

Quinn Workbench

Simulating QUIC traffic in deep space

Why?

- We are investigating the suitability of QUIC on top of IP for deep space communication
- First step is to run experiments in a simulated network, to gather insights before testing more advanced setups
- Quinn workbench offers an easy way to test various transport configurations under specific network conditions

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 and run the repository:

```
git clone https://github.com/aochagavia/quinn-workbench.git
cd quinn-workbench
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@lockpiger:~/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 ---
```

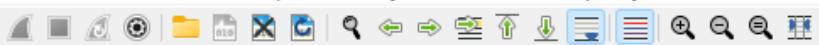
```
* Quinn seed: 0
* Network seed: 42
* Transport config path: example-configs/dtn.json
* Delay: 5.00s (10.00s RTT)
* Extra delay (10.00% chance): 0.20s
* Packet loss ratio: 5.00%
* Packet duplication ratio: 5.00%
```

```
--- 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)
```



Apply a display filter ... <Ctrl-/>

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)

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
- QUIC IETF
 - > QUIC Connection information [Packet Length: 1046]
 - > QUIC Short Header PKN=7
 - 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 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.

```

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