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Experimental study of RED Performance by regulating Upper Threshold Parameter

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Abstract-The Active Queue Management [AQM] algorithms achieve high throughput and low average delay by stabilizing the average queue size by mapping the congestion level into packet drop probability [PDP]. Random Early Detection [RED] is widely used AQM mechanism for detection and avoidance of incipient congestion, but it is very sensitive to its parameter setting that can degrade network performance. This paper describes a new enhanced mechanism to reduce parameter sensitivity and to improve the network performance in a congested network. This mechanism has been tested in different network scenarios to test its validity and results shows that proposed mechanism have improved packet delivery ratio and throughput in a congested network.

1. INTRODUCTION

Mobile Ad hoc Network (MANET) [1] is self-organizing network of mobile devices which does not rely in any fixed infrastructure. 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 network, and devices which are outside the transmission range of network cannot take part in communication. The dynamic nature of MANET with limited resources that can vary with time such as battery power, storage space, bandwidth makes QoS provisioning, a more challenging problem. To prevent congestion, current internet use end-to-end congestion control [2], in this mechanism end host is responsible for detection of congestion. Packet loss is treated as an incipient congestion notification signal from routers. After detection of incipient congestion, packet transmission rate is reduced by the source to decrease the congestion.

Power limit will be also a restriction of the ad hoc networks. The mobile node in the ad hoc wireless network may be a notebook or PDA**.** It is unlike common static equipment, such as PC, that the equipment usually has to depend on the finite energy source primarily by batteries. In order to save the consumption of electricity, “power off’ or “disconnected” is the measure we often take. As above, when a mobile host takes a measure of power off or disconnection, the mobile host will disappear in the network and also the network topology by change. Sometimes link failure is inevitable; thereupon, when network topology’s speed of reconnection changes, it affects not only the communication among the nodes in networks but also the quality of packets sending.

Congestion control and queue management in the network have been one of the active areas of research in the past few years. Some improvements have been made by some researchers to solve the high packet loss rates problems. Loss rates are especially high in heavy network congestion, when a large number of connections compete for limited network bandwidth and other resources. Due to an exponential increase in network traffic, there are a number of congestion control mechanisms have been proposed, including the use of explicit congestion notification (ECN), along with Random Early Detection (RED) techniques.

The mechanism of AQM is that packets are dropped or marked before the buffer overflow on the router to convey the congestion information to the source, and then source reduces their sending rate to alleviate the network congestion. A lot of good AQM schemes are proposed, such as PAQMAN [7], ARTAQM [8], MRED [9], innovative TCP [10], URED [11]. AQM schemes try to stabilize the instantaneous queue length through mapping the congestion measurement into packet drop probability [12]. In this paper, we propose a new AQM scheme with congestion measurement and mapping, which can also work effectively.

This paper is organized as follows. Chapter II descries RED algorithm, RED drop function, and problems in RED. In chapter III our proposed algorithm has been explained. Chapter IV simulation results and comparisons are shown. Chapter V is the conclusion of the research and in rest part references is included.

2. RANDOM EARLY DETECTION

Floyds et al proposed Random Early Detection (RED) [3] in 1993. The basic idea of this mechanism is that the router can detect incipient congestion by monitoring the average queue length. Once the incipient congestion is being detected, router can select the source to notify the congestion, so that source terminal can reduce the data transmission rate before the queue being overflowed to reduce the network congestion. RED [4][5] algorithm calculates incipient congestion in two steps: In a first step it calculates the average queue length, and the second step it calculate the packet drop probability. Packet drop probability to take decisions whether to drop the packet or not, packet drop is treated as the signal of congestion.

A. Calculation of the Average Queue Length

RED calculates the average queue length (Avg), by Exponential Weighted Moving Average (EWMA) of the original average queue size as follows:

$Avg = (1-W) * Avg + Q * W$ ………… (1)

Here, W represents the weighted value, and Q represents the actual queue length in the sampling moments.

B. Calculation of the Packets Drop Probability

RED algorithm has two threshold minimum threshold (Min_{th}) and maximum threshold (Max_{th}), which are related with queue length. When the packet reaches at the router, RED calculates the average queue length (Avg) immediately and it determines the packet drop probability based on Avg , Min_{th} and Max_{th} . When avg is greater than Max_{th}, all packets are discarded, and the packet loss rate is 1. When Avg is between Min_{th} and Max_{th}, Then following Packet Drop Probability (PDP) formula is used:

$P_b = Max\_p * (Avg-Min_{th}) / (Max_{th}-Min_{th})$…. (2)

$P = P_b / (1 – count* P_b)$ ……………………..(3)

Packet drop probability is used to take decision whether to drop the packet or not, packet drop is treated as the signal of congestion.

RED algorithm uses the average queue size (Avg) to estimate 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 instantaneous queue size. It is often set to slightly small in order to prevent the average queue size (Avg) from varying too rapidly and dynamically.

As the average queue size Avg is under the minimum threshold Min_{th}, all incoming packets are enqueued sequentially. If the average queue size Avg is greater than the maximum threshold Max_{th}, all arriving packet are dropped unconditionally. As the average queue size Avg ranges between the minimum threshold Min_{th} and the maximum threshold Min_{th}, the nominal packet dropping probability P is given in equation 3.

Problems with RED

RED performance is sensitive to the number of competing sources/flows and highly sensitive to its parameter settings. In RED, at least 4 parameters, namely, minimum threshold (min_{th}), maximum threshold (max_{th}), maximum packet dropping probability (max_p), and weighting factor (W), should have to be properly set for better performance.

3. PROPOSED UTRED MECHANISM

In our proposed algorithm is inspired by the URED [11], in this we have also introduced a new Threshold for better use of buffer space, to queue more packets which reduces packet drops due to constant packet drop probability p_a is 1 when the average queue size is greater than max_{th} with the additional condition of switching of max_{th} and Uth whenever there is available buffer space. As in RED and other enhanced RED algorithm pa increases linearly up to packet dropping probability max_p. If the average queue size goes greater than max_{th} then p_a is set to 1 and all incoming packets are dropped. In order to get full advantage of the queue buffer packet drop probability is calculated by another linear function when the average queue size reaches between max_{th} threshold and Uth threshold and extra condition is applied when the average queue size is greater than Uth then the algorithm switches the value of max_{th} to Uth and Uth to buffer size for maximum utilizing of the buffer size.

Following is the pseudo code of the UTRED algorithm with Upper Threshold RED (Uth):

```
Step 1: If the average queue size is less than min_th
            Then P = 0 ;
Step 2: If the average queue size is between min_th and max_th
            then calculate P
            P_b = (avg - min_th) / (max_th - min_th);
             P = P_b *max_p;
 Step3: If the average queue size is between max_th and Uth,
            then calculate P
            P_b = (avg - max_th) / (max_th - min_th);
             P = P_b *(1 - max_p);
Step 4: : If the average queue size is greater than max_th then
            calculate P
            Exchange value of max_th and Uth
             max_th = Uth;  Uth = Buffer_Size ;
            P_b = (avg - max_th) / (max_th - min_th);
             P = P_b *(1 - max_p) ;
if at any step  (P > 1.0)
         P = 1.0;
            return P;
}
```

4. SIMULATION AND RESULTS

Experimental network topology map to calculate the results we have used 25 mobile nodes moving in 500*500 Sq meter area with average speed of 5 m/s in Mobile ad hoc network scenario. Simulation is done in five different scenarios with different threshold setting. Using the threshold setting Sce 1 (Min_{th} 10 Max_{th} 30 Uth 60), Sce 2 (Min_{th} 15 Max_{th} 45 Uth 75), Sce 3 (Min_{th} 20 Max_{th} 50 Uth 75), Sce 4 (Min_{th} 12 Max_{th} 36 Uth 72), Sce 5 (Min_{th} 16 Max_{th} 32 Uth 64). All the simulations are done with RED and UTRED algorithm. Results are compared in terms of Packet Delivery Ratio and Throughput and Total Packets received and Total Packets drop.

a. Throughput

Throughput is the average rate of successful data delivery over the communication channel. Throughput is generally measured in kbps.

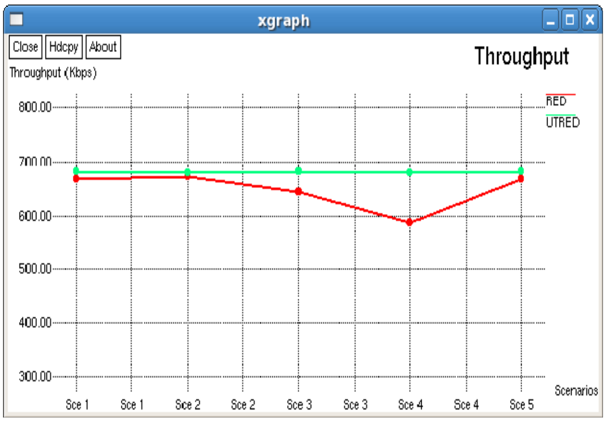

Figure 1: Throughput

Figure 1, shows that the throughput is consistently above in each case of using different scenario with different parameter settings. Quantitative measures of throughput between RED and UTRED are given in table 1.

	Throughput (kbps)	
Scenarios	RED	UTRED
Scenario 1	665.52	679.41
Scenario 2	672.18	679.31
Scenario 3	643.68	680.82
Scenario 4	588.04	679.06
Scenario 5	665.89	679.74

Table 1: Throughput

b. Packet delivery Ratio

Packet Delivery Ratio (PDR) is calculated as the number of packets delivered at destination to the number of packet transmitted by the source.

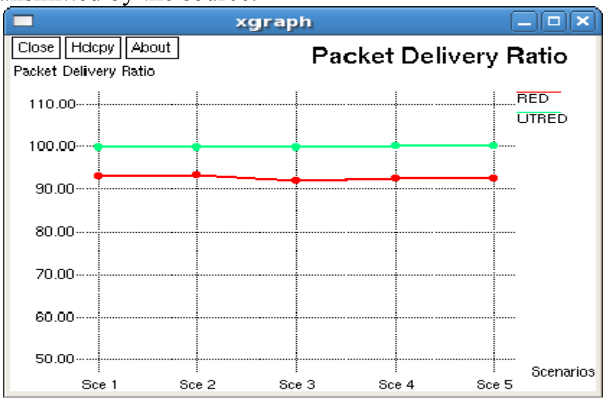

Figure 2: Packet Delivery Ratio

Figure 2, shows that the packet delivery ratio is consistently above in each case of using different scenario with different parameter settings. PDR in RED is consistently around 92 and 93 and in the proposed UTRED mechanism PDR is around 99 to 100. Quantitative measures of PDR between RED and UTRED are given in table 2.

	Packet Delivery Ratio	
Scenarios	RED	UTRED
Scenario 1	93.15	99.97
Scenario 2	93.37	99.96
Scenario 3	92.14	99.95
Scenario 4	92.51	100.0
Scenario 5	92.67	100.0

Table 2: Packet delivery Ratio

c. Comparisons of packet receive and drop

Table 3 shows the Total packets received and Total packets drops comparisons of RED and UTRED with different thresholds setting in the network. Simulation results show that performance of UTRED is better than RED algorithm. As it gives higher throughput and lower packet drops in different network scenario in a congested network.

	Total Packets Received		Total Packets Drop	
Scena-rios	RED	UTRED	RED	UTRED
Sce 1	7969	8179	585	2
Sce 2	8047	8159	570	3
Sce 3	7686	8160	633	4
Sce 4	7631	8164	555	0
Sce 5	8012	8194	633	0

Table 3: Comparison of Packets received and drop

5. CONCLUSION

In this paper we have presented enhanced queue management algorithm based on the different control methodology. Compared to the standard RED, this proposed algorithm clearly demonstrates its superior performance. Proposed UTRED algorithm maximizes utilization of buffer space and increases the performance of network in congested network.

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