Chair of Network Architectures and Services
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Introductory talk for the Bachelor's Thesis

Available Bandwidth Estimation

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Topic

Observing the rapid development in technology such as real-time systems or the popularity of streaming services, the Internet's penetration rate increased tenfold in the last 20 years [1]. Thus, it is essential to have knowledge about the available-bandwidth to enhance quality-of-service (QoS) requirements by selecting the optimal route for a designated service or to detect anomalies and to monitor the network's state. As a consequence, there are several end-to-end tools for available-bandwidth estimation such as `Pathload` [2]. Since most tools require access at both ends, their applicability is limited. Additionally, they rely on UDP/ICMP which is often blocked or rate limited [3].
Of more interest are single-ended tools based on TCP such as `abget` [3], `ABwprobe` [4] and its successor `fabprobe` [5]. Their ideas are based on `Pathload's` approach and redesigned for estimation with TCP. As a result of TCP, it is more complicated to estimate the available-bandwidth because packets can take different routes from host to host.
Although the source code is available, it is hardly feasible to run the code today. Therefore the goal of this thesis is to implement a single-end available-bandwidth estimation tool based on `fabprobe` and `abget` . Subsequently, to evaluate its accuracy and applicability for large-scale Internet measurements.

This thesis aims to survey the following research questions:

1. How good is the accuracy?
2. Trade-off between accuracy and efficiency?
3. What limitations and restrictions constraint the usage of the considered approaches on the internet?
4. What is the difference in accuracy of single-end and both-ended tools?

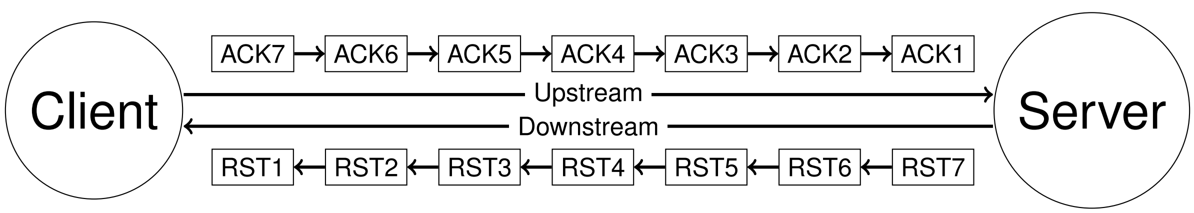
Implementation Approaches

One approach to this problem is `abget` an iterative algorithm, based on the idea of `Pathload` which transmits periodic TCP instead of UDP packet streams. In order to send packets at a certain rate R the client sends "fake" ACKs over to the TCP server, through a raw IP socket interface to emulate the TCP protocol [3] . Because of this, it is possible to determine the available-bandwidth through an increasing or decreasing trend in the One-Way-Delay (OWD). This implies the probing rate R is higher or lower than the available-bandwidth.

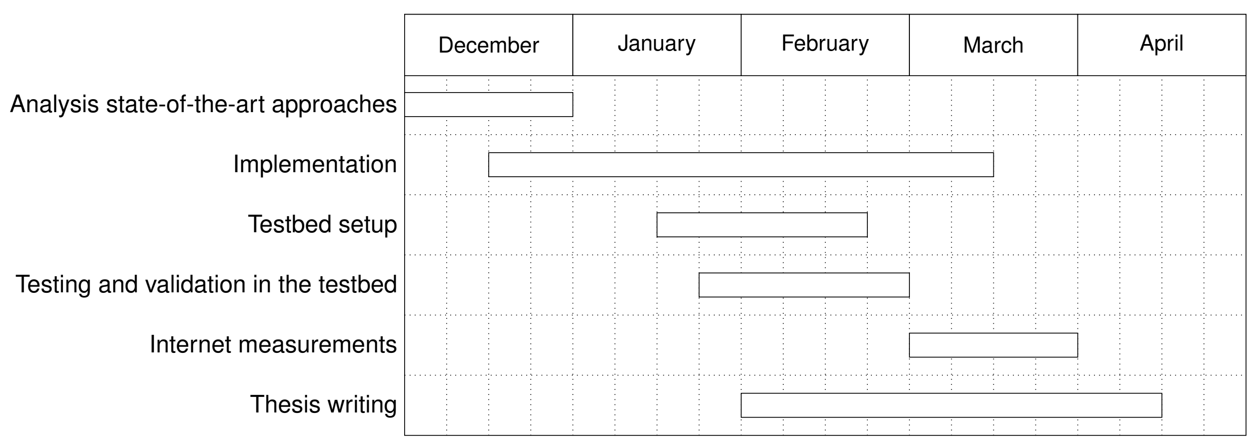
An alternative to solve the problem is `fabprobe`, that uses a binary search-like algorithm [5]. First the path is probed with a fleet of packets at an initial rate *R*. The available-bandwidth can be derived from the packet's RTT. If the RTT shows an increasing trend, the rate *R* is reduced, thus meaning the rate is greater than the available-bandwidth. Consequently, a decreasing trend results in increasing *R*. `fabprobe's` main focus is the trade-off between efficiency and accuracy, with fewer numbers of samples to achieve the highest accuracy possible.

Approach

Since `fabprobe` is designed for large-scale measurement, we will mainly focus on its approach. First, the tool will be implemented in Python. The prototype will be tested in the chair's `Baltikum` testbed following by tests with `Mininet` [6] where various scenarios will be emulated to analyze the influence of different network conditions. The results will be evaluated according to accuracy, stability, overhead, mean relative error and derivation. If the results are promising, a second test on the Internet will follow. In the large-scale measurement the implementation will be tested against an active end-to-end tool such as `Pathload` to verify the accuracy and its applicability.



Schedule



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