Chair of Network Architectures and Services
School of Computation, Information, and Technology
Technical University of Munich

C++-based MASQUE-Proxying for Lower OSI-Layer Protocol Traffic

Intermediate talk for the IDP by

Christoph Rotte
advised by Lion Steger and Richard von Seck

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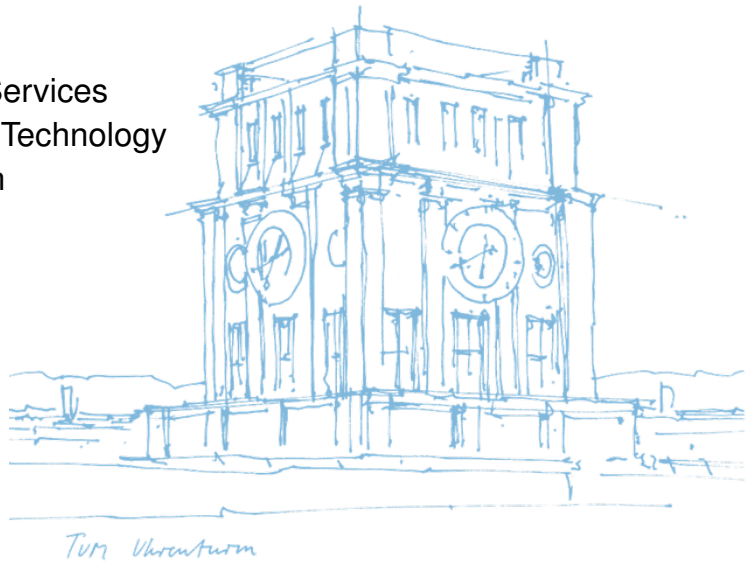

MASQUE-Proxying

Current Status

- **Idea**: Adapt general approach of **HTTP CONNECT** for HTTP/3
- HTTP CONNECT: TCP/IP tunnel over HTTP
- HTTP **CONNECT-UDP** (MASQUE): UDP/IP tunnel over HTTP
- HTTP **CONNECT-IP** (MASQUE): IP tunnel over HTTP

MASQUE-Proxying

Current Status

- **Idea**: Adapt general approach of **HTTP CONNECT** for HTTP/3
- HTTP CONNECT: TCP/IP tunnel over HTTP
- HTTP **CONNECT-UDP** (MASQUE): UDP/IP tunnel over HTTP
- HTTP **CONNECT-IP** (MASQUE): IP tunnel over HTTP
- MASQUE Working Group
- Current Status:
  - CONNECT-UDP: `rfc9298`
  - CONNECT-IP: `draft-ietf-masque-connect-ip-10`
- Early stage regarding implementation

Background

TCP Proxying

- Many proxy protocols (SOCKS, PEPs, HTTP CONNECT) are based on TCP
- HTTP CONNECT: **several logical streams** over **one TCP connection**

→ performance problems like **head-of-line blocking**

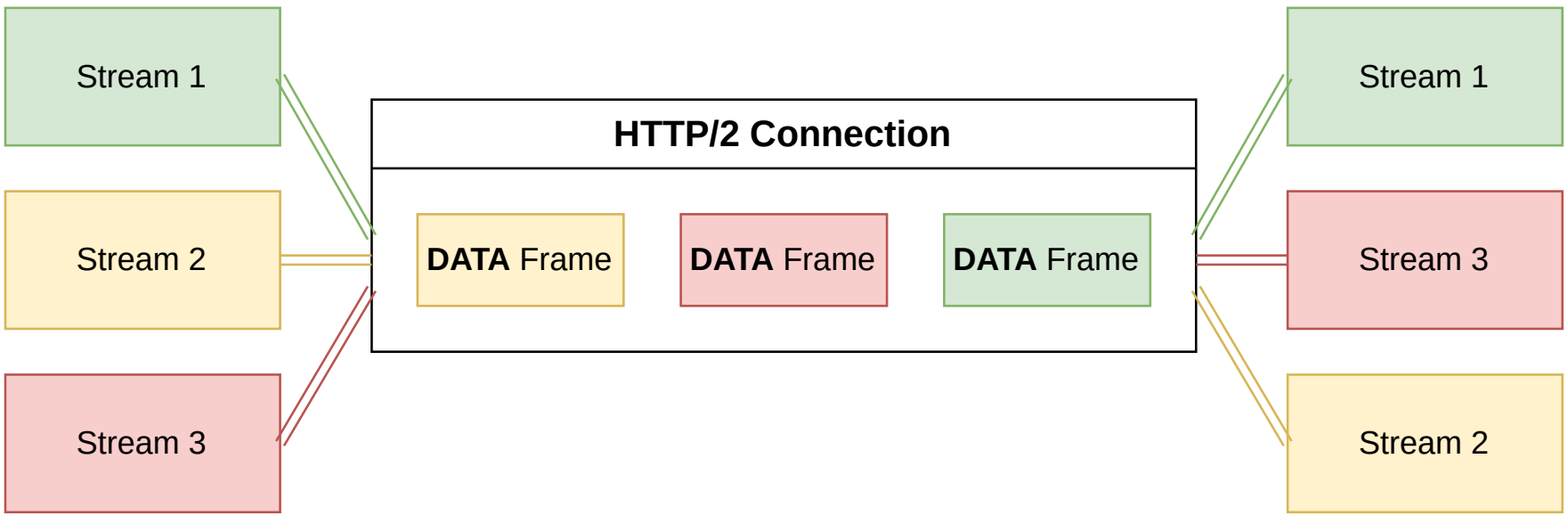

Figure 1: HTTP/2 Proxying via CONNECT [5]

Background

QUIC and QUIC Datagrams

- QUIC: UDP-based TCP alternative (used for HTTP/3)
- Logical streams consist of **reliable** STREAM frames [1]
- **RFC9221**: Unreliable QUIC Datagram Extension [2]

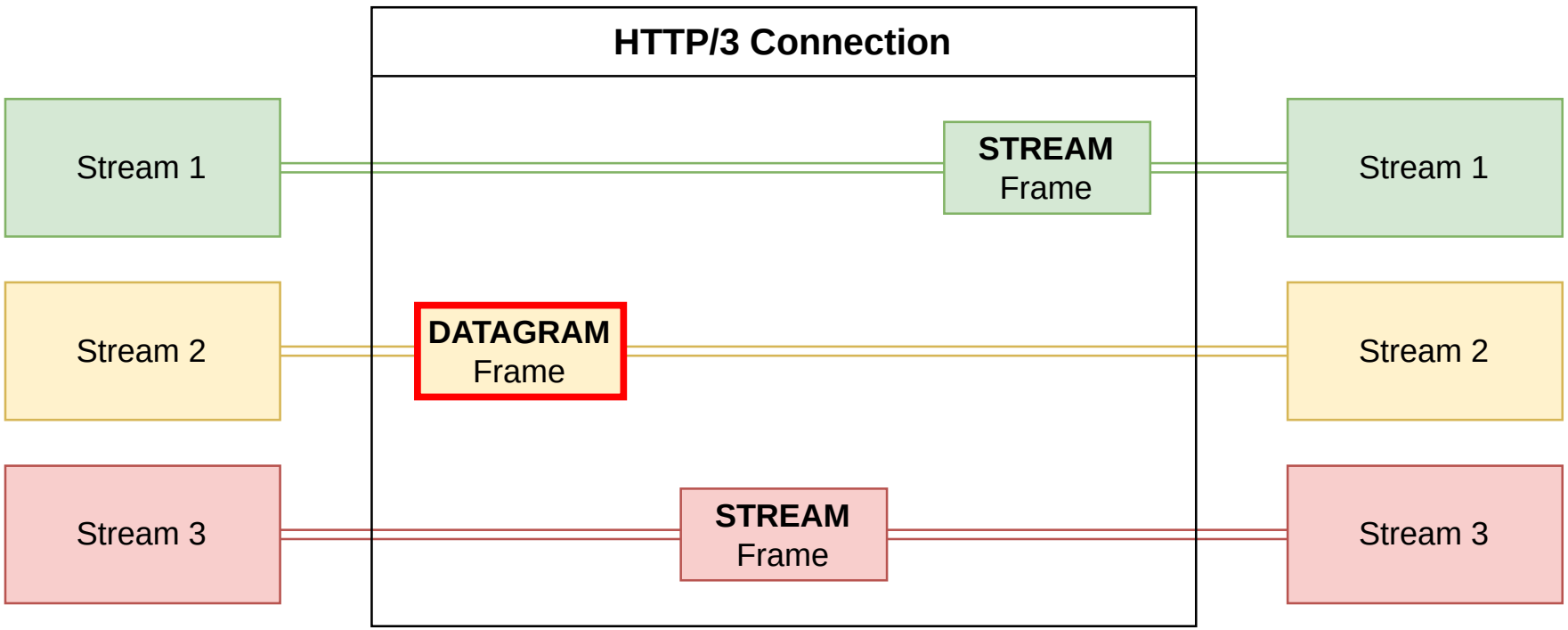

Figure 2: QUIC Streams Using Unreliable QUIC Datagrams

MASQUE-Proxying

CONNECT-UDP Method

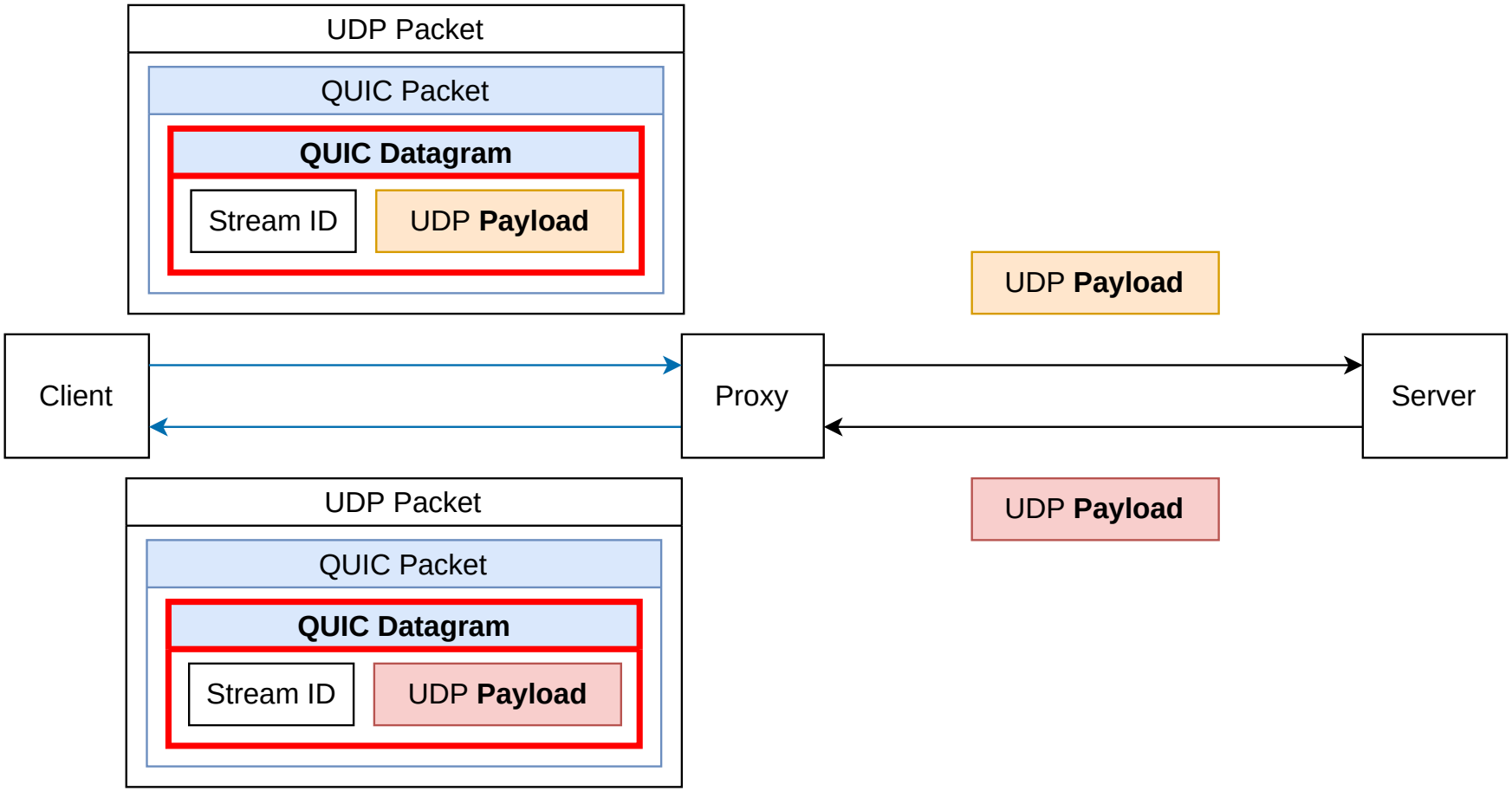

Figure 3: Proxying via QUIC and CONNECT-UDP [4]

MASQUE-Proxying

CONNECT-IP Method (DRAFT)

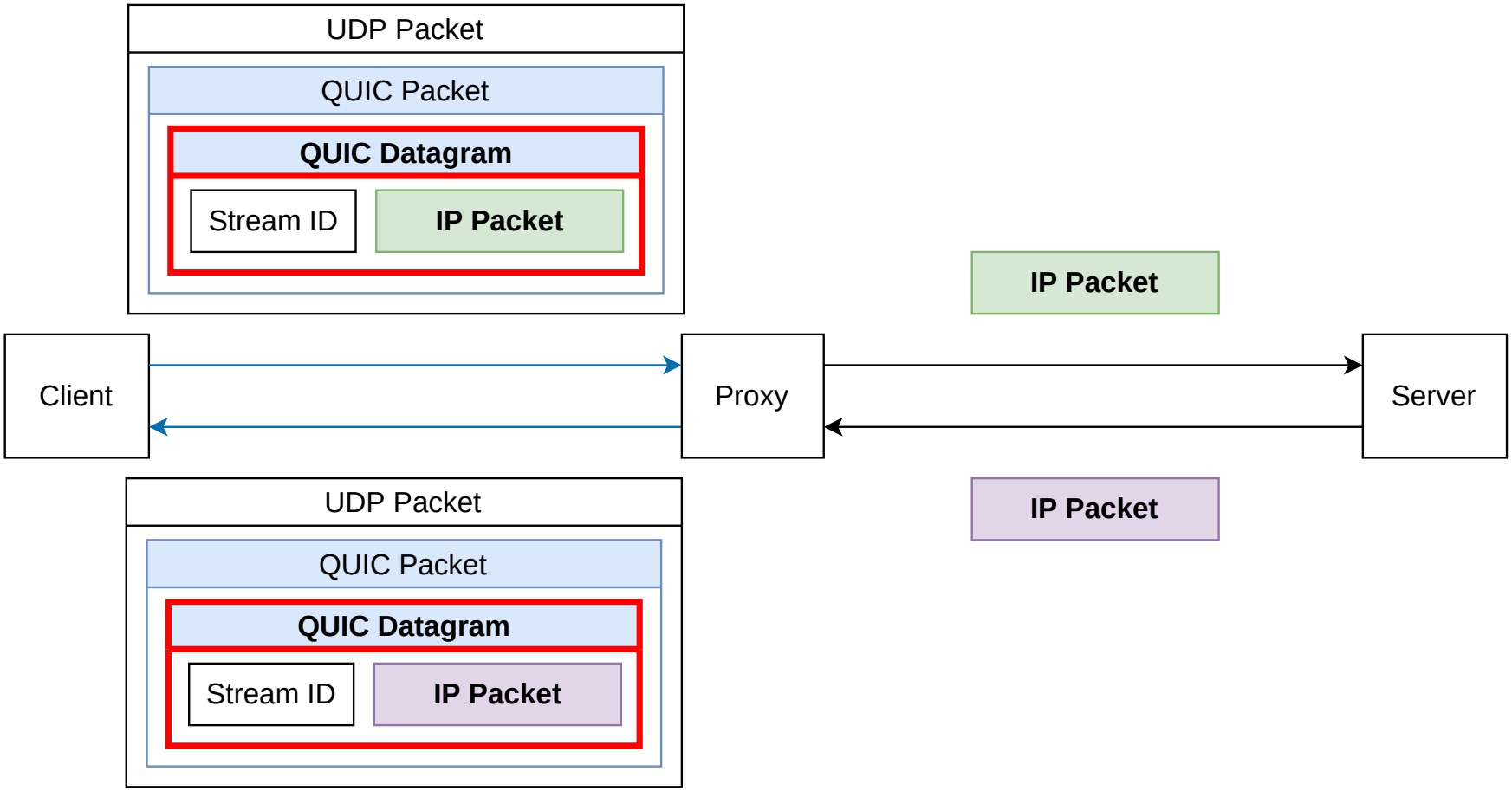

Figure 4: Proxying via QUIC and CONNECT-IP [3]

MASQUE-Proxying

Motivation: Research Questions

RQ 1 What are the implications of using CONNECT-IP in the context of overhead caused by encapsulation?

RQ 2 How does CONNECT-IP behave in the context of transmission performance compared to CONNECT-UDP?

RQ 3 What areas may cause library-specific differences and which challenges may occur because of this?

Encapsulation Overhead (CONNECT-IP)

- **Reduced available packet size** due to headers and MTU
  - Typical MTU: **1500B** $\leftrightarrow$ Minimum required MTU for Masque: **1200B**
  - Overhead for encapsulated packets: **49B - 94B**
    - Context ID: 1B - 8B
    - HTTP/3 Datagram Frame header: 1B - 8B
    - QUIC Datagram Frame header: 1B - 9B
    - QUIC (short) header: 2B - 25B
    - QUIC MAC: 16B
    - UDP header: 8B
    - IPv4 header: 20B

  $\rightarrow$ Conservative bound for multi-hop setups: **3** CONNECT-IP connections

MASQUE-Proxying

Research Questions: Preliminary Analysis

Encapsulation Overhead (CONNECT-IP)

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  $\rightarrow$ Conservative bound for multi-hop setups: **3** CONNECT-IP connections
- Preliminary measurement (proxy on the same host):

  ```
  $ curl https://speed.hetzner.de/10GB.bin --interface tun0
  ```

  CONNECT-IP: $\sim$ **18.1 MiB/s**

  w/o CONNECT-IP: $\sim$ **19 MiB/s**

CONNECT-IP vs. CONNECT-UDP

- Only difference in terms of packet structure:
  Absence of IP header + UDP header (20B + 8B)

→ Expected similar performance characteristics in relative terms of latency and **absence of head-of-line blocking**

→ Logical streams theoretically **scale on one** QUIC connection

Library-Specific Differences

- **Parameterization**, i.e. exchanging proxy configuration information (like available IP routes)
- Implementations **following different draft versions**
  $\rightarrow$ transport parameter sizes, different handling of methods like CONNECT, etc.
- Example (QUIC):
  - facebookincubator/mvfst[1] seems to be based on **draft-ietf-quic-transport version $\leq$ 23**
  - google/quiche[2] seems to be based on the finalized **RFC 9000**

  $\rightarrow$ Sending a datagram size of 2^{16} leads to an overflow in mvfst

[1] https://github.com/facebookincubator/mvfst
[2] https://github.com/google/quiche

Implementation

Library

- Motivation:
  - Evaluation / measurements ($\rightarrow$ RQs)
  - Current MASQUE implementations do not contain all features
- facebook/proxygen[3] (HTTP/3 Library)
- facebookincubator/mvfst[4] (QUIC Library)

[3] https://github.com/facebook/proxygen
[4] https://github.com/facebookincubator/mvfst

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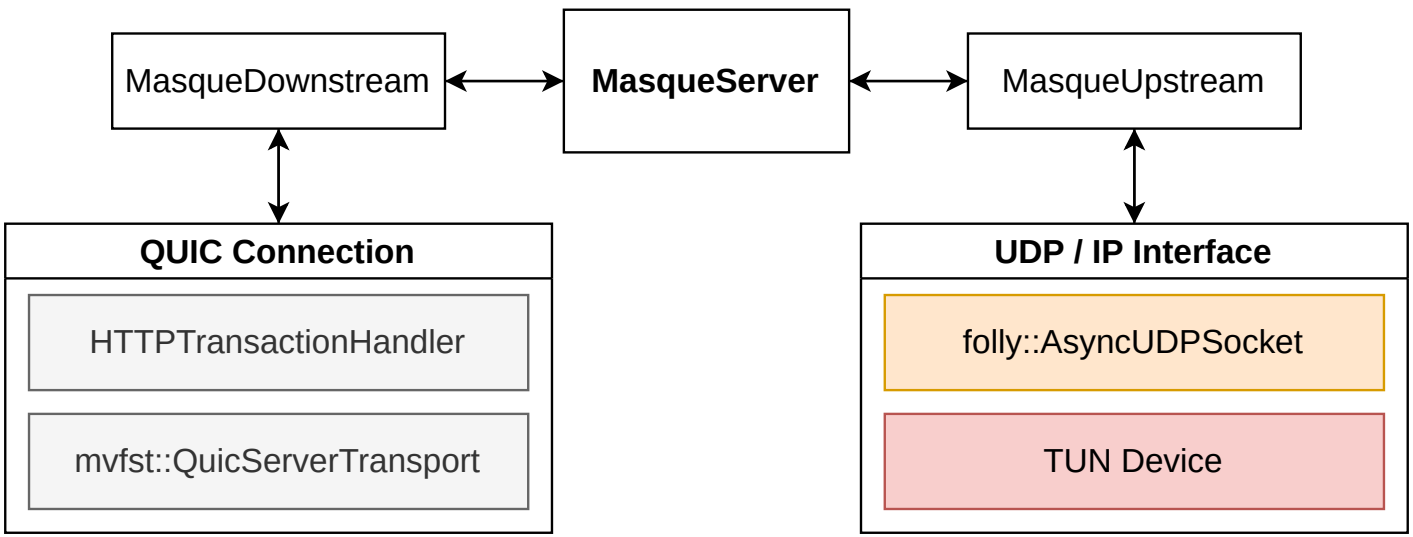

Figure 5: Architectural Overview

[3] https://github.com/facebook/proxygen
[4] https://github.com/facebookincubator/mvfst

Next Steps

Progress + Planned

- CONNECT-UDP implementation (client + server) ✓
- CONNECT-IP implementation (client + server) ✓
- CONNECT-UDP implementation cross-tested ✓

- CONNECT-IP Implementation cross-tested
- Evaluation / Analysis of the theoretic assumptions
  - Testbed
  - Multihop setup
  - ...
- Library Comparison (Cross-Evaluation)
  - Google QUICHE[5]
  - ...

[5] https://github.com/google/quiche

Bibliography

[1] J. Iyengar and M. Thomson.
QUIC: A UDP-Based Multiplexed and Secure Transport, 2021.
http://tools.ietf.org/html/rfc9000.

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[3] T. Pauly, D. Schinazi, A. Chernyakhovsky, M. Kühlewind, and M. Westerlund.
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https://www.ietf.org/archive/id/draft-ietf-masque-connect-ip-10.html.

[4] D. Schinazi.
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http://tools.ietf.org/html/rfc9298.

[5] M. Thomson and C. Benfield.
HTTP/2, 2022.
http://tools.ietf.org/html/rfc9113.

Appendix

CONNECT-IP Implementation

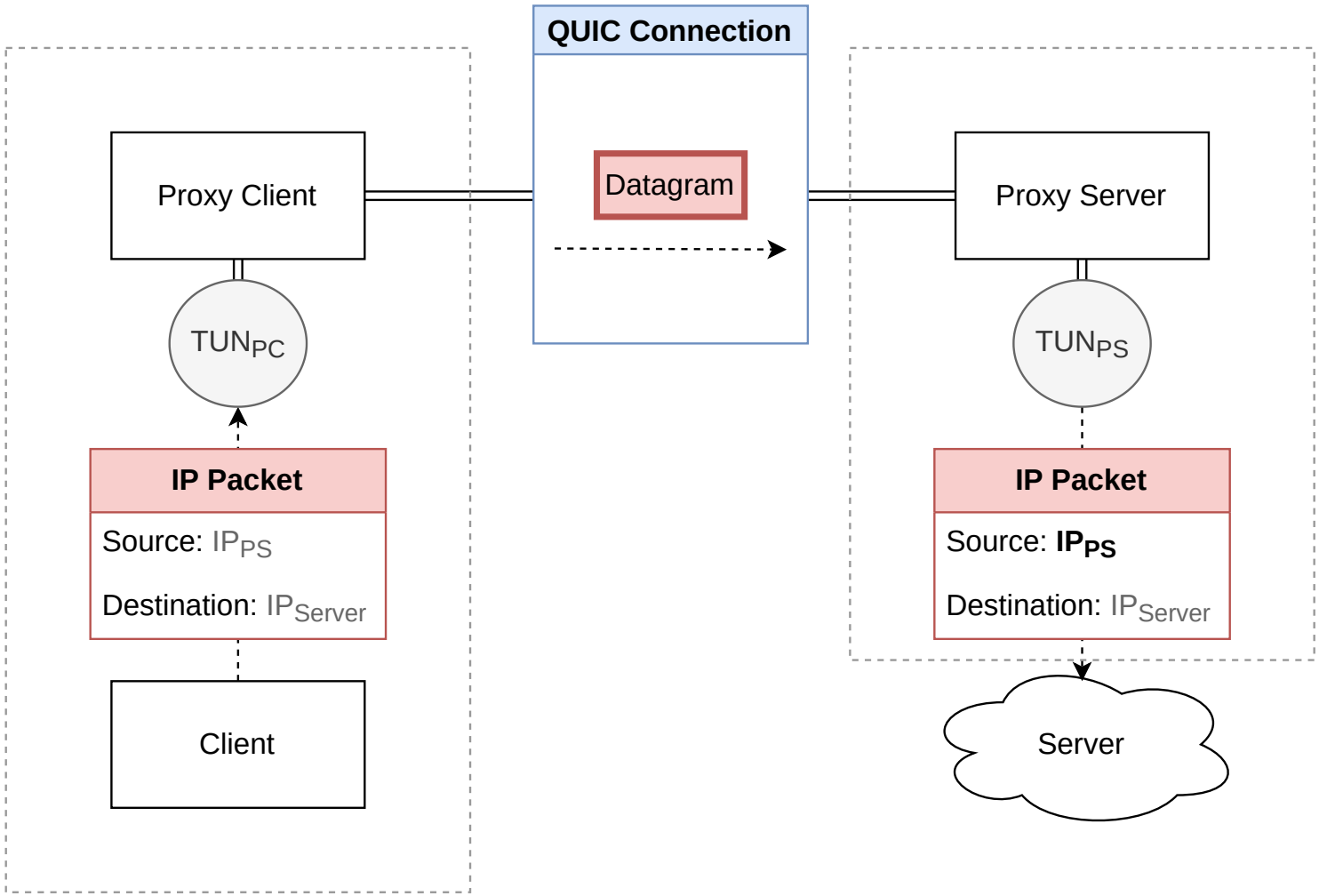

Figure 6: CONNECT-IP Implementation Overview

Appendix

Multithreading

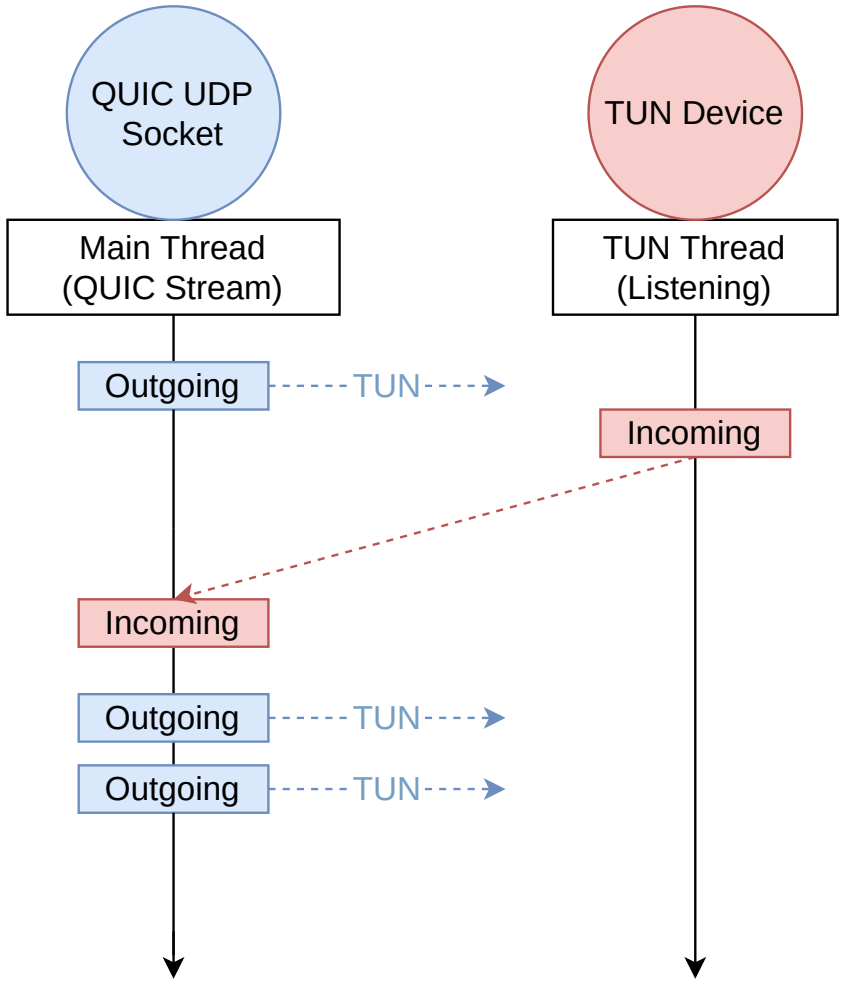

Figure 7: Proxygen Multithreading Overview for CONNECT-IP