HTTP Live Streaming (HLS)

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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

- Whirlwind tour of GStreamer
- What's HTTP Live Streaming (HLS)
- HLS implementation

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[1]

Gstreamer pipeline for a basic ogg player
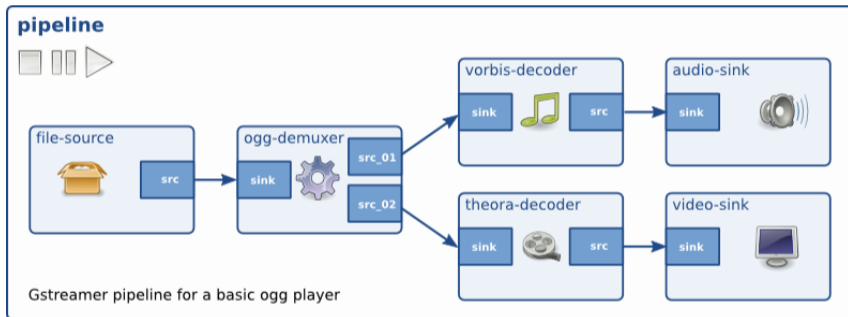
HLS

- HTTP-based adaptive bit-rate streaming communications protocol
- Developed by Apple and released in 2009
- Standardised in RFC 8216
- HTTP traffic, unlike UDP-based protocols such as RTP
- Content can be offered from conventional HTTP servers
- Delivered over widely available HTTP-based content delivery networks

Motivation

- Video on demand content
    - HLS is better than just serving media directly over HTTP
    - Can describe metadata
    - Variants using a bit rate ladder
    - Alternate media renditions
- Live content
    - Reuse the same mechanism
    - Trading off lower cost distribution via CDN at the cost of latency over real time

Playlist[2]

```
#EXTM3U
#EXT-X-TARGETDURATION:10
#EXT-X-VERSION:3
#EXTINF:9.009,
http://media.example.com/first.ts
#EXTINF:9.009,
http://media.example.com/second.ts
#EXTINF:3.003,
http://media.example.com/third.ts
#EXT-X-ENDLIST
```

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[2]RFC 8216

Master playlist[3]

```
#EXTM3U
#EXT-X-STREAM-INF:BANDWIDTH=1280000,AVERAGE-BANDWIDTH=1000000
http://example.com/low.m3u8
#EXT-X-STREAM-INF:BANDWIDTH=2560000,AVERAGE-BANDWIDTH=2000000
http://example.com/mid.m3u8
#EXT-X-STREAM-INF:BANDWIDTH=7680000,AVERAGE-BANDWIDTH=6000000
http://example.com/hi.m3u8
#EXT-X-STREAM-INF:BANDWIDTH=65000,CODECS="mp4a.40.5"
http://example.com/audio-only.m3u8
```

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[3]RFC 8216

Master playlist[4]

```
#EXTM3U
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="aac",NAME="English", \
    DEFAULT=YES,AUTOSELECT=YES,LANGUAGE="en", \
    URI="main/english-audio.m3u8"
#EXT-X-MEDIA:TYPE=AUDIO,GROUP-ID="aac",NAME="Deutsch", \
    DEFAULT=NO,AUTOSELECT=YES,LANGUAGE="de", \
    URI="main/german-audio.m3u8"
#EXT-X-STREAM-INF:BANDWIDTH=1280000,CODECS="...",AUDIO="aac"
low/video-only.m3u8
#EXT-X-STREAM-INF:BANDWIDTH=2560000,CODECS="...",AUDIO="aac"
mid/video-only.m3u8
#EXT-X-STREAM-INF:BANDWIDTH=7680000,CODECS="...",AUDIO="aac"
hi/video-only.m3u8
#EXT-X-STREAM-INF:BANDWIDTH=65000,CODECS="mp4a.40.5",AUDIO="aac"
main/english-audio.m3u8
```

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[4] RFC 8216

Implementation

- New GStreamer plugin
- Written in Rust
- Uses m3u8-rs and existing `hlssink3`
- Open MR:
  https://gitlab.freedesktop.org/gstreamer/gst-plugins-rs/-/merge_requests/1515

Demo

Using

- videojs
- `python3 -m http.server`
- Sample GStreamer Rust Code[5]

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[5]HLS sample app

References

- RFC 8216
- HLS in depth
- LL-HLS in depth
- HTTP Live Streaming - A Practical Guide
- HTTP Live Streaming - Wikipedia

Questions

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