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Performance Evaluation of TCP Protocol Using Network Simulator

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***Abstract*: The algorithms for Transmission Control Protocol (TCP) congestion control are the main reason of the performance for the TCP variant; there are different implementations among TCP: Taho, Reno, Newreno, Sack and Vegas. We will use simulation to evaluate these TCP congestion control algorithms from many aspects, such as effective resource utilization (throughput utilization, packet dropping probability). We will use Network Simulator for our simulations with different scenarios and many factors that may influence the performance of TCP variant.**

Index Terms: performance, TCP protocol, network simulator, network parameters.

I. INTRODUCTION

The algorithms for TCP congestion control are the main reason of the performance for the TCP variant; there are different implementations among TCP Taho, Reno, Newreno, Sack and Vegas. We will use simulation to evaluate these TCP congestion control algorithms from many aspects, such as effective resource utilization (throughput utilization, packet dropping probability) We will use Network Simulator for our simulations with different scenarios and many factors that may affect the performance of TCP variant. We also focused on the effect of different queue type algorithms, such as Drop Tail and RED and different buffer size. We will use simulation to compare TCP Taho, Newreno, Reno, Sack and Vegas in different situations. All the simulations use traffic source File Transfer Protocol (FTP), which corresponds to inflate data transfer. We use packet receive number with time ratio to indicate the throughput occupancy ratio (Cwnd/time =Throughput). The capacity of the buffer and window sizes are the number of units of packet. The first evaluation will have realized is the following: we will compare the Impact of resource utilization to show the available network bandwidth as the performance metric (effective throughput) application of each TCP variant and the percentage of drop when the comparisons are based on each type of TCP running individually on a congested network. The second evaluation answers this question, "How frequently does each of TCP variant packets dropping probability?" when the TCP agents running together and sharing the bottleneck path.

II. THROUGHPUT RARE

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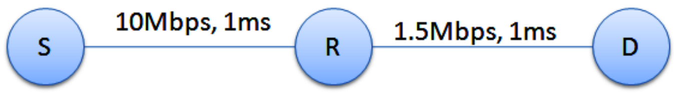
We used the Topology 1 to show the simple simulation network. The circle (R) indicates a finite-buffer Drop Tail gateway, and the circles (S and D) indicate sender and receiver hosts. The links are labeled with their bandwidth capacity and delay. We used these parameters show in the table below (table 1) in the simulation and we add a model called (error model) which make the packet dropping to compare the effective throughput application of these five algorithms.



Network Topology 1

NO.	Fixed Parameters	Value
1	TCP sender Capacity	10Mbps
2	Propagation Delay	1ms
3	TCP receiver Capacity	1.5Mbps
4	Queue Type	Drop Tail
5	Traffic Regenerator	FTP
6	Packet Size	500
7	Buffer Size	15
8	Window Size	300

Table 1: Parameters of Topology 1

Packet Sent				
Taho	Newreno	Sack	Reno	Vegas
3257	4309	4422	3357	5855
Packet Received				
3160	4202	4313	3270	5722
Packet dropped				
97	111	113	90	133
Drop percentage				
2.97%	2.57%	2.55%	2.68%	2.27%

Table 2: Throughput rate

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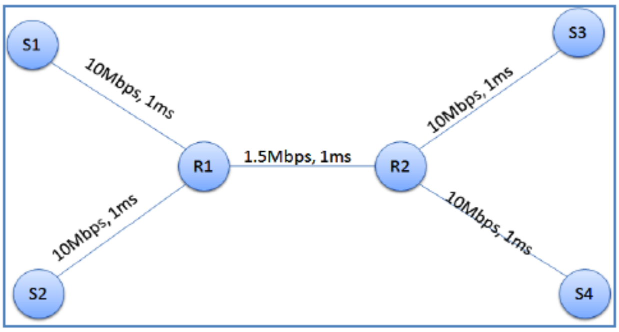
We measured the performance of Taho, Newreno, Vegas, Reno and Sack on this topology. This table shows the results. We found that the Throughput utilization of these TCP protocol, the simulation results in 5s detect that the TCP Vegas in this scenario can achieve higher throughput and less packet drop percentage than other TCP variant (table 2).

III. PACKETS DROPPING PROBABILITY

We used the network configuration that is shown in Topology 2. R1 and R2 are finite-buffer switches and S1~S4 are the end hosts. Connection 1 transmits packets from S1 to S3, and connection 2 from S2 to S4. The links are labeled with their capacities and propagation delays and the table 3 illustrate the used parameters according to the topology 2.



Network Topology 2

NO.	Fixed Parameters	Value
1	TCP sender Capacity	10Mbps
2	Propagation Delay	1ms
3	TCP receiver Capacity	10Mbps
4	Queue Type	Drop Tail
5	Traffic Regenerator	FTP
6	Packet Size	500
7	Bottleneck	1.5Mbps
8	Buffer Size	10
9	Window Size	300

Table 3: Parameters of topology 2

We changed the S1 – S3 and S2 – S4 connections to different two TCP types, and get ten possible results. These two sender agents' experiments are to test the dropped rate of TCP Taho (Kadry & Al-Issa, 2015; Parvez et al., 2010), Newreno, Reno, Sack and Vegas, when each two of these agents running together. The results from simulation are shown in the table 4.

Packet Dropping Probability			
Taho/Vegas	28/6	Newreno /Reno	29/29
Vegas/Reno	3/26	Taho/Sack	30/28
Vegas/Newreno	3/27	Sack/Newreno	29/29
Vegas/Sack	3/27	Sack/Reno	29/29
Taho/Newreno	29/29	Taho/Reno	28/26

Table 4: Packet dropping probability

The results from this table, show the number of drop packet of TCP Variant when each two of these variant compete together, these result show that TCP Vegas has less percentage of the dropped packet than others (Afanasyev et al., 2010; Ibrahim et al., 2009). The number of dropped packet in TCP Vegas is between 3 to 6 only when it's running with the other TCP protocols. It loses a little amount of packet because of the TCP Vegas is used conservative algorithm which can lead Vegas to detect and predict the congestion of the network before it happened, while the other TCP protocol used aggressive algorithm to increase their window size until drop happens. When the Sack, Newreno, Reno and Taho are competing, they share the bandwidth but with the expense of higher loss rate.

IV. FAIRNESS BETWEEN THE SAME TCP AGENTS

We want in this section to experience the fairness between connections have the same and different delay when the same versions of TCP run together on one bottleneck link, and participate in the bandwidth. We want to experiment the effect of delay on TCP Reno, Sack, Newreno, Taho, and Vegas, and check the behaviors of TCP variant in the same situation. We used in our simulation the network topology 3 where R1 and R2 are limited keys buffers and S1 ~ S4 are the host end. Connection 1 sends the packets to the address of S2 to S4, and a connection 2 from S1 to S3. We are setting S1 and S2 the same agents of TCP, such as Two Taho, two Newreno, two Vegas, two Sack, and two Reno TCP agents respectively. We described the links with the capacity and propagation delay, where the Bandwidth or the capacity of the router is (1.5 Mbps) to allow the congestion state in the network, and to other hosts are (10 Mbps), other simulation parameters explained in the table 5. We will change the delay of the link that connect R2 and S3, which is denoted by X in the topology 3, to show the effect of delay on the fairness between different connections, X has two value (1ms & 30ms). The throughput occupancy graphs show the fairness between the various delay connections. Connections 1 and 2 start at time 0.0 and end at 20 seconds, respectively. When the simulation is beginning, we take the correct data after 5 seconds to eliminate the temporary effect.

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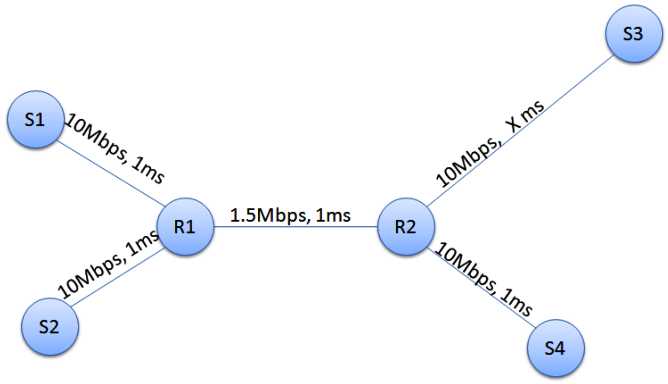

Figure5-3 Network Topology 3

Table 5: Fixed Parameters setting of topology

NO.	Fixed Parameters	Value
1	TCP sender Capacity	10Mbps
2	Router Propagation Delay	1ms
3	TCP receiver Capacity	10Mbps
4	Queue Type	DropTail, RED
5	Traffic Regenerator	FTP
6	Packet Size	500
7	Bottleneck	1.5Mbps
8	Buffer Size	15
9	Sender propagation delay	1ms
10	Receiver propagation delay	1, 30ms
11	Window Size	300

V. CONCLUSION

The performance of TCP Vegas that can produces the higher amount of throughput and less packets drop percentage than other TCP Taho, Newreno, Reno and Sack on link when there are exist a traffic or congestion. The performance of TCP Vegas perfect when congestion network is appeared, the dropped packet number is between 3 to 6 only when running with the other TCP protocols. When the Sack, Newreno, Reno and Taho are competing, they share the bandwidth almost in half and half, but with the expense of higher loss rate.

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