

QUIC's ACK policy and satellite

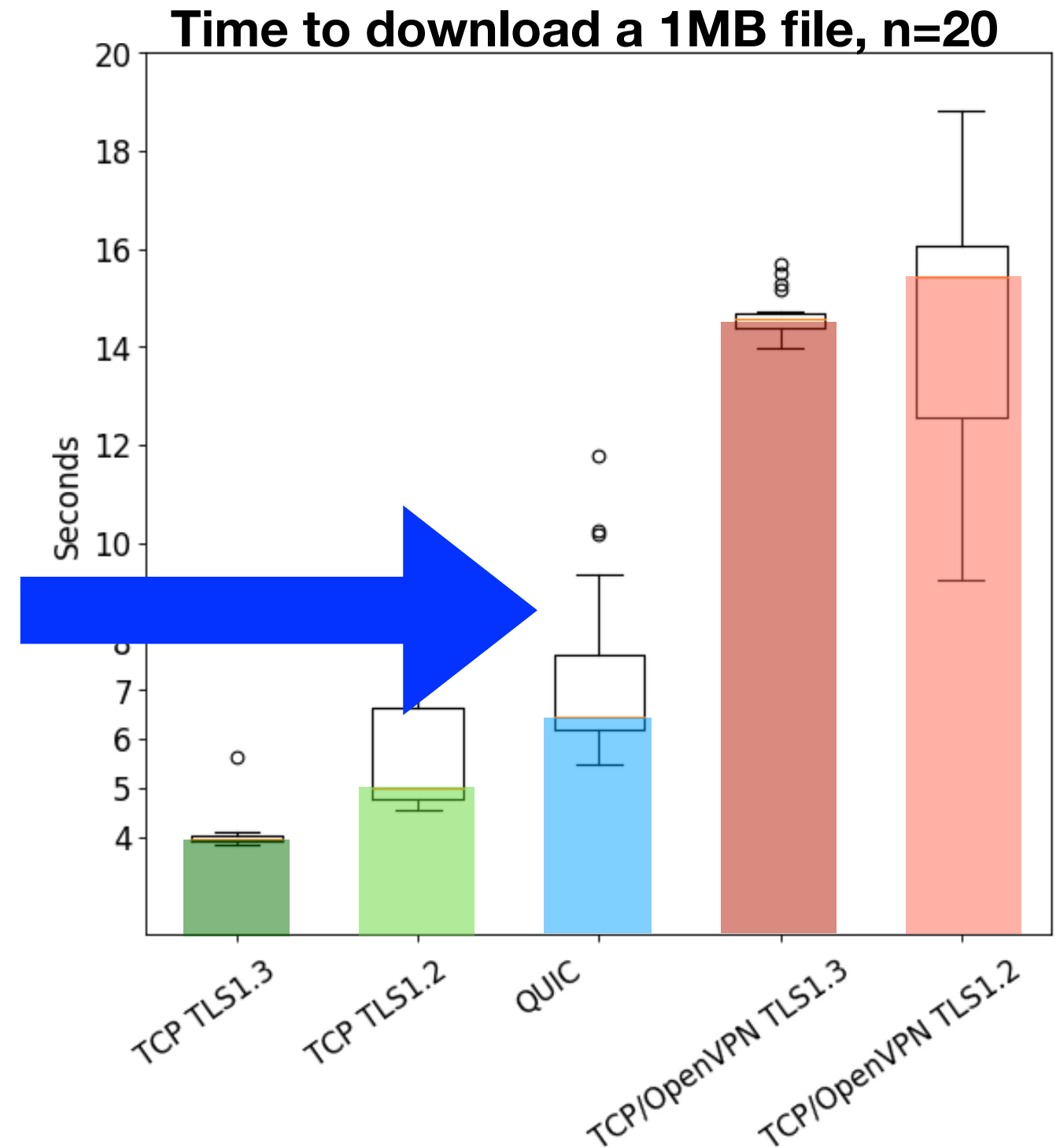
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QUIC and Satellite Open Stakeholder Meeting

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QUIC Initial Sat Performance

**QUIC is worse than H2/TCP
with a PEP!**



How does QUIC's ACK policy impact this?

QUIC ACK Policy

- **QUIC mimics TCP:**
 - Default AR (ACK Ratio) of 1:2
 - ACK delay of 25 ms

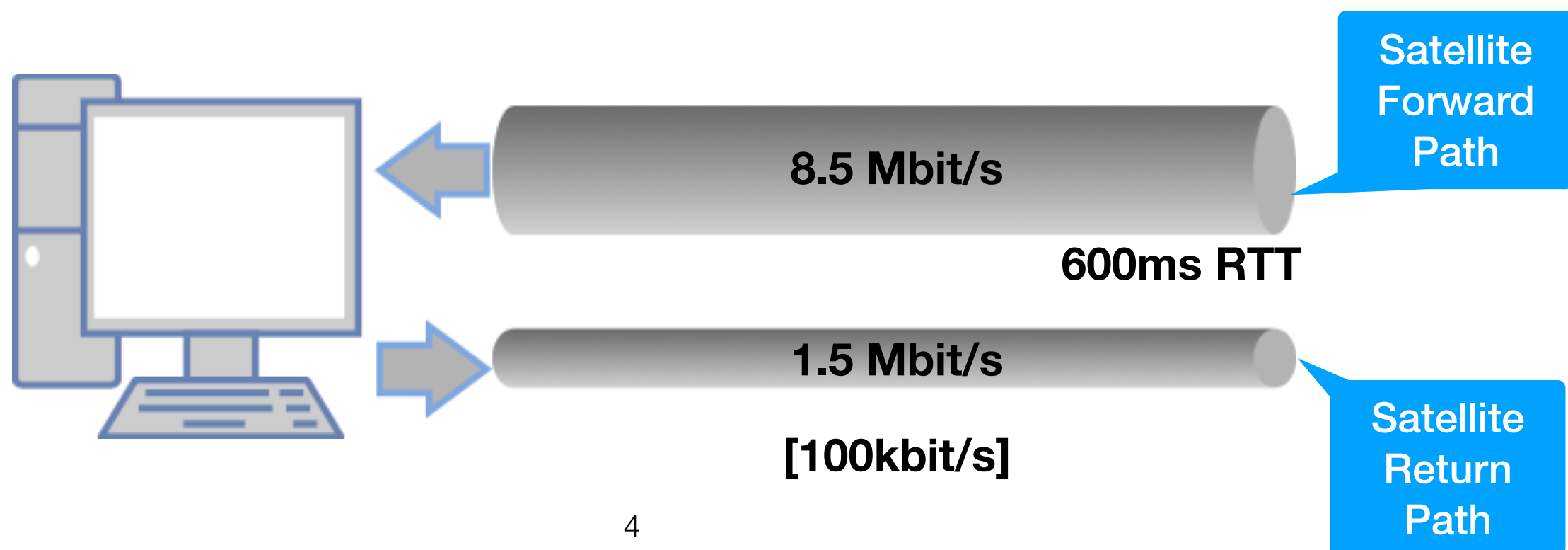
...However:

- QUIC does not block a connection on packet loss
- QUIC sends many frames to coordinate connection state
- **No QUIC PEPs exist (yet or ever?)**
- **can impact the satellite return path**

Exploring QUIC with a Satellite Return Path

Methodology: Paths and Workload

- Single stream with a 10 MB transfer
 - Compares TCP and QUIC on an emulated satellite testbed
 - No loss or 1% packet loss
- Network traces and logs collected and analysed



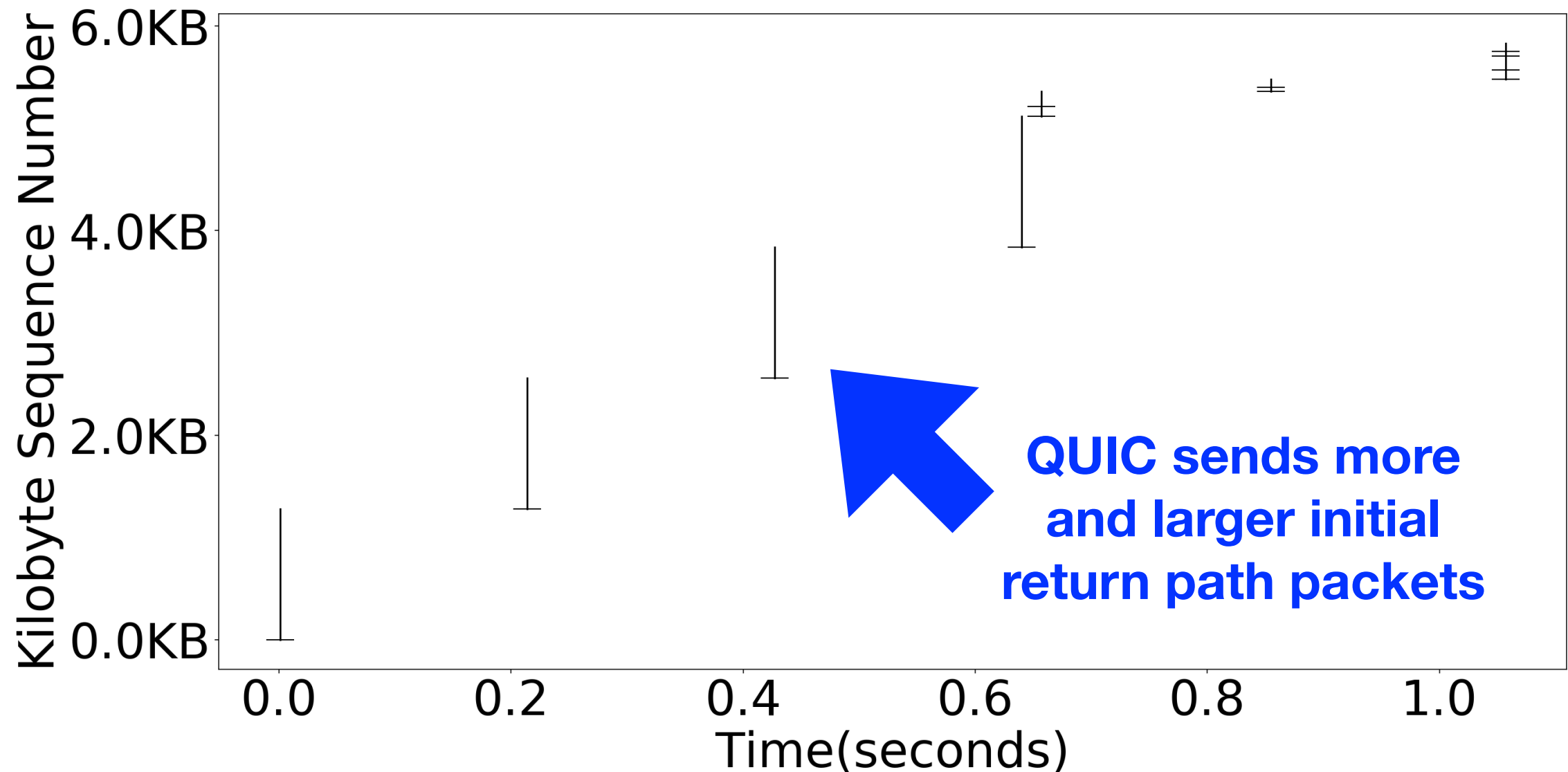
Exploring QUIC with a Satellite Return Path

Methodology: Endpoints

- Endpoints used in our experiments:
 - Quicly, draft revision 27
 - PicoQUIC, draft revision 26
 - Chromium, draft revision 26,
 - Linux TCP (default AR 1:2)
- QUIC code was modified to use a different ACK ratio

How does QUIC compare to TCP?

(1) Packets to Setup the Connection



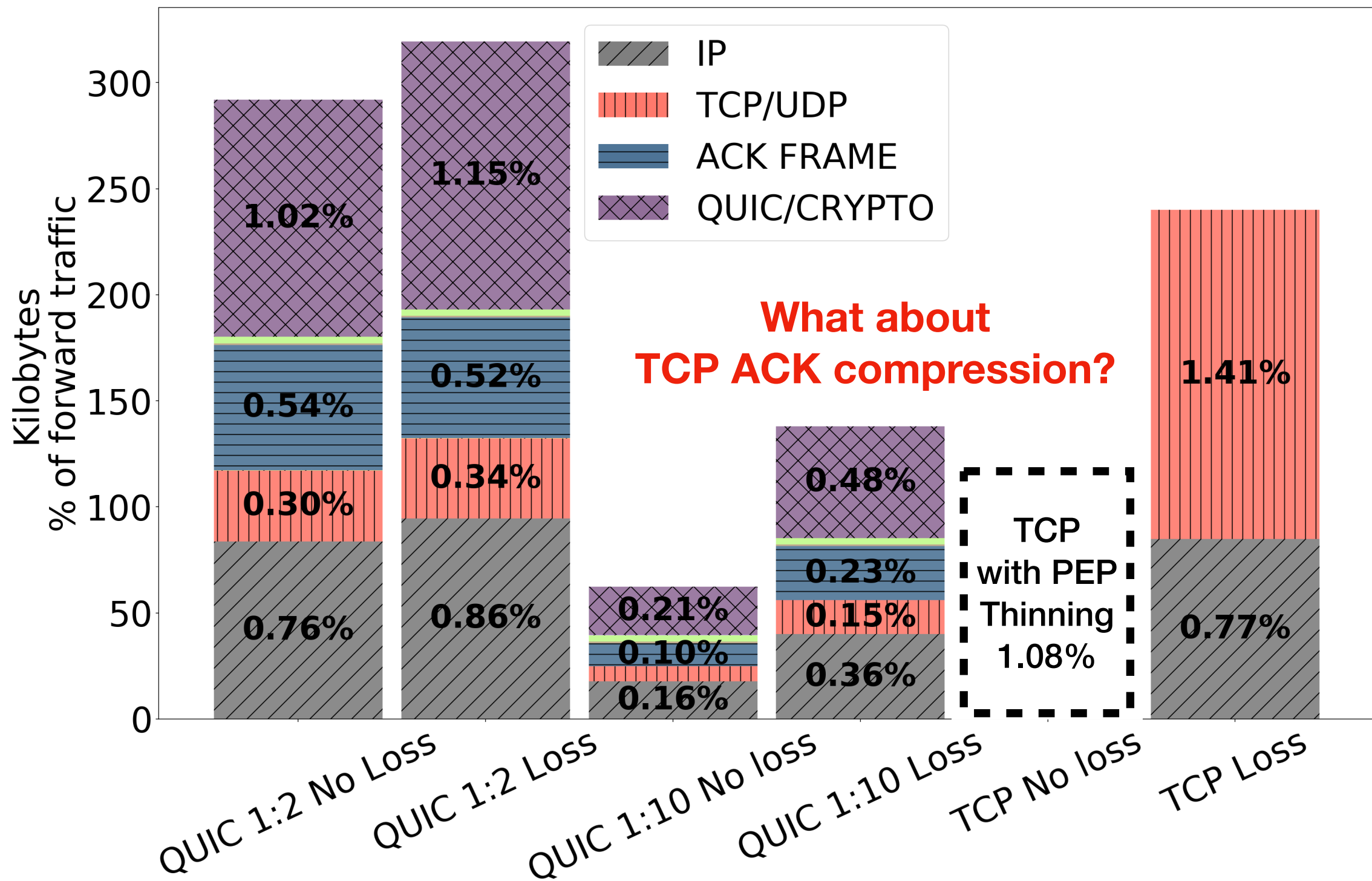
Data sent by a QUIC client during the first RTT of a connection over an emulated satellite network, and showing 4 QUIC handshake packets, spaced 200 ms apart. Subsequent packets carry smaller control frames.

How does QUIC compare to TCP?

(2) Packets after Connection Setup

- QUIC has 25%-50% more byte overhead than TCP
 - ... TCP ACKs are currently thinned by PEPs!
 - ... after loss, size of QUIC ACKs can grow unlimited
 - ... *varint* encoding means ACKs grow for longer connections
 - ...other QUIC frames are also sent over the return path
- The forward rate can be limited on very asymmetric paths if the default AR of 1:2 is used for QUIC!

Analysis of Return Traffic by Type (Volume)



Volume of ACKs measured for a 10 MB transfer,
with and without link loss, emulated 600ms Path RTT.

A Better QUIC ACK Policy for Satellite?

- Current policy mimics TCP, with poor results for GEO satellite
- We proposed draft-fairhurst-quic-ack-scaling:
 - An AR of 1:10 **mitigates** the impact for asymmetric paths
 - An AR 1:10 **does not impact** performance: download time and cwnd growth was not impacted on satellite paths
 - An AR of 1:2 could be retained at the **start of a connection**, to grow the cwnd benefiting paths with a short RTT
- A QUIC client could negotiate ACK changes using a proposed method: draft-iyengar-quic-delayed-ack

Questions

- Do you have operational experience with QUIC over satellite?
- Do you have any satellite links or testbeds?