Optimization of Internet quality of experience in home networks

**Level of qualifications required**: Graduate degree or equivalent

**Function**: PhD Position

**Context**

*Within the framework of a partnership*

- Collaboration between Inria MiMove and Princeton University within the associate team HOMENET: https://team.inria.fr/homenet/

**Objective**:

The goal of this doctoral thesis is to develop a system for tracking Internet QoE (Quality of Experience) and then to develop methods to improve Internet QoE.

**Is regular travel foreseen for this post?** The student may travel to Princeton to visit our collaborators.

**Assignment**

**Research context**:

Despite the steady increase in home broadband speeds, simple tasks such as watching a video streamed over the Internet or having a Skype call can still be a frustrating experience. Overloaded servers, network congestion, and poor home WiFi quality are just a few of the potential root causes that can hamper users’ Internet Quality of Experience (QoE) [1]. Without the knowledge of where the problems might be located and in the hope of improving their experience, users often opt to pay higher fees to their residential Internet provider for increased access capacities. Yet, access link capacity is only one of the many potential bottlenecks impairing Internet quality. The key question to improve Internet QoE is: what is the root cause of Internet QoE impairments? Answering this question is challenging. No single entity (user, access ISP, content provider) has all the information to fully diagnose poor Internet QoE: the content provider can track QoE impairments, but it cannot directly identify the root causes within the network; ISPs have more information about in network issues, but no direct knowledge of Internet QoE.

To identify the root causes of Internet QoE impairments, we have developed a novel lightweight system that runs at the home gateway. This vantage point is ideal for distinguishing issues within the user’s home versus the access link [3]. Unfortunately, more and more content providers that rely on encryption (HTTPS/QUIC), which prevents our system from using deep-packet inspection to infer Internet QoE [2]. We current have a system that focuses on tracking video quality, which overcome this constraint by relying on DNS requests to identify video flows within network traffic and then tracks traffic patterns to infer key video QoE metrics such as average bitrate and re-buffering events. Moreover, the system exploits novel algorithms that use simple probing techniques, i.e. lightweight pings and traceroutes, to take advantage of the home network vantage point to pinpoint where potential root causes hampering the streaming process might be located.

**Assignments**:
The goal of this thesis is to broaden this system for tracking Internet QoE for a variety of applications instead of just video and then to develop methods to improve Internet QoE. In other words, when we detect that Internet QoE is poor, can we bypass this problem to improve Internet QoE? This thesis must answer a number of challenging research questions. First, how to infer Internet QoE from the noisy and often encrypted network traffic? We envision leveraging the HostView [4] end-host monitoring tools developed in our group to obtain Internet traffic annotated with the user QoE. Second, how to improve Internet QoE with limited control points? We assume that it is possible to develop methods at the home gateway and at most a few servers within the Internet (for example, by relying on cloud services). We must develop strategies that optimize QoE under these limitations.

References:

Collaboration:
The student will be advised by Renata Teixeira (Inria) in collaboration with Nick Feamster. The student will collaborate with the other post-docs and students working on the existing system to monitor QoE within home networks.

Main activities
Main activities:
- Analysis of network traffic and network performance data collected in home networks
- Development of methods to infer QoE from network traffic analysis
- Development of methods that run within home networks to identify the sources of QoE degradations
- Developments of methods to optimize QoE from within the home network
- Evaluation of the developed methods

Additional activities:
- Writing of research papers
- Presentation of research work in conferences, seminars

Benefits package
- Subsidised catering service
- Partially-reimbursed public transport

Remuneration
Gross Salary per month: 1 982 € the first 2 years and 2 085 € the last year

General Information
- **Theme/Domain**: Distributed Systems and middleware
  System & Networks (BAP E)
- **Town/city**: Paris
- **Inria Center**: CRI de Paris
- **Starting date**: 2018-10-01
- **Duration of contract**: 3 years
Deadline to apply: 2018-04-23

Contacts

- **Inria Team**: MIMOVE
- **Recruiter**: Cruz Teixeira Renata / renata.cruz-teixeira@inria.fr

The keys to success

The candidate should have a strong background in computer networks (TCP/IP and application layer protocols, HTTP(S), in particular) and computer systems performance measurement. The candidate should have knowledge of data analysis techniques (statistics, data mining, machine learning) and some related tools such as Matlab or gnu R.

The candidate should be able to write (scientific writing) and communicate fluently in English.

Conditions for application

**Defence Security**: This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

**Recruitment Policy**: As part of its diversity policy, all Inria positions are accessible to people with disabilities.

**Warning**: you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.