



AI and computer vision accelerated camera development system

Presented By

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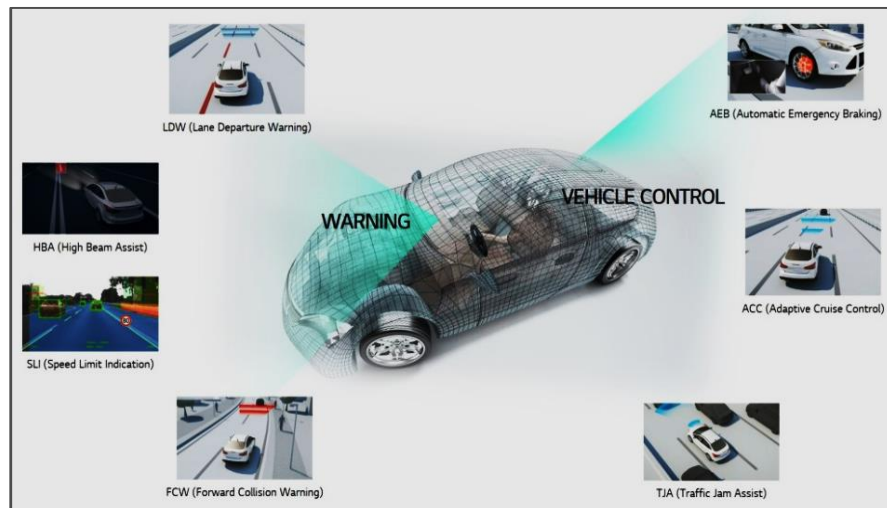
Market Segment Manager for Artificial Intelligence / Machine Learning / Vision

December 10, 2018



Multi-camera applications

- Advanced Driver Assistance System (ADAS) / Automotive
- Autonomous Guided Vehicles (AGV)
- Machine vision / Smart industries
- Video surveillance and smart camera's / Smart cities
- Drones / Unmanned Aerial Vehicles (UAV)
- Video analytics

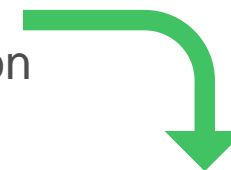


Challenges for high-resolution multi-camera solutions

- ✓ Higher resolution -> more details of objects, also from further distance
- ✓ Higher framerates (FPS*) -> lower latency = faster detection

	Resolution		FPS*	Megapixels/sec	
1Mp/720p					
	1280	720	30	28	Reference
8Mp					
	3840	2160	60	498	18x increase
4x2Mp + 2x8Mp					
	1920	1080	30	62	
	1920	1080	30	62	
	1920	1080	30	62	
	1920	1080	30	62	
	3840	2160	60	498	
	3840	2160	60	498	
				1.244	45x increase

* FPS = Frames Per Second



Require

More processing capabilities

Better algorithm performance

Requirements of a multi-camera solution for autonomous applications

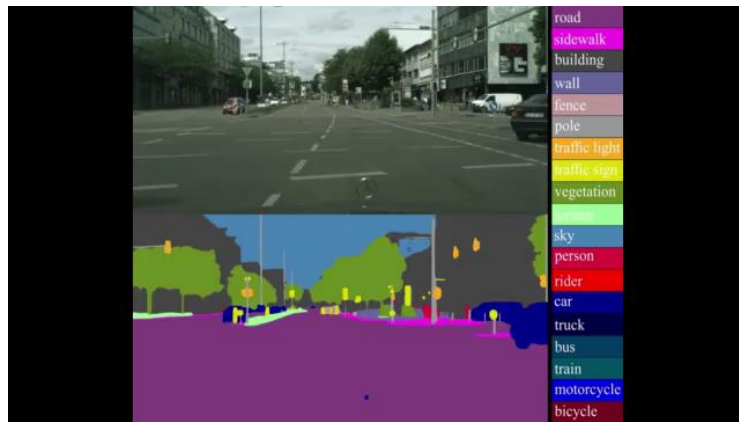
- High data rate
- Low latency - real-time execution / fast reaction time
- Low power consumption
- Reliability and safety
- Flexibility
- Intensive computer vision and machine learning (deep learning)



Lane and car detection



Sign recognition



Paper: "Pyramid Scene Parsing Network"
<https://arxiv.org/pdf/1612.01105.pdf>

System Overview – Hardware Architecture

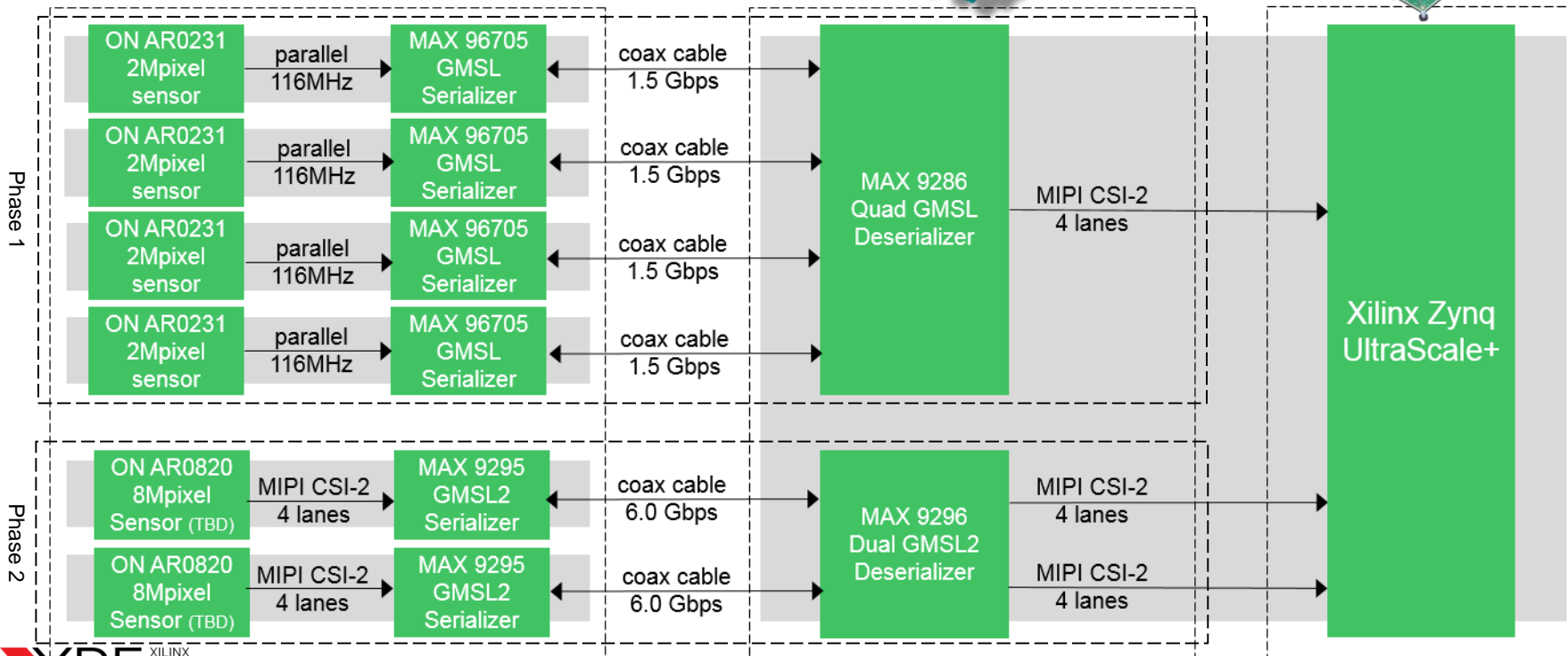
Camera modules



Multi-Camera FMC module

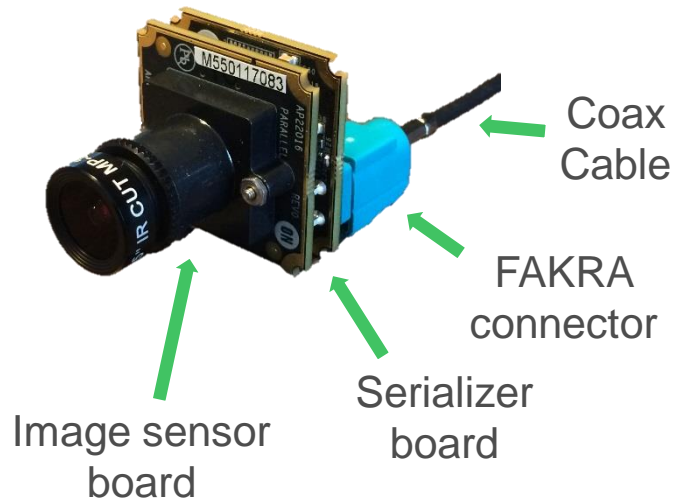


Carrier card



MARS - Modular Automotive Reference System

<https://www.onsemi.com/site/pdf/FLR0105.rev0.pdf>

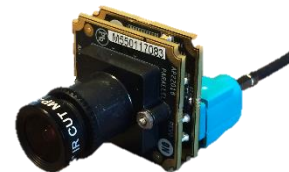


- 2Mp camera module
 - AR0231AT 2.3 Mp 1/2.7" CMOS image sensor
 - MAX96705 GMSL Serializer
- 8Mp camera module (TBD)
 - AR0820AT 8.3Mp 1/2-inch CMOS image sensor
 - MAX9295 GMSL2 Serializer

- Optimized for low light and high dynamic range scene performance
- Optimized for long range setup up to several meters

Camera Modules

MARS - Modular Automotive Reference System



1) Image Sensor Board


- ON Semiconductor AR0231AT Image Sensor 
- 2.3Mpixel (1920x1200 pixels)
- 1/2.7" optical size, M12 lens
- Automotive grade Back Side Illumination (BSI) pixel
- High-dynamic range (4-exposure HDR, 120dB)
- LED Flicker Mitigation (LFM)



Non-HDR

HDR activated

2) Serializer Board

- MAXIM Integrated MAX96705 Serializer  maxim integrated
- 1.5 Gbps data-rate (1080P30)
- Low-cost coax cable, up to ~15m



Without LFM

With LFM

Avnet Multi-Camera FMC Modules

- FMC LPC

- MAXIM GSML deserializers
 - Support for ON Semiconductor image sensors
- Automotive industry standard FAKRA connectors (HFM)
 - Low cost coax cables (max length ~ 45')

- Phase 1 => AES-FMC-MULTI-CAM4-G

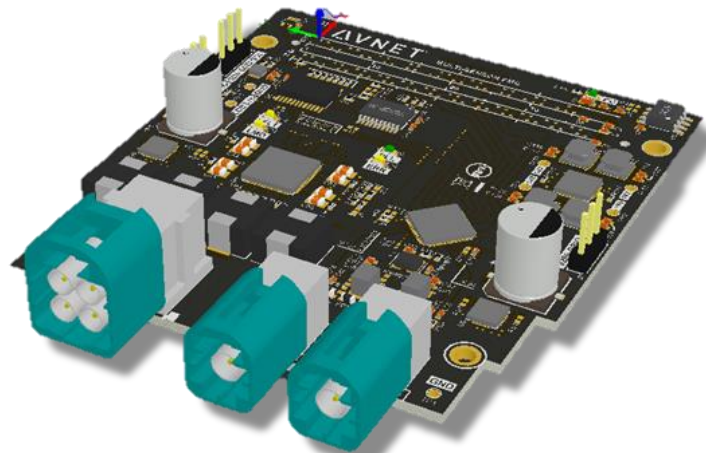
- GMSL (1.5Gbps) - MAX9286 Quad Deserializer
 - Quad 2 Mpixel Camera module support
- Available

- Phase 2 => AES-FMC-MULTI-CAM6-G

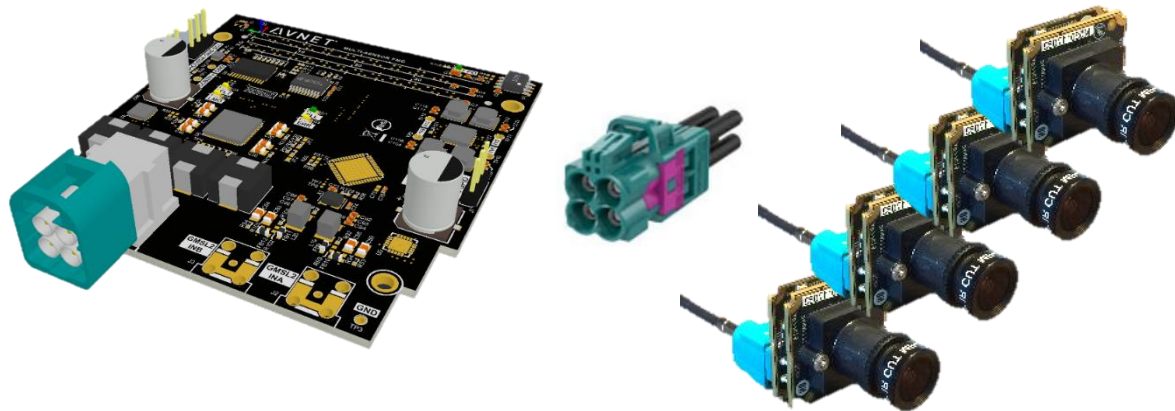
- Similar to “Phase 1” with additional support for:
- Next-generation GMSL => GMSL2 (6.0Gbps)
 - Dual 8 Mpixel Camera module support
- Availability TBD

Multi-Camera FMC Module \$399

Partnr: AES-FMC-MULTI-CAM4-G



Quad Camera FMC bundle

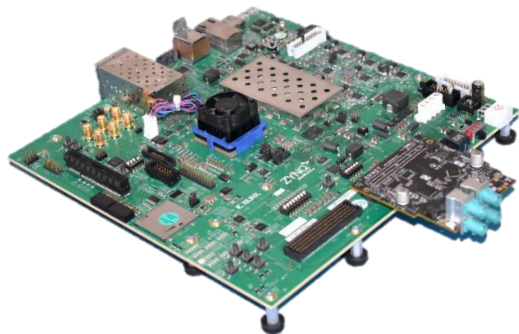


Quad camera FMC bundle \$1699

Partnr: AES-FMC-MC4-AR0231AT-G

Manufacturer	Part Number	Description
Avnet	AES-FMC-MULTI-CAM4-G	Multi-Camera FMC Module
ON Semiconductor	MARS1-AR0231AT7-GEVB	AR0231AT Image Sensor Board
ON Semiconductor	MARS1-MAX96705-GEVK	MAX96705 Serializer Kit (with FAKRA cable)
Rosenberger	L02-026-1000-Z-ZZZZ_V2	Quad HFM to 4 FAKRA Cable Assembly (1m)

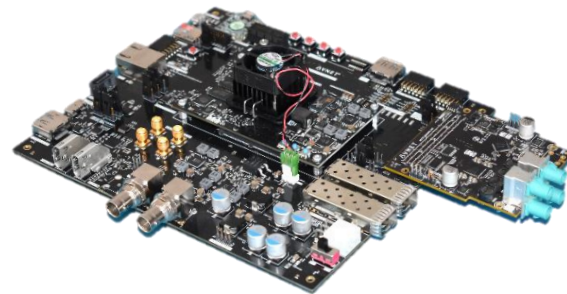
Supported FMC Carrier Cards



Xilinx ZCU102 Evaluation kit



Xilinx ZCU104 Evaluation kit



*Avnet UltraZed Carrier card with
Avnet UltraZed-EV SOM*

Flexible configuration options

FMC Carrier	Processing	FMC slot	Quad-GMSL (2Mp)	GMSL2-a (8Mp)	GMSL2-b (8Mp)	Total number of camera modules
Xilinx ZCU102 Evaluation kit	UltraScale+ 9EG MPSoC	FMC slot 1	4	1	1	10
		FMC slot 2	4	-	-	
Xilinx ZCU104 Evaluation kit	UltraScale+ 7EV MPSoC	FMC slot 1	4	1	1	6
Avnet UltraZed EV Carrier card	UltraScale+ 7EV SOM	FMC slot 1	4	1	-	5

Quad Camera FMC – Camera Pipelines

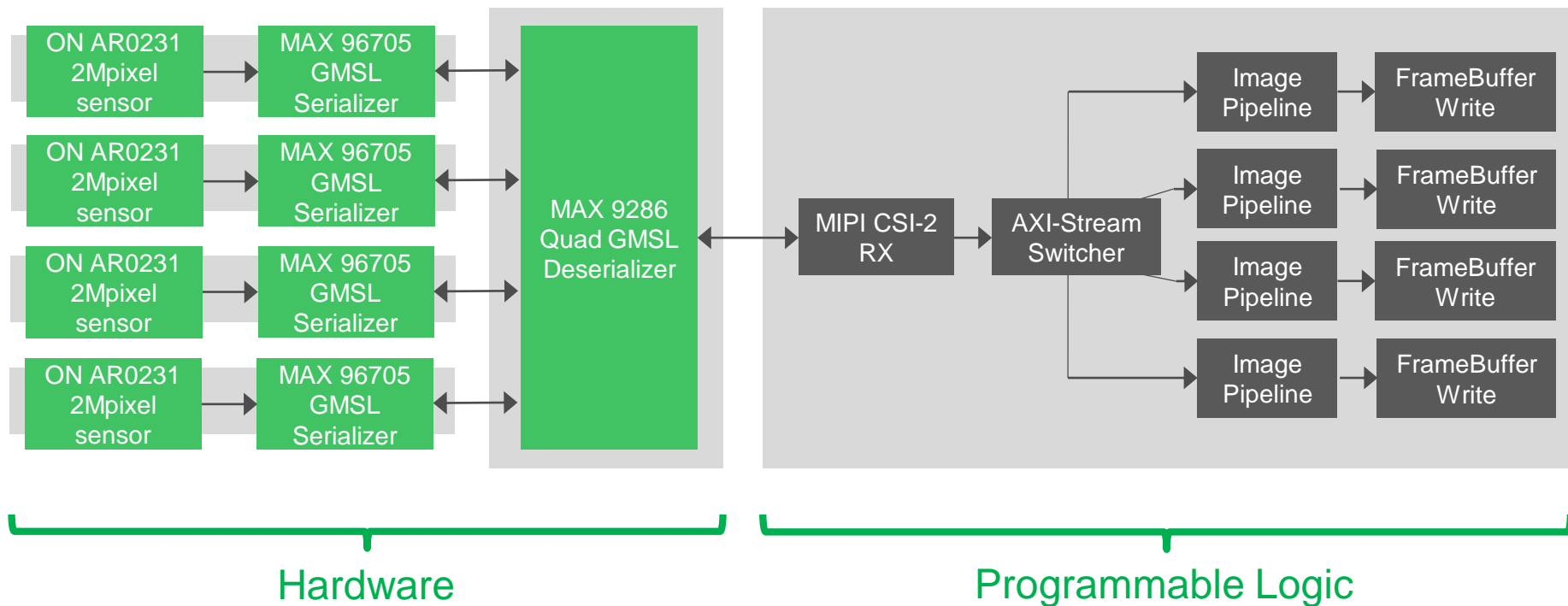
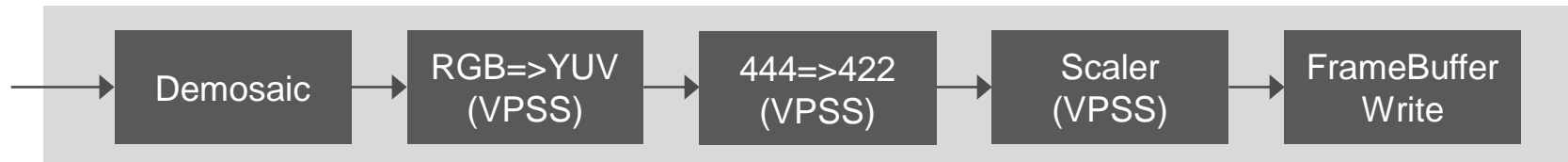


Image Pipeline – IP's



- Xilinx IP based Image Pipeline
 - Demosaic
 - Color Filter Array interpolation : RAW => RGB
 - Video Processing Sub-System
 - Color Space Conversion : RGB => YUV
 - Chroma Resampling : 4:4:4 => 4:2:2
 - Resizing (Scaler)
 - Frame Buffer Write
 - Replacement to AXI_VDMA

Linux Drivers

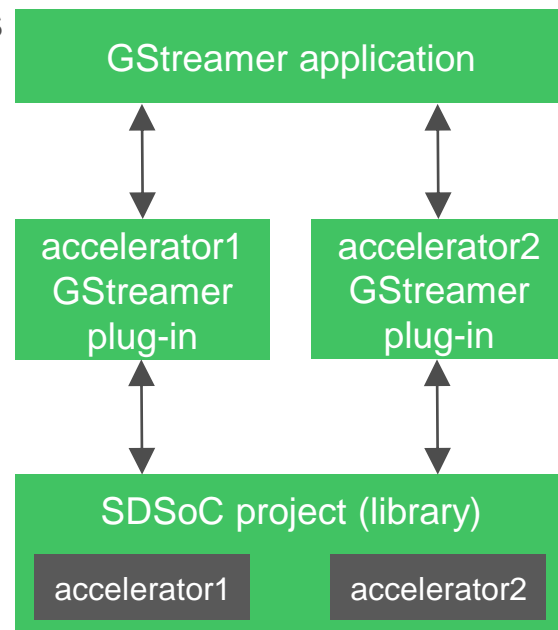
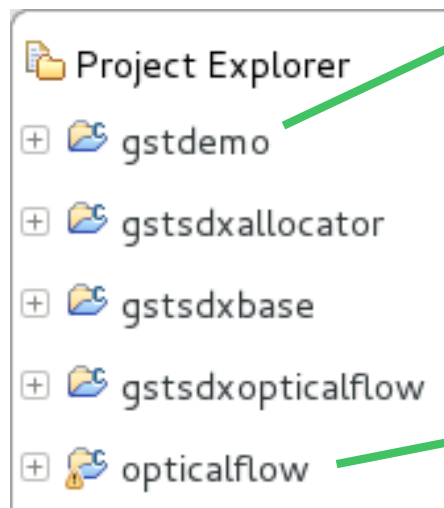
- Video for Linux 2 (V4L2) Framework
 - V4L2 sub-device drivers
 - AR0231AT image sensor
 - MAX96705 GMSL serializer
 - MAX9286 Quad GMSL deserializer
 - MAX20087 Power Over Coax
- Release
 - Kernel patch, included with designs

reVISION platforms – GStreamer support

- GStreamer support

- Samples now use the GStreamer framework
- Sample design examples are built as GStreamer plugins
- Sample apps are included, to exercise the sample plugins

- Examples provided as multi-project workspace



reVISION platforms – GStreamer Examples

- Launching a pass-through pipeline from camera to display

```
gst-launch-1.0 \
```

```
v4l2src device=/dev/video3 io-mode=dmabuf ! \
```

```
"video/x-raw, width=1920, height=1080, format=YUY2" ! \
```

```
kmssink driver-name=xilinx_drm_mixer plane-id=26 sync=false
```

- Launching an optical flow pipeline from camera to display

```
gst-launch-1.0 \
```

```
v4l2src device=/dev/video3 io-mode=dmabuf ! \
```

```
"video/x-raw, width=1920, height=1080, format=YUY2" ! \
```

```
sdxopticalflow filter-mode=1 ! queue ! \
```

```
kmssink driver-name=xilinx_drm_mixer plane-id=26 sync=false
```

reVISION platforms – General Architecture

- Video Sources

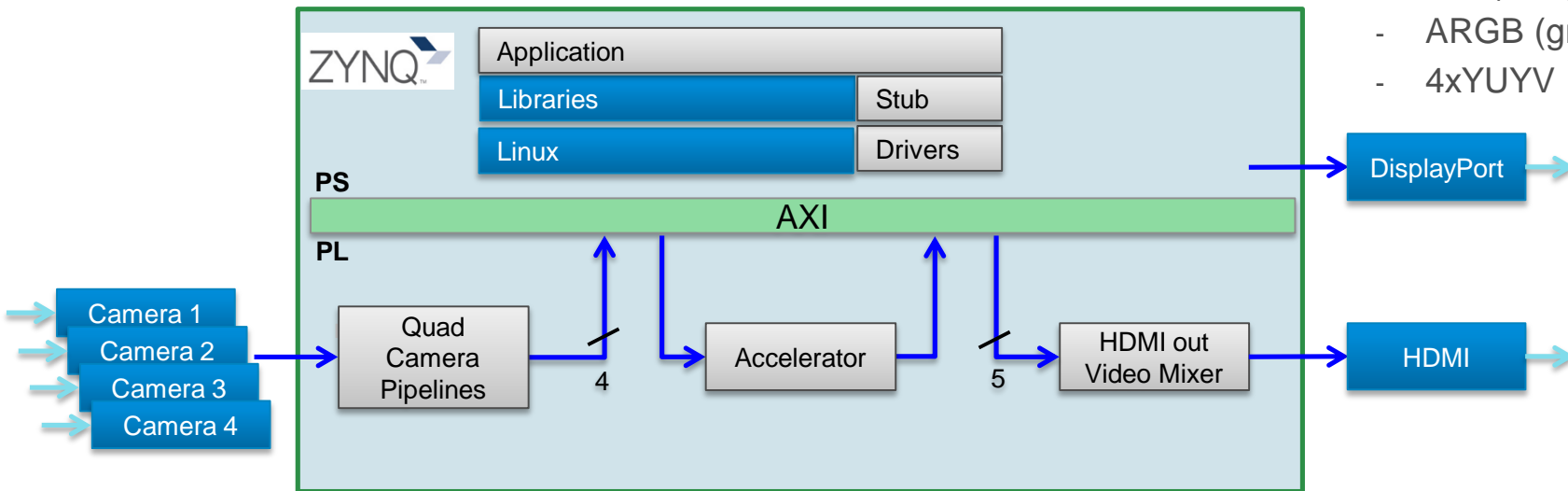
- Quad Camera

- Video Accelerators

- Generated by SDSoC

- Video Sinks

- DisplayPort (2 layers)
 - ARGB (graphics)
 - YUYV (camera)
- HDMI (5 layers)
 - ARGB (graphics)
 - 4xYUYV (cameras)



reVISION platforms – Overview

- Based on Xilinx platforms

- ZCU102_RV_SS – Single Sensor reVISION platform for ZCU102
- ZCU104_RV_SS – Single Sensor reVISION platform for ZCU104

- reVISION Getting Started Guide

- <http://www.wiki.xilinx.com/reVISION+Getting+Started+Guide>

- Avnet platforms

- ZCU102_RV_MC4 - Quad camera reVISION platform for ZCU102
- ZCU104_RV_MC4 - Quad camera reVISION platform for ZCU104
- UZ7EV_RV_MC4 - Quad camera reVISION platform for UltraZed EV UltraZed 7EV SOM + FMC carrier card

- Stay in Sync with Xilinx releases of SDSoC / reVISION platforms

- Xilinx MPSoC reVISION (2018.2)

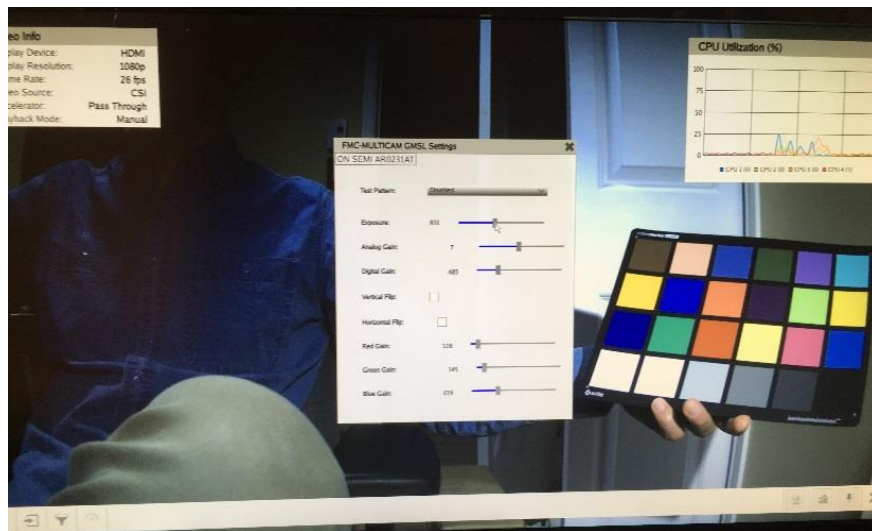
Design example: Computer Vision with QT GUI – Single Camera

Computer Vision functions

- Filter 2D
- Optical Flow

Additional features with GUI

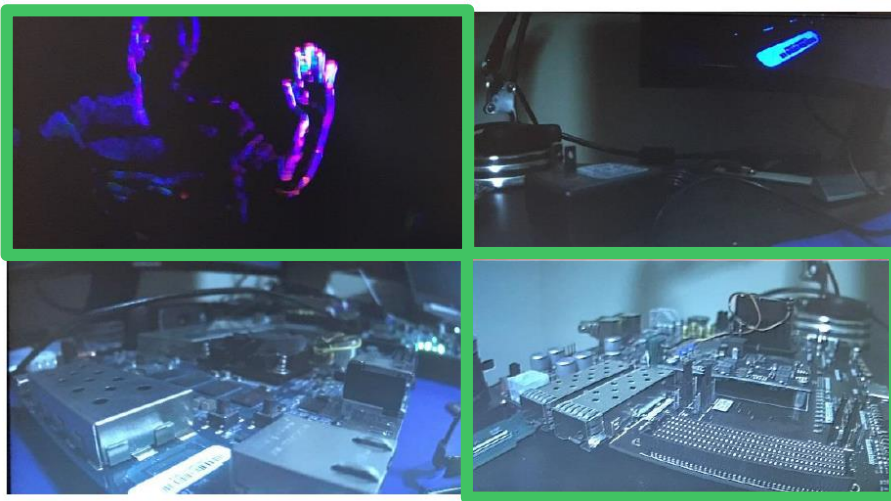
- Filter Mode / Type
- Camera Controls
 - Vertical / Horizontal flip
 - Exposure
 - Analog / Digital Gains
 - Red / Green / Blue Gains



Design example: Computer Vision – Quad Camera

Computer Vision functions

- **Top-left quadrant**
Running the “Optical Flow” accelerator,
indicating movement in the scene
- **Bottom-right quadrant**
Running the “Filter 2D” accelerator,
enhancing the edges in the scene
- **Other two quadrants**
Running a pass-through

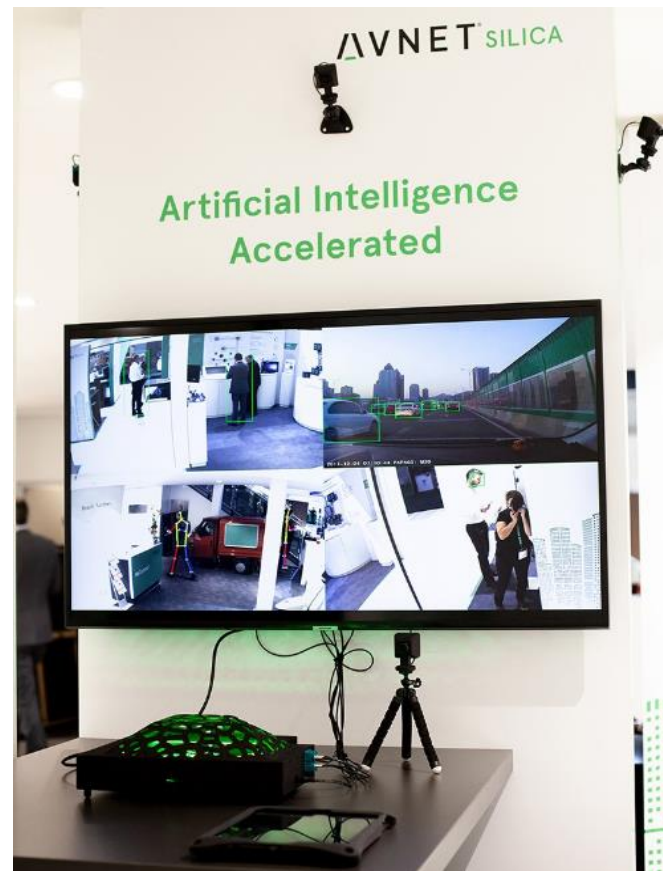


Design example: Xilinx DNNDK Deep Learning– DPU Quad Analytics

Neural Networks with Xilinx Deephi

- **Cam1 (top-left)**
Person/pedestrian detection (SSD)
- **Cam2 not used (top-right)**
Vehicle detection (SSD) – video input from SD card
- **Cam3 (bottom-left)**
Gesture/pose detection
- **Cam4 (bottom-right)**
Face detection (Dense Box)

XDF => See demo on our booth



Design examples status

Design	ZCU102	ZCU104	UZ7EVCC
Computer Vision with QT GUI – Single Camera	OK	OK	OK
Computer Vision Examples – Quad Camera	OK	OK	- (1)
DeePhi Deep Learning Examples – DPU Quad Analytics	SD (2)	-	-

Notes:

- (1) UltraZed EV port of Computer Vision Examples
Quad-Camera / DisplayPort working, HDMI output in progress ...
- (2) DeePhi DPU Demo
ZCU102 only, SD card image only

Summary

- Flexible development system with different hardware and software options valid for single or multi-camera designs
- Flexible architecture for any precision for AI / Machine learning
- BSP (Board Support Package) build on reVISION/SDSoC including Linux drivers, GStreamer
- Design examples for computer vision and deep learning

Additional information:

- Michaël Uyttersprot – michael.uyttersprot@avnet.eu
- Or contact your local Avnet Silica office
- Or send your request to artificial-intelligence@avnet.eu



The logo features a red chevron pointing right, followed by the letters 'XDF' in a white, bold, sans-serif font.

XDF XILINX
DEVELOPER
FORUM

