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SMOOTH DATA TRANSMISSION USING DCCP

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Abstract
Online applications such as streaming require high speed and timely delivery of data. Usually the transport layer protocols with the enhancement of new streaming applications demand for in time delivery of data is higher as compared to the reliability. Transport layer protocols, transmission control protocol (TCP) and user datagram protocol (UDP) are used to transmit the data packets over the IP managed network such as Internet. TCP gives a reliable communication protocol to transmit the data but its reliable communication may be results in transmission delay. UDP never providing any acknowledgment system also it does not provide any congestion control method. Nevertheless the unreliable performance of UDP results in much less delay in data transmission. In these days one of the major problem is the Quality of Service (QoS) guarantee. On the other side, the performance of transport layer protocols can disturb the QoS. So in such cases to avoid these concerns few new transport layer protocols have been designed by Internet Engineering Task Force. The DCCP is at highest rank for the researchers due to its lightweight and design. DCCP is particularly designed to bypass congestion in the network. It is appropriate for in time distribution of data. DCCP also offers service of an unpredictable transport layer protocol, as we know the real time connections demand for in time transmission rather than reliability. This paper evaluates the performance of DCCP protocol. For that, simple network scenarios are proposed for the simulation. In order to see its performance it is compared with the UDP. The experiments are carried on scenario of 80 nodes, 64 nodes and 8 nodes. In all of the experiments the throughput generated by DCCP is greater than UDP.

1 Introduction

The growth of real-time services has changed the expectations placed on network protocols. Applications such as video streaming [1], VoIP, and online gaming require data to arrive not only correctly, but also on time. This creates a challenge for the transport layer. The Transmission Control Protocol [2] ensures reliable delivery through acknowledgments and retransmissions. While effective for accuracy, this approach increases delay, which can disrupt time-sensitive applications. On the other hand, the User Datagram Protocol [3] removes this overhead and enables faster transmission, but it lacks congestion control and flow regulation. As a result, UDP traffic can lead to packet loss and unstable network behavior, especially under heavy load. To overcome these limitations, the Internet Engineering Task Force developed the Datagram Congestion Control Protocol. Rather than guaranteeing delivery, DCCP [4] focuses on controlling how data is sent. It provides flexibility through congestion control identifiers such as TCP-Like (CCID2) and TCP-Friendly Rate Control (CCID3). These mechanisms allow applications to prioritize smooth data flow and low delay. Previous work has shown that DCCP performs well across different environments. It achieves better throughput and fairness compared to several TCP variants [5], including NewReno, BIC, and CUBIC. In multimedia and VoIP scenarios, it maintains more stable throughput while reducing jitter and delay. Its adaptability has also been demonstrated in wireless and next-generation networks, where bandwidth and delay conditions vary frequently. The two main DCCP mechanisms behave differently. TCP-Like follows an additive-increase/multiplicative-decrease strategy similar to TCP, while TFRC adjusts the transmission rate more gradually. This smoother behavior makes TFRC suitable for applications where consistency is important. Despite these findings, detailed comparisons of these variants under different network conditions are still limited. This work addresses that gap by evaluating TCP-Like and TFRC against UDP using simulation. Metrics such as throughput, delay, jitter, and packet loss are considered to identify which approach performs better in real-time scenarios.

2 Related Work

A lot research studies done on the DCCP protocol and TCP, UDP protocols. Follows as under the studies on the DCCP performance and other network protocol. In the work [6], the evaluation of DCCP is presented with relative to other transport protocol. Through the findings it is concluded that the DCCP offers better throughput and in addition the fairness over end to end connections. BIC and CUBIC provide less fairness when compared with New Reno and DCCP. According to the author's findings, the DCCP provides good throughput and also provides fairness over end to end paths. In this work [7], author evaluated the voice quality over the Internet streams such as voice data. The IETF introduced a standardized new datagram congestion protocol - DCCP with variants; DCCP has been developed to transmit media files with congestion-controlled functionalities. The authors in [8] carried out simulation of 4G network to determine its utilization as an advance remote innovation technology. The results indicate that the DCCP outperforms in terms of throughput with the minimization of jitter and delay when compared with the TCP, UDP and SCTP at the end. Further for shared video files DCCP is better in path selection with high throughput. The authors in [9] suggested that DCCP is good with continuous data traffic. Author assessed the implementation of DCCP /CCID3 algorithm and recognized few problem areas: the dignified DCCP /CCID3 rate is lesser then the rate achieved with the standard TCP. The rate fluctuations in TFRC are also observed in the simulation. The parameters are configured to replicate long delay system where DCCP provides higher data rate. Another experimental work of online streaming media packets with DCCP transport bond over 802.11-g network systems is presented in [10]. The author's main area of study is to identify the behavior of DCCP with continuous media packets. The method used in DCCP flows in the existence of UDP and TCP Flows. Then the authors examined the behavior of each protocol generally in respects to the congestion algorithm. Moreover author also measured end points flexibility necessities. The work on congestion techniques is presented in [11]. There are two congestion control types of DCCP, first TCP Congestion Control Identifier 2 (CCID2), second is TCP Congestion Control Identifier 3 (CCID3). Application such as streaming sound, internet communication system and multi user games, real time games depends on timeliness in data and its dependability. TCP is reliable for such application however it could be further improved in order to achieve the high speed data transfer. Due to which for these applications UDP could improve transmission rate while compromising the reliability, because UDP has no congestion control. IETF- Internet Engineering Task Force launched DCCP which is appropriate for these application because of its cutting edge new features and it tends to be suitable for these applications. The results findings indicates that DCCP good for those applications which undergoes the exchange of timeliness and dependent data. DCCP protocol in speedy networks is compared by authors in [12] where they provided critical discussion on adaptability, reasonability, grouping and resemblance of DCCP and compared it with TCP-Reno. The simulations are carried out in network simulator 2. In most of the scenario the DCCP provides less delay and less packet loss when compared with other protocols. This research in [13-16] analyzed the emerging transport protocols in particular for wired networks in random conditions.

3 Experimental Setup and Configuration

This chapter contains the detail information of simulation, discussions, results and analysis of result we have obtained from the simulations. These result taken from the simulation experiments by using NS2 simulator. DCCP protocol analysis with the UDP protocol, the main parameters of analysis are propagation delay, throughput, bandwidth, In first experiments we have changed value of bandwidth from 10 mbps to 200 mbps, delay and packet size are fixed. In second experiment we have change the value of delay from 2ms to 200ms, Bandwidth and packet size are fixed. In third experiment packet size changed from 300 bytes to 2000 bytes, bandwidth and delay are fixed these experiments done with the 80,64 and 8 node network simulation. After the analysis the result the throughput of DCCP protocol more efficient than UDP in streaming media. Analysis results based on simulation experiments, each experiment carries different parameters. Values of first experiment shown below in Table 1.

Table 1: *List of Experiments*

Experiments	Simulations	
Experiments with 80 Nodes	1.	10mbps-100mbps, 1ms, packet size 1600bytes
	2.	2ms-200ms, 100mbps, packet size 1600bytes
	3.	300bytes-2000bytes, 200ms, 100mbps

Table 2: *List of Experiments values*

Bandwidth mbps	UDP	TCP LIKE	TFRC	PACKET (bytes)	TIME(ms)
10	0.131284	1.10236	1.83056	1600	2ms
20	0.2132847	1.210236	1.90188	1600	2ms
30	0.130912	1.310236	1.89786	1600	2ms
40	0.3132373	1.410236	1.70132	1600	2ms
50	0.130475	1.10236	1.93193	1600	2ms
60	0.4128893	1.510236	1.61302	1600	2ms
70	0.132331	1.10236	1.91608	1600	2ms
80	0.3130448	1.210236	1.51026	1600	2ms
90	0.131008	1.210236	1.91867	1600	2ms
100	0.3130801	1.210236	1.72794	1600	2ms

4 EXPERIMENTS WITH 80 NODES

This simulation experiments was analysis to measure the throughput of DCCP and UDP in this network scenario are 80 nodes used. There is one sending node and one receiving node.This network simulation was execute by 10 times.

4.1 Scenario 1

Observed from first simulation when bandwidth increases from 10mbps to 100mbps the performance of DCCP increases and performance of UDP decreases when value of bandwidth increased. The throughput of DCCP (TFRC) is higher than UDP. Because UDP data packets are lost during transmitting data to the other side DCCP don't lost data packets either bandwidth increases, the graphical view of two protocol is shown in Figure 1.

4.2 Scenario 2

The second network simulation performed with changing delay,bandwidth fixed 10mbps and packet size fixed 1600 bytes and delay changes from 2ms to 200ms. Observed from this simulation when propagation delay increases from 2ms to 200ms the performance of DCCP (TFRC) increases and performance of UDP decreases when value of propagation delay increased.graphical view of two protocol is shown in Figure 1.

4.3 Scenario 3

The third network simulation performed with changing packet size,bandwidth fixed 100mbps and propagation delay are fixed with 200ms.Gray and Orange lines shows the performance of DCCP and Blue line shows the performance of UDP.

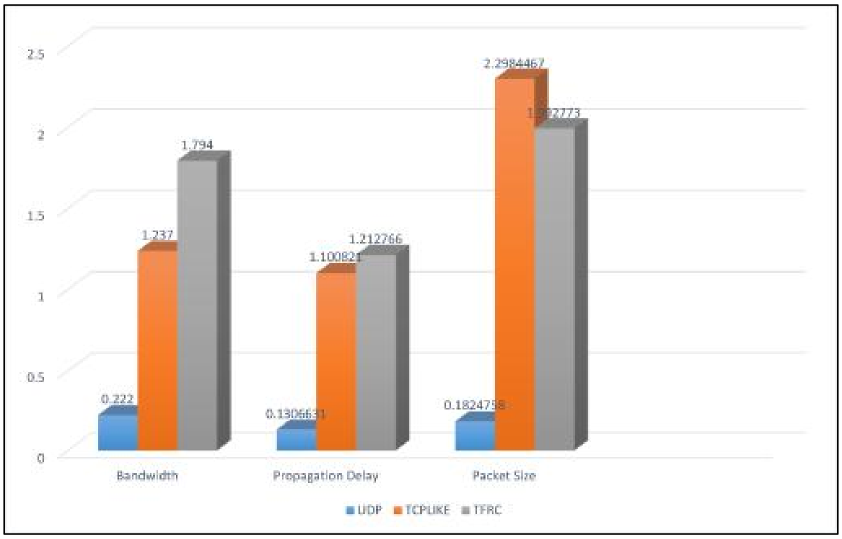

Figure 1: DCCP and UDP with 80 node

After comparing the values of three simulations with 80 nodes bar chart shows the throughput average of DCCP (TFRC) increases by ≈8 times when compared with UDP when bandwidth increases. Throughput on average of TFRC increases by ≈9 times when compared with UDP when propagation delay increases. Throughput average of TCP-LIKE increases by ≈10 times then the UDP when packet size increases as show in Figure 1.

5 EXPERIMENTS OF SIMULATION WITH 64 NODES

In the network simulation used 64 nodes with DCCP and UDP for calculating throughput. Throughput are calculated on the basis of propagation delay, bandwidth and packet size, nodes are connected with routers. In first simulation bandwidth changed from 10mbps to 100mbps, propagation delay is fixed 10mbps and packet size 1600bytes.When propagation delay increased the performance of DCCP higher than UDP. The 32 nodes are senders send data and 32 nodes are receiving nodes, sending nodes are denoted from S1 to S32 and receiving nodes are denoted with R1 to R32. The network scenario of 32 nodes is shown below.

Table 3: ***List of Experiments Results***

Bandwidth mbps	UDP	TCP LIKE	TFRC	PACKET (bytes)	TIME(ms)
10	2.15768	1.55335	3.06349	1600	2ms
20	2.35199	1.35335	3.26762	1600	2ms
30	2.15808	1.45336	3.50615	1600	2ms
40	2.45822	1.65363	3.55785	1600	2ms
50	2.15829	1.55336	3.25964	1600	2ms
60	2.55836	1.45336	3.36163	1600	2ms
70	2.15837	1.55336	3.15213	1600	2ms

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80	2.75839	1.35336	3.35751	1600	2ms
90	2.2584	1.45336	3.26403	1600	2ms
100	2.35841	1.55336	3.40671	1600	2ms

5.1 Network Simulation 2 with 64 Nodes

This experiment done with 64 node simulation, in this simulation bandwidth changes from 10mbps to 100mbps, propagation delay fixed 1ms and packet size is fixed 1600bytes. In this simulation we have observed different throughput of DCCP and UDP protocols. The throughput of DCCP is better than UDP when the number of nodes decreases the performance of UDP improve and the performance of DCCP (TFRC) Decreases at the end DCCP performance is better than UDP (Figure 2).

5.2 Network Simulation 2 with 64 Nodes

This experiment done with 64 node simulation, in this simulation propagation delay changes from 2ms to 195ms, bandwidth fixed 100mbps and packet size is fixed 1600bytes. In this simulation we have observed different throughput of DCCP and UDP protocols. The throughput of DCCP (TFRC) is better than UDP when the number of nodes decreases the performance of UDP improve and the performance of DCCP (TCP-LIKE) Decreases at the end DCCP performance is better than UDP.

5.3 Network Simulation 3 with 64 Nodes

This experiment done with 32 node simulation, in this simulation Packet size changes from 300bytes to 2000bytes, bandwidth fixed 100mbps and propagation delay is fixed 200ms. In this simulation we have observed different throughput of DCCP and UDP protocols. The throughput of DCCP (TCP-LIKE) is better than UDP when the number of nodes decreases the performance of UDP improve and the performance of DCCP (TFRC) Decreases at the end DCCP performance is better than UDP.

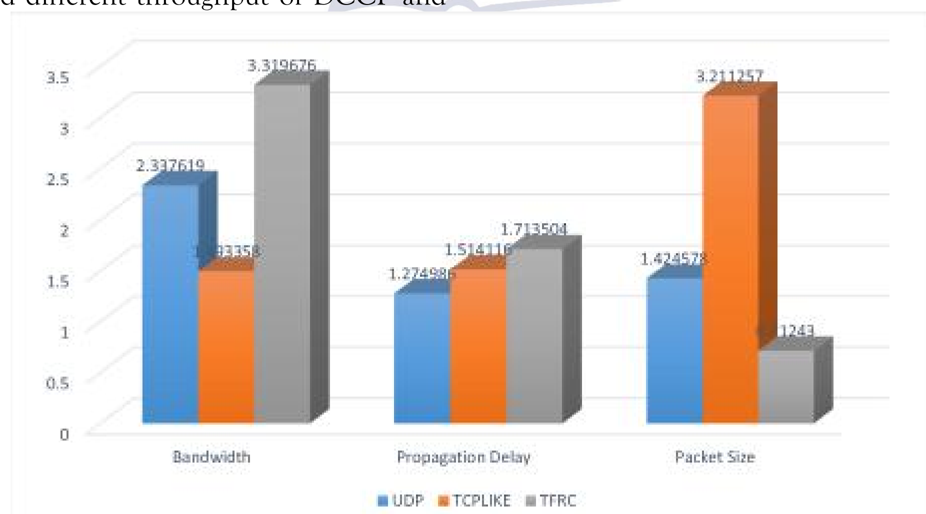

Figure 2: DCCP and UDP with 64 nodes

After comparing the values of three simulations with 64 nodes bar chart shows the throughput average of DCCP (TFRC) increases by ≈1.4 times when compared with UDP when bandwidth increases. Throughput on average of TFRC increases by ≈1.3 times when compared with UDP when propagation delay increases. Throughput average of TCP-LIKE increases by ≈2.5 times then the UDP when packet size increases as show in Figure 5.10

6 EXPERIMENTS OF SIMULATION WITH 8 NODES

This simulation experiment was analysis to check the throughput of DCCP and UDP, for measuring throughput of these two protocols used scenario of 8 nodes. Sender denoted with S1 and Receiver denoted with R1. The simulation experiment was repeated 10 times to measure the throughput. This simulation measured in three ways Bandwidth, Propagation delay and Packet Size network simulation shown in figure 5.11

Table 4: ***List of Experiments Results***

Bandwidth mbps	UDP	TCP LIKE	TFRC	PACKET (bytes)	TIME(ms)
10	2.24015	1.12191	3.28098	1600	2ms
20	2.34015	1.62191	3.48078	1600	2ms
30	2.44015	1.32191	3.28096	1600	2ms
40	2.24015	1.22195	3.32809	1600	2ms
50	2.54015	1.42119	3.48101	1600	2ms
60	2.64015	1.32691	3.58088	1600	2ms
70	2.24015	1.52165	3.38089	1600	2ms
80	2.34015	1.72153	3.68079	1600	2ms
90	2.44015	1.43791	3.58098	1600	2ms
100	2.54015	1.65193	3.38078	1600	2ms

6.1 Network Simulation 1 with 8 Nodes

This experiment done with 8 node simulation, in this simulation bandwidth changes from 10mbps to 100mbps, propagation delay fixed 1ms and packet size is fixed 1600bytes. In this simulation we have observed different throughput of DCCP and UDP protocols. The throughput of DCCP (TFRC) is better than UDP when the number of nodes decreases the performance of UDP improve and the performance of DCCP (TCP-LIKE) Decreases at the end DCCP performance is better than UDP.

6.2 Network Simulation 2 with 8 Nodes

This experiment done with 8 node simulation, in this simulation propagation delay changes from 2ms to 195ms, bandwidth fixed 100mbps and packet size is fixed 1600bytes. In this simulation we have observed different throughput of DCCP and UDP protocols. The throughput of DCCP (TFRC) is better than UDP when the number of nodes decreases the performance of UDP improve and the performance of DCCP (TCP-LIKE) Decreases at the end DCCP performance is better than UDP.

6.3 Network Simulation 3 with Nodes

This experiment done with 32 node simulation, in this simulation Packet size changes from 300bytes to 2000bytes, bandwidth fixed 100mbps and propagation delay is fixed 200ms. In this simulation we have observed different throughput of DCCP and UDP protocols. The throughput of DCCP (TFRC) is better than UDP when the number of nodes decreases the performance of UDP improve and the performance of DCCP (TCP-LIKE) Decreases at the end DCCP performance is better than UDP.

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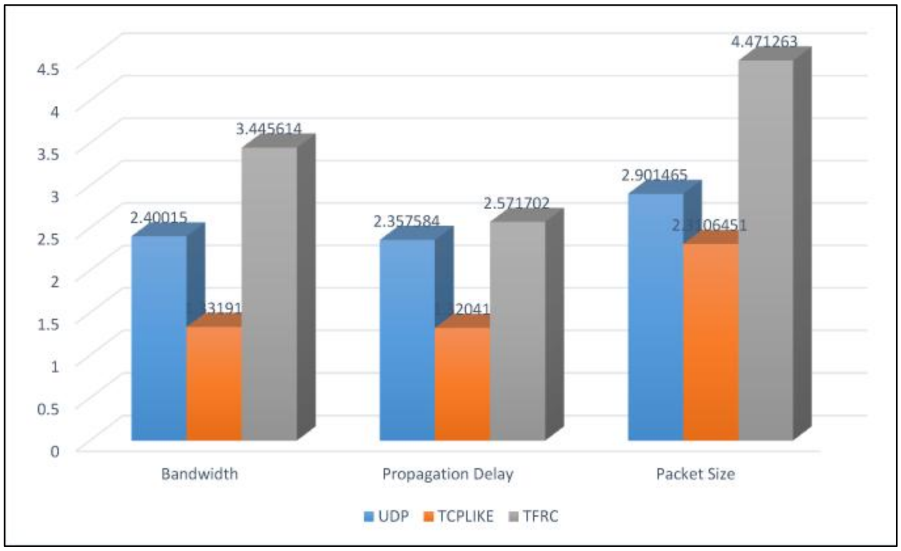

Figure 3: DCCP and UDP with 8 nodes

After comparing the values of three simulations with 8 nodes bar chart shows the throughput average of DCCP (TFRC) increases by ≈1.4 times when compared with UDP when bandwidth increases. Throughput on average of TFRC increases by ≈1.0 times when compared with UDP when propagation delay increases. Throughput Average of TRFC increases by ≈0.99 times then the UDP when packet size increases as show in Figure 5.1.

7 MEASURE END-TO-END DELAY NETWORK SIMULATION

One way delay or End to End delay shows that time taken for a data packet to be transmitted through a network from sender to receiver .Share with IP network Checking and differs from round trip time that may be only track in One Way from sender to receiver is distinguished. Different network simulation scenarios have been select to calculate the End to End delay

7.1 Calculating End to End Delay with 80 Nodes

Calculating End to End delay or One way Delay in this simulation bandwidth 10- 100mbps fixed, Propagation delay 2ms and Packet Size 1600bytes 80node simulation are used. End to End delay shown in the figure 4.

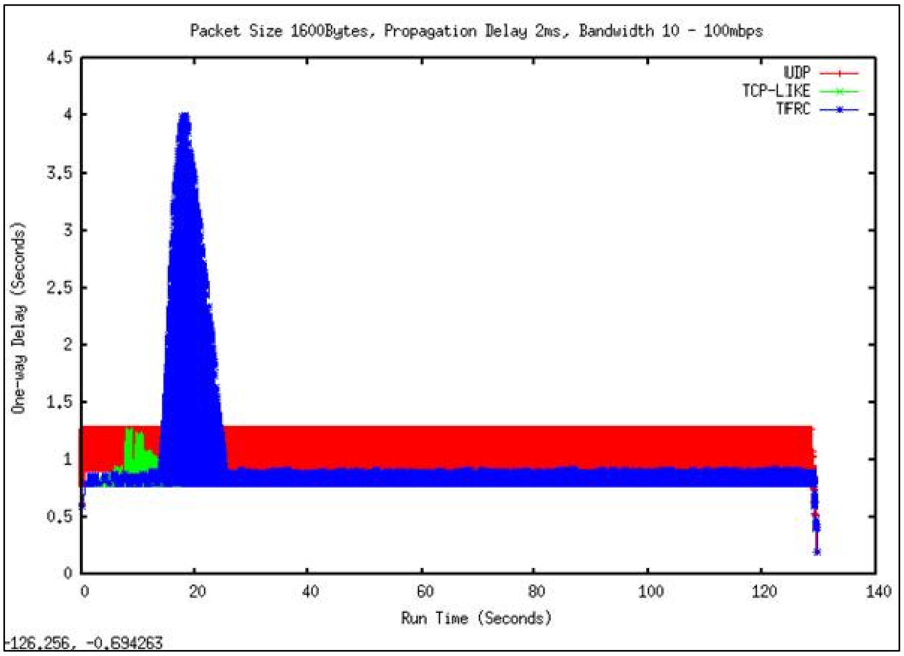

Figure 4: End to End Delay of DCCP and UDP

This figure 4 clearly shows that the data packets of DCCP protocol takes less time to transmit from source to destination nodes.Which means DCCP (TFRC) getting more throughput and minimize the delay.

7.2 Calculating Delay in Simulation with 64 Nodes

Calculating End to End delay or One way Delay in this simulation bandwidth 10- 100mbps fixed, Propagation delay 2ms and Packet Size 1600bytes64 node simulation are used. End to End delay shown in the figure 5.

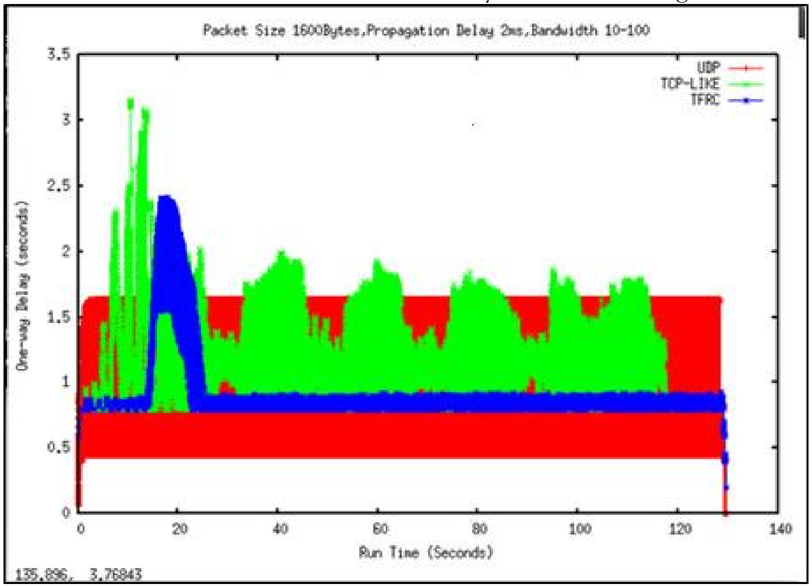

Figure 5: End to End Delay of DCCP and UDP

This figure 5 clearly shows that the data packets of DCCP protocol takes less time to transmit from source to destination nodes. Which means DCCP (TFRC) getting more throughput and minimize the delay.

7.3 Calculating Delay in Simulation with 8 Nodes

Calculating End to End delay or One way Delay in this simulation bandwidth 10- 100mbps fixed, Propagation delay 2ms and Packet Size 1600bytes 8 node simulation are used. End to End delay shown in the figure 6.

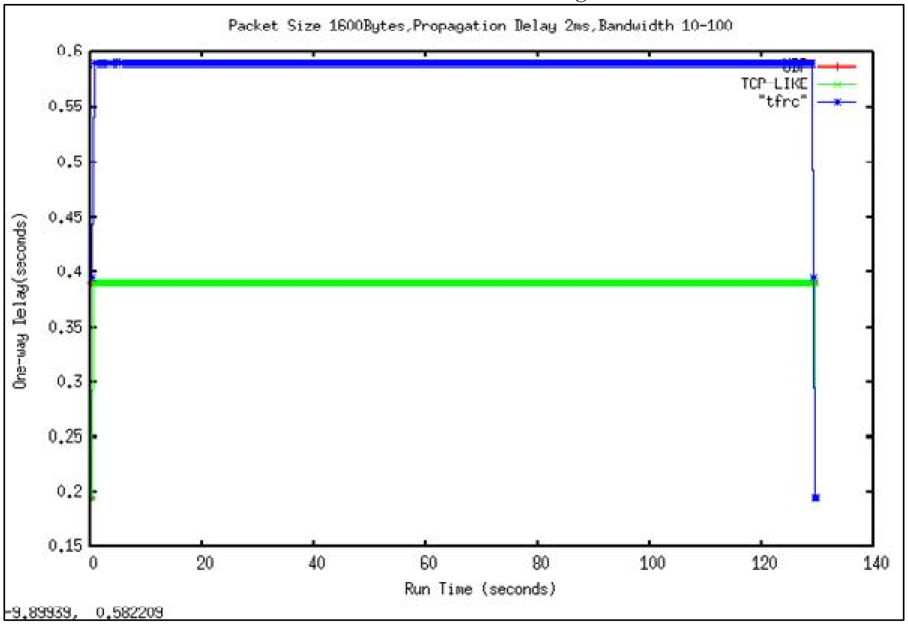

Figure 6: End to End Delay of DCCP and TCP

This figure 6 clearly shows that the data packets of DCCP protocol takes less time to transmit from source to destination nodes. Which means DCCP (TFRC) getting more throughput and minimize the delay. It shows when number of nodes are small DCCP (TCP-LIKE) takes less time and in large networks DCCP (TFRC) takes less time.

8 Conclusion

Datagram Congestion Control Protocol-DCCP is a emerging protocol and still in research module but its high rate of data transmission, with congestion control mechanism, reliability and the utilization of existing bandwidth, the structures of DCCP is very appropriate for such applications like online games, video gaming, video streaming, download large amount streaming data from the internet DCCP select suitable link from many available links. In this research work different network simulations are developed with DCCP and UDP protocol configuration. Most of the network scenario are used with different nodes. After the analyzing the results the DCCP gives high throughput then UDP. When bandwidth increased the performance of TFRC is significantly high than other two protocols with high margin. In terms of delay packets in TFRC takes less time to reach destination. It is due to the switching of links while transmission using TFRC. The throughput of

TFRC is also greater when packet size increases, however in this case the throughput of TCP-Like is also greater. In terms of number of nodes, the throughput of TFRC is greater in all scenarios. However the throughput of UDP is greater when the network is small. When network is large the throughput of UDP is less.

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