Performance Evaluation of UDP, DCCP and TCP in Congested Wired Networks

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ABSTRACT

Communication through the internet is one of the dominant methods of exchanging information. TCP and UDP are the transport layer protocols responsible for transit of nearly all Internet communications. Due to the growth of real-time audio and video applications, UDP is being used more frequently as a transport protocol, but unlike TCP, UDP has no mechanism for congestion control leading to wasted bandwidth and poor performance, so the DCCP protocol has appeared as a replacement for UDP. In this article, the author performs some simulations using NS2 for Drop Tail and RED queuing models to evaluate the performance of TCP, UDP, DCCP CCID2, and DCCP CCID3 protocols in congested wired networks. The performance metrics used are throughput, end to end delay, number of sent and lost packets. The obtained results show that the DCCP CCID2 performs the best throughput with the minimum of delay as compared to UDP, TCP, and DCCP CCID3.

KEYWORDS
CCID2, CCID3, DCCP, Drop Tail, NS-2, RED, TCP, UDP

1. INTRODUCTION

Internet communications have become the principal method of gathering and transporting information. TCP and UDP are responsible for the transit of nearly all Internet communications. TCP is a reliable protocol that provides congestion control. But, reliability and congestion control need much overhead and delay. TCP overhead reduces throughput, making it difficult to run applications that must stream large amounts of data in real-time (Kumar, 2012).

UDP is an unreliable protocol with no mechanism for reliability or congestion control. This makes it ideal for streaming video, IP phone, and other applications that require high throughput and low latency. But the absence of congestion control in UDP cause problem. When UDP applications push more data through a congested network, packets must be buffered or dropped and performance will be bad. The Datagram Congestion Control Protocol (DCCP) is one of the replacements for UDP (Wheebe, 2015).

DCCP is unreliable protocol and provides a congestion control mechanism. It has many congestion control mechanisms as TCP-like congestion control (CCID 2) and TCP-friendly rate control (CCID 3) (Kohler, 2006). The first is a window-based congestion control mechanism and the latter is a rate-
based mechanism. the acknowledgments are utilized to ensure congestion control not for Reliability. DCCP is suitable for applications that prefer timeliness over reliability (Sarwar & Boreli, 2009).
However not only the End nodes but also Routers can detect and avoid congestion, and There are many algorithms used in them to do that, such as RED and Drop tail algorithms.
In this paper, we will analyze the behavior of TCP, DCCP CCID2, DCCP CCID3 and UDP protocols in the congested wired networks when applying Drop tail and RED algorithms in the routers (Postel, 1981).

2. TRANSPORT LAYER PROTOCOLS
In the TCP/IP model, the transport layer accepts the data from the application layer and adds its header, then forwards to the lower layers for further processing. The transport layer provides efficient, reliable services such as reliable data transfer, congestion control, buffering, flow control and multiplexing / demultiplexing. Therefore, its performance directly affects the application performance as perceived by the user. Many protocols have been proposed by IETF to meet the requirements of the transport layer, the most known are User Datagram Protocol (UDP) (Postel, 1980), Transmission Control Protocol (TCP) (Postel, 1981), Datagram congestion control protocol (DCCP) (Kohler, 2006). UDP is one of the basic protocols of internet protocol stack. It is a simple transport layer protocol that does not provide any reliability and in-order delivery of the data packets. Also, there is no congestion control mechanism in UDP. It is very suitable for applications that prefer packet loss to jitter or time critical requirements. UDP is considered where the in-time delivery of data is important rather than reliable delivery. So, most of the multimedia application such as video streaming use UDP as their transport protocol.
TCP is one of the main protocols of the internet it provides reliable, ordered, and error-checked delivery of a stream of octets (bytes) between applications running on hosts communicating by an IP network. TCP uses a number of mechanisms to achieve high performance and avoid congestion collapse, where network performance can fall by several orders of magnitude. These mechanisms control the rate of data entering the network, keeping the data flow below a rate that would trigger collapse. Acknowledgments for data sent, or lack of acknowledgments, are used by senders to infer network conditions between the TCP sender and receiver. Coupled with timers, TCP senders and receivers can alter the behavior of the flow of data. This is more generally referred to as congestion control and/or network congestion avoidance. Modern implementations of TCP contain four intertwined algorithms: slow-start, congestion avoidance, fast retransmit, and fast recovery (Kumar, 2012).
DCCP is a new transport layer protocol proposed by IETF. the Datagram Congestion Control Protocol (DCCP) is a message-oriented transport layer protocol. DCCP implements reliable connection setup, teardown, Explicit Congestion Notification (ECN), congestion control, and feature negotiation. The IETF published DCCP as RFC 4340, a proposed standard, in March 2006. RFC 4336 provides an introduction.
DCCP provides a way to gain access to congestion-control mechanisms without having to implement them at the application layer. It allows for flow-based semantics like in transmission control protocol (TCP), but does not provide reliable in-order delivery. Sequenced delivery within multiple streams as in the stream control transmission protocol (SCTP) is not available in DCCP. A DCCP connection contains acknowledgment traffic as well as data traffic. Acknowledgments inform a sender whether its packets have arrived, and whether they were marked by Explicit Congestion Notification (ECN). Acknowledgements are transmitted as reliably as the congestion control mechanism in use requires, possibly completely reliably.
DCCP is useful for applications with timing constraints on the delivery of data. Such applications include streaming media, multiplayer online games and Internet telephony. In such applications, old messages quickly become useless, so that getting new messages is preferred to resending lost messages.
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