Towards a Versatile Transport Protocol

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ABSTRACT

In the context of a reconfigurable transport protocol, this paper introduces two protocol instances based on the composition and specialisation of the TFRC congestion control and Selective Acknowledgment mechanisms. The two resulting transport architectures lead respectively to the QTP_{AF} protocol, specifically designed to operate over QoS-enabled networks and the QTP_{light} protocol, specifically designed for resource-limited end systems connected to powerful servers. QTP_{AF} combines QoS-aware TFRC congestion control with full reliability to provide a transport service similar to TCP but additionally taking into account network-level bandwidth reservations. QTP_{light} proposes a modification of TFRC that shifts from the receiver to the sender the complexity of the loss rate estimation mechanism. This modification allows to alleviate the processing and communication load of "light" resource limited mobile receivers. We present the concept of these protocols and their adaptation in the EuQoS European project framework.

Categories and Subject Descriptors

C.2.2 [**Network Protocols**]: Transport Mechanisms

General Terms

Transport Protocol

Keywords

TFRC, SACK, QoS-enabled networks, mobile devices

1. INTRODUCTION

Pervasive communications are more and more driven over mobile devices and personal digital assistants (PDA). These devices offer a panel of features allowing then to play multimedia streams. This convergence between media streaming and mobility has been observed during the last football worldcup, where cellular phones service providers have measured a significant increase of the multimedia traffic. Conversely to powerful multimedia streaming servers, mobile end systems are resource-limited. Therefore the lightening of recurrent communication processing is a critical issue for increasing performances and autonomy of mobiles end systems. Additionally, new QoS oriented network services, adapted to media streaming, have emerged. However current transport protocol are not able to map application layer needs down to these services. This paper addresses the challenge of designing a versatile transport protocol capable of performing efficiently over multiple network contexts.

The contribution of this paper is to propose such versatile transport protocol able to take into account the underlying configuration of the network and the nature of the devices. This issue is addressed from a new protocol that makes it possible to compose TFRC [4] and SACK [6] mechanisms. This protocol provides and allows the following features to be negotiated between the transport entities: (1) partial/full reliability; (2) light processing for receiver; (3) QoS-awareness. In the following, we introduce the design of two specific instances respectively named QTP_{AF} protocol and QTP_{light} protocol.

2. MOTIVATION

The present contribution aims at demonstrating how the combined use of TFRC and SACK can help designing new transport protocols adapted to the pervasive delivery of multimedia streams. TFRC and SACK share the common goal of improving the QoS delivered to flows by offering respectively a mechanism for enhancing flows' rate smoothness and a mechanism for loss recovery. Their combined use, associated with their potential modification, offers a source of performance improvements we aim at exploring. The composition of the SACK and TFRC can be motivated by the few following points: (1) there are proofs of the poor TCP performances over wireless and multi-hop networks [9] and it exists evidence of the good behaviour of rate controlled congestion control over these networks [1]; (2) SACK is an efficient mechanism for reliability control and allows partial or full reliability to be achieved. In the following, we introduce two different instances of transport services and protocol that result from the composition of these two mechanisms. This composition aims at improving the QoS delivered to application above two different and complementary network contexts.

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3. PROPOSING A PROTOCOL FOR MULTIMEDIA TRAFFIC AND SMALL COMPUTATIONAL ENTITIES

TFRC is considered as the current congestion control mechanism that offers the best trade-off between TCP fairness and the smooth throughput required by multimedia flows. In the traditional TFRC architecture, as defined by RFC 3448, the evaluation of the loss rate is made on the receiver side. This evaluation requires maintaining on the receiver memory the complex loss event history data structure, as explained in [4]. The management of this data structure and the related periodic processing of the loss event rate entails a CPU, and memory overhead that is not compatible with the resource constraints of "light" mobile client end-systems. Therefore, we propose to shift loss event history management and loss rate processing on the sender side. In order to tackle this problem, the standard feedback packet sent by the flow receiver is replaced by a light and simple SACK mechanism.

This shifting offers the following advantages. On one hand, it allows the receiver load to be dramatically decreased. On the other hand, it offers a robust protection against selfish receivers as defined in [3]. Indeed, the sender is no longer dependent of the accuracy and the veracity of the information given by the receiver as it computes itself the packet loss rate. Even if it is not the purpose of TFRC, our solution allows applying efficient selective retransmission of lost data. Furthermore, compared to other proposal such as [3], our solution is easily implementable with few changes and does not require numerous and complex modifications in the TFRC header and algorithm.

4. PROPOSING A COMPLIANT RELIABLE TRANSPORT PROTOCOL FOR QOS- ENABLED NETWORKS

The EuQoS project provides a class of service DiffServ/AF-like for Non-Real-Time Traffic (NRT). However, the TCP throughput guarantee inside this class is not feasible under various network conditions [8]. In order to cope with this problem, many research works focused on various efficient TCP traffic conditioning mechanisms [2, 7]. Unfortunately, the numerous conditioning schemes proposed are still too sensitive to the network conditions and sometimes difficult to implement.

Since none transport protocol offer an efficient QoS mapping between an AF network service and application needs, we propose to design a DiffServ/AF compliant transport protocol. In a first step towards this solution, we have defined a QoS-aware congestion control mechanism. This has been achieved through the proposal and design of the gTFRC mechanism currently under discussion at the IETF [5]. gTFRC offers a TCP friendly congestion control mechanism while delivering the negotiated minimum bandwidth linked to a traffic AF class. We have designed the QTP_{AF} transport protocol by composition of the so defined AF compliant congestion control protocol with a SACK mechanism for reliability control. Preliminary measurements show that QTP_{AF} obtains the QoS negotiated by the application with the network service whereas TCP fails to delivers this QoS. As a conclusion, QTP_{AF} appears to be the first reliable transport protocol really adapted to carry efficiently QoS traffic.

5. CONCLUSION AND FUTURE WORKS

We have presented in this paper the motivation and the basic design features of two transport protocols instances based on the composition and specialisation of the TFRC congestion control and SACK mechanisms. Firstly, we have introduced QTP_{light} which shifts the TFRC loss rate estimation from the receiver to the sender side. This shift lightens the processing load of the receiver which is particularly useful for mobile clients with ressource constraints. Secondly, the QTP_{AF} transport protocol composes and adapts differently these two mechanisms for delivering a QoS-aware transport service. We have implemented these two protocols and conducted successfully a large range of measurements to evaluate them under various network conditions. The next step of this work is a deployment of QTP_{AF} over a large pan-European QoS-aware backbone. Moreover, for the QTP_{light} protocol, validation measurements are also driven over a wired and unwired networks. Finally, we are currently working on the standardization the two types of TFRC specialisation introduced in this paper.

6. REFERENCES

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