Measuring QUIC Dynamics over a High Delay Path

IETF-105, Montreal
MAP-RG Meeting

r09

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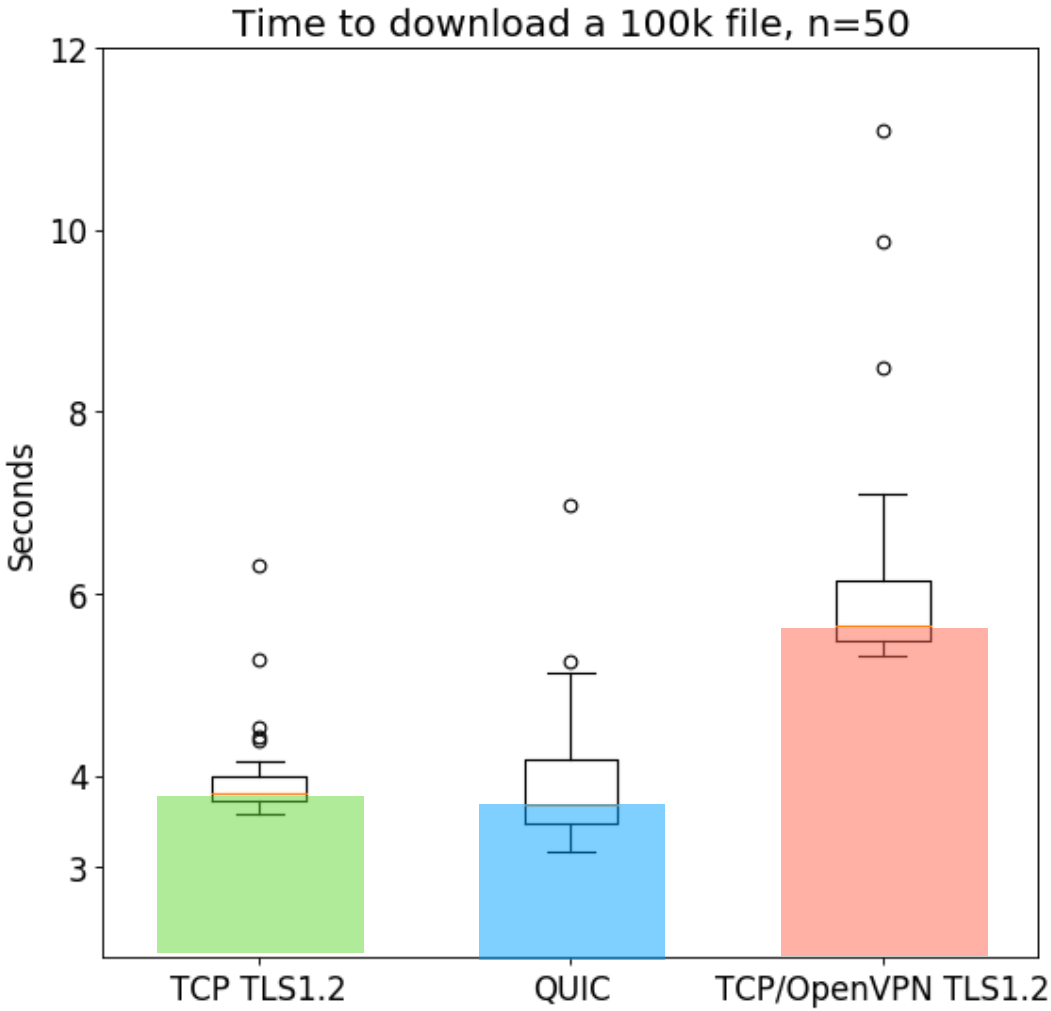
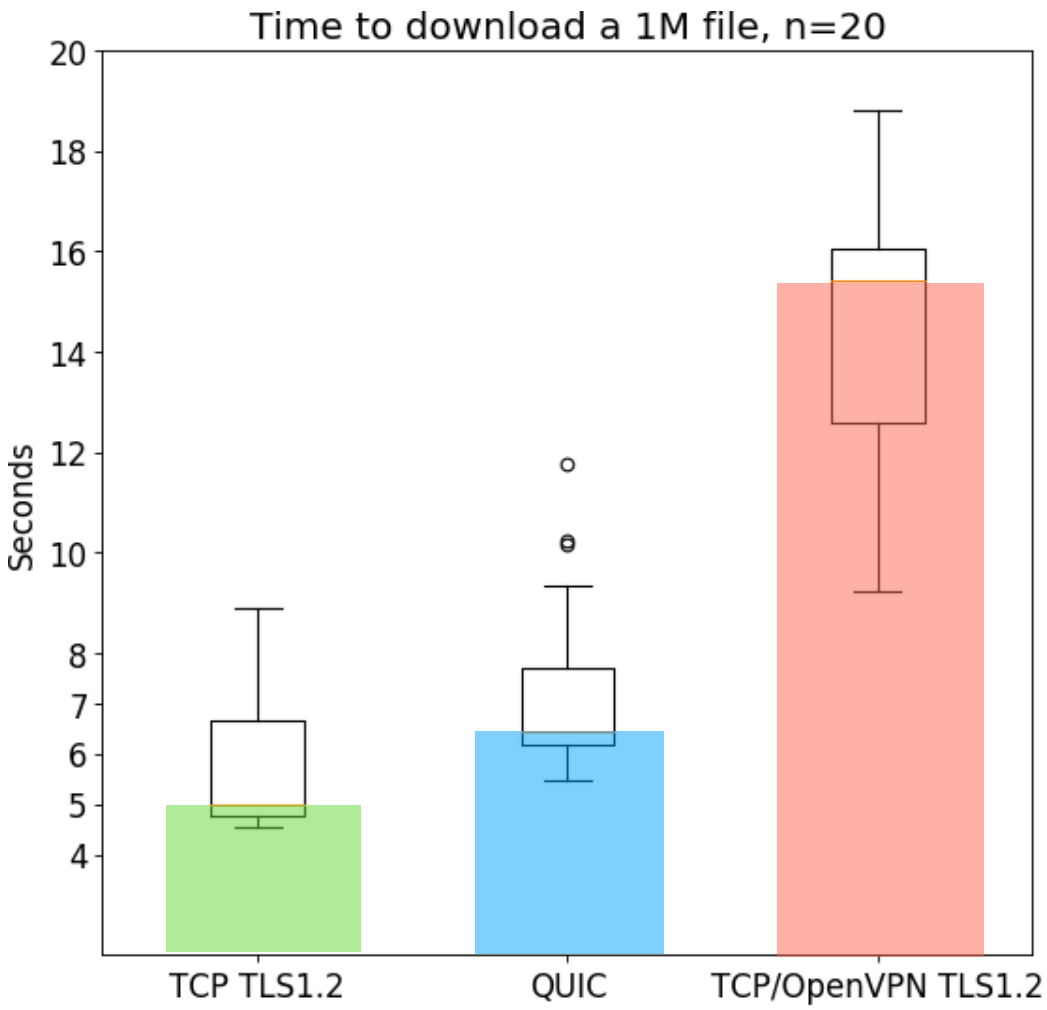
QUIC vs HTTP/TLS & OpenVPN

QUIC: Debian Linux, quicly v20, reno

TCP: Debian Linux, cubic, SACK, IW10

TCP: Debian Linux, OpenVPN, cubic, SACK, IW10





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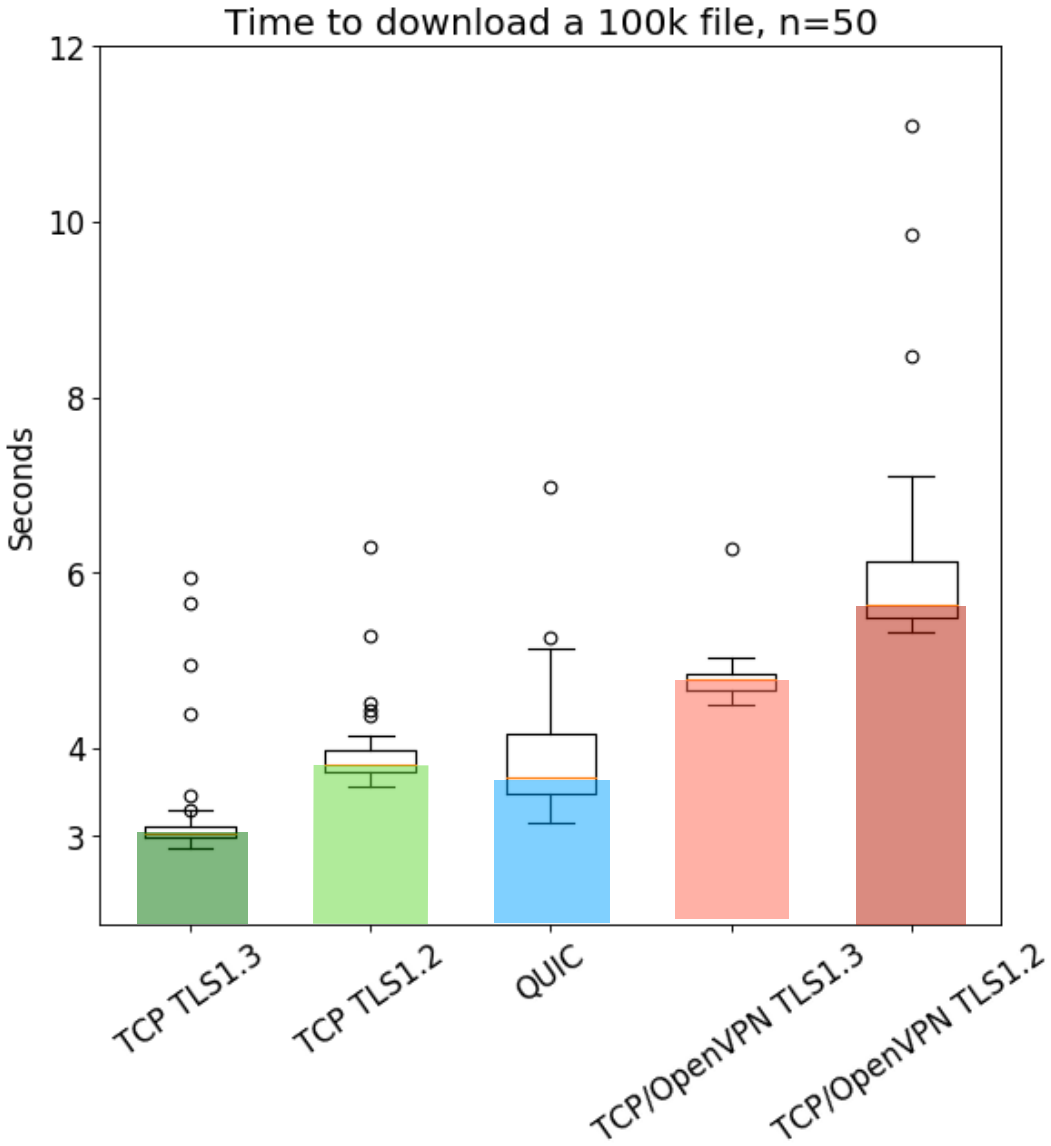
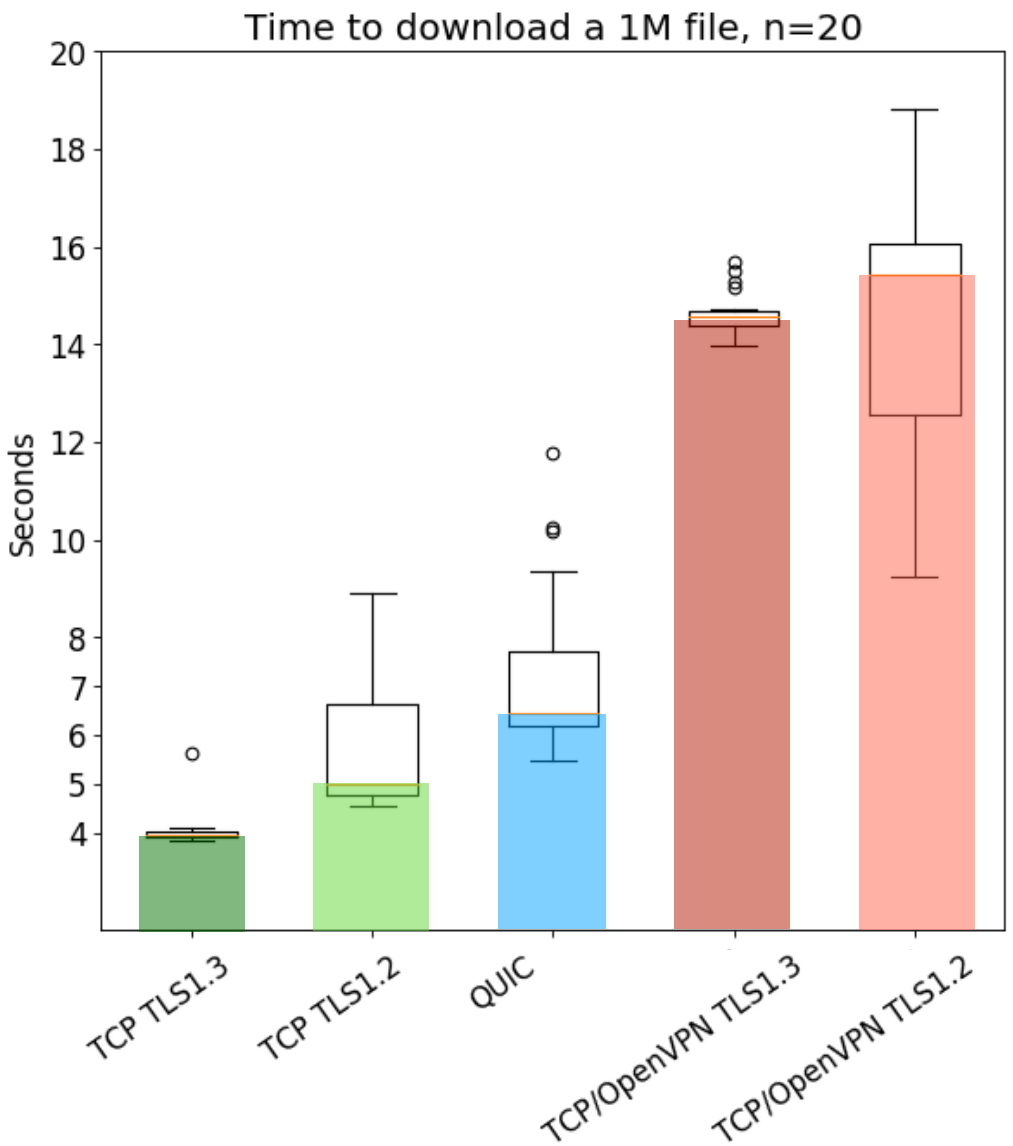
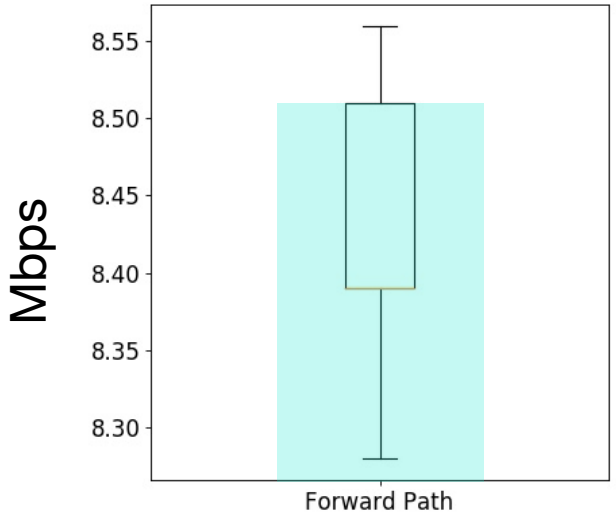
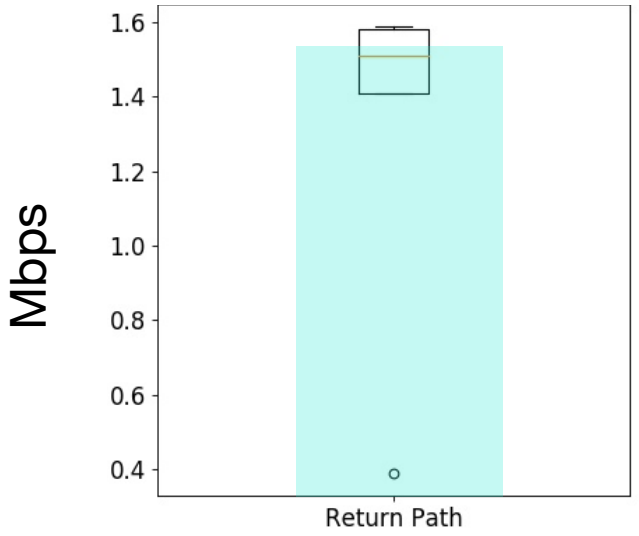




Satellite Residential Broadband (SLA varies by customer)

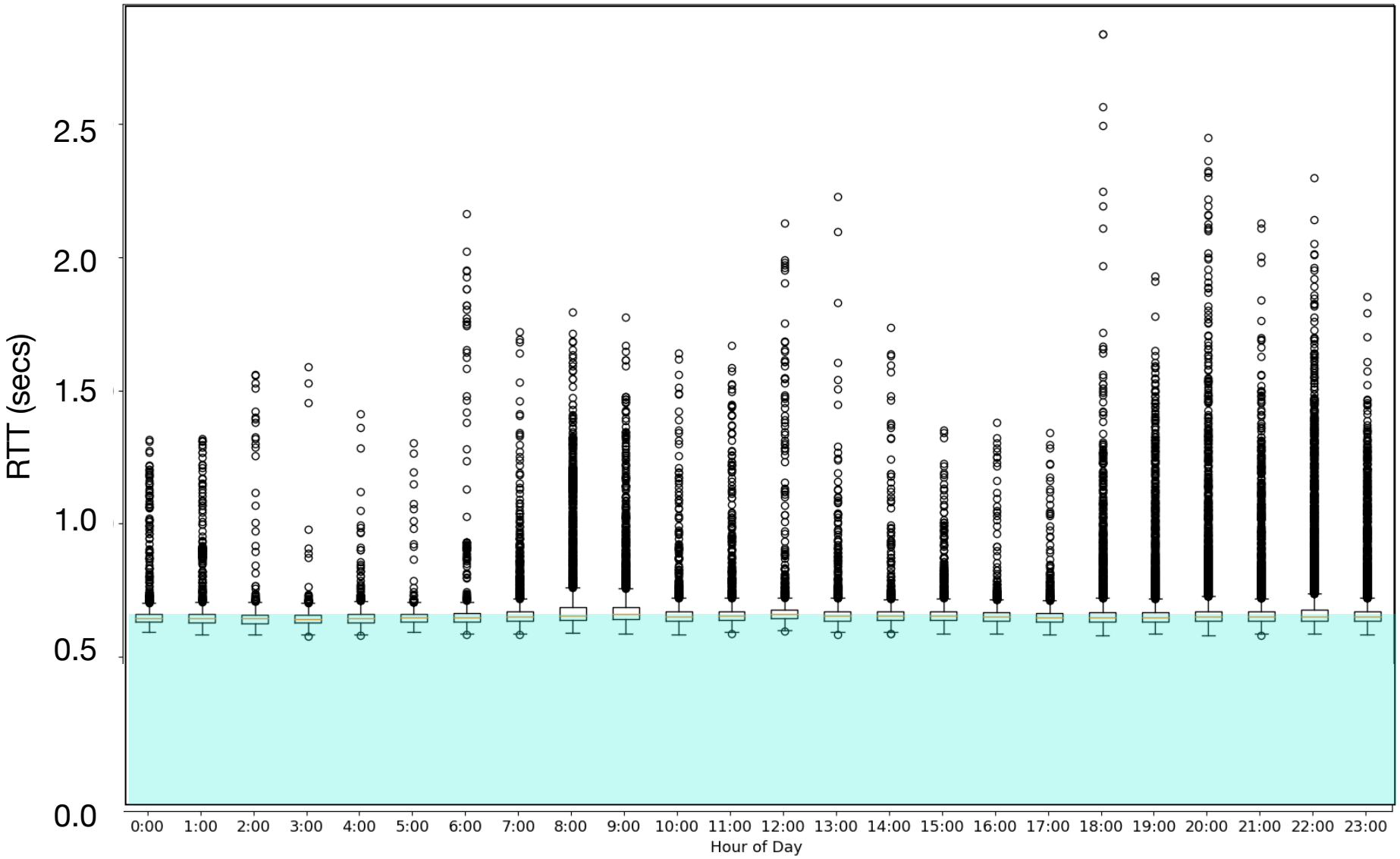
- Shared: MF-TDMA network
- Ave. Forward Capacity: 8.5 Mbit/s
- Ave. Return Capacity: 1.4 Mbit/s
- Large BDP: RTT > 550 ms





Measured with `iperf3` using TCP

Hourly RTT Measurements
RTT 580 - 2900 ms, ave. 639 ms

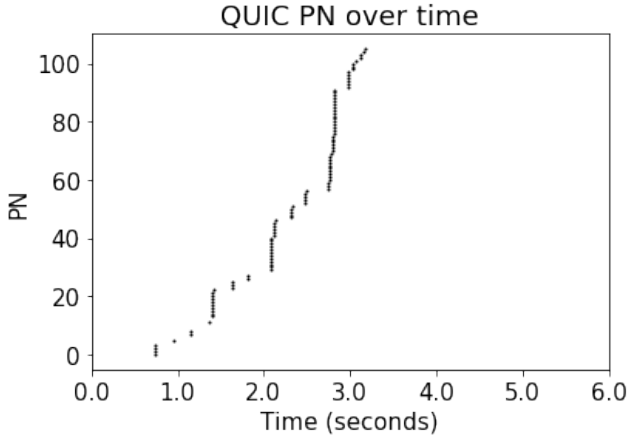


Measured with `ping`

Packet Number v Time - QUIC vs HTTP+TLS1.3

100KB

QUIC



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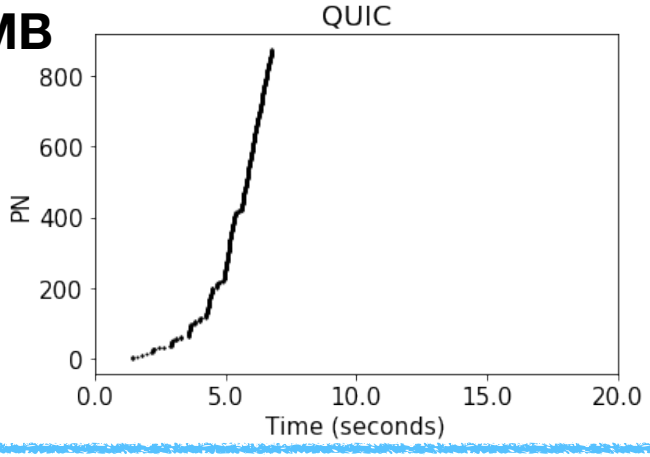
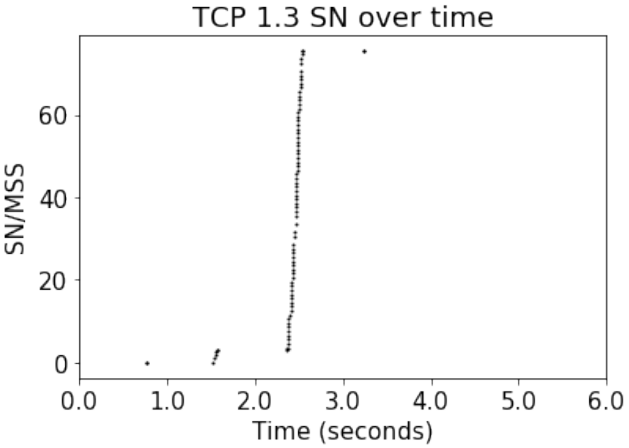
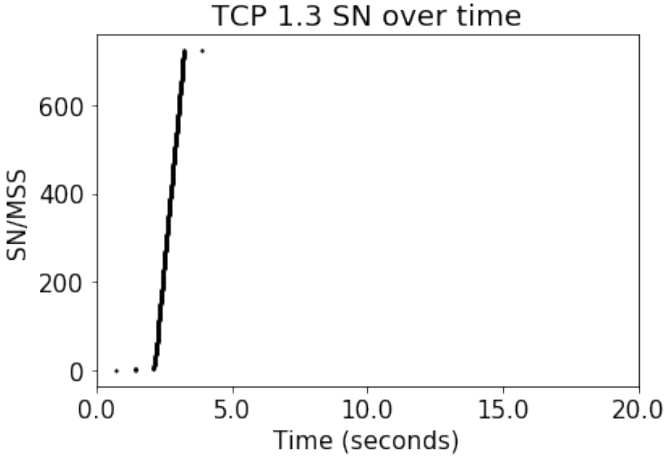
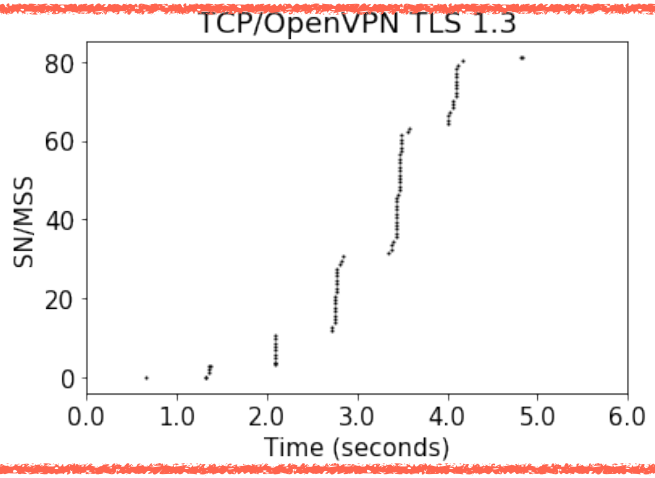


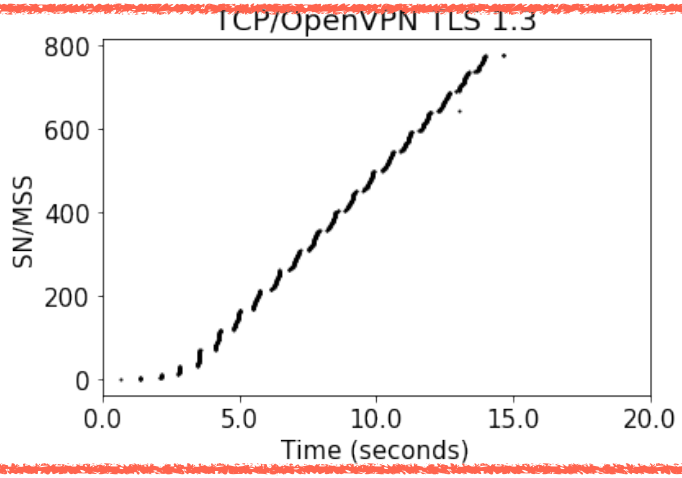
TCP/PEP



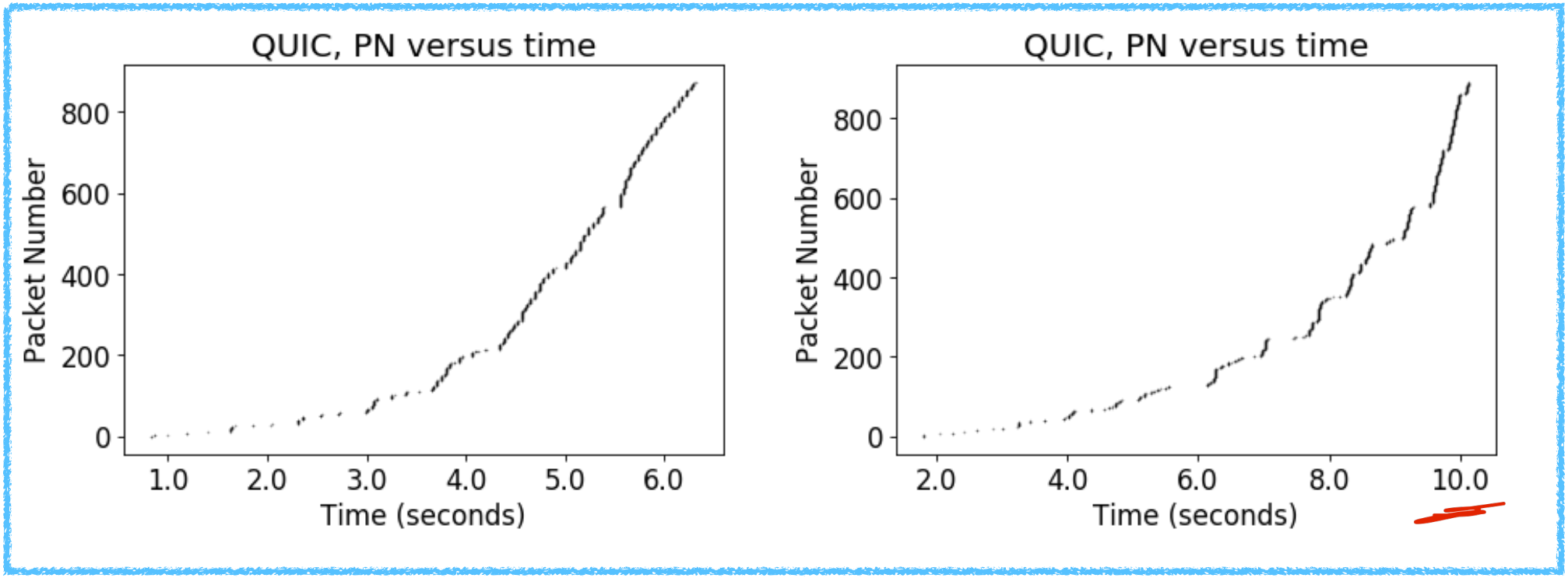


TCP





QUIC - 1MB downloads



- Not always the case: Same download, different behaviour, e.g the second download takes 10s to complete

Conclusions

- Using quicly was a good experience
- TLS 1.3 has a 2 RTT advantage, more noticeable in small transfers
- Performance of QUIC over satellite not as good as for TCP (with PEP)
- Down-grading to TCP is ***not*** a long-term solution
- Need to understand the root causes of performance issues
  - Could be implementation details or need small changes to spec
  - Likely to benefit from new (maybe simple) mechanisms…

Future Plans

- We will continue measurements
  - Happy to talk about logging and tracing!
  - Aware there are many different satellite systems!

Extra Slides

Test setup

- QUIC on Debian Linux
- QUIC 20
- RENO
- IW10 (12800 B))
- MSS 1460

- HTTP over TLS 1.2/1.3 on Debian Linux
- SACK, W Scaling
- CUBIC
- IW 20 (29200 B)/ IW 10 (14600 B)
- MSS 1460

- HTTP over TLS 1.2/1.3 over OpenVPN
- SACK, W Scaling
- CUBIC
- IW 20 (27160 B)/ IW 10 (13580)
- MSS 1358

Measurements

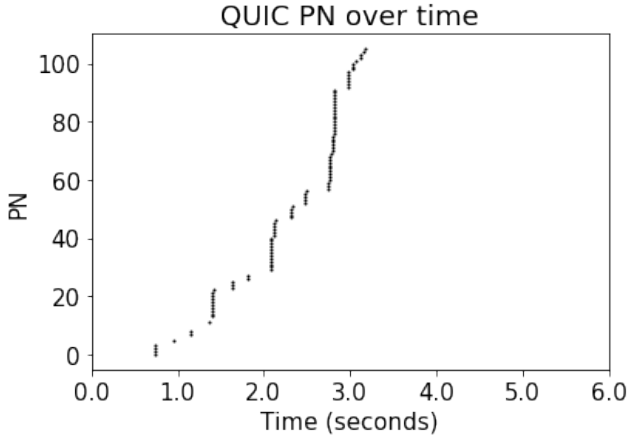
- We use `vagrant` to configure and start a test virtual machine,
- This compiles and builds `quicly` from source, and also installs `openvpn-client`
- The machine is bridged on the satellite network and runs scripts that:
- 1. start `tcpdump`, writing pcap files to a shared results folder
- 2. perform a `wget` request to a webserver hosted by the University of Aberdeen
- 3. stop `tcpdump`
- 4. performs a `quicly` download from a `quicly` webserver hosted by the University of Aberdeen, saving `json` logs to a shared result folder
- 5. sets up `openvpn`
- 6. performs steps 1 -> 3
- 7. stop `openvpn`
- //Rinse and repeat every hour and with different file sizes etc.
- 8. In parallel, the webservers continuously capture packets and log `quicly` webserver interactions.
- The `pcap` traces were analyzed with `python3-libtrace`, which allows access to the IP and TCP layers. The `quicly` logs are `json` and therefore easily parsed - they provide fields for PNs, ACKs, CWND and timestamps.
- We use `python3-matplotlib` to plot the data extracted from traces and logs.

Forward path

Packet Number v Time - QUIC vs HTTP+TLS1.2

100KB

QUIC



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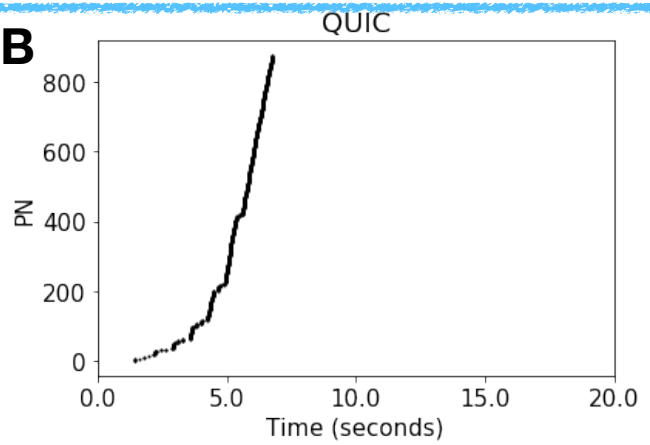
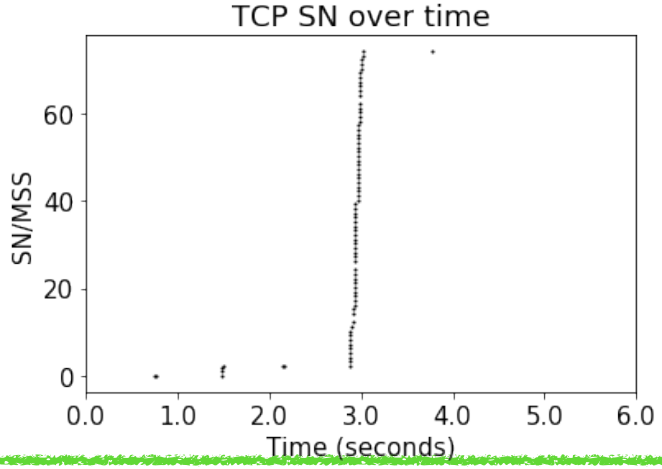
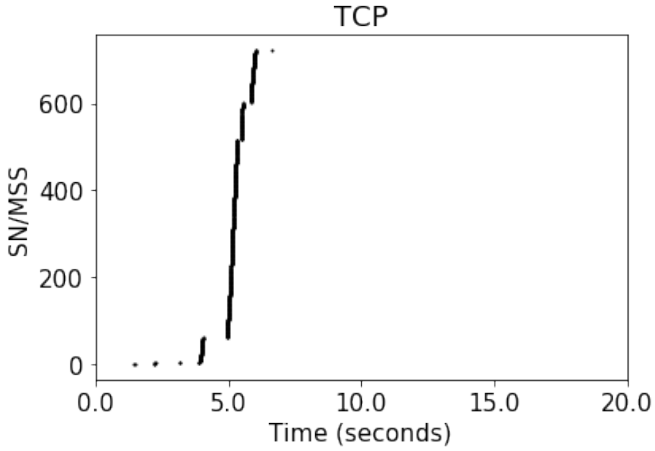
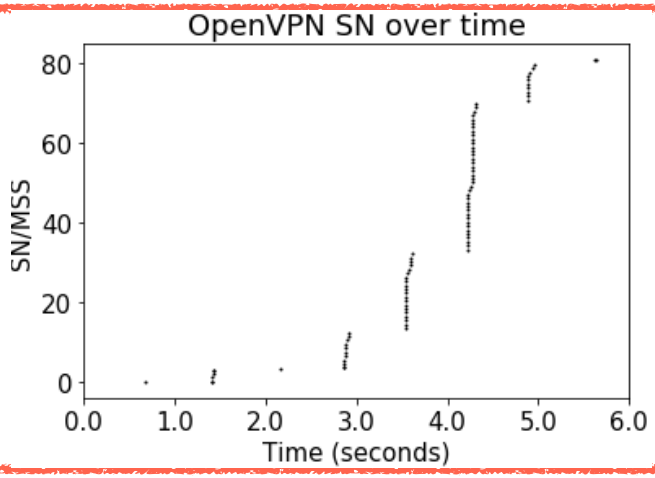


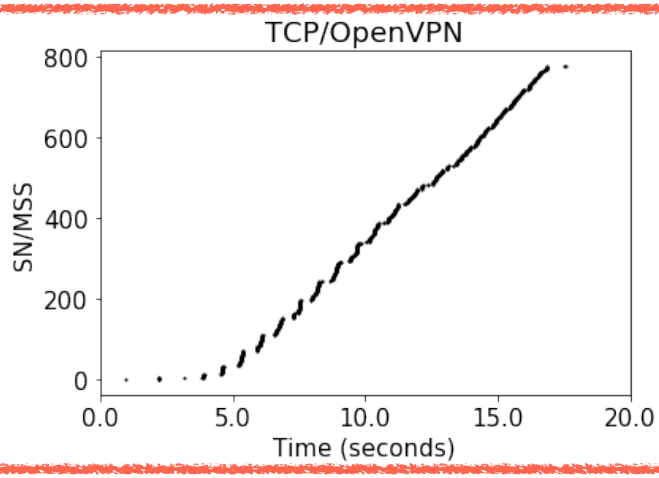
TCP/PEP



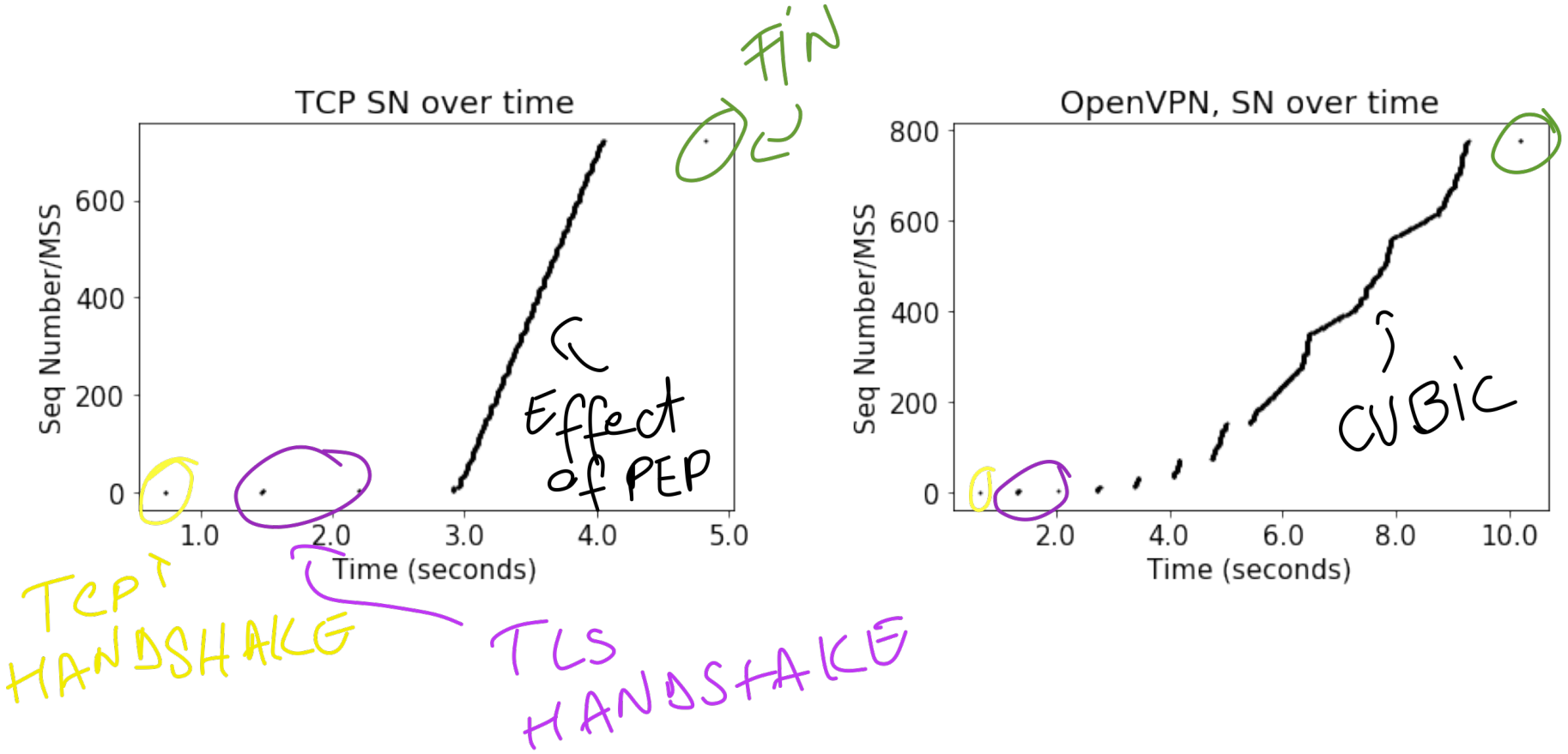


TCP



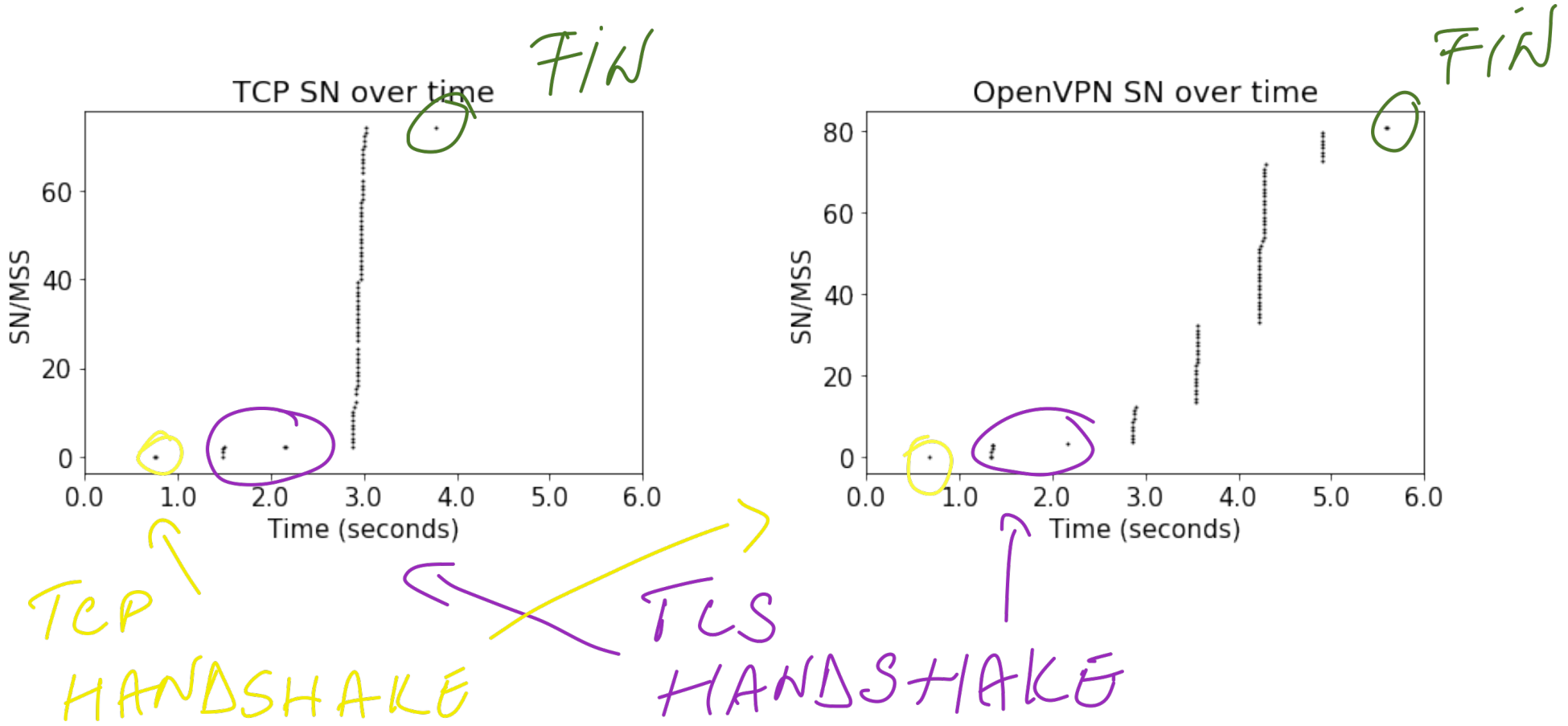


TCP and TCP over OpenVPN - 1MB downloads



- Connection setup with TLS 1.2 - adds 2x RTT

TCP and TCP over OpenVPN - 100KB downloads



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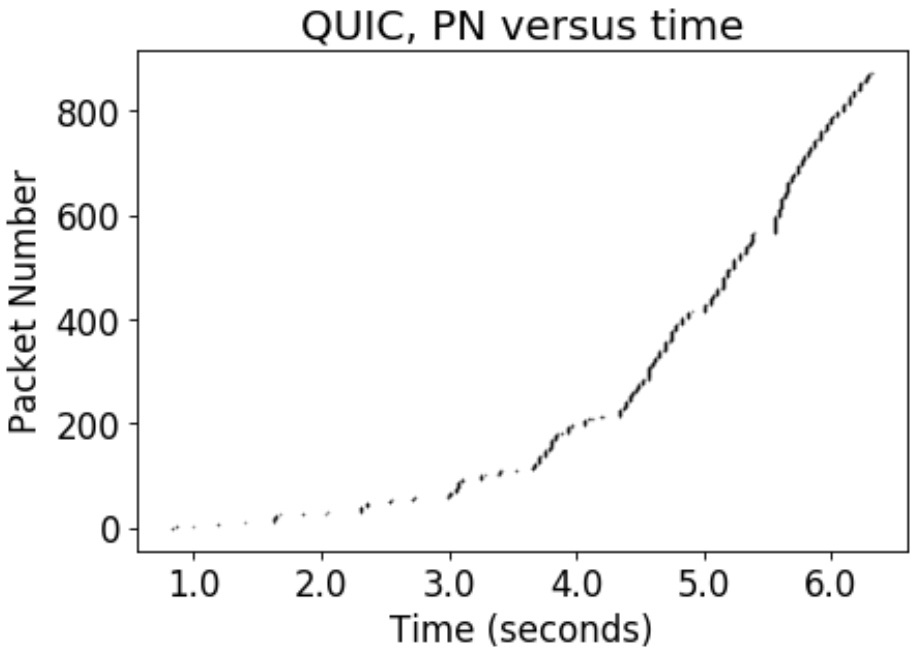

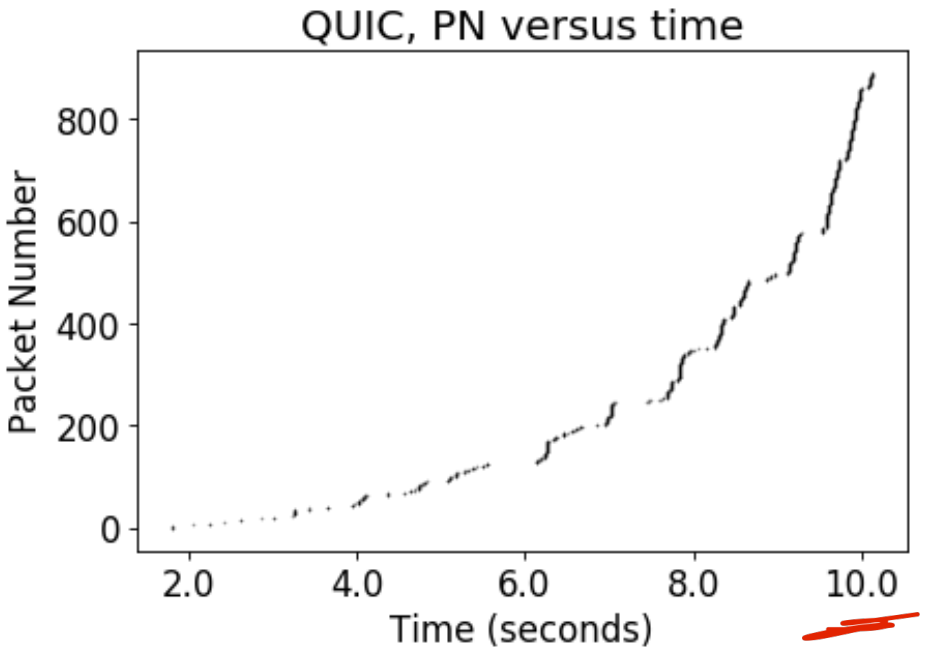

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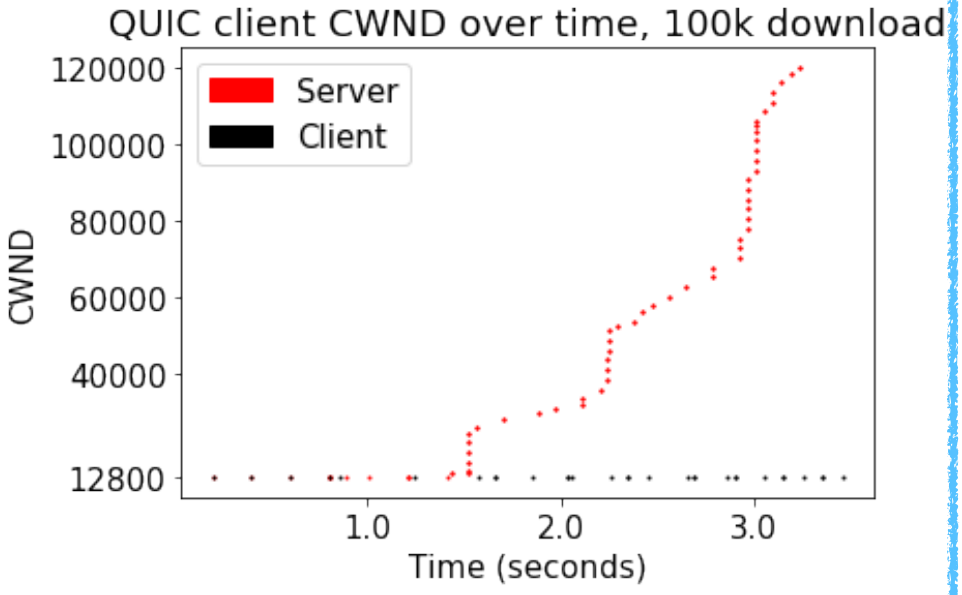
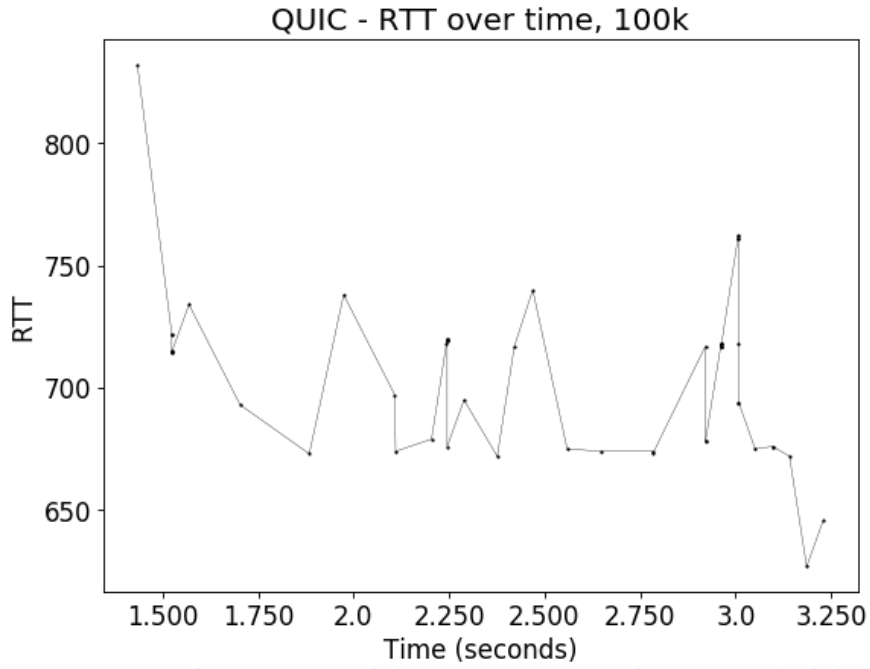
QUIC RTT and CWND

100KB





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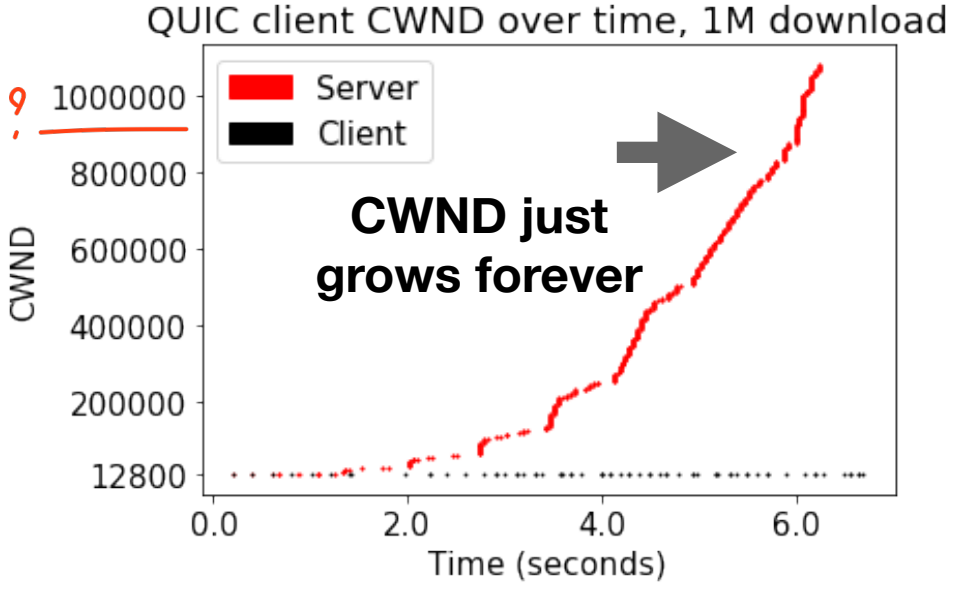

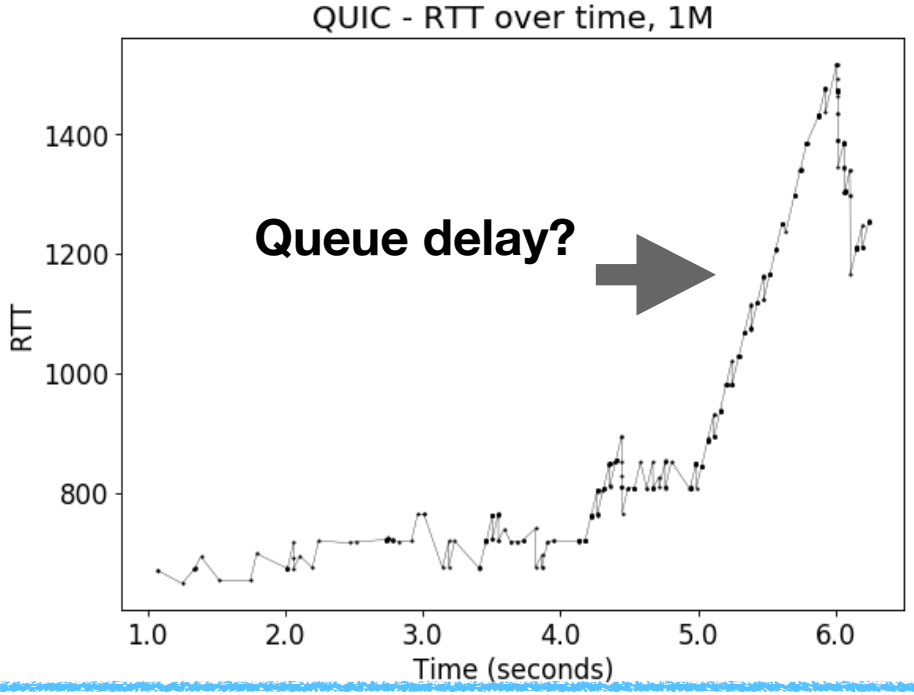

TCP RTT and CWND

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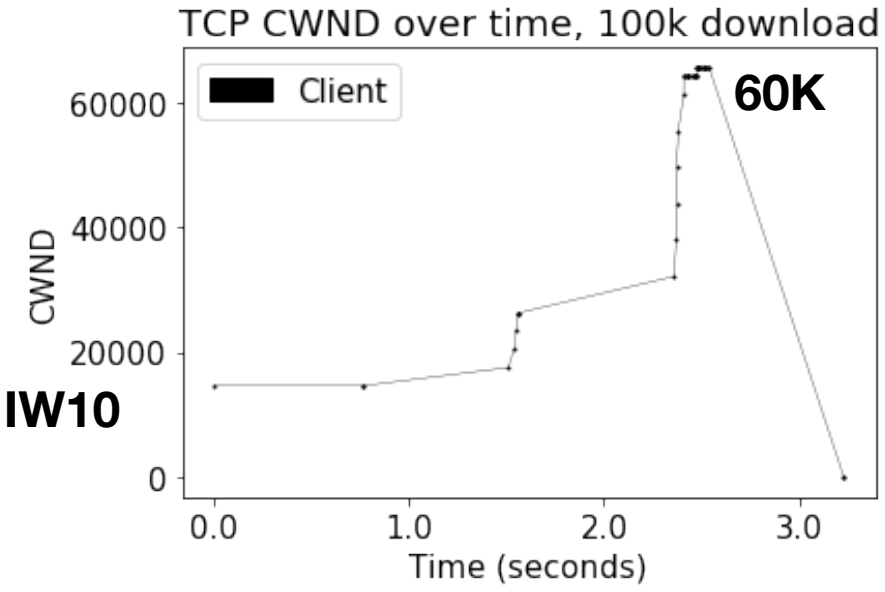

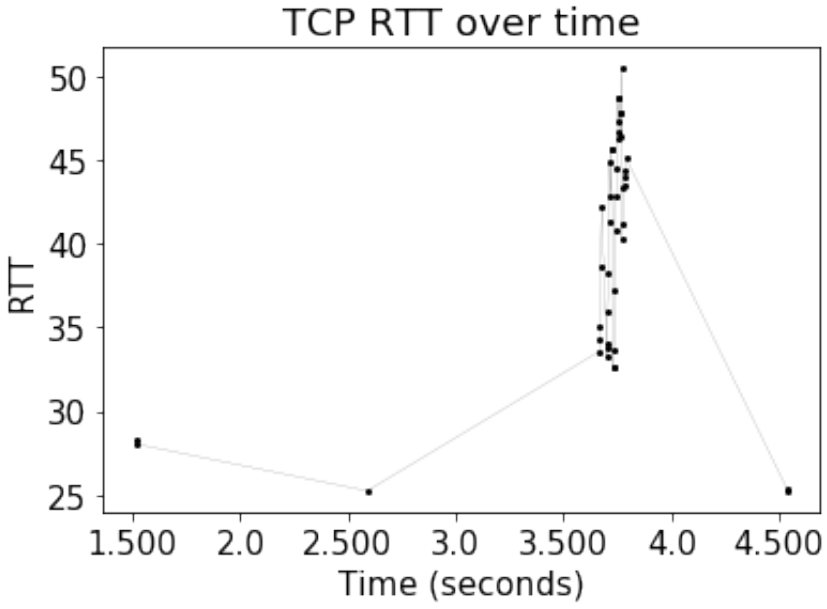

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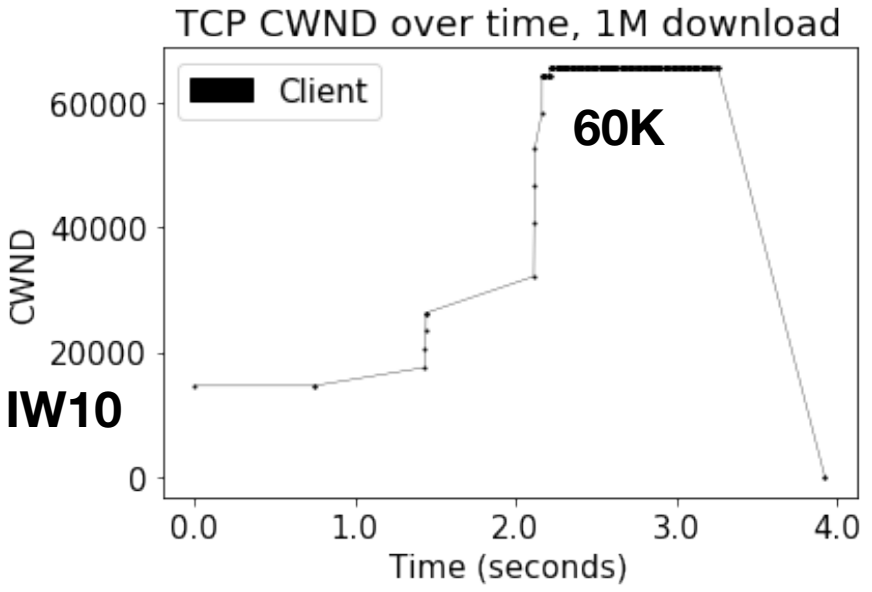

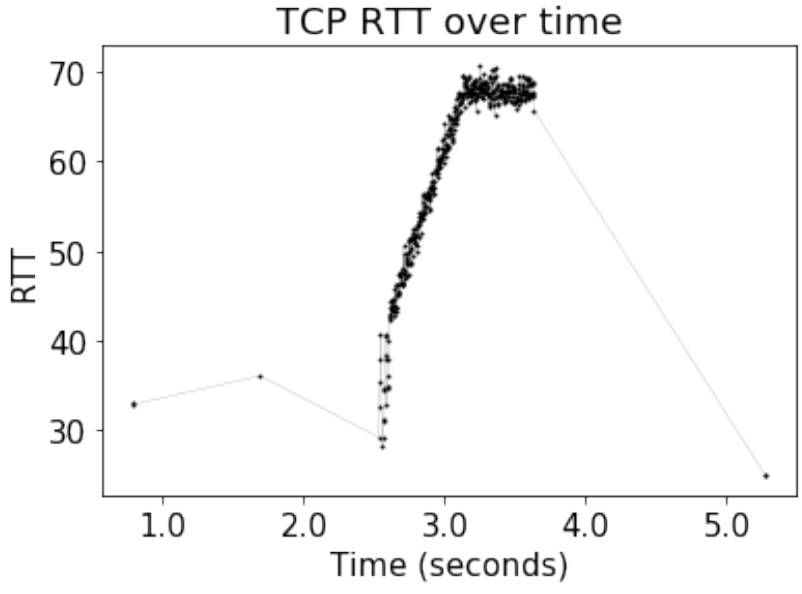

OpenVPN RTT and CWND

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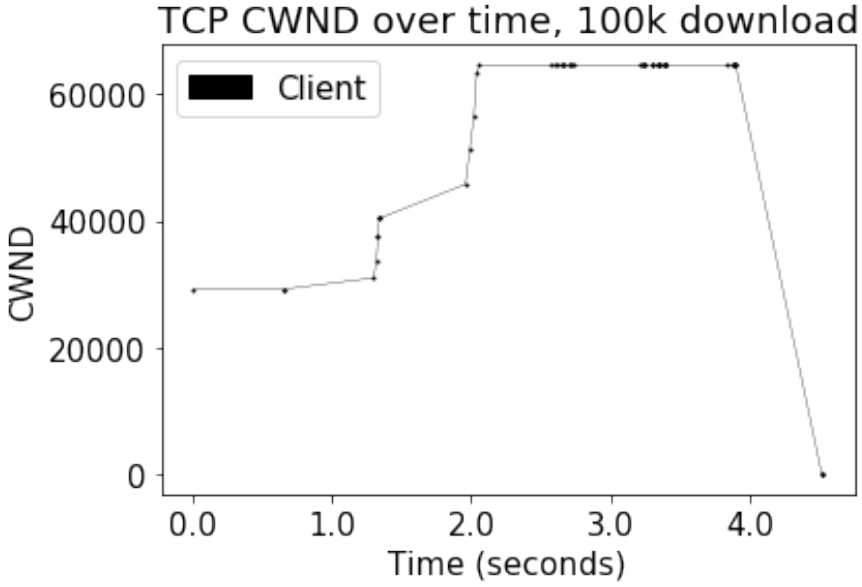

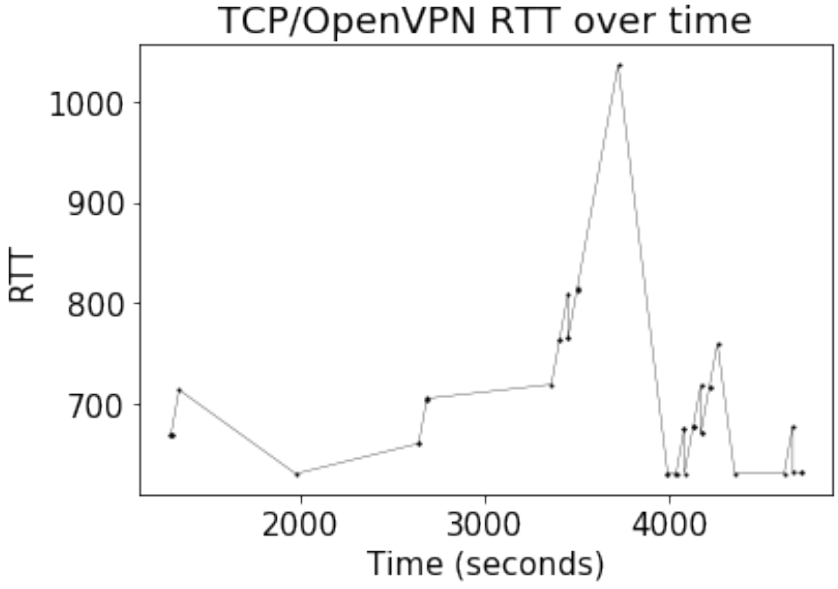

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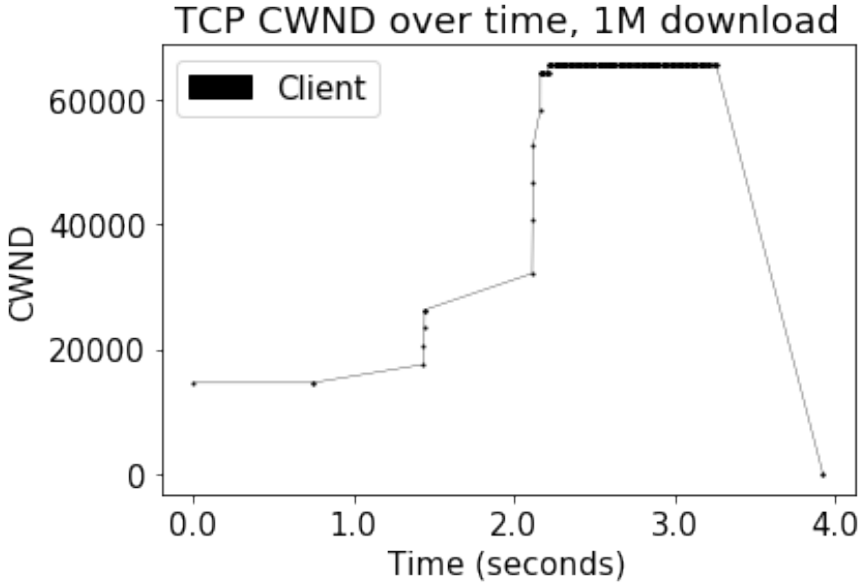
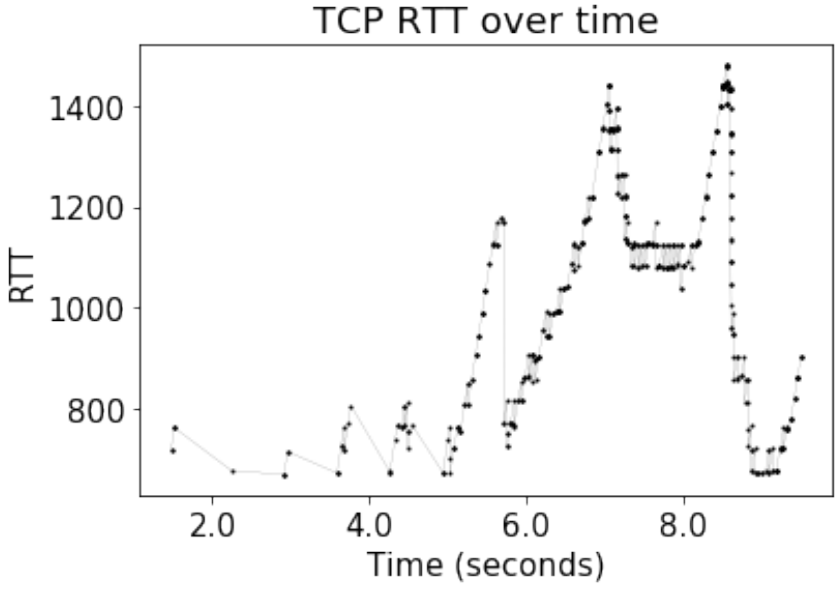
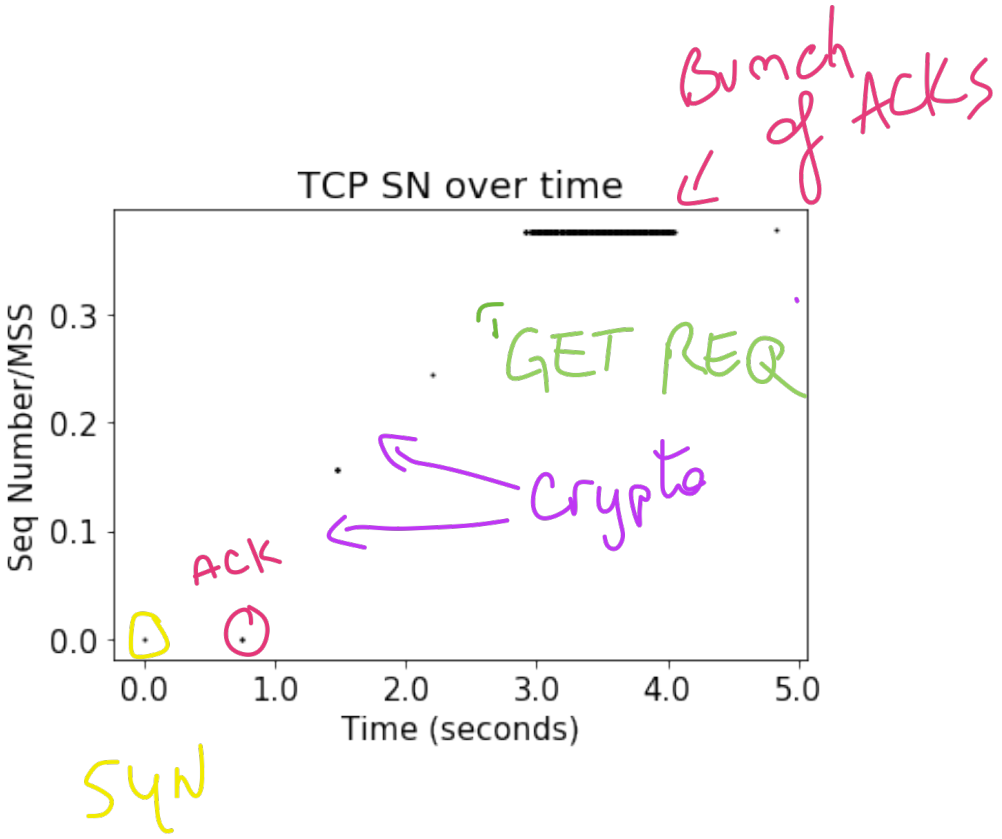
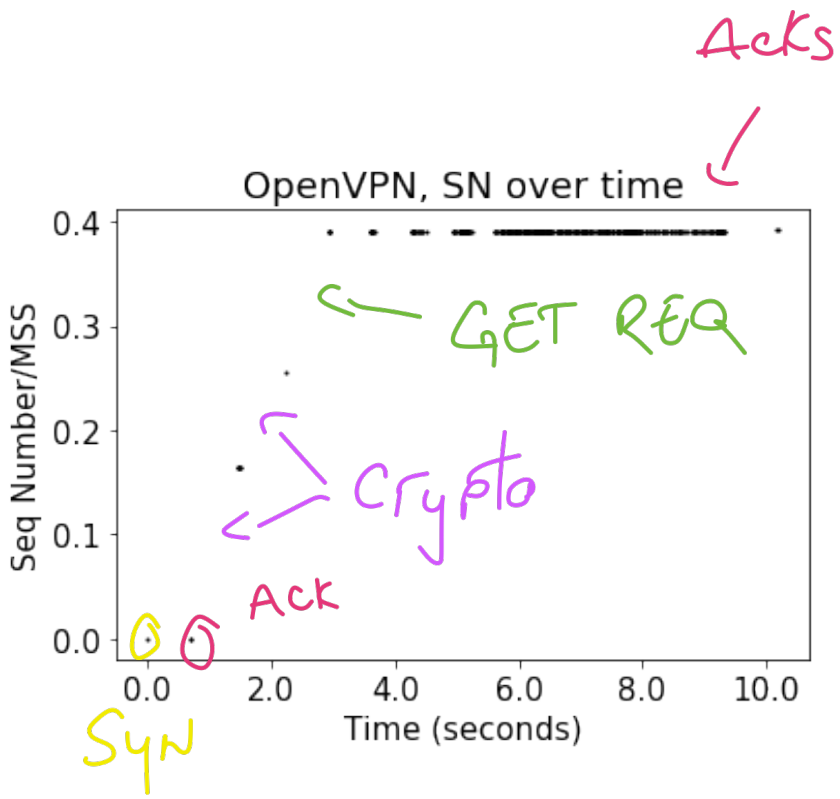




Return path

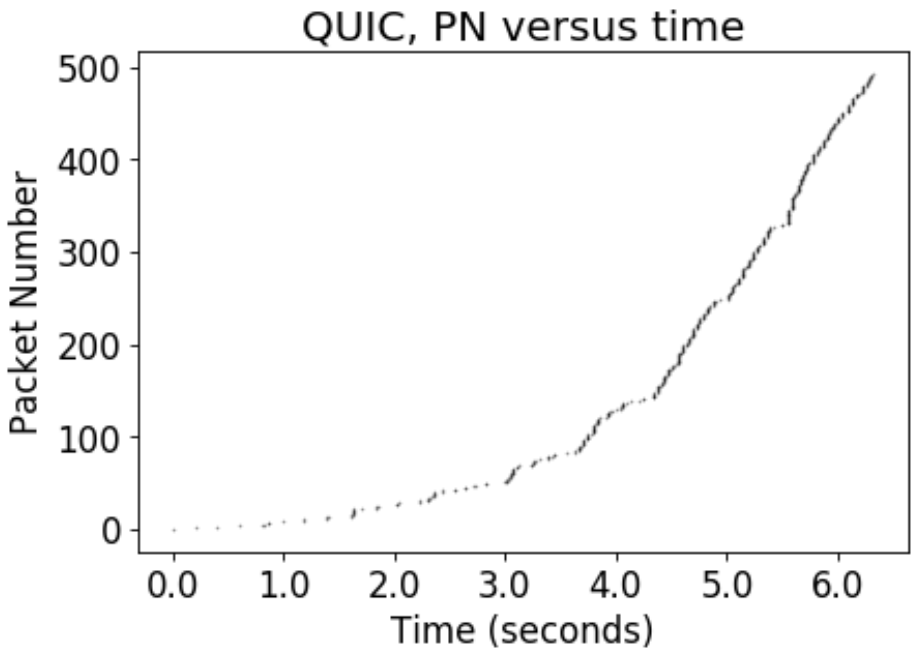
TCP and TCP over OpenVPN - 1M Requests





- The horizontal lines were ACKs all along

QUIC 1M Requests



- ACKs for every packet, closely following data received from server
- Cannot pinpoint where the GET request and initial crypto happen