RED, GRED, AGRED CONGESTION CONTROL ALGORITHMS IN HETEROGENEOUS TRAFFIC TYPES

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ABSTRACT. There are several Active Queue Management algorithms (AQM) exist to deal with the congestion at the router buffer such as RED, DRED, BLUE, AGRED. This paper presents an analysis of RED, GRED and AGRED algorithms with three different Traffic distributions which are Exponential distribution, Geometrical distribution and ON-OFF model using simulation. The performance metric used to show the analysis of these algorithms with mentioned distributions is Packet Loss (Pl). Results of simulation show that each algorithm performed a fair dropping of data packets without considering of their types.

Keywords: Active queue Management, queue congestion control, traffic distribution, packet loss, quality of service

INTRODUCTION

There are various active queue management algorithms proposed to overcome congestion issue such as Random Early Detection (RED), Gentle Random Early Detection (GRED), and Adaptive Gentle Random Early Detection (AGRED) for TCP/IP networks since last two decades (Zhu et al., 2002).Congestion happens at the router buffer when incoming requests (Packets) exceed the available network resources (router buffer). Network congestion increases queuing delay, packet loss and it degrades the throughput (Hosam, 2009).

RED is well known AQM algorithm which was proposed by sally Floyd and Van Jacobson in 1993 to deal with congestion (S. Floyd & Jacobson, 1993).In RED average queue length (apl) which is calculated using a low pass filter with Exponential Weighted Moving Average (EMWA), is used to make the decision regarding dropping a packet.

Stabilized RED (SRED) is another variant of RED which was developed by Ott et al. in 1999 (Ott, T.V.Lakshman, & Wong, 1999). Dropping policy of SRED dependent on load probability based on the instantaneous queue length and number of flows. The buffer utilization in the proposed algorithm is stabilized without concerning the load level (Ryu, Rump, & Qiao, 2003).

In (Sally Floyd, 2000), Gentle Random Early Detection (GRED) was proposed in order to increase throughput and reduce the undesired oscillation in buffer size of router by enhancing parameter settings of RED. GRED was evaluated using same simulation as it used in RED. In (Sally Floyd, Gummadi, & Shenker, 2001) authors proposed adaptive parameter setting for RED based on the traffic load. In Adaptive Random Early detection (ARED), packet dropping decision is based on parameter setting of max probability. Although ARED provides the advantage of automatic parameter setting in response to changes of traffic but it lacks the

clarity regarding best policy of parameter setting (Hosam, 2009). GRED proposed to deal with RED issues but still packet loss rate is high in GRED. Adaptive Gentle Random Early Detection (AGRED), proposed by (Mahmoud Baklizi, Hossein Abdel-jaber, 2012) to deal with packet loss issue in GRED. AGRED modified the calculation of dropping probability formula and was evaluated using simulator developed in java programming language. Geometrical distribution was used for packet generation purpose in AGRED simulation environment.

The design of robust and reliable networks and network services is becoming increasingly difficult in today's world. The only path to achieve this goal is to develop a detailed understanding of the traffic characteristics of the network (Chandrasekaran, 2009). There exists several type of traffic distributions such as Exponential, Geometrical, ON-OFF Model and etc., which each of them represent a traffic model in reality for example Exponential and geometrical traffic distributions represent text traffic and ON-OFF model represent audio traffic in reality.

This paper present an analysis of RED, GRED and AGRED algorithms with three mentioned traffic distributions. Analysis of algorithms with different traffic distributions can provide us information like link utilization, average load and packet loss which is our concern in this paper. Also we can analysis the behavior of the algorithms in the congestion and non-congestion situation to show how each algorithm treats each packet whether the packets are text or audio.

The rest of the paper is organized as following order. Three active queue management algorithms are discussed and analyzed in next section, after that simulation and its parameters are described in simulation section. In performance metric section, the measure used to evaluate the algorithms is presented and after that collected results by the simulation are presented and explained in results section. Finally at the end paper in concluded and a future work is given in conclusion and future work section.

RED, GRED AND AGRED DESCRIPTION

Random Early Detection algorithm detects incipient congestion at router buffer in preliminary stages. RED consists of two separate algorithms. The first algorithm is for calculating the average queue length (aql) which is calculated based on the following formula:

$$aql = aql \times (1 - qw) + qw * queueSize \qquad (1)$$

where qw is queue weight and queueSize is instantaneous queue length.

The second algorithm is for calculating the packet marking probability which defines how frequently the gateway marks the packets at given current level of congestion(S. Floyd & Jacobson, 1993). The formula for calculating the dropping probability is shown as follow:

$$Dp = Dinit / (1 - C * Dinit) \qquad (2)$$

Where C is a counter that represents the number of packets arrived at router buffer and has not dropped since the last packet was dropped and Dinit which is the initial packet dropping probability is defined as follow:

$$Dinit = Dmax + [(1 - Dmax) * (aql - max. threshold) / max.threshol] \qquad (3)$$

RED decides to drop a packet with comparison of calculated aql with two thresholds which are min threshold and max threshold as represented in figure 1. If the aql is smaller than min threshold no packet will be dropped and no congestion has occurred yet and it

continues to add packets to the queue. if the aql is bigger than max threshold, a sever congestion occurred and every arriving packet will be dropped with Dp = 1. And if aql is between the min threshold and max threshold RED needs to calculate the Dp in order to add or drop packet.
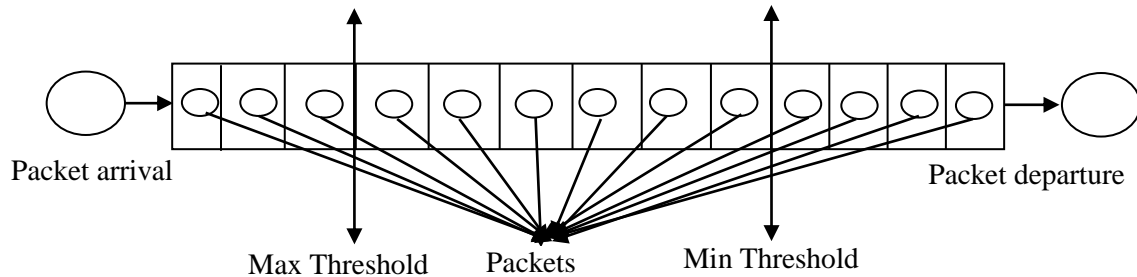
Figure 1. Single router buffer for RED

GRED process is almost same as RED but the main difference is in parameter setting in order to be optimized and have a better performance regarding to Packet loss and throughput. In GRED another parameter was introduced namely, Double max threshold which is illustrated in figure 2.

As mentioned in introduction AGRED tries to overcome high packet loss issue in GRED. This issue was settled with modification in calculation of initial dropping probability (Dinit) in the situation if aql is between max threshold and Double max threshold which is presented in Eq. (4).

$$Dinit = Dmax + \{[(1 - Dmax) / 2]* (aql - max. threshold) / max.threshol \} \qquad (4)$$
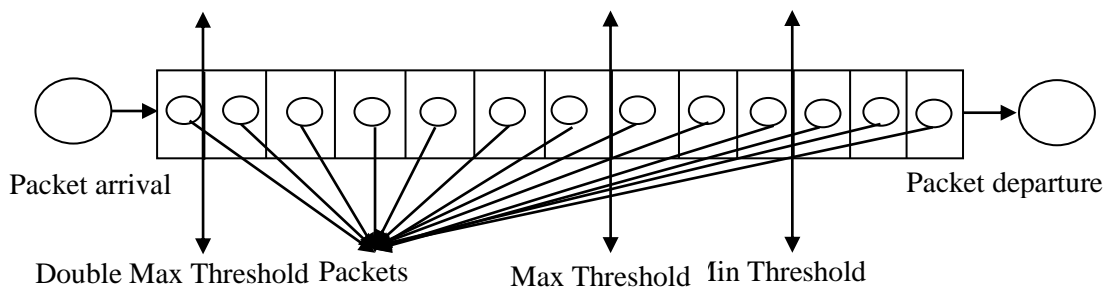
Figure 2. Single router buffer for GRED and AGRED

SIMULATION

This section describes our simulator which is used to analysis of RED, GRED and AGRED algorithms with three traffic distributions which are Exponential, Geometrical and ON-OFF model. In this paper three algorithms simulation are implemented using java programming language. The parameters used in the simulation are illustrated in table 1 which is derived from (Mahmoud Baklizi, Hossein Abdel-jaber, 2012). The three algorithms simulated with single node, single queue and single source.

Table 1. Simulation Parameter

	Parameter	Value
a.	Queue size	20
b.	Simulation end time	2,000,000
c.	Mean inter arrival time	0.18,0.33,0.48,0.63,0.78,0.93
d.	Mean service time	0.5
e.	Min threshold	3
f.	Max threshold	9
g.	Double max threshold	18
h.	The maximum value of dropping (D_p)	0.1
i.	Queue weight	0.002

Each algorithm with each traffic distribution run six times based on the mean inter arrival times. Mean inter arrival time define the rate of incoming packets to the queue and is intended to create non-congestion and congestion situations.

PERFORMANCE METRIC

In computer network performance metrics such as throughput, delay, packet loss are measures used to evaluate and assess given algorithm, model or framework. In this research the performance metric has been used to evaluate the simulator is packet loss (Pl). Packet loss happens when one or more packets fail to reach destination while travelling across computer networks. In this paper packet loss is calculated based on the following formula:

$$Pl = nap - ndp \qquad (5)$$

Where nap is number of arrived packets and ndp is number of departed packets.

RESULTS

This section presents the results for RED, GRED and AGRED algorithms with Exponential, Geometrical and ON-OFF model. The results are shown using diagram which is presented in figure 3.

Figure 3 illustrates packet loss rate for each algorithm with regards to mentioned traffic distributions. Packet loss rate for AGRED is less than the GRED due to the modification of Dinit which has increase Dinit value .Packet loss rate for GRED is less than the RED because a new parameter was introduced which Double max threshold.

The result from figure 3 also shows, there is no significant difference in packet loss rate using Exponential, Geometrical and ON-OFF model for each algorithm since each algorithm fairly drop all packets when queue get congested without considering their types.
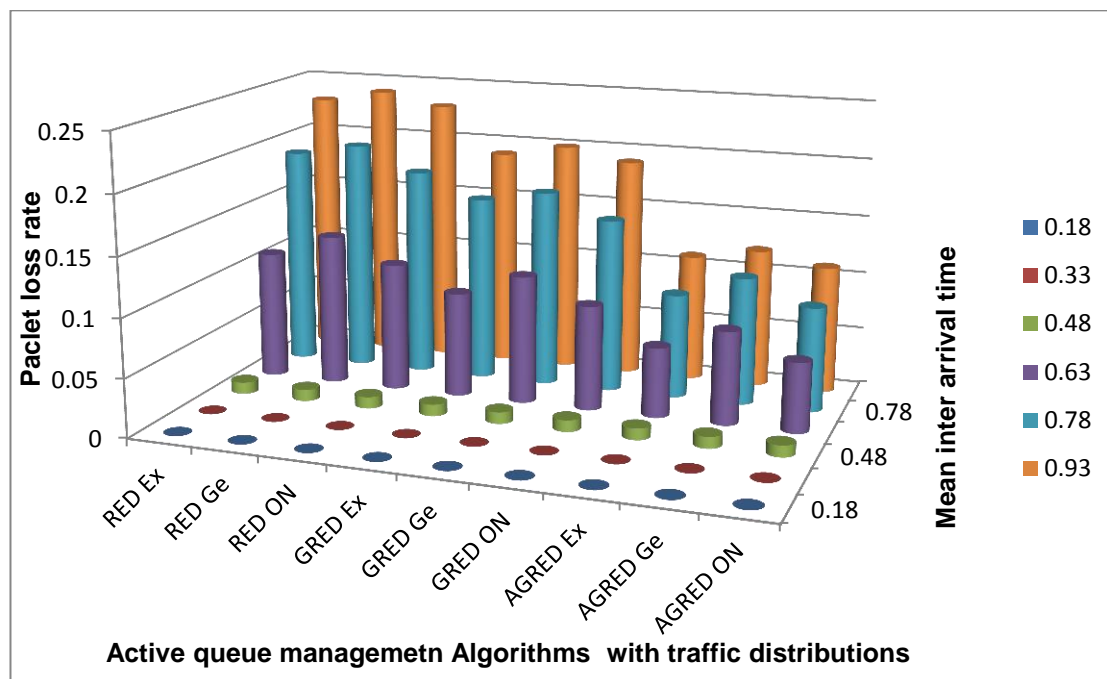
Figure 3. Packet loss results for six packet arrival rates with three traffic distributions

CONCLUSION

This paper has analyzed three active queue management algorithms which are RED, GRED and AGRED with three traffic distributions such as Exponential, Geometrical and ON-OFF model. As mentioned before, each traffic distribution represents a traffic model in reality. Regardless of type of incoming packets, the simulation result for each algorithm showed a fair dropping of data packets. AGRED outperformed GRED algorithm due to modification in packet dropping probability formula and it also outperformed RED algorithm by taking into account Double max threshold.

For future work, we plan to evaluate the performance of RED, GRED and AGRED algorithms on priority basis due to delay sensitive nature of multimedia in order to satisfy required quality service constrain.

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