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Transport Layer Congestion Control Technique (TCP VEGAS)

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Abstract: As TCP is more popular and dominant congestion control technique. TCP congestion control techniques assure reliable data transmission and detecting congestion based on packet loss or packet delay. When the network is heavily loaded there is a loss of network performance called congestion. There are two types of network that is Homogenous and Heterogeneous network and various TCP variants which can be evaluated using network simulators. There is not a fair bandwidth allocation in a homogeneous network, but fair in heterogeneous network and has a significantly lower delay. This paper will present various TCP Variants related to TCP Vegas.
Indexed Terms: TCP Vegas, Performance, Throughput, Efficiency, TCP Variants, Bandwidth

I. INTRODUCTION

TCP Congestion Control makes user access the Internet despite of resource bottlenecks and unpredictable user access pattern. Earlier, TCP uses go-back-n model with cumulative acknowledgement so Tahoe added new algorithms like Slow-Start, Congestion Avoidance and Fast Retransmit. After that modified Fast Retransmit operation and included Fast Recovery. There are certain factors like:

A. Effect on Window size.
B. How frequently the retransmission occurs.
C. Bandwidth Utilization.

All the evaluations will be performed using ns2 simulator which uses C++ and TCL language.

Higher-Level
TCP
Internet Protocol
Communication Network

Fig:1 Protocol Layering

D. *TCP deal with following issues like,*
1) *Data Transferring:* TCP decides when to forward and when to block data.
2) *Reliability:* TCP dealing with damaged, duplicate, lost and reordered packets to ensure reliability.
3) *Flow Control:* Sender sending not more than the receiver receiving capacity. This can be done by specifying a window with every acknowledgement.
4) *Multiplexing:* Allows multiple processes within a given host means single socket used for multiple connections.
5) *Connections:* TCP uses 3-way handshaking mechanism with clock based sequence number.

II. LITERATURE REVIEW

A. "Literature Survey On Congestion Control For High-Speed Wired Network" [1]

This paper described the router based congestion control approach and its main issues and challenges in controlling the congestion of high speed wired networks. Router based congestion described the strength and weakness by measuring the parameters like

Packet loss rate, Queuing delay and Queue length. All the mentioned three parameters considered most important while designing the router based congestion control algorithm.

B. Design of TCP Congestion Control Techniques by Router Assisted Approach"[2]

This paper focused to improve the initial version of TCP. This paper introduced a new method called "TCP Muzha". This algorithm allowed the router to feedback to sender about their status because accordingly they dynamically adjust their data rate and used the ns2 simulator to evaluate the performance.

C. "Performance Comparison between TCP Sack and TCP Vegas using NS-2 Simulator" [3]

This paper showed the comparison between two TCP Variants that is TCP SACK and TCP VEGAS to classify out of which one performs better than each other and the results showed that TCP Vegas is much better than TCP SACK in terms of throughput.

D. "Performance Evaluation of TCP VEGAS versus Different TCP Variants in Homogenous and Heterogeneous networks by using network simulator 2" [4]

This paper analyzed the performance of TCP Vegas in terms of throughput, average, average delay and throughput fairness in homogenous and heterogeneous wired as well as wired-cum-wireless networks. TCP Vegas performed well for wired homogenous networks, but performed worst for heterogeneous wired-cum-wireless network. There is unfair bandwidth allocation by TCP Vegas in wired and wired-cum-wireless heterogeneous networks and always exhibits lower delay.

E. "Improving Performance of TCP Vegas for High

1) *Bandwidth-Delay Product Networks"[5] :* This paper improved the TCP Vegas algorithm and renamed it as "QUICK VEGAS". It uses an estimated amount of data that is extra to update to congestion window at a connection source. Quick Vegas intelligently adjust the window size. Its simulation is also faster, which improves the overall performance
2) *"A Comparative Study of TCP Protocols: A Survey" [8]:* This paper focused on comparative study of all TCP Variants and compared their throughput, fairness, RTT fairness and Loss Ratio. TCP Cubic and HS TCP is best in terms of loss based. TCP Jersey and TCP Yeah good in both loss and delay based.

F. "A Survey on TCP Congestion Control Schemes in Guided Media and Unguided Media Communications" [10]

This paper shown the end to end delivery in guided and unguided network and also focused on TCP Congestion Control Principles and Mechanisms. Described the performance characteristics during congestion for wired as well as wireless network.

Year	Event
1974	TCP published
1988	TCP Tahoe
1990	TCP RENO
1994	TCP VEGAS
1996	NEW RENO/ SACK
1997	Proposed as standard for dealing with a TCP slow start, congestion avoidance, fast retransmit and fast recovery.
2002	3G network availability
2003	S-TCP/ HS-TCP
2004	BIC-TCP/ H-TCP
2005	TCP Africa
2006	TCP illinous/ C-TCP
2007	YEAH TCP/ TCP FUSION
2008	CUBIC
2010	A Proposal to reduce retransmission timeout from three to one
2015	Agile SD-TCP

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III. TYPES OF CONGESTION CONTROL TECHNQUES

S. No	Technique Name	Feature
1	BIC TCP (2004)	• Default Congestion Control Algorithm • Used in Linux
2	COMPOUND TCP (2006)	• Delay based • Developed by Microsoft • Used in Windows Vista
3	FAST TCP	• Queuing delay
4	HAMILTON TCP	• Use Additive Increase Multiplicative Decrease
5	HIGH SPEED TCP	• 2003 Implemented
6	SCALABLE TCP	• TCP Reno adaptation
7	TCP HYBLA	• Satellite Network • Overcome Extremely Long Round Trip Time
8	TCP LOW PRIORITY	• Use Extra Bandwidth
9	TCP NEW RENO (1999)	• Modified Fast Recovery and Fast Retransmit
10	TCP RENO	• Fast Recovery + Fast Retransmit
11	TCP TAHOE (1988)	• Fast Retransmit
12	TCP VEGAS (1999)	• Focus on Delay • Similar to Fast TCP
13	TCP VENO	• TCP Reno modification • Heterogeneous Wireless Network
14	TCP WESTWOOD	• Estimate end to end bandwidth • Wireless Network

IV. TCP VEGAS ALGORITHM

Brakmo et el. Introduced TCP Vegas. TCP VEGAS is the modification of TCP RENO and is proactive in nature. It overcomes the problem of getting three duplicate acknowledgements to detect packet loss and also it detect congestion before packet loss occur.

In Reno, during one RTT interval for any loss the congestion window is possibly decreased more than once where as in Vegas, if the retransmitted segment was previously sent after the last shrink then there is decrease in congestion window. Any loss that happened before the last window decrease do not indicate that the network got congested for the current congestion window size. Vegas detect losses faster than TCP Ren.

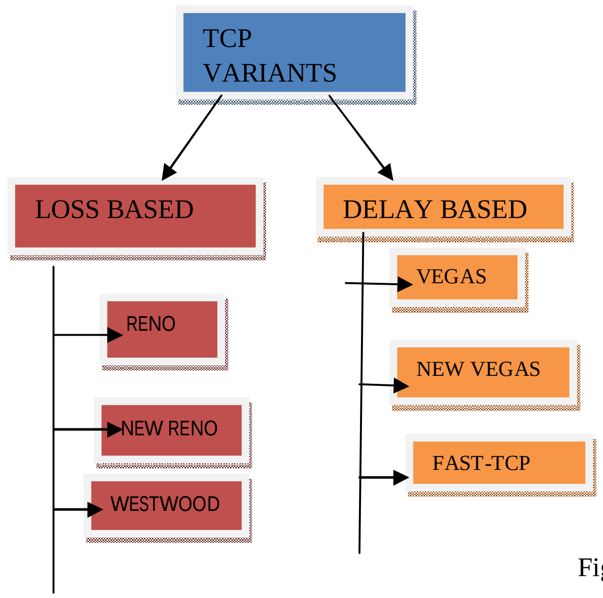

Fig:2 TCP Variants

A. Algorithm [6]:

Step1: Initalize Cwnd=1

Step2: For each ack received

Cwnd=Cwnd+1

Step3: Change Cwnd value with RTT

Cwnd=Cwnd*2

Step4: Congestion Avoidance Mechanism Phase

Cwnd>=ssthresh

TCP Vegas detects congestion by comparing the measured and expected throughput.

Expected Throughput=Cwnd/Base RTT

Actual Throughput=Cwnd/RTT

Difference=(Expected-Actual)/Base RTT

V. ISSUSES WITH TCP VEGAS

A. Fairness

As TCP Vegas is a conservative algorithm it tries to maintain smaller queues. TCP Reno and TCP New Reno keeps more packets in there bufer on average resulting in capturing more available bandwidth.

B. Re-routing

Vegas assumes that the increase in Round Trip time is because of Congestion in any network path which decreases the congestion window size.

C. Unfair treatment of 'old' connections

TCP Vegas is unfair to older connections. In any uncongested network when any Vegas connection is established ,the base RTT is close to the minimal RTT.

VI. TCP VEGAS-A (ADAPTIVE) ALGORITHM

The Slow Start mechanism and Congestion Recovery algorithm of TCP Vegas-A are same. Modified Congestion avoidance mechanism is used by TCP Vegas-A which are termed as actual throughput at time 't' and actual throughput 'th' at previous RTT. TCP Vegas uses two parameters as fixed values, like suppose 'a' and 'b' which is usually set to 1 to 3 means the average number of packets in the buffer of router is kept within 'a' and 'b'.

```
If  b>diff>a

{
If t>th
 {
Cwnd=cwnd+1
a=a+1,b=b+1
}
Else if t<=th
{
No update of cwnd, a, b
}
}
Else if diff<a
{
If a>1 and t<th
{
Cwnd=cwnd-1, a=a-1, b=b-1
}
Else if a==1
Cwnd=cwnd-1, a=a-1, b=b-1
}
```

A. Explaination

1) Diff>a means the network is not been fully utilized even the network bandwidth is available so the sending rate is increased.
2) a=a+1, b=b+1 means 'a' and 'b' are increased to help the congestion window to grow. They are increased and decreased at the same time to maintain the relationship with each other.
3) Cwnd=cwnd-1, a=a-1, b=b-1 means when congestion occurs the values are increased. Hence cwnd, the parameter 'a' and 'b' are decreased.

VII. RESEARCH METHODOLOGY

There are various connection control techniques in the transport layer for wired as well as wireless connections. In this, we are introducing a new technique for controlling congestion before packet loss or congestion occurs. If there are n packets going from source to destination and the capacity of router to hold maximum packet is n/2 in between the path. So the remaining n/2 packets would be diverted to another path.

The packets would be diverted in reverse order like first nth packet, then n-1 packet, then n-2 packet and so on. Also determining the peak time of the occurrence of congestion by estimating and analyzing the traffic over the network and When there are multiple path for sending data packets, then the speed of sending the data packets should be reduced to overcome collision at certain points. This can be better explained with the help of an example of Railway Signal System:When the train is going to cross the road, the road is blocked for a few minutes and the people having their vehicles who arrives first has to wait till that train bypasses from that location.

The vehicles who are near to crossing also cannot move back because there are several other vehicles which are behind it. But the vehicles who are at last can change the path, although the distance is more compared to that still the time taken by the vehicles who are near the crossing would be same compared to those vehicles who arrives later

VIII. IMPORTANT SUB PROBLEM

A. Throughput

Vegas throughput is 40-70%. But under heavy load TCP Vegas behaves like TCP Reno. There is a throughput loss when there is a path rerouting which may change the base RTT.

B. Utilization

TCP Vegas does not distinguish between Random loss and Congestion loss. Performance degrades when there is asymmetrical network. There is no proper utilization of resources.

IX. FUTURE WORK AND CONCLUSION

There are various types and variants of TCP and all have specific property and significance which play a major role in detecting and avoiding congestion. Hence TCP Vegas is a congestion avoidance mechanism in which throughput and utilization can be later improved more. As TCP Vegas works well with symmetrical network and also it is more aggressive than TCP Reno. Hence TCP Protocol is very reliable in-order delivery.

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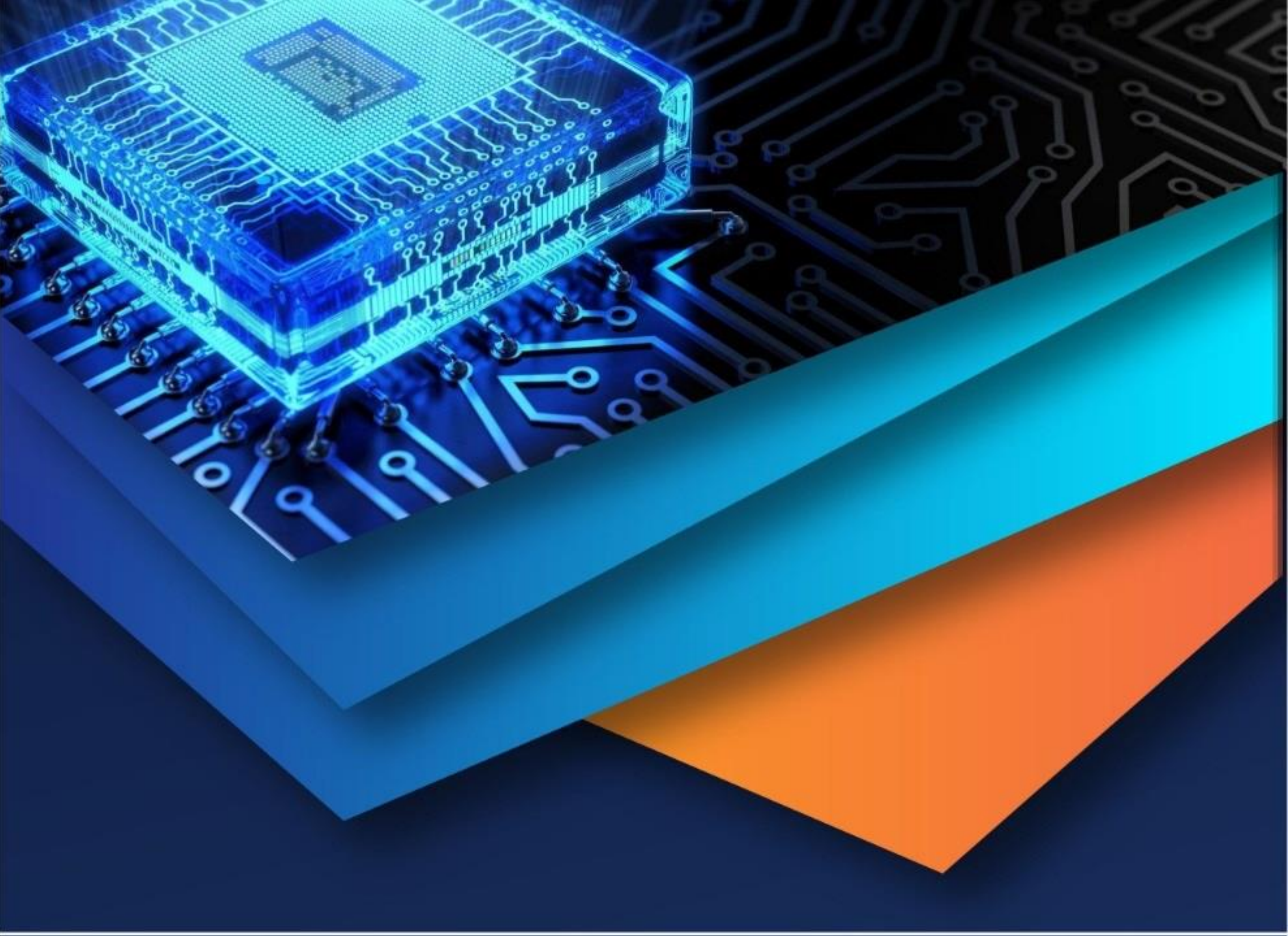

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