Effective Congestion Indication for Performance Improvement of Random Early Detection

Kiran Chhabra, Manali Kshirsagar, A. S. Zadgaonkar

Abstract ***: A congestion avoidance scheme allows a network to operate in the region of low delay and high throughput. Such scheme prevent a network from entering in to congested state. RED(Random Early Detection), is one such congestion avoidance mechanism used for effectively control of congestion. In RED, router uses only the average queue size, as a congestion indicator and the average queue length is insensitive to input traffic load variation. Due to this effective incipient congestion becomes difficult to detect and there is no matching between current queue size and average queue size as in [4]. The present paper deals with these two problems and proposed a way in which packet dropping is not only based on average queue size but also on the rate of change of input. The work which is carried out is to find out significant changes in input rate and use this climbing rate as indication of impending congestion for sources to react quickly. Here we have analyzed the performance of our proposed algorithm using network simulator ns2.***

Keywords: Average queue size, Congestion Avoidance, Network Simulator (ns), Random Ear ly Detection (RED).

I. INTRODUCTION

Internet congestion occurs when the aggregate demand for a resource (e.g. link bandwidth) exceeds the available capacity of the resource. Resulting effects from such congestion include long delays in data delivery, wasted resources due to lost or dropped packets and even possible congestion collapse in which all communication in the entire network ceases as in [1]. Congestion occurs in data transmission path in the intermediate nodes, so we need to solve the network congestion problem by applying the congestion control solution in the intermediate nodes. The node congestion is often caused by buffer overflow queue, so the node queue management becomes the key for suppression of network congestion. The management of queue on the node is called Active Queue Management (AQM) mechanism.

Random Early Detection (RED) was first proposed AQM mechanism and is also promoted by Internet Engineering Task Force (IETF) as in [2] . Random Early Detection (RED) was introduced in 1993 [3] by Floyd and Jacobson and then many variants were also proposed RED [3] is most well known AQM algorithm. It averages queue length avg_i by using an exponential weighted moving average (EWMA) and calculate drop probability by applying a linear mapping function.

Manuscript published on 30 July 2013.
*****Correspondence Author(s)
Kiran Chhabra : Associate Professor and Research Scholar, .Computer Science and Engineering, MM College of Technology, Raipur(C.G.) India.
Dr. Manali Kshirsagar : Professor, Computer Technology, Yashwantrao Chawan College of Engineerng, Nagpur(M.S.) India.
Dr. A.S. Zadgaonkar, Vice Chancellor, Dr, C, V. Raman University, Kota, Bilaspur (C.G.), India.

The mapping function has three parameters two queue length threshold min_{th} and max_{th} and maximum drop probability P_{max} . Equations are given below, here w_q is queue constant and q_i is actual queue length.

$$avg_{i+1} \leftarrow (1 - w_q)avg_i + w_q q_i \quad (1)$$

$$P_b \leftarrow P_{max}(avg - TH_{min})/(TH_{max} - TH_{min}) \quad (2)$$

Available queue length in the operation range [min_{th},max_{th}] is linearly mapped to a drop probability in the range [0,P_{max}]. Below min_{th}, , packets are not dropped and above max_{th}, they are always dropped. Stochastic drops allow RED to avoid global synochrinization and bias against bursty traffic when used in conjunction with TCP based flows. Though RED outperforms Drop Tail in terms of average queue length and loss rate, it is not widely deployed because some weaknesses like hard setting of parameters, unstable behavior during bursty traffic, insensitivity to the input traffic load variation, mismatch between current queue length and average queue length as in [4].

According to the metrics used to measure congestion, AQM schemes can be classified into three catalogs : queue-based, rate based, and schemes based on concurrent queue and rate metrics. In queue based schemes, congestion is observed by average or instantaneous queue length and the control aim is to stabilize the queue length as in [6-13]. The drawback of queue-based schemes is that a backlog is inherently necessitated. Rate- based schemes accurately predict the utilization of the link, and determine congestion and take actions based on the packet arrival rate as in [14-19]. Rate-based schemes can provide Early feedback for congestion. Other AQM schemes deploy a combination of queue length and input rate to measure congestion and achieve a tradeoff between queues stability and responsiveness as in [20-23].

The paper has been organized in the following manner, section 2 gives the proposed work, section 3 deals with working of the proposed algorithm, section 4 gives simulation results and section 5 deals with conclusion and further scope and final section gives all the references made in completing the present work.

II. PROPOSED WORK

In RED, during the calculation of average queue length using EWMA filter, the changes in average queue length (macroscopic behavior that is long term) does not match with actual or instantaneous queue length (microscopic behavior that is short term). Changes in average queue length are slow due to w_q and changes in actual queue length are fast according to traffic of input burst of packets.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

This causes delay in prediction of incipient congestion or this congestion indicator is not only the sufficient one to tell about incipient congestion. This causes many oscillation in queue length in bursty traffic.
The basic idea behind the proposed work is as follows :
Here congestion indication is done based on both average queue size and elevated input rate. We are calculating climbing rate of input and depending on that dropping of packets is done earlier compare to RED. By earlier informing senders, routers could decrease packet drop rate. In other words, method informs senders by dropping packets earlier at the time of input rate climbing, it can avoid dropping a number of packets later. This method will help to make queue dynamic stable also.
We have implemented our approach by making minimal changes to original RED algorithm while leaving basic idea intact, and then evaluated its performance using different simulations.
The proposed algorithm as shown in figure 1 and we have named it ***ISRED*** that is ***Input Sensitive Random Early Detection.***

III. WORKING

1. Comparison of input rate value with slope threshold value indicate whether there are significant changes in input rate that is sudden rise in input traffic (heavy burst of packets). Here the slope threshold value is taken constant and value is approximately 80% of buffer size
2. Packets are dropped earlier if the input rate is climbing high and senders are notified earlier to reduce their sending rate.

IV. SIMULATION RESULTS

We implemented the proposed scheme using network simulator ns-2[5] to evaluate the improvement. Network topology is shown in figure 2. Two FTP sessions randomly start in between 0 to 0.1 Sec. and last to the end of simulation i.e. 30 Seconds. In middle of simulation another m FTP session would randomly start in between 10.0 to 10.1 Seconds and last to the end, which is to simulate change of network condition (to show input load variation). TCP Reno is used for all simulations, the mean packets size is 500 for TCP and both AQM methods. Parameters used are : $max_{th} = 15$, $min_{th} = 5$, $max_p = 0.1$, $w_q = 0.002$, slope = 25, qsize = 30.
Various Graphs are plotted here for m = 30 sources to show the improvement of proposed method.

Initialization
pavg←0
ptime←ctime
for each packet arrival
pavg←avg
if(avg>min$_{th}$) /* average queue size exceeds minmum .threshold */
{\

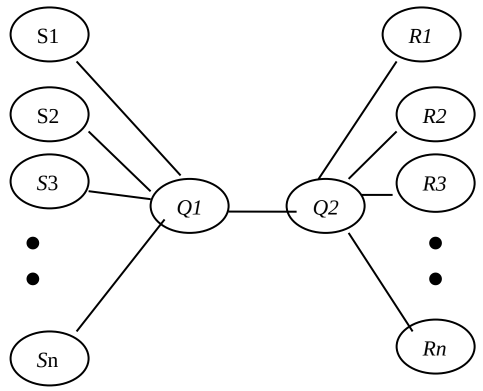
$$Rate \leftarrow \frac{avg-pavg}{ctime-ptime}$$

if (Rate > slope) /* checking for high input rate */
{ edrop( ) /* procedure to drop packets earlier */
}
else
{ drop( ) /* use the same formula as RED */
}
ptime← ctime

Variables:

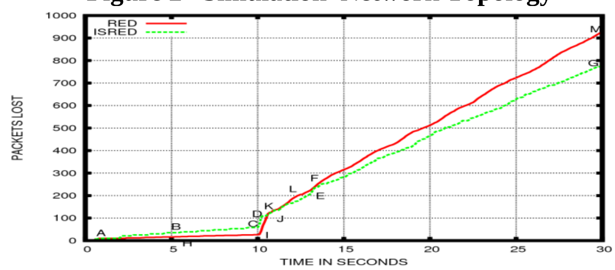
avg : average queue size (current sample)
pavg : average queue size (previous sample)
ptime : previous sampling time
ctime : current samoling time

Figure 1 ISRED algorithm



S1,S2,,R1and R2 have bandwidth of 2Mb and delay of 10 ms
S3 to Sn and R1 to Rn have bandwidth of 10Mb
S3 to Sn and R3 to Rn have delay from 14 to 15 ms
Q1 to Q2 have 20ms delay and bandwidth 0.7Mb

Figure 2 Simulation Network Topology



Fiigure 3 Packet Loss Ratio

Figure 3 shows a graph plotted between packets lost against time in seconds for both RED and ISRED. Initially number of packets loss(Points A to C) is more in case of ISRED but as sources increase their sending rate, packets lost are less compare to RED (Points I to M and Points D to G). This graph show the improvement in packet loss ratio in case of ISRED compare to RED.

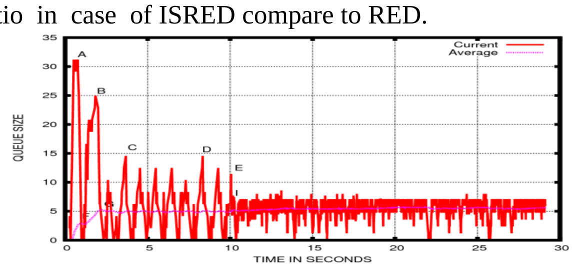


Figure 4 Queue Size Variation

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-3 Issue-2, July 2013

Figure 4 is graph which shows the variation of current and average queue size in case of ISRED.
This graph shows that during entire simulation queue overflows occurs only once shown by point A. At time 10.0 second there is heavy load of packets indicating high climbing of input rate which causes prior losses and earlier informing to senders to reduce incoming rate which is shown by point E onwards. Leaving Transient phase of congestion, there is a correspondence between current and average queue size which moves ISRED towards stable behavior

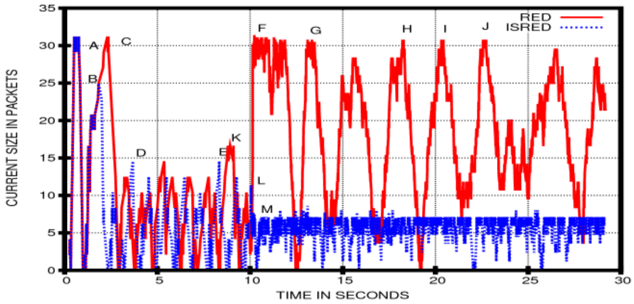


Figure 5 Current Size Variation

Figure 5 shows variation in current size for both RED and ISRED. Current size of buffer also decides loss of packets due to overflow as in this case every incoming packet is lost. From the graph it is clear that overflowing of buffer is there initially for both cases indicated by points A & C but after ward during congestion overflowing of buffers in RED is there lot of times indicated by points F,G,H,I, but there is no overflowing in case of ISRED,

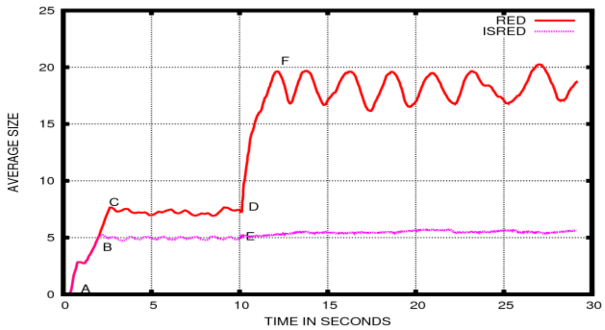


Figure 6 Average Queue Size Variation

Figure 6 shows average size variation for both cases and it depicts that in heavy congestion also the behavior of ISRED is more stable compare to RED.

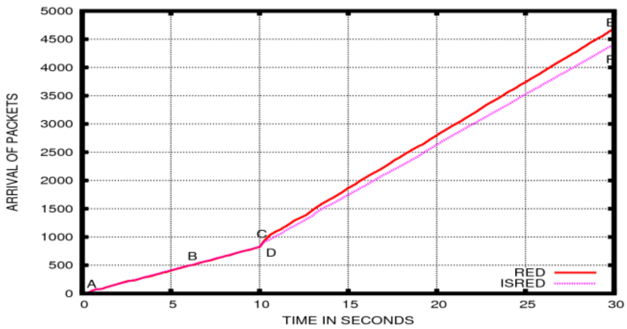


Figure 7 Arrival Rate of Packets

Figure 7 shows arrival of packets for both cases and initially it is same for both but from time 10.0 seconds onwards arrival of packets in case of ISRED is less compare to RED to show anticipation of congestion effectively.

Figure 8 shows that initially throughput of RED and ISRED is same but point E onwards IERED has more throughput compare to RED.

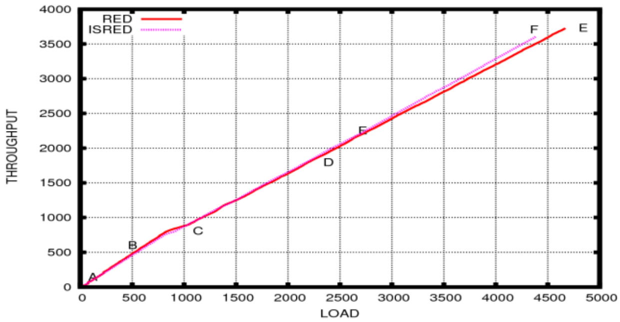


Figure 8 Throughput versus Load

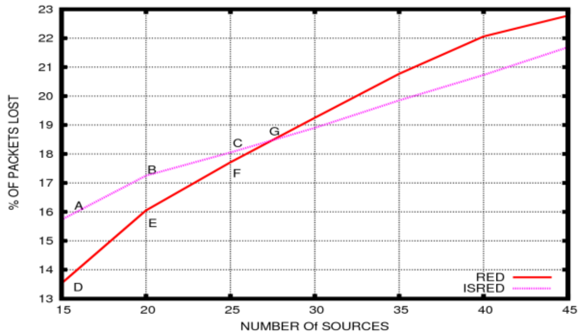


Figure 9 Performance Improvement

We have carried out simulation by varying number of sources from 15 to 45 and averaged 10 simulation for each case .These results are shown in Table 1 which also indicates ISRED outperform RED ,

Figure 9 is a graph plotted between percentage of packets lost against increasing number of sources. Points A to C and Points D to F shows initially when number of sources is less RED outperform ISRED . Point G onwards performance of ISRED is becoming better compare to RED.

Table 1 Various Simulation results

Number of sourcessr	RED			ISRED		
	Arrived Packets	Dropped Packets	% of loss	Arrived Packets	Dropped Packets	% of loss
15	4244	574.4	13.53	4027.6	633.8	15.73
20	4403.9	707.1	16.05	4114.2	710.1	17.25
25	4531.7	803	17.71	4229	763.66	18.05
30	4620.5	889.5	19.25	4321.6	817.2	18.9
35	4729.2	982.4	20.77	4420	877.5	19.85
40	4820.1	1063.4	22.06	4475.8	927.8	20.73
45	4854.5	1106	22.78	4531.9	983	21.69

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

V. CONCLUSION

1. Packet loss ratio decreases in case of ISRED compare to RED.
2. Insensitivity of RED towards input load variation is reduced a lot .
3. By making ISRED more sensitive to input load variation, overflowing of buffers is avoided which remove the possibility of penalizing new innocent packet from dropping on overflow of queue (buffer).
4. Congestion indication is done effectively which is indicated by decrease in arrival of packets.
5. There is correspondence between input current size and average queue size (mismatch behavior of input current size and average size decrease a lot)
6. There is less variation in average size due to which end to end delay is controlled.

In the future work a mechanism to tune slope threshold automatically based on the characteristic of length and dynamics of network condition would be investigated and comparison of ISRED can be analyzed with AQM techniques such as ARED and REM .

VI. ACKNOWLEDGEMENT

The Authors thankfully acknowledge to Dr. A. K Dubey, Principal Dr C. V. Raman University(Kota), Bilaspur, Dr. Shamita Chakraborty, Director MM College of Technology, Dr Ramesh Kumar Prof. Computer Science & Engineering, Bhilai Institute of Technology, Durg, Dr, Kamal Mehta, Prof. Computer Science & Engineering, S.R.I.T, Bhopal , Prof Mahesh Pawar, Yashwantrao College of Engineering, Nagpur for their valuable and motivational support to carry this research.

REFERENCES

1. P. Gevros, J. Crowcroft, P. Kirstein, and S. Bhatti, "Congestion *control* mechanisms and the best effort service model," IEEE Network, vol. 15, no. 3 pp 16-26, May 2001.
2. B. Braden, D. Clark, J. Crowcroft, B. Davie, S. Deering, D. Estrin, S. Floyd, V. Jacobson, G. Minshall, C. Partridge, L. Peterson, K. Ramakrishnan, S. Shenker, J. Wroclawski and L. Zhang **RFC 2309**: **Recommendations on Queue Management** in April 1998
3. S. Floyd and V. Jacobson, "Random early detection gateway for Congestion avoidance, "IEEE/ACM Transaction on Networking, vol. 1, no.4, pp.397-413, Aug. 1993.
4. Seunwan Ryu, Christopher Rump, And Chunming Qiao "Advances in Internet Congestion Control" third quarter 2003, Volume 5, No.1 http://www.comsoc.org/pubs/surveys,
5. "ns [network simulator]", 1999 [Online] Available http://www.isi.edu/nsnam/ns,
6. W. Feng D. D. Kandlur, D. Saha ," A Self Configuring RED gateway", Proceedings of IEEE INFOCOMM, 1999,Vol 3 pp 1320-1328
7. D. Lin R. Moris," Dynamics of Random Early Detection",,Proceedings of ACM SIGCOMM, October 1997
8. T. J. Ott, T. V, Lakshman and L. Wong, " SRED : Stablized RED" in IEEE INFOCOM, March 1999
9. Bing Zheng, Mogammed Atiquzzaman," DSRED: An Active Queue Management for Next Generation Networks" Proceedings of 25th IEEE conference on Local Computer Networks LCN 2000,November 2000.
10. S. Floyd., R .Gummadi, S. Shenkar,"Adaptive RED: An algorithm for Increasing the robustness of RED's active Queue Management",Berkely CA, [online] http:www.icir.org/floyd/red.html.
11. Jinsheng Sun, King-Tim Ko. Guanrong Chen. Sammy Chan, Moshe sukerman.,"PD RED : To Improve Performance Of RED", IEEE COMMUNICATIONS LETTER August 2003.
12. Tae-Hoo Kim., Kee-Hyun Lee" Refined Adaptive RED in TCP/IP Networks", IEEE ICASE, October 2006.
13. Jeong-Hwan, Seol,Ki Young Lee, Yoon Sik Hong " Performance Improvement of Adaptive AQM Using the variation of Queue Length", IEEE Region 10 Conference TENCON, November 2006.
14. Wu Chung Feng, Kang G Shin, Dilip D Kandlur, Debnanin Saha," .,"The BLUE Active Queue Management", IEEE ACM Transactions on Networking, August 2002.
15. A.Kamra, S.Kapila,V.Khurana, V.Yadhav H.Saran,"SFED: a rate control based active queue management discipline", IBM India research laboratory Research Report, available online from http://www.cse.iitd.ernet.in/srajeev/publications.htm
16. Srisankar S.Kunniyur., R.Srikant , " An Adaptive Virtual Queue [AVQ] for Active Queue Management"., IEEE/ACM Transactions on Networking, April 2004.
17. Cheng-Nian long., Bin Zhao., Xin-Ping Guan.," SAVQ : Stablized Adaptive Virtual Queue Management" IEEE Communications Letters ., January 2005,
18. Qian Yanping, Li Qi, Lin Xiangze, Ji Wei," A stable Enhanced Adaptive Virtual Queue Management Algorithm for TCP Networks", IEEE International Conference on Control and Automation,2007.
19. Chengnian Long., Bin Zhao, Xinping Guan., Jun Wang," The Yellow active queue management algorithm", Computer Networks, November 2004.
20. Athuraliya., D.E Lapsley., S.H Low" Random Exponential Marking for internet congestion control" IEEE Transactions on Network, June 2001.
21. Xidong Deng., Sungwon Yi., George Kesidis., Chita R.Das.," Stabilised Virtua Buffer [SVB] An Active Queue Mangement Scheme for Internet Quality of Service", IEEE Globecom November 2002.:
22. Jaesung Hong., Changhee Joo, Saewoong Bahk" Active queue management algorithm considering queue and load states", Computer Communications, November 2006.
23. Jinsheng Sun., Moshe Zukerman,." " RaQ: a robust active queue management scheme based on rate and queue length", Computer Communications, February 2007

AUTHOR PROFILE

Kiran Chhabra received her B.E. degree in Computer Science from Nagpur University in 1995 and M.E. in Computer Technology and Applications from Chhatisgarh Swami Vivekanand Technical University, Bhilai in 2009. She is pursuing Ph. D in Computer Science and Engineering in congestion avoidance area. Currently she is working as Associate Professor in Computer Science Department at MM College of Technology, Raipur.
Email: grk108@rediffmail.com

Dr. Manali Kshirsagar received her B.E. degree in Computer Technology from Nagpur University in 1992, M.E. degree in Computer Science and Engineering **from** Amravati University in 2001. She was awarded Ph. D in 2009 by Allahabad University for her work on Data Mining Strategy to Explore Cotton Genome. Currently she is working as Professor and Head of the Computer Technology department in Yashwantrao Chavan College of Engineering, Nagpur. She has many papers to her credit in various international journals, international conference and national conference Her areas of interest include Data Mining, Biometrics, Computer Networks. She is also member of professional bodies like MIE, ISTE, ACM.
Email : manali_kshirsagar@yahoo.com

Dr. A. S. Zadgaonkar, has obtained B. E. degree in Electrical Engineering from Pt.Ravishankar Shukla University, studying at Govt. Engineering College, Raipur in 1965. He obtained M. E. in 1978 from Nagpur University. His research paper for M. E. was awarded "Best paper" by the Institution of Engineers [India] in the year 1976 & 1977 respectively. The testing technique for quality of wood developed by him as included in ISI in 1979. He was awarded Ph. D. in 1985 by Indira Gandhi Kala & Sangeet University, Khairagah for his work on

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

"Acoustical and Mechanical Properties of Wood for Contemporary Indian Musical Instrument Making." He was awarded Ph. D. in 1986 by Pt. Ravishankar Shukla University on "Investigation of Dynamic Properties of Non-Conducting Materials Using Electrical Analogy." He has 47 years of teaching experience. He has published more than 500 technical papers in various journals, and National and International conferences. He has written Four Books on Engineering and Five on " Science and Technology in Indian Mythology. He is currently adding glory to the post of Vice Chancellor of Dr. C. V. Raman University, Bilaspur[Chhattisgarh] He is life member of Acoustical Society of India, Biomedical Society of India, Linguistic Society of India, Indian Society for Technical Education and many social bodies,

Email: arunzad28@hotmail.com

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)