Asian Journal of Convergence in Technology *Volume III, Issue II*
ISSN No.:2350-1146, I.F-2.71

Performance Evaluation of Transmission Control Protocol (TCP) on Different Topologies by Varying Impairments

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Abstract- **In the tactical networks the transmission of data from one node to another node without data loss place a vital role. Usually successful delivery of message depends on a type of channel, bandwidth and bit error rate (BER). The information of the network can be measured by considering different impairments like throughput, packet loss, packet delivery ratio (PDR) in different type of topology. There are various protocols to transfer the data efficiently. Among those one of the major core protocol is Transmission Control Protocol (TCP), TCP provides reliable, order and error checked delivery of data. It is a widely used deployed transport protocol. This paper evaluates the performance of different link level impairments for considering three main topologies such as dumbbell, mesh and tree topology. We analyzed TCP by changing BER in each topology and compared the results by varying impairments.**

Keywords- ***Topology, BER, Packet delivery ratio.***

I. INTRODUCTION

A systematic representation of any network can be done precisely with the help of topology. Topology is a physical representation of a network. In a communication network there are different basic topologies such as star topology, mesh topology, ring topology and bus topology. The combination of more than one basic topology is called Hybrid topology. The performance evaluation has been done using various hybrid topologies such as tree and dumbbell topology in our research work. The given rules and regulations to perform the data communication is called as protocol. There are several protocols to transmit and receive the data. Among such widely used protocols of transport layer are Transmission Control Protocol (TCP)/User Datagram Protocol (UDP).

TCP is one of the main protocols in data communication system. TCP is a connection oriented protocol.TCP establishes the connection between the two hosts and then exchange byte stream of data. It provides reliable service because for data transfer we will get an acknowledgement. Once it start to transfer data in form of a packet and will be delivered in same order in which they were send. It provides an error free data transmission due to acknowledgement service. It helps to retransmission of dropped packets. When a web server sends an HTML files to a client it uses HTTP protocol to do so, the HTTP program layer asks the TCP layer to set up the connection and send the file. The TCP starts provide the file into packet, assign number to them and then forward them individually to IP layer for delivery. Each packet in the transmission will have same source and destination IP address. The packet may send along multiple routers the TCP program layer in the client computer was receive the entire packet. If there is a missing of any packet it will send acknowledgement to transmitter for retransmission of packet (based on missing packet number) then assemble packet in sequence order to form a file.

In digital data transmission the number of bit error in the data transmission over a communication channel that have been change due to noise, interference, distortion, attenuation and wireless multipath fading.

The number of bit changed per unit time is called bit error rate (BER). BER may be improved by choosing strong signal strength by considering line coding scheme and improve the channel coding scheme. If the channel between the transmitter and receiver is too good and the signal to noise ratio is high, then BER will be too small. Therefore communication medium plays a vital role for data transmission to any networks.

If the medium can be work well and properly the speed of the data transmission is good

and also increases the accuracy of the system. But if the medium will not work properly then data would be delayed or losses. It will decrease the accuracy of the system.

The paper is structured as follows, section two explains the literature work, section three explains the system model and design, section four depicts the performance metrics, section five detailed the results drawn and conclusions are drawn in the last section.

II. RELATED WORK

A physical representation of a network is called topology. There are various number of topology in which we have considered dumbbell topology, mesh topology and tree topology.

In [1] paper the torus, mesh, modified mesh interconnection has been briefed out. In a mesh topology all the nodes are connected with one another. In this topology every node is connected to every other node in a network. If in case of failure in one path, it takes another path to send or receive the data. The TCP and UDP protocol has been considered to evaluate above mentioned three topologies and it has been outcome that mesh topology performs better for TCP environment.

The most commonly and widely used topology by network researches for the research work is dumbbell topology. It is a topology in which the number of senders at one end and the number of receivers at the other end. In such a way that these two are connected by common routers. In this topology we can easily scaled up and scaled down the number of senders and receivers. It has been analyzed various TCP variant with different traffic environment [2].

Another important typical topology of a network communication is tree topology. It is topology in which the nodes are individually connected as similar to star topology. As the name itself indicates this topology is similar to a "tree" in which all the nodes are connected to a root. Any number of nodes can be added and also deleted easily without any conflict with the other node. Tree topology is commonly used in Network on Chip (NoC). In this topology if any nodes to fail to work its branched nodes also fails to work [3].

III. SYSTEM MODEL

In this paper the three topologies are discussed in detail namely 2*4 mesh topology, tree topology and dumbbell topology.

A. Topology

2*3 mesh topology was designed and simulated using ns-2.This topology is easily scaled and is shown in Fig. 3.1. The three basic entities of the topology are switch, resource and link.

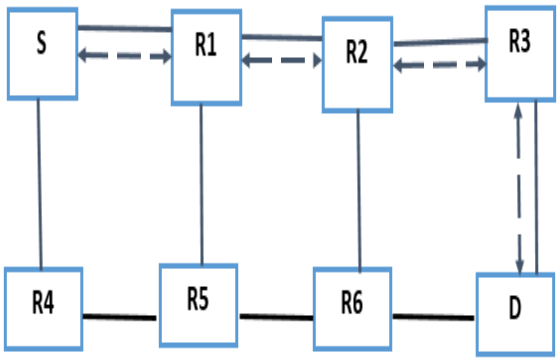


Fig. 3.1 2*4 Mesh Topology

Let 'M' be the total number of nodes in network then total number of links connected to

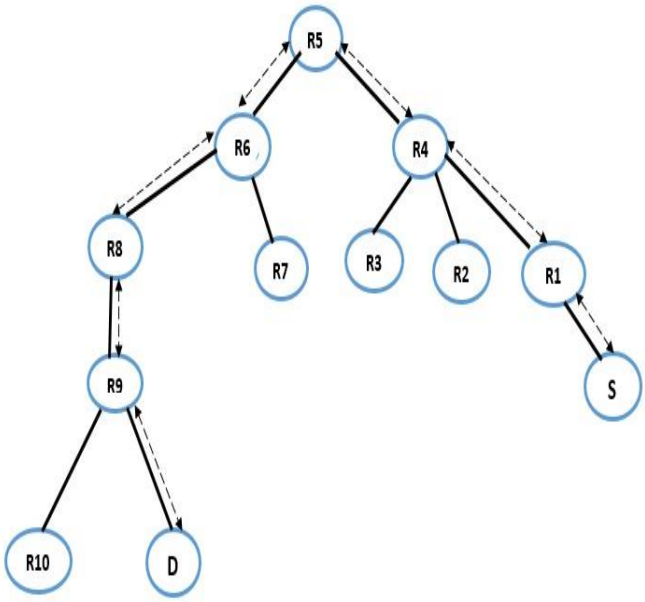


Fig. 3.2 Tree Topology

A tree topology with eleven nodes was simulated using network simulator NS-2, as shown fig. 3.2.

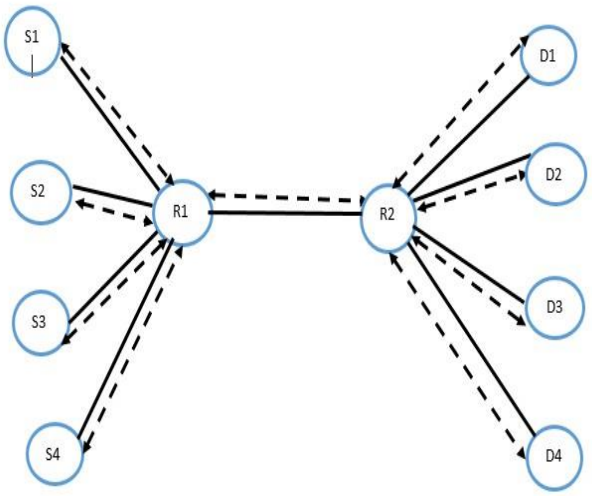


Fig. 3.3 Dumbbell Topology

S: Sender
D: Destination
R: Routers
: Link
: Data transfer

Universal acceptable topology that is dumbbell topology was designed and simulated by considering ten nodes as shown in above Fig. 3.3. These topologies reduce number of paths in routing, hence forth resulting into reduction in power consumption and keep the some level of reliability and performance.

B. Communication path

All nodes in the topology are dedicated to point to point link to other nodes in a network. The traffic carries between the nodes only when they are connected. When a link down between two nodes it results that data cannot be moved between these directions.

IV. PERFORMANCE MATRICES

To evaluate TCP protocol under different topologies the important link level impairments considered as,

A. Bit error rate (BER)

TCP is a transfer layer protocol meant for error correction and detection a single bit change in the input data is called as bit error. Bit error rate is the number of bit per unit time. The BER leads the prominent effect to the malicious data communicating in tactical networks.

B.Throughput

It is a very important parameter to measure the network performance. The number of data packets send per respective time of interval is called throughput. Basically we can consider two entities of throughput, one is Average throughput another is Instantaneous throughput. We can measure for each and every flow where in case of average throughput will be determined for all the flows in the networks. Throughput is the rate of successful message delivery over a communication channel.

C. Packet loss

Whenever, in a network the capacity of a sender and receiver is mismatched or if the channel capacity is can't able to hold to sender rate packet loss will be happened. The loss of packet in a network degrades the performance.

D. PDR (packet delivery ratio)

It is defined as the total number of packet receives per total number of packet send. It is also defined as the ratio of data packet received by the destination to those is generated by the sources. PDR should increase to achieve performance of the network.

V. RESULT ANALYSIS

An event driven simulator network simulator-2(NS-2) is used to evaluation of results.

In simulation environment we had consider number of packets=500, execution time=0.5ms to 2.5 ms, and channel bandwidth=1Mbps. Upon this simulation setup results has been drawn using trace files.

In mesh topology we considered S as source and D as a destination, the path selected is (S)-(R1)-(R2)-(R3)-(D) as shown Fig. 3.1.

In tree topology we considered S as a source and D as a destination, the path selected is (S)-(R1)-(R4)-(R5)-(R6)-(R8)-(R9)-(D), as shown in Fig. 3.2.

In dumbbell topology they considered S1,S2,S3 and S4 as a source node and D1,D2,D3 and D3 as a destination node and R1 and R2 are taken as intermediate node., the path selected is (S1)-(R1)-(R2)-(D1),(S2)-(R1)-(R2)-(D2),(S3)-(R1)-(R2)-(D3)-(S4)-(R1)-(R2)-(D4), as shown in Fig. 3.3

The Transport layer protocol TCP will be used by all the topologies for the communication we are build an error module. The code for error module used for simulation is shown below.

set err [new Error Model]

$err set rate_ 0.1

$err ranvar [new Random Variable/Uniform]

$err drop-target [new Agent/TCP Sink]

[$ns link $n0 $n4] error module $err.

#we have considered different bit error rate 10^{-1} to 10^{-5}

Evaluation of TCP Bit Error rate (BER)

Name of the Topology	MESH Topology		TREE Topology		DUMBBELL Topology	
BER	Packet loss	PDR (%)	Packet loss	PDR (%)	Packet loss	PDR (%)
10^{-1}	17	89	20	87	32	72
10^{-2}	10	91	14	30	30	74
10^{-3}	3	92	3	16	16	83
10^{-4}	1	93	1	3	3	93
10^{-5}	0	95	0	2	2	95

Table 5.1Evaluation of TCP by varying BER

The Table 5.1 depicts that the packet loss and packet delivery ratio for a different topologies for varying impairments. The bit error rate affects the data transfer for TCP protocol. The analysis has been done using different performance matrices such as throughput, packet delivery ratio and packet loss.

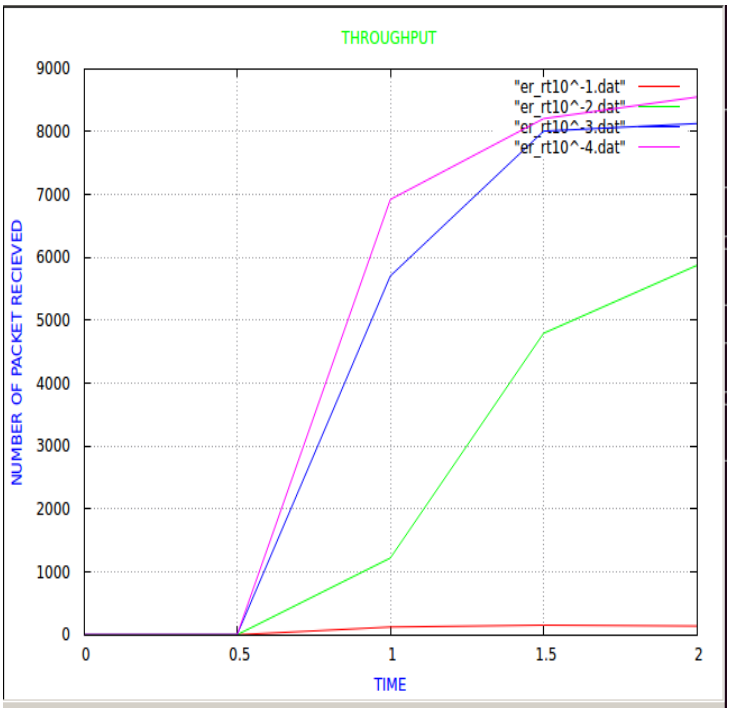
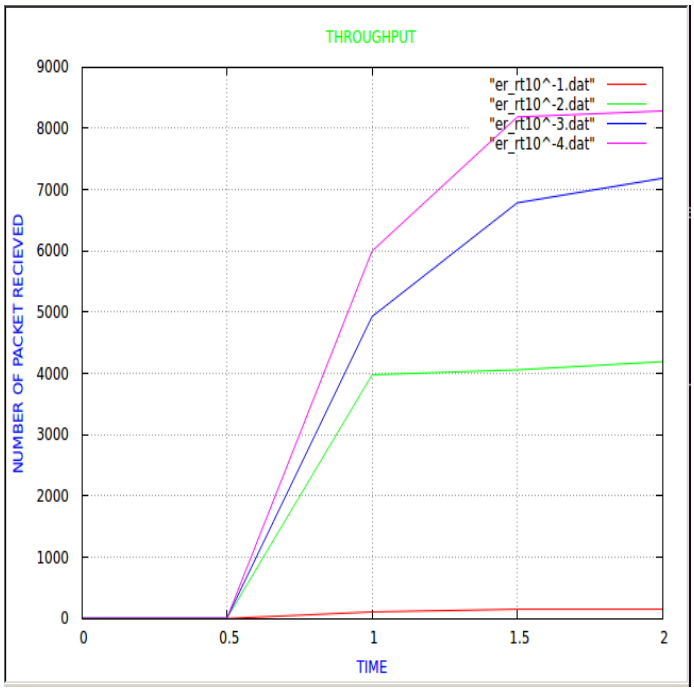


Fig. 5.1 Throughput in mesh topology

Fig. 5.2 Throughput in tree topology



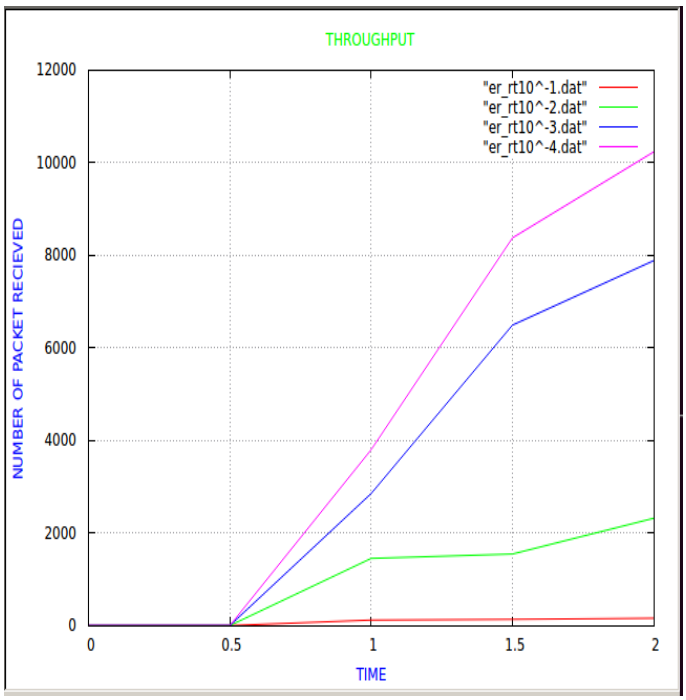
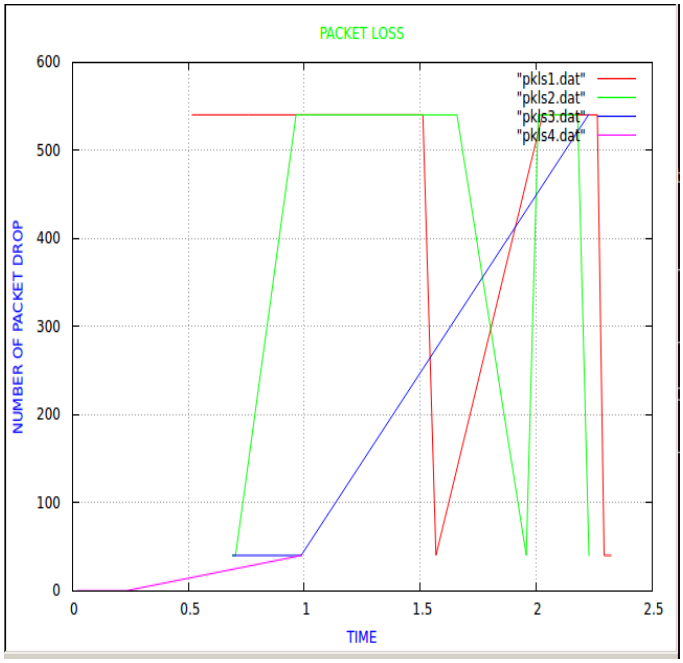


Fig. 5.3 Throughput in dumbbell topology

The throughput is optimally more for less bit error rate for all the topologies and is depicted in the above graphs Fig. 5.1, 5.2 and 5.3 respectively. We have plotted the graphs using GNU PLOT.



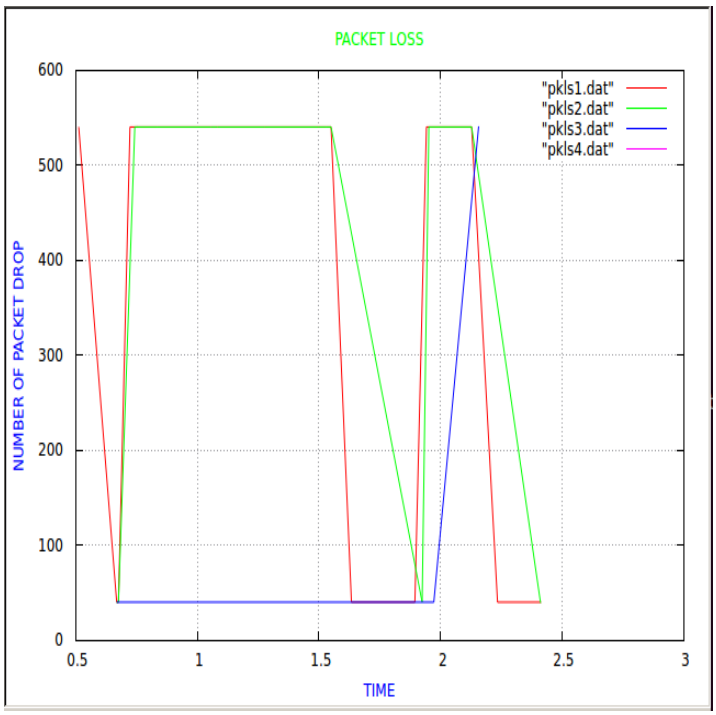


Fig. 5.5 Packet loss in tree topology

Fig. 5.4 Packet loss in Mesh topology

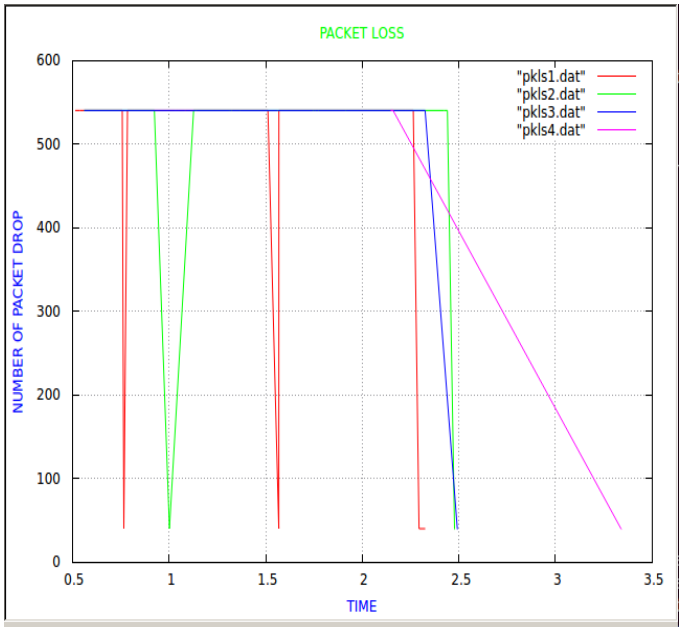


Fig. 5.6 Packet loss in dumbbell topology

The losses are more when the error rate is more as depicted in the above Graphs Fig. 5.3, 5.4 and 5.6 respectively From this comparative analysis of different topology a bit error rate affects drastically on the valuable protocol TCP their by which affects the performance of the whole network. This analysis makes us to know about bit error rate on TCP protocol.

VI. CONCLUSION

In the above analysis dumbbell, mesh and tree topology we found that on TCP protocol bit error rate and also bandwidth affects more on varying impairments such as packet loss, throughput and packet delivery ratio. It is evident that as the bit error rate increases performance all the topologies degrade. From this comparative evaluation we studied the in detail aspect of bit error rate. Further we are intended to build a novel model which eliminates bit error rate on TCP protocol in different network.

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