Linux Stateless Video Decoder Support
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Embedded Linux Conference North America
About me

- Over 10 years at Collabora
- Core GStreamer developer
- Contribute to Linux Media
The beginning of Linux CODECs

- Google partners with Samsung and Asus
- Produce the first ARM Chromebook
- Based on Exynos 5 SoC
- Includes Samsung MFC Decoder
- MFC V4L2 M2M driver landed mainline
State-Full
• A V4L2 output queue is used for the bitstream

• A V4L2 capture queue is used for the decoded pictures

• Additional control flow are added to support draining, flushing

• Inter-queue configuration flow is needed
Pros

- Minimal per CODEC code needed

Cons

- Requires a firmware
- Harder to multiplex
CODA Driver

- CODA driver was added
  - Design from Chips&Media
  - CODA Hx4 and 960 support
- Enabling i.MX51 and i.MX6
- Reversed engineering
The beginning of Linux State-Less CODECs

- Google partners with Rockchip
- 2nd gen of ARM Chromebook
- New type of CODEC hardware
- Rockchip VDPU?
State-Less

Reference(s)

Bitstream

Parameters

ACC

ACC

ACC

Picture
- Registers are replaced with a command as part of the command stream.
- Crafting command stream is HW specific and is only implemented in userspace drivers (Mesa).
- Commands are scheduled by the GPU driver.
- Exposing VPU in Mesa is done through standards API (VA API, VDPAU, DXVA2, NVDEC), but without a GPU, using these APIs can be cumbersome and overkill.
- Using multiple GPU hardware in the same application remains tedious.
• Per-frame (or slice) controls are associated with bitstream buffers using requests

• References are signaled using user defined timestamps

• Better identification can be done using the Media Controller topology
H.264

NALU Sequence

- SPS
- PPS
- IDR Slice
- P Slice
- B Slice

Annex B NALU

- Start-Code (0x0000001)
- HDR
- Payload

AVCc NALU

- Size
- HDR
- Payload
Decoding process

• Locate and parse NAL headers
• Parse non-VLC and VCL NAL (SPS, PPS, Slice Headers)
• Calculate frame_num (and handle gaps)
• Calculate POC and pic_num
• (Sliced Base) prepare reference lists
• ....
Decoding process (continued)

- Fill SPS / PPS, Decode parameters, Slice params V4L2 structures
- (Slice Based) Modify reference lists
- Decode the slices/frame
- Do DPB management as per spec
- Output frames that could be re-ordered
V4L2 Specific Process

- Allocate a Request (an FD)
- Set per-frame/slice params for this request
- Queue a v4l2_buffer for the request
- Queue the request
- Poll the request FD for completion
MediaTek VPU

- State-full H.264, VP8 and VP9 decode
- Tiled output only (requires HW converter)
Qualcomm Venus

- State-full MPEG4, MPEG2, H.264, VC1, H.264, VP8, VP9 and HEVC decode
- MPEG4, H.263, H.264, VP8, HEVC
Upstreaming Stalled

- Could not settle on the Request / Job API
- Low knowledge of CODEC decoding process by the linux-media maintainers
- Only one hardware to test the API design
- No formal specification (not that state-full CODEC had any either)
Allwinner VPU support Kickstarter by Bootlin

- Request API is finalized
- MPEG2 Support landed in Staging
- H.264 support was progressing (but only sliced based)
- Reversed engineered from binary userspace blob
- VA-API userspace drivers
- The crowd funding had gain good momentum
- A formal specification was merged
- H264, VP8, HEVC uAPI added as staging control API
- Cedrus gained H264 and HEVC support
- RK3288 driver was mainlined (MPEG2, H264, VP8)
- RK3288 driver was renamed !?!
The Hantro Driver

- I.MX8M Quad, using Hantro G1/G2
- Registry compatible with the RK3288
• `stmmac` is an ethernet driver, that was thought to be an STM design

• It was later found to be DesignWare design, shared across numerous SoC

• Still called `stmmac` to maintain kernel API stability
Testing and Fixing

- FFMPEG support
- Bug fixing
- Interlaced Content Support
- RK3399 JPEG, MPEG2, H.264 and VP9 support landed
- GStreamer gained base classes for state-less CODEC, with already merge DXVA2 and NVDEC support
- **GStreamer** H.264 and VP8 V4L2 support landed
- Embedded World Conference 2020 **canceled**
- VA V4L2 Request driver was abandoned
- And a lot more coming ...
- (at 2m distance of course)