ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Distributed
Computing

Semester Thesis:
"Selfish Network Link Speedup"

This document describes the subject and the general time schedule of David Stolz' semester thesis in the Fall term 2011. Adaptations or changes can be agreed upon by the advisers.

Subject

The performance (i.e. throughput) of network connections is primarily determined by two factors: the *actual bandwidth* offered by the communication link, and the quality of the *transport layer protocol* between the sender and the receiver. The former is typically determined by a bottleneck in the hardware, or by regulations imposed by the network owners, e.g. ISPs limiting up- and downstream of customers. The latter is determined by the design of the transport layer protocol, in particular by its scheme of controlling the sending rate of packets, and by its behavior regarding retransmissions of packets. As the actual bandwidth of the intermediate communication link cannot be directly influenced by an end user we may consider the actual bandwidth as an upper bound on the achievable throughput. In that sense, the goal of an efficient transport layer protocol is to use the provided bandwidth as good as possible, and to approximate the actual bandwidth as closely as possible. The question of how good the actual bandwidth can approximated, and how the maximum throughput can be achieved within the given network limits is non-trivial. Especially if the transport layer protocols is to implement reliable transmission. To achieve reliability, every lost packet needs to be retransmitted. Therefore, simply bursting out as many packets as possible usually does not work as a lot of them will be lost at intermediate nodes (e.g. at the bottleneck of the link) and have to be sent again. Depending on how the transport layer protocol works, this might lead to a significant overhead and ineffective throughput. Today, TCP is the most used reliable transport layer protocol. TCP does not only implement a dynamic send rate adaption mechanism (in order to try to get a suitable throughput), but at the same time tries to use its send rate mechanism to be fair, i.e. all connections using the same network parts should get a fair share of the capacity. Striving for fairness might be a good general approach. However, in certain scenarios, such fairness might not be desirable: for instance, if a user wants to run several streams of which some should get a higher throughput with respect to the others then TCP fails. In other words, TCP does not provide means to prioritize data streams, even if they have the same starting and end point. Moreover, we believe it is possible for a selfish user to exploit TCP's fairness property by tampering with the TCP protocol (by forging TCP packets) to allocate a connection with a bigger share of the available bandwidth at the expense, not of his own connections, but at the expense of other network users' connections. Obviously,

if such an exploit is feasible it would be appealing to any user who wants to increase her throughput disproportionally.

The task of this thesis is to investigate whether and how the throughput of a single connection can be increased–if needed at the expense of others–in several scenarios where most other network users employ TCP. If possible, David should design such a predatory protocol, and evaluate its effectiveness in different scenarios both theoretically and experimentally. Additionally, David should discuss counterattacks, or enhancements to TCP that prevent such behavior. If TCP turns out to be insusceptible to such an exploit David should provide reasoning for this finding, and discuss the key features of TCP that lead to this property.

Outline of Work Plan

- Read existing work on the subject.
- Extend the protocol designed for the thesis "**Tweaking Throughput on the Transport Layer**" so that experiments can be conducted.
- Come up with scenarios to test the protocol, on its own as well as against TCP streams.
- Develop or extend existing test programs to allow the experiments to be performed.
- Write the report, and prepare the final presentation.

Duties of the Student

- Regular meetings with the advisers. Ideally, there will be a meeting every week, but the frequency of meetings can be adapted.
- There will be one presentation given by the student in front of the research group at the end of the thesis.
- Finally, the student has to write a report (about 10 pages, English or German), presenting his work and results. This report should also include a critical review of the work.

General

- Independent working is expected.
- A possibility to work in our building (ETZ) is provided. It is also possible to work at home.

Contacts/Advisers

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