International Journal of
Advances in Scientific Research and Engineering (ijasre)

E-ISSN : 2454-8006

DOI: 10.31695/IJASRE.2019.33123

Volume 5, Issue 3
March-2019

Internet Congestion Control Protocol in a Complex Network

Akani Okemeka Machiavelli[1] and Dr.Ugochukwu Kamalu[2]

PG Scholar[1] and Senior Lecturer[2]

[1-2]Department of Electrical and Electronics Engineering

Faculty of Engineering

University of Port Harcourt

Rivers State, Nigeria.

ABSTRACT

Congestion control on the internet is a major function of the transmission control protocol (TCP). One major algorithm that works well with the TCP and supports its proper functioning is the Active Queue Management (AQM) Algorithm of which the Random Early Detection (RED) Architecture is a subset of. The RED architecture focuses on stabilizing the queue length, ensuring fairness in link flows and notifies the sources when congestion begins. This paper proposes a novel RED architecture called 'Timed Out RED' simulated and modelled with SimEvents which manages the queue length using timeouts to limit packet queuing time as the measure of controlling congestion in a complex network.

Keywords: *Congestion Control, RED, AQM, Timed Out RED, SimEvents.*

1. INTRODUCTION

The internet network today has developed with increased complexity due to the integration of mobile communications, satellite, fibre-optics etc. All these complexities have led to large bandwidth delays which degrades the quality of service[3][4]. In feedback dependent congestion control systems, longer delays are experienced which implies that the congestion notice from the receiver will take longer to reach the receiver and in this time frame, the sender has sent more packets into the system which worsens congestion. Traffic jams and network congestion share a lot of similarities [1]. The complexity of the internet today as with VOIP, online gaming and various social media platforms for real-time communication aids the internet congestion issue [3].

Internet networks try to manage transmission of packets between a sender and a receiver via flow control mechanisms ensuring amount of packets sent are not too much for the receiver to handle and also attempts to reduce bottlenecks by managing length of queues [2].

In most routers which serve as gateways for internet traffic by switching packets and connecting several sources to their destinations, there exists a queuing system. Traditionally, most routers employ the tail drop Algorithm which detects congestion only when the queue is full and packets deemed to be excess are dropped before the sender is notified of congestion [2]. The tail dropping algorithm is a passive queue management algorithm and also introduces significant delays in the network, therefore its considered to be less efficient [3]. A more efficient algorithm is the Active Queue Management algorithm which RED is a subset of. The RED Architecture uses FIFO (first in-first out) to enhance the performance of the network, it manages the queue length and ensures fairness in packet flow by servicing each packet based on time of arrival and informs the sources earlier before even congestion occurs[4].

2. DESIGN CONSIDERATIONS

The tail dropping algorithm and use of feedback control mechanisms introduce significant amount of delays in the network which in turn makes the sender to send more packets to the receiver before an ACK notifying congestion is received [5]. As a measure to control the queue length and reduce the system delay, most packets already queued for too long has to be timed out to make room for new packets to get queued and the timed out packets re-sent by their senders after receiving a notification.

This novel RED algorithm, the Timeout RED ensures;

1. Fairness among flows by timing how long an enqueued packet can stay in the buffer.
2. Proper queue length management by protecting the network from being unnecessarily overloaded due to extensive bandwidth-delay product.

It is based on the behaviour of human beings to become impatient with long queues and leave to return at a later time, thereby creating space for new persons to queue [9].

In order to achieve the Timeout RED architecture some factors were considered which are;

a. The desired average queue length has to depict a balanced trade-off between utilization and delay.

b. The desired queue length should be between minimum and maximum threshold when congestion occurs.

c. To manage queue length, packets should be timed out before queue gets to maximum threshold where queue is full and the time out of packets continues even after queue is full.

d. The service Order is based on FIFO and the service times and inter arrival times are mutually independent.

3. RED

This is a type of AQM that maintains small queue lengths in the internet network whose principle of operation depends on informing the sources of high congestion levels by marking packets when the average queue length is large [6], the probability of marking is commensurate with the intensity of congestion[8].

Mathematically,

Marking probability at the link is determined by;

$$f(y_{av}) = \begin{cases} 0, & if\ y_{av} \leq Y_{min} \\ K(y_{av} - Y_{min})\ if\ Y_{min} < y_{av} \leq Y_{max} \\ 1, & if\ y_{av} > Y_{max} \end{cases} \text{-----------------(1)}$$

Where;

y_{av}= link average queue length

K = constant

Y_{min}= minimum threshold which equates the dropping probability to null when average queue length is less than Y_{min}

Y_{max}= maximum threshold which equates the dropping probability to one when average queue length is greater than Y_{max}.

The average queue length is obtained as follows using a weighting process.

$$y_{av}(t+1)=(1 - \frac{1}{\epsilon_l})\, y_{av} + \frac{1}{\epsilon_l}y(t)\text{--(2)}$$

Where; y(t) is the queue length at the time t.

The queue dynamics is given by

$$y=(a-C)_y^{+}\text{---(4)}$$

Where; a= arrival rate at the link

C= capacity of the link.

The reactiveness of the average queue length depends on C[8].

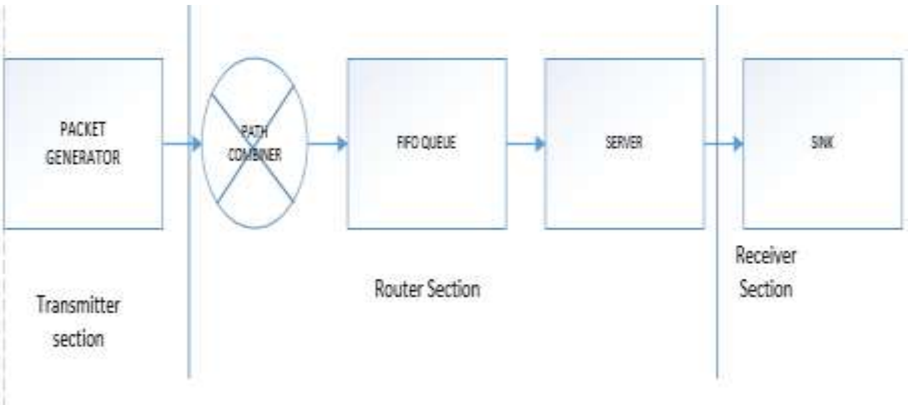

Figure1. Block diagram for RED

DOI: 10.31695/IJASRE.2019.33123

4. TIMEOUT RED ARCHITECTURE IN SIMEVENTS

This is an enhancement of the RED architecture; it helps improve the congestion issues by timing out packets that have stayed too long in the queue by assigning equal waiting times to packets as they enter the queue. It is a router based congestion control architecture.

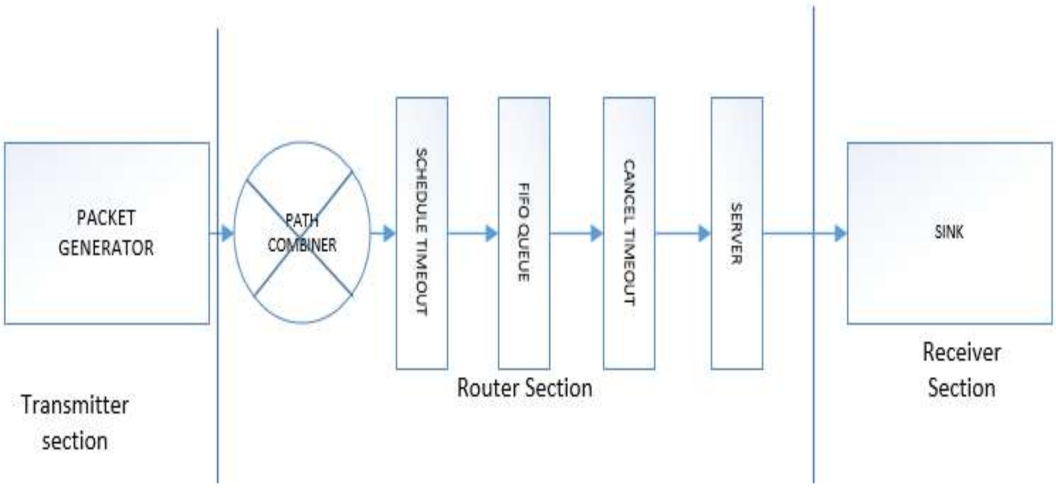

Figure 2 block diagram for timed out RED

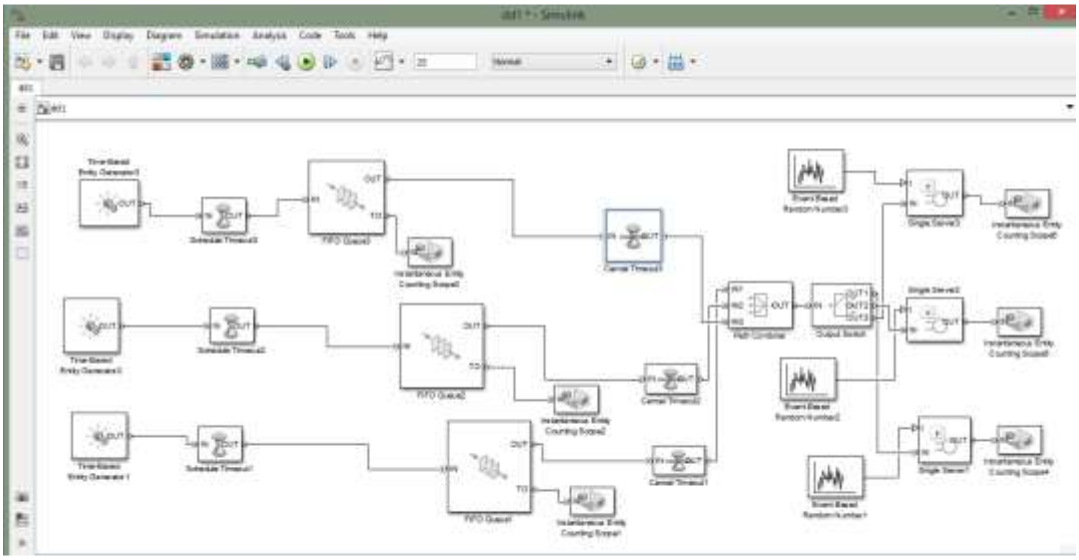

Figure 3. simevents simulation of timed out RED

4.1 Block libraries used for Timeout RED simulation are;

Time based entity generator: Generates packets according to particular distribution based on settings.

Scheduled timeout: Assigns specific time to packets which times out the packet if it has not been serviced before its assigned time frame elapses.

FIFO Queue: Enqueues packets in the order which they arrive and notifies the senders early when congestion starts.

Instantaneous entity counting scope: This block takes record and plots the number of timed out packets.

Cancel timeout: Cancels the assigned time if the packet gets serviced before it runs out.

Path combiner and Output switch: helps to route packets from FIFO block to the server.

DOI: 10.31695/IJASRE.2019.33123

Server: services the packets and sends an ACK to the sender after servicing a packet.

Event based random number: used to generate random numbers based on preferred distribution

5. SIMULATION AND RESULT ANALYSIS

5.1 Simulation Parameters

Table1. parameters and their values

Capacity/ Queue length	25
Interarrival time of packets	Random
Simulation Time	20 seconds
Scheduled Timeout	0.05 seconds
Mean service time	0.15 seconds

Packets are generated at an exponential rate following a Poisson distribution, which makes the intergeneration time between two successive packets random. On a simulation time of 20s, 121 packets were randomly generated

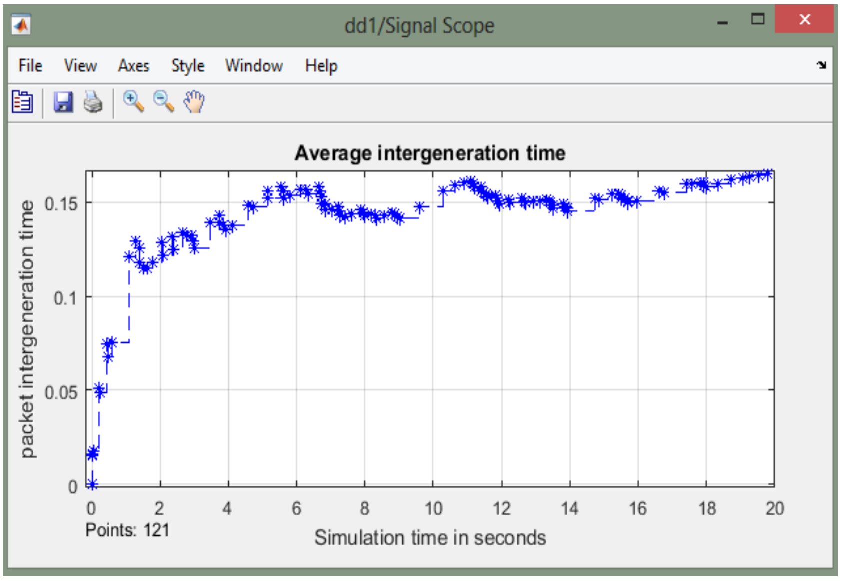

Figure4. Random packet generation

A typical analysis of the performance of timeout RED in a complex network is explored in the following section.

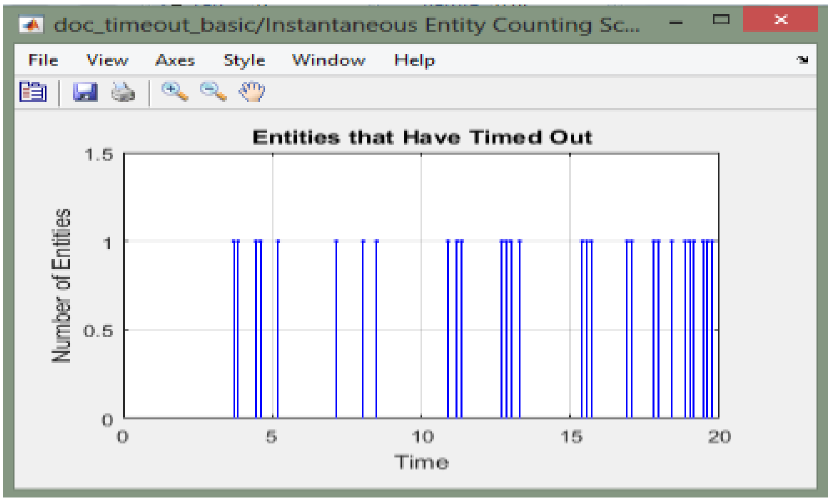

Figure5. Shows timed out packets/entities

DOI: 10.31695/IJASRE.2019.33123

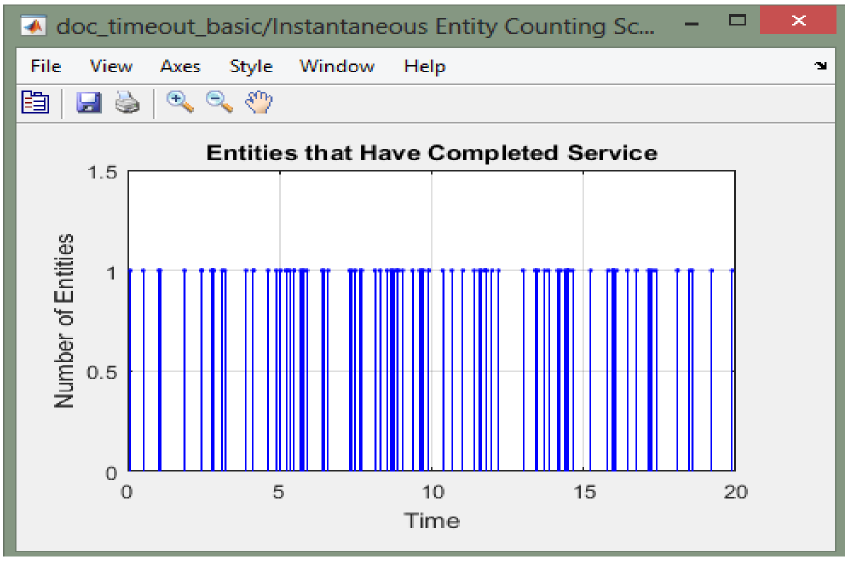

Figure6. Shows packets/entities well serviced

From figure5, timed out packets was observed to be 50 at a scheduled timeout interval of 0.05secs for each arriving packet based on 20 seconds simulation time while figure6 shows fully serviced packets at 105 at a service time interval of 0.15seconds and the arrival rate of the packets was random. It was further observed that increasing the mean service time to 0.5seconds reduced the number of serviced packets to 50 and increased the number of timed out packets to 64. This implies that a good balance is required between the mean service time and the scheduled timeout which controls the inflow or arrival rate of packets.

5. CONCLUSION

In this article, we were able to show a queue length based management congestion control architecture, which is an enhanced RED Architecture with additional feature of timing out packets. From the results obtained it can be concluded that simevents makes a notable impact in network design although it doesn't have enough supportive features for all algorithms. By developing the TIME OUT RED algorithm, we analyzed the performance of a congestion control scheme which proved to be sufficient in complex network applications where bandwidth delays cause extra packets to be sent to the router during early congestion notification. Our novel algorithm provides an extra layer of protection in such cases.

REFERENCES

1. Feisheng Yang,Jing Wang and Jing He, "Improved Internet congestion control design based on Smith predictor," *IEEE PROCEEDINGS*, *Chinese Automation congress*, vol. I, pp. 1315-1319, 2017.

2. Lu Guang, Luo Guoming, Zeng Fan, Pan Jia, "Study on Congestion Control in Internet," *International Conference on Networking and Digital Society*, vol. 1, pp. 290-293, 2010.

3. Alaa A. Alsebae, Student Member, IEEE, MAlaa A. Alsebae,Mark S. Leeson and Roger J. Green , "SimEvents-based Modeling and Simulation Study of Stop-and-Wait Protocol," *IEEE Transactions on information and computing*, vol. I, pp. 239-244, 2013.

4. Ling Su, Rong Zheng and Jennifer C. Hou, "An Active Queue Management Scheme for Internet Congestion Control and Its Application to Differentiated Services," *IEEE Transactions*, vol. I, pp. 62-68, 2000.

5. Seungwan Ryu, Christopher Rump and Chunming Qiao, "Advances In Internet Congestion Control," *IEEE Communications Surveys & Tutorials*, vol. 5, no. No.1, pp. 28-39, 2003.

6. S. Varma, Internet Congestion Control, New york: Morgan Kaufmann is an imprint of Elsevier, 2015.

7. Ming Yan, Yuanwei Jing, Yaliang An, "Congestion Control over Internet with Uncertainties and Input Delay Based on Variable Structure Control Algorithm," *Proceedings of the 2007 IEEE International Conference on Mechatronics and Automation* , vol. II, pp. 1788-1793, 2007.

8. R. Srikant, The Mathematics of internet congestion control, Illinois, USA: Springer-Science+Business Media, LLC, 2004.

9. Wuyi Yue, Yutaka Takahashi and Hideaki Takagi, Advances in Queueing Theory and Network Applications, tokyo: springer, 2009.

10. Sim events; getting startedguide, MATLAB AND SIMULINK. © COPYRIGHT 2005–2015 by The MathWorks, Inc.

DOI: 10.31695/IJASRE.2019.33123