XDF XILINX DEVELOPER FORUM

Multimedia SoC System Solutions

Presented By

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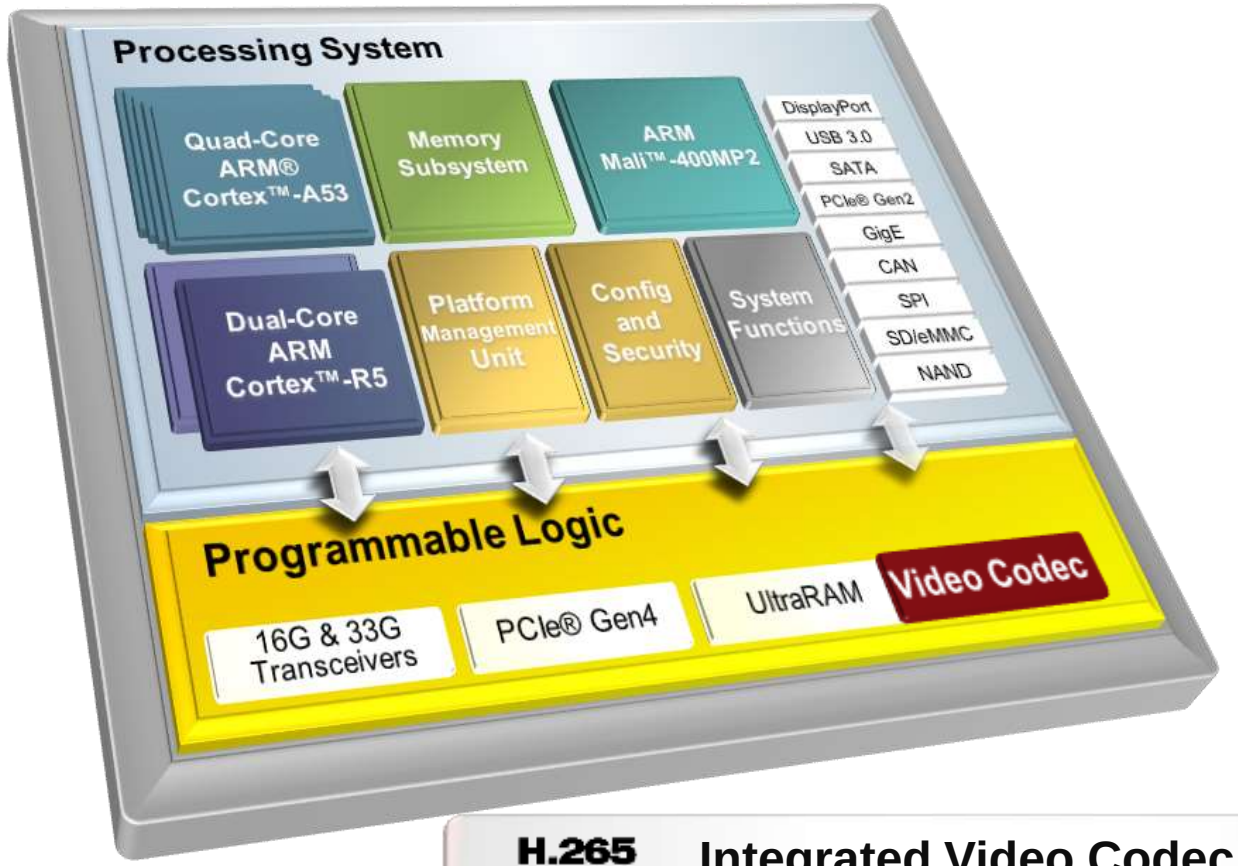
Agenda

- Zynq Ultrascale+ MPSoC and Multimedia blocks
- Software overview
- Multimedia Framework
- Target Reference design
- Platforms

Multimedia Blocks

Zynq® UltraScale+™ MPSoC EV Devices

Next-Generation SoC with Integrated Video Codec



Application Processor
- 64-bit Quad-core A53
- Up to 1.5GHz

Real-Time Processor
- 32-bit Dual-core R5
- 128KB TCM w/ ECC

Graphics Processor
- ARM Mali-400/MP2
- 2D/3D Visualization

16nm Programmable Logic
- Any-to-Any Connectivity
- Processor Offloading

Integrated Video Codec
- UHD 4K (60fps) / 8K (15fps)
- 8 Simultaneous Encode/Decode Streams

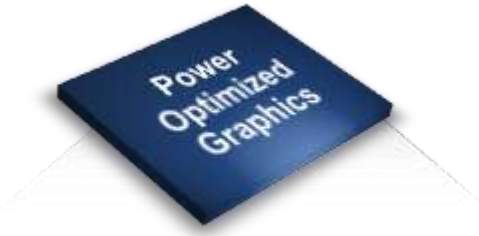
High Speed Peripherals
- PCIe Gen2, USB 3.0
- DisplayPort, SATA 3.1

Different classes of Graphics Processing unit

ZYNQ UltraSCALE+

Gaming, 3D Vision, & 4K Display

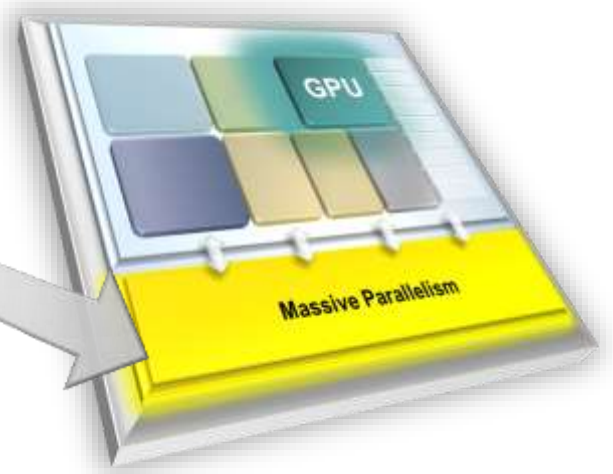
Data Center Acceleration and High Performance Computing



Embedded Graphics

Hardware Acceleration

OpenCL



- ✓ **Power-Optimized GPU for Embedded Graphics**
- ✓ **Programmable Logic for Accelerated Compute**

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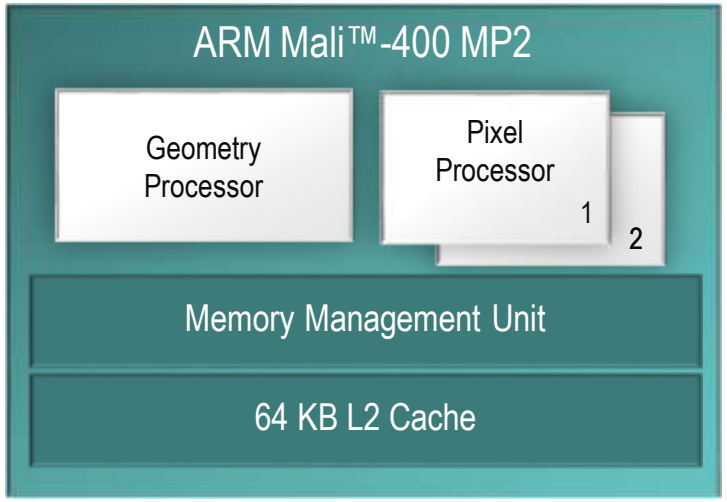
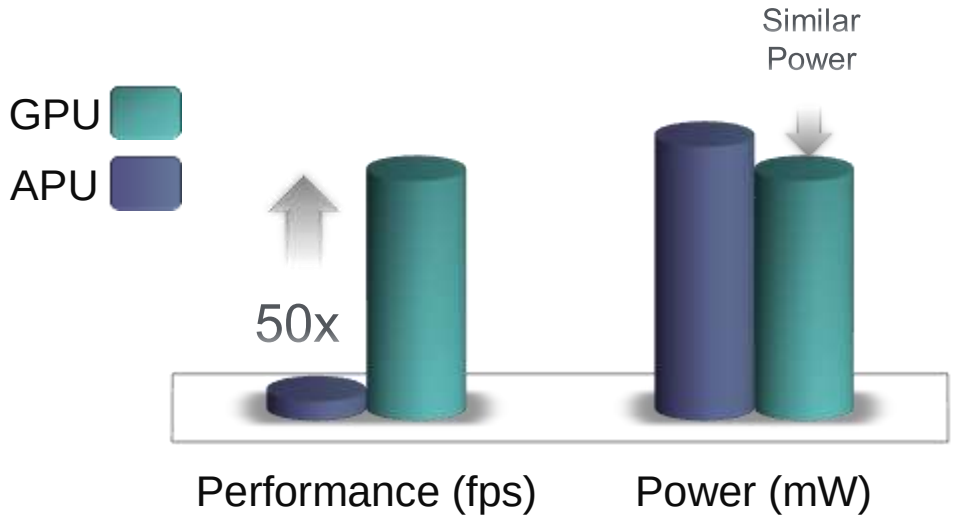
Graphics Processor Unit

ARM Mali-400 MP2

Feature	Benefit
ARM Mali™-400 MP2 up to 667MHz	• Most power-optimized ARM GPU with Full HD support (1080p) • Ideal for 2D vector graphics and 3D graphics (e.g., HMI, waveform processing) • Supports open standards, e.g., OpenGL ES 1.1 & 2.0
Native Embedded Linux Support	Out-of-the-box drivers and libraries for graphics support
Dual Pixel Processors	• Up to 1.3 GPix/s fill rate for smoother transition and frame rate • Up to 20 GFLOPS shader rate for complex 3D scenes
Optimized Memory Interface	Tightly coupled w/memory controller for efficient communication with DisplayPort controller



Full HD (1920x1080) GLmark2 Benchmark



Video Codec Implementation Strategies

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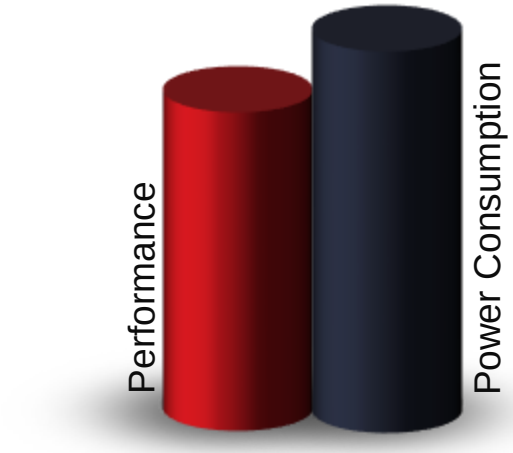
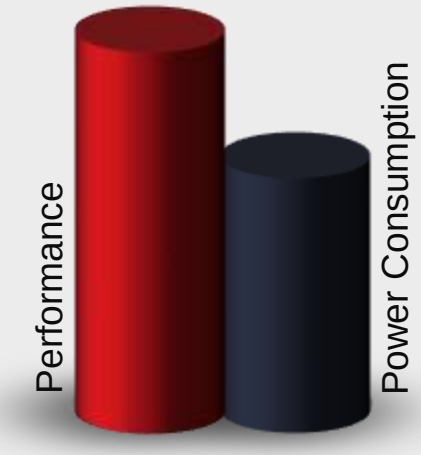
Software Solution



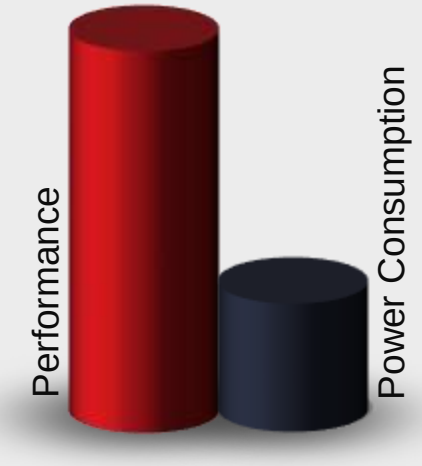
- Cost Effective
- Physically Large
- Flexible

Soft IP Solution



- Cost Effective
- Large Fabric footprint
- Flexible

Dedicated Video Codec

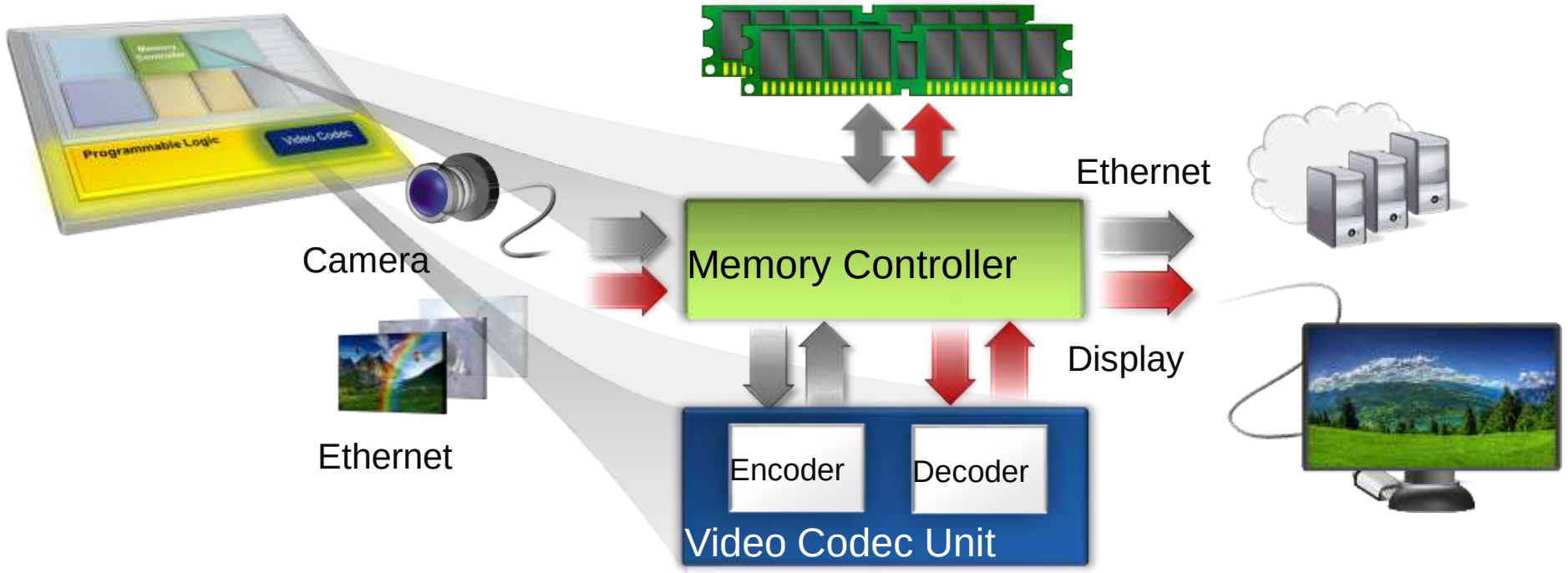


- Cost Effective
- Highly Integrated
- Flexible

Video Codec Unit

Integrated H.264/H.265 Video Codec Engine

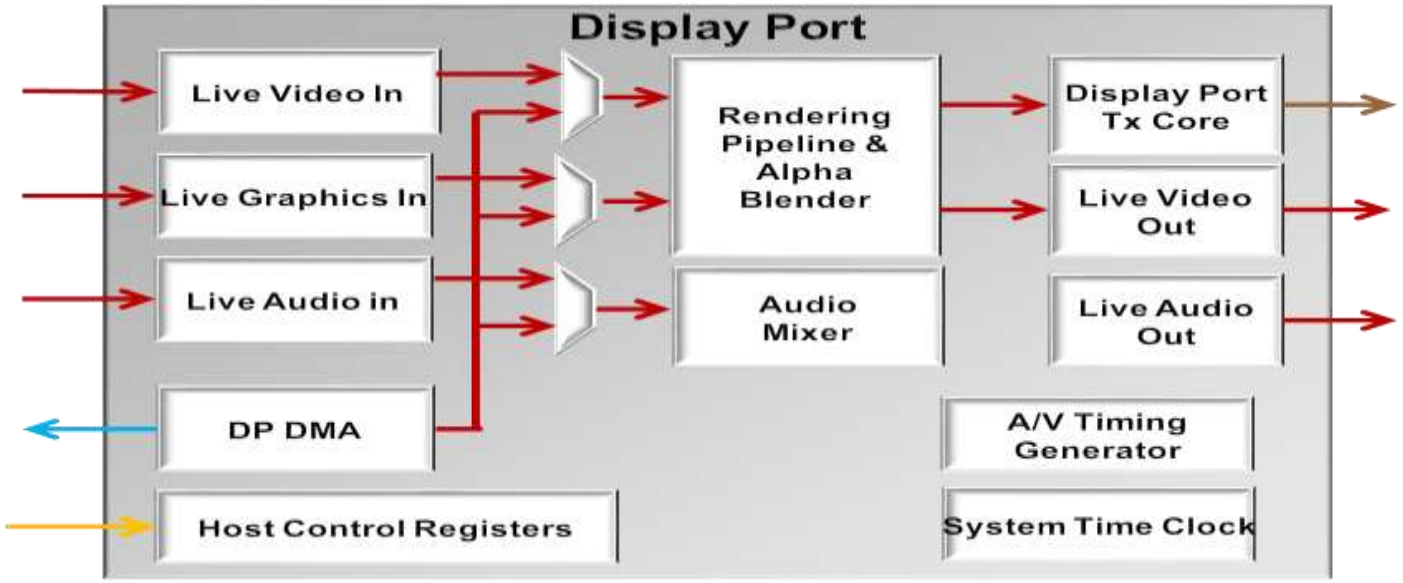
Feature	Benefit
Integrated Video Codec Unit	• Up to 4K UHD (60 fps) or 8Kx4K (15 fps) • Up to 8 simultaneous streams • Flexible memory topology to enable scalable system performance
Power Management, Performance Monitoring	• Clock gating (codec firmware automatically clock gates unused engines) • Measure task execution time, bandwidth, and latency for fast design optimization



DisplayPort

Architecture Overview

Feature	Benefit
Video Resolution	Upto 4kp30 Hz
Audio Support	2 Channel of 24 bit Audio upto 96 KHz
Multiple channel	Once channel of Graphics and Video
Features	• Chroma Keying • Alpha Blending • Live and Non-live video



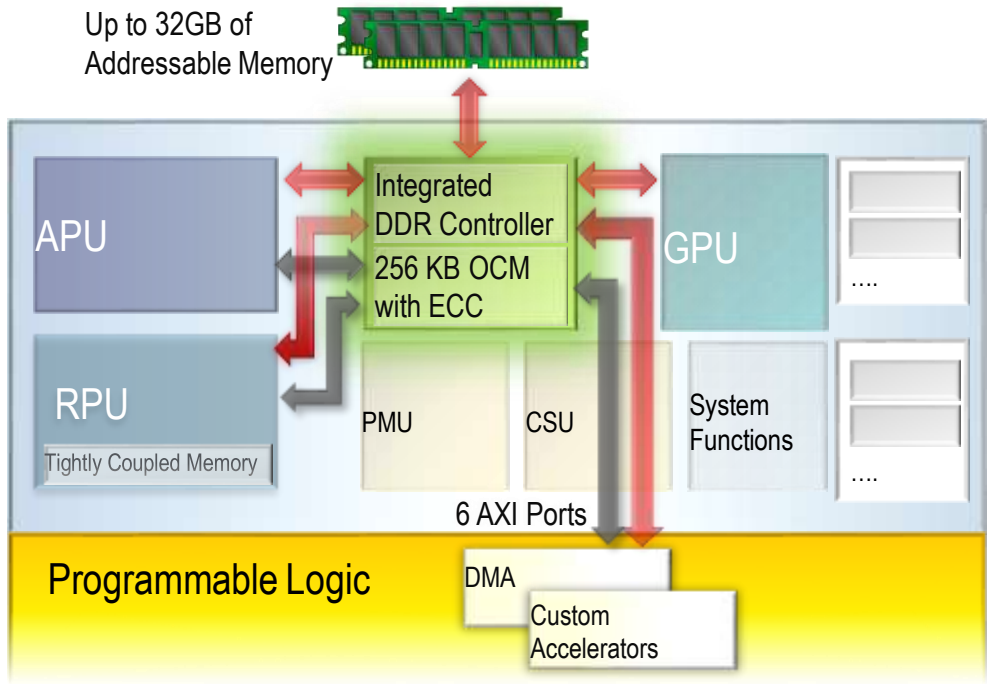
Memory Subsystem

Feature	Benefit
Dedicated DDR Memory Controller	Integrated in processing system for lower power usage and reduced latency
6 AXI Ports For Shared System Access	Multi-ported controller enables PS and PL shared access to common memory
32/64-bit Configurable Widths w/ECC	Supports varying data widths from processing engines
256KB On-Chip Memory (OCM) w/ECC	• Low latency memory decreases cost for additional external memory • Shareable by Cortex-A53s, Cortex-R5s, and programmable logic
Tightly Coupled Memory (TCM)	Low-latency, deterministic memory access for Cortex-R5s in functional safety applications

Supported Interfaces in Processing System

Interface	(Mb/s)
DDR4	2400*
LPDDR4	2400
DDR3	2133
DDR3L	1866
LPDDR3	1800

*DDR4 up to 2,667Mb/s in Programmable Logic



Programmable Logic IPs

Programmable Logic IPs Video capture and Display

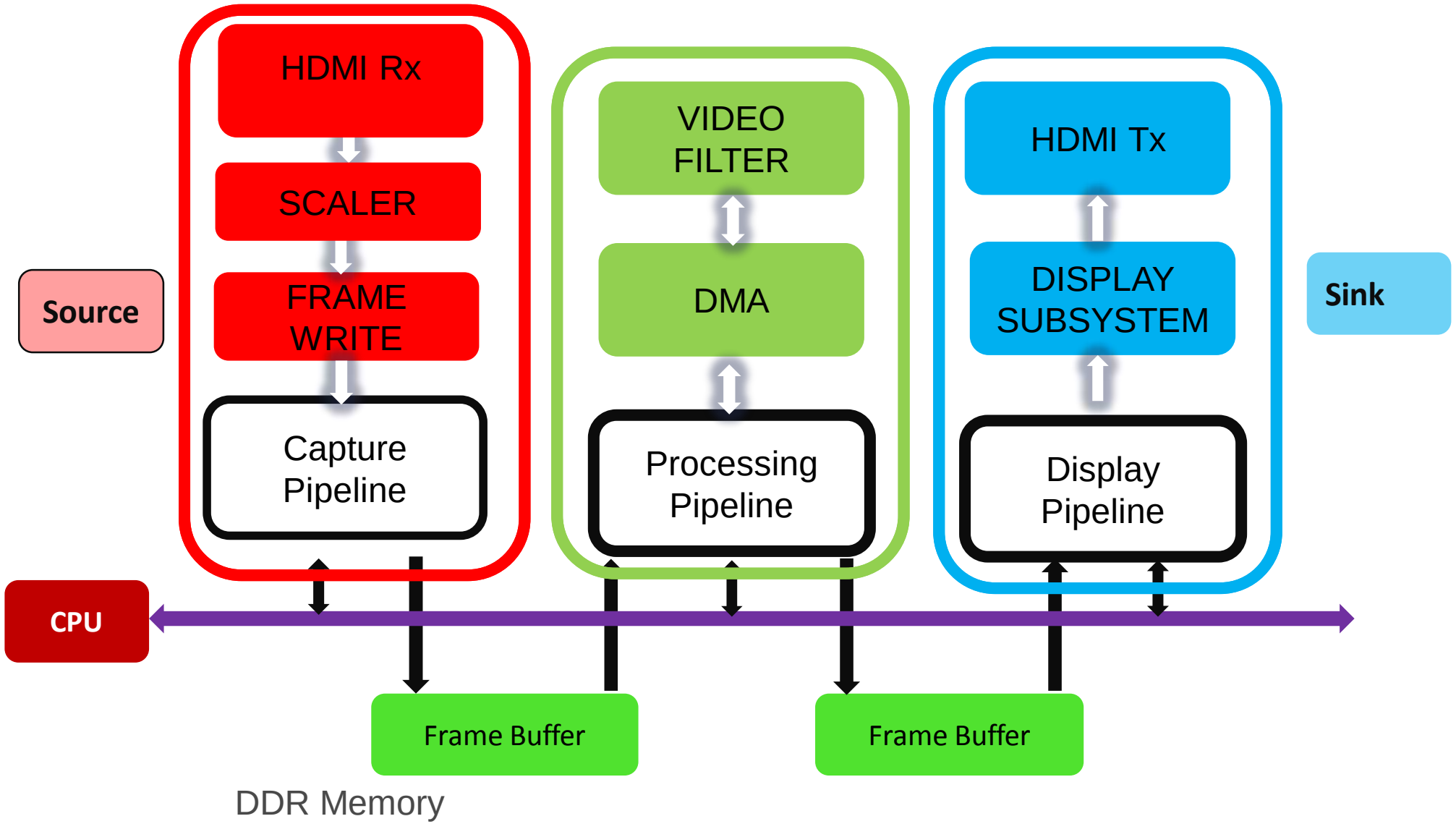
HDMI	MIPI	SDI	DisplayPort
HDMI2.0 @6Gbps/lane 4K60 RX and TX RGB and YUV	MIPI CSI Rx and DSI Tx DPHY@ 1.5Gbps/lane RAW, RGB and YUV	12G-SDI 4K60 YUV	DisplayPort TX 4K60 in Programmable logic 4K30 in Programmable PS

Programmable Logic IPs Video and Image processing

Video Processing subsystem	ISP	Video Mixer	Frame Buffer
Scaling, Color space conversion, deinteracing Up to 4K60	Demosaic and GammLUT Up to 4K60	8 Layers of mixing + graphics	Write and Read Frames for Video codec consumption

Software Overview
Multimedia Components

Typical Video Pipeline



Video Support in Linux

- Different solutions, provided by different subsystems:
  - FBDEV: Framebuffer Device
  - DRM/KMS: Direct Rendering Manager / Kernel Mode Setting
  - V4L2: Video For Linux 2

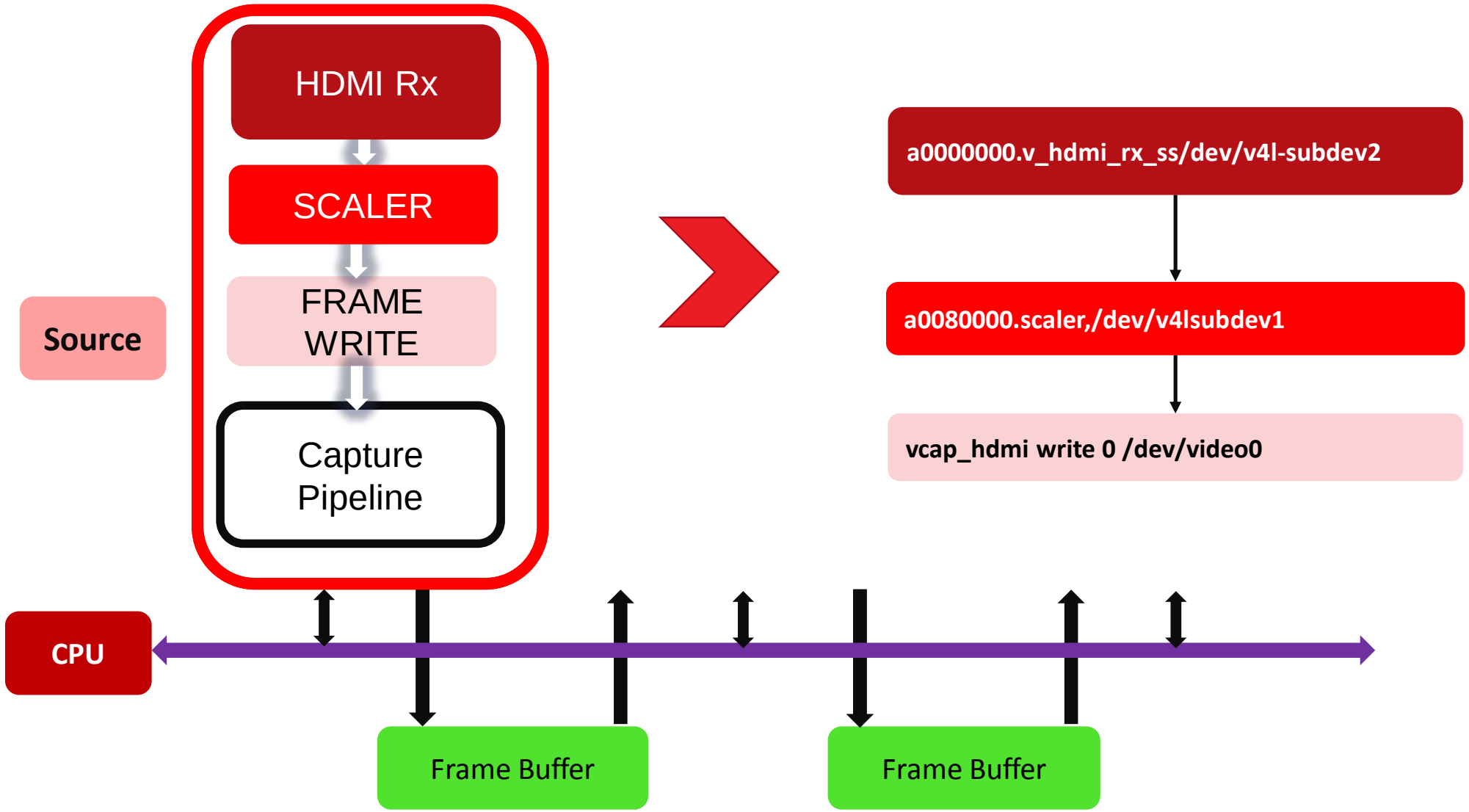
- How to choose one: it depends on your needs
  - Each subsystem provides its own set of features
  - Different levels of complexity
  - Different levels of activity

Video For Linux (V4L2)

Key Feature

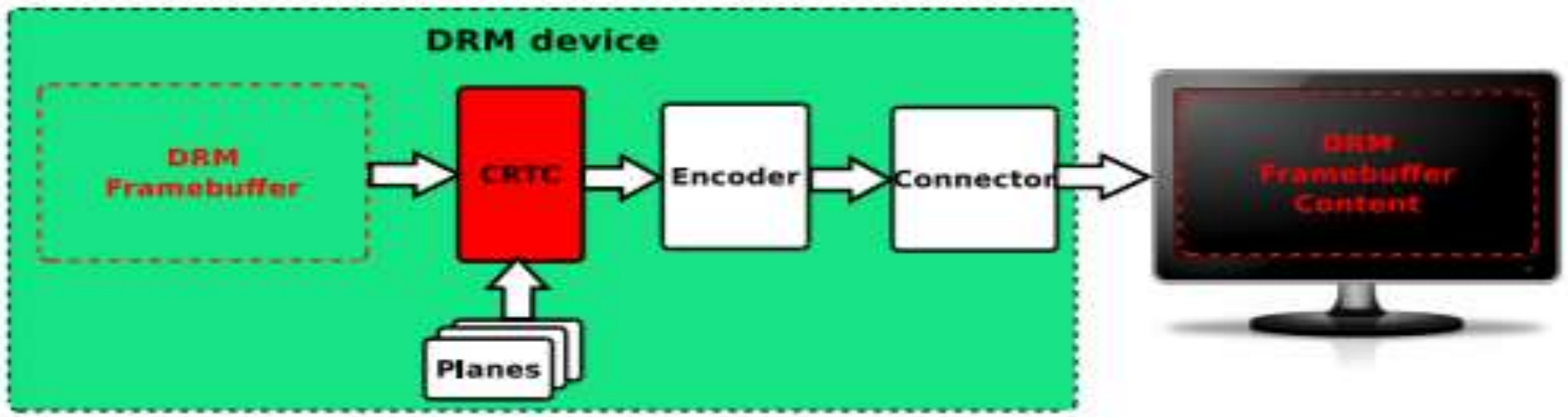
- **Frame-based video pipelines with streaming and/or memory interfaces**
  - **Video capture devices**
  - **Video memory to memory devices**
  - **Video output devices (no graphics)**
- **DMABUF**
  - **0-copy buffer sharing**
- **Media controller**
  - **Describes logical topology and data-flow**
- **Multimedia libraries**
  - **Gstreamer, OpenCV, OpenMAX**

Top View- Capture Pipeline

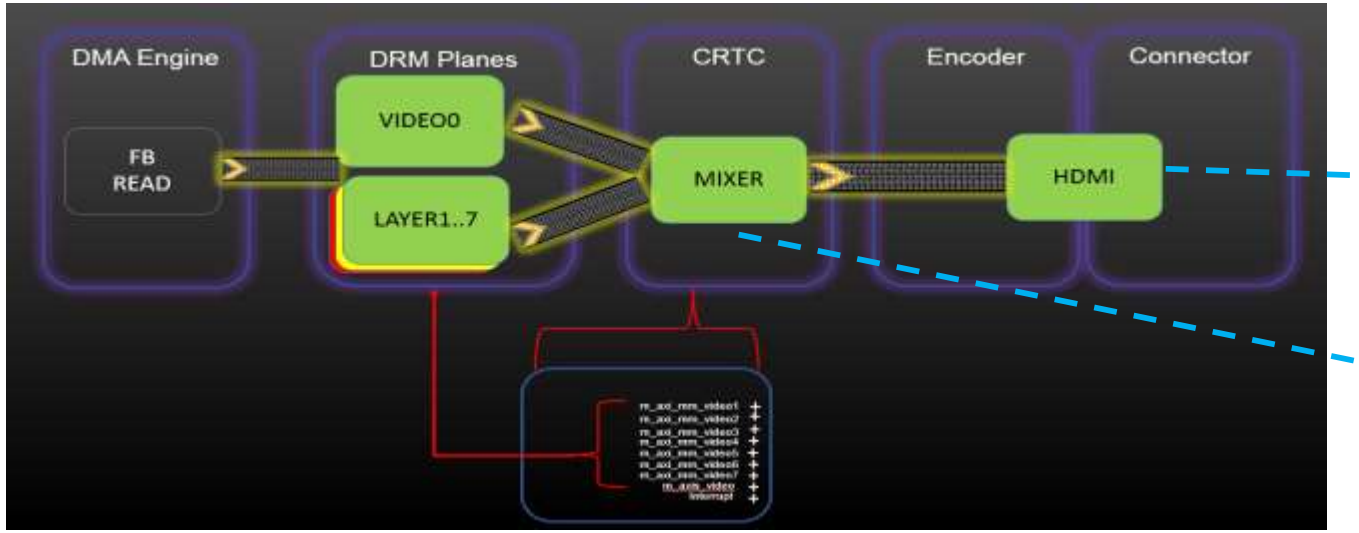


Direct Rendering Manager (DRM)

- Introduced to deal with display cards with embedded GPUs
- KMS stands for Kernel Mode Setting and is a sub-part of the DRM API
  - >> Provide a way to configure the display pipeline of a graphic card (or an embedded system)



Top View of Display Pipeline



HDMI Tx
(Programmable Logic)

MIXER

Sink

Capture Pipeline

Processing Pipeline

Display Pipeline

CPU

Source

Source

DDR Memory

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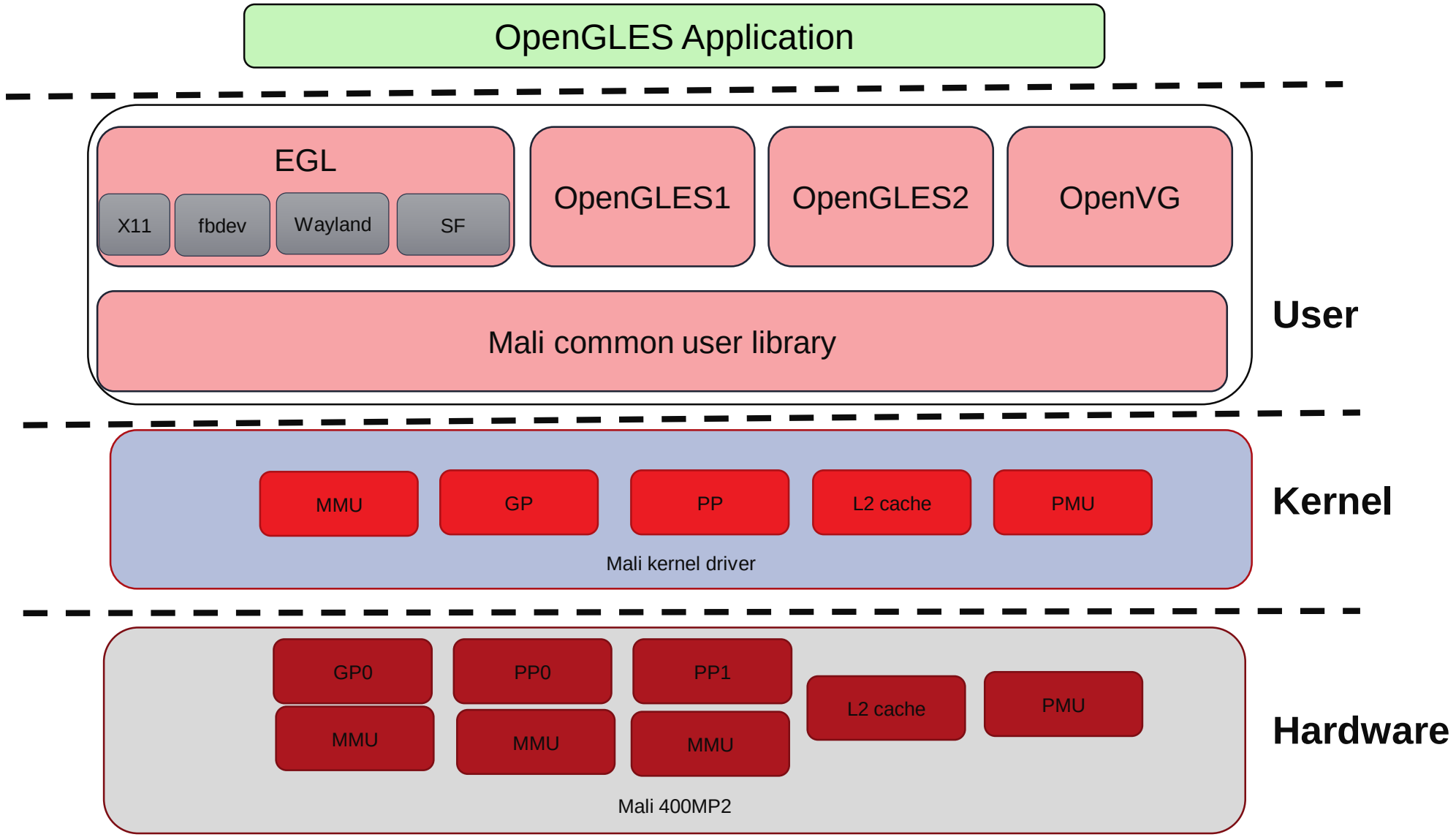
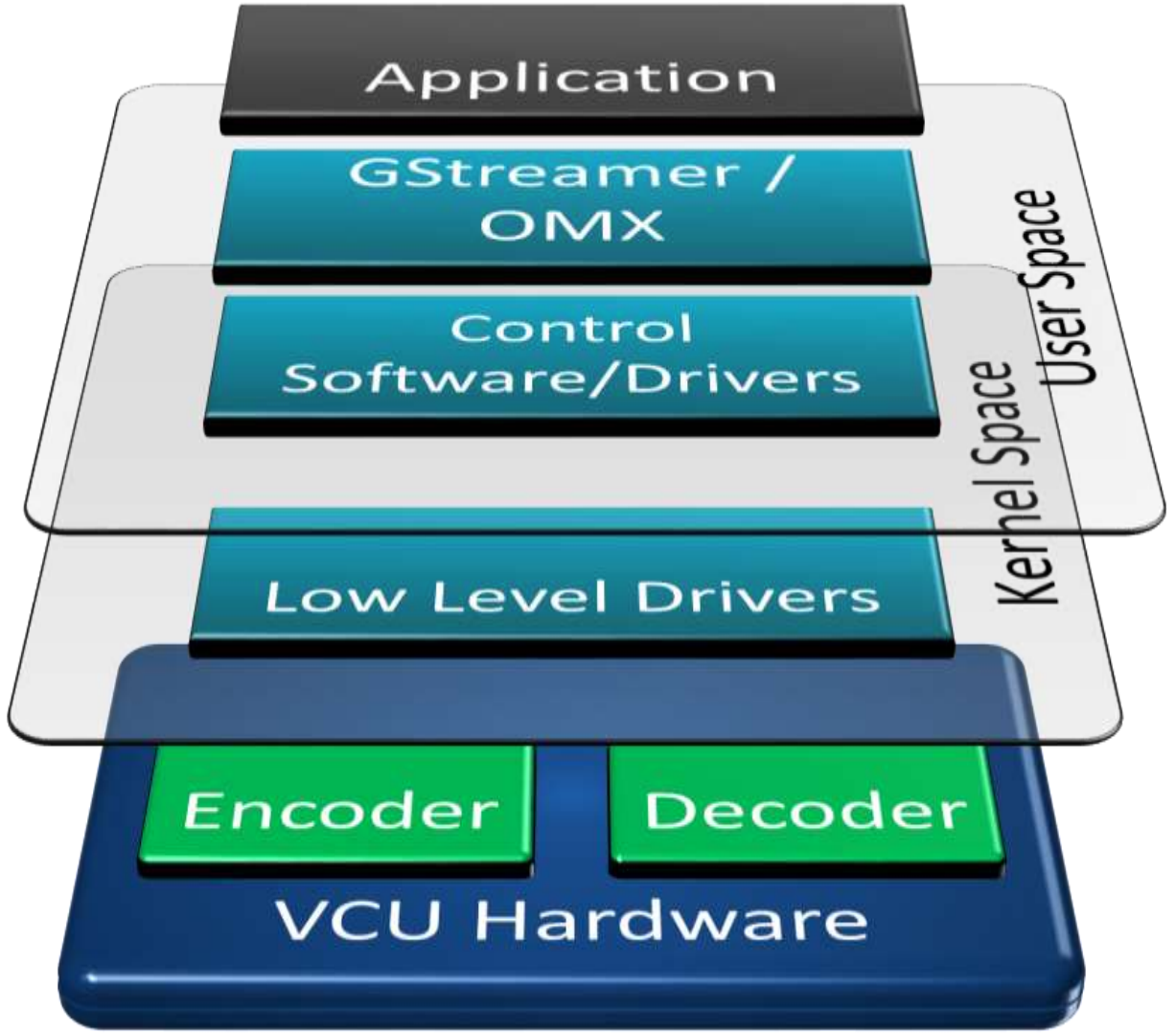
Graphics Software Stack

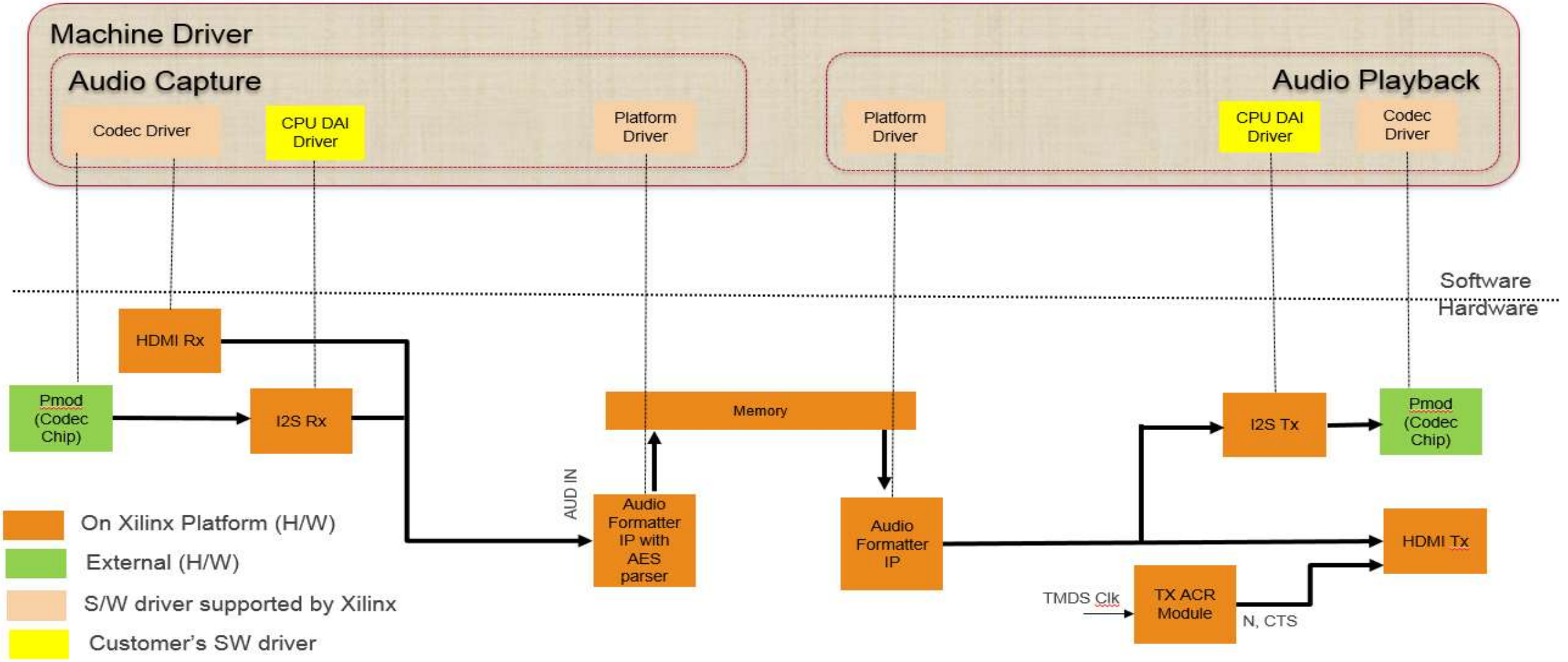


VCU Software Stack

- Control Software allows control of the VCU at a low level
  - >>Direct access to the low level drivers
- GStreamer provides Video Framework at a high level
- Zynq® UltraScale+™ EV devices are true solution-level products from Xilinx



ALSA Framework



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Multimedia Solution
Gstreamer Framework

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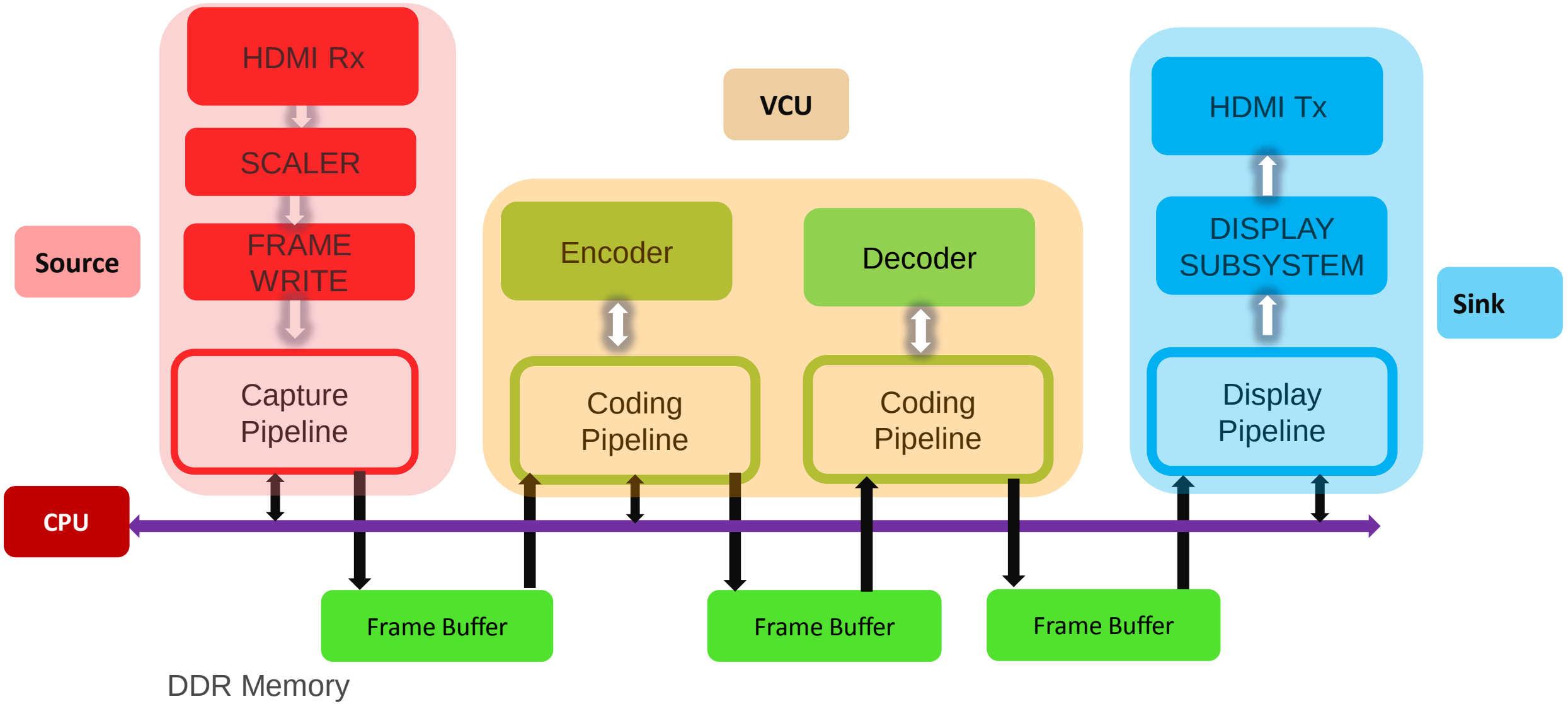
Multimedia Pipeline



What is Gstreamer framework?

- GStreamer is a pipeline-based multimedia framework for creating streaming media applications
- A Multimedia framework designed to be cross-platform
- Various types of media processing can be realized by describing data flows, called ‘pipelines’, with components, called ‘plugins’.
- Over 200 plugins exist
- Gstreamer operates dynamically at *run time*

Why Gstreamer Framework?

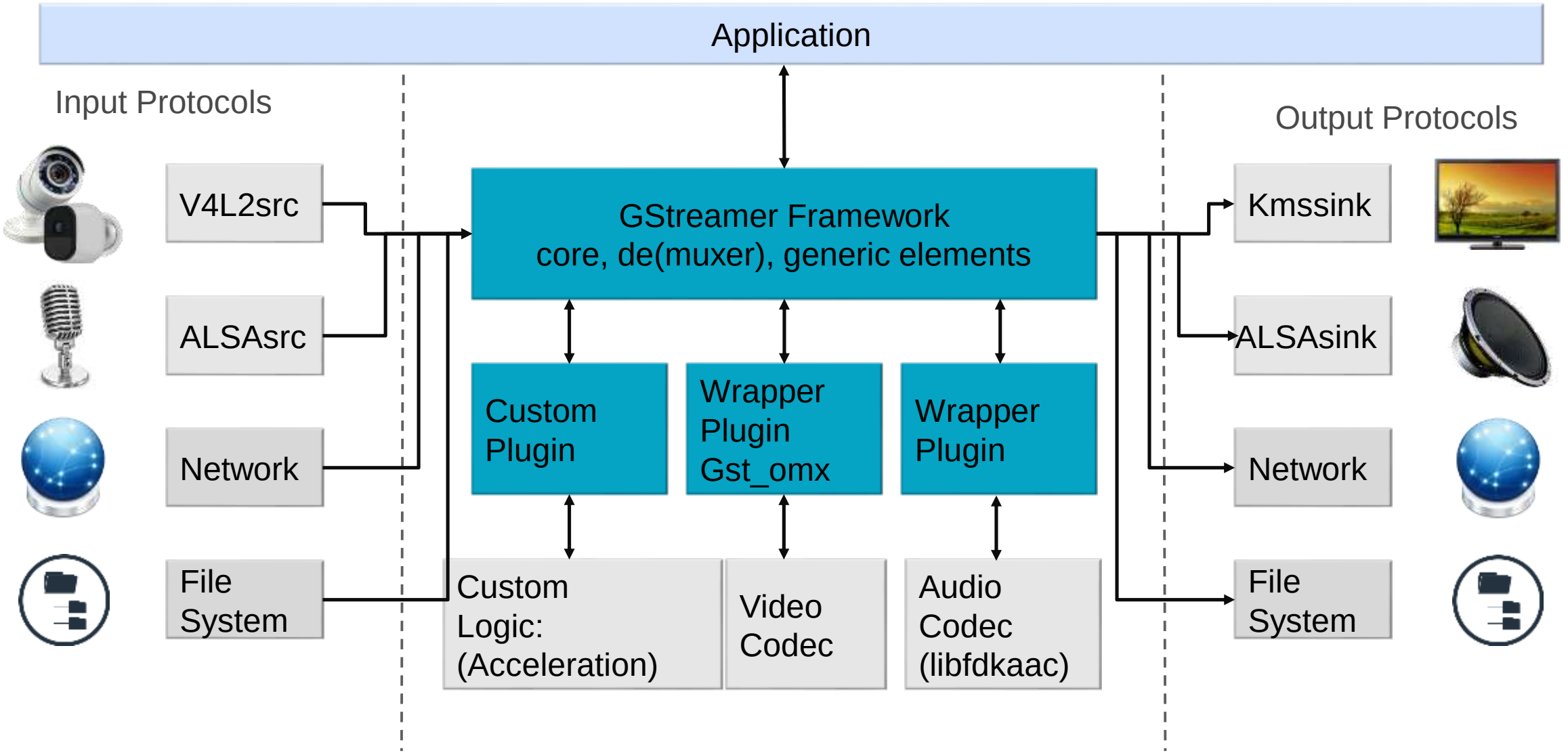
- **Multimedia challenges**
  - Creating Multimedia pipeline is complex process.
  - Lack of reuse of code among different media processing block
  - Inconsistent APIs among different codecs, Libraries and devices

- **Gstreamer open-source collaborative solution for non-trivial media frameworks**
  - allows processing units to be treated generically “Elements” are connected at connection points
  - Along with related/associated open solutions (e.g. Linux, DRM, ALSA, OMX, V4L2

- **Mature Code base and widely used**

- **Fundamentally the reason is to leverage the huge amount of work – aka “re-use”**

GStreamer Framework



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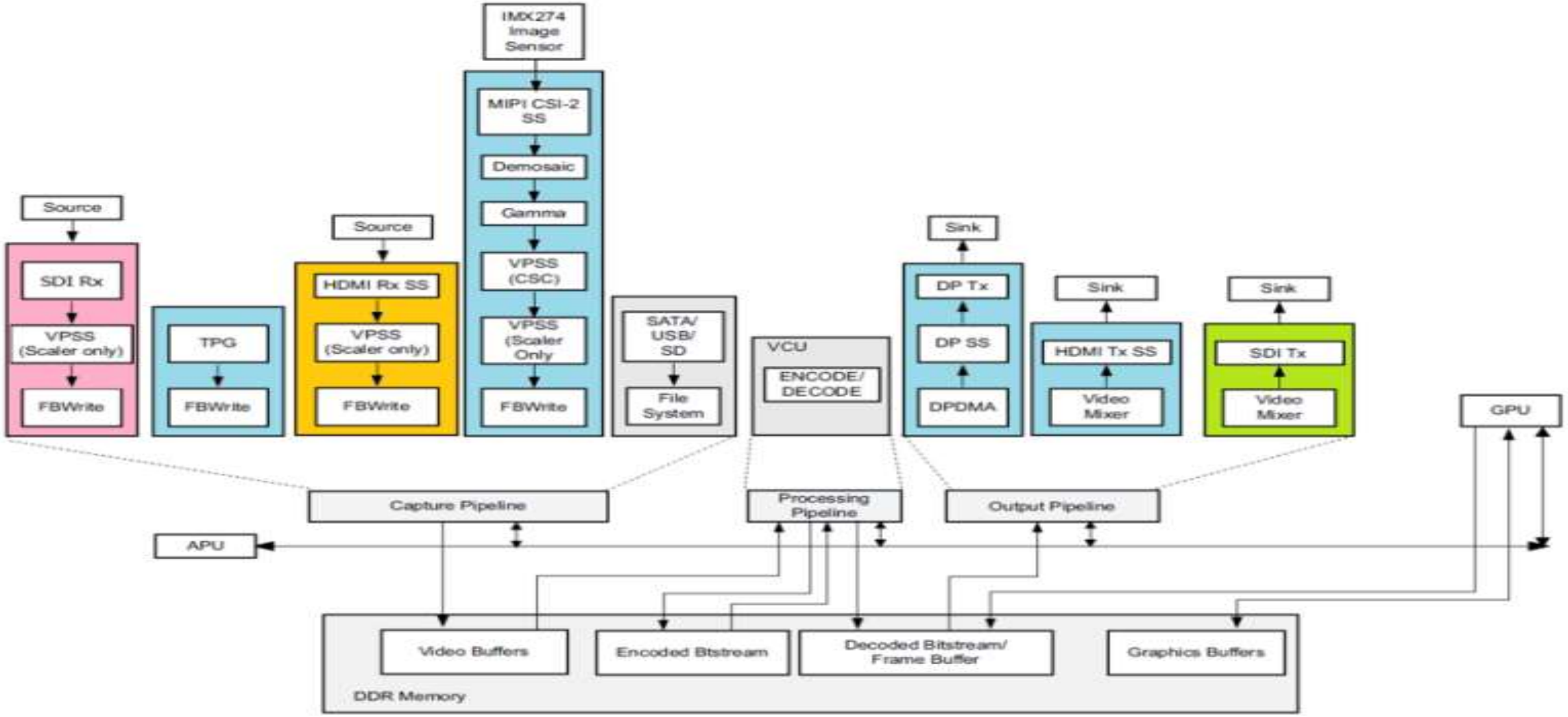
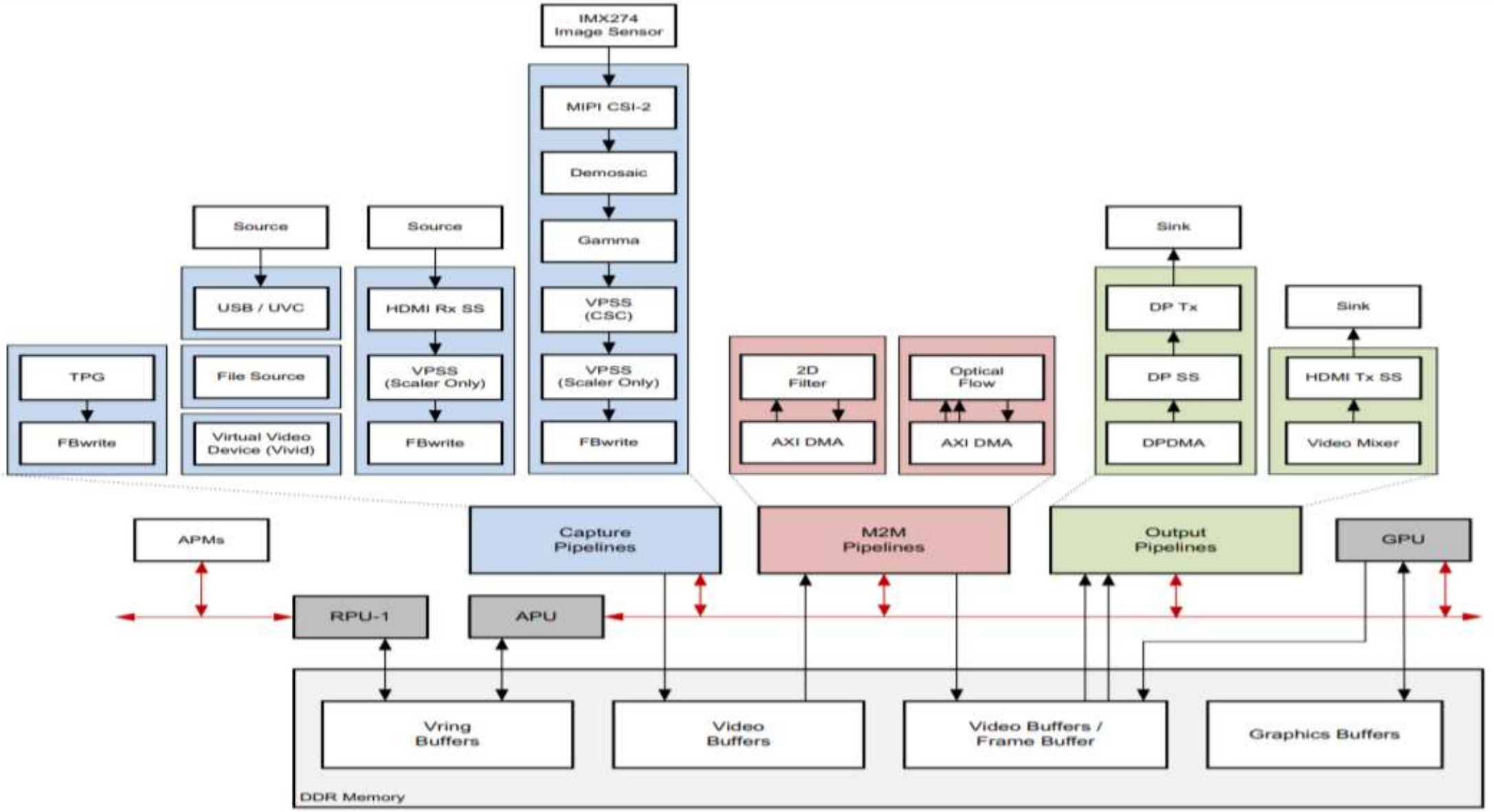
Target Reference Designs

VCU TRD on the ZCU106 Board



ZCU102 base TRD



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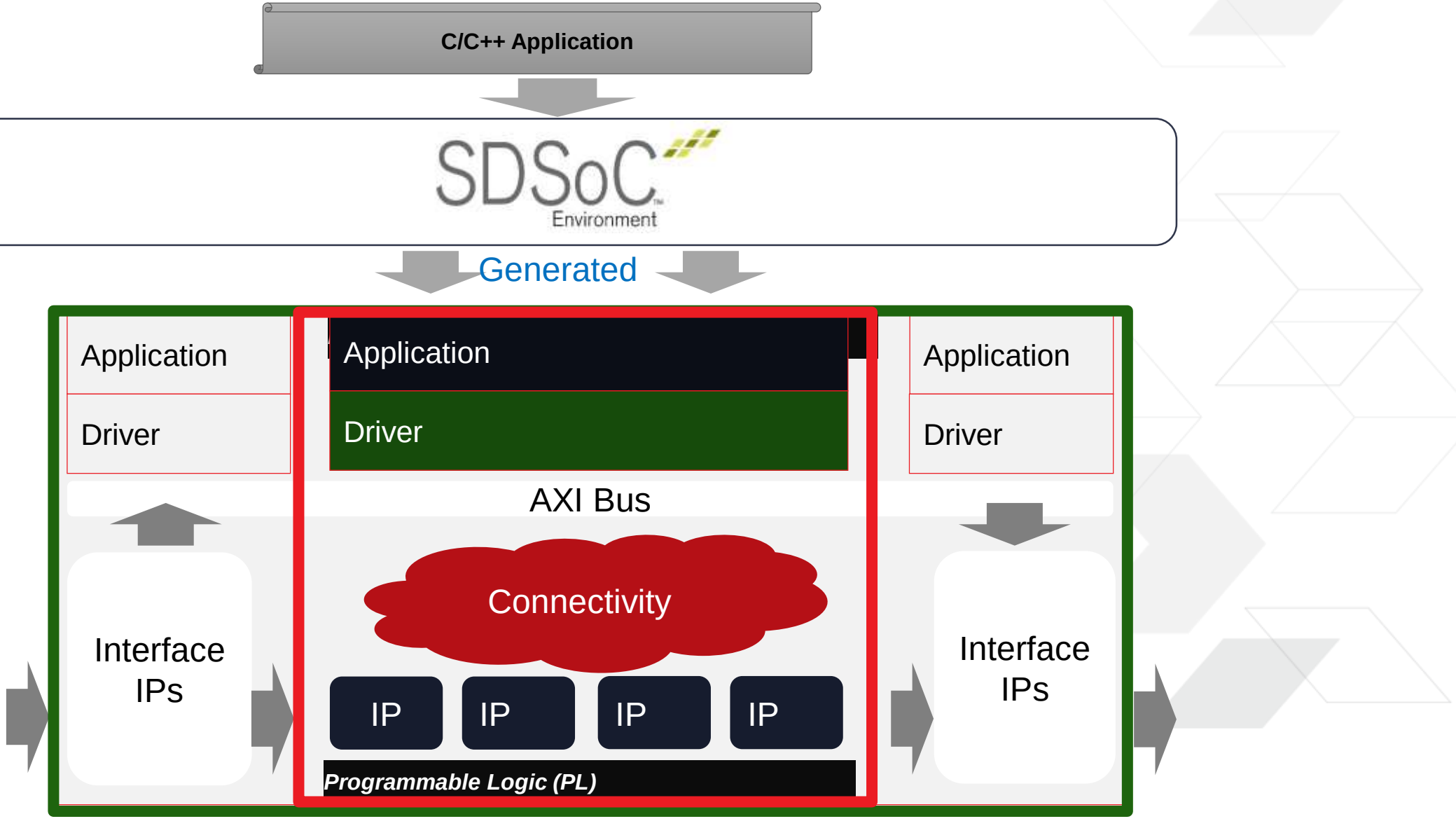
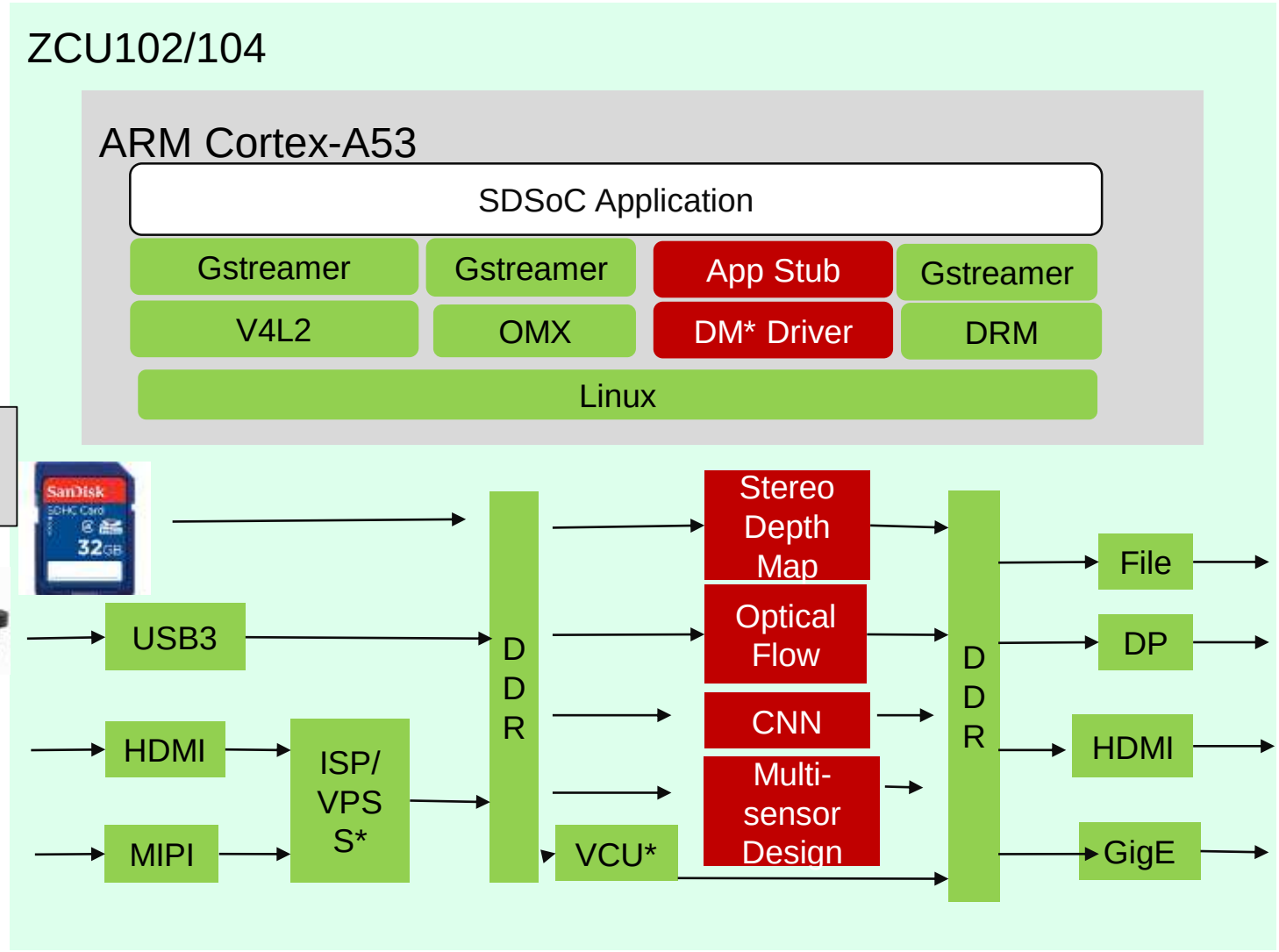
Platform for acceleration

Platform-Based Development



reVISION Platforms: Single sensor platform

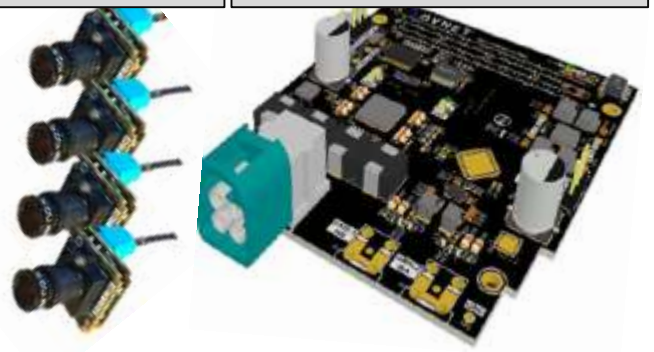


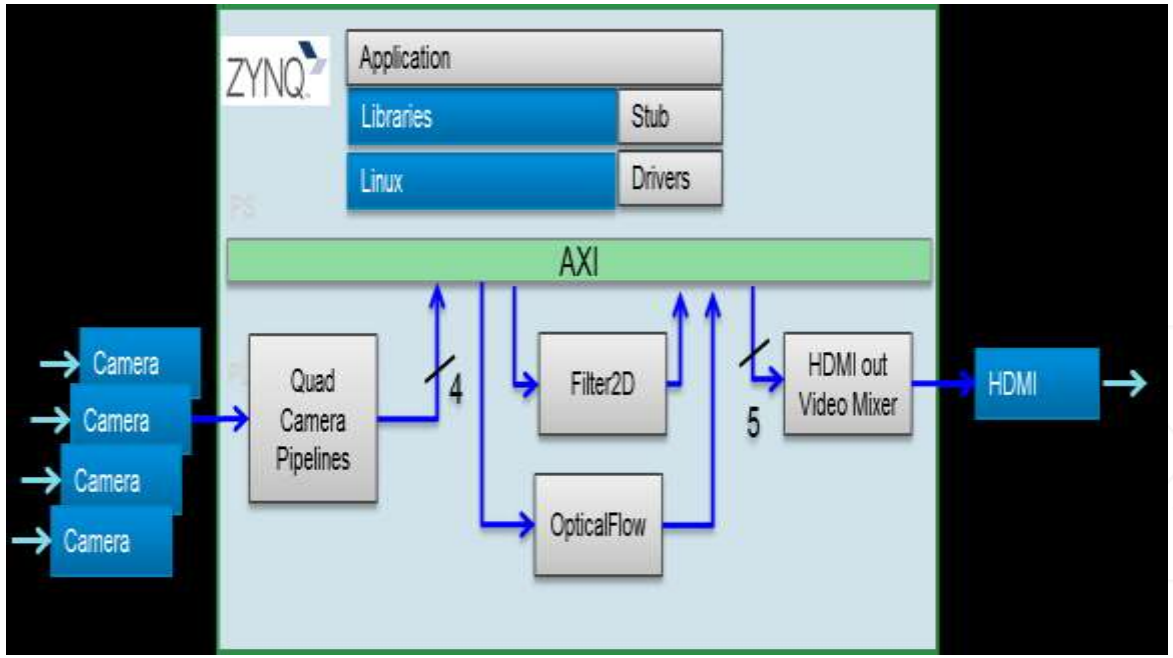
- **Platform Support for Zynq US+ Boards: ZCU102 and ZCU104**
- **Live capture over HDMI, MIPI, USB**
- **Display over HDMI or DP**
- **Neural network support for AlexNet, GoogLeNet, VGG, SSD, and FCN**
- **OpenCV acceleration support thru Xfopen CV**
- **Linux sample designs**
  - Dense optical flow Lucas-Kanade
  - 2D Filter for sharpening and edge detect
  - Stereo depth vision

reVISION Platforms: Multi-camera Imaging and Analytics

Kit sold by Avnet

On-semi MARS:	**Avnet MULTI_CAM4-G:**
2MP AR0231 camera MAX96705 GMSL serializer	4-camera input MAX9286 GMSL Quad De-serializer





Optical Flow

Filter 2D

- **Linux drivers for**
  - AR0231
  - MAX96705 Deserliazer
  - MAX9286 Serializer
- **reVISION platform support for Zynq US+ Boards: ZCU102 and ZCU104**
  - Linux based reference designs with
    - Quad camera capture pipes, OpenCV accelerators and Live Display
  - Sample designs showing OpenCV acceleration on quad cameras
    - Optical flow
    - Filter_2D

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