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Importance of TFRC Congestion Control Mechanism in the Real Time Multimedia Applications

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Abstractions: - This paper evaluates the suitability of TFRC congestion control mechanism and shows some current developments that make use of the protocol. Additionally, it should be looked at further developments of the protocol. TCP-Friendly Rate Control (TFRC) is a congestion control mechanism designed for uncast flows operating in an Internet environment and competing with TCP traffic [2]. TFRC is designed to be reasonably fair when competing for bandwidth with TCP flows, where a flow is ``reasonably fair'' if its sending rate is generally within a factor of two of the sending rate of a TCP flow under the same conditions. A problem with TFRC is that it uses additive increase to adjust the sending rate during periods with no congestion. This leads to short term congestion that can degrade the quality of voice applications. This paper highlights the additional bandwidth of congestion that are used in multimedia applications in the network.

Key words: - TFRC mechanism overview, TCP throughput equation, TFRC mechanism implementation, comparison of TFRC and TCP TFRC Protocol Specification, TFRC throughput equation, TCP, comparison of TFRC and TCP.

1. INTRODUCTION

This paper represents TCP-Friendly Rate Control (TFRC). TFRC is a congestion control mechanism designed for unicast flows operating in an Internet environment and competing with TCP traffic [2]. Instead of specifying a complete protocol, this paper simply represents a congestion control mechanism that could be used in a transport protocol such as RTP [7], in an application incorporating end-to-end congestion Control at the application level, or in the context of endpoint congestion management [1]. TFRC is designed to be reasonably fair when competing for bandwidth with TCP flows, where a flow is "reasonably fair" if its sending rate is generally within a factor of two of the sending rate of a TCP flow under the same conditions. However, TFRC has a much lower variation of throughput over time compared with TCP, which makes it more suitable for applications such as telephony or streaming media where a relatively smooth sending rate is of importance.

11. RELEATED WORK

A. TFRC protocol specification:

The penalty of having smoother throughput than TCP while competing fairly for bandwidth is that TFRC responds slower than TCP to changes in available bandwidth. Thus TFRC can only be used when the application has a requirement for smooth throughput, in particular, avoiding TCP's halving of the sending rate in response to a single packet drop. For applications that simply need to transfer as much data as possible in as short a time as possible we recommend using TCP, or if reliability is not required, using an Additive-Increase, Multiplicative-Decrease (AIMD) congestion control scheme with similar parameters to those used by TCP. TFRC is designed for applications that use a fixed packet size, and vary their sending rate in packets per second in response to congestion. Some audio applications require a fixed interval of time between packets and vary their packet size instead of their packet Rate in response to congestion.

TFRC is a receiver-based mechanism, with the calculation of the Congestion control information (i.e., the loss event rate) in the data receiver rather in the data sender. This is well-suited to an application where the sender is a large server handling many concurrent connections, and the receiver has more memory and CPU cycles available for computation. In addition, a receiver-based mechanism is more suitable as a building block for multicast Timestamps is used. The main task of the data receiver is provide the feedback to a sender the receiver periodically sends feedback reports to the sender, containing the estimated value of the loss event rate and the information that allows the sender to calculate the round-trip-time. Those reports should be sent at least once per RTT, unless the sending rate is lower than one packet per RTT.

111. TFRC THROUGHPUT EQUATION

TCP-Friendly Rate Control for Unresponsive Flows TCP-friendly equation-based rate control (TFRC) was introduced to ensure proper congestion avoidance for multimedia applications using unresponsive transport protocols The Equation 1 developed in [7], roughly describes TCP's sending rate as a function of the loss event rate, round-trip time and packet size. The loss event rate *p*is given by the number of packet loss events as a fraction of the number of packets transmitted.

$$T = \frac{1}{RTT\left[\sqrt{\frac{2p}{3}} + 12\sqrt{\frac{3p}{8}}p(1+32p^2)\right]},$$

1V. TCP

The Transmission Control Protocol (TCP), sometimes called the Transfer Control Protocol, is one of the core protocols of the internet protocol suite TCP is one of the two original components of the suite, complementing the Internet Protocol (IP), and therefore the entire suite is commonly referred to as TCP/IP. TCP provides reliable, ordered delivery of a stream of bytes from a program on one computer to another program on another computer. TCP is the Protocol that major Internet applications such as the World Wide Web, email, remote administration and file transfer rely on. Other applications, which do not require reliable data stream service, may use the User Datagram Protocol (UDP), which provides a datagram service that emphasizes reduced latency over reliability.

V.COMPARISON BETWEEN TCP AND TFRC

In this section we compare TFRC with TCP. How TCP is differ from TCP. One main goal during the development of TFRC was reaching TCP-friendliness while having a smoother sending rate than TCP. The major difference between TCP and TFRC is TCP is a complete transport protocol which support features like flow and congestion control as well as connection establishment, in other side TFRC just takes care of congestion control and is intended to be used by a transport protocol that provides an unreliable data transmission. In practice TFRC is not planned to replace the TCP protocol. It is an alternative to the use of TCP and enables congestion control to applications which cannot use the Transmission Control Protocol. Experiments have shown that TFRC is well suited to compete fairly with TCP under same conditions. In the following, some of these results are presented. More detailed results can be found in [3] and [7]. To be fair when competing with TCP, TFRC needs to have nearly the same throughput in steady-state. Therefore, TFRC uses the TCP response function as described in the previous section, to determine its sending rate. Figure 3-1 (taken from [2]) shows that TFRC's throughput is almost equivalent to the one of TCP. Especially if many data flows compete against each other, fair sharing of the bandwidth is reached.

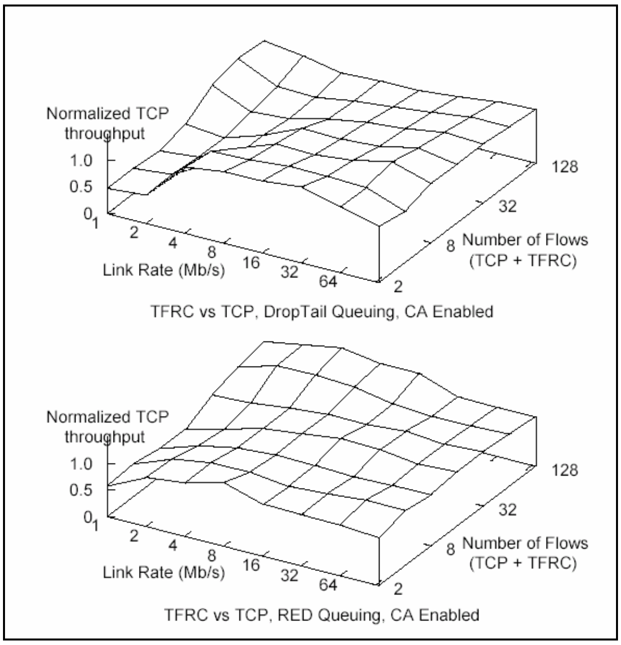

Figure 2: TCP throughput while sharing the bandwidth with TFRC flows

The figure presents the average throughput of a TCP-flow competing with other TCP- and TFRC-flows. The throughput is presented in a normalized way, where a value of 1 means a fair share of bandwidth between the different flows.

These results indicate, that TFRC performs reasonably well when sharing the bandwidth with TCP flows.

Another important goal is that the transmission rate of TFRC connections changes over time much slower than the rate of TCP connections. Figure 3-2 is also taken from [2] and depicts the throughput of competing TCP and TFRC flows at a bottleneck bandwidth over time.

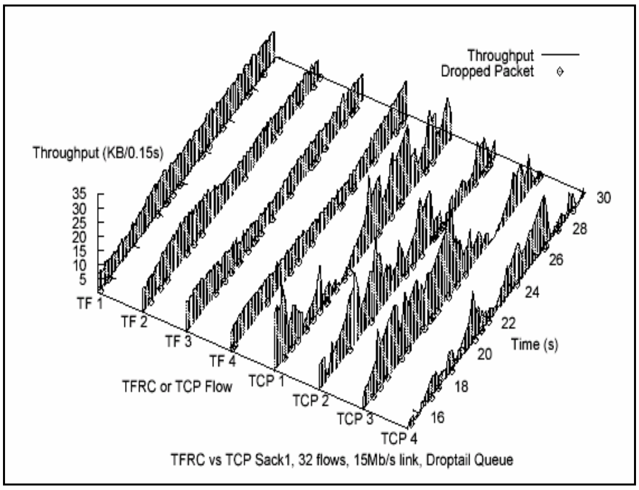

Figure3: Comparison of TCP's and TFRC's transmission rate

The transmission rates of the TFRC flows are less fluctuating than the rates of the TCP flows. Thus, TFRC may offer advantages to applications like multimedia streaming. Finally, an important difference between TFRC and TCP has to be mentioned. While both protocols react to a sudden decrease of the bandwidth in nearly the same time, TFRC needs much longer to recover when more bandwidth gets available. Figure 3-3 describes this fact.

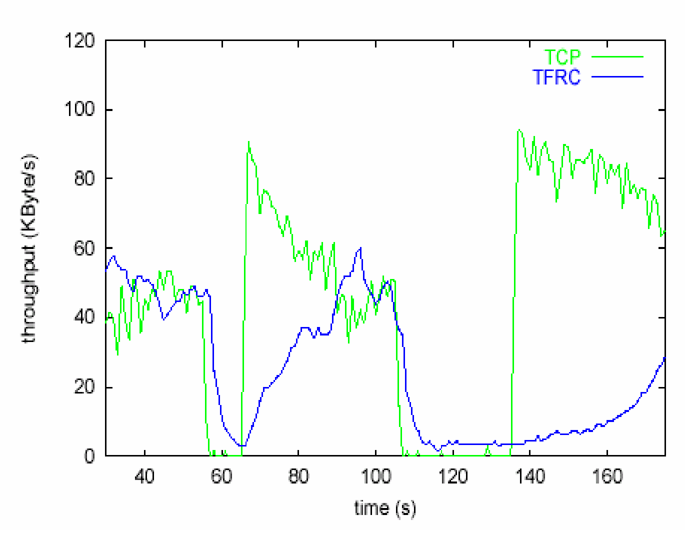

Figure4: Responsiveness of TFRC compared with TCP

It might be shown clearly more than 20 seconds until the fair sharing of the bandwidth is reached again. This could be a problem for applications like video telephony because the video quality would be bad over a quite long period. An improvement of this behavior can be reached by the use of History Discounting as described above.

V1. FUTURE WORK

TFRC is mainly intended to be used with applications that prefer a nearly constant transmission rate and may be delay sensitive. Therefore they are not able to make use of TCP. As already mentioned earlier, voice-over-IP, video on demand and video telephony are some examples. It is to be expected that the importance of these applications will increase drastically in the following; some developments using TFRC are presented.

A. Datagram Congestion Control Protocol (DCCP):

The Data Congestion Control Protocol (DCCP) is a new transport protocol which is able to provide a congestion-controlled and unreliable flow of datagram's. A detailed specification of DCCP can be found in [5] According to [6] some of the main feature of DCCP is

a. Unreliable transport of datagram's with acknowledgments
b. Mechanism for reliable connection establishment and termination
c. Reliable negotiation of different protocol feature

DCCP is used with applications that attach great importance to a fast packet delivery rather than the correct order of the packets. The data of such applications may need outdated very fast, thus TCP is not suitable in this case. Today, those applications would use UDP and either their own (proprietary) congestion control mechanism or refrain from using any congestion control.

B. MPEG-4 Video Transfer with TFRC:

In the last years, the Internet traffic caused by video transmission has increased. The data transmission of most multimedia application is based on UDP [9]. Here we can describe how MPEG-4 videos transfer with TRFC. A MPEG-4 video stream is divided into several "Visual Objects" (VO), which may be a whole video frame or just part of it e.g. a single person. Each Visual Object consists of many "Visual Object Planes" (VOP) that are arranged to "Groups of VOPs" (GOV), this transfer mechanism uses TFRC to determine a target sending rate. In order to be able to cooperate with TFRC, applications need mechanisms to adjust the video rate according to guideline of TFRC. This is done by controlling the amount of video data that is transmitted to the receiver. Thus, the video rate can be adjusted by changing the coding parameters, which affects the video quality.

VII. CONCLUSION

TCP-friendly Rate Control is a congestion control mechanism for unreliable datagram transmission. it has many advantages to application that required stable transmission TCP's congestion control mechanism reacts very fast to changes in the level of congestion, and perform great role in the multimedia application in addition TFRC calculating the loss event rate, instead of regarding the packet loss rate. Loss rate is determined loss event rate is determined at the receiver. Therefore TFRC uses a feedback mechanism between receiver and sender, to provide the sender with the actual loss rate. To improve the slower reaction of TFRC on a fast decrease of congestion compared with TCP, History Discounting is introduced. At last we can say TFRC is an important congestion control mechanism that performs an important role in the applications that does not require stable transmission .internet telephony, video on demand etc .is the example of these types of application .and theses application is become popular in today's environment.

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