Internship Proposal 2020

Title: Achieving application fairness through network management and quality inference

Hosting laboratory: LISTIC, Polytech Annecy-Chambéry, 5 chemin de bellevue, Annecy-le-Vieux, 74940 ANNECY

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Description. Network fairness [4] covers the general problem of understanding whether traffic flows are receiving a fair share of a common resource, i.e., the networks they traverse. Network fairness is normally achieved through the use of dedicated congestion protocols at the end points (e.g., TCP [1]) or through queuing policies inside the network (e.g., DRR [7]). Both approaches work at flow level under the assumption that each application uses a single flow to transport data. While this assumption held in the past, modern applications have increasingly adopted newer, TCP-unfriendly protocols, such as QUIC [5], as well as aggressive application logic [6] (e.g., using many flows simultaneously). Such behavior can quickly overcome traditional flow-based fairness mechanisms. Ultimately, the final goal of network fairness should be to guarantee that *applications*, not flows, do not overuse their fair share of common resources and are all allowed to achieve a comparable level of performance.

To enforce application fairness operators would need to 1) track how applications are behaving and 2) apply new traffic policies that can enforce the desired fairness. Unfortunately, more and more content providers rely on encrypted protocols (HTTPS/QUIC) to transport application data, which prevents monitoring systems from using deep-packet inspection to extract application performance from the monitored traffic. To overcome this constraint, network operators have to rely on statistical models that infer the application quality, such as the resolution or startup time of a video streaming session [3], from encrypted traffic. While effective, these solutions are inherently "imperfect", providing outputs that solely approximate the experienced application quality. Applying new traffic policies tailored towards application fairness requires to design new mechanisms that *understand* and *compensate* for these shortcomings.

The proposed internship builds on the premise application quality inference can be used to improve network application fairness from inside the network. The goal of the internship will be to study how different media applications (e.g., video streaming, online gaming) behave and develop novel ways to enforce fairness at the application level.

Internship goals and activities The goal of the internship will be to develop new techniques to achieve network application fairness. The internship will be structured in three phases:

1. First, the student will use an existing network monitoring system [2], as well as tools to extract quality ground truth for media applications [3], to study the problem of network application fairness across three media application — i.e., video streaming, video conferencing, and online gaming.

2. Second, the student will design potential approaches to enforce application fairness from inside the network, using standard network management mechanisms (e.g., bandwidth shaping).

3. Finally, if the time will allow, the student will implement a working solution of the complete system.

A successful internship will conclude with a publication in an internationally recognized conference.

Candidate requirements.

- The candidate should be a 2nd year Master student (or a 3rd year student of "cycle d'ingénieur").
- Comfortable speaking English (French is not required).
- Proficiency with at least one programming language, preferably Python or Golang.
- Knowledge of computer networks protocols.
- Knowledge of network measurement, management, and/or quality inference is a plus.

References

[1] M. Allman, V. Paxson, W. Stevens, et al. Tcp congestion control. 1999.

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[3] 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*, 3(3), Dec. 2019.

[4] R. K. Jain, D.-M. W. Chiu, W. R. Hawe, et al. A quantitative measure of fairness and discrimination. *Eastern Research Laboratory, Digital Equipment Corporation, Hudson, MA*, 1984.

[5] A. M. Kakhki, S. Jero, D. Choffnes, C. Nita-Rotaru, and A. Mislove. Taking a long look at quic: an approach for rigorous evaluation of rapidly evolving transport protocols. In *Proceedings of the 2017 Internet Measurement Conference*, pages 290–303, 2017.

[6] J. Martin, Y. Fu, N. Wourms, and T. Shaw. Characterizing netflix bandwidth consumption. In *2013 IEEE 10th Consumer Communications and Networking Conference (CCNC)*, pages 230–235. IEEE, 2013.

[7] I. Stoica, S. Shenker, and H. Zhang. Core-stateless fair queueing: Achieving approximately fair bandwidth allocations in high speed networks. In *Proceedings of the ACM SIGCOMM'98 conference on Applications, technologies, architectures, and protocols for computer communication*, pages 118–130, 1998.