**Internship proposal 2018/2019**

**Topic:** Optimizing Video Quality of Experience in a Mobile Context

**Duration:** 4 to 6 months

**Hosting team:** MiMove, Inria Paris (https://mimove.inria.fr/)
Joint team between Inria and Princeton University

**Apply at:** https://goo.gl/forms/kmLbN5m9tlOcUkFr1

**Mentors:**
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**Keywords:** Video Quality of Experience (QoE), Mobility, Wireless Networks.

**Description:**

Most mobile devices today are equipped with more than a single interface; e.g., LTE, 3G, and Wifi. Making use of all these interfaces simultaneously is bound to give significant throughput increase over a single interface [1, 6], as well as robustness to path failures. This is particularly interesting with the emergence of pervasive Wifi in big cities (e.g., community Wifi such as Free in Paris and BT Wifi in London). This means that we can potentially use both LTE and Wifi as we move around a city, or even alternate between these two connections to reduce the usage of the metered link (cellular) when Wifi is available [2], or in the event of failure of one path (e.g., patchy wifi coverage). A key research question, is how to support stable application performance in such a dynamic and heterogeneous network environment. This is particularly critical for interactive applications such as video streaming, voice-over-IP, and video conferencing (among others). For instance, in the case of dynamic-adaptive video streaming over HTTP (DASH), the video quality is adapted based on the perceived throughput. Hence, as we enter and exit the range of an access point (AP), the overall throughput changes. This may cause constant quality switches, disrupting the perceived video quality [4]. Moreover, the underlying transmission protocol must be able to quickly shift the load across interfaces as we move between APs. Failure to do so, might yield increased transmission loss at the edge of an AP range, perturbing application performance [3, 5].

The goal of this project is to optimize Quality-of-Experience (QoE) of interactive applications for mobile users. We envision users walking or driving by road-side Wifi AP with full 3G/LTE coverage and patchy Wifi coverage (i.e., community Wifi or Wifi APs on Lampposts). To achieve this goal, we plan to leverage multi-path and cross-layer optimizations. As a first step, we will be studying the impact of multi-pathing on interactive applications in a mobile context. The objective of this study is to answer the following set of open research questions: i) How well do existing multi-path transport protocols support interactive applications in a mobile context? How to accurately and timely switch between interfaces to support preference-aware multi-pathing? And how to do so while sustaining a stable application performance? The answer to these research questions will guide the design of a scheduler that intelligently allocates packets across multiple paths while ensuring stable and reliable interactive applications performance in a mobile context. As part of this design, we will be investigating the benefits of a cross-layer design, where information are pushed across layers to guide the decision of the multi-path scheduler.

The goal of this internship is to collect and analyze packet traces of experiments running over multi-path transport protocol in a mobile context. The student will conduct experiments (walking and/or in-car) to collect data traces that will shed light on the performance of existing multi-path streaming protocol. This also includes setting up the needed platforms to run these experiments (e.g., end-systems running Multi-path TCP and Multi-path Quic). The student will also analyze the collected traces to help answer some of the above research questions. During the internship, the student should develop scientific skills on network systems design and development and wireless technologies as well as scientific writing and presentation. If the student is interested, there is a possibility of staying for the doctoral studies after the internship.

**Desirable skills:**

- Knowledge of Android.
- Comfortable communicating in English.
- Kernel-space implementation.
- Comfortable with at least one scripting language (e.g. python).
- Knowledge of network protocols and network development tools.
- Knowledge of matlab or gnu R.

**References**

[1] Raiciu, Costin, et al. "How hard can it be? designing and implementing a deployable multipath TCP." *Proceedings of the 9th USENIX conference on Networked Systems Design and Implementation*. USENIX Association, 2012.

[2]. Han, Bo, et al. "MP-DASH: Adaptive video streaming over preference-aware multipath." *Proceedings of the 12th International on Conference on emerging Networking EXperiments and Technologies*. ACM, 2016.

[3] Lim, Yeon-sup, et al. "Cross-layer path management in multi-path transport protocol for mobile devices." INFOCOM. 2014.

[4] James, Cyriac, et al. "Is multipath TCP (MPTCP) beneficial for video streaming over DASH?." *2016 IEEE 24th International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS)*. IEEE, 2016.

[5] Li, Li, et al. "A measurement study on multi-path TCP with multiple cellular carriers on high speed rails." *Proceedings of the 2018 Conference of the ACM Special Interest Group on Data Communication*. ACM, 2018.

[6] Yap, Kok-Kiong, et al. "Making use of all the networks around us: a case study in android." *ACM SIGCOMM Computer Communication Review* 42.4 (2012): 455-460.