Abstract:

The complexity and heterogeneity of Internet applications makes it hard (including for network experts) to locate the causes of poor application performance. Existing network performance monitoring tools (e.g., speedtest) measure general properties of network paths, which fail to capture per-application performance as different applications react differently to the same network conditions. The goal of our research is to build an open-source software tool that performs lightweight on-demand active probing to detect network bottlenecks behind poor application performance. The novelty of our proposal is to combine passive (end-to-end) network and application performance monitoring with active (targeted) monitoring of network segments. The coupling of active and passive monitoring is essential for application-aware bottleneck detection: passive observation of user traffic allows to infer per-application quality, while embedded active probes within the application flow allows to infer the location of network bottlenecks behind poor application performance. Our tool ideally runs in a CPE such as a home gateway, which is ideally placed to identify bottlenecks to the home wireless and other segments of the end-to-end paths. We envision that ISPs can use our detector either as a stand-alone troubleshooting tool or as part of larger monitoring system. When the bottleneck is in the ISP network, the detector can automatically raise a support ticket. Such tool can also provide the ISP with visibility on impairments inside the client's home. Ultimately, our tool should increase customer satisfaction and provide faster time to resolve support tickets for the ISP. Beyond that, a wide spread deployment of our tool will answer key research questions on the causes and effects of application performance degradation.

Expected research output and publication:

Our proposed research will lead to a number of important contributions:

* Software release: An open-source per-application bottleneck detector that runs in a CPE (example a home gateway). Our tool consists of three main components: a WAN monitor that trails application flows, a wireless monitor that probes end-user devices to sense home wireless conditions, and finally an application-aware bottleneck detector that infers network bottlenecks affecting home users application QoE.
* Publications:
  + We will publish a manuscript to describe the design of our application-aware bottleneck detector. This manuscript will motivate the importance of per-application bottleneck detection, the key research challenges associated with the realization of such a tool, the design and implementation of our detector, and finally results on the test and validation of our inference methods. We will disseminate our findings in a systems-focused venue (e.g., NSDI)
  + This proposal will help fund equipment purchase that will increase the number of deployments in homes across Paris. As a result, we will have 100 home deployments across Paris and the US. These deployments will allow us to conduct a study on the causes and effects of application performance degradation. Some key research questions that we hope to answer out of this study are: Where are network bottlenecks concentrated? Which classes of applications are mostly affected by bottlenecks? We will disseminate our findings in a measurement-focused venue (e.g., Sigmetrics).

Previous Comcast Research

Renata Teixeira was PI of the Comcast Research grant: “Collaborative Home Network Troubleshooting” in 2015. The goal of our research was to develop an easy-to-use home network troubleshooting tool that can reliably identify performance and functionality shortcomings rooted in the home and propose ways to fix them. Our approach built upon our work on a network measurement platform for the browser (called Fathom) and considered methods where several instances of the tool within a single home and the home router can share measurement data to identify the problem. The project has delivered novel methods of identifying throughput bottlenecks within the home network. We developed a method that runs on the home router to identify whether downstream throughput is bottlenecked in the home wireless or the access link. We have also developed methods that leverage Web technologies to conduct delay measurements to assist in bottleneck identification and showed that it is possible to perform sophisticated measurements with standard Web technologies, which are available to any web page.

This project led to two master theses:

- Michele Pittoni, “Online Identification of Last-Mile Throughput Bottlenecks on Home Routers”, UPMC, 2016. https://hal.inria.fr/hal-01401856

- Maximilian Bachl, “Collaborative Home Network Troubleshooting”, UPMC, 2016. https://hal.inria.fr/hal-01415767

The project involved a large software development effort. The work was released as open source:

- The online implementation of the Home or Access (HoA) bottleneck detection was released as a module for collectd: https://github.com/apietila/collectd OpenWRT package build files: https://github.com/inria-muse/browserlab

- The project helped support our efforts on the development of the Fathom browser-based network measurement platform (https://muse.inria.fr/fathom). In particular, the work on Fathom’s “Homenet discovery” functionality and on of home network devices. Fathom’s code is available here: https://github.com/inria-muse/fathom.addon