Multimedia SoC System Solutions

Presented By

Yashu Gosain & Forrest Picket: System Software & SoC Solutions Marketing

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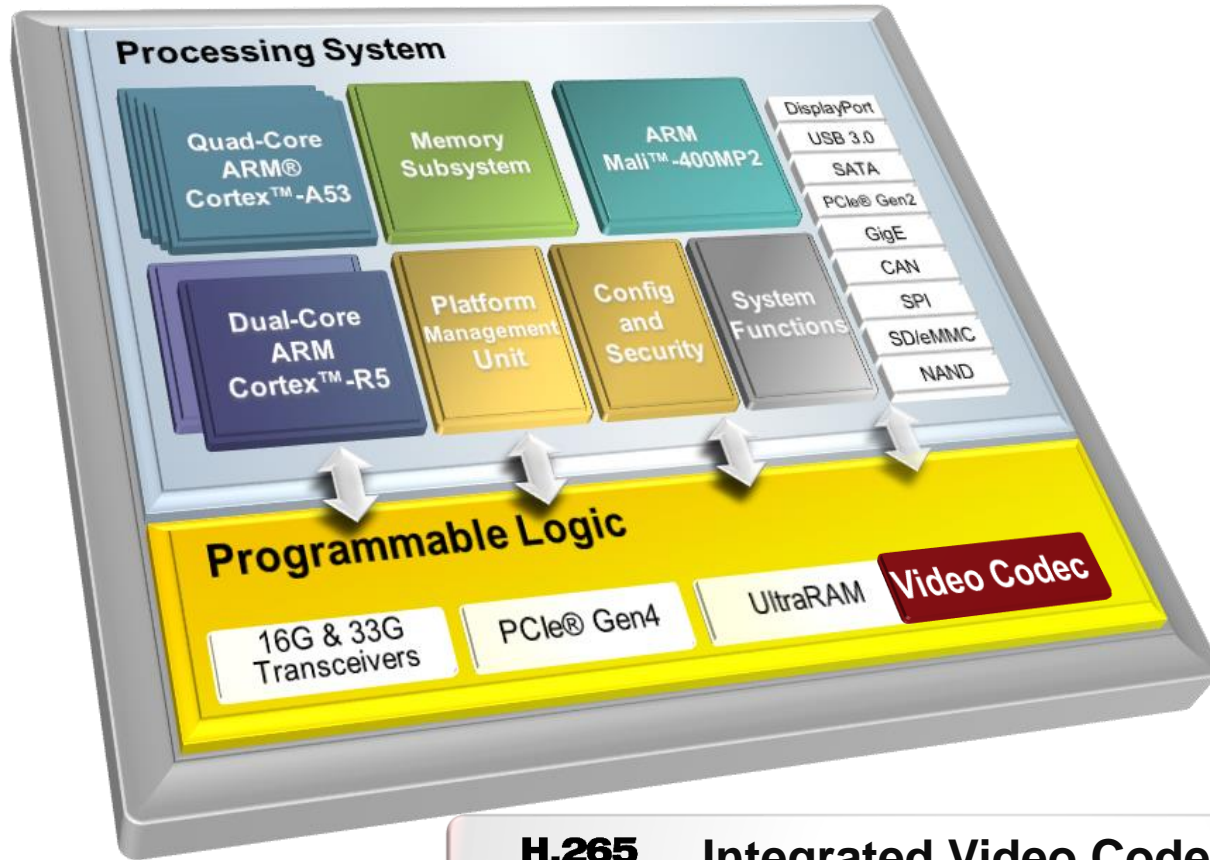# Agenda

> Zynq Ultrascale+ MPSoC and Multimedia blocks

> Software overview

> Multimedia Framework

> Target Reference design

> Platforms

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Multimedia Blocks

Zynq® UltraScale+™ MPSoC EV Devices

Next-Generation SoC with Integrated Video Codec

Processing System

- Quad-Core ARM® Cortex™-A53
- Memory Subsystem
- ARM Mali™-400MP2
- DisplayPort
- USB 3.0
- SATA
- PCIe® Gen2
- GigE
- CAN
- SPI
- SD/eMMC
- NAND
- Dual-Core ARM Cortex™-R5
- Platform Management Unit
- Config and Security
- System Functions

Programmable Logic

- 16G & 33G Transceivers
- PCIe® Gen4
- UltraRAM
- Video Codec

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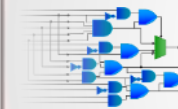- 64-bit Quad-core A53
- Up to 1.5GHz

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
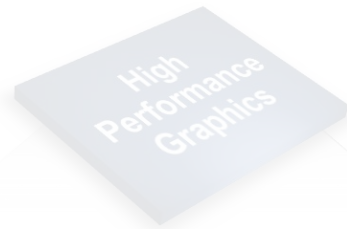- Processor Offloading

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
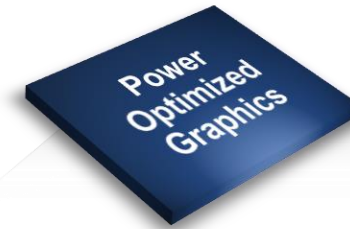
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Different classes of Graphics Processing unit

ZYNQ
UltraSCALE+

Power Optimized Graphics

High Performance Graphics

General Purpose GPU

Gaming, 3D Vision, & 4K Display

Data Center Acceleration and High Performance Computing

Embedded Graphics

GPU

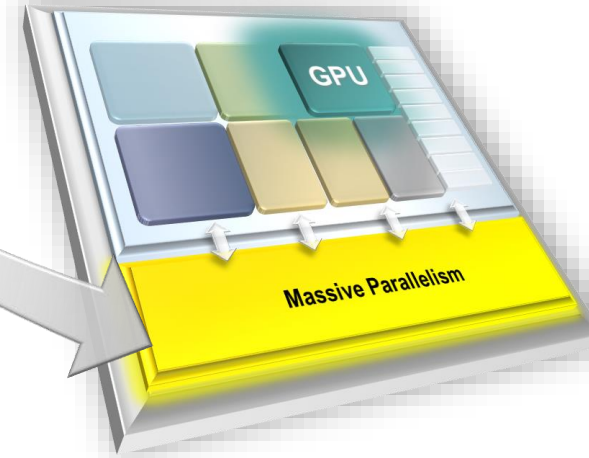Hardware Acceleration

Massive Parallelism
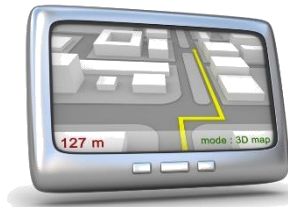
✓ **Power-Optimized GPU for Embedded Graphics**

✓ **Programmable Logic for Accelerated Compute**

OpenCL

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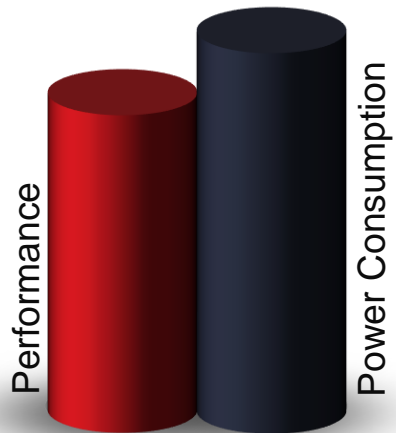## ARM Mali-400 MP2

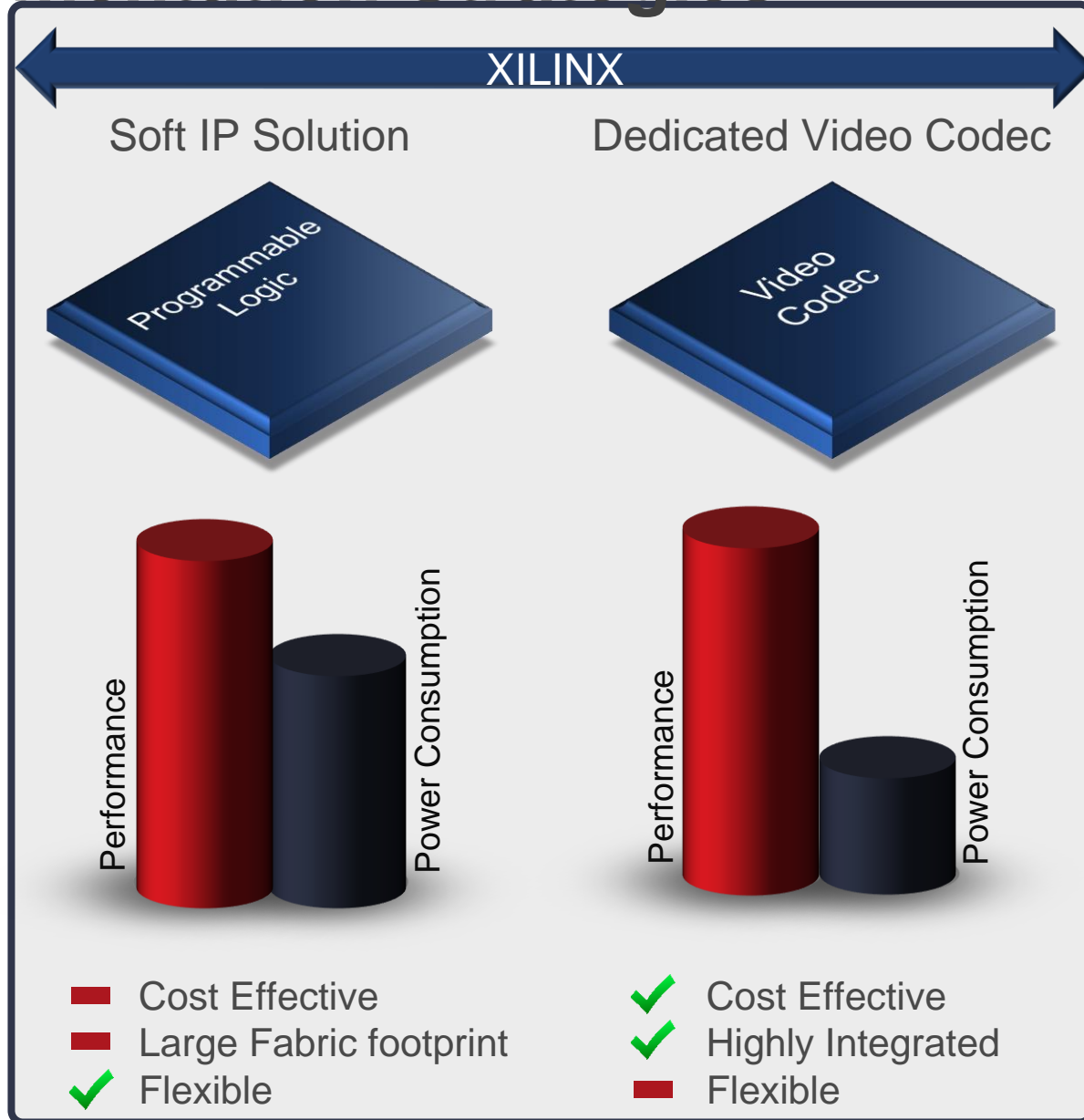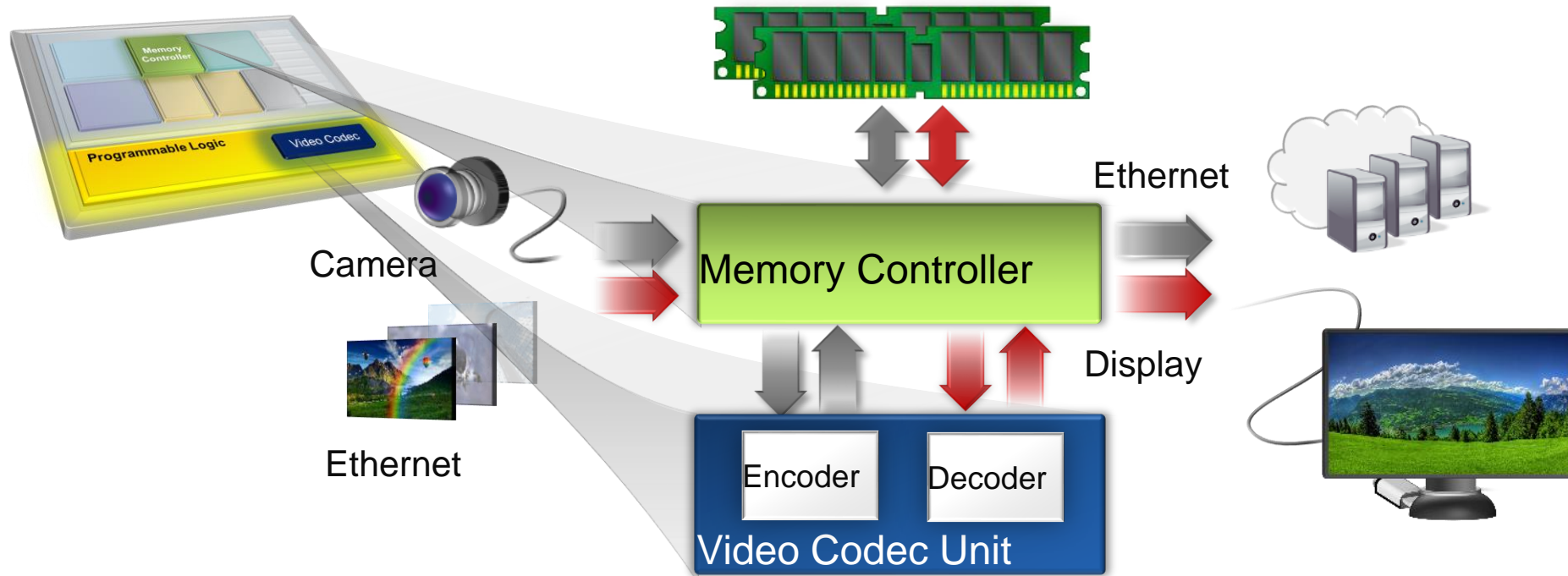| Feature	Benefit
ARM Mali™-400 MP2 up to 667MHz	• Most power-optimized ARM GPU with Full HD support (1080p) • Ideal for 2D vector graphics and 3D graphics (e.g., HMI, waveform processing) • Supports open standards, e.g., OpenGL ES 1.1 & 2.0
Native Embedded Linux Support	Out-of-the-box drivers and libraries 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
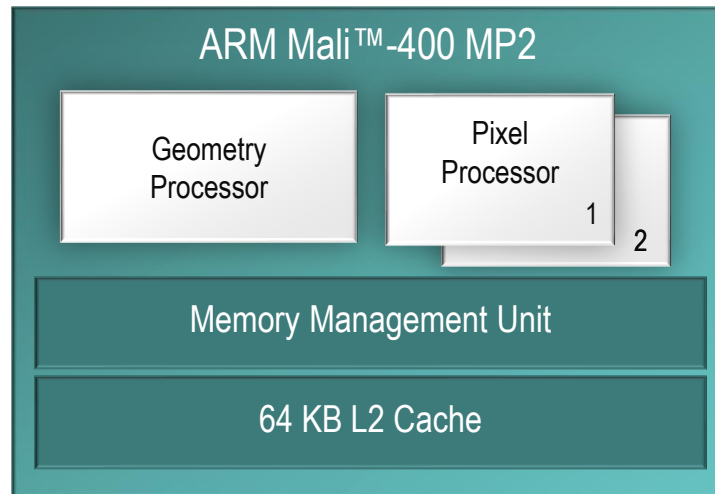
Full HD (1920x1080) GLmark2 Benchmark

ARM Mali™-400 MP2

Geometry Processor

Pixel Processor
1
2

Memory Management Unit

64 KB L2 Cache

GPU

APU

Similar Power

50x

Performance (fps)   Power (mW)

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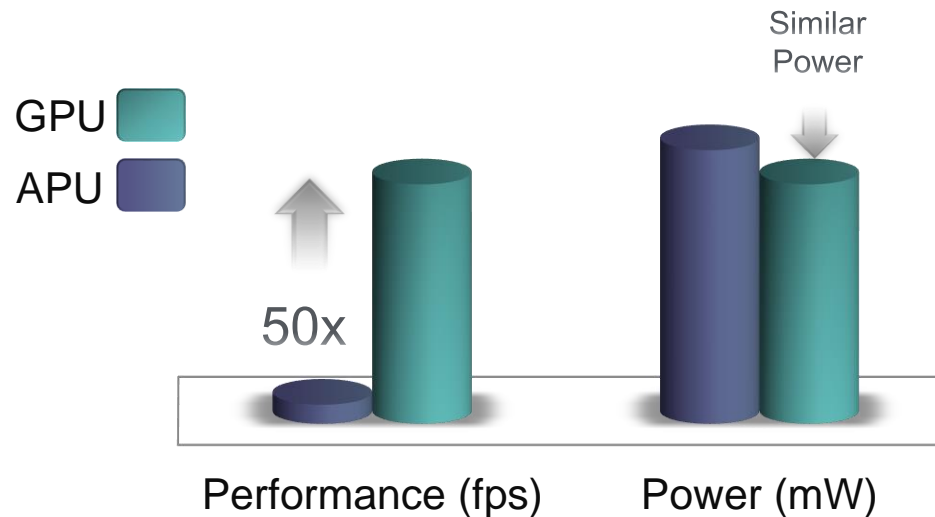
Video Codec Implementation Strategies

Software Solution

Server Class CPU / Cloud Based

Performance | Power Consumption

- Cost Effective
- Physically Large
- Flexible

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Soft IP Solution

Programmable Logic

Performance | Power Consumption

- Cost Effective
- Large Fabric footprint
- Flexible

Dedicated Video Codec

Video Codec

Performance | Power Consumption

- Cost Effective
- Highly Integrated
- Flexible

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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

Camera

Ethernet

Memory Controller

Ethernet

Display

Video Codec Unit

Encoder

Decoder

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DisplayPort

Architecture Overview

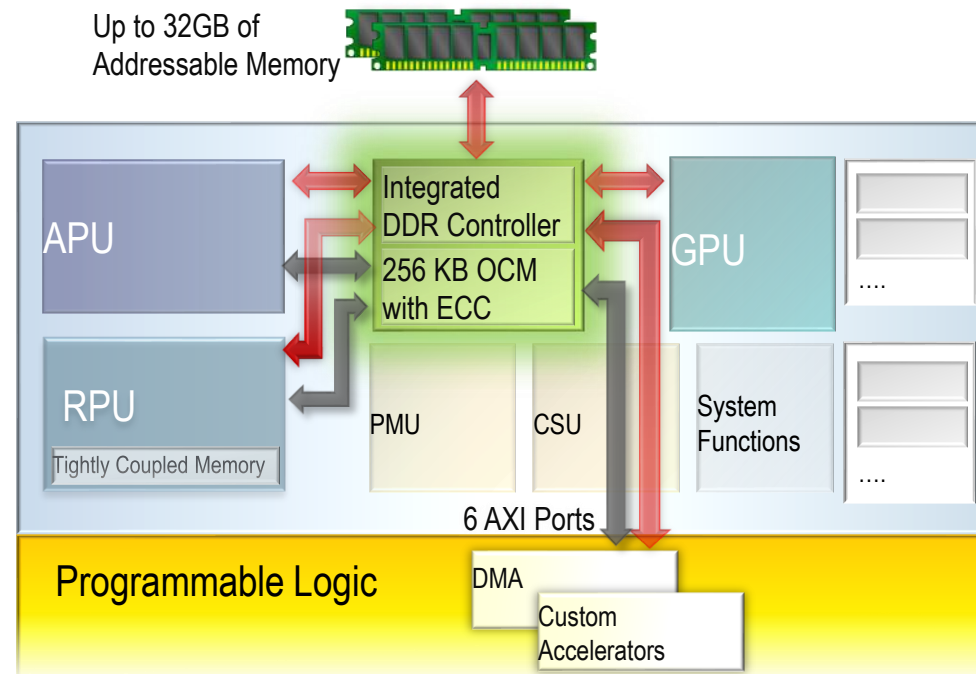| Feature	Benefit
Video Resolution	Upto 4kp30 Hz
Audio Support	2 Channel of 24 bit Audio upto 96 KHz
Multiple channel	Once channel of Graphics and Video
Features	• Chroma Keying • Alpha Blending • Live and Non-live video

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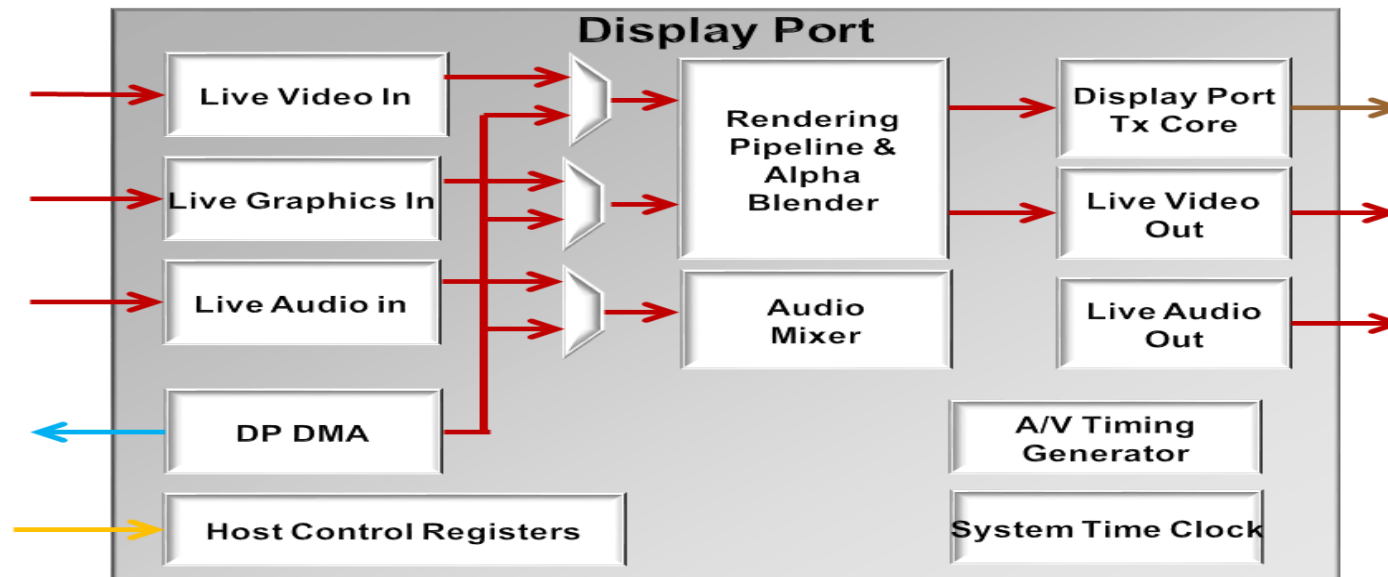
Memory Subsystem

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

Up to 32GB of Addressable Memory

APU

Integrated DDR Controller

256 KB OCM with ECC

GPU

RPU

Tightly Coupled Memory

PMU

CSU

System Functions

....

6 AXI Ports

Programmable Logic

DMA

Custom Accelerators

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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

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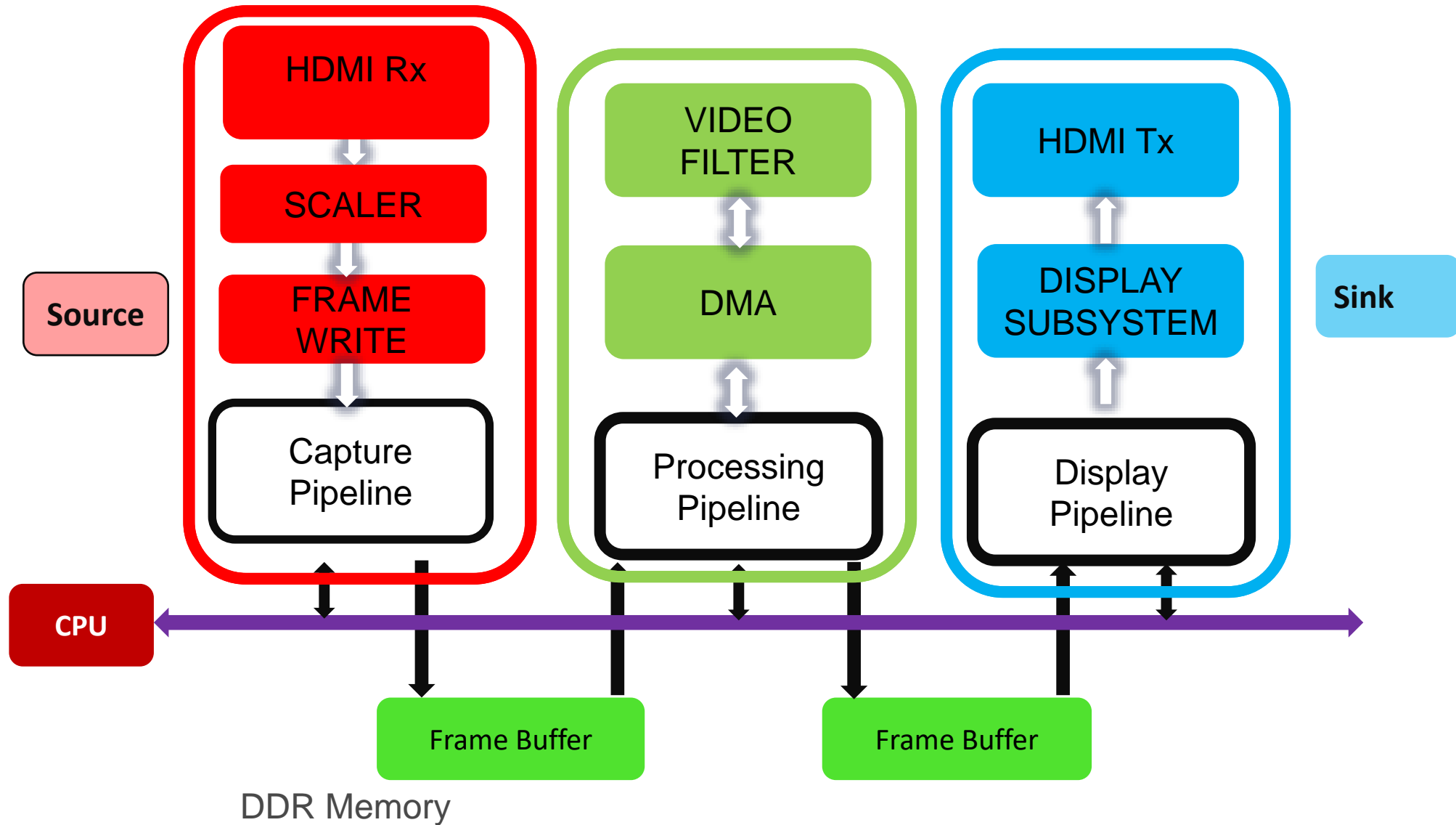
Video Support in Linux

Different solutions, provided by different subsystems:

>>**FBDEV: Framebuffer Device**

>>**DRM/KMS: Direct Rendering Manager / Kernel Mode Setting**

>>**V4L2: Video For Linux 2**
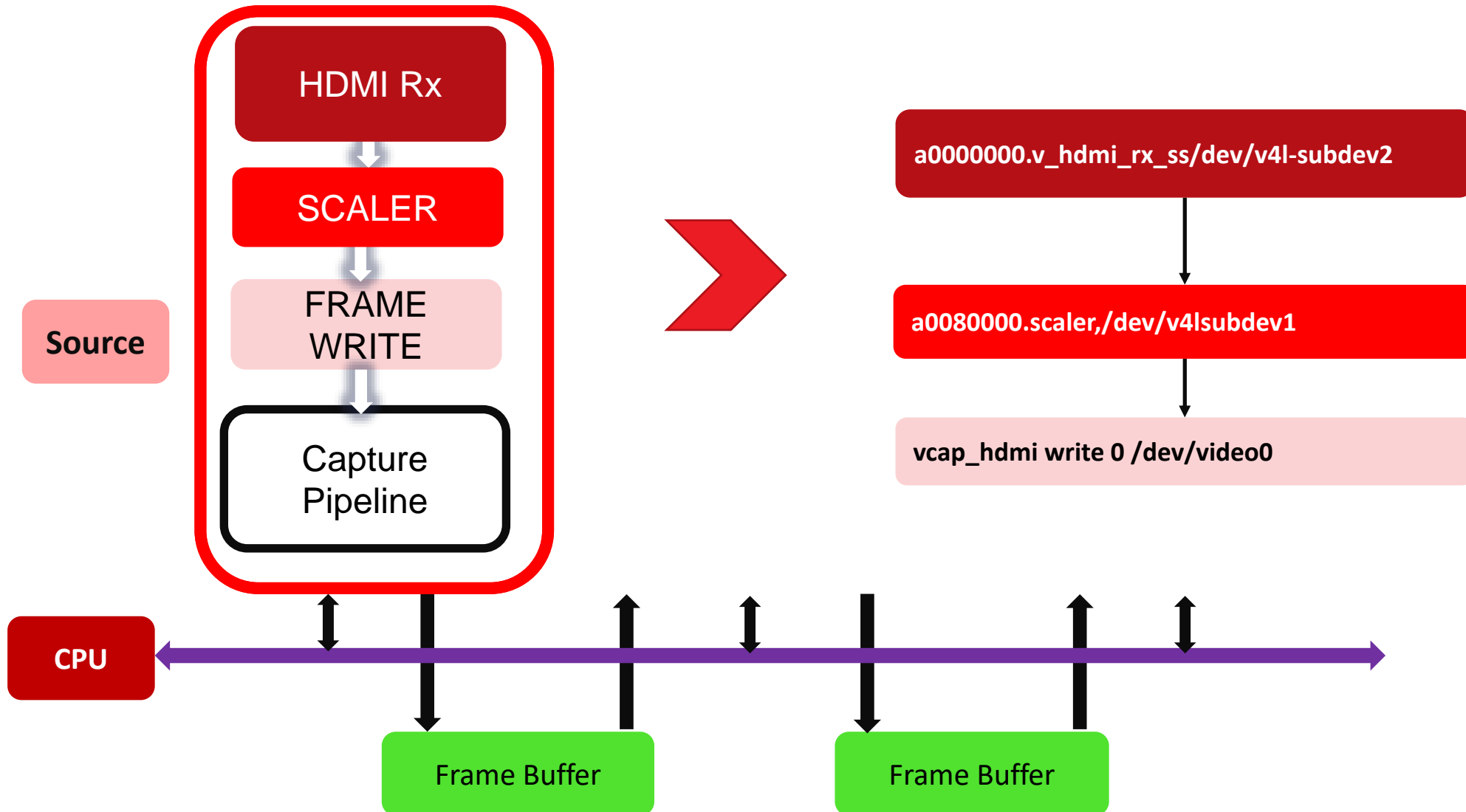
How to choose one: it depends on your needs

– **Each subsystem provides its own set of features**

– **Different levels of complexity**

– **Different levels of activity**

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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**

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HDMI Rx

SCALER

FRAME WRITE

Source

Capture Pipeline

a0000000.v_hdmi_rx_ss/dev/v4l-subdev2

a0080000.scaler,/dev/v4lsubdev1

vcap_hdmi write 0 /dev/video0

CPU

Frame Buffer

Frame Buffer

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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)

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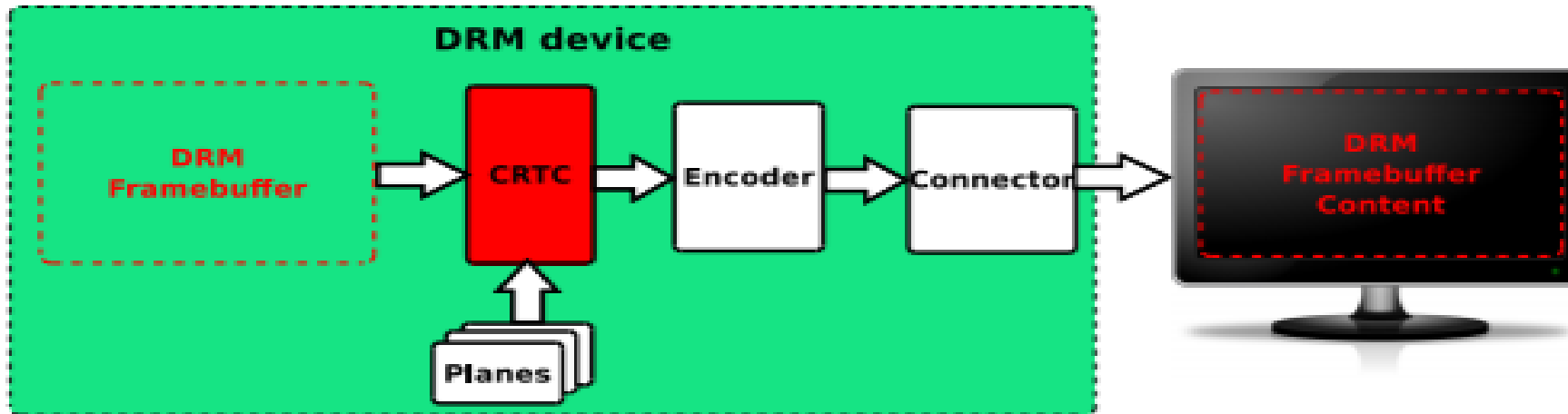
Top View of Display Pipeline

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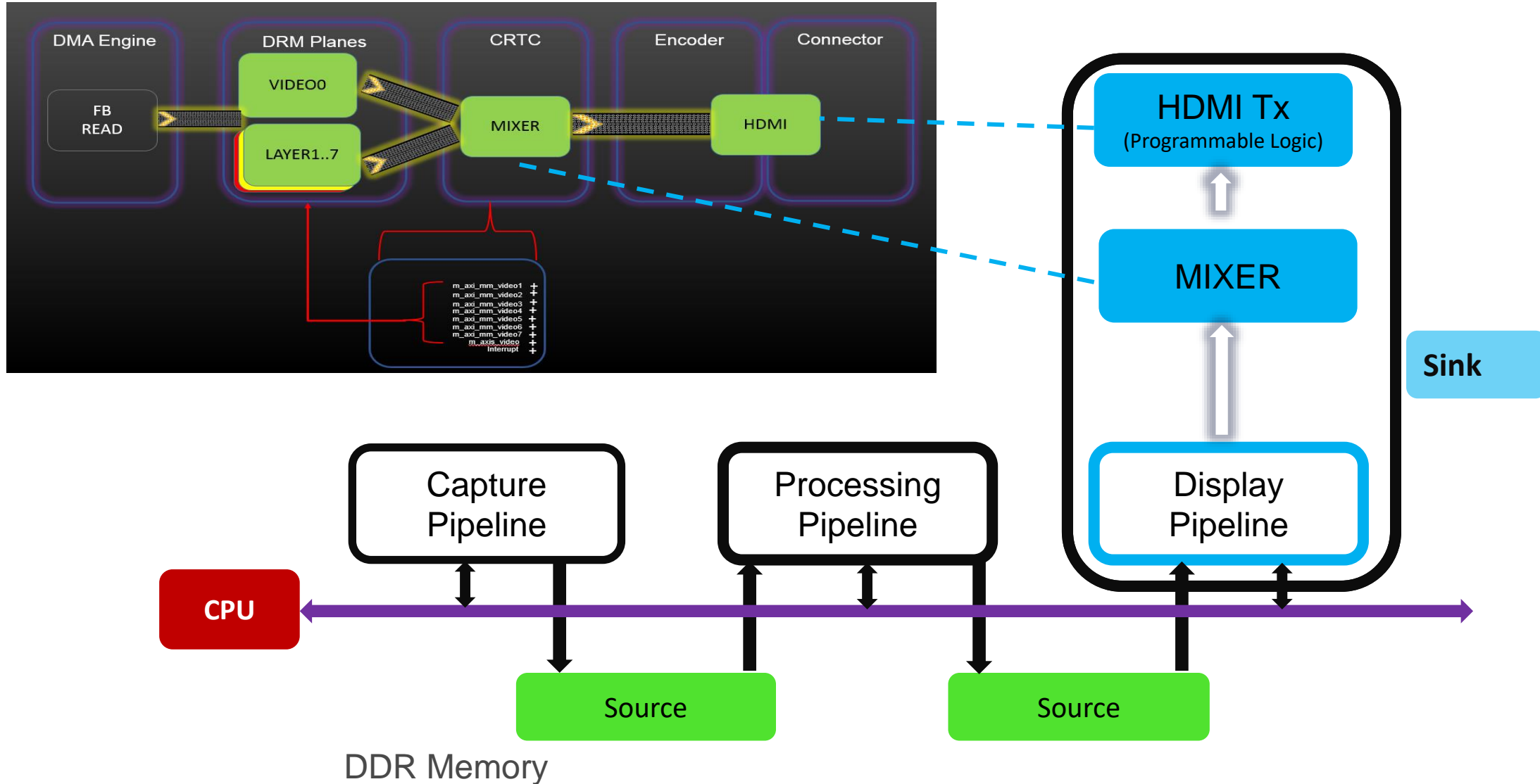
Graphics Software Stack
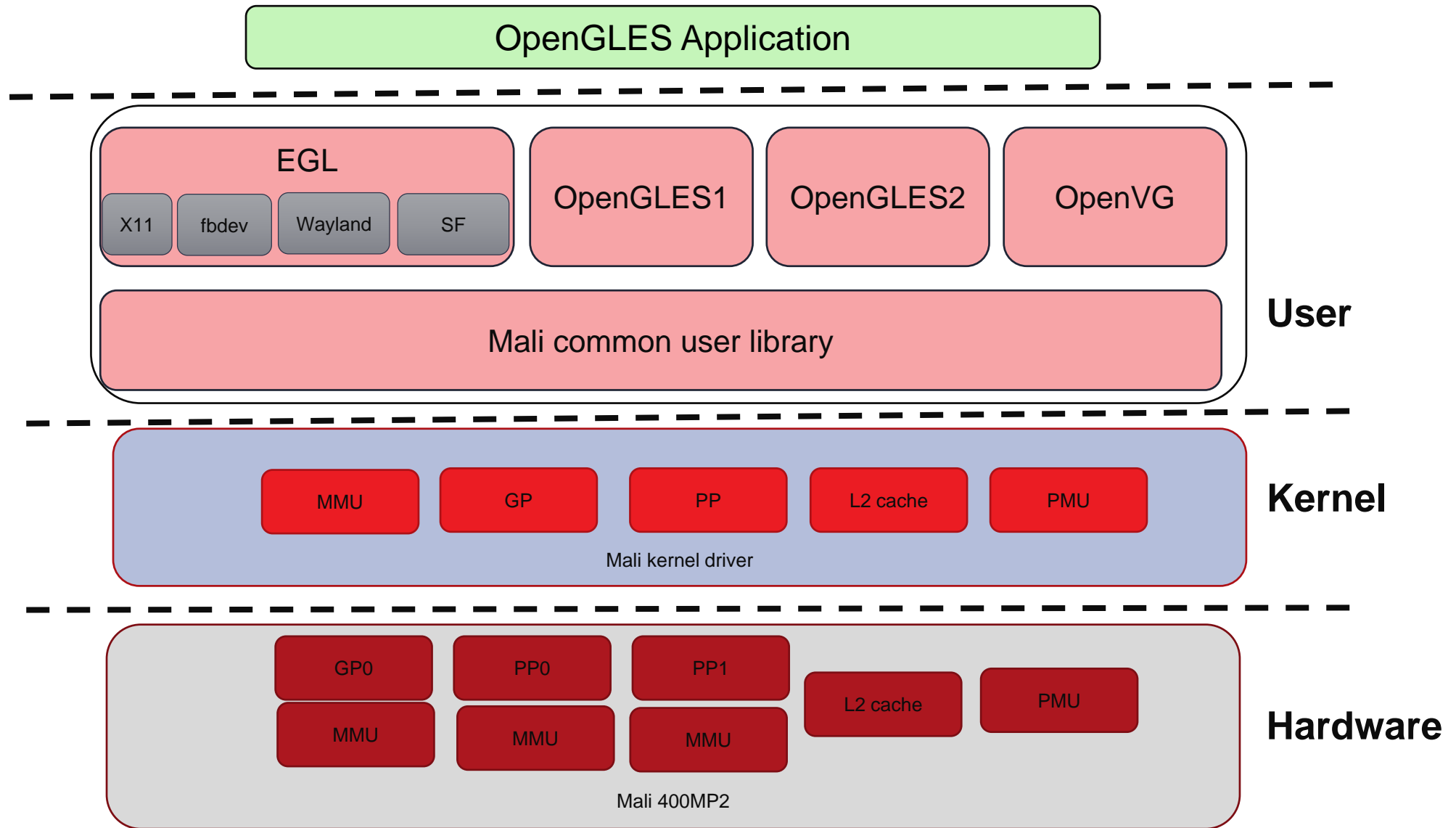
VCU Software Stack

> 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

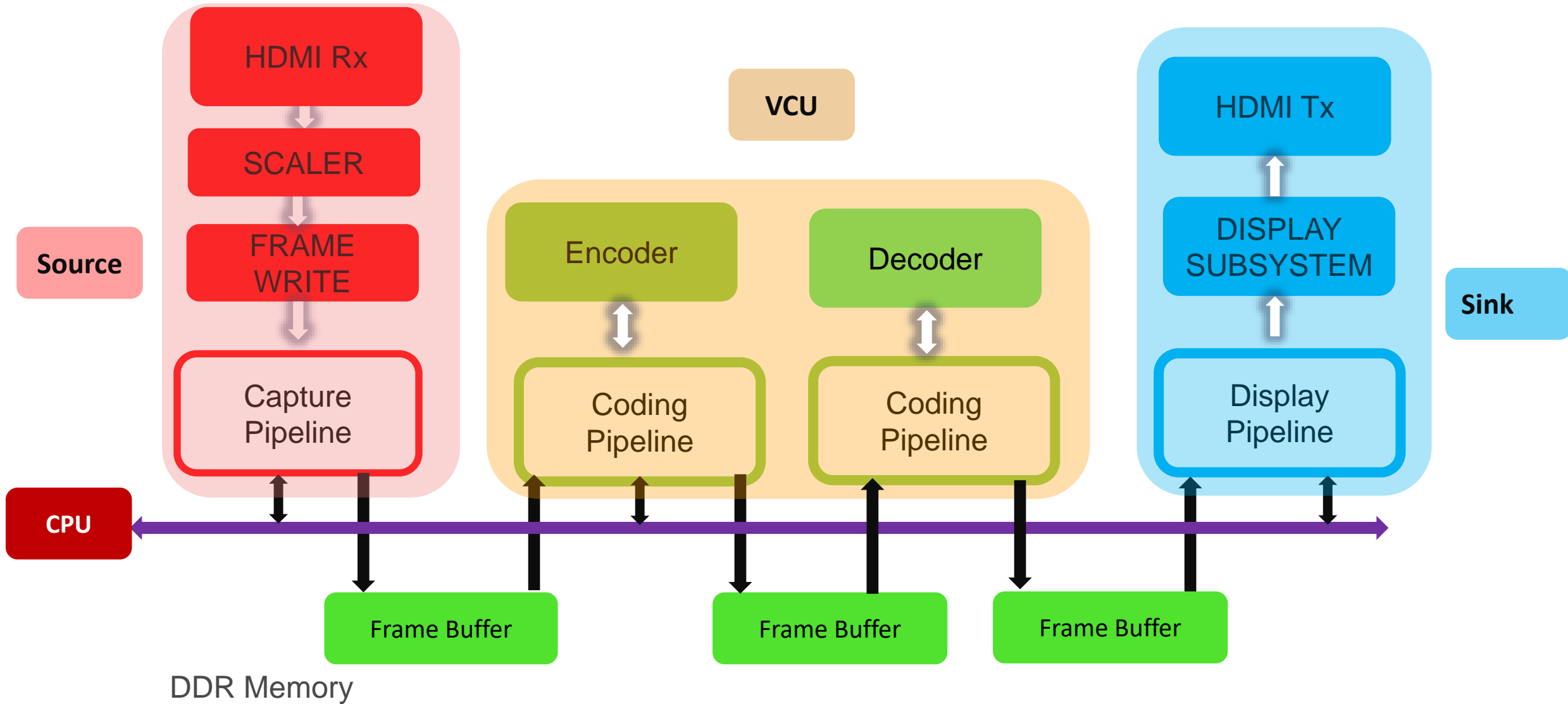> Zynq® UltraScale+™ EV devices are true solution-level products from Xilinx
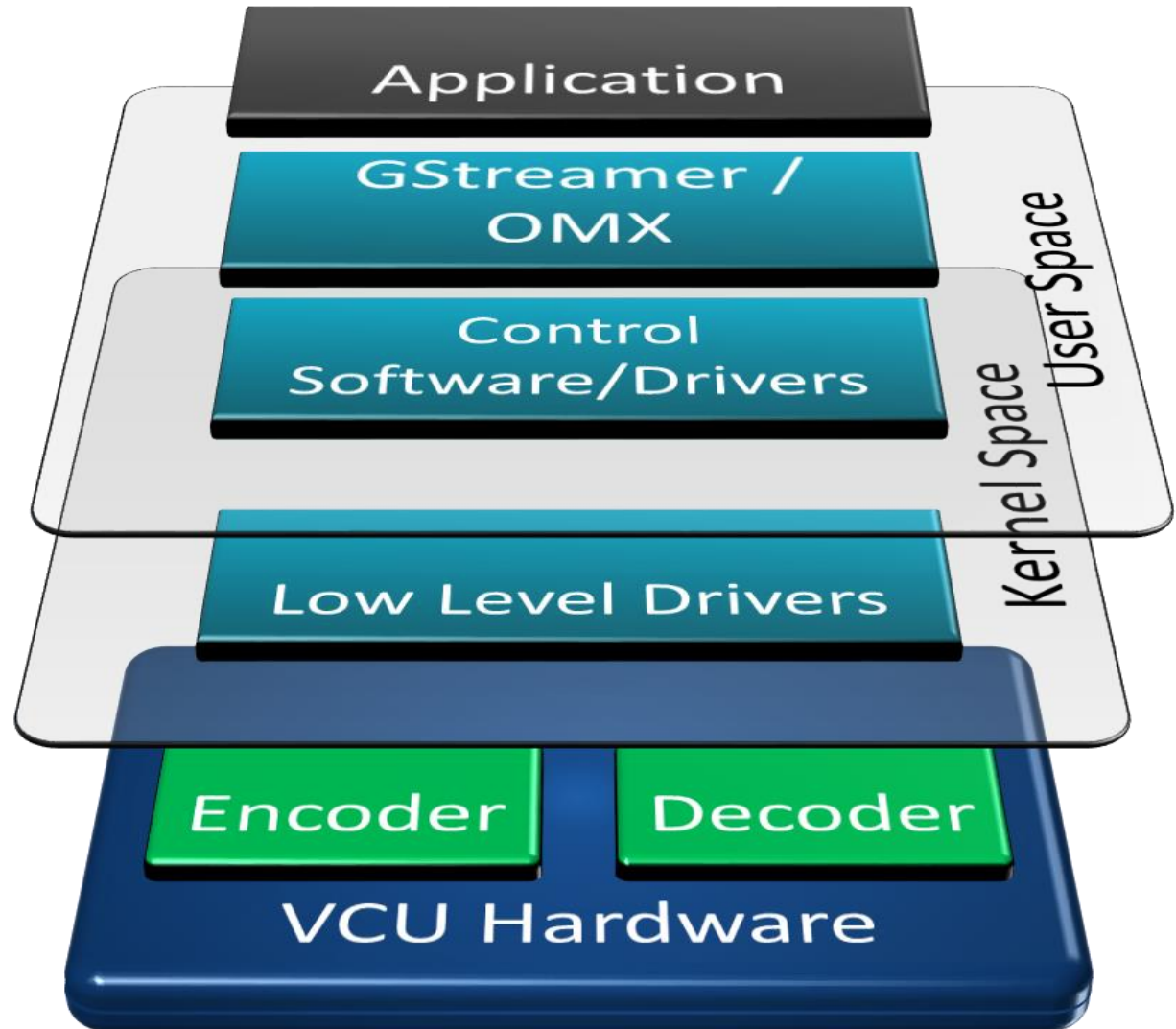
ALSA Framework
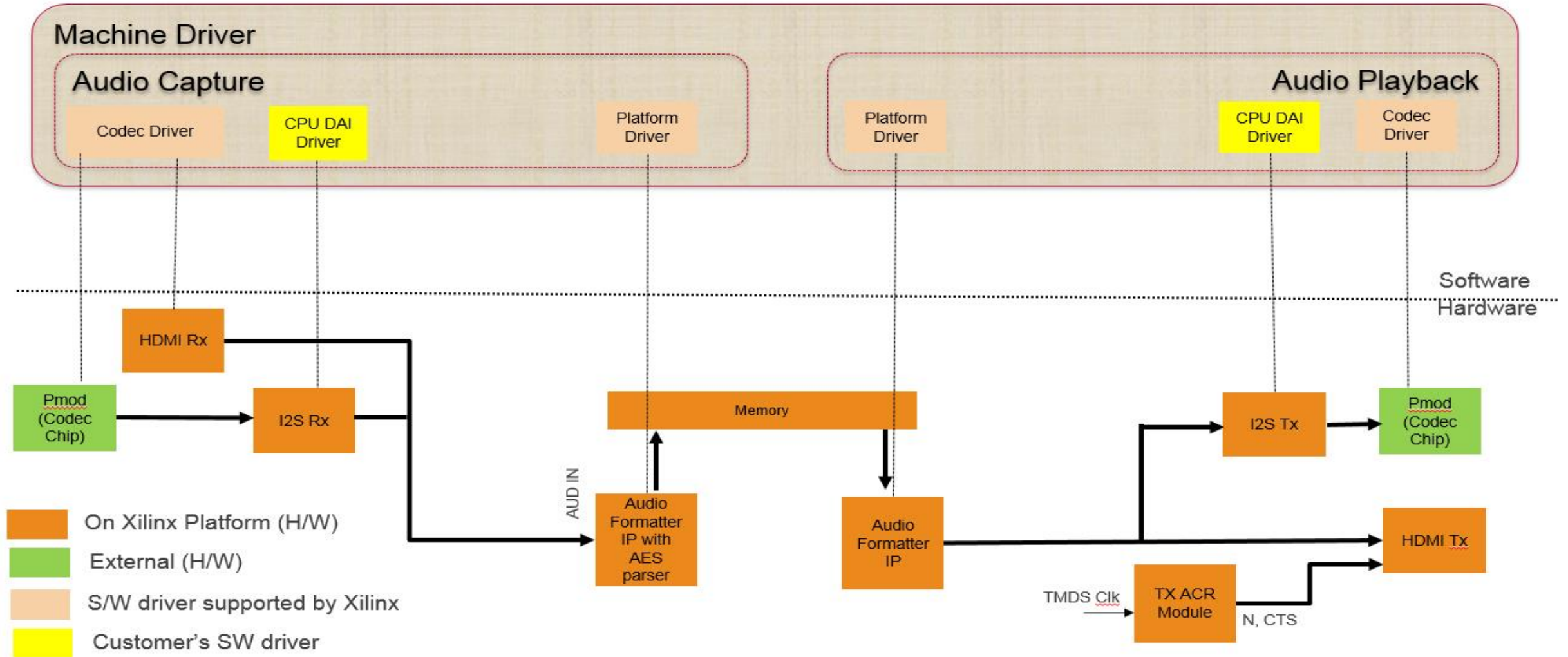
Multimedia Solution
Gstreamer Framework

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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***

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Why Gstreamer Framework?

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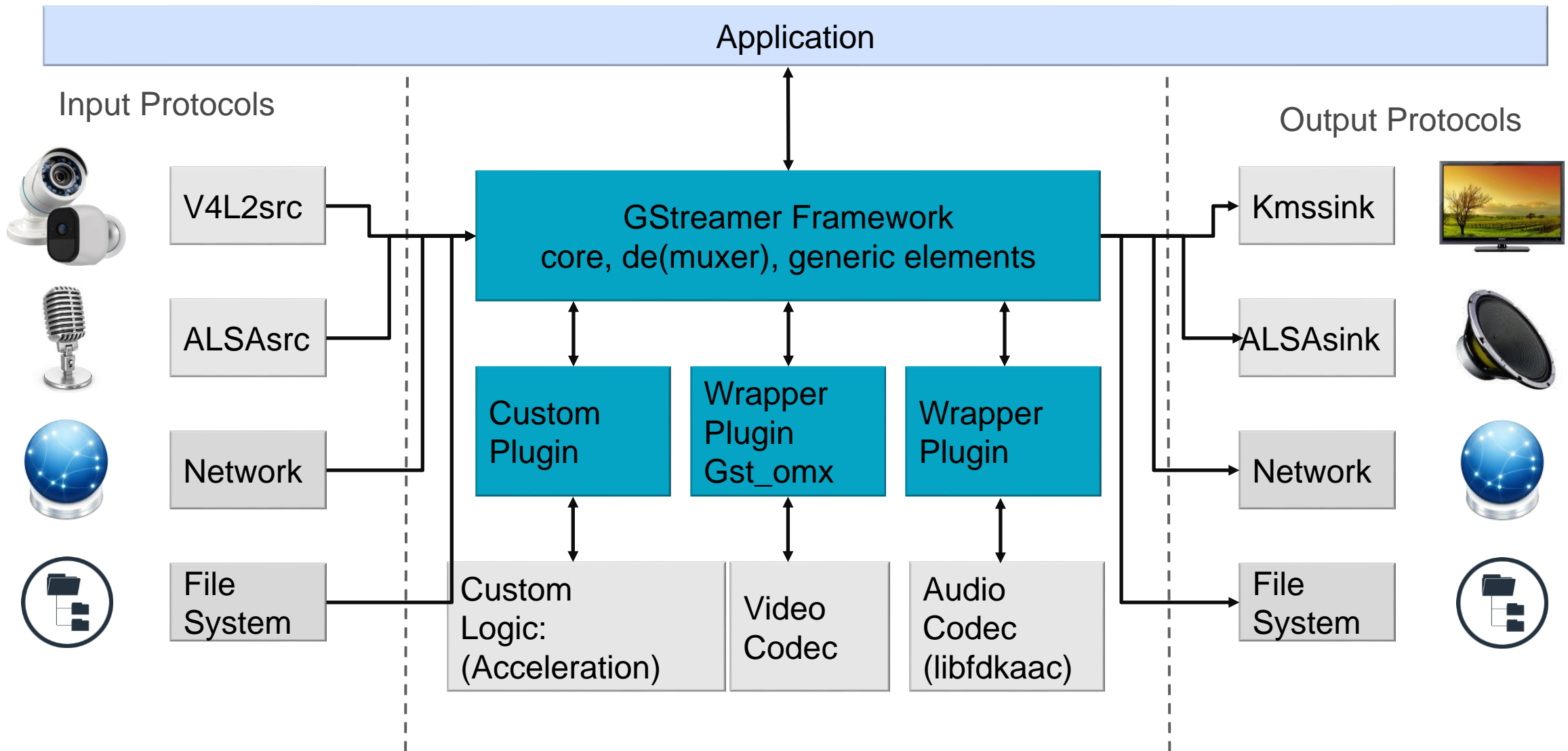>> Inconsistent APIs among different codecs, Libraries and devices

> **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**

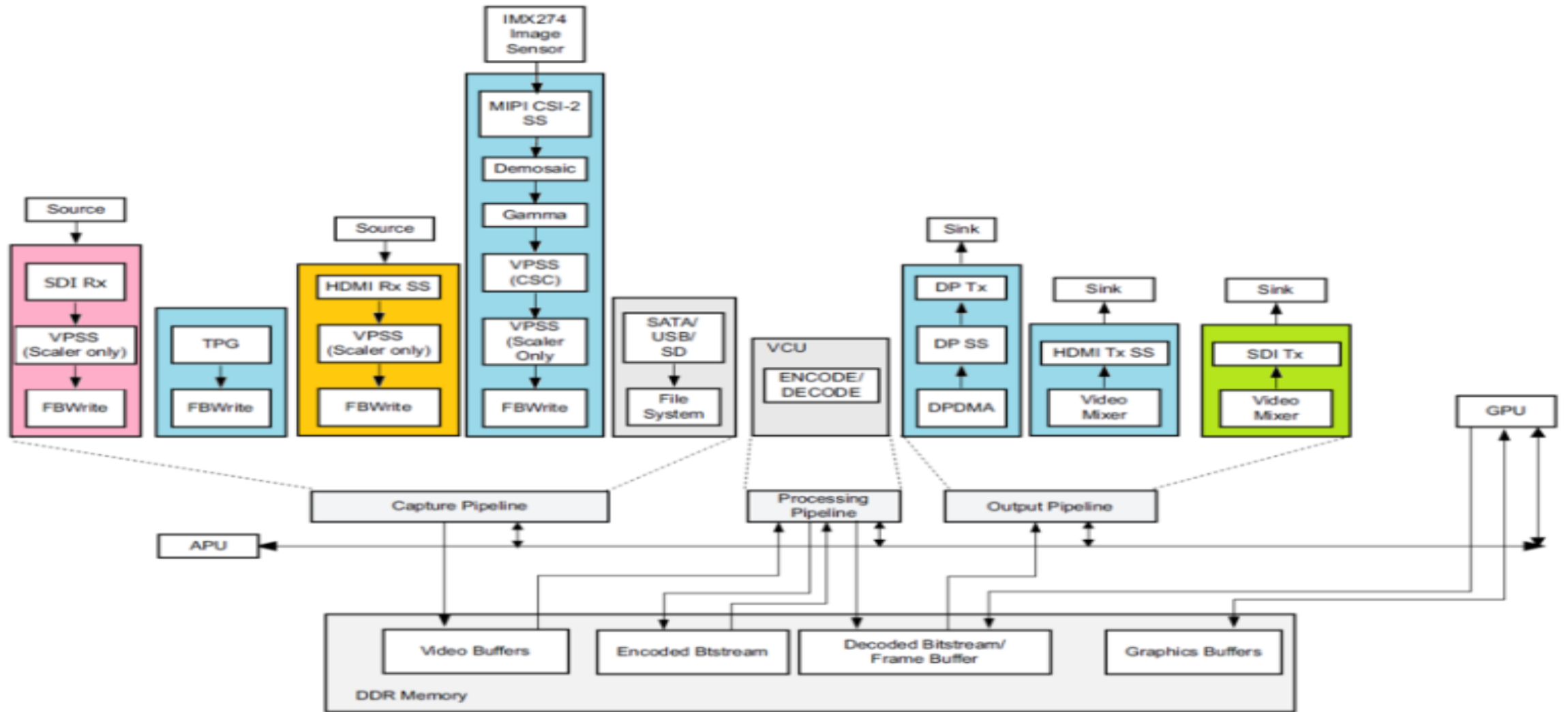> **Fundamentally the reason is to leverage the huge amount of work – aka "re-use"**
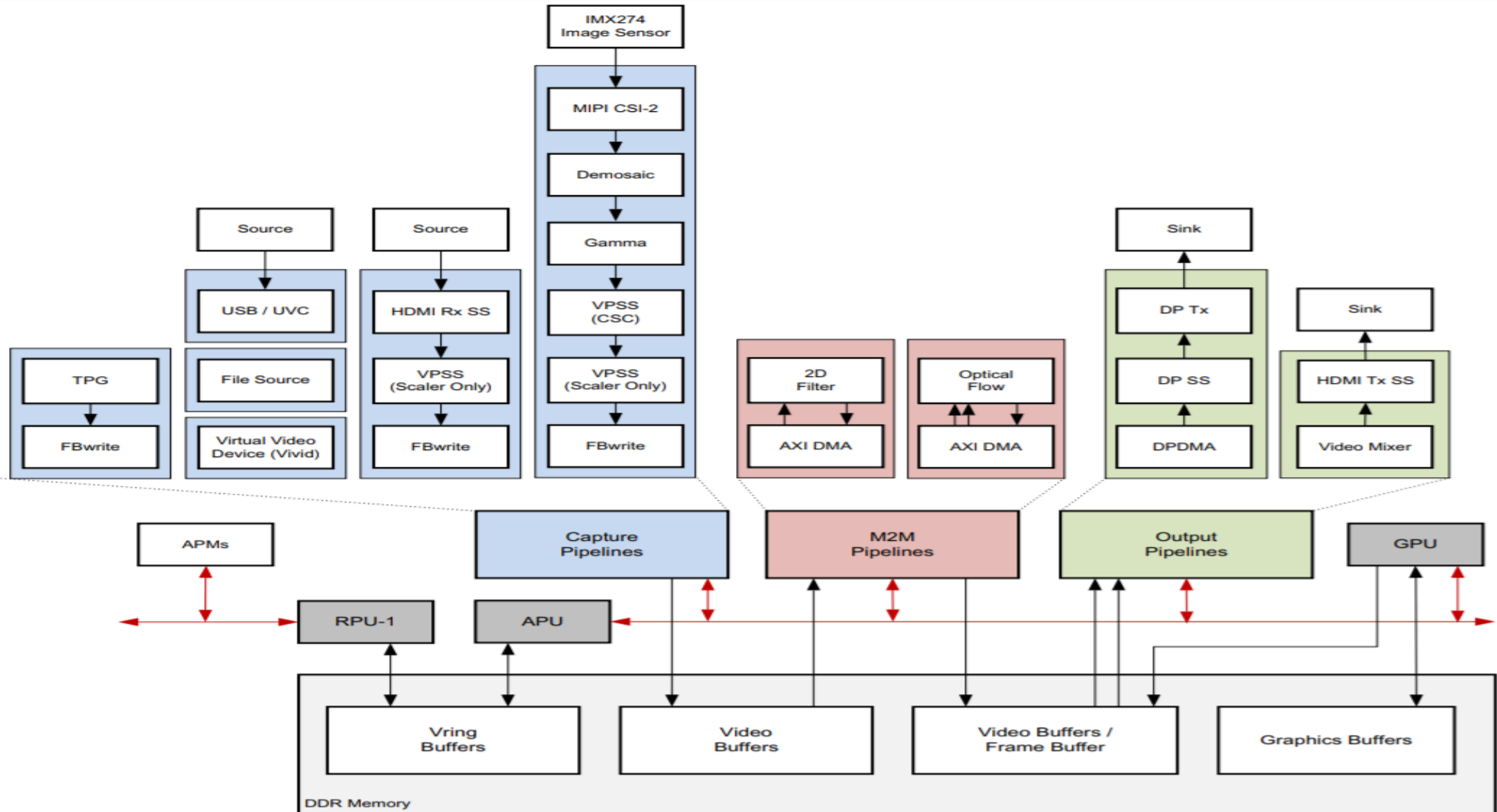
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GStreamer Framework

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Target Reference Designs

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VCU TRD on the ZCU106 Board

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ZCU102 base TRD

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Platform for acceleration

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Platform-Based Development

Platform
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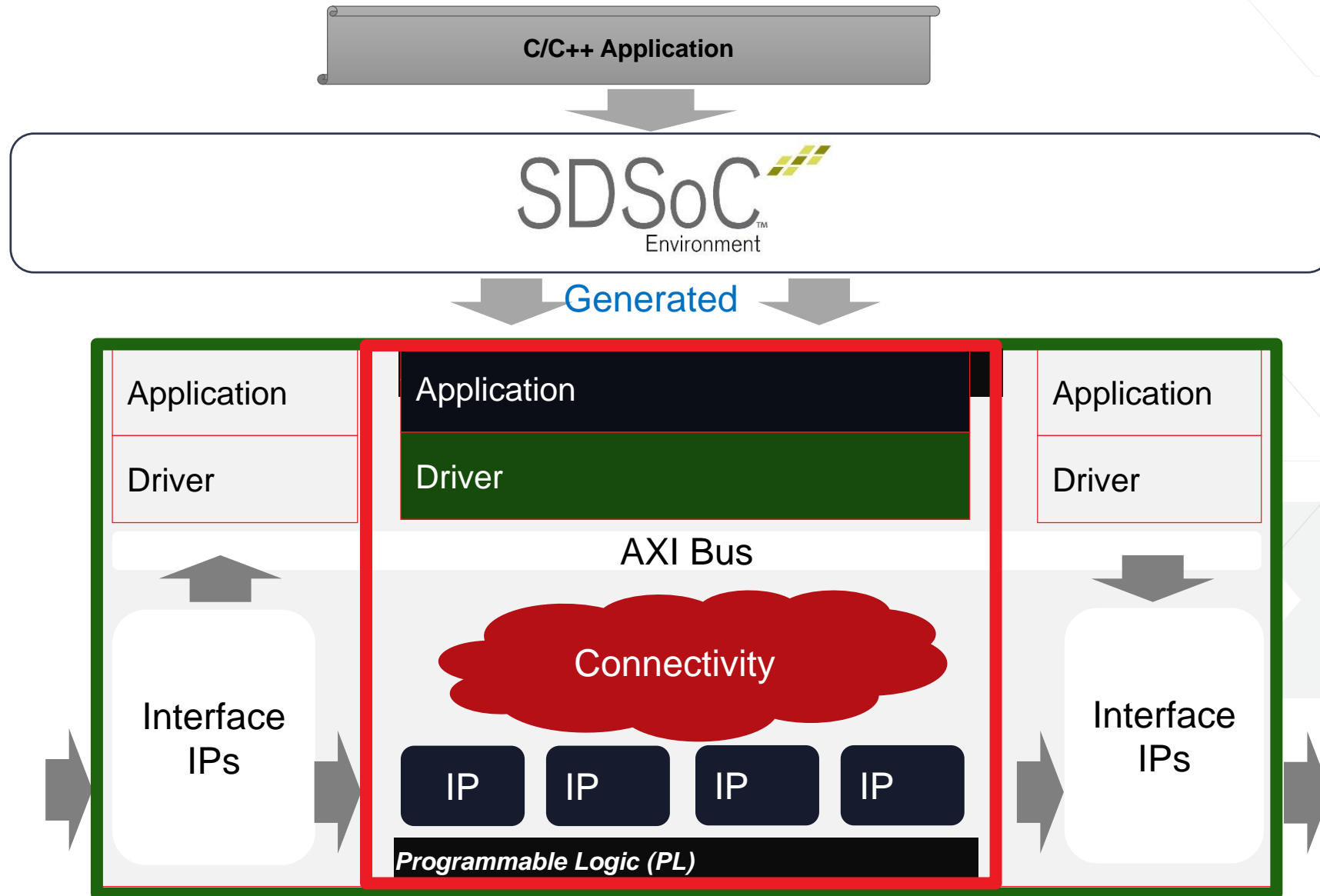
# reVISION Platforms: Single sensor platform
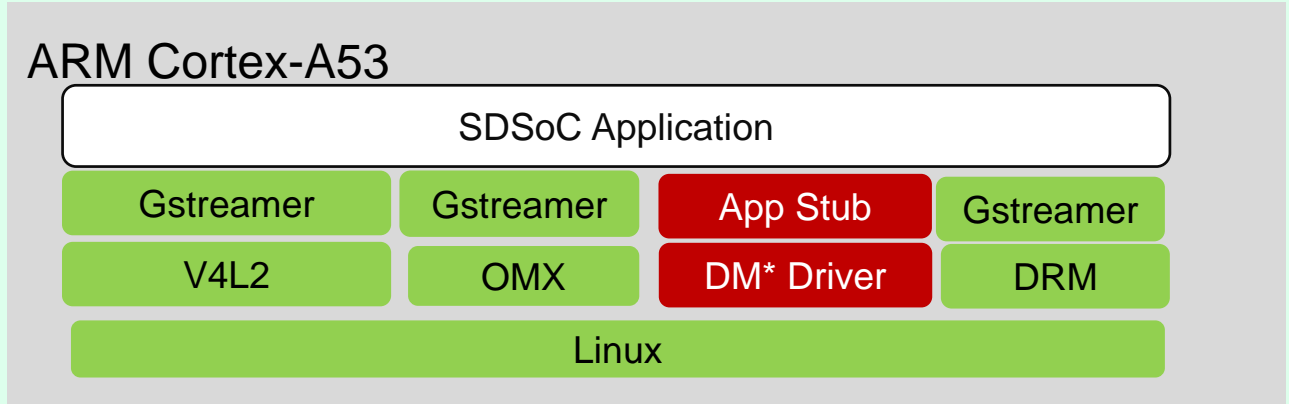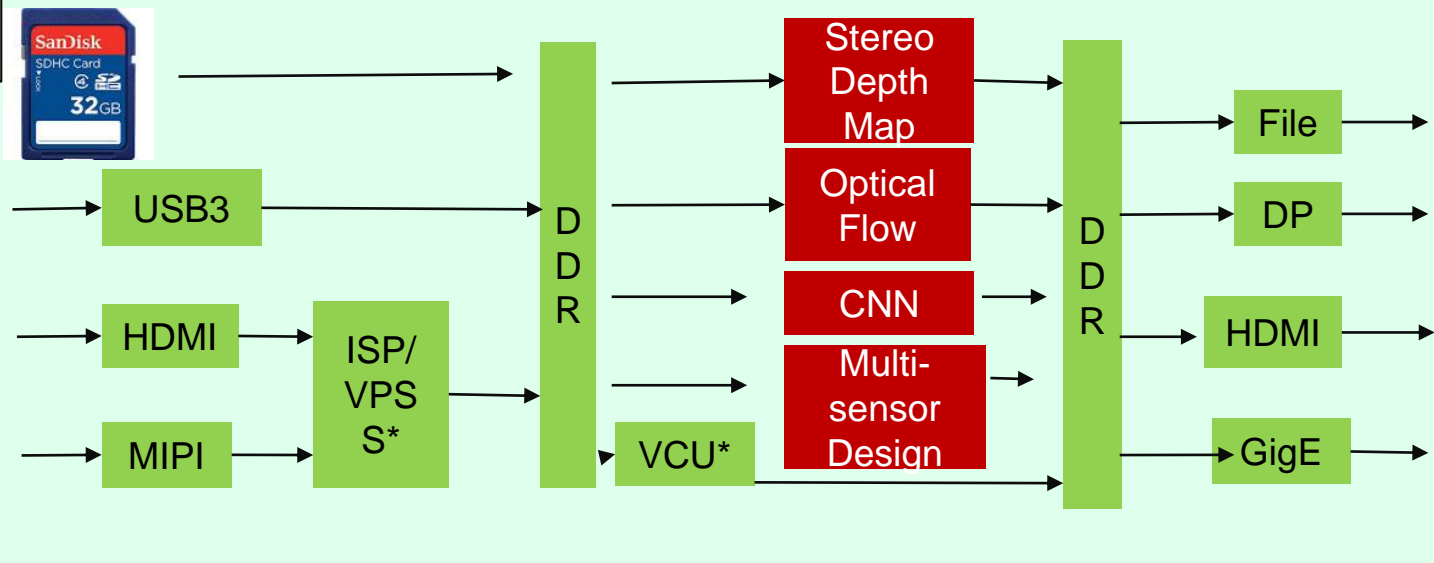
> **Platform Support for Zynq US+ Boards: ZCU102 and ZCU104**

> **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

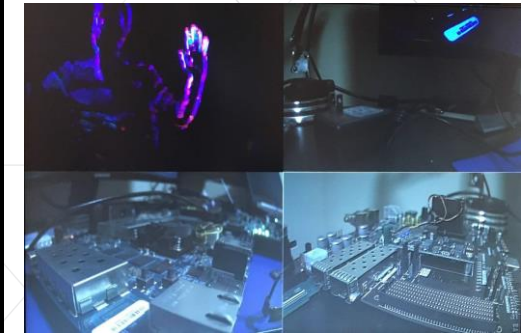# reVISION Platforms: Multi-camera Imaging and Analytics

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
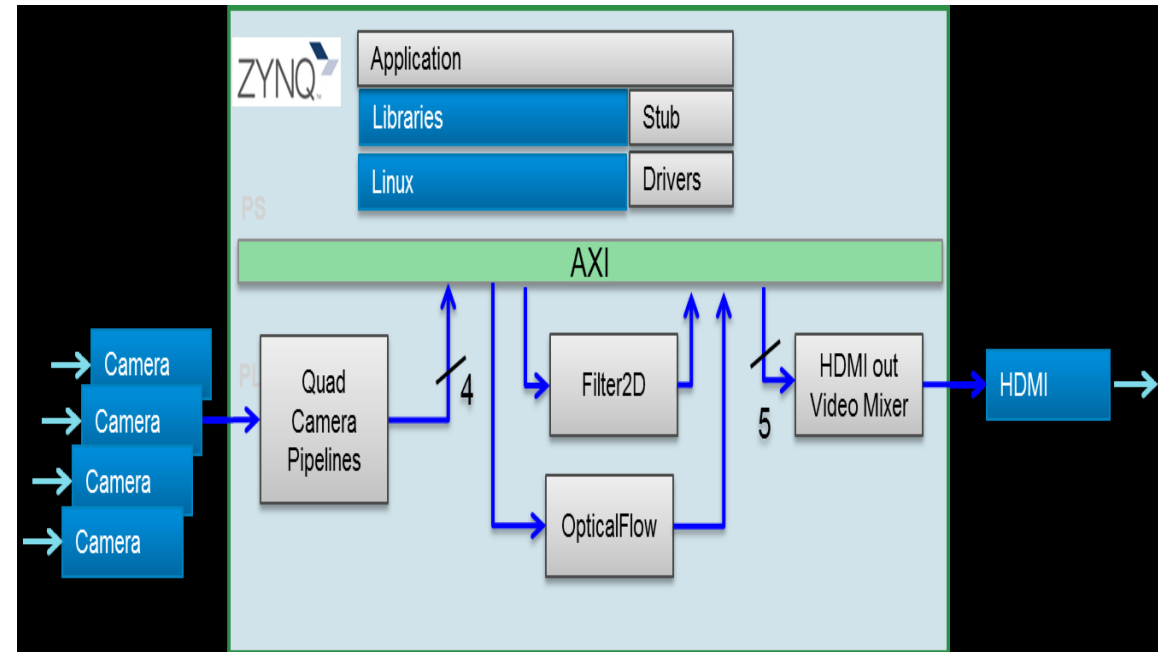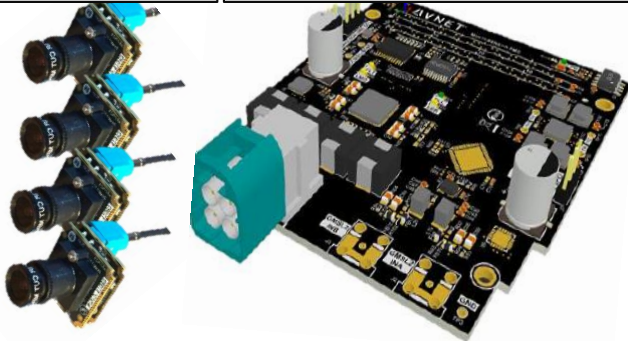
Optical Flow

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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