Quinn Workbench

Simulating QUIC traffic in deep space

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Why?

- Investigating suitability of QUIC on top of IP for deep space communication
- Need to run experiments to prove (or disprove) QUIC is a viable alternative
- First step is to run experiments in a simulated network, to gather insights before testing more advanced setups

What?

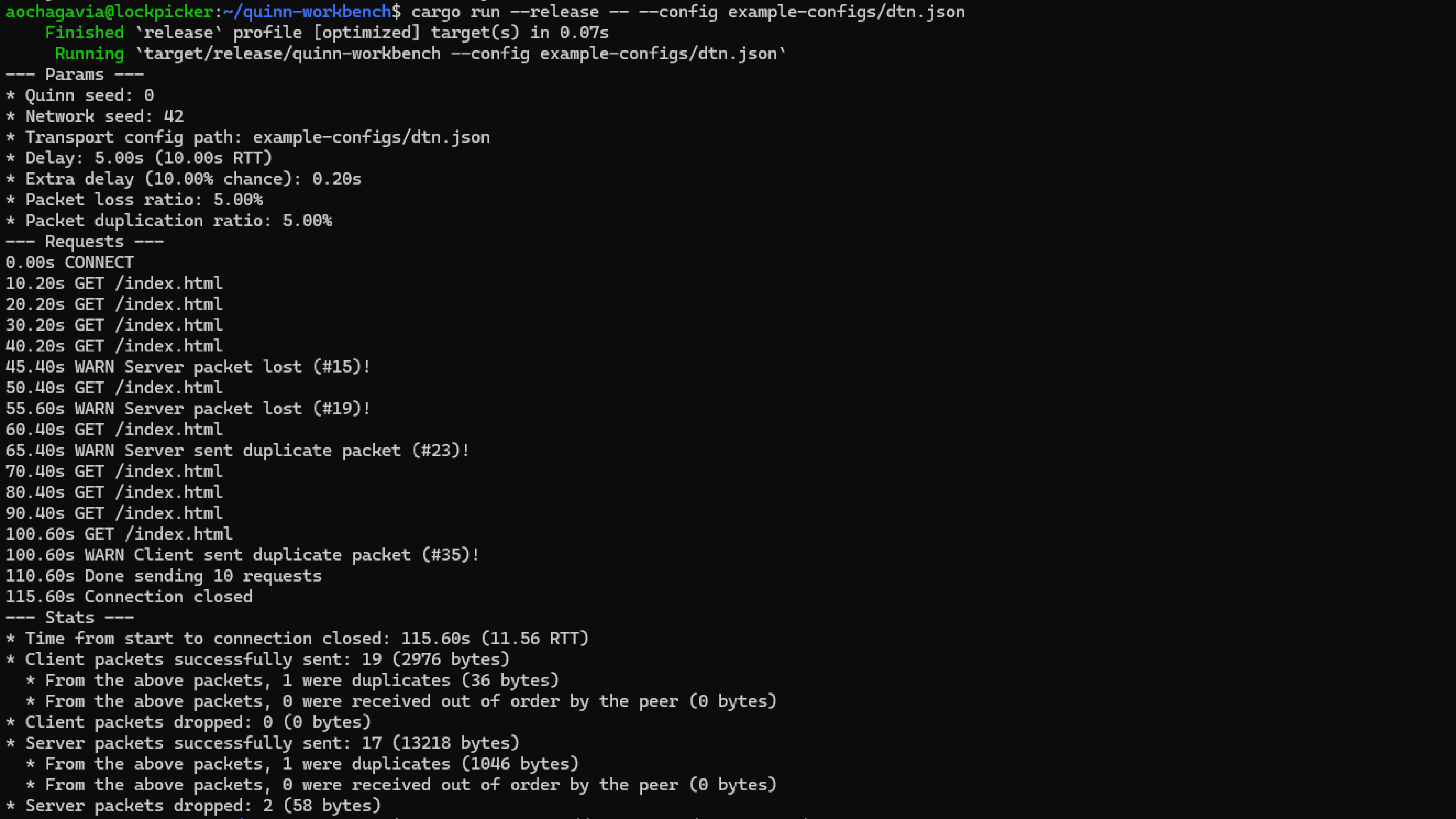
- A command line tool to simulate request-response traffic between two machines
- Measures total time to transfer and time to recover after packet loss, will also measure memory usage in the future
- Deterministic output (the same parameters always yield the same results)
- Finishes instantly, allowing simulation of huge RTTs (parameters are configurable)
- Generates a synthetic pcap file, allowing packet inspection using standard tools (e.g. Wireshark)
- Uses the Quinn implementation of the QUIC protocol

How?

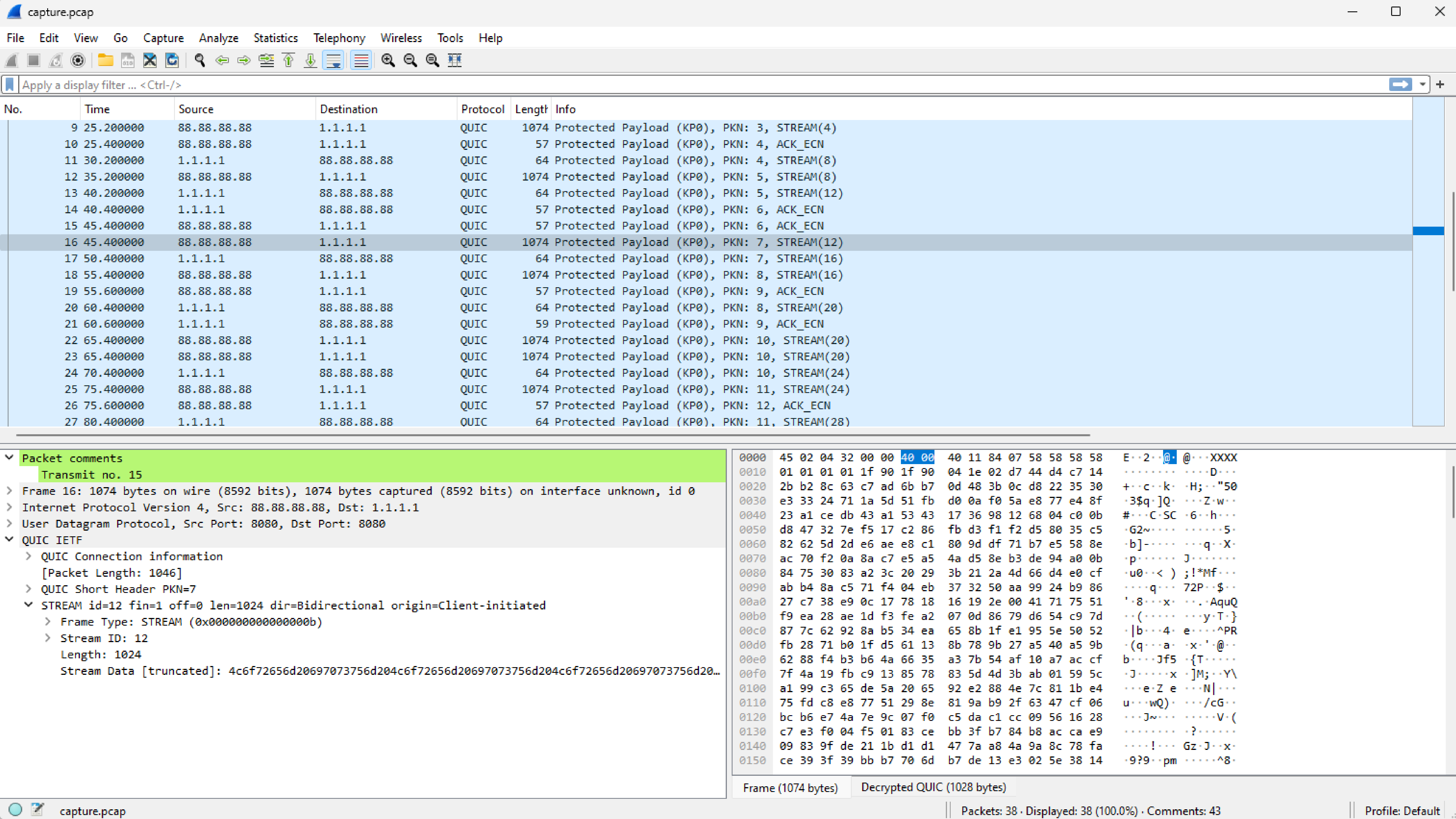
- Install the Rust programming language (see https://rustup.rs/)
- Clone: `git clone https://github.com/aochagavia/quinn-workbench.git`
- Run: `cargo run --release -- --config example-configs/dtn.json`

Details:

- Endpoint and network configuration are loaded from the specified JSON file
- Simulator configuration is loaded from command-line arguments
- Text output is logged to the console
- Pcap and keylog files are generated at `capture.pcap` and `keylog.key`



```
aochagavia@lockpicker:~/quinn-workbench$ cargo run --release -- --config example-configs/dtn.json
    Finished `release` profile [optimized] target(s) in 0.07s
     Running `target/release/quinn-workbench --config example-configs/dtn.json`
--- Params ---
* Quinn seed: 0
* Network seed: 42
* Transport config path: example-configs/dtn.json
* Delay: 5.00s (10.00s RTT)
* Extra delay (10.00% chance): 0.20s
* Packet loss ratio: 5.00%
* Packet duplication ratio: 5.00%
--- Requests ---
0.00s CONNECT
10.20s GET /index.html
20.20s GET /index.html
30.20s GET /index.html
40.20s GET /index.html
45.40s WARN Server packet lost (#15)!
50.40s GET /index.html
55.60s WARN Server packet lost (#19)!
60.40s GET /index.html
65.40s WARN Server sent duplicate packet (#23)!
70.40s GET /index.html
80.40s GET /index.html
90.40s GET /index.html
100.60s GET /index.html
100.60s WARN Client sent duplicate packet (#35)!
110.60s Done sending 10 requests
115.60s Connection closed
--- Stats ---
* Time from start to connection closed: 115.60s (11.56 RTT)
* Client packets successfully sent: 19 (2976 bytes)
  * From the above packets, 1 were duplicates (36 bytes)
  * From the above packets, 0 were received out of order by the peer (0 bytes)
* Client packets dropped: 0 (0 bytes)
* Server packets successfully sent: 17 (13218 bytes)
  * From the above packets, 1 were duplicates (1046 bytes)
  * From the above packets, 0 were received out of order by the peer (0 bytes)
* Server packets dropped: 2 (58 bytes)
```



```
No.  Time       Source        Destination   Protocol Length Info
   9 25.200000  88.88.88.88   1.1.1.1       QUIC     1074 Protected Payload (KP0), PKN: 3, STREAM(4)
  10 25.400000  88.88.88.88   1.1.1.1       QUIC       57 Protected Payload (KP0), PKN: 4, ACK_ECN
  11 30.200000  1.1.1.1       88.88.88.88   QUIC       64 Protected Payload (KP0), PKN: 4, STREAM(8)
  12 35.200000  88.88.88.88   1.1.1.1       QUIC     1074 Protected Payload (KP0), PKN: 5, STREAM(8)
  13 40.200000  1.1.1.1       88.88.88.88   QUIC       64 Protected Payload (KP0), PKN: 5, STREAM(12)
  14 40.400000  1.1.1.1       88.88.88.88   QUIC       57 Protected Payload (KP0), PKN: 6, ACK_ECN
  15 45.400000  88.88.88.88   1.1.1.1       QUIC       57 Protected Payload (KP0), PKN: 6, ACK_ECN
  16 45.400000  88.88.88.88   1.1.1.1       QUIC     1074 Protected Payload (KP0), PKN: 7, STREAM(12)
  17 50.400000  1.1.1.1       88.88.88.88   QUIC       64 Protected Payload (KP0), PKN: 7, STREAM(16)
  18 55.400000  88.88.88.88   1.1.1.1       QUIC     1074 Protected Payload (KP0), PKN: 8, STREAM(16)
  19 55.600000  88.88.88.88   1.1.1.1       QUIC       57 Protected Payload (KP0), PKN: 9, ACK_ECN
  20 60.400000  1.1.1.1       88.88.88.88   QUIC       64 Protected Payload (KP0), PKN: 8, STREAM(20)
  21 60.600000  1.1.1.1       88.88.88.88   QUIC       59 Protected Payload (KP0), PKN: 9, ACK_ECN
  22 65.400000  88.88.88.88   1.1.1.1       QUIC     1074 Protected Payload (KP0), PKN: 10, STREAM(20)
  23 65.400000  88.88.88.88   1.1.1.1       QUIC     1074 Protected Payload (KP0), PKN: 10, STREAM(20)
  24 70.400000  1.1.1.1       88.88.88.88   QUIC       64 Protected Payload (KP0), PKN: 10, STREAM(24)
  25 75.400000  88.88.88.88   1.1.1.1       QUIC     1074 Protected Payload (KP0), PKN: 11, STREAM(24)
  26 75.600000  88.88.88.88   1.1.1.1       QUIC       57 Protected Payload (KP0), PKN: 12, ACK_ECN
  27 80.400000  1.1.1.1       88.88.88.88   QUIC       64 Protected Payload (KP0), PKN: 11, STREAM(28)
```

```
v Packet comments
    Transmit no. 15
> Frame 16: 1074 bytes on wire (8592 bits), 1074 bytes captured (8592 bits) on interface unknown, id 0
> Internet Protocol Version 4, Src: 88.88.88.88, Dst: 1.1.1.1
> User Datagram Protocol, Src Port: 8080, Dst Port: 8080
v QUIC IETF
  > QUIC Connection information
    [Packet Length: 1046]
  > QUIC Short Header PKN=7
  v STREAM id=12 fin=1 off=0 len=1024 dir=Bidirectional origin=Client-initiated
    > Frame Type: STREAM (0x000000000000000b)
    > Stream ID: 12
      Length: 1024
      Stream Data [truncated]: 4c6f72656d20697073756d204c6f72656d20697073756d204c6f72656d20697073756d20…
```

```
0000  45 02 04 32 00 00 40 00  40 11 84 07 58 58 58 58   E··2··@· @···XXXX
0010  01 01 01 01 1f 90 1f 90  04 1e 02 d7 44 d4 c7 14   ········ ····D···
0020  2b b2 8c 63 c7 ad 6b b7  0d 48 3b 0c d8 22 35 30   +··c··k· ·H;··"50
0030  e3 33 24 71 1a 5d 51 fb  d0 0a f0 5a e8 77 e4 8f   ·3$q·]Q· ···Z·w··
0040  23 a1 ce db 43 a1 53 43  17 36 98 12 68 04 c0 0b   #···C·SC ·6··h···
0050  d8 47 32 7e f5 17 c2 86  fb d3 f1 f2 d5 80 35 c5   ·G2~···· ······5·
0060  82 62 5d 2d e6 ae e8 c1  80 9d df 71 b7 e5 58 8e   ·b]-···· ···q··X·
0070  ac 70 f2 0a 8a c7 e5 a5  4a d5 8e b3 de 94 a0 0b   ·p······ J·······
0080  84 75 30 83 a2 3c 20 29  3b 21 2a 4d 66 d4 e0 cf   ·u0··< ) ;!*Mf···
0090  ab b4 8a c5 71 f4 04 eb  37 32 50 aa 99 24 b9 86   ····q··· 72P··$··
00a0  27 c7 38 e9 0c 17 78 18  16 19 2e 00 41 71 75 51   '·8···x· ··.·AquQ
00b0  f9 ea 28 ae 1d f3 fe a2  07 0d 86 79 d6 54 c9 7d   ··(····· ···y·T·}
00c0  87 7c 62 92 8a b5 34 ea  65 8b 1f e1 95 5e 50 52   ·|b···4· e····^PR
00d0  fb 28 71 b0 1f d5 61 13  8b 78 9b 27 a5 40 a5 9b   ·(q···a· ·x·'·@··
00e0  62 88 f4 b3 b6 4a 66 35  a3 7b 54 af 10 a7 ac cf   b····Jf5 ·{T·····
00f0  7f 4a 19 fb c9 13 85 78  83 5d 4d 3b ab 01 59 5c   ·J·····x ·]M;··Y\
0100  a1 99 c3 65 de 5a 20 65  92 e2 88 4e 7c 81 1b e4   ···e·Z e ···N|···
0110  75 fd c8 e8 77 51 29 8e  81 9a b9 2f 63 47 cf 06   u···wQ)· ···/cG··
0120  bc b6 e7 4a 7e 9c 07 f0  c5 da c1 cc 09 56 16 28   ···J~··· ·····V·(
0130  c7 e3 f0 04 f5 01 83 ce  bb 3f b7 84 b8 ac ca e9   ········ ·?······
0140  09 83 9f de 21 1b d1 d1  47 7a a8 4a 9a 8c 78 fa   ····!··· Gz·J··x·
0150  ce 39 3f 39 bb b7 70 6d  b7 de 13 e3 02 5e 38 14   ·9?9··pm ······^8·
```

Packets: 38 · Displayed: 38 (100.0%) · Comments: 43

Profile: Default

JSON parameters

(see the project's readme for a detailed explanation)

QUIC:

- initial_rtt_ms
- maximum_idle_timeout_ms
- packet_threshold
- mtu_discovery
- maximize_send_and_receive_windows
- max_ack_delay_ms
- ack_eliciting_threshold
- fixed_congestion_window

Simulated network:

- delay_ms
- extra_delay_ms
- extra_delay_ratio
- packet_duplication_ratio
- packet_loss_ratio
- bandwidth

CLI arguments

(see the project’s readme for a detailed explanation)

- --repeat
- --response-size
- --non-deterministic
- --quinn-rng-seed
- --simulated-network-rng-seed

Note: the rng seeds are necessary to achieve determinism, because both Quinn and the simulated network make use of randomness