QUIC with GStreamer & Rust

Sanchayan Maity

Who

- Who am I?
  - Embedded Systems background
  - Prefer C, Haskell and Rust
  - Organize and speak at Rust and Haskell meet-ups in Bangalore
- Work?
  - Software Engineer @ asymptotic
  - Open source consulting firm based out of Bangalore and Toronto
  - Work on low level systems software centred around multimedia
  - GStreamer, PipeWire, PulseAudio
  - Language Polyglots

Open source contributions

- GStreamer
- gst-plugins-rs
- PipeWire
- PulseAudio
- Linux
- u-boot

Agenda

- QUIC which is a UDP-Based Multiplexed and Secure Transport and standardized in RFC 9000
- Whirlwind tour of GStreamer
- QUIC implementations in Rust
- QUIC support in GStreamer
- Demo
- Future work

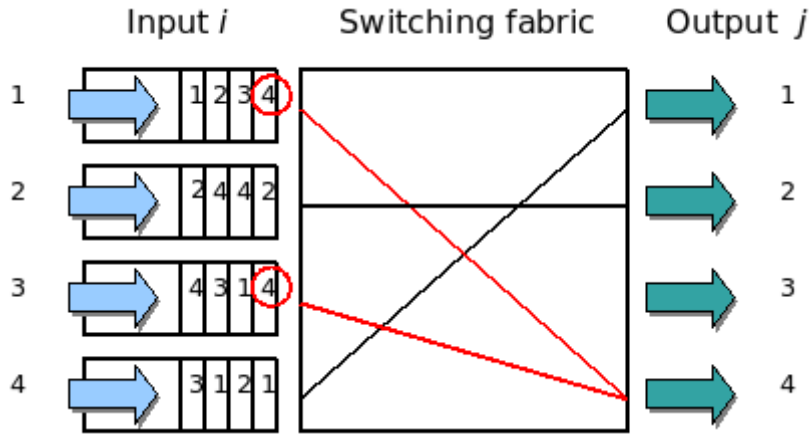
QUIC

- QUIC is pronounced exactly like the English word “quick”
- Not an acronym
- Reliable and secure transport protocol
- Addresses some of the known shortcomings of doing HTTP/2 over TCP and TLS
- Standardized QUIC in RFC 9000
- Supported by RFC 8999, RFC 9001 and RFC 9002

Building on shoulders of giants

- HTTP/2 RFC7540 published in May 2015
- Makes use of multiplexing
  - Multiple logical streams over same logical connection
  - Better congestion control
  - Makes better use of TCP with bandwidth saturation
  - Less bandwidth consumption due to header compression

Head of line blocking[1]



[1] Head of line blocking

Protocol

- Something new?
- TCP?
- UDP?

Security/encryption

- No clear text version of the protocol
- Negotiation employs cryptography and security with TLS 1.3

QUIC

- Implemented on top of UDP
- Uses UDP port numbers
- Implements re-transmission, congestion control among others
- Logical streams similar to HTTP/2
  - In-order
  - Reliable
  - Different streams can be out-of-order
- Flow control
- Fast handshakes (0-RTT and 1-RTT)

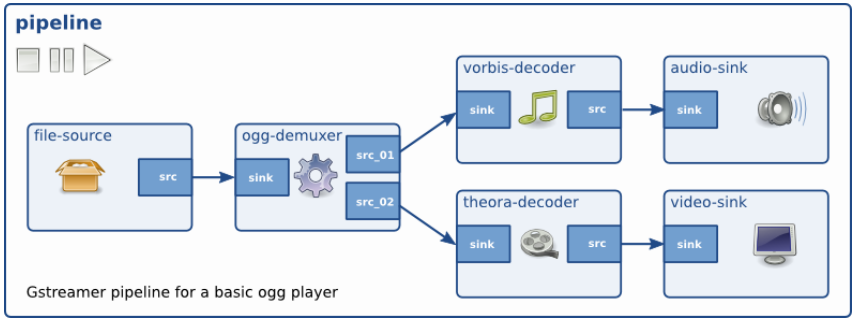
GStreamer

- Multiplatform Pipeline based multimedia framework
- Bindings for various languages
- Allows building complex media processing workflows
- Some applications
  - PiTiVi (Video Editor)
  - amaroK, Banshee, Clementine (audio players)
  - Empathy (VOIP and video conferencing)
  - GstLAL (gravitational wave data analysis)
  - Rygel (DLNA streaming server and renderer)
  - Totem (movie player for the GNOME desktop)

Simple pipeline

```
gst-launch-1.0 videotestsrc ! autovideosink
gst-launch-1.0 audiotestsrc ! autoaudiosink
```

Media pipeline[2]



[2]Dynamic Pipelines

Rust implementations

- quinn-rs
- quiche
- s2n-quic
- neqo
- msquic

QUIC in GStreamer

- Prior work
  - gst-quic-transport
- `quinnquicsink` and `quinnquicsrc` (Merged just a month ago)
- Written in Rust
- Uses quinn-rs
- New elements `quinnquicmux` and `quinnquicdemux` to support stream multiplexing

Audio demo

```
gst-launch-1.0 -v -e audiotestsrc blocksize=4096 ! \
audio/x-raw,format=S16LE,rate=48000,channels=2,layout=interleaved ! \
opusenc ! quinnquicsink use-datagram=false secure-connection=false
```

```
gst-launch-1.0 -v -e audiotestsrc blocksize=4096 ! \
audio/x-raw,format=S16LE,rate=48000,channels=2,layout=interleaved ! \
opusenc ! quinnquicsink use-datagram=false secure-connection=false
```

Video demo

quin-quic-mux

- Shows stream and datagram multiplexed on same connection
- Merge request: !1634

Future work

- Handling flow control
- Congestion control
- RTP over QUIC
- Media over QUIC

References

- RFC 9000
- Road to QUIC
- 0-RTT

Questions

- Reach out on
  - Email: sanchayan@sanchayanmaity.net
  - Mastodon: sanchayanmaity.com
  - Telegram: https://t.me/SanchayanMaity
  - Blog: sanchayanmaity.net