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Performance Evaluation of Heterogeneous Network Based on RED and WRED

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Abstract

The developing of wireless networks becomes a very important issue nowadays, since it is considered as an easy-using tool without building new infrastructure to cover a wide working area. Applying TCP protocols with the application demands are implemented this work by considering heterogeneous environment of wireless networks connecting with wired networks. The TCP congestion is critical problem is faced heterogeneous environments, this problem is appeared through sending and receiving huge data from wireless networks to wired networks and vice versa. This work is proposed a new approach of using active queue management (AQM) technique with random early detection (RED) and weight random early detection (WRED) strategies to avoid the expected congestion between the heterogeneous environments. Our simulation results show that the quality of service (QoS) is improved by reducing the queue delay and buffer usage, and by increasing the average throughput and utilizationof the system. The simulation is carried out by using OPNET software to test the proposed models for different scenarios.

Keywords: *congestion, heterogeneous networks, RED, WRED, OPNET*

1. Introduction

The speed of data transmission is very important in these days, and it is increasing on demands of high-speed Internet applications to transmit big data through networks. Because it can be used in multi-purposes such as military environments, emergency operations, civilian environments (meeting rooms, sports stadiums), sending and receiving big data between clients and servers. The wired and wireless networks give a new meaning to the Internet as a heterogeneous network [1].

The networks can be classified into wired and wireless networks. The general differences between them are characterized as follows: the wireless networks do not need physical connectivity between nodes [2]; and the wired transmissions are moving much longer than the wireless transmissions due to their time-varying characteristics [3]. While, the heterogeneous network is a network connecting the wired and/or wireless networks with computers and other devices of different operating systems and/or protocols. For example, the local area networks (LANs) that connect Microsoft Windows with Apple Macintosh computers are heterogeneous [4]. The term of a heterogeneous network is also referring to the wireless networks when they are using different access technologies. As an example of a wireless heterogeneous network, a wireless network is able to continue its service when switching to a cellular network [5]. In this study, we emphasize the heterogeneous network as wired network connected to a wireless network in different environments.

However, there are some problems facing the heterogonous networks because of using a variety of different wired and wireless environments. The main problem that is considered in this work representing by the average queue delay due to the congestion which happens when the traffic load confronts with a bottleneck. In our study,a new approach will be proposed to avoid this congestion by using two detection strategies: random early detection (RED) and

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weight random early detection (WRED). These two strategies are examined for the heterogeneous network to extent of their effects in many parameters [6-9]. Almost all researchers focus on the congestion avoidance under consideration either the wired or wireless environments rather than the heterogeneous. In this paper, we will discuss how to avoid congestion in the heterogeneous networkwhich is composed both wired and wireless networks.

2. System Model

2.1. QoS Management by RED and WRED Strategies

To achieve the high QoS, applications should be implemented in gateways(routers) to let the networks exchange the information between nodes with high speed, and tolet the networks don't consume toomuch connection space [10]. So, we used RED gatewayswith theheterogeneous network to keep lower space in average queue size. During congestion, the gateway increases the probability of reducing window approximately proportional to that connection’s share of the bandwidth through the gateway [11]. The random early detection (RED) algorithm is becoming the main factor standard forcongestion avoidance in the packet switched networks or on the Internet. Authors of [2, 12] state that RED should be used as the default strategy for managing queues in routers unless there are good reasons to use another strategy. So, these are strong recommendations for testing, standardization and widespread deployment of QoS, to improve the performance of today’s Internet are made.

The simple idea of congestion avoidance strategy is that, when buffer utilization of a router’s reaches a certain threshold, it will drop packets to achieve the aim of congestion avoidance [13]. RED and WRED are used to congestion avoidance strategies, these two strategies are summarized and analyzed in the calculating of RED operators by depending on the average of queue size (Q_{avg}) and a drop probability (P_d), based on the instantaneous queue size and a weight factor (w).In addition, RED maintains two thresholds of queue size Q_{min} and Q_{max}. The algorithm of RED [9] is presented as follows:
To keep low queue size of router, the equation is:

$$avg = (1 - W_q) \times avg + W_q \times q \quad (1)$$

Where W_q is the weight the value range is from 0 to 1, q is the actual queue length of sampling measurement. According to average queue length to calculate the drop probability, the equation is given by:

$$P_d = P_{max} \times (avg - MIN_{th}) / (MAX_{th} - MIN_{th}) \quad (2)$$

$$P = P_d / (1 - count \times P_d) \quad (3)$$

Where MIN_{th} and MAX_{th} are the minimum and maximum thresholds respectively, which they represent the average of queue length boundaries. P_{max} is the highest drop probability when the average queue length reaches MAX_{th}. Calculate the number of queued packets when avg stays between MIN_{th} and MAX_{th}.

Note that when ($avg \leq MIN_{th}$), RED does not need to drop the arriving packets; while, when ($MIN_{th} \leq avg < MAX_{th}$), RED drops the arriving packets with the probability P. Finally, when ($avg \geq MAX_{th}$), RED drops all arriving packet. The drop probability of RED algorithm is described in Figure 1.

The WRED algorithm is used the random early detection factors in additional to the weight in order to make it more efficient and robust from the RED strategy in the process. WRED is the making of RED and Priority Queuing, it sets different minimum threshold MIN_{th}, maximum threshold MAX_{th} and the highest drop probability P_{max} for packets with different kind of services, WRED will drop packets selectively depending on the priority [9] as shown in Figure 2 below.

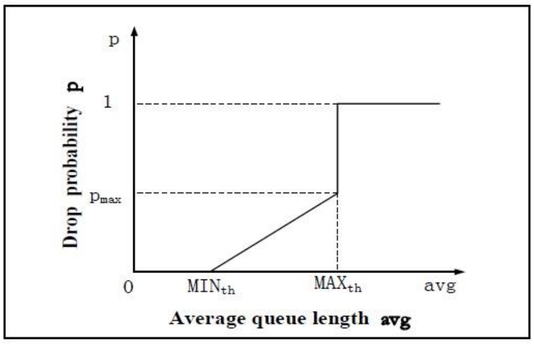

Figure 1. Description of drop probability at RED algorithm

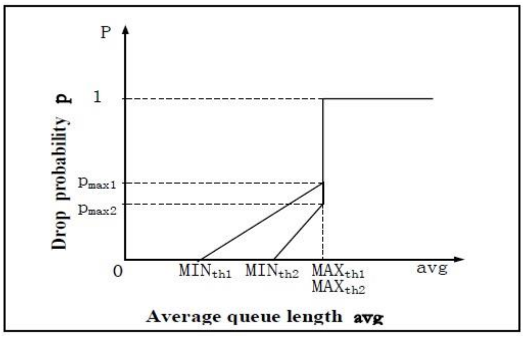

Figure 2. Description of Drop Probability at WRED Algorithm

2.2. Wireless Environment

The Mobile Ad-Hoc Network (MANET) is one kind of wireless networks [14-18], where the wireless network's nodes communicate by broadcast in multi-hop links [5]. The main problem of this network is the network congestion when data packets are sending from source to destination,the cause of network congestion appears by loss data and retransmission packets which effect on the performance of the network in addition to the delay in queue. The advantages of the wireless networks are easy in distribution than wired networks, scalability and flexibility [16, 17].

3. OPNET Simulation Requirements

The simulation background contents two different environments (wire and wireless networks) in theareaof (2500m* 5000m), and 24 MANET nodes are deployed randomly, these nodes are connected toeach other through IP address wireless connected with the access point. The access point is connected by wire with router type (base-100), the first router connects with the second router by wire (PPP_DS1) link (1.53Mbps), and the second router is connected to aswitch (Ethernet16_switch) and the switch is connected to theserver by the base-100 wire. The parameters should be set in order to configure our simulation environment with time duration is 600 seconds. The element of the experiments is listed in Table 1 below.

Table 1. The Elements of Heterogeneous Network

Element	Numbers	Device	Connect	application	service
Router	2	Ethernet slep4	wire	FTP file	Best-efforts
Switch	1	Switch	wire	FTP file	Best-efforts
Access point	1	Access point	Wire/wireless	FTP file	Best-efforts
Server	1	Server	wire	FTP file	Best-efforts
Mobile node	24	Wlan_wkst_adv	wireless	FTP file	Best-efforts
Application	1	Application definition	----------	FTP file	Best-efforts
Profile	1	Application profile	----------	FTP file	Best-efforts
QOS	1	IP QOS	----------	FTP file	Best-efforts

Table 2. The Configurations of Network Simulation

	queue process	Max queue size	Weight	Min Threshold	Max Threshold
Scenario1	FIFO	30	9	100	200
Scenario2	FIFO	30	9	5	15
Scenario3	FIFO	30	12	5	15

When we run this heterogeneous network to transfer the (FTP) file between client and server, the bottleneck appears between routers, the RED and WRED strategies are activated. We adopt OPNET to demonstrate the effectiveness of the RED/WRED strategies in different networks, and to achieve the QoS. The scenarios are configured, and each scenario is built asdifferent QoS strategy. The different QoS design for each scenario is shown in Table 2.

There are three different scenarios considered in our simulation:

a. Scenario 1 (normal demand): is an application without the use of any strategy.
b. Scenario2 (RED): is an application with RED strategy.
c. Scenario3 (WRED): is an application with WRED strategy.

With the size of package (500000) bit\sec and with exponential 0.5.To measure the result in the simulation, we need to define the following four important parameters in our simulation:

a. ***Queue delay:*** It is the job time which it waits in a queue until it can execute, this term is almost used in reference to routers, which it also refers to the time spends in the router to processed and transmitted.

b. Buffer usage: The routers' buffer is an important parameter to effect on the QoS of the network services under certain conditions, since it may modify some traffic characteristics, as delay or jitters, and may also drop packets.

c. ***Throughput:***This term is used to measure the performance of a network, and it is the number of packets successfully delivered per unit time.

d. ***Utilization***: (High efficiency in utilization of network resources), this term is used to host a larger amount of traffic on the different networks, thus lowering the operation cost and being the foundation for hosting the exponential growth of modern networks.

4. Simulation Results

Figure 3 below shows that a point to point queueing delay and we can note that the curve of WRED is lower than RED and new demand (the networks without RED and WRED strategies), which it means theWRED strategy is better than RED, and it is a good strategy to activate it with a queue to reduced queuedelay.

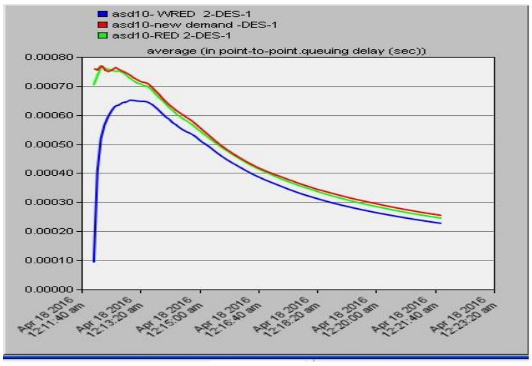

Figure 3. Average Point to Point Queuing Delay

The buffer usage can be defined as the rate of used space in thequeue, the less space used in thequeue is better because it increases the performance of thenetwork.The average of FIFO buffer usage is high in new demand than RED and WRED respectively as shown in Figure 4 below, that it means the WRED takes small spaces in buffer comparing with others.

The average point to point throughout (bits/sec) is high in WRED strategyif we compare it with the RED and new demand as shown in Figure 5 below.

Figure 6 shows the comparison among RED, WRED and New demand with respect to the point to point utilization, and it is also clear that WRED gives the better network performance than others strategies.

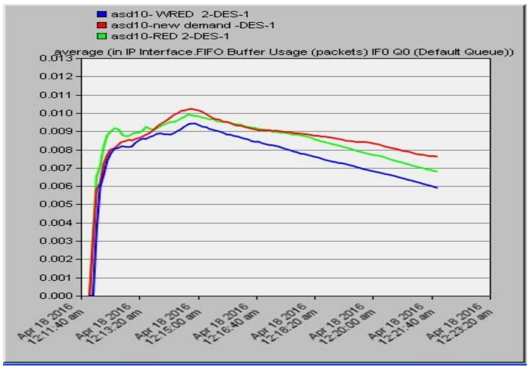

Figure 4. Average FIFO Buffer Usage

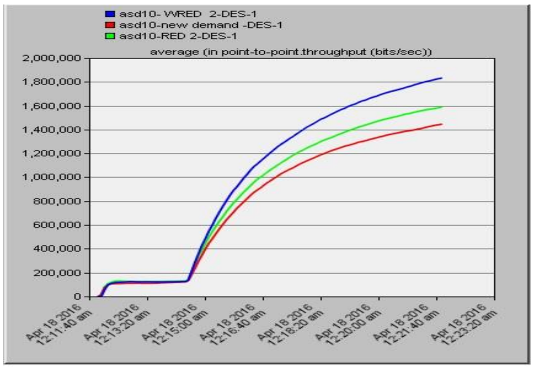

Figure 5. Average Point To Point Throughput (bit/sec)

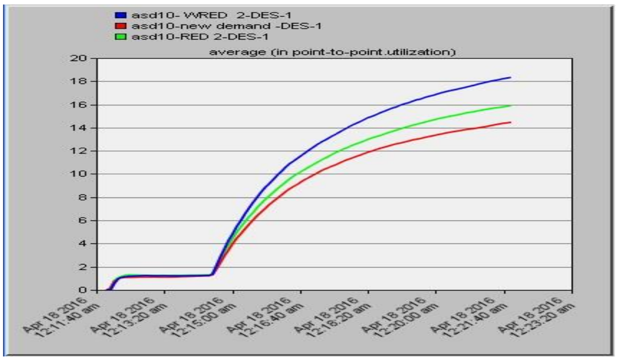

Figure 6. Average Point to Point Utilization

Finally, through these OPNET simulation results we can get a new strategy to work with theheterogeneous network, since we test the all important factors for the indication of the efficiency of theheterogeneous network and we may avoid major problems that reduce efficiency and performance of this network.

5. Conclusion

Through the results of this work, we conclude that our proposed approach can work with heterogeneous networks since the four performance parameters (queue delay, buffer usage, throughput and utilization) are investigated and enhanced in the heterogeneous network and they are leading to improve the overall network performance. The results of our experiments show that the queue delay is high if we don't use RED or WRED strategies and it is less in RED and more less in WRED which it means the WRED strategy is better for reduced the queue delay. Then we can conclude that the buffer usage behaves better at WRED strategy than others in reserved memory space, which it means providing a safe area more than the rest strategies.Also we can conclude that the throughput and utilization of the WRED strategy are higher than the other strategies, since we achieved and succeed to reduce network congestion and then transferring FTP file becomes more easily and more quickly.

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