EVALUATING THE PERFORMANCE OF TCP-RENO, TCP-NEWRENO AND TCP-VEGAS ON AN OBS NETWORK

Ratna Pavani.K[1] and N.Sreenath[2]
[1]Deptt. of Computer Science, Indira Gandhi College of Arts and Science, Puducherry, India
[2]Department of Computer Science, Pondicherry Engineering College, Puducherry, India

ABSTRACT

In TCP over OBS networks, packets from various IP sources assemble into a data burst at the ingress node and are transmitted to egress node cutting through the core network all-optically. The control packet always precedes the data burst by an offset time. This time gap between the control packet and the data burst is adequate to process the burst header packet and configure the switches at the core nodes. These switches down the route are configured only when the data burst arrives to facilitate the burst to cut through an all-optical path. The basic assumption of TCP variants is that the transmitting physical medium is electronic and packets are experiencing delay due to IP routers, but with TCP over OBS networks there will be a change in performance of TCP flavours due to the underlying network. In these conditions an experimental study was made to evaluate the performance of three popular TCP variants, TCP-Reno, TCP-Newreno and TCP-Vegas using NS-2.

KEYWORDS*: Transmission Control Protocol (TCP), Internet protocol (IP), Optical Burst Switching (OBS) Network, TCP-Reno, TCP-Newreno, TCP-Vegas, Network Simulator version-2 (NS-2).*

I. INTRODUCTION

The demand for high bandwidth applications and services has tremendously increased due to major growth in the number of Internet users and raise in bandwidth intensive applications such as video conferencing, voice-over-IP and interactive video-on-demand [1]. In transport protocols used, Transmission control protocol (TCP) is the standard protocol. When considering a new networking model for the potential Internet backbone like optical burst switching (OBS) it is necessary to evaluate network performance taking into account the characteristics of upper layers [2]. It is a known fact that TCP has been subjected to a remarkable amount of research over the past years and several variants of TCP were suggested for adapting to new network scenarios with varied transmission characteristics [3]. TCP can be classified into three major categories based on congestion control, i.e., Loss-based, Delay-based and Explicit notification-based. In this paper our study is to analyze the performance of loss based TCP-Reno and TCP-Newreno with delay based TCP-Vegas on an all-optical network [4]. All these designs are on the assumption that the network congestion can be effectively designated by way of loss of a packet, extended round trip time (RTT), or by both the conditions. This assumption is however true for only buffer-oriented networks.

In an OBS network burst forms the basic entity. The three major components of OBS are an ingress node, an egress node and a network of core nodes. Ingress nodes and egress nodes can be collectively termed as edge nodes. The edge nodes should assemble the IP packets and assimilate them into bursts called as burstification. The TCP/IP packets collected are aggregated into data burst at the ingress node and transmitted over optical domain. Usually all the packets destined for the same egress node are put in the same burst. To circumvent optical processing and buffering of the optical data burst at core nodes, a control packet that contains the information about the length and arrival time of the data burst is sent ahead with an offset time [5, 6]. This offset time amid the control packet and the data burst is sufficient to process the control packet and configure the switches at the core nodes to permit the data burst to cut through an all-optical path in the core network. At the egress node data burst is disassembled into IP packets.

In the core network to reserve required wave-length there are two important signalling mechanisms in tell-and-go (TAG) protocol called Just-enough-time (JET) and Just-in-time (JIT). With JIT signalling mechanism the allocated wavelength will be relinquished by explicit control message. In JET, the wavelength is allocated only for the duration of the data burst hence no explicit message is required to surrender the acquired resource. This augments the usage of the wavelength but increases the processing time of the control packet. OBS networks will typically experience Random Burst Losses (RBL) even at minimum traffic loads [7] appropriating to bufferless nature of the network and one way signalling scheme. These RBL will be construed as network congestion by TCP layer. For example, if a burst that has many packets from a single TCP connection is dropped due to contention at trivial traffic loads, the TCP sender times out, which leads to false congestion detection by TCP. This false congestion detection is expressed as False Time Out (FTO) [8]. When TCP identifies this false congestion, it will commence congestion control mechanism which will shrink the size of the Congestion Window (CW). The conventions used for dealing with modification of CW differ for various TCP variants. It is therefore necessary to evaluate the performance of TCP over bufferless OBS to identify the change in variation of TCP variants when congestion occurs due to random contention.

In section II a literature survey with respect to variants of TCP is presented. Section III explains the impact of TCP variants over OBS and motivation to the proposed work. In Section IV confers the network model and simulation setup. Results of Simulation are in section V. Conclusion is present in Section VI followed by Future work in Section VII.

II. LITERATURE SURVEY

TCP is responsible of controlling end-to-end communications by the services provided through the network layer, which is usually IP. Apart from other functions of TCP like maintaining end-to-end semantics and providing connection oriented services to the receiver, congestion control is done by TCP sender with the help of CW. TCP sender transfers data in chunks called segments which are acknowledged by the TCP receiver. To avoid buffer overflow at the receiver and make use of the available bandwidth optimally TCP uses CW to determine the number of segments that are allowed to be sent. For every successful acknowledgement from the receiver the size of the CW is incremented. There are various stages in the congestion control of TCP which principally controls the rate of transmission in the network to avoid congestion and retransmit the lost packets.

During Slow start period TCP has a low CW typically one segment and its size is increased linearly every time a positive acknowledgement is received. This growth continues either till a packet is dropped or TCP window's size equals stipulated threshold value. If a loss of segment is acknowledged or if there is a triple duplicate acknowledgement then TCP enters Congestion avoidance (CA) phase. Throughout this phase the size of the window (W) is increased by 1/W each time an acknowledgement is received from the receiver. This increase continues until maximum window size is reached or a packet loss is detected. If a segment arrives out of order then TCP receiver sends a duplicate acknowledgement .These acknowledgements are understood by the TCP sender about the lost segments and enters Fast Retransmit phase. Whenever a TCP sender receives triple duplicate ACK it is considered as an indication of network congestion. TCP sender straight away transmits the lost packets without waiting for the retransmission time out (RTO). After retransmission of the lost segment Fast recovery algorithm is initiated by the TCP sender. The implementation of Fast recovery algorithm is dependent on the type of TCP variant used [9].

OBS network endures from RBL due to contention even at low traffic loads due to the bufferless nature of the network and one-way signalling mechanism used. In these circumstances when a burst loss occurs at low traffic loads and if there are multiple packets in the burst from the same TCP source, TCP acknowledges it to be congestion in network and will react to the congestion by reducing the size of CW. In this paper an analysis has been made to investigate the performance of loss based TCP variants like TCP-Reno and TCP-Newreno with delay based variant of TCP, TCP-Vegas over bare bone OBS networks using NS-2.

III. TCP VARIANTS OVER OBS

TCP-Reno is fundamentally a dropping-based variant of TCP. Performance of TCP-Reno will be similar to other TCP variants in congestion control mechanism during SS, CA and FR phases. In case of multiple packet loss from the same window there will be deterioration in the performance of TCP-Reno. TCP-Newreno tries to modify TCP-Reno in this phase [10]. Implementation of Fast retransmit algorithm of TCP-Newreno is similar to that of TCP-Reno. TCP-Newreno retransmits the lost packet and initiates fast recovery phase when there is a triple duplicate acknowledgement. The remaining packets in the window are retransmitted by the sender in as many Round trip times (RTT) as the number of packets in the window, thereby retransmitting one packet per RTT. In this aspect, performance of TCP-Newreno is vulnerable by the fact that it takes one RTT to identify a packet loss. This implies that the loss of other segments can only be detected when the acknowledgement for the first retransmitted segment is received.

TCP-Vegas utilizes RTT measurement to verify the available network capacity. It does not depend on lost packets like TCP-Newreno or TCP-Reno to approximate network capacity. Once for every RTT, TCP-Vegas computes the estimated throughput and actual throughput [11]. This difference is then used to assess the number of packets that are queued in the network. If the variation goes beyond the threshold value then TCP-Vegas terminates SS and commences CA. TCP-Vegas, unlike TCP-Reno and TCP-Newreno, has the ability to terminate slow-start before CW exceeds the network's offered capacity. At this stage TCP-Vegas shrinks the size of CW by 1/8 of its current size in order to guarantee that the network does not remain congested. In SS phase, for every second RTT CW is increased by one segment per acknowledgment. In CA phase, for every RTT, CW will be increased by one segment or decreased by one segment or is left unchanged [12].

If a non-duplicate acknowledgement arrives at the TCP sender TCP-Vegas checks for its timeout value from the time the packet was sent and retransmits without waiting for the duplicate acknowledgement if the segment time exceeds the timeout value. In this way, when there are multiple packet losses in the same window TCP-Vegas outperforms TCP-Reno. In addition, TCP Vegas does not rely on lost packets in order to estimate network capacity, as an alternative it uses RTT measurements to determine the available network capacity. Therefore TCP-Vegas perform better than TCP-Newreno in retransmitting lost packets in case of triple duplicate acknowledgements. In this situation, it is understood that the TCP variants discussed above are predestined on the supposition that the network congestion can be effectively indicated either by packet loss, prolonged RTT or combination of both [12].

With OBS as the underlying network there is a probability of RBL imposing a significant impact on the upper-layer protocols like TCP as most of its variants take packet loss as the only indication of network congestion. Both the TCP variants TCP-Reno and TCP-Newreno adjust the size of CW based on the packet loss and the acknowledgement received by the sender. TCP-Vegas adjust the CW based on the difference between estimated throughput and actual throughput for every RTT. So the motivation of the work is to evaluate the performance of TCP-Reno, TCP-Newreno and TCP-Vegas over OBS networks and asses their performance with varying burst sizes and offset time.

IV. NETWORK MODEL AND SIMULATION SETUP

NS-2 simulator with modified OBS patch is used to simulate the environment [13]. Burstification of IP packets is done using Random uniform distribution algorithm. Topology used is NSFNet with 14 optical nodes, 28 electrical nodes with 10 TCP/IP connections. Packets within the core network are processed by optical-classifier. As the next hop for a packet is within the optical domain, optical-classifier forwards the packet for burstification. OBS isolates the data plane and the control planes in the optical and electronic domain respectively there by eliminating the difficulty in all-optical processing of packet headers. MAX-PACKET-NUM variable denotes the number of IP packets enclosed in a single burst. In this simulation the size of MAX-PACKET-NUM is varied from 10 packets to 10000 packets per burst to evaluate the throughput and calculate burst-delivery-ratio. In order to configure control packet’s information, JET signalling mechanism is used in the core network so that data burst traverses from ingress node to egress node cutting through the switching matrix all-optically avoiding optical-electrical-optical conversion. The control packets are generated and forwarded by the edge nodes followed by the data burst.

The optical classifier at the node entrance is used for separating TCP segments from optical bursts. Latest Available Unused Channel with Void Filling (LAUC-VF) [14] and Minimum Starting Void (Min-SV) [15] are the two scheduling algorithms utilized inside OBS core network. The core network within OBS consists of 1Gbps links with 10 ms propagation delay. The access links have 1ms link transmission impediment with 155Mbps bandwidth. Here simulations are done with varying offset times and the burst sizes to analyze the performance of TCP-Reno, TCP-Newreno and TCP-Vegas over OBS network.

V. Simulation Results

In figure-1 Maximum-flow-queue is set to 100.The offset time is 0.01. File Transfer Protocol (FTP) is used to generate traffic from TCP source to TCP destination. In order to consider traffic in only one direction and avoid acknowledgements to be burstified, TCP-ACK variable in the simulation is set to 1, so that TCP-acknowledgement packets are not burstified.

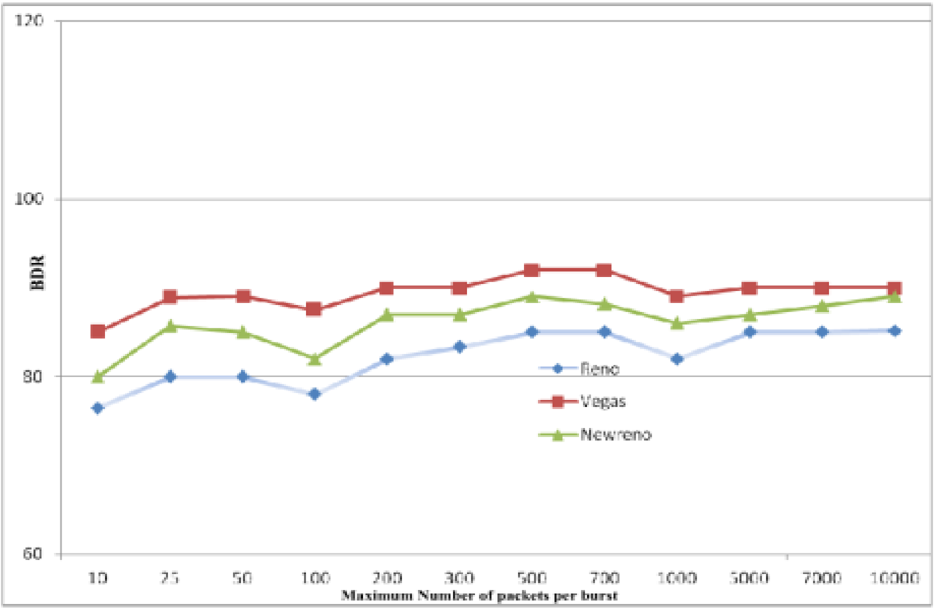

Figure1: Simulation results of TCP-Reno, TCP-Newreno and TCP-Vegas with offset time 0.01

Every simulation with varying parameters was executed for a period of 15 minutes. TCP-Reno, TCP-Newreno and TCP-Vegas are tested with varying burst sizes to calculate burst delivery ratio (BDR). In the above simulation the throughput of TCP-Vegas is slightly better than TCP-Reno and TCP-Newreno. The overall performance of TCP-Vegas is consistent throughout simulation. There is a decline in performance of three variants after 1000 packets. We have experience a negative delay from this point on wards and there are multiple retransmissions, may be due to random contention. But the BDR of all the three variants remained below 90. When the maximum-packet-num is 7000 there is an improvement in the BDR of TCP-Reno and TCP-Newreno.

In Figure-2 Maximum-flow-queue is set to 100.The offset time is 0.001. Here we have decreased the offset time there by increasing the processing speed in the core network. With minimum variation in BDR TCP-Vegas performed better than TCP-Newreno. There is only a slight variation in the BDR of TCP-Vegas and TCP-Newreno, but the performance of TCP-Reno started to diminish after the burst size of 2000 packets.

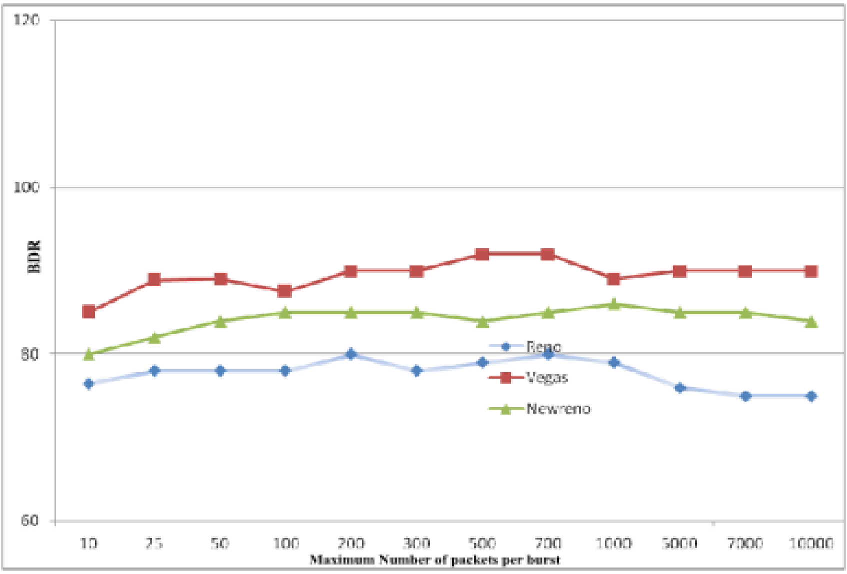

Figure2: Simulation results of TCP-Reno, TCP-Newreno and TCP-Vegas with Offset time 0.001

VI. CONCLUSION

In the above simulation results it is significant that when there is an increase in the size of the burst and processing speed in the core network, TCP-Reno shows a diminishing trend. Though delay based TCP-Vegas is better than other loss based variants like TCP-Reno and TCP-Newreno, its performance is also slightly varied when burst size is increased to 1000 packets. When the offset time is 0.001 and when burst size is more than 7000 packets we can find an improvement in the performance of TCP-Vegas whereas TCP-Reno shows a diminishing trend. Simulation results confirm that TCP-Vegas outperforms TCP-Newreno and TCP-Reno over OBS networks when the burst size is more than 7000 packets and with minimum offset delay.

VII. FUTURE WORK

When OBS is used as the underlying transmission medium that has high bandwidth and faster transmission speeds, a TCP variant that can clutch maximum data is optimal. Therefore a study has to be through to make out which variant of TCP is more appropriate for OBS networks to attain maximum throughput without wasting the available bandwidth and circumvent random contention loss. As a future work we propose to extend the study to various other TCP variants that can show optimal performance over OBS networks.

REFERENCES

[1]. Sagar H. Sodhatar, Rohit B. Patel, Janardana V. Dave "Throughput Based Comparison of Different Variants of TCP in Optical Burst Switching (OBS) Network", 2012 International Conference on Communication Systems and Network Technologies.

[2]. Oscar González de Dios · Anna Maria Guidotti · Carla Raffaelli · Kostas Ramantas · Kyriakos Vlachos, "On transmission control protocol synchronization in optical burst switching," Photon Network Communication 2009.

[3]. B. Shihada and P-H. Ho, "Transport Control Protocol (TCP) in Optical Burst SwitchedNetworks: Issues, Solutions, and Challenges," Communications Surveys & Tutorials, IEEE , 2008.

[4]. W. Stevens, "TCP Slow Start, Congestion Avoidance, Fast Retransmit, and Fast Recovery Algorithms," RFC 2001, 1997.

[5]. Y. Xiong, M. Vandenhoute, and H. Cankaya, "Control architecture in optical burst switched WDM networks," IEEE Journal on Selected Areas in Communications, vol. 18, no. 10, pp. 1838-51, 2000.

[6]. X. Yu, Y. Chen, and C. Qiao, "Study of traffic statistics of assembled bursts in optical burst switched networks," Proceedings of Opticomm, 2002.

[7]. Qiong Zhang, Vinod M. Vokkarane, Yuke Wang, and Jason P. Jue, "Analysis of TCP over Optical Burst-Switched Networks with Burst Retransmission," Proceedings' IEEEGLOBECOM, St. Louis, MO, 2005.
[8]. Xiang Yu, Chunming Qiao and Yong Liu, "TCP implementations and False Time Out Detection in OBS Networks," Proceedings of IEEE INFOCOM, pp. 358–366 2004.
[9]. Xiang Yu, Chunming Qiao and Yong Liu, "TCP plementations and False Time Out Detection in OBS Networks". Proceedings of IEEE INFOCOM, pp. 358–366 2004.
[10]. S. Floyd, T. Henderson, A. Gurtov, "The NewReno Modification to TCP's Fast Recovery Algorithm," Network Working Group, RFC 3782, April 2004.
[11]. Joel Sing and Ben Soh, "TCP New Vegas: Improving the Performance of TCP Vegas Over High LatencyLinks", Proceedings of the 2005 Fourth IEEE International Symposium on Network Computing and Applications (NCA'05).
[12]. Joel Sing and Ben Soh, "TCP New Vegas: Performance Evaluation and Validation," Proceedings of the 11th IEEE Symposium on Computers and Communications (ISCC'06) 2006.
[13]. Guray Gurel, Onur Alparslan and Ezhan Karasan, "nOBS: an ns2 based simulation tool for performance evaluation of TCP traffic in OBS net- works,"Annals of Telecommunications, vol. 62, no. 5-6, 2007.
[14]. Xiong , Vandenhoute , Cankaya , "Control Architecture In Optical Burst-Switched WDM Networks, " IEEE Journal on Selected Areas in Communications, 18, no 10, pp. 1838–1851, Oct. 2000.
[15]. Xu , Qiao, Li, Xu ," Efficient Channel Scheduling Algorithms In Optical Burst Switched Networks," Proceedings of IEEE, Infocom'03, 3, pp. 2268 - 2278, 30 March-3 April 2003.

Authors

N. Sreenath is a professor in the Department of Computer science and Engineering at Pondicherry Engineering College Pillaichavady, Puducherry – 605014, India. He received his B.Tech in Electronics and Communication Engineering (1987) from JNTU College of Engineering, Ananthapur – 515002, Andra Pradesh, India. He received his M.Tech in Computer science and Engineering (1990) from University of Hyderabad, India. He received his Ph.D. in Computer science and Engineering (2003) from IIT Madras. His research areas are high speed networks and Optical networks.

Ratna Pavani.K is an Assistant Professor in Indira Gandhi College of Arts and science, a government of Puducherry undertaking. She is pursuing a Doctoral Degree in Computer science Mother Theresa Women's University Kodaikanal. She received her MCA degree from Nagarjuna University Nagarjuna Nagar, Guntur, AP, 522510. She completed her MPhil (Computer science) from Manonmanian Sundarnar University Tirunalveli. Areas of research include high speed networks and optical networks.