

## Introductory talk for the Bachelor's Thesis

# Available Bandwidth Estimation

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## Topic

Observing the rapid development in technology such as realtime 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. 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 [2] 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 not possible to run the code today. Therefore the goal of this thesis is to implement a single-end available bandwidth estimation tool based on the fabprobe and abget, evaluate its accuracy and applicability for large-scale internet measurements.

Following research questions are to be considered:

1. How good is the performance?
2. Trade-off between accuracy and efficiency?
3. What limitations and restrictions constraint the usage on the internet?

## Basic Ideas

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.

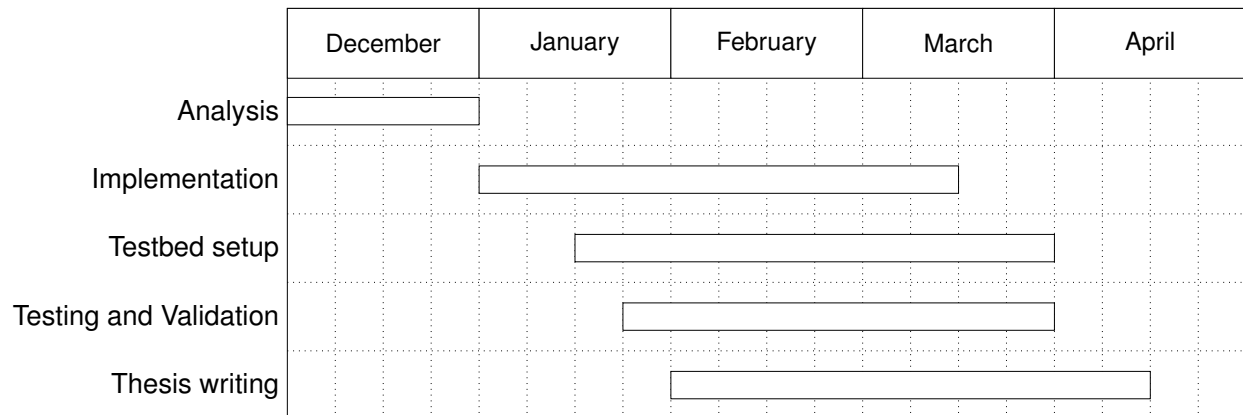
An alternative to solve the problem is fabprobe, that uses a binary search-like algorithm. [5] First the path is probed with a fleet of packets at an initial rate  $R$ . The available-bandwidth can be derived from the packet's RTT. If the RTT shows an increasing trend, the rate  $R$  is reduced, thus 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 focus on its approach. First, the tool will be implemented and tested in Mininet, a small testbed, under control. The results will be evaluated according to accuracy, stability, overhead, mean relative error and its derivation. If the results are promising, a test on the Internet will follow and be tested against an active end-to-end tool such as pathload to verify the previous results.

## Schedule



## References

- [1] "World internet usage and population statistics 2019 mid-year estimates," <https://www.internetworldstats.com/stats.htm>, [Accessed: 2019-11-11].
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- [4] D. Croce, T. En-Najjary, G. Urvoy-Keller, and E. W. Biersack, "Non-cooperative available bandwidth estimation towards adsl links," in *IEEE INFOCOM Workshops 2008*, April 2008, pp. 1–6.
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