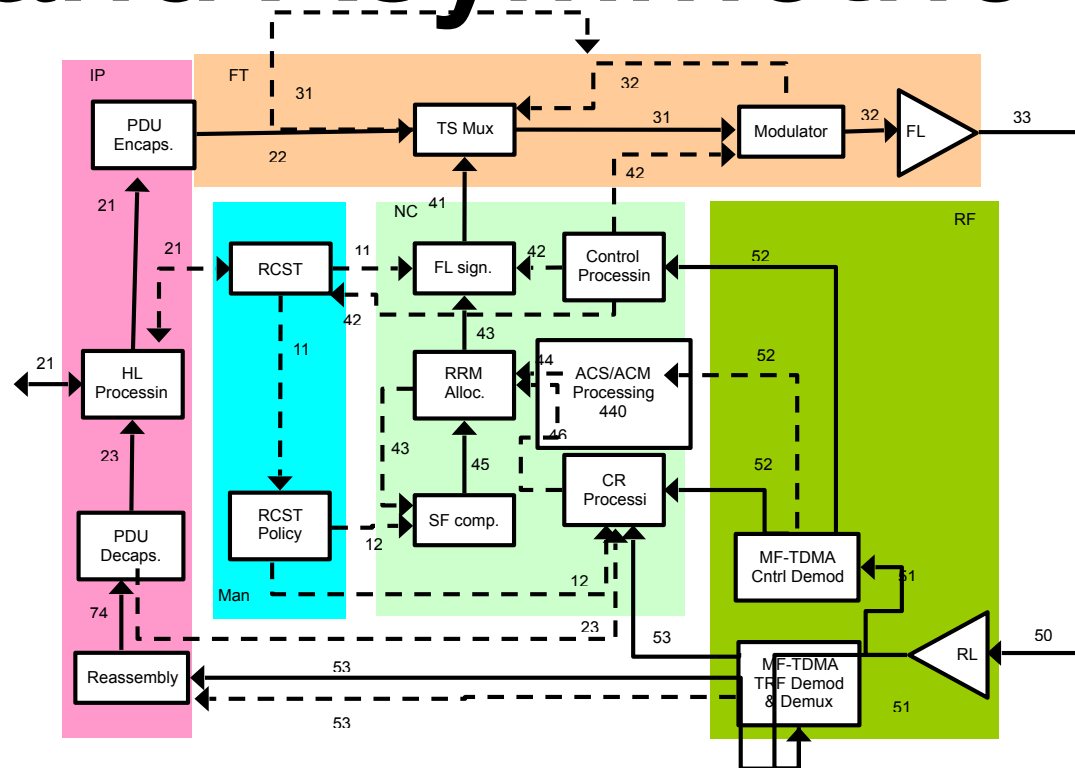


QUIC & Satellite Return Link

QUIC-4-SAT
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TCP and Asymmetric Paths

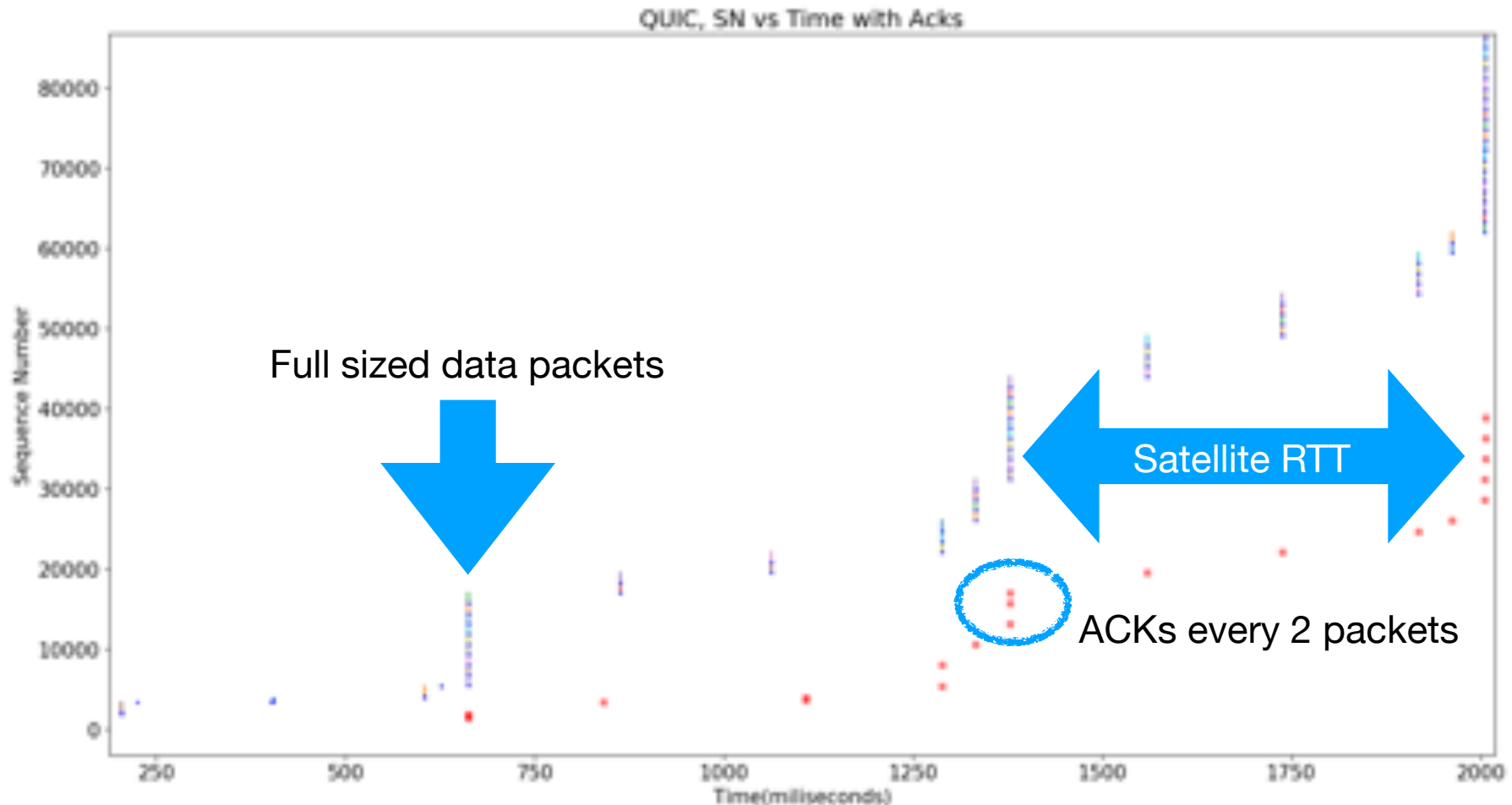


ACK traffic can constrain forward link throughput

Asymmetry in broadband satellite, cellular mobile, DOCSIS

- ACKs are expensive (RRM allocation, LTE scheduling)
- Historically, ACK thinning (by PEPs and similar boxes)

QUIC - Sender View

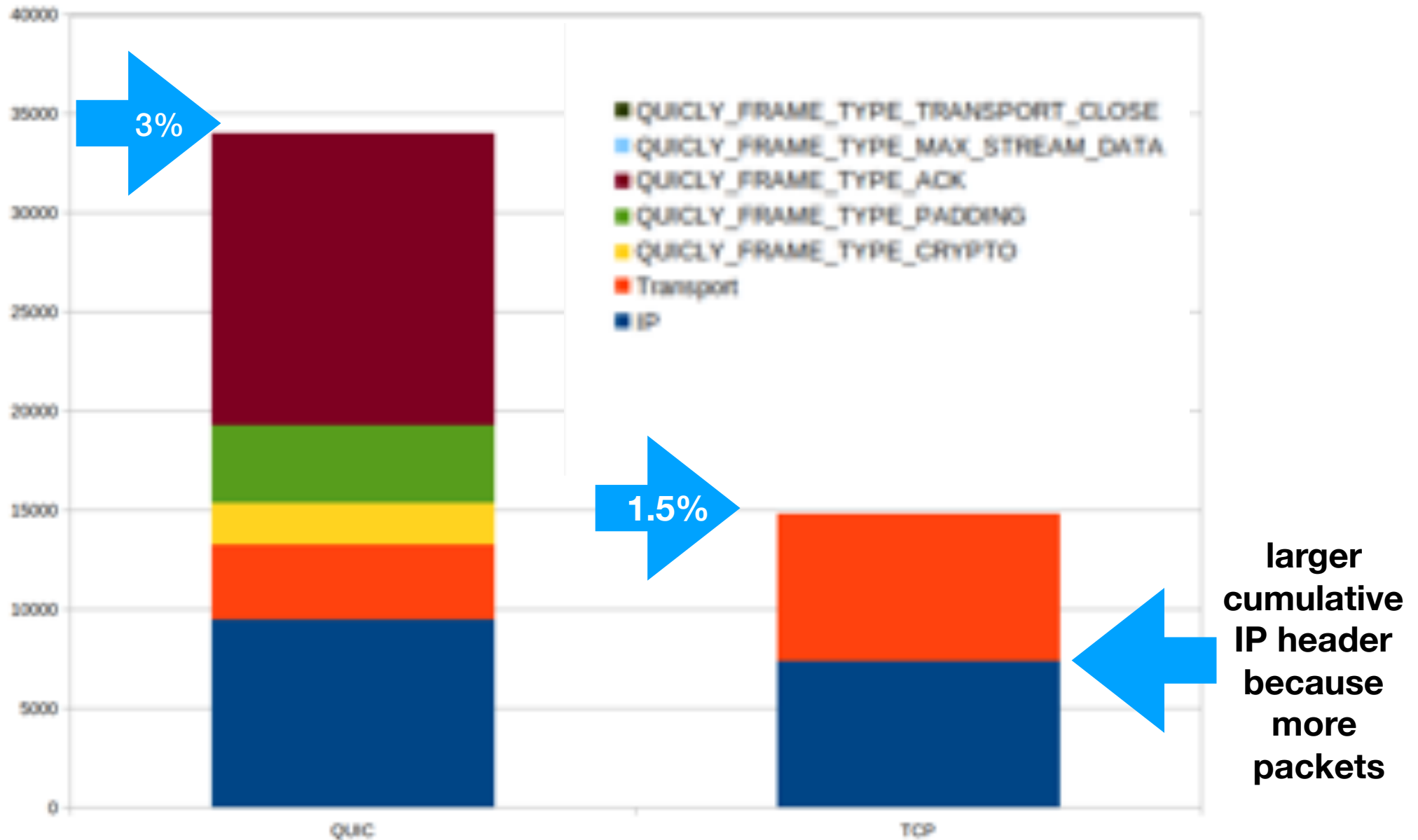


There is an ACK delay interval (set to 25ms in Quicly)

ACKs every 2 packets (mimics TCP)

There is no DAASS (not needed)

**Linux TCP vs Quicly draft 22 on a
satellite path with an average delay of
430 ms; HTTP/TLS1.3 TCP transfers**

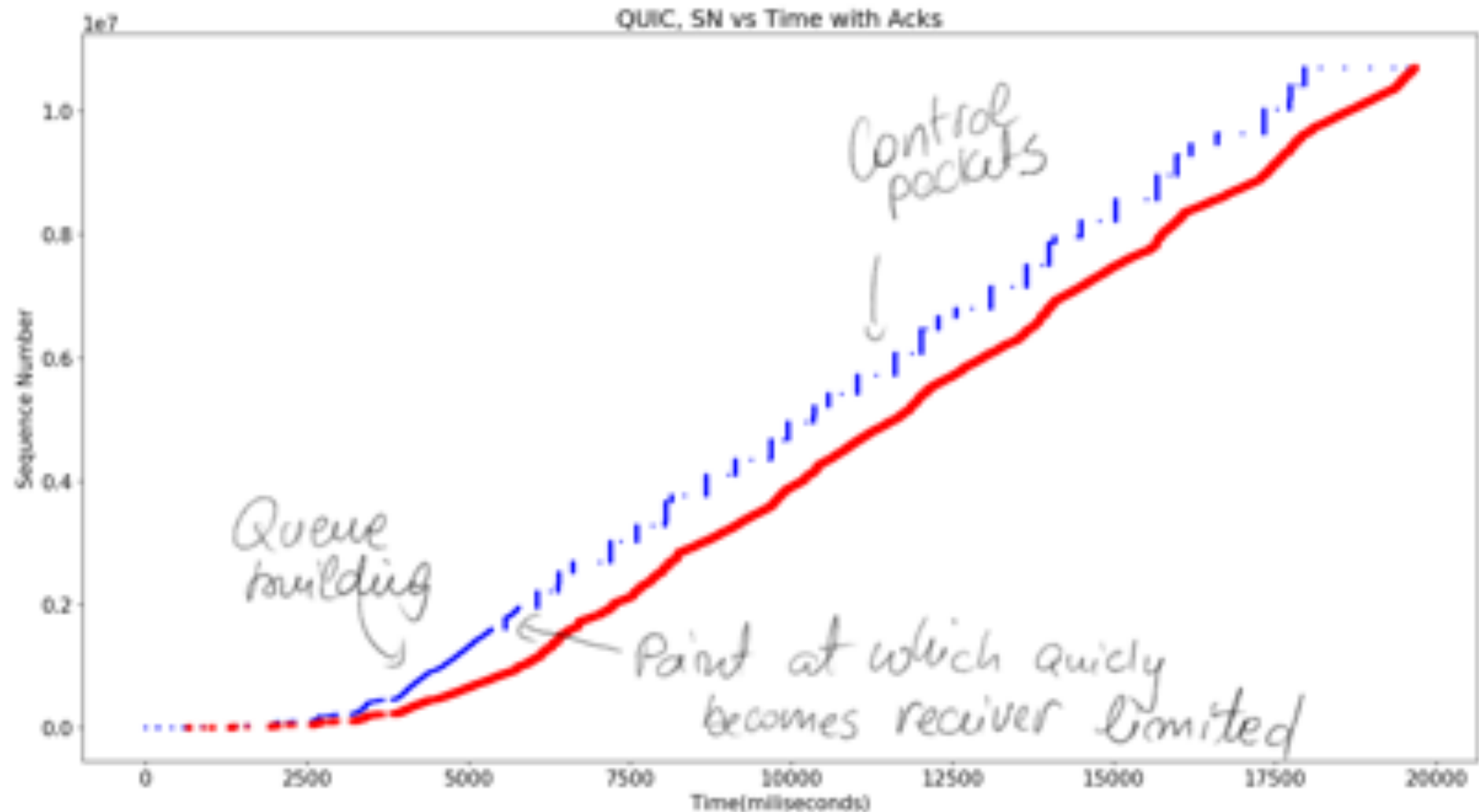


Experiment: changing the QUIC ACKing policy

- Real satellite link + VDSL broadband (long RTT vs short RTT)
- We modified Quicly to ACK every 10 segments (not in spec)
- We performed 10MB downloads ACKing every 2 segments
- We repeated the download ACKing every 10 segments
- Effects on congestion control were evaluated in PN over Time plots

Satellite: QUIC ACKs every 2 packets

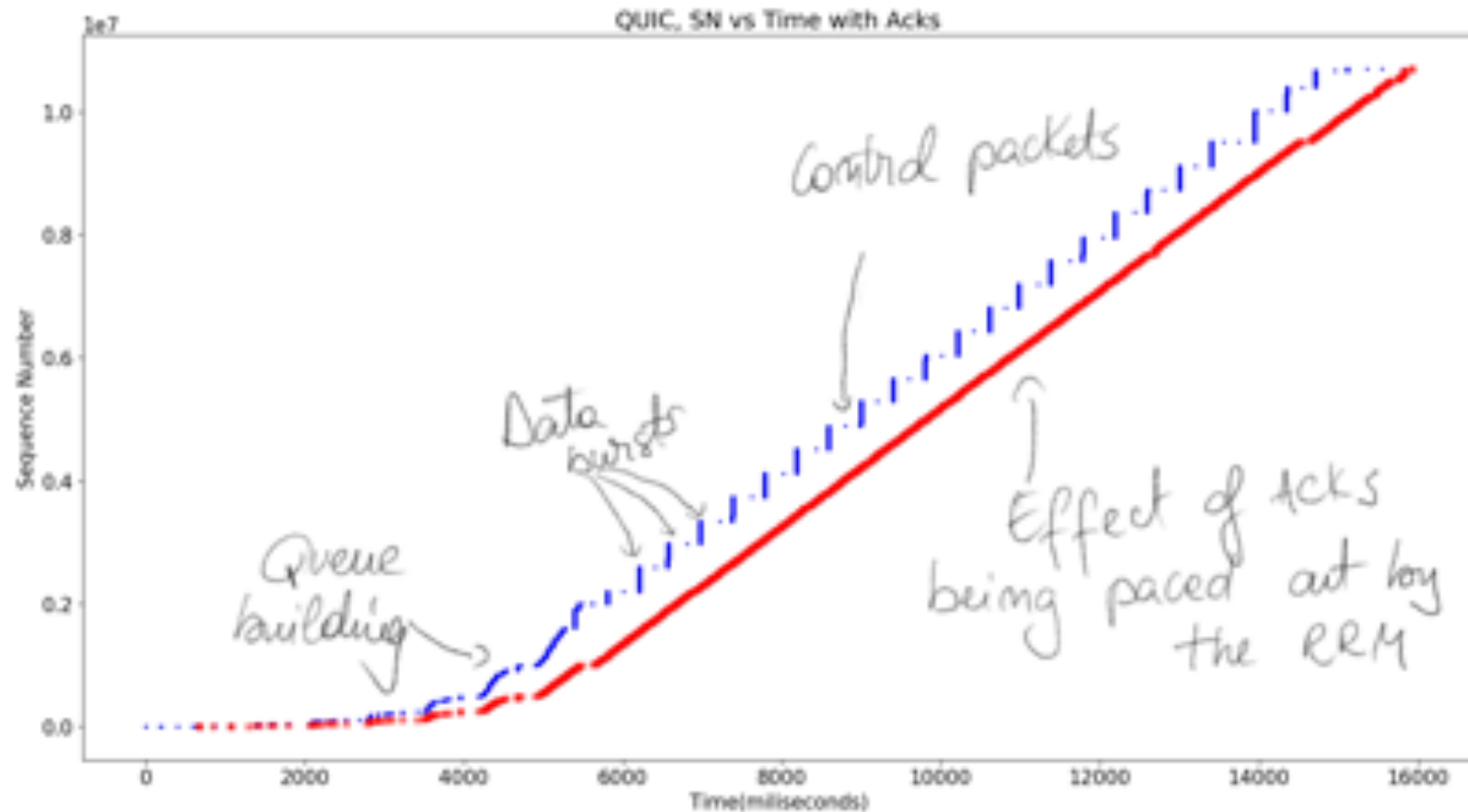
Ack every 2 segments, 25ms ack delay and 630ms average RTT



Satellite:

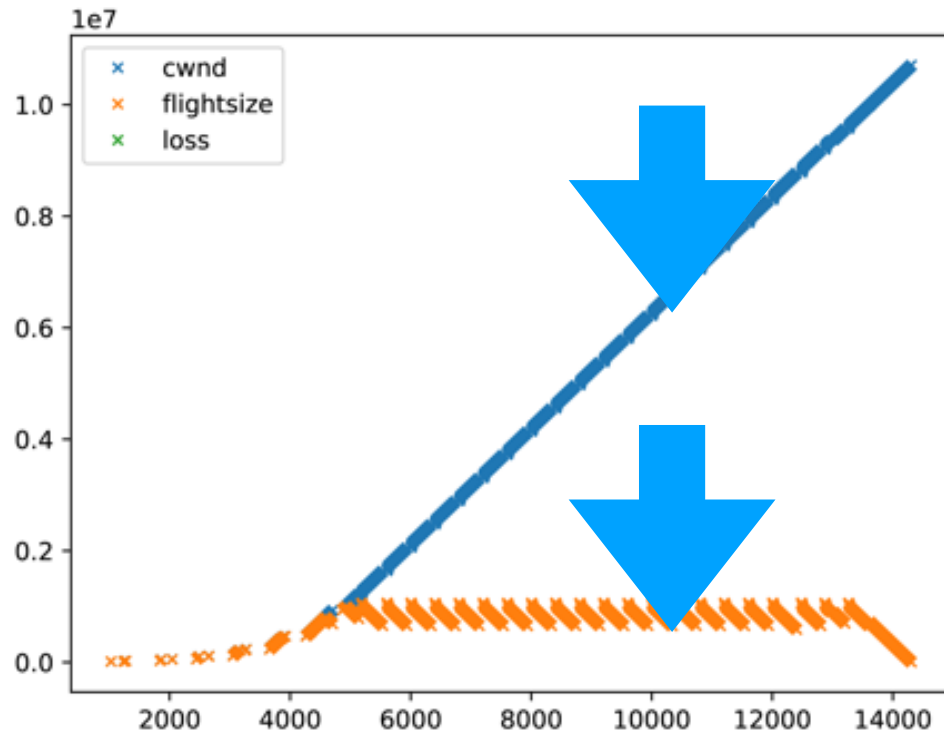
QUIC ACKs every 10 packets

Ack every 10 segments, 25ms ack delay and 630ms average RTT



- Reduces total time of transfer (Throughput from 4 Mbps to 5 Mbps)
- Reduces number of ACKs by a factor of ~ 5

Flow Control for QUIC :-)



- Flow control limits performance:
 - Lower throughput because no PEP
 - H3 delegates flow control to QUIC
 - Uses periodic updates (compared to TCP rwnd updates)
 - Credit updates should not be delayed for a large RTT
 - Set a minimum update period
 - (e.g., at least every 50ms?)

Conclusion

- ACK rate can limit forward data rate/consume resources
- Changing ACK policy (1:10 segments) helps
- We need to do more work on this topic
 - Need to know when to use a 1:2 or 1:10 ACK Policy
- We believe this can be fixed for QUIC
- Finally, flow control complicates this!
 - Need to

Questions