Chair of Network Architectures and Services
School of Computation, Information, and Technology
Technical University of Munich

Evaluating QUIC Implementations on High-rate Links

Motivation

QUIC is implemented in user-space

- Multiple implementations from different developers
- Various languages and architectures

Advantages and Disadvantages

+ Flexibility
– More context switches

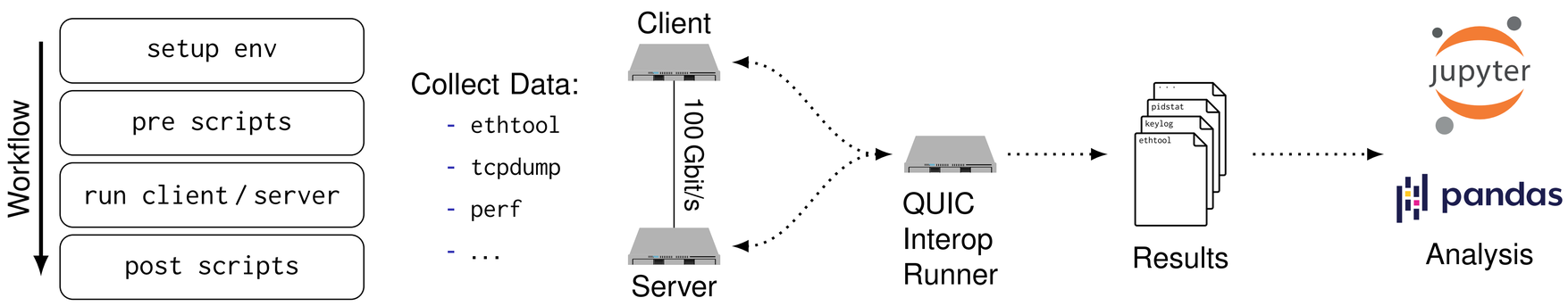
Approach

Goal: Identify performance bottlenecks in QUIC stacks

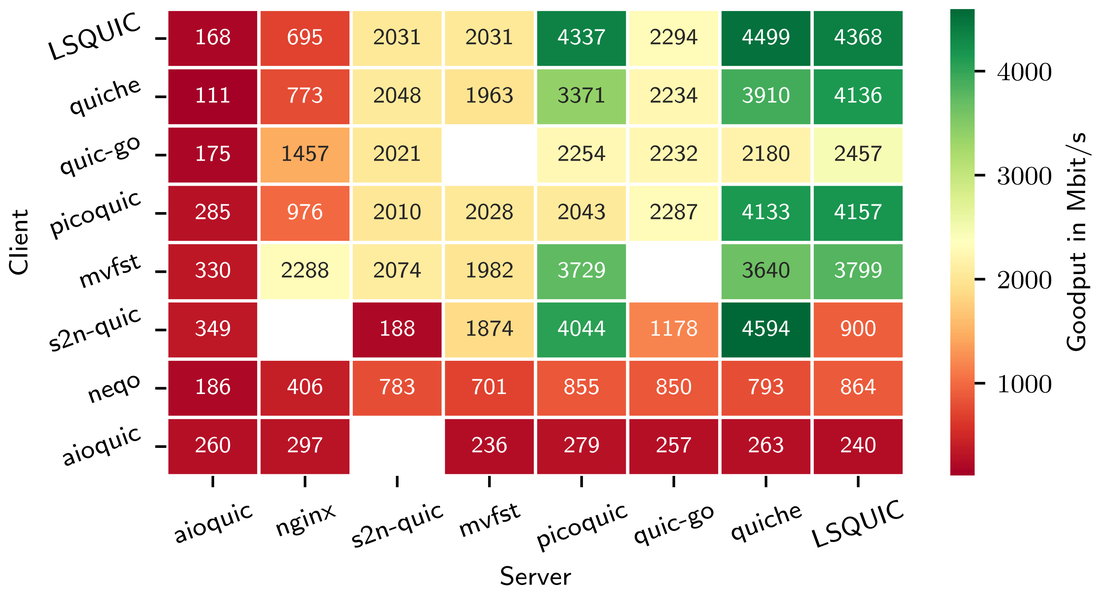
- Dedicated physical hosts for client and server
- Support for core pinning, profiling, DPDK, fiber tapping, . . .
- Collect CPU, OS, and NIC metrics with various tools
- Experiment orchestration via POS [1]

⇒ **Flexibility, Portability, Reproducibility**

Measurement Setup



Evaluation



- High variations between implementations
- Implementations in C & Rust show best performance
- Performance as client / server often varies
- Some implementations have interoperability issues

Performance Bottlenecks

- Performance is usually limited by the CPU of the sender
- Default UDP socket buffer size is too small and causes packet drops
- Offloading features that could significantly reduce CPU load are rarely used
- Acknowledgement frequency is often too high for high-rate links
- Crypto operations are CPU intensive but not a bottleneck

Summary

Take Away Messages

- QUIC implementations show different behavior (acknowledgement frequency, congestion control, . . .)
- Many QUIC implementations do not use available optimizations
- Default OS settings often not optimized for QUIC

Outlook

- More implementations to be evaluated
- Support for Multipath QUIC

[1] S. Gallenmüller*, D. Scholz*, H. Stubbe, and G. Carle. The pos Framework: A Methodology and Toolchain for Reproducible Network Experiments. In *The 17th International Conference on emerging Networking EXperiments and Technologies (CoNEXT '21)*, Munich, Germany (Virtual Event), Dec. 2021.
[2] B. Jaeger, J. Zirngibl, M. Kempf, K. Ploch, and G. Carle. QUIC on the Highway: Evaluating Performance on High-Rate Links. In *International Federation for Information Processing (IFIP) Networking 2023 Conference (IFIP Networking 2023)*, Barcelona, Spain, June 2023.

Marcel Kempf *kempfm@net.in.tum.de*