources used in the calculation of the throughput in the simulation. The graph is drawn between conventional Random Early Detection [RED] mechanisms and proposed a solution mechanism v number/s of sources.

Table 4.4 Shows that throughput of ERED is higher than RED. Numerical analysis is done in Table 4.4. Numerical analysis shows that throughput is consistently higher in ERED than RED. Numerical result also shows that throughput has been increased by increasing number of sources due to increasing of multiple TCP flows.

V. CONCLUISION

In this paper ERED (enhanced random early detection) algorithm is proposed based on the study of existing RED algorithms by introducing variable (min, max) threshold. Performance of ERED is improved in terms of throughput and packet delivery ratio. Simulation results show that ERED is more efficient than existing RED algorithm. It has lower packet drops and higher throughput than RED.

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