Friedrich-Alexander-Universität
Technische Fakultät

Computer Science 7

Performance of QUIC Implementations Over Geostationary Satellite Links using the QUIC Interop Runner

https://arxiv.org/abs/2202.08228

IETF113 maprg, Vienna

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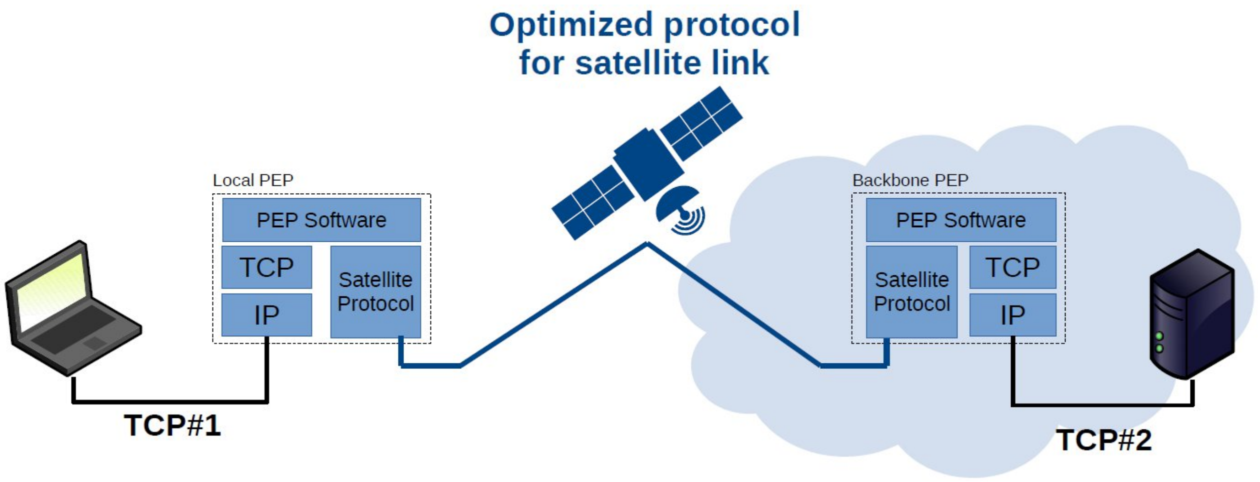
Motivation

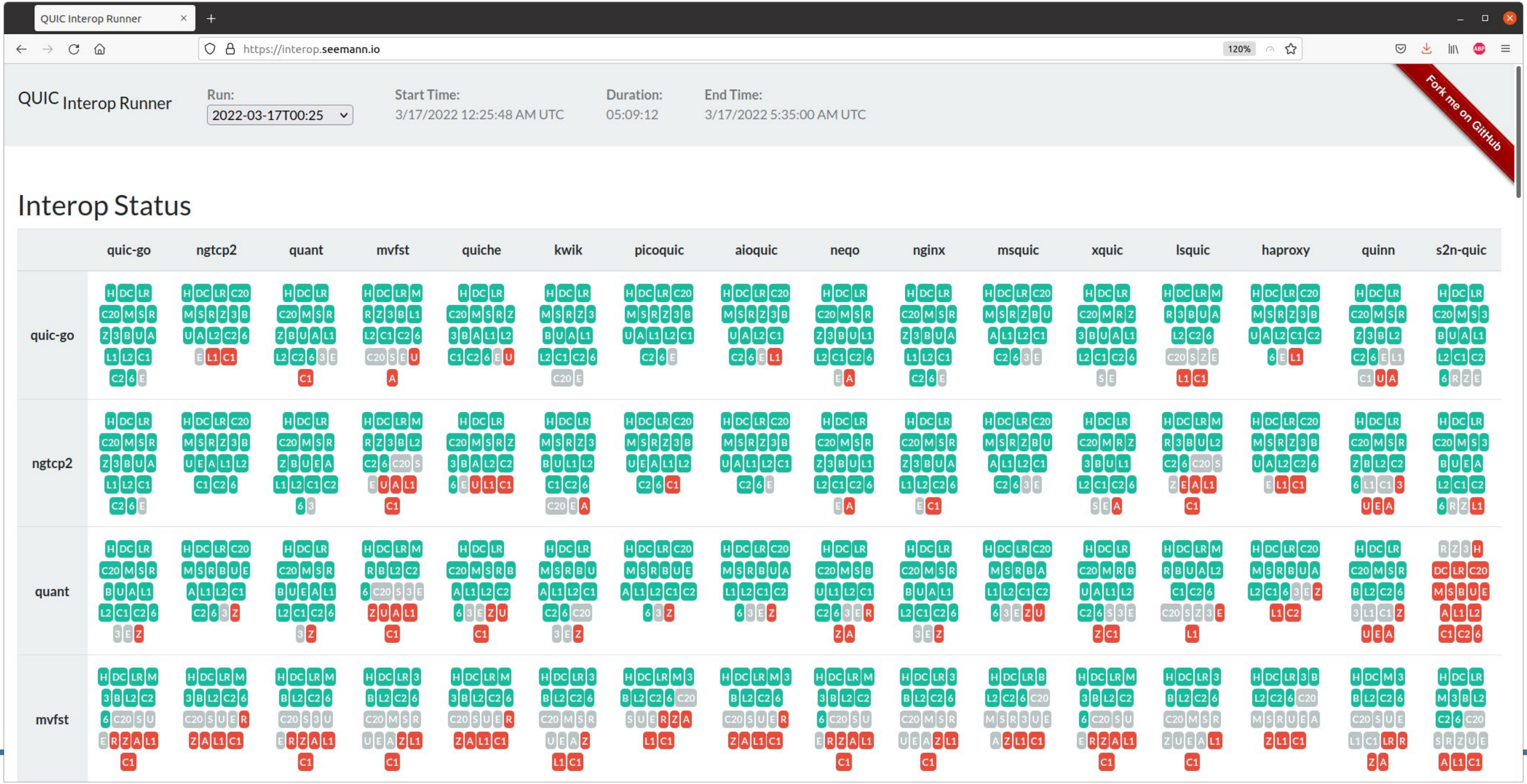
- Performance Enhancing Proxies not applicable with QUIC



- Poor performance of QUIC over geostationary satellite links
  - draft-jones-tsvwg-transport-for-satellite, previous maprg meetings
  - Literature overview
  - So far: tests with specifically selected QUIC implementations

Motivation

- QUIC Interop Runner https://interop.seemann.io



Motivation

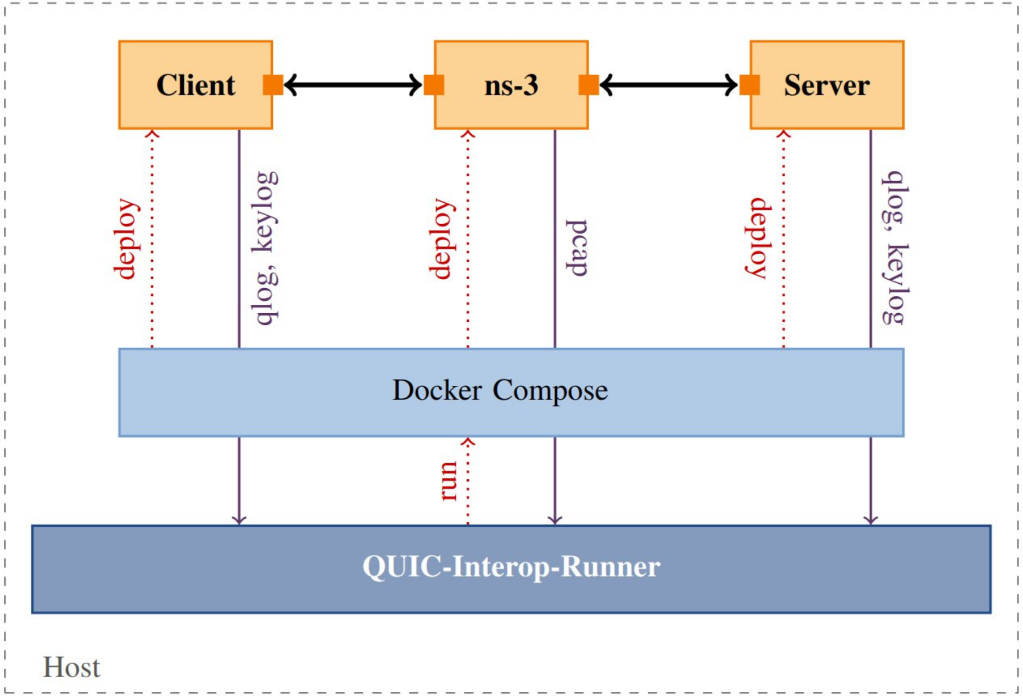
- QUIC Interop Runner
  https://interop.seemann.io
  - Several interop tests
  - Performance tests
    - Bulk data transfer, symmetrical links, 10 Mbit/s, 30ms RTT, no packet loss
    - **GOODPUT** (good results for almost all implementations)
    - **CROSSTRAFFIC** with one competing TCP flow (results show significant unfairness)

- QUIC Interop Runner Satellite Edition
  https://interop.cs7.tf.fau.de
  - Added performance tests
  - Modified architecture includes real satellite links
  - Generation of time-offset graphs

Name	RTT [ms]	Link Rate [Mbit/s]	PLR [%]
TERR.	30	20/2	0
SAT	600	20/2	0
SATLOSS	600	20/2	1
ASTRA	$\gtrsim$600	20/2	$\lesssim$0.1
EUTELSAT	$\gtrsim$600	50/5	$\lesssim$0.1

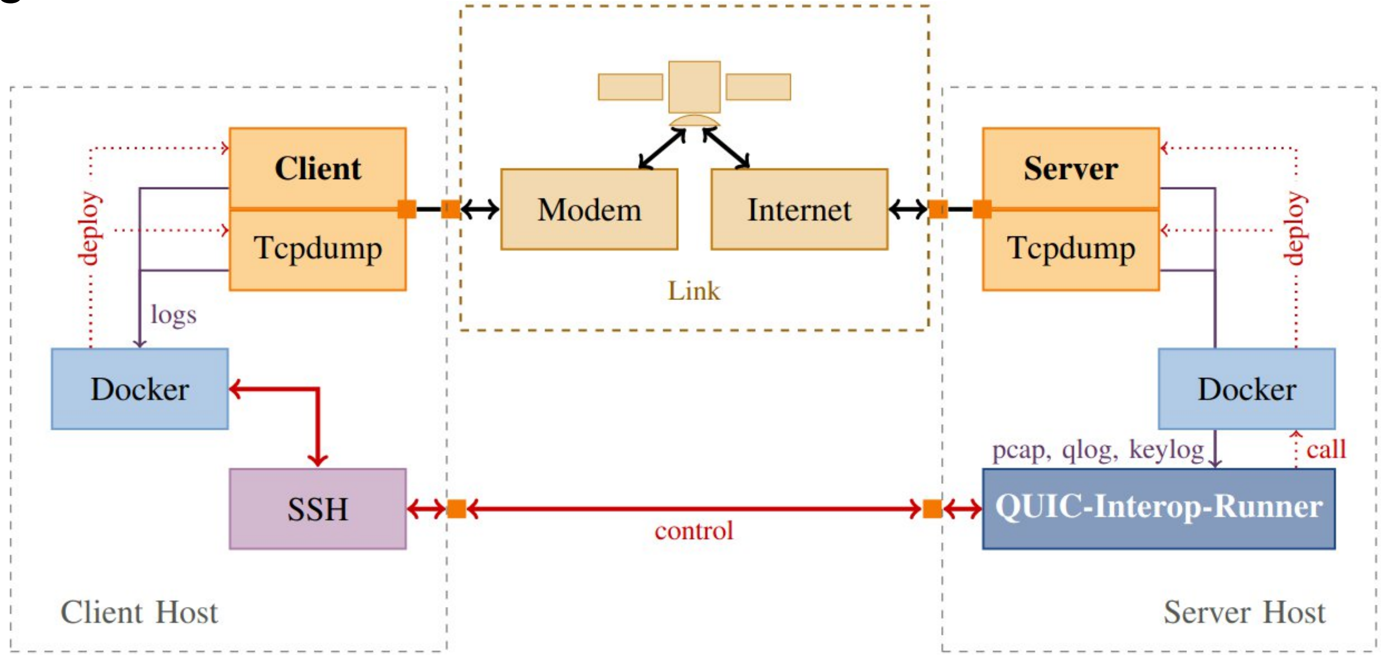
Architecture and Setup (original QUIC Interop Runner)

- Docker containers on single host machine
- ns-3 link emulation
- Performance tests with emulated links
  - TERRESTRIAL
  - SAT
  - SATLOSS
- 10 iterations per QUIC client/server combination

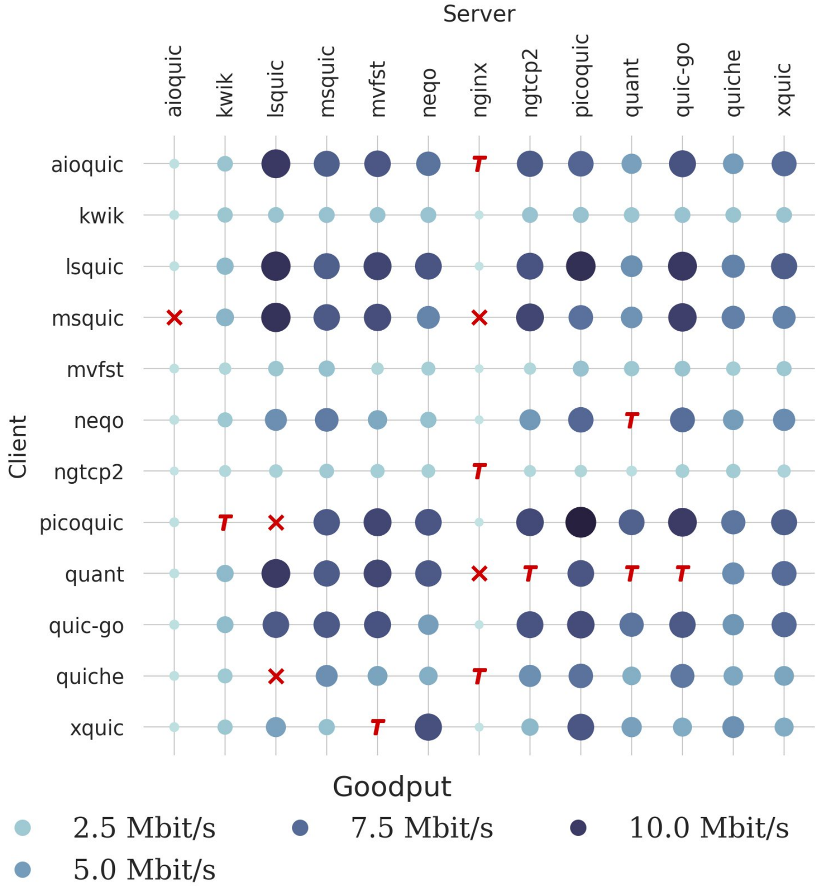


Architecture and Setup (modified for real satellite links)

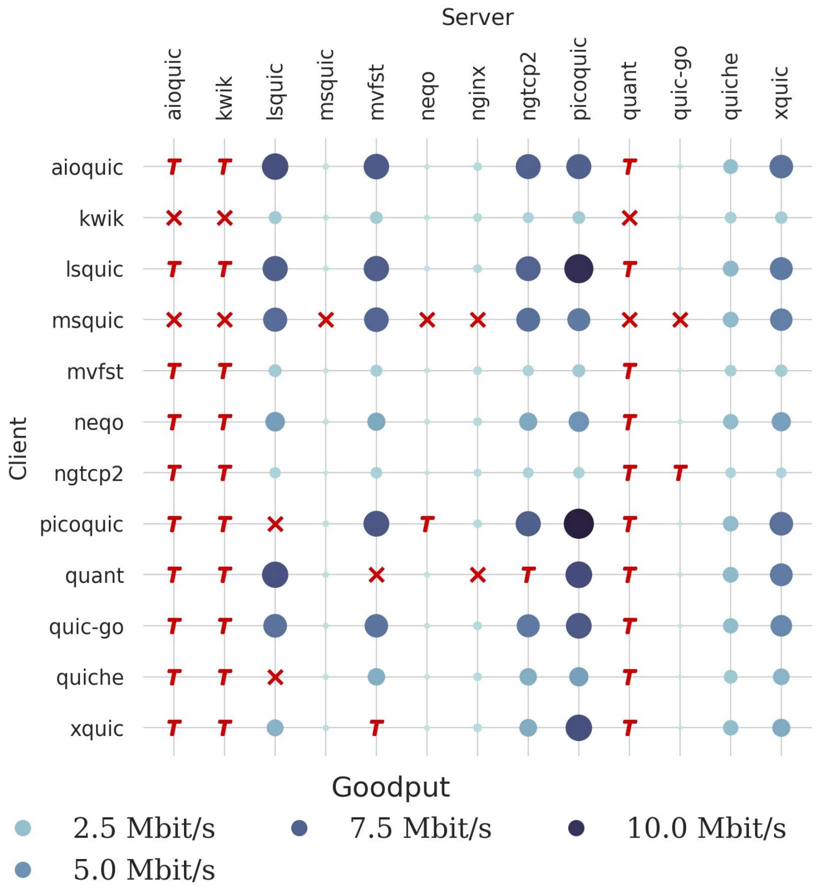
- Distributed setup
- Performance tests with real links
  - ASTRA
  - EUTELSAT
- Single vantage point
- 5 iterations per QUIC client/server combination



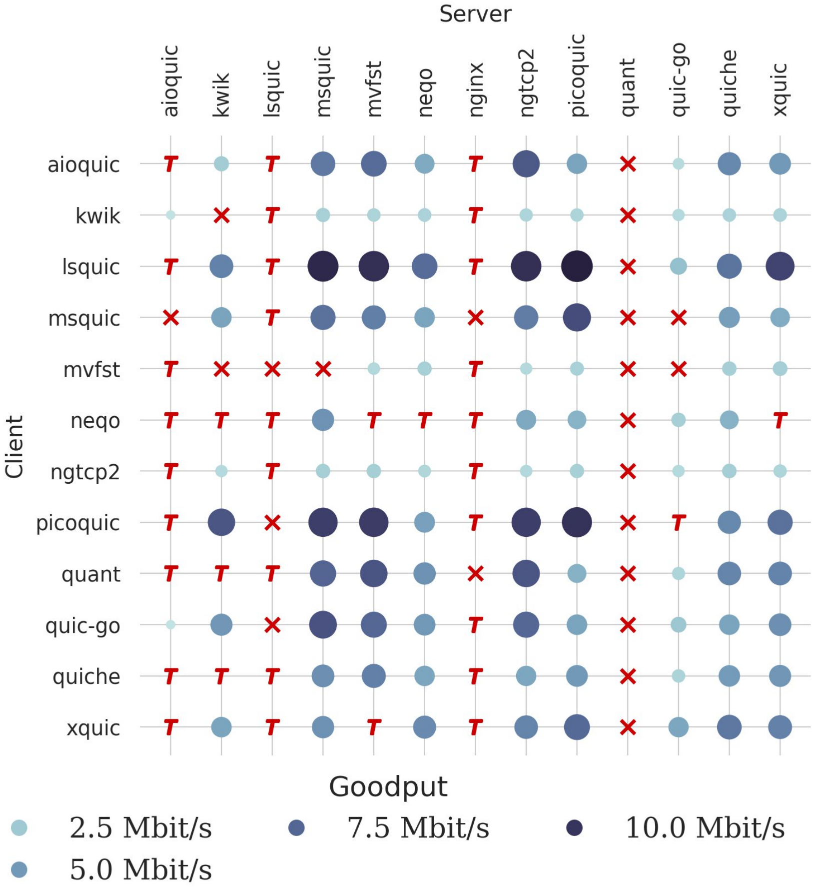
SAT
(20/2 Mbit/s, 600ms RTT, no packet loss)



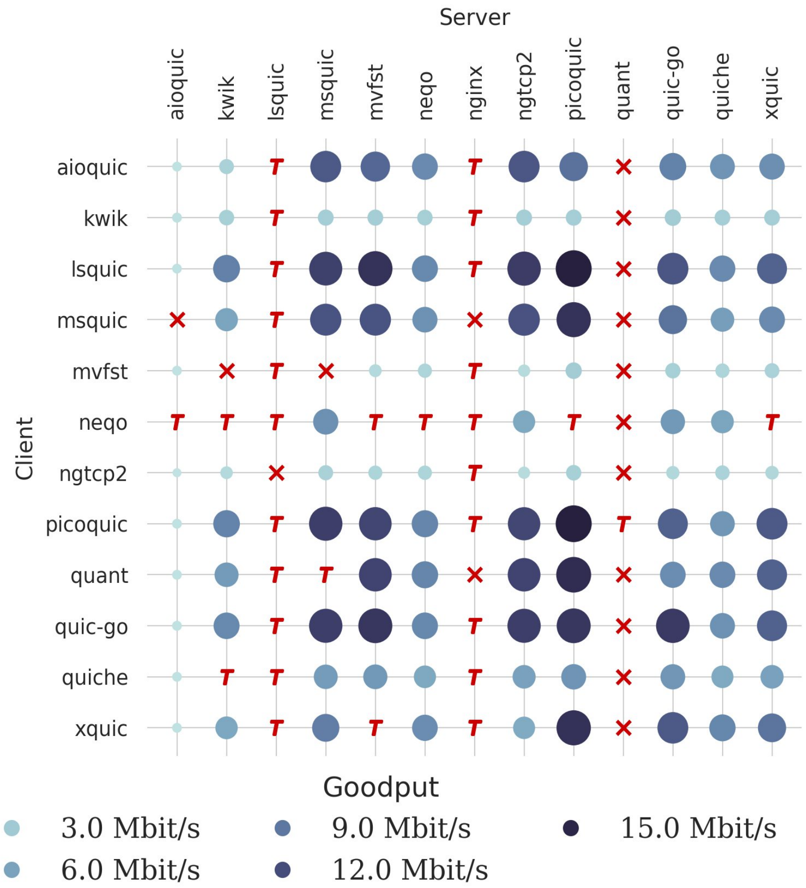
SATLOSS
(20/2 Mbit/s, 600ms RTT, 1% packet loss)



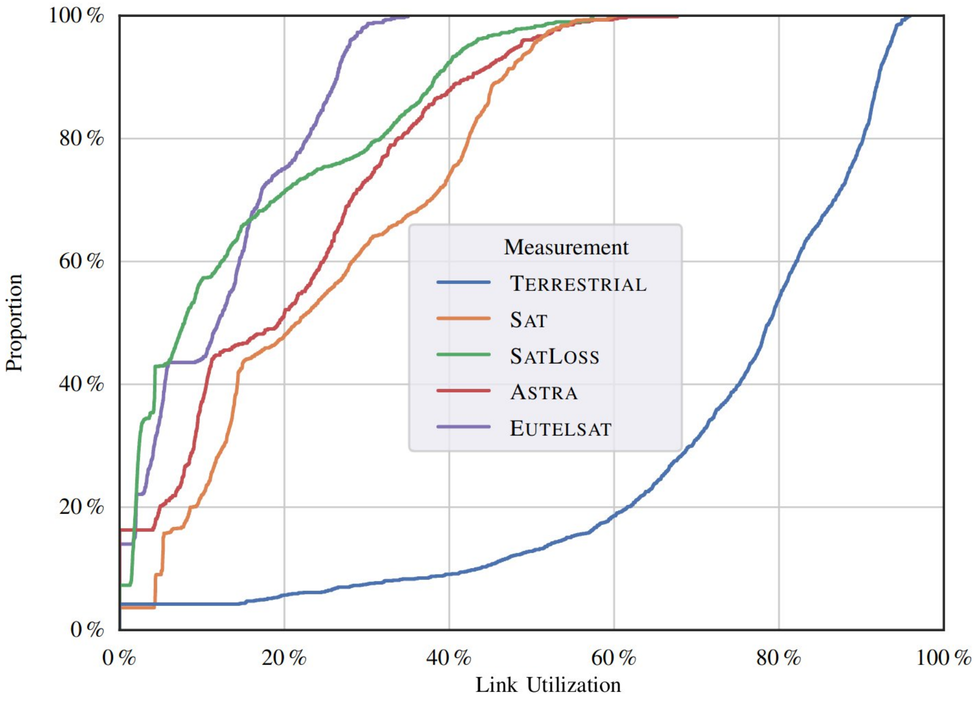
ASTRA
(real satellite link, 20/2 Mbit/s)



EUTELSAT
(real satellite link, 50/5 Mbit/s)



Results Overview



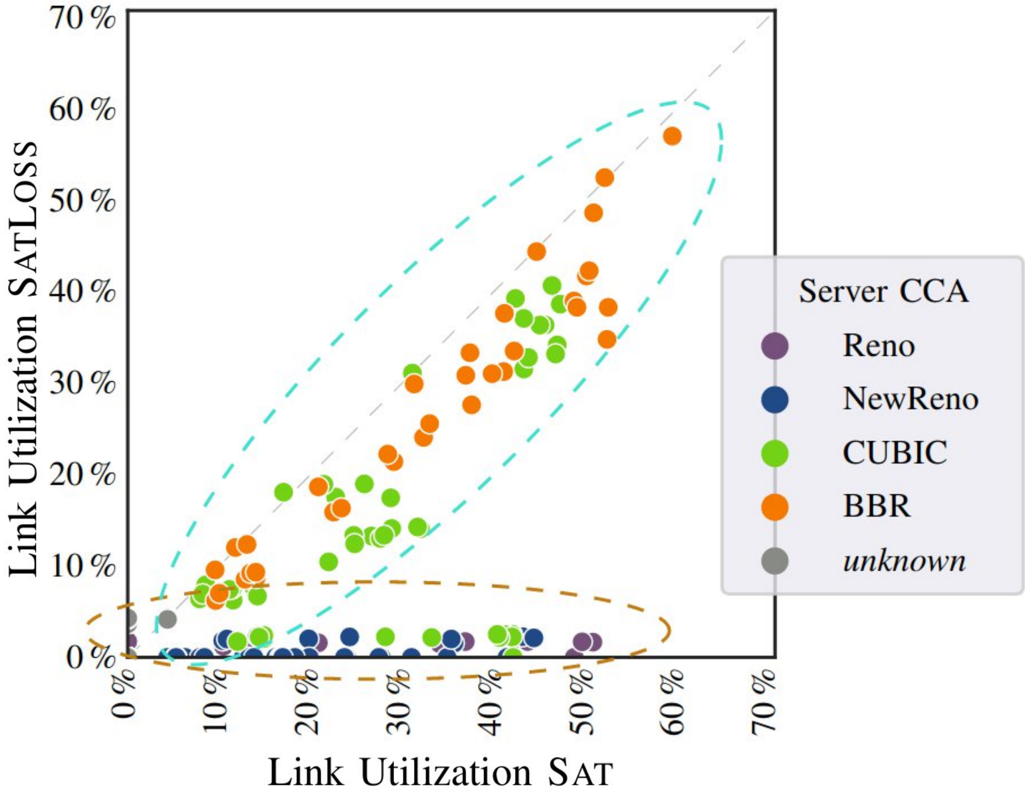
$$\text{Link Utilization} = \frac{\text{Goodput}}{\text{Link Data Rate}}$$

Name	RTT [ms]	Link Rate [Mbit/s]	PLR [%]
TERR.	30	20/2	0
SAT	600	20/2	0
SATLOSS	600	20/2	1
ASTRA	$\gtrsim$600	20/2	$\lesssim$0.1
EUTELSAT	$\gtrsim$600	50/5	$\lesssim$0.1

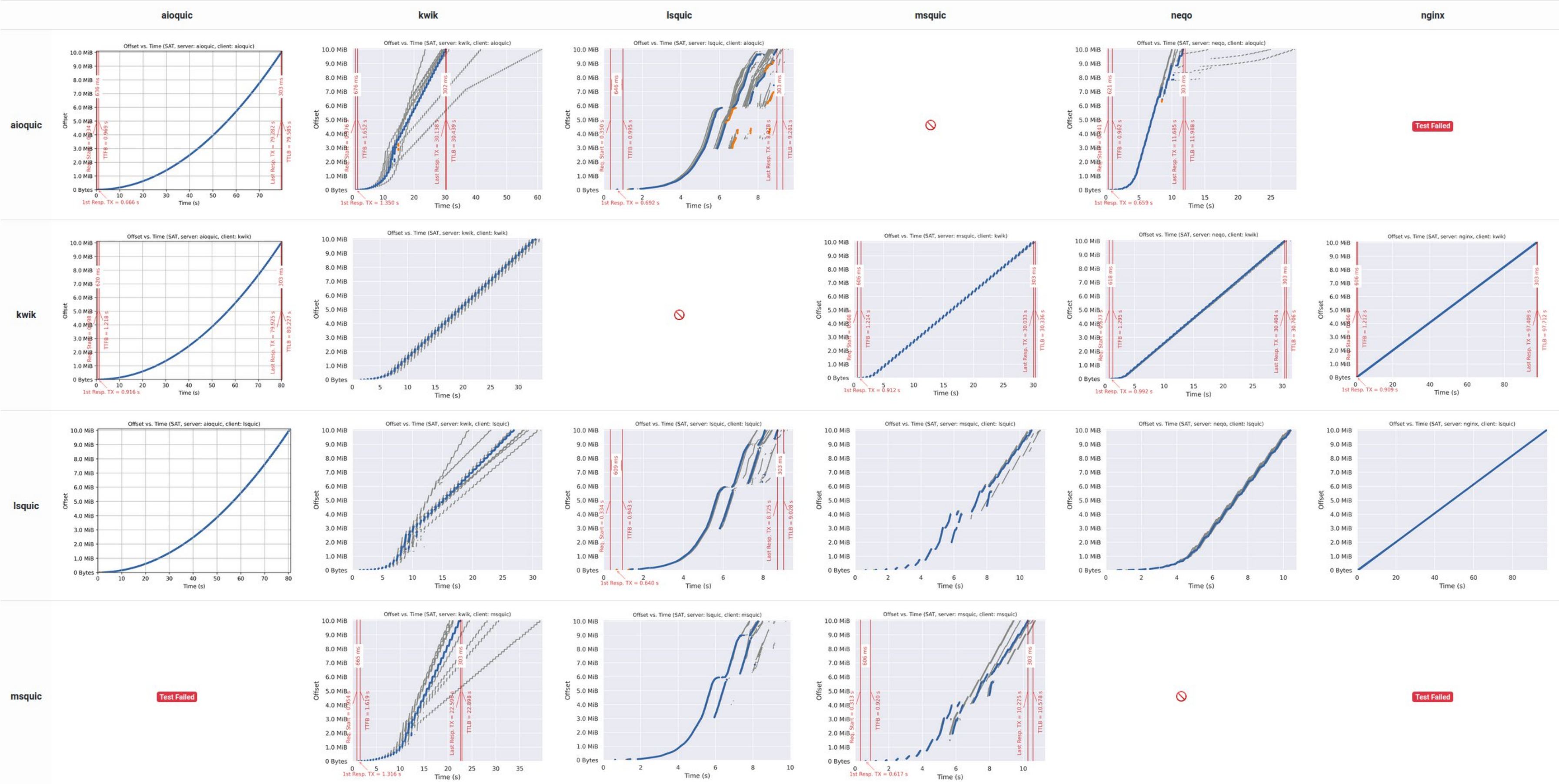
Measure-ment	Mean [Mbit/s]	Max [Mbit/s]	Time-out *T* [%]	Failed ✗ [%]
TERR.	15.11	19.2	12	1
SAT	5.05	12.0	3	6
SATLOSS	3.06	11.5	13	17
ASTRA	4.91	13.5	23	15
EUTELSAT	6.98	17.5	20	11

Influence of CC Algorithm

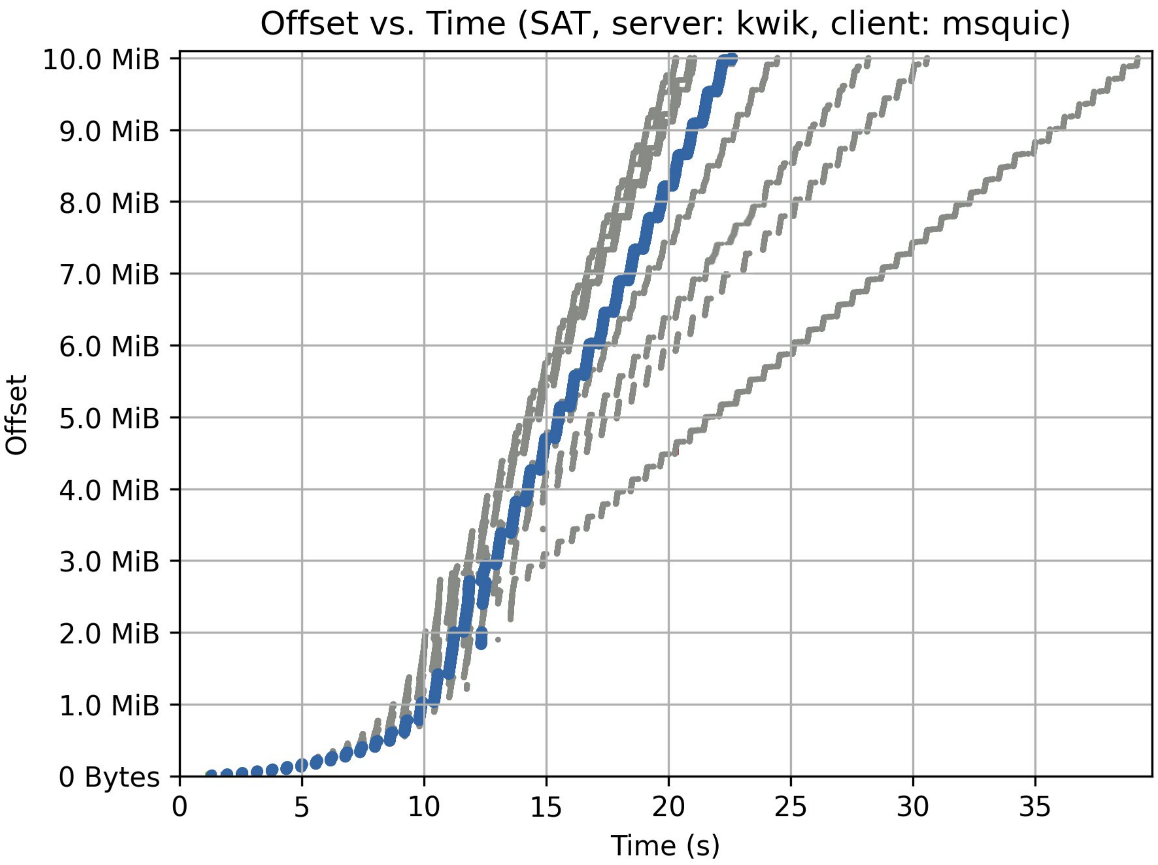
Name	CCA	HyStart
aioquic	**NewReno**	✗
chrome	BBRv2, CUBIC	✓
kwik	**NewReno**	✗
lsquic	**BBR**, CUBIC	✗
msquic	**CUBIC**	✗
mvfst	**BBR**, CUBIC, NewReno, …	✓
neqo	CUBIC, **NewReno**	✗
nginx	?	✗
ngtcp2	BBRv2, BBR, **CUBIC**, Reno	✗
picoquic	**BBR**, CUBIC	✓
quant	**NewReno**	✗
quic-go	CUBIC ?, Reno ?	✗
quiche	**CUBIC**	✓
quicly	CUBIC, **Reno**, pico	✗
xquic	**BBR**, CUBIC, Reno	✗



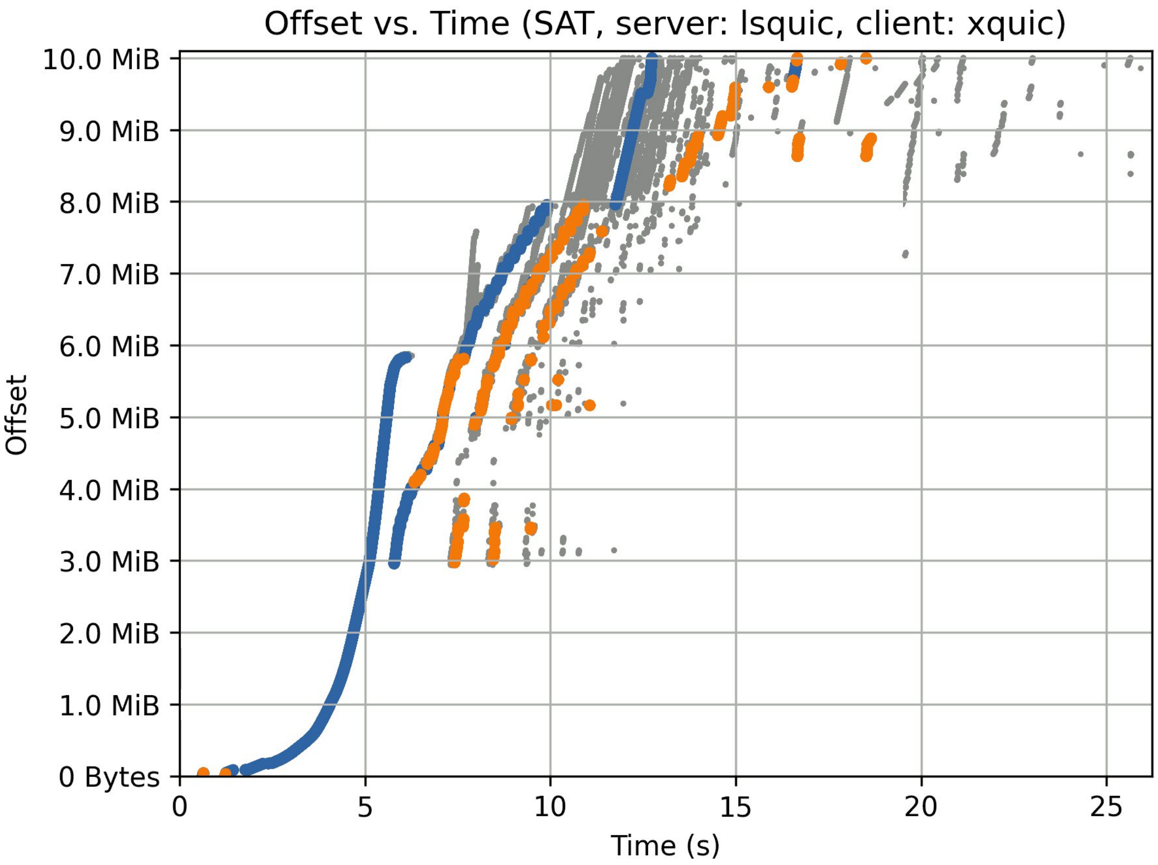
Time-Offset Diagrams



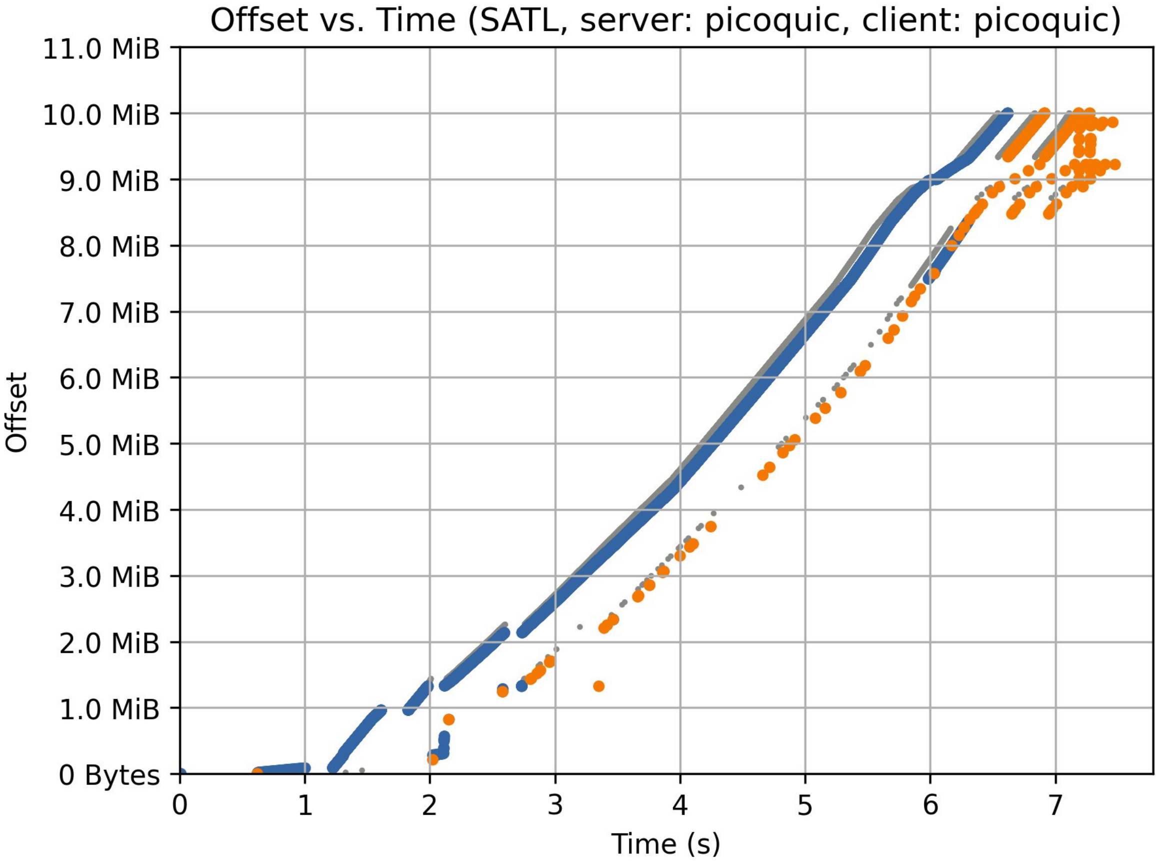
kwik (server) – msquic (client) – SAT (no loss)



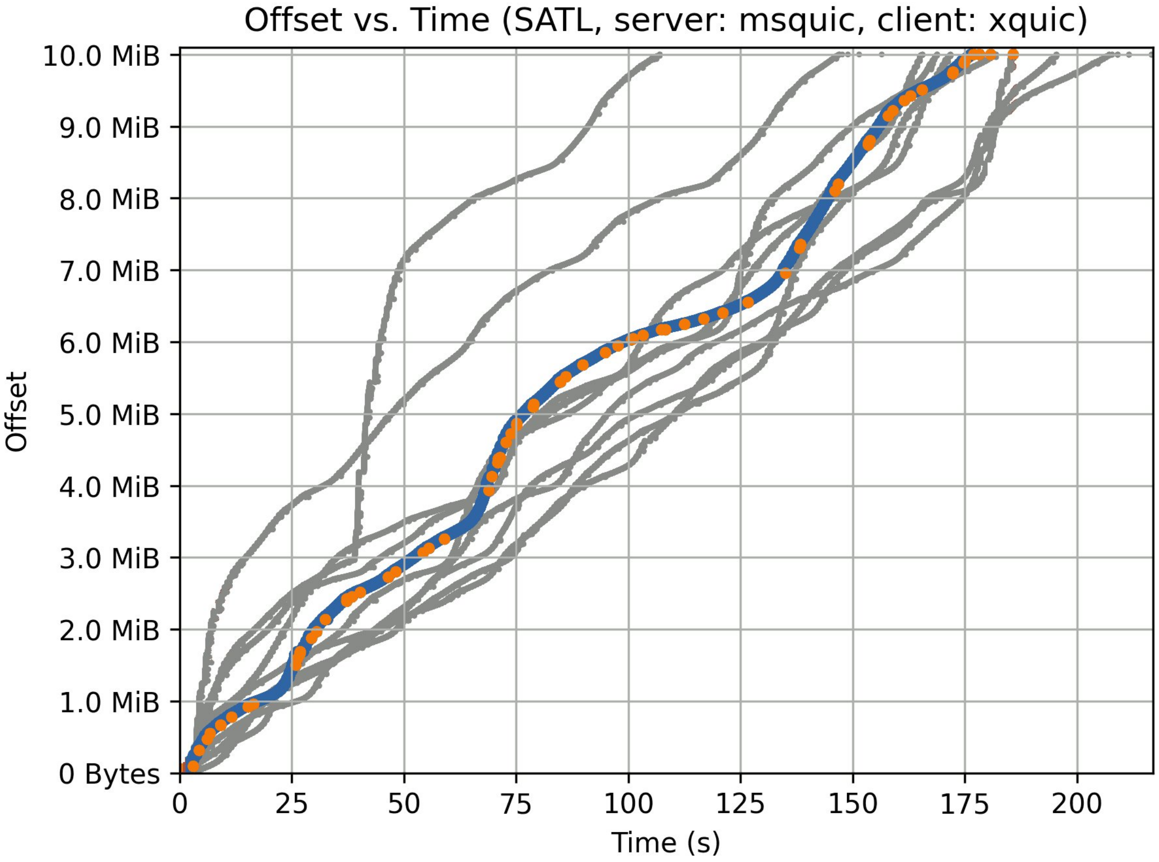
lsquic (server) – xquic (client) – SAT (no loss)



picoquic (server) – picoquic (client) – SATLOSS (1% loss)



msquic (server) – xquic (client) – SATLOSS (1% loss)



Summary

https://interop.cs7.tf.fau.de https://arxiv.org/abs/2202.08228

- Modified QUIC Interop Runner
  - Emulated satellite links and real satellite operators
  - Generation of time-offset diagrams
- QUIC + geostationary satellites: very poor performance in general
  - Worse with packet loss – CUBIC and BBR better than (New)Reno
  - Performance depends on both client and server
  - Implementations probably not optimized for such link characteristics
  - Hard to debug each and every implementation / combination
- Next steps
  - More detailed analysis (e.g., influence of flow control)
  - Additional test scenarios and long term measurements
  - Discussion on EToSat mailing list