Abstract:

Poor home WiFi quality, congested network links, or overloaded content servers are just a few examples of *application performance bottlenecks*. The complexity and heterogeneity of Internet applications makes it hard (even for network experts) to locate application performance bottlenecks. 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 that identifies application performance bottlenecks. 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 performance bottleneck detection: passive observation of user traffic allows inferring per-application quality, while active probes embedded within the application flow allows to infer the location of application performance bottlenecks. Our tool ideally runs in a box acting as a home gateway, which is well 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 bottlenecks.

Expected research output and publication:

Our proposed research will lead to the following contributions:

- Software release: An open-source application performance bottleneck detector. Our tool consists of three main components: a WAN monitor that mimics application traffic to measure properties of per-application paths, a wireless monitor that probes end-user devices to measure home wireless conditions, and finally a detector of application performance bottlenecks.

- We plan to publish at least two papers. One to describe the design of our application performance bottleneck detector in a systems-focused venue (e.g., NSDI) and another that analyzes the data from the home deployments in a measurement-focused venue (e.g., IMC or Sigmetrics) to answer questions such as: What are the most common causes of application performance bottlenecks? Which classes of applications are mostly affected by bottlenecks?

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