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Investigation on TCP/IP Congestion Control in Optical Burst Switched (OBS) Network

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Abstract

Transport Control Protocol (TCP) is the dominant protocol in modern communication networks, in which the issues of reliability, flow, and congestion control must be handled efficiently. In this review paper an analytical switching is used to exploit the huge bandwidth of optical fibers for future high speed internet backbone. It carries multiple packets, in their turn. Different aggregation schemes have been considered and evaluated. TCP performance greatly depends on the TCP congestion window behavior that is related to loss events occurring in the optical burst switched network, there is a special term called traffic shaping by which we control over the network according to the network load .that means we increase or decrease the send rate according to the network demand.

Keywords

Traffic Grooming, Congestion control, Send rate, Optical network. Optical burst switching.

1. Introduction

Most of today's Internet applications use the TCP for maintaining reliable and congestion-tolerant data transmission. Using OBS networks as an all-optical long-haul backbone switching technology has proven to affect TCP throughput negatively. Therefore, understanding the burst-transmission behavior along with the associated impact on the TCP congestion-control algorithms can contribute to better exploitation of the advantages of OBS networks. OBS is considered a promising solution for all-optical switching in Wavelength Division Multiplexing (WDM) networks. OBS has attracted researcher's attention due to its ability to achieve dynamic and on-demand bandwidth allocation, which offers improved network economics and enables control and management integration. The evolution of OBS technology is highly coupled with its ability to support upper-layer applications. TCP performance greatly depends on the TCP congestion window behavior that is related to loss events occurring in the optical burst-switched network. Congestion in optical burst switched network is the main problem in today's network. It can be controlled in many ways. Here in this will work on the send rate of TCP/IP to reduce congestion in OBS networks.

1.1. TCP/IP

TCP provides a connection oriented, reliable, byte stream service. The term connection-oriented means the two applications using TCP must establish a TCP connection with each other before they can exchange data. It is a full duplex protocol, meaning that each TCP connection supports a pair of byte streams, one flowing in each direction. TCP includes a flow-control mechanism for each of these byte streams that allow the receiver to limit how much data the sender can transmit. TCP also implements a congestion-control mechanism. The Transmission Control Protocol (TCP) is one of the core protocols of the Internet Protocol Suite. TCP is one of the two original components of the suite, complementing the Internet Protocol (IP), and therefore the entire suite is commonly referred to as TCP/IP. TCP provides reliable, ordered delivery of a stream of bytes from a program on one computer to another program on another computer. TCP is the protocol that major Internet applications such as the World Wide Web, email, remote administration and file transfer rely on. Other applications, which do not require reliable data stream service, may use the UDP, which provides a datagram service that emphasizes reduced latency over reliability.

1.2. TCP over OBS Networks

An OBS network is basically buffering less yet best-effort in nature. The buffer less and all-optical (AO) natures distinguish OBS networks from traditional packet- switched networks, which rely on electronic processing. The implementation of OBS networks requires precise signaling and higher switching speed than current Optical Circuit Switched (OCS) networks. In order to transmit a burst from the source OBS node (ingress node) to a certain destination (egress node), a corresponding control packet is created at the source OBS node and is sent prior to launching the burst . The burst cuts through the network following the control packet in a one-way (i.e., Tell-and-Go) transmission scheme. Although OBS achieves better flexibility and efficiency than OCS networks, OBS suffers from a burst contention phenomenon which leads to burst drops. Burst contention occurs when more than one burst simultaneously attempts to traverse through one output port or wavelength channel. When n bursts contend, n-1 of them is dropped. This is due to the one-way resource reservation and signaling protocol, where resources are reserved. The fly (i.e., without acknowledgement or reservation guarantee) and the lack of burst buffering. Burst retransmission, burst deflection routing, burst buffering through Fiber Optic Delay Lines (FDL), burst segmentation, and wavelength conversions are some approaches to dealing with the problem. However, these mechanisms are not considered to be part of typical OBS networks. TCP behavior is influenced by the aggregation of segments in a burst. Burst assembly/disassembly takes place at network edges. Ingress edge routers perform the electrical to-optical interfacing, collect the incoming IP packets accordingly to the class they belong to, and form optical bursts. TCP congestion control, which adapts the Additive Increase Multiplicative Decrease (AIMD) approach, is designed to cope with buffer-oriented Internet Protocol (IP) networks. However, OBS networks aggregate multiple TCP/IP packets in a single burst. The burst is transmitted without any buffering delay, delivery guarantee, or processing overhead. The aggregation of multiple TCP/IP packets in single burst, the buffer less burst transmission, the burst contention problem, and the proposed burst contention resolution schemes affect TCP performance. Therefore, modifying TCP congestion control is necessary to cope with the new burst-transmission characteristics.

2. Literature Review

In 2010, Maurizio Casoni [1] proposed that TCP performance over Optical Burst Switching networks is investigated by considering the burst assembly function implemented in the edge nodes. This function has a very important role on end-to-end performance and edge node architecture is here proposed for improving performance. Atimer. Based burst assembly algorithm operating on multiple queues. Where each queue is characterized by given time limit and incoming TCP segments are assigned to a given queue depending on the estimation of the current.

In 2010, Manish Devendra Chawhan et al. [2] proposed that TCP has been performing well over the traditional wired networks where packet losses occur mostly because of congestion, it cannot react efficiently in wireless networks, which suffer from significant non-congestion-related losses due to reasons such as bit errors and handoffs. The paper shows how Explicit Congestion Notification (ECN), Snoop protocol and their combination can be used to improve the performance of TCP in Wi-Fi Bidirectional Network and in Handoff. ECN will help in congestion control and SNOOP will retransmit the packets that are lost from nodes in between, saving nearly half the retransmission time and avoiding the decreasing in Transmission speed. In order to improve the performance of TCP over wireless network both ECN and SNOOP should be applied simultaneously. Most of today’s Internet applications use the Transport Control Protocol (TCP) for maintaining reliable and congestion-tolerant data transmission. Using OBS networks as an all-optical long-haul backbone switching technology has proven to affect TCP throughput negatively. Therefore, understanding the burst-transmission behavior along with the associated impact on the TCP congestion-control algorithms can contribute to better exploitation of the advantages of OBS networks.

In 2007, Yan Zhang et al. [3] proposed B-Reno which is based on New- Reno, which means that B-Reno remains the main algorithms of New-Reno such as Slow Start, Congestion Avoidance, Fast Retransmit and Fast Recovery. However, B-Reno adopts the mechanisms named SS (Slow but Steady) and PWD (Partial Window Deflation) both of the two mechanisms are about the TCP sender’s reaction upon receiving a partial ACK during the phase of Fast Recover. In TCP over OBS networks, consecutive multiple packet losses are common since an optical burst usually contains a number of consecutive packets from the same TCP sender. To overcome Reno and New- Reno’s inefficiencies in dealing with consecutive multiple packet losses over OBS networks.

In 2006, Carla Raffaelli et al. [4] proposed an analytical model to calculate the send rate of TCP sources as a function of the main design parameters of OBS networks. The novelty of the work is the possibility to deal with generic source speed that was previously evaluated only by simulation. An application example that couples this model with the evaluation of burst loss probability in core OBS nodes has been given and related network design issues have been discussed to achieve the target of end-to-end performance optimization.

In 2005, Cheng-Yuan Hoa et al. [5] proposed that TCP is known to send bursts of packets during its slow start phase due to the fast increase of window size and the ACK-clock based transmission. This phenomenon causesTCP Vegas to change from slow-start phase to congestion avoidance phase too early in the large BDP (Bandwidth Delay Product) links. A new variant of the slow-start mechanism in TCP Vegas, called Gallop-Vegas, to reduce the business, to raise the rate to the available bandwidth in shorter time, and to improve the start-up performance. It achieves more efficient throughput in slow start phase comparing with original TCP Vegas. Although Gallop-Vegas is more suitable for large bandwidth or long delay networks, it still increases transmit performance in small bandwidth or short-delay networks. The design of Gallop-Vegas is simple and implementation feasible on existing Operating systems.

In 2003, S.Y. Wang [6] proposed an OBS area, because the basic mechanism of the TCP decoupling approach matches the mechanism of the OBS very well, it proposes using a modified TCP decoupling approach to congestion-control the traffic load offered to an OBS switch and regulates the timing of sending bursts. Using a modified TCP decoupling approach to improve the performances of anOBS network. These approaches can congestion-control the traffic load offered to an OBS switch, thus avoiding unnecessary packet droppings. This approach also exploits TCP's famous "self-clocking" property to regulate the sending times Of contending bursts, thus resulting in a much reduced packet drop rate.

In 2001, Jumpot Phuritatkul [7] proposed Congestion control mechanisms in UBR service for TCP sources is investigated in this work not only static TCP sources but also dynamic TCP sources are applied to investigate the performance of congestion control in the practical way. The ABR and UBR services provide efficient sharing of the remaining bandwidth to support delay-insensitive data applications, especially Internet traffic.

In 2000, B. P. Lee et al. [8] proposed the attributes of TCP tunnels which are TCP circuits that carry IP packets and benefit from the congestion control mechanism of TCP/IP. The deployment of TCP tunnels reduces the many flows situation on the Internet to that of a few flows. TCP tunnels eliminate unnecessary packet loss in the core routers of the congested backbones which waste precious bandwidth leading to congestion collapse due to unresponsive User Datagram Protocol (UDP) flows. A suitable technique for use as a tunnel would be a TCP-like protocol offering the flow and congestion control characteristics of TCP/IP and yet, without its (TCP's)reliable delivery of data. Such a protocol would not be unlike RTP complemented by flow and congestion control Principles of TCP. If it is utilized as a tunnel for transporting IP packets, it would allow us to reap the benefits of aggregation and yet, eliminate the disadvantage of inaccurate RTT(Round Trip Time) estimations by its payload of TCP user connections.

3. End to End Design Principle

The end-to-end principle is a classic design principle of computer networking which states that application specific functions ought to reside in the end hosts of a network rather than in intermediary nodes, provided they can be implemented "completely and correctly" in the end hosts. By considering the burst assembly function implemented in the edge nodes. This function has a very important role on end-to-end performance and edge node architecture is here proposed for improving performance. The OBS network is evaluated through simulations by means of the ns2 simulation. A timer based burst assembly algorithm operating on multiple queues has been proposed, where each queue is characterized by a given time limit and incoming TCP segments are assigned to a given queue depending on the estimation of the current. Value of the congestion window of the flow they belong to. A simple but effective estimator has then been added to make the assembly algorithm more realistic and feasible. Results, obtained through simulations by means of the ns2 simulation tool, show that this algorithm can lead to TCP Performance improvements of 100%, compared to a timer based assembly scheme operating on a single queue. More importantly, this new protocol would be of greater relevance as a transport protocol for end-to-end delay sensitive applications.

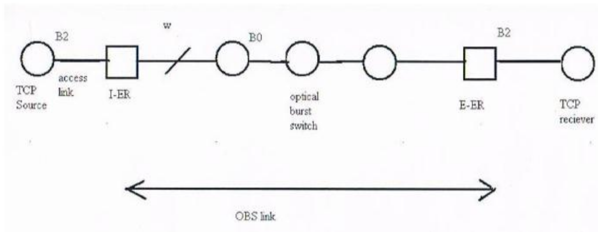

Fig.1. The end-to-end connection model.

Two algorithms are used to control the send rate:-

3.1 The Leaky Bucket Algorithm

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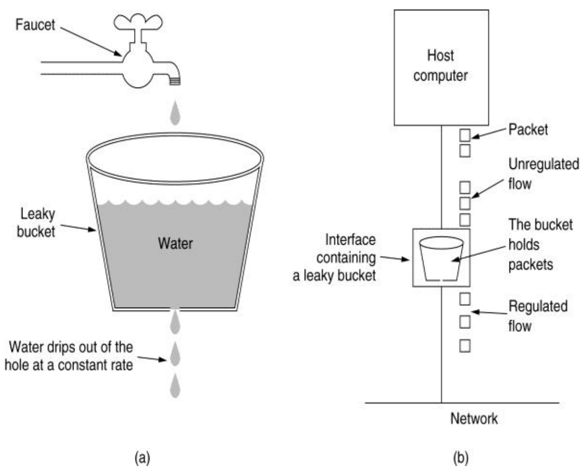

Fig. 2. (a). A leaky bucket with water. (b) A leaky bucket with packets.

- The leaky bucket enforces a constant output rate (average rate) regardless of the burstiness of the input. Does nothing when input is idle.
- The host injects one packet per clock tick onto the network. This results in a uniform flow of packets, smoothing out bursts and reducing congestion.
- When packets are the same size (as in ATM cells), the one packet per tick is okay. For variable length packets though, it is better to allow a fixed number of bytes per tick. E.g. 1024 bytes per tick will allow one 1024-byte packet or two 512-byte packets or four 256-byte packets on 1 tick

3.2 Token Bucket Algorithm

- In contrast to the LB, the Token Bucket
- Algorithm allows the output rate to vary, depending on the size of the burst.
- In the TB algorithm, the bucket holds tokens. To transmit a packet, the host must capture and destroy one token.
- Tokens are generated by a clock at the rate of one token every Δt sec.
- Idle hosts can capture and save up tokens (up to the max. size of the bucket) in order to send larger bursts later. The Token Bucket Algorithm

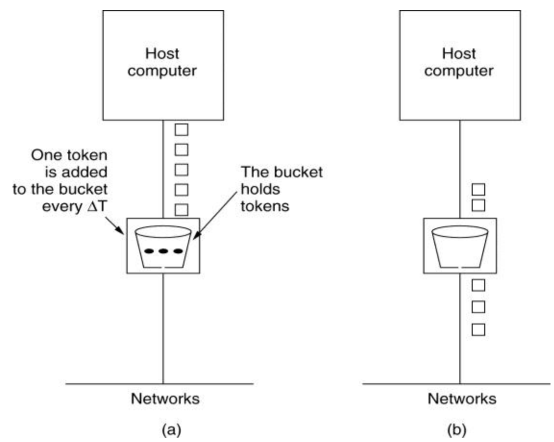

Fig.3. (a). Before. (b)After.

4. Conclusion

Since a lot of work has already been done and there is still more there is still more to do, we have been reviewed mainly on the area, particularly the techniques and a comparative study to highlight the prominent features to provide support for TCP over OBS network. Our finding is that if the send rate of TCP/IP reduces then there will be less congestion in the network occurs.

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