Proportional Cram of Congestion ControlTechnique in High Fastness Network

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Abstract—

Due to enhancement of broadband infrastructure, many multimedia applications such as streaming media, IPTV, video conference, online gaming and video surveillance are emerging. These video streaming generally require high bandwidth but are not responding to network congestion. And most of them prefer timeliness to reliability. TCP seems not suitable to real time applications because it rather focuses onensuring data transmission. Currently most of the applications are using UDP, but UDP is lacking of congestion protocol and no guarantee of packet delivery. DCCP is a new transport protocol being standardized by IETF that provides unreliable congestion controlled flows of data packets. In this paper, we compare the behavior of congestion control of these transport protocol by manipulating the queue size, link capacity and packet delay. Network Simulator NS-2 was used to evaluate the network scenarios.

Key words—

Transport Protocol, TCP, DCCP, Congestion Control.

I. INTRODUCTION

High Definition (HD) and three dimensional (3D) type ofTV and video streaming is seen to be the next milestone in theevolution of digital video storage and transmission. It willtransforming TV watching into an immersive interactiveexperience with technology capitalizing on advances in digitalTV broadcast, 3D visualization, image processing, and efficientcommunication of rich interactive multimedia material hasbecome an important target to create new revenues in thebroadband arena [1],[2]. Fast growing internet mediaapplications such as streaming media, video conferences, videosurveillance and online gaming need a new requirement ofnetwork protocol. They are extremely sensitive to qualityfluctuation and delay, but losing a certain number of

packetswould not affect the quality of service [3].The first consideration to the transmission over IP networkis the bandwidth needed to ensure an appropriate Quality ofservice (QoS) at the transport layer because at thislayer the service could be sent in uncast, multicast orbroadcast. Another important issue with the real time,

highbandwidth media delivery over IP is congestion prevention andcontrol because transmission of large data without suitablecongestion control may reduce the throughput and increasedelay for other applications which sharing the same links [4].

Applications	HTTP, FTP, 3D Video Traffic (MPEG/H.264)
Transport	TCP, UDP, SCTP, DCCP, …
Network	IP, ICMP, IGMP, …
Link	Device driver
Physical	Wired, Wireless Technology

Table 1: Traffic flows from application to link layer

Transmission Control Protocol (TCP) [5] and User Datagram protocol (UDP) [6] are no longer suitable as the transport protocol since they present several problems when working with modern real time applications and networks. They are also does not use a standardized way to adjust for congestion. TCP has its own limitations, for example it rather focuses on ensuring data transmission. With UDP having noconnection state, firewalls will often not allow traffic through which means that media applications will revert to using TCP. This is becoming a bigger problem as home users switch to broadband connections

behind firewalls, utilize network address translator (NAT) and extensively use media applications. Where UDP is used it also causes the problem of higher than desired traffic on the Internet as many packets arediscarded due to lack of congestion control. The Datagram Congestion Control Protocol (DCCP) [7], [8] is a new transport protocol, but it is no longer too young to be usable, since the first RFCs were published in 2006, and a stable and quite complete Linux implementation exists. But how good is the service provided to applications by this protocol? And how the congestion control works among the same sets of traffic

flow?In this paper, the behavior of congestion control of TCP and DCCP is investigated and we present results ofexperiment evaluations in network states varying queue size,link capacity and packet delay.

II. TRANSPORT LAYER PROTOCOL

In computer networking, Transport Layer provides end-toendcommunication services. When data transmitted, thetransport layer gets data from Application layer and dividesthem into several data packets. In this section, fundamentalknowledge of typical protocols in this layer which are TCP,UDP and DCCP are described.TCP is meant for highly reliable end-to-end protocol. Web browser is one of the best examples of TCP applications. To establish a connection, TCP uses a "three-way handshake". Before a client attempts to connect with a server, the server must first bind to and listen at a port to open it up for connections. Once the passive open is established, a client may initiate an active open. Figure 1 shows the three-way handshake. Firstly, client send SYN packet and server reply assending SYN+ACK packet. By replying ACK, connections between client and server are established, and terminals can send data

packet. It goes the similar to the disconnection [9].When sending data, TCP control the number oftransmission data by maintaining *congestion window* to avoidcongestion. When receiver received data packet, every packetreception, has to send ACK packet to sender. If sender couldnot receive ACK for certain period of time, it will retransmitsame data packet. Using these controls, TCP provides packetsreliability. The advantage and the drawback of TCP are asbelow.

Advantage

・Guarantee packets delivery

・Friendly to other protocol or other session packet.

Drawback

・High latency due to some process

B. DCCP [10], [11, [12]

DCCP is a massage oriented transport layer protocol that implements reliable connection setup, tear down, andcongestion control. It is used for applications that have strict timing constraints on the delivery of data. It also provides a congestion control mechanism at user's choice but without data retransmission. In DCCP, there are choices of congestion control mechanisms which are made via Congestion Control identifiers (CCIDs). CCID2 and CCID3 are the mature

identifiers and already implemented in Linux OS.

1) *CCID2* [13]

CCID2 provides a TCP-like congestion control mechanism that describes Additive Increase Multiple Decrease (AMID). This mechanism has the following features: [5]

a) Sender maintains a congestion window and sends packets until that window is full.

b) One ACK per 2 packets by default.

c) ACK declares exactly which packets were received.

d) Dropped packets and ECN (Explicit CongestionNotification) indicate congestion.

e) Response to congestion is to halves the congestionwindow.

f) ACK contain the sequence numbers of all receivedpackets within some window related to selective ACK(SACK)

2) *CCID3* [14], [15]

CCID3 or TCP-Friendly Rate Control (TFRC) is anequation-based and rate-controlled congestion control mechanism. TFRC is designed to be reasonably fair when competing for bandwidth with TCP-like flows. TFRC congestion control in DCCP's CCID3 uses a different approach. Instead of a congestion window, a TFRC sender uses a

sending rate. The receiver sends feedback to the sender roughly onceper round trip time (RTT) reporting the loss event rate. The sender uses this loss event rate to determine its sending rate. If no feedback is received for several round-trip times, the sender halves its rate.

C. *Congestion Control Difference in TCP and DCCP*

The main difference between this two is that DCCP packet is datagram, and TCP packet is segment. So, DCCP does not have to retransmit. Other differences are as below.

・DCCP uses ACK as a detection of congestion, TCP uses ACK as a prompting retransmission.

・DCCP does congestion control for not only data packet also ACK by using ACK ratio control.

・Terminal can send ACK packet when process of header using DCCP. Using TCP, terminal can't send ACK packet, until process all data.When establish and disconnect end-to-end connection,DCCP uses hand shake, as same as TCP. However when datapacket are sent, DCCP and TCP are different. There are lots ofwork has been done on comparing the performance ofstreaming video over DCCP

with TCP and UDP showingpromising results [16], - [21].

III. SIMULATION SETUP

In this section, the performance of TCP, UDP and DCCPare compared by referring some papers related, withmodification to the simulation architecture. The networksimulation topology used is classic dumb-bell which is a verycommon topology that has been used in many networksimulations. The network simulator NS-2 version 2.35 wasused in this simulation. The DCCP patch in this version isbased on the patch written by Nils-Erik Mattsson for NS-2version 2.26 [22], [23], [24]. The default parameters are set asfollows. All the senders and receivers are connected as statedin figure 2 and table 3 as the default values. The connection tothe routers is through 10 Mbps links with 2ms propagationdelay.
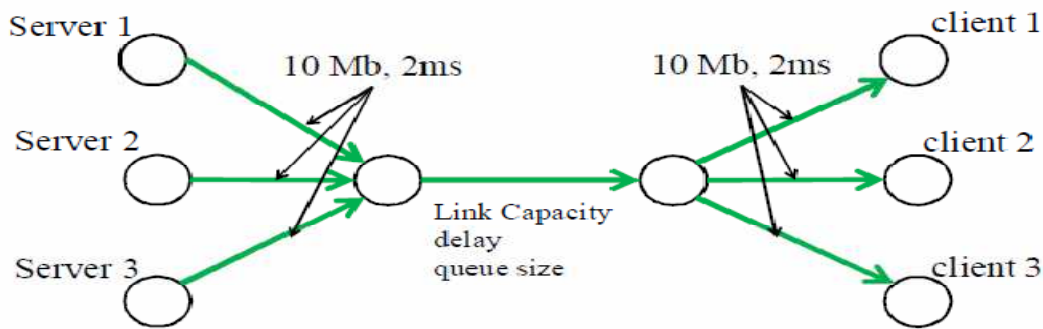
Fig. 2. Simulation Topology

TCP maximum window size	20
Queue Size	20
Link Capacity	10 Mb
Delay	2 ms
Packet size	500 byte

In this simulation environment, the performance of thoseprotocols area measured and compared with changing value -the bottleneck's link capacity, the queue size and the packetdelay value. To simulate video streaming, Constant Bitrate(CBR) is used in this simulation. Table 4 shows the traffictime for each client.

	Client1	Client2	Client 3
Start time	0 s	5 s	10 s
Stop time	50 s	50 s	50 s

Table 4. Start / Stop time traffic flows

IV. RESULTS AND ANALYSIS

A. *TCP*

Fig.3 shows the result using default value as mentioned in Table.1. This figure shows, Client 1 flow start first seems to have advantage over the bandwidth. In this simulation we did not set client priority.
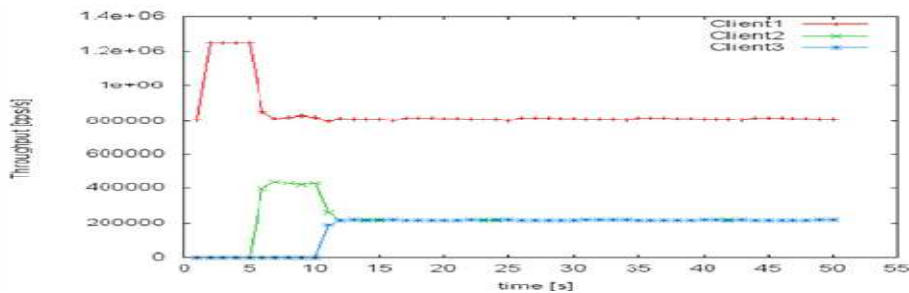

Fig. 3. TCP default value

When the link queue size is increased from 20 to 100, allclients shared the bandwidth fairly as show in Fig. 4. Biggerqueue can accommodate packet, so all client's packet can stack
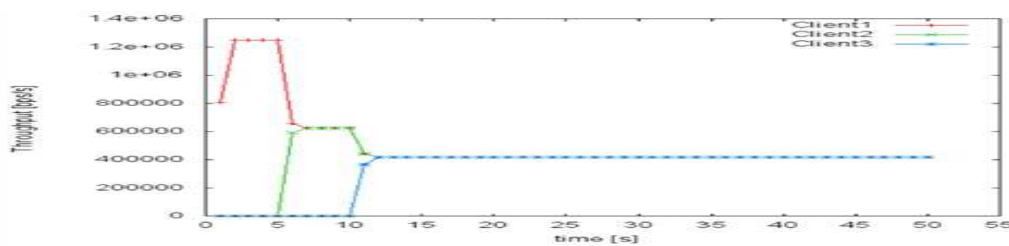
Fig. 4. TCP Queue Size = 100

Figure 5 is a result when the TCP link capacity increasedfrom 10Mb to 20 Mb. It seems that the network canaccommodate more packet, and all client's throughput areincreased compared to previous results, but still client1 hasadvantage compared to other clients who start late.
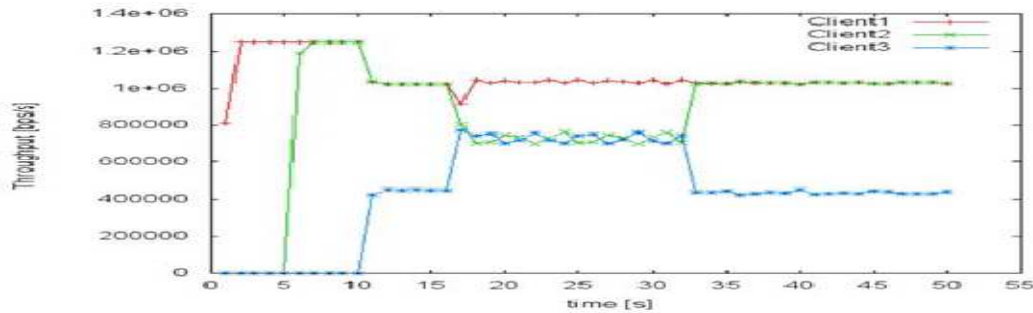
Fig. 5. TCP Link Capacity = 20Mb

Default value for Link delay is set at 2ms. Following resultswas the behavior when we increased the delay value to 10ms,and 50ms.

Fig.6 and Fig 7 shows the result of link delay =10ms, 50ms respectively. Due to delay, throughput decrease,however clients could share bandwidth with each other.
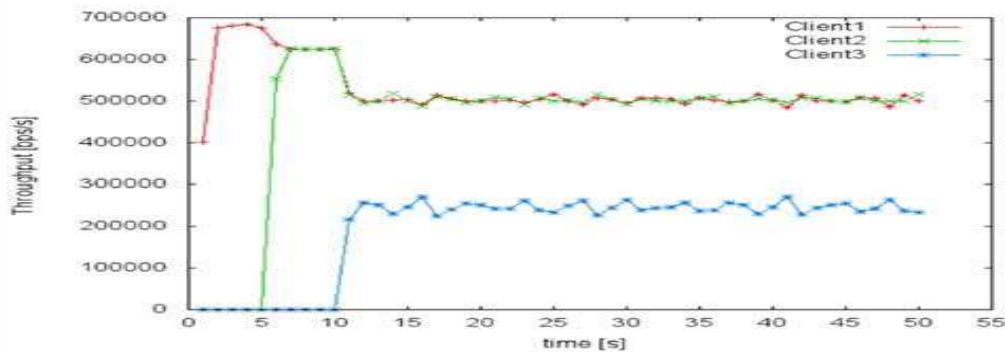

Fig. 6. TCP Link delay = 10ms

B. *DCCP – CCID2*

Figure 8 shows a result of DCCP – CCID2 using defaultvalue in table 3. Compare to TCP, CCID2 could have fair sharewith each other, but until 25 second we can see a fluctuationamong clients. This big fluctuation may have influence ofquality of service or TCP-Like congestion control mechanism.

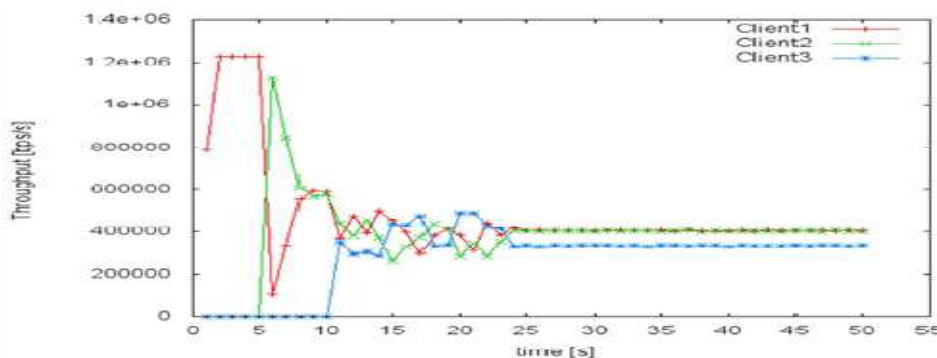*Proportional Cram of Congestion Control Technique in High Fastness Network* | S. Uma Rani & T. Lakshmi Narayanan

Fig. 8. DCCP-CCID2 using default value

When we increase the queue size, the fluctuation amongclients was bigger and took longer time to get stable. However,all clients still consume bigger bandwidth. From this result(figure 9) when the queue size is big, RTT may longer in NS2.
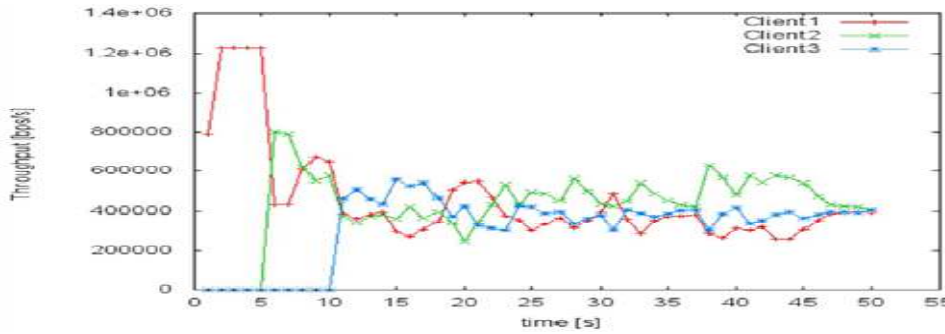

Fig. 9. DCCP-CCID2 Queue Size = 100

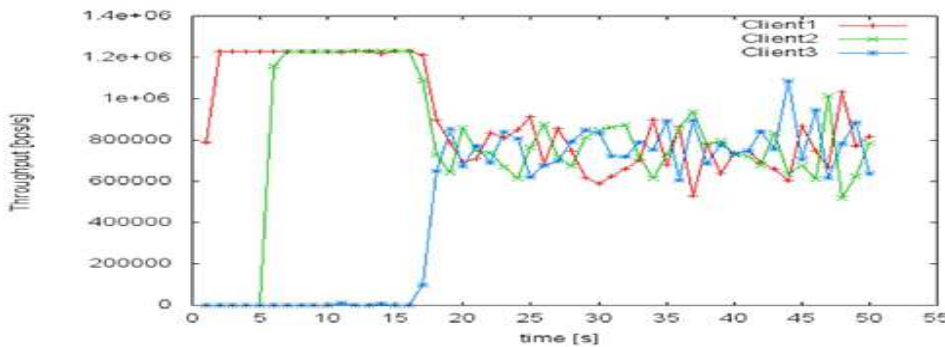Figure 10, is the result of CCID2 when the link capacitywas increased to 20Mb. We can see the throughput wasincreased and still clients have a fairly shared bbandwidth

Fig. 10. DCCP-CCID2 Link Capacity = 20Mb

Figure 11 and 12 are the result when the link delay was setto 10ms and 50ms. From the graph, we can see a bigfluctuation, and the fluctuation velocity get low. This couldbecause of CCID2 control traffic by prediction and ACKpackets. But due to long a delay, sender cannot get ACKinformation rapidly. And causing congestion window toincrease until congestion happened. Sometimes sender couldn'tget ACK packets within the certain times, and congestionwindow get decreases.
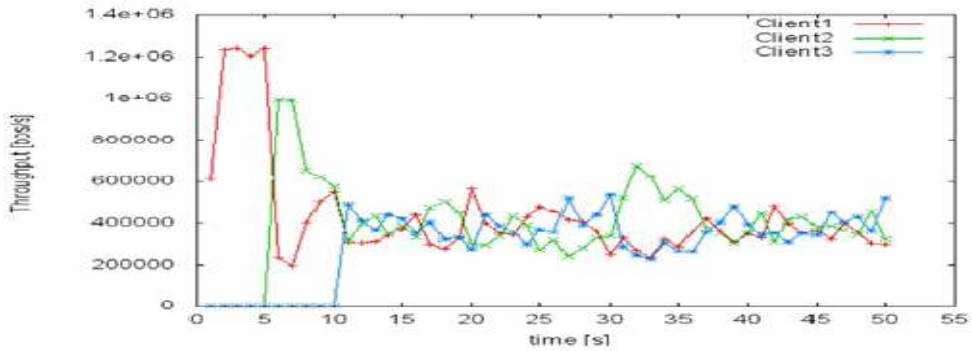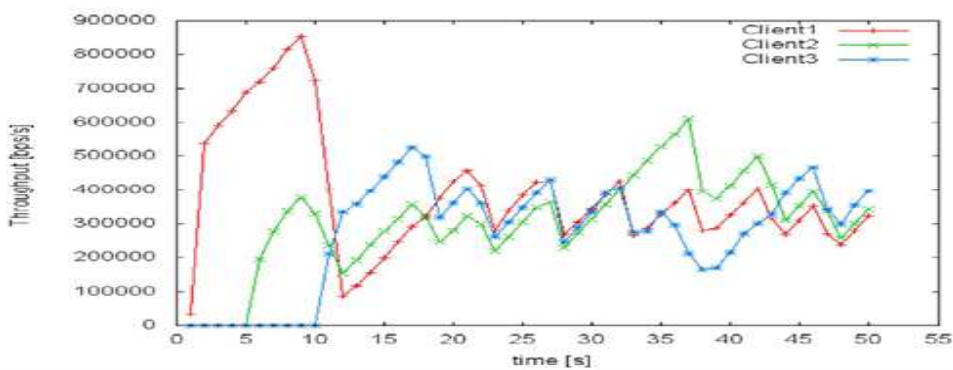
Fig. 11. DCCP-CCID2 Delay = 10ms

Fig. 12. DCCP-CCID2 Delay = 50ms

C. DCCP-CCID3

The result of using default value for CCID3 is shown inFigure 13. Compare to CCID2's result in figure 8, fluctuationin CCID3 is smaller, and the throughput line seems smoothly.CCID3 known to be more suitable for application such as VoIPandVideo streaming
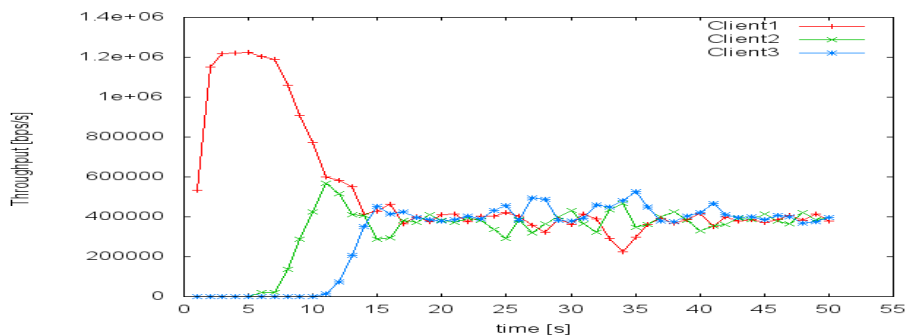

Fig. 13. DCCP-CCID 3 using default value

Figure 14 is the result when the queue size was increased to100. From this result, when queue size is big, fluctuation issmall and it took longer time for new coming packet tostabilize the throughput.
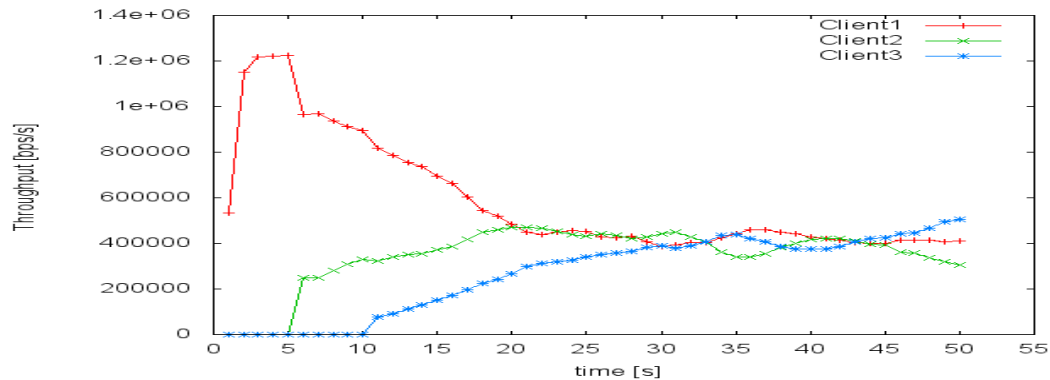
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Fig. 14. DCCP-CCID 3 Queue Size = 100

When the link capacity increased to 20Mb, we can see fromthe graph (Figure 15) that throughput increased and theperformance are not that fluctuated. This behavior shows theCCID3 (TFRC) uses a smooth rate adjustment.
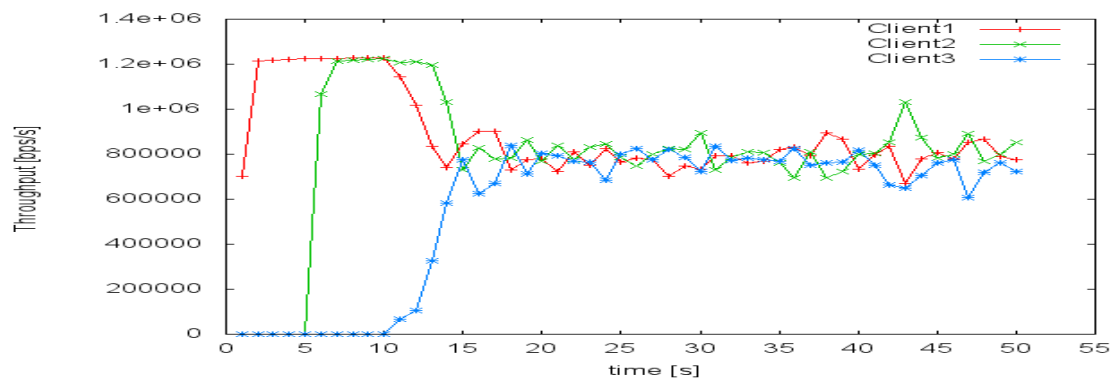

Fig. 15. DCCP-CCID 3 Link Capacity = 20Mb

On the delay test for the CCID 3 shows significantdifference compare to other protocol. Figure 16 shows theeffect when we increased the delay to 10ms. Here the graphstill shows similarity to the default graph (figure 13). Only thethroughput need time to be stabilized. But, from figure 17, wecan see that the CCID3 cannot transmit packet when the delayequal to 50ms. CCID3 control traffic by received ACK.However, within certain time if sender cannot receive ACKpackets, CCID3 decrease the traffic to 1 packet. So, high delayhas bad impact on CCID3.
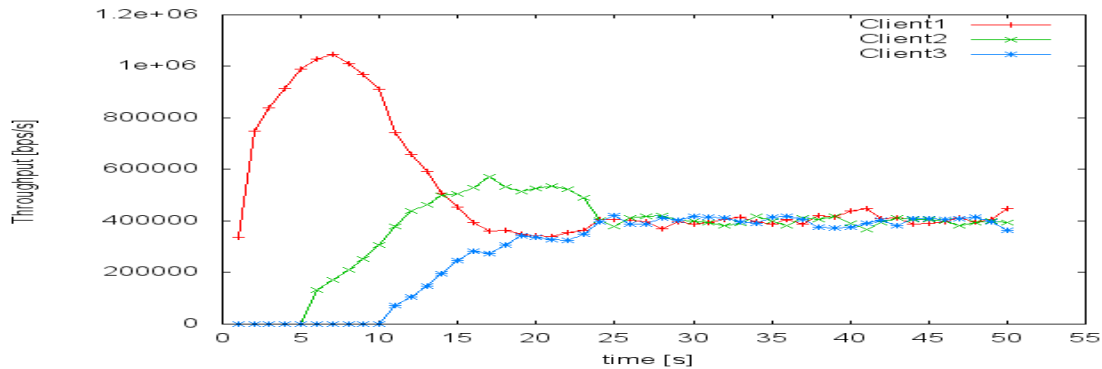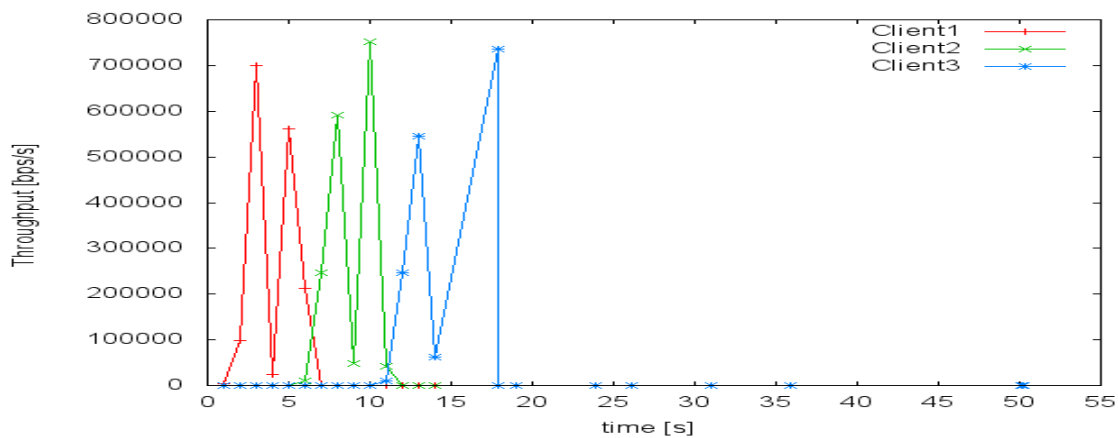
Fig. 16. DCCP-CCID 3 Delay = 10ms

V.

CONCLUSION

Many research papers discussed on the DCCP effect overTCP and UDP. In this paper, an experimental of TCP, DCCPCCID2and DCCP-CCID3 behavior over three servers-clientson the same network is presented. It is shown that certain timeof delay can give a bad impact to the TCP and DCCPtransmission. However, DCCP-CCID2 (TCP-Like) still canreact to the situation compare to DCCP-CCID3 (TFRC). Interm of capability to have a fairly bandwidth tolerance amongother transmission, DCCP shows a better result compare toTCP where the later packet in the network normally will nothave chances to gain better throughput. Among all, DCCPCCID3(TFRC) shows the best traffic flows as they have asmooth adaptation to make the total transmission less fluctuateand suitable for Video streaming and VoIP.

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