Internship Proposal 2025

Title: Not yet another speedtest! Toward Internet scale measurement of network quality.

Host laboratory: LIP, ENS de Lyon, 46 allée d'Italie, Lyon, France

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Description. Home network monitoring at access points enables ISPs to assess application quality, detect security threats, and diagnose connectivity issues without requiring end-host instrumentation. While traffic analysis pipelines have proven effective at inferring quality metrics from encrypted flows [1], their deployment on residential access points faces two critical challenges: the need to capture all packets passing through the kernel efficiently, and the severe computational constraints of router hardware that must simultaneously handle routing, wireless management, and other essential functions.

Extended Berkeley Packet Filter (eBPF) offers a promising solution by enabling programmable, in-kernel traffic analysis without kernel modifications or costly context switches to userspace. eBPF programs can hook into multiple kernel network stack points (XDP, TC, socket filters) to observe packets early in the processing pipeline, extract features, and perform lightweight inference directly in kernel space. However, deploying machine learning-based quality inference pipelines via eBPF on resource-constrained access points remains unexplored. Key challenges include: (1) determining optimal hook points to capture bidirectional flows without packet loss, (2) designing feature extraction that balances inference accuracy with strict eBPF verifier constraints (limited instructions, no unbounded loops, restricted memory access), and (3) adapting inference models to fit within CPU and memory budgets while maintaining real-time performance alongside routing workloads.

This internship will develop and evaluate an eBPF-based quality inference pipeline for residential access points. The student will profile existing quality inference models to identify computational bottlenecks, implement optimized eBPF programs for feature extraction and lightweight inference, and benchmark performance on commercial access point hardware (e.g., OpenWrt-compatible devices). The work will investigate trade-offs between model complexity, inference accuracy, and system overhead, producing guidelines for deploying ML-based traffic analysis on constrained edge devices.

Deliverables. The intern will produce an eBPF-based traffic analysis toolkit, performance evaluation across multiple access point platforms, and a research paper quantifying the feasibility of real-time quality inference on edge devices. The work will demonstrate whether production-ready deployment is achievable within typical home router constraints.

Candidate Requirements.

- The candidate should have completed a qualifying program by the starting date of the thesis.
- Comfortable speaking English or French (French is not required).
- Good understanding of at least one between computer networks protocols and systems (preferably both)
- Good proficiency with at least one programming language, preferably Golang or Rust.

What to submit. An up to date CV, university transcripts, and a letter of motivation clearly stating what the motivations to work on the described subject.

References

[1] F. Bronzino, P. Schmitt, S. Ayoubi, G. Martins, R. Teixeira, and N. Feamster. Inferring streaming video quality from encrypted traffic: Practical models and deployment experience. *Proceedings of the ACM on Measurement and Analysis of Computing Systems*, 2019.