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Performance Comparison of Transport Layer Protocols for Multimedia Application in Wired Networks

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Abstract: *In this paper, we present to discuss the performance of transport layer protocols for multimedia application in the wired network. More precisely, TCP and UDP Performance are evaluated then compared. Two scenarios implemented to evaluate the performance of the two transport layer protocols, first scenario TCP and UDP are simulated independently. Whilst, TCP, and UDP Simulated Interoperation in the second scenario. Performance evaluated according to the QoS metrics like throughput, packet delivery ratio, fairness, and end-to-end delay. This QoS criterion has been determined for each of two transport protocol. Network simulator (NS-2.35) used to simulate and implement both of TCP and UDP.*
Keywords: *Multimedia application, Transport layer, TCP, UDP, and Performance*.

I. Introduction

Transport layer protocol is one of the important issues that may have an effect on the QoS of multimedia applications whereas transportation over the network. Many transport layer protocols used for end -to-end data transmission. UDP is one of the important protocols in the transport layer which provides end-to-end communication. It is considered for the transportation of multimedia applications since its give less delay and multimedia applications are delay intolerant. The main drawback in UDP is lack of congestion control mechanisms which might result in some packet loss and congestion in the network. TCP is another transport layer protocol this provides that connection-oriented service and also it provides congestion control mechanisms with the reliable transfer of the data onto transportation. These two protocols are the most common transport protocols used for wired networks. The capability of a network to supply better service to choose network traffic over various networking technologies called Quality of Service (QoS). The main goals of QoS are to supply priority including dedicated bandwidth, controlled to delay, and Jitter and loss characteristics. Depending upon on the handling of network traffic completely different applications have different needs. This paper focuses on the delay, packet loss, and throughput.

We work as follows:

- This research gives an overview of the TCP and UDP protocols used in the wired network and its features focusing on analysis the performance of the transport layer protocols.
- Different scenarios are implemented in order to investigate the performance. The effect of single and share link is present in the different scenarios, to see how the bandwidth of node channel have an effect on the performance of transport layer protocols.
- The QoS metrics like, throughput, delay, packet loss are used to analyze the performance of these transport layer protocols. The Network Simulator 2 (ns-2.35) is used to simulate the transport layer protocols in the wired network.

II. Related Work

M. N. Khalid, 2010[4] analyzed performance based simulation of UDP, SCTP and DCCP protocols for the transport of MPEG-4 video streaming over WiMAX as a wireless access technology. Considering single cell the WiMAX network, performance metrics such as that throughput, jitter, and delay had been determined for every of the three protocols in varied WiMAX network scenarios and typologies. On the basis of this study, it's been found that both SCTP and DCCP outmatch UDP by massive extent. Further, DCCP performance is higher than SCTP in terms of delay and jitter .While P. Gangurde.et al. 2012[5] analyzed the performance offered by SCTP for Session Initiation Protocol (SIP) message delivery from the perspective of historic research work within addition determined call setup time using UDP and SCTP out of simulating SIP traffic on the Network Simulator- 2 (ns-2). They also evaluated TCP, UDP, and SCTP traffic with a constant bit rate of traffic through ns-2. While P. G. Vanparia.et al. 2014[6] study and compared the transport layer protocols SCTP with TCP and UDP. One of the most requirements of 4G systems is that the users shouldn't feel any distinction between a wired and a wireless network and that they should have multiple choices of connectivity over heterogeneous networks. The transport layer's primary role is to provide end-to-end communications services between two or additional applications running on totally different hosts. The transport layer can additionally perform sophisticated actions like flow management, error recovery, and reliable delivery, which may be necessary. While A. H. Wheeb, 2015[7] compared the performance of transport layer protocol TCP and UDP on the wired network. Network Simulator (NS2) had been used at performance Comparison since it is most popular by the networking analysis community. Application traffic Constant bit rate (CBR) used for both TCP and UDP protocols. While C. Pakanati.et al. 2015[8] compared a performance of the transport protocols TCP, UDP, and TFRC in wired networks. The Internet has to support applications with totally different requirements. Reliability is the essential demand for file transfer whereas delay and jitter are the essential needs of streaming applications; all of the layers contribute to the successful operation of the internet. But the layer that has a direct impact on the user of the service is the transport layer. The results show that TFRC has to be finessed before it's employed on the internet. NS-2.35 is used as Network simulator.

III. Proposed Method

Finally the network simulators and how to implement the transport layer protocols such as TCP and UDP in wired networks. We describe the network topology used in the simulation. The study has been done by using Network Simulator (NS-2), AWK scripts language and Gnu plot tool. The simulation focuses on the performance of TCP and UDP using different scenarios with different parameter. Our simulation is classified into two scenarios, in the first scenario the two transport protocols TCP and UDP are simulated independently. In the second scenario, the interoperation of TCP/UDP is studied. Furthermore, simple dumbbell topology with one bottleneck link is used for both scenarios. The performance metrics used in these scenarios are throughput, packet loss, fairness, and total byte received.

IV. Results And Discussion

The performance of TCP and UDP is evaluated by using the CBR traffic high data rate (500 kbps) application traffic with large packet size (500 bytes) to simulate multimedia application traffic in the real word like a video stream over wired networks.

A. Throughput

The average rate of successful transmission data passes over a communication channel. It is measured in bytes/sec. The throughput of multimedia application refers to the total amount of data transfer between source and destination. "Fig.1" and "Fig.2" show the instantaneous throughput of TCP and UDP when simulated separately. The instantaneous throughput can generate a graph showing the amount of data received by the destination node over each second. The instantaneous throughput for both types of transport protocols TCP and UDP is shown in "Fig.3", "Table I." presents the average throughput of TCP and UDP for all simulation cases. The average throughput can produce a single value showing the average throughput for the whole duration of a simulation. The resulting average throughput between TCP and UDP under interoperation simulation is close. This is due to the share bottleneck link with limited capacity so that the total application traffic shares bandwidth. As seen from the "Table.1" the average throughput under UDP protocol is greater than average throughput under TCP protocol when simulated separately.

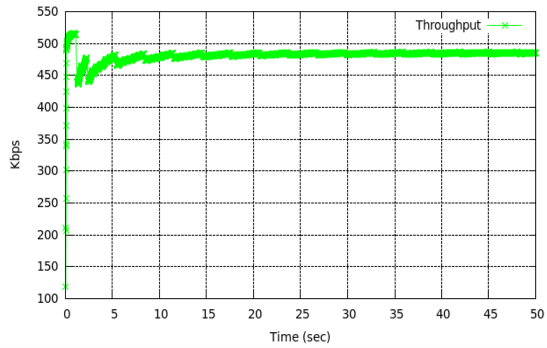

Fig.1. Instantaneous throughput of UDP- separately

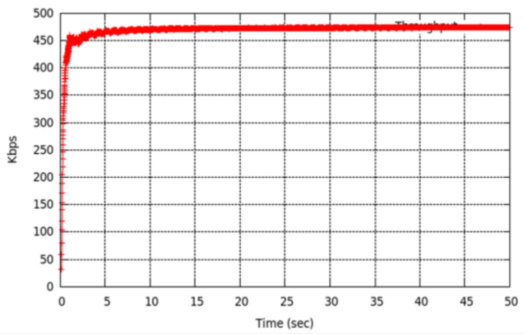

Fig.2. Instantaneous throughput of TCP- separately

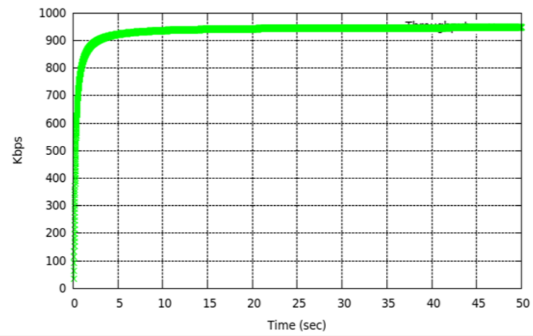

Fig.3. Instantaneous throughput of UDP- Interoperation

B. Packet Loss

The results in noticeable performance issue significantly affecting many networks application such as VoIP, video conferencing, and online game. The performance of these applications is degrading when packet loss is high. “Fig.4” and “Fig.5” show the total number of packets dropped at the gate away (238 packets) When TCP and UDP are simulated independently. Also, “Fig.6” and “Fig.7” below shows the total number of packets dropped at the gate away when the TCP and UDP are simulated simultaneously used. The loss, in this case, is 6330 packets, a remarkable difference. “Table I.” presents packet loss ratio of both TCP and UDP for all simulation scenarios.

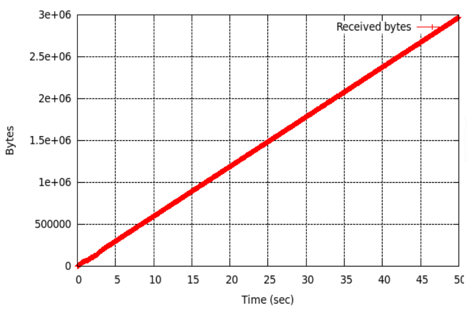

Fig.4. Total packets drop for TCP- independently

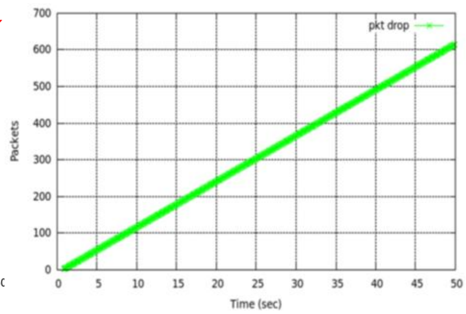

Fig.5. Total packets drop for UDP- independently

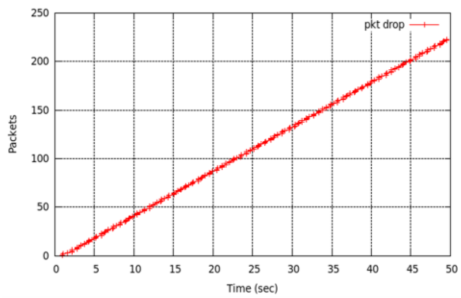

Fig.6. Total packets drops of TCP- interoperation

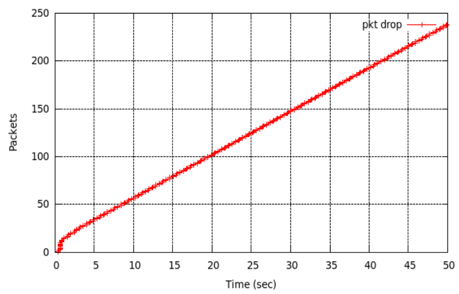

Fig.7. Total packets drops of UDP- interoperation

C. Fairness

Basically, the queue management mechanisms employed in the bottleneck router try to enforce fairness between the different connections crossing the router. “Table I.” shows the fairness of two transport protocols TCP and UDP when simulated separately and interoperation. TCP attached to one source is not fair with TCP attached to other traffic source and the same case for UDP protocol. So, there is a significant difference between the bytes transmitted by two sources and received by destinations. We can observe that fairness achieved under TCP protocol is better than UDP protocol when they simulated separately. Also, the fairness remains the same when both TCP and UDP protocols simulated interoperation.

D. Total Byte Received

At first total byte received has been measured for TCP/TCP protocol, and UDP/UDP protocol. Then it has been measured and compared between TCP/UDP protocols. Application traffic (CBR) active along the simulation time. “Fig.8” and “Fig.9” shows total byte received for both TCP and UDP protocols, when they simulated independently. On another side, total byte received for interoperation simulation of both TCP and UDP is shown in “Fig.10” and “Fig.11”. “Table I.” display total byte received for TCP and UDP in all simulation scenarios. The packet loss ratio is significantly more for UDP protocol than for TCP protocol when they simulated independently. This matches the theoretical results, in which the unreliability of UDP protocol will result in higher packet loss. On another side, the packet loss ratio of TCP protocol is more than of UDP protocol when simulated interoperation. This result is due to that UDP is unfriendly protocol when it coexists with TCP under limited bandwidth.

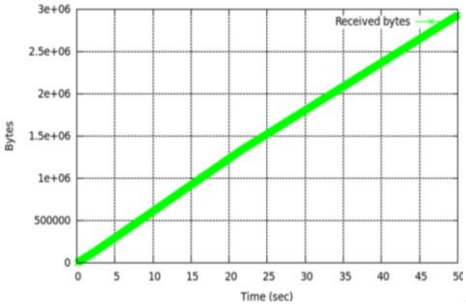

Fig. 8. Total bytes received for TCP- independently

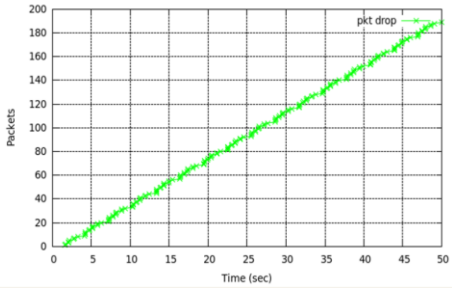

Fig.9. Total bytes received for UDP- independently

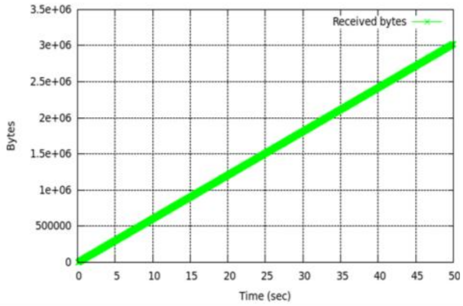

Fig.10. Total bytes received for TCP- interoperation

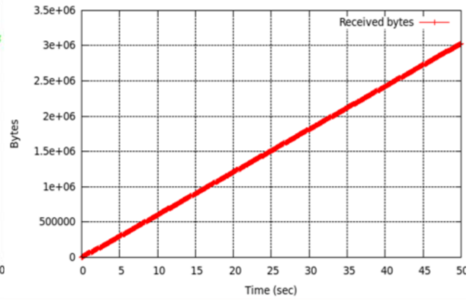

Fig.11. Total bytes received for UDP- interoperation

TABLE I: The evaluated Results OF TCP and UDP performance

Data Rate	Protocol	Simulation	Average Throughput	Packet loss ratio	Connection 1	Connection 2	Fairness	Total Byte Received
1	TCP	separately	475.064 kbps	2.11724 %	2975440	2947360	28080	2975440
2	UDP	separately	949.439 kbps.	4.92472%	3116000	2808000	308000	3116000
3	TCP	interoperation	484.971 kbps.	3.81719%	3029980	3022000	7980	3029940
4	UDP	interoperation	489.707 kbps.	3.02982%	3029980	3022000	7980	3022000

V. Conclusion

This research present performance comparison of transport layer protocols for multimedia application in the wired network. It is implemented in network simulator 2 (ns-2.35) to evaluate its performance. The two standard protocols TCP and UDP are simulated in wired networks. First TCP and UDP are simulated independently and then interoperation of TCP-UDP Is studied. TCP increases the data rate based on the bandwidth available in the network. One flow based on TCP is not fair with another flow based on TCP. Also, UDP doesn’t react to the bandwidth available. It tries to transmit every packet that is given to it by the attached application. When the data rate is high and network bandwidth is relatively low its packet loss ratio is increased. When interoperated simulation was done, UDP affects severely both TCP and overall throughput. Fairness is not the property processed by all the two protocols and to achieve it appropriate router mechanisms like queue management and schedule are required.

Notation	
UDP	User Datagram Protocol
TCP	Transmission Control Protocol
QOS	Quality of Service
SCTP	Stream Control Transmission Protocol
DCCP	Datagram Congestion Control Protocol
SIP	Session Initiation Protocol
NS2	Network Simulator 2
CBR	Constant bit rate

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