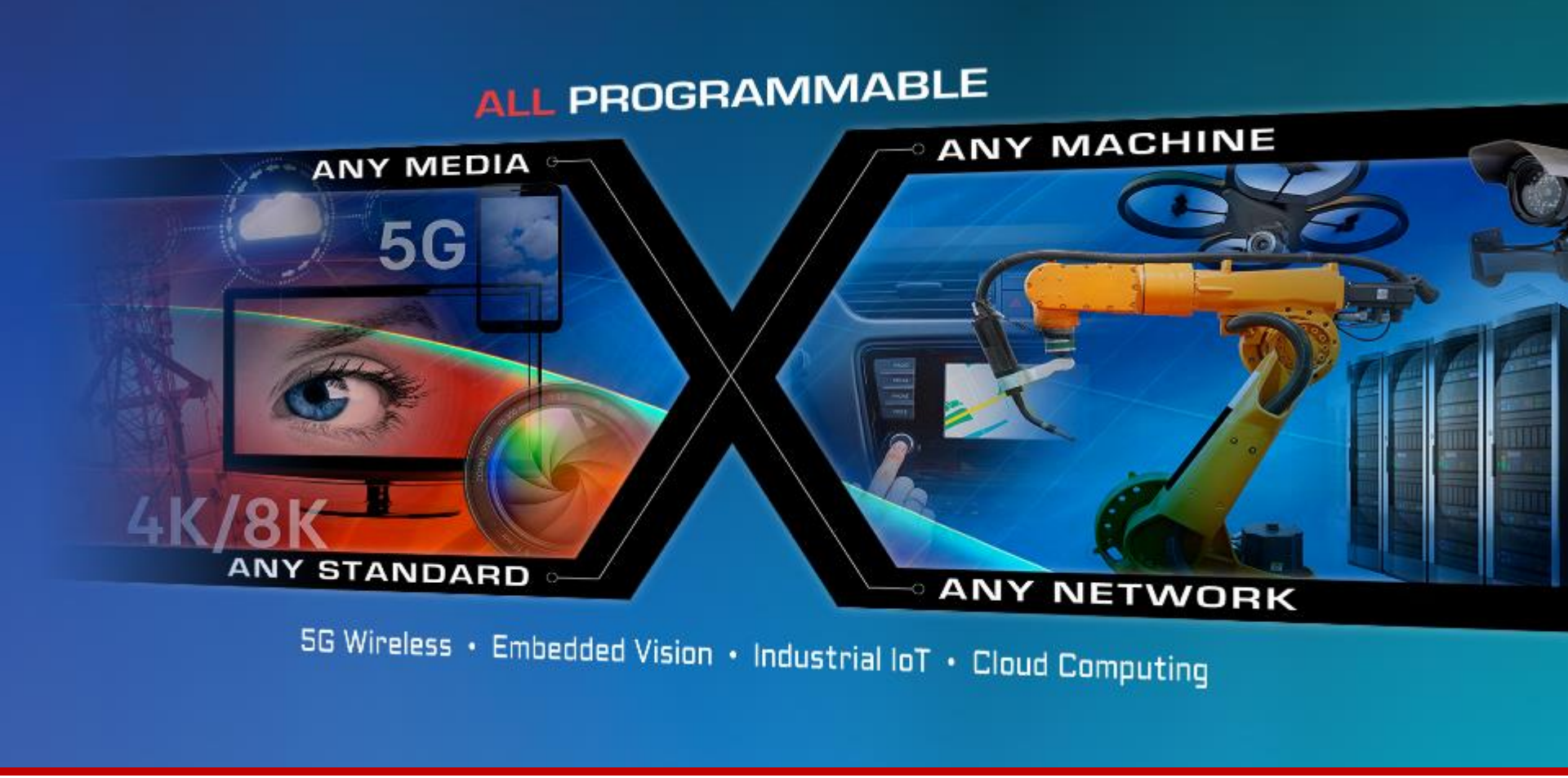


XILINX
ALL PROGRAMMABLE

Vision with Precision Webinar Series

Medical Imaging

Aaron Behman, Xilinx
Mike Looijmans, TOPIC Embedded Products

Xilinx Vision with Precision Webinar Series

- Monitoring Things: Medical Imaging
- Perceiving Environment / Taking Action
  - *ADAS and the Road to Autonomous Vehicles*
  - *Drones & Other Vision Guided Robotics*
  - *Augmented, Virtual and Mixed Reality*

XILINX
ALL PROGRAMMABLE

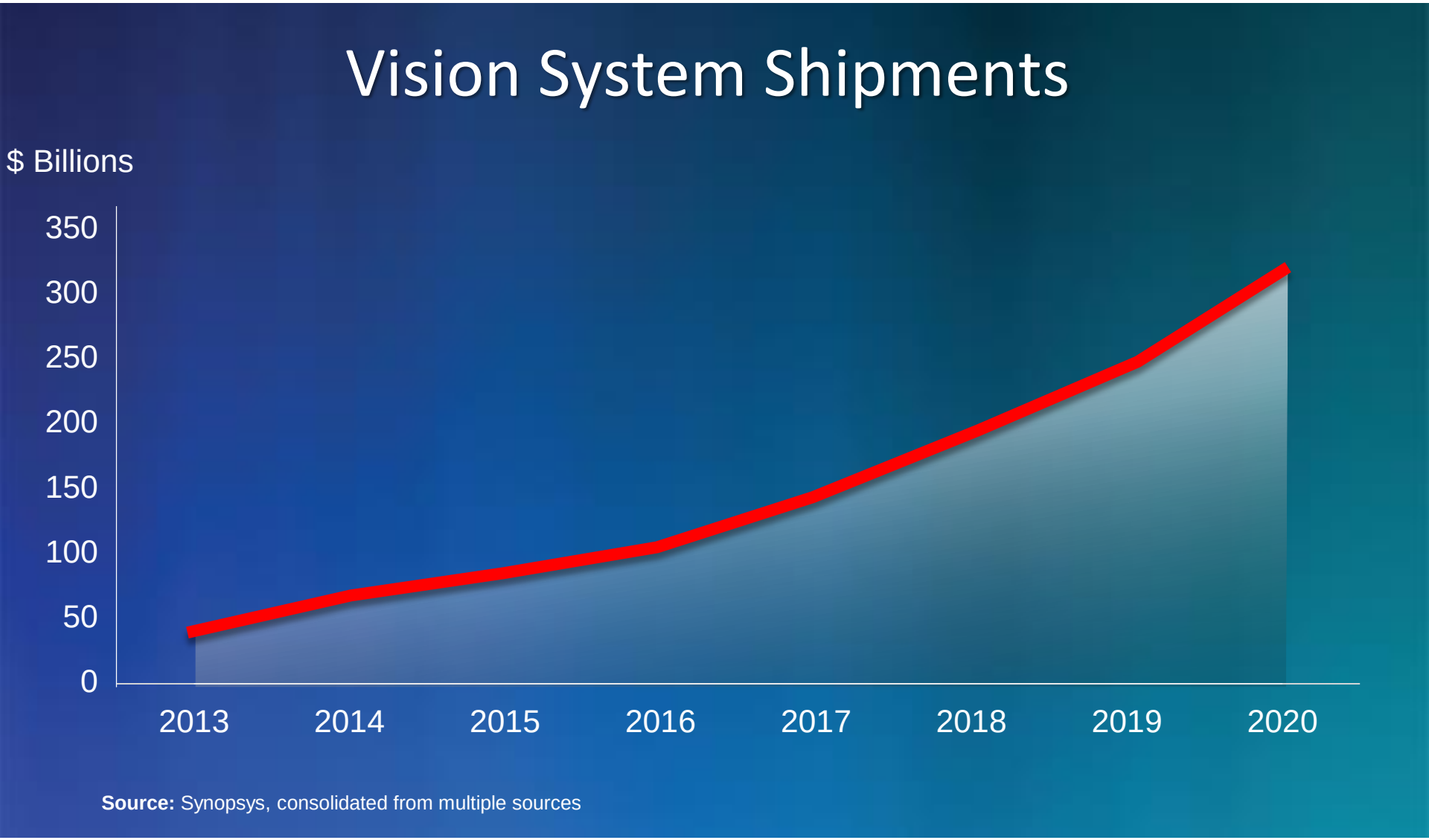
Agenda

- Embedded Vision Market Trends
- Medical Imaging Technology Trends
- Introducing TOPIC Embedded Products
- TOPIC Embedded Solutions
- Q&A

Enabling Embedded Vision

ADAS, Machine Vision, Surveillance, Medical, Drones/VGR, AR/VR

Rapid Growth of Vision Systems

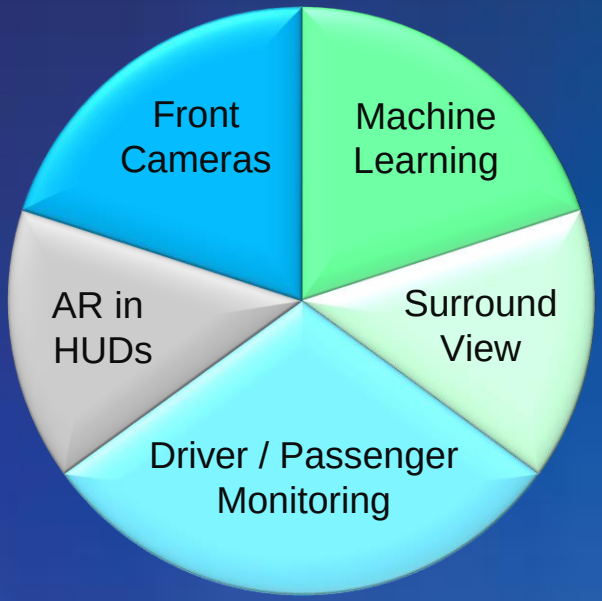


Source: Synopsys, consolidated from multiple sources

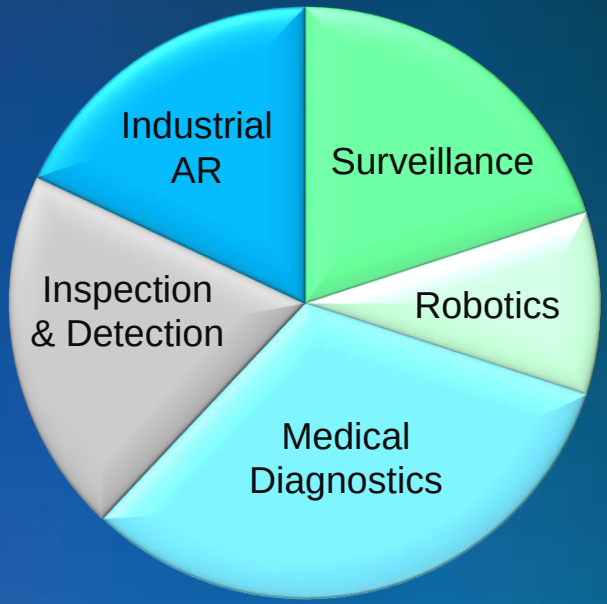
Embedded Vision Applications

Embedded Vision

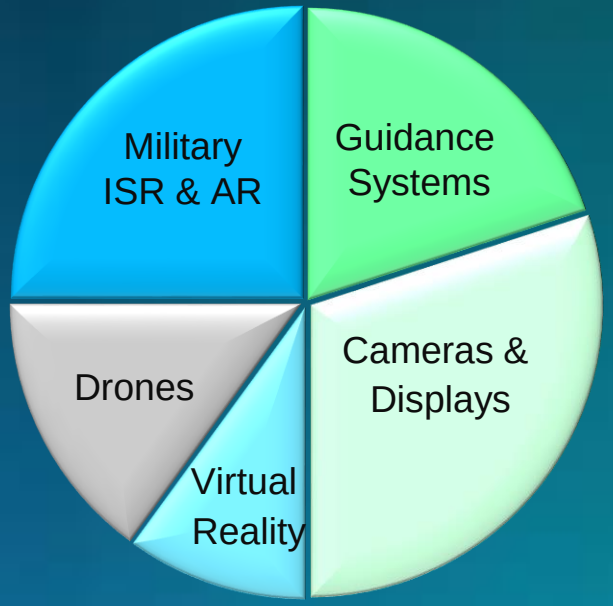
Automotive



ISM



A&D, AVB, Consumer



>200 Vision Customers Powered by Xilinx

POWERED BY XILINX

Camera

>30 Camera Brands

ADAS

23 Auto Makers, 85 Models

Industrial

>50 Equipment Manufacturers

Broadcast

8 Major Broadcasters

ProAV

>70 Equipment Makers

Drones

>5 Drone Companies

VR/AR

8 VR/AR Companies

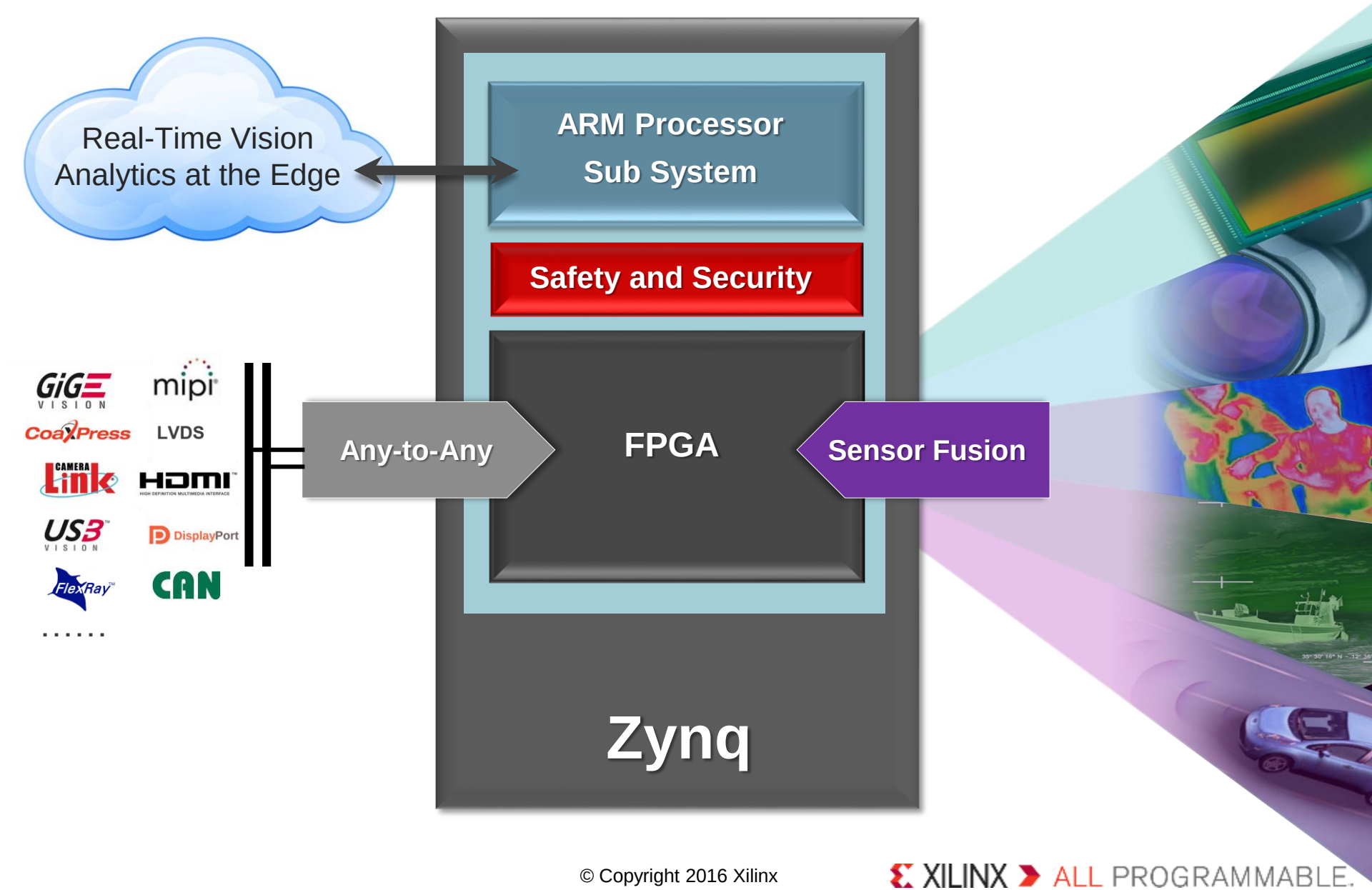
Medical

>10 Medical Companies

Display

>30 Major Brands

Best Platform for Embedded Vision

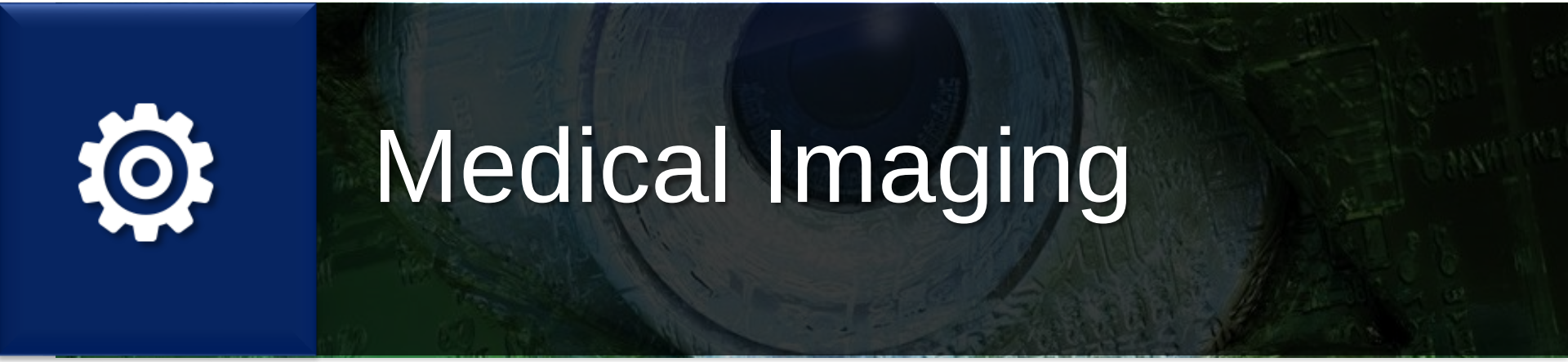


Vision and ADAS

5 Differentiating Advantages

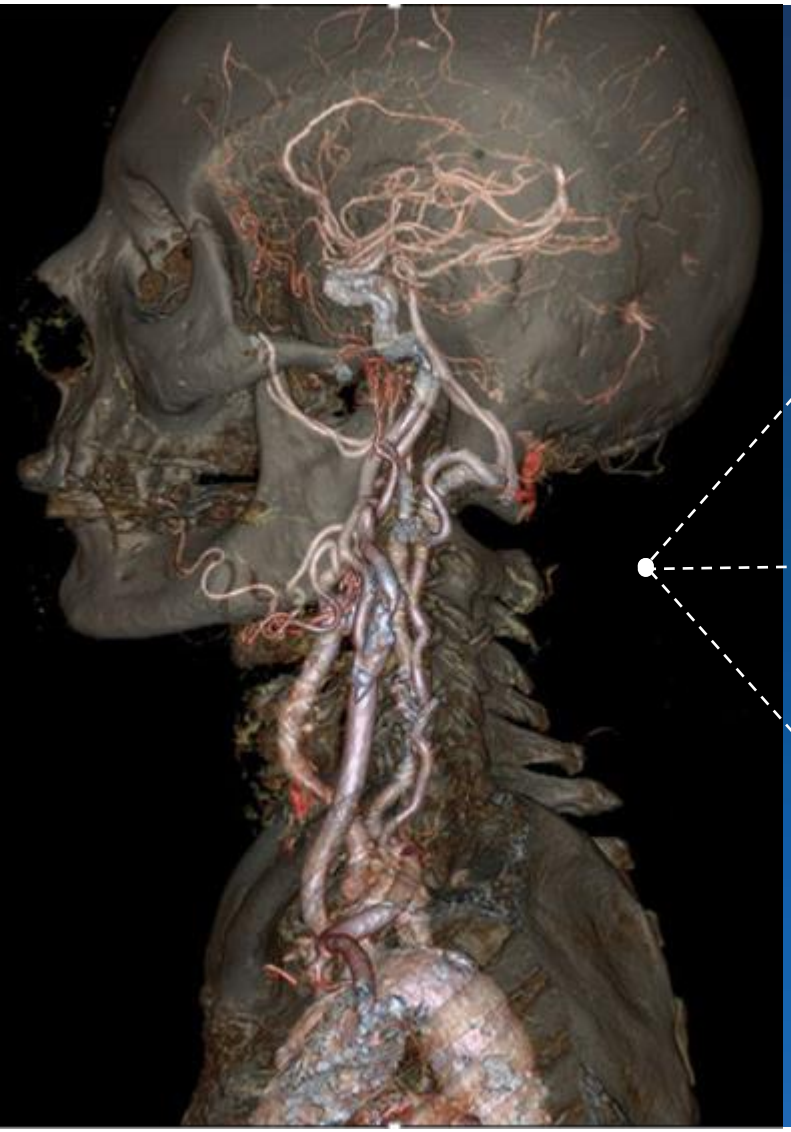
"Vision with Precision"

1. Real-time Image Recognition and Analytics
2. All Programmable Platform Reuse
3. Scalable Sensor Fusion
4. Highest Performance/Watt
5. Only Single Chip Safety and Security



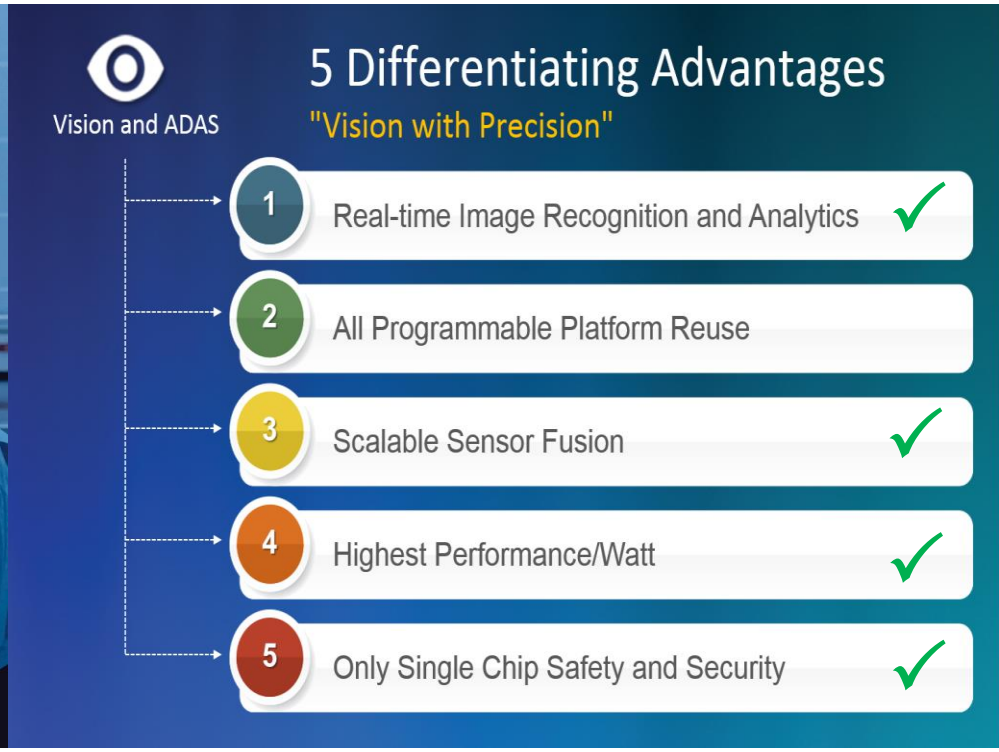
Medical Imaging

Enabling Smarter Medical Imaging Systems



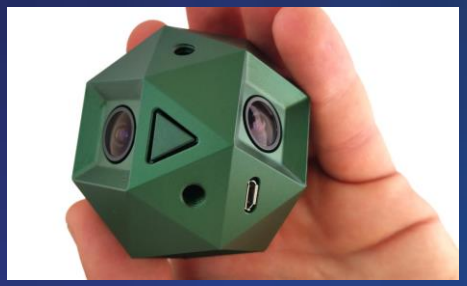
- Multi-Sensor Fusion
- Real-Time Intelligence
- Compute at the Edge

Differentiating Advantages in Medical Imaging



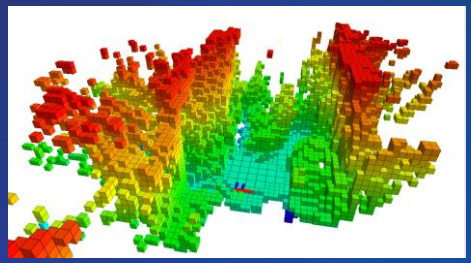
- Very high frame rate, recognition and analytics enabled through massive parallelism
- Scalable *sensor fusion* supports stereo to N vision pipelines + different sensor types
- Most computationally productive platform enabling highest performance per Watt
- ARM TrustZone & TRUST compliance for anti-tamper and information assurance

TECHNOLOGY TRENDS IN MEDICAL IMAGING



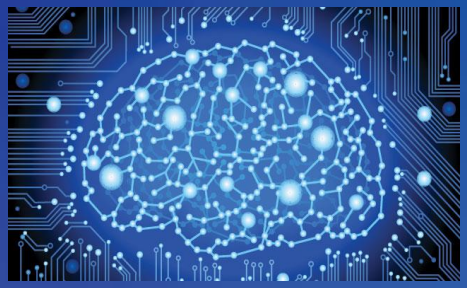
Multi Camera Vision

- Complete perspective with surround view
- Diverse sensor modalities provide enhanced vision
- Processing performance can now support dense fusion



Computer Vision (CV) Techniques

- OpenCV/OpenVX libraries increase productivity
- Optical Flow provides enhanced motion detection
- 3D/Stereo Vision enhances depth perception



Machine Learning Techniques → Building on CV

- Promises better recognition capability
- Object Detection & Classification thru Neural Networks
- Includes Convolutional, Deep and Recursive Neural Nets

The Machine Learning Dichotomy

Training

Photo: NVIDIA

- How the model is formed and developed
- Many approaches: DNN, CNN, RNN
- Low volume application requiring HPC
- DPfpu required to build models

Best Suited for GPGPUs

Inference

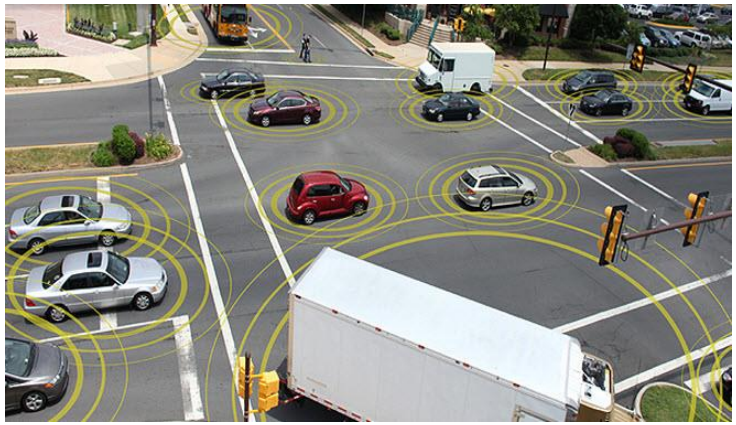
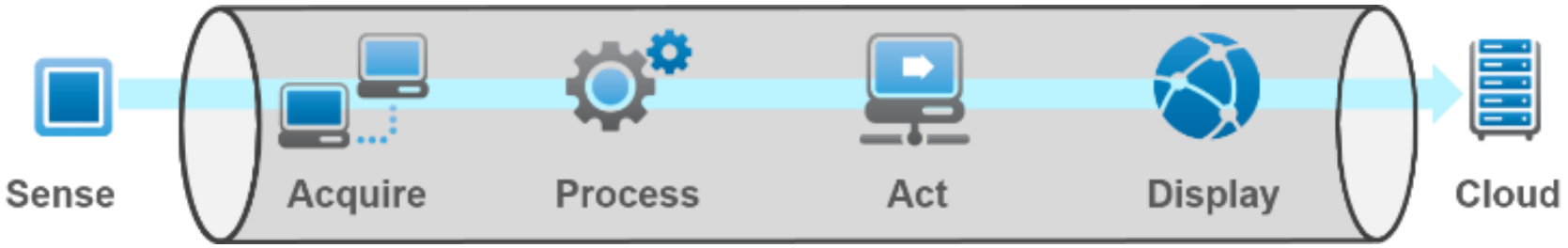


Photo: US DOT

- Requires efficient processing
- Does not need the precision of training
- High volume application targeting…
  - Automotive
  - VGR & Drones
  - Surveillance
  - Medical Imaging
- Fixed point math used to deploy models

Best Suited for FPGA / FPGA SoCs

Typical Image Pipeline



Sensor Interface	Pre-processing	CV → Machine Learning	Output Interface
- LVDS	- ISP / Debayer	- OpenCV / OpenVX	- HDMI
- MIPI	- Color Space Conversion	- Deep Learning (CNN)	- GigE Vision
	- Scaling	- Optical Flow	- CoaXPress
		- SLAM	- Camera Link
		- Stereo Vision	- USB3
			- SDI

The Xilinx Embedded Vision Ecosystem

EMBEDDED SYSTEMS ECOSYSTEM FOR VIDEO / VISION

Sensor Processing	Video Processing	Analytics CV / xNN	Codecs	Connect
apical	DDC	Auviz Systems	Ae Technologies	pixTico	inrevium
logicBRICKS	Omnitek	MULTICORE WARE	BarcoSilex	NGCODEC	NORTHWEST LOGIC
	XILINX	HALCON	CoreEL	PATHPARTNER	sensor to image
			IBEX	SIC	XILINX

DESIGN ENABLEMENT

NATIONAL INSTRUMENTS
OpenCV
MathWorks
SiliconSoftware speed up your business
TOPIC EMBEDDED SYSTEMS
VIVADO HLx Editions
SDSoC Environment

MODULES & BOARDS

Evaluation Boards

AVNET
XILINX

Production Ready SOMS

ALPHA DATA
ENCLUSTRA
AVNET
Nextera Video
DAVE
MYiR
TOPIC EMBEDDED SYSTEMS
DIGILENT
fidus
iveia
trenz electronic
image

DESIGN SERVICES

fidus
OKI
FUJITSU
logicBRICKS
Ae Technologies
HCL
Omnitek
TOPIC EMBEDDED SYSTEMS
inrevium
DDC
iveia
Adeas
CoreEL

Agenda

- Introduction to TOPIC
- Example Projects
- Common Factors
- Designing a Solution
- Summary

About TOPIC Embedded Systems

- **Real embedded company**
- **170 employees**
  - 135+ embedded software developers
  - 15+ FPGA designers
  - 10+ board designers
- **Founded in 1996, privately owned**
- **Three Business Units:**
  - Since 1996: Consultancy: The Netherlands
  - Since 2006: Project execution: Europe & North America
  - Since 2014: Product development and sales: Worldwide

XILINX
ALLIANCE PROGRAM
PREMIER MEMBER

TOPIC EMBEDDED PRODUCTS
XILINX ALLIANCE PROGRAM PREMIER

XILINX ALL PROGRAMMABLE.

TOPIC Embedded Products

- **One of three TOPIC business units**
- **Started in Q1, 2014**
- **Team of 14 people:**
  - 1 Director
  - 1 Systems Architect / Product Manager
  - 10 Developers (HW/SW)
  - 1 Customer Care
  - 1 Assistant

TOPIC Embedded Products

FLORIDA Powered by TOPIC

MIAMI Powered by TOPIC

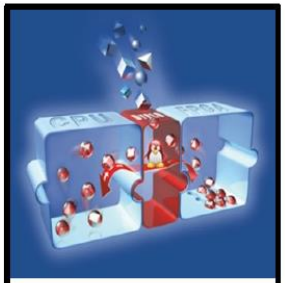
DYPLO® Powered by TOPIC

IPWARE Powered by TOPIC

DSIGN Powered by TOPIC

Carrier boards: Gen, PCI-e

System on Modules: Zynq, Kintex, MPSoC



Dynamic Process Loader

Plug and Play IP blocks

Custom software and hardware services

Medical Imaging Projects

- Let's take a look at some projects…
  - Objectives
  - Technologies
  - Hardware design
  - Development methodology
  - Tools
  - Safety
  - Performance
  - …


CERTIFICATE

Number: 2114873

The management system of:

TOPIC Embedded Systems
Eindhovenseweg 32-C
5683 KH Best
The Netherlands

including the implementation meets the requirements of the standard:

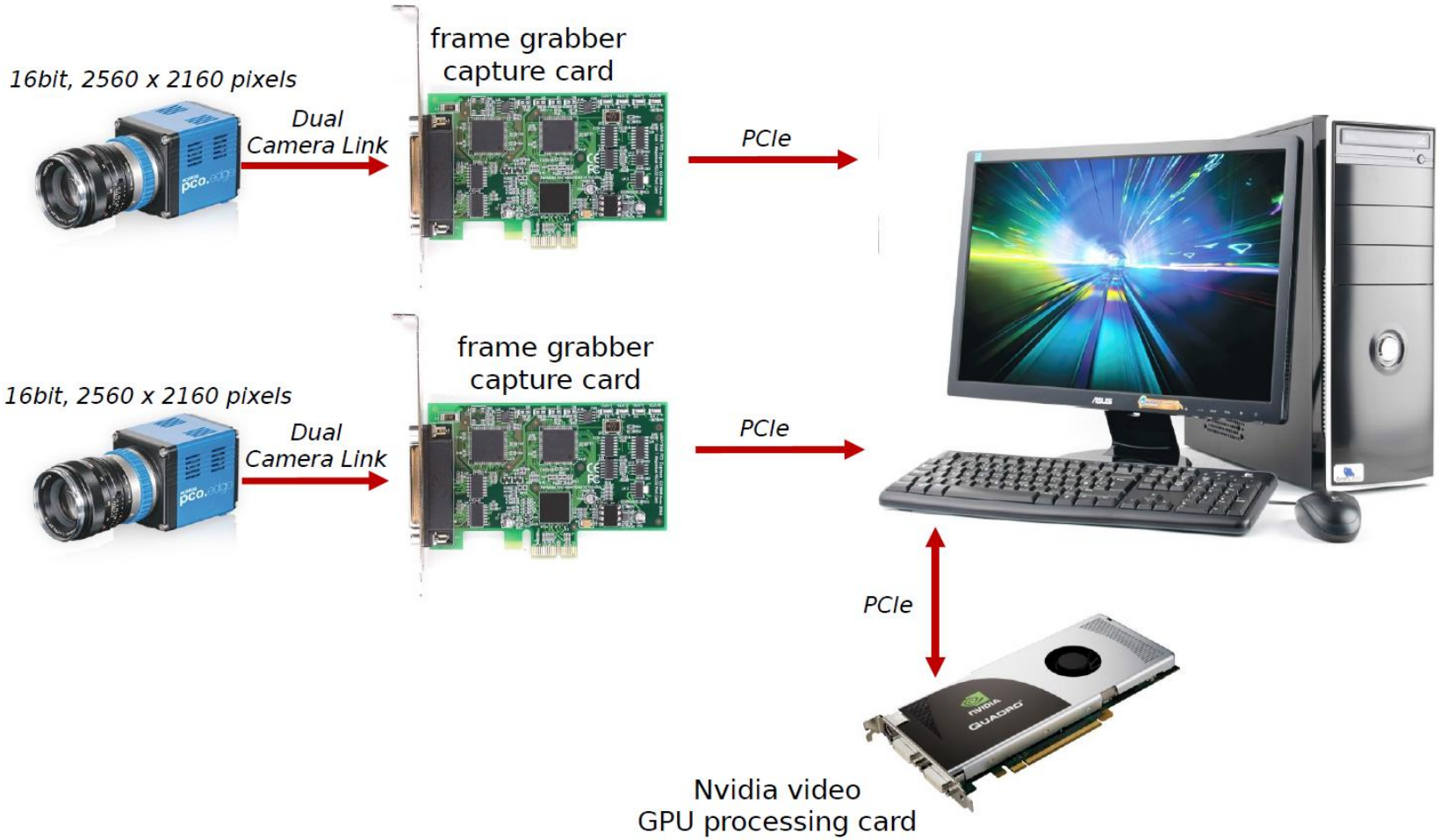
EN ISO 13485:2003

Scope:
Design, development and release of (embedded) medical software and related hardware as a subcontractor.

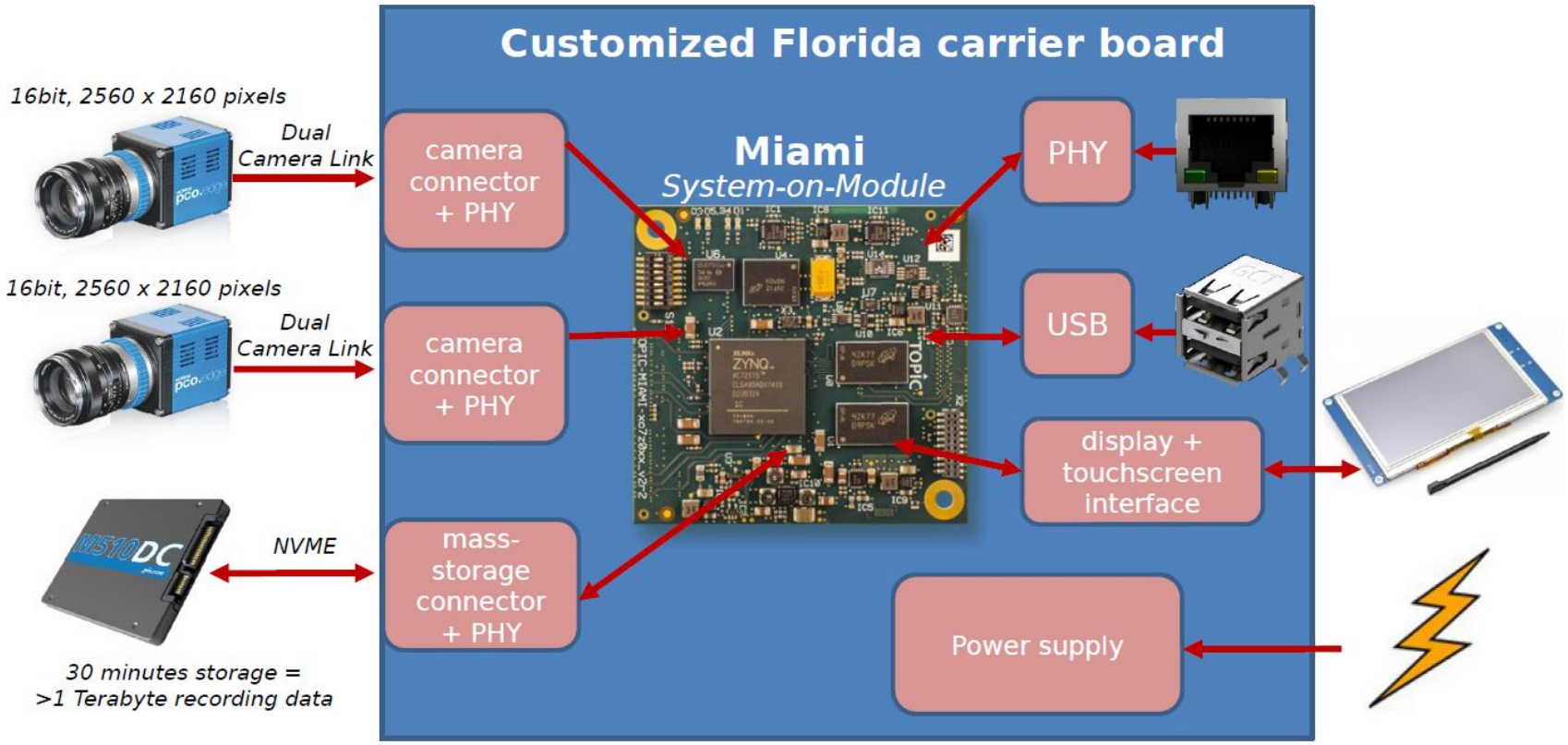
Certificate expiry date: 1 July 2014
Certified for the first time: 8 July 2008
Certificate effective date: 1 July 2011

(Before we arrive at solutions, let's take a look at the problems first…)

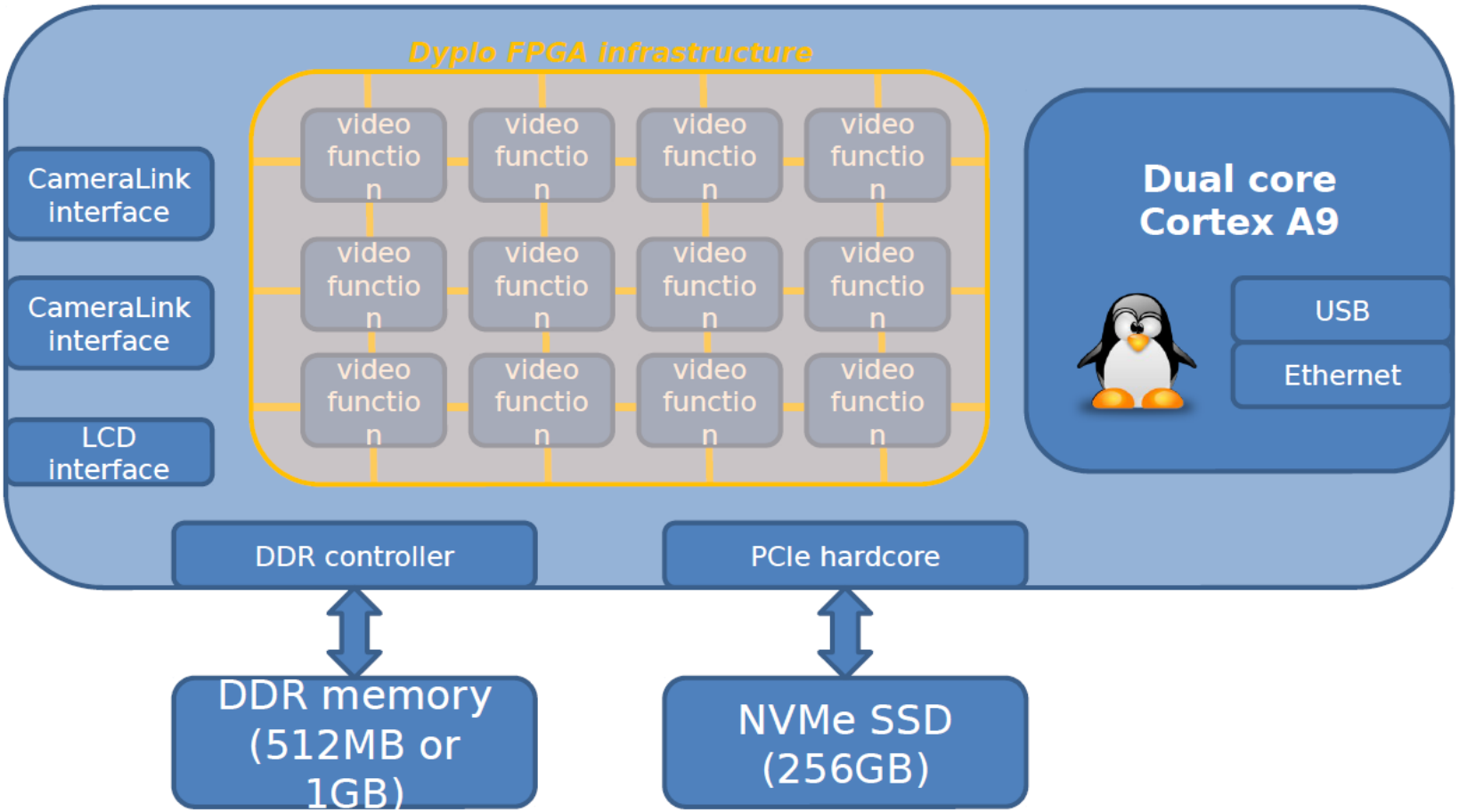
Endoscopy 1: Current



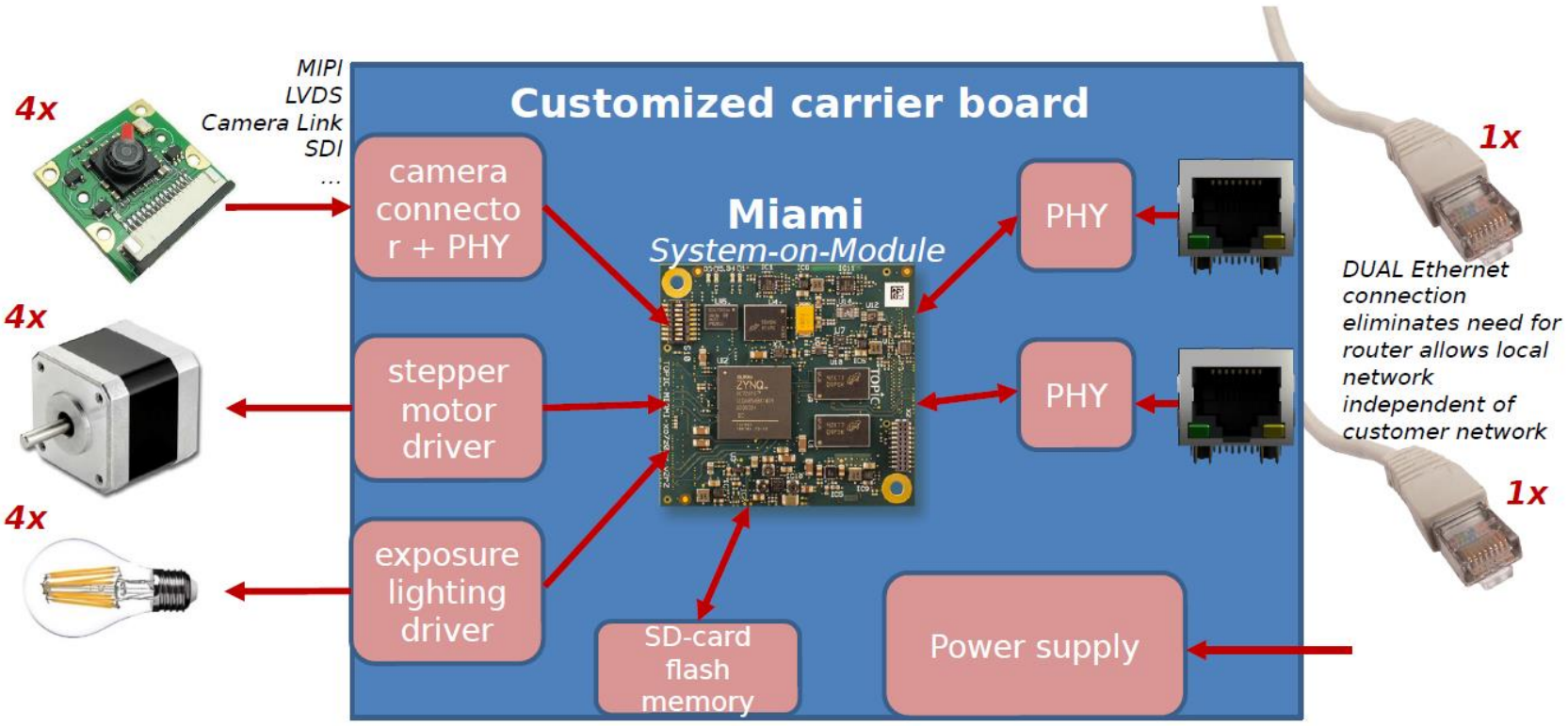
Endoscopy 2: Board



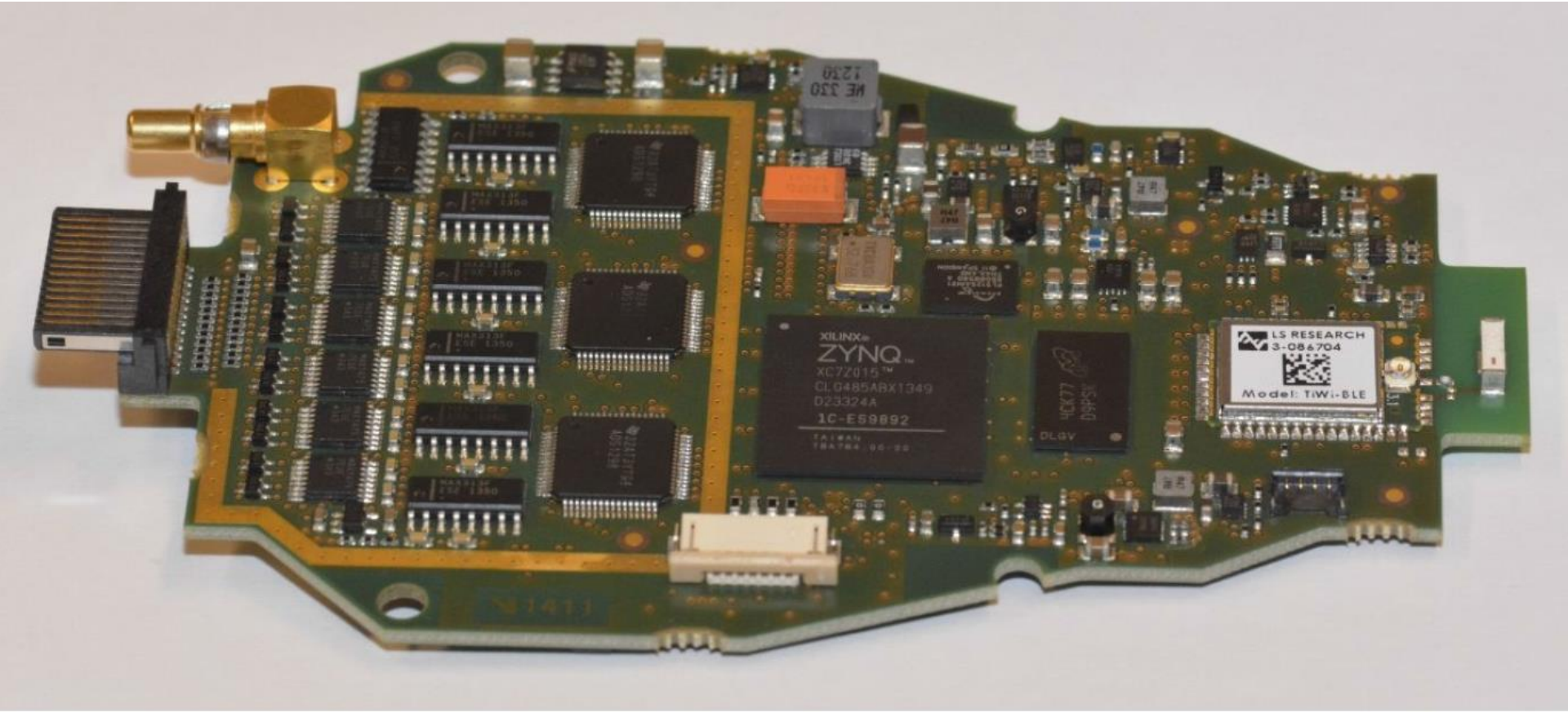
Endoscopy 3: System



In-Vitro Optical Inspection

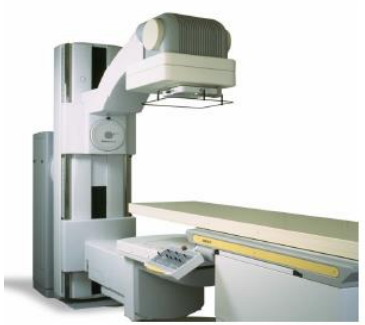


Maple Board



More Medical Projects…

- Product: Simulix
  - Simulation and verification of treatment plans for radiation



- Product: Flexitron
  - Afterloader voor brachytherapy

- Product: Maple
  - Therapeutic device for measuring and stimulating pelvic floor muscles

Summary

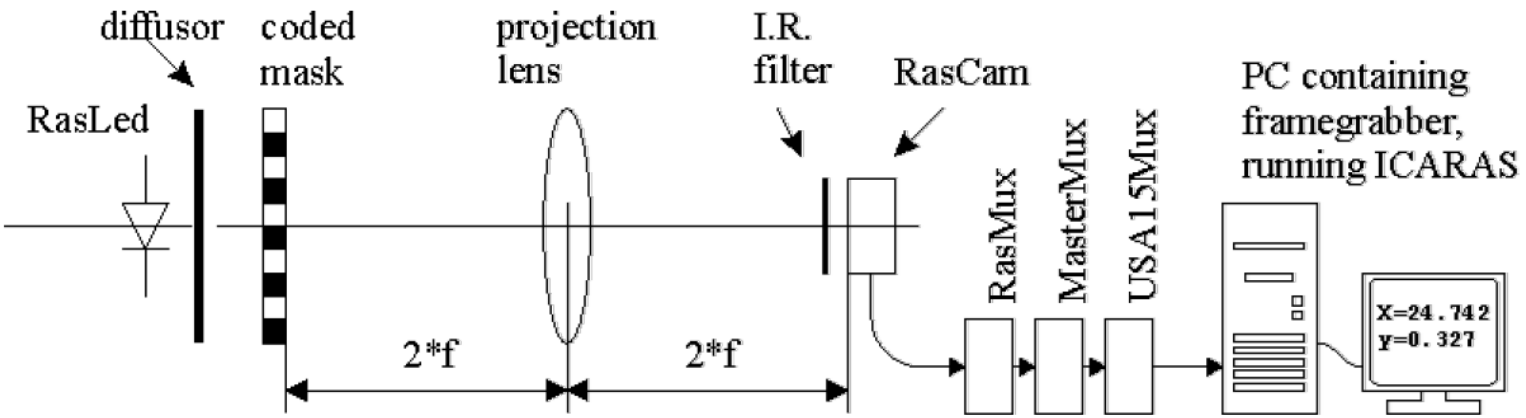
- Acquisition
- Processing
- Storage
- Presentation
- Connectivity
- Battery-powered
- Domain Hardware
- Performance
- Safety
- Power efficiency
- Reliability
- Security
- Real-time

TOPIC EMBEDDED PRODUCTS

XILINX ALLIANCE PROGRAM PREMIER

XILINX ALL PROGRAMMABLE.

Step 1: Definition



- Problem domain
- Technologies
- Mathematical modeling
- Algorithmic design

Step 2: Prototype

TOPIC EMBEDDED PRODUCTS

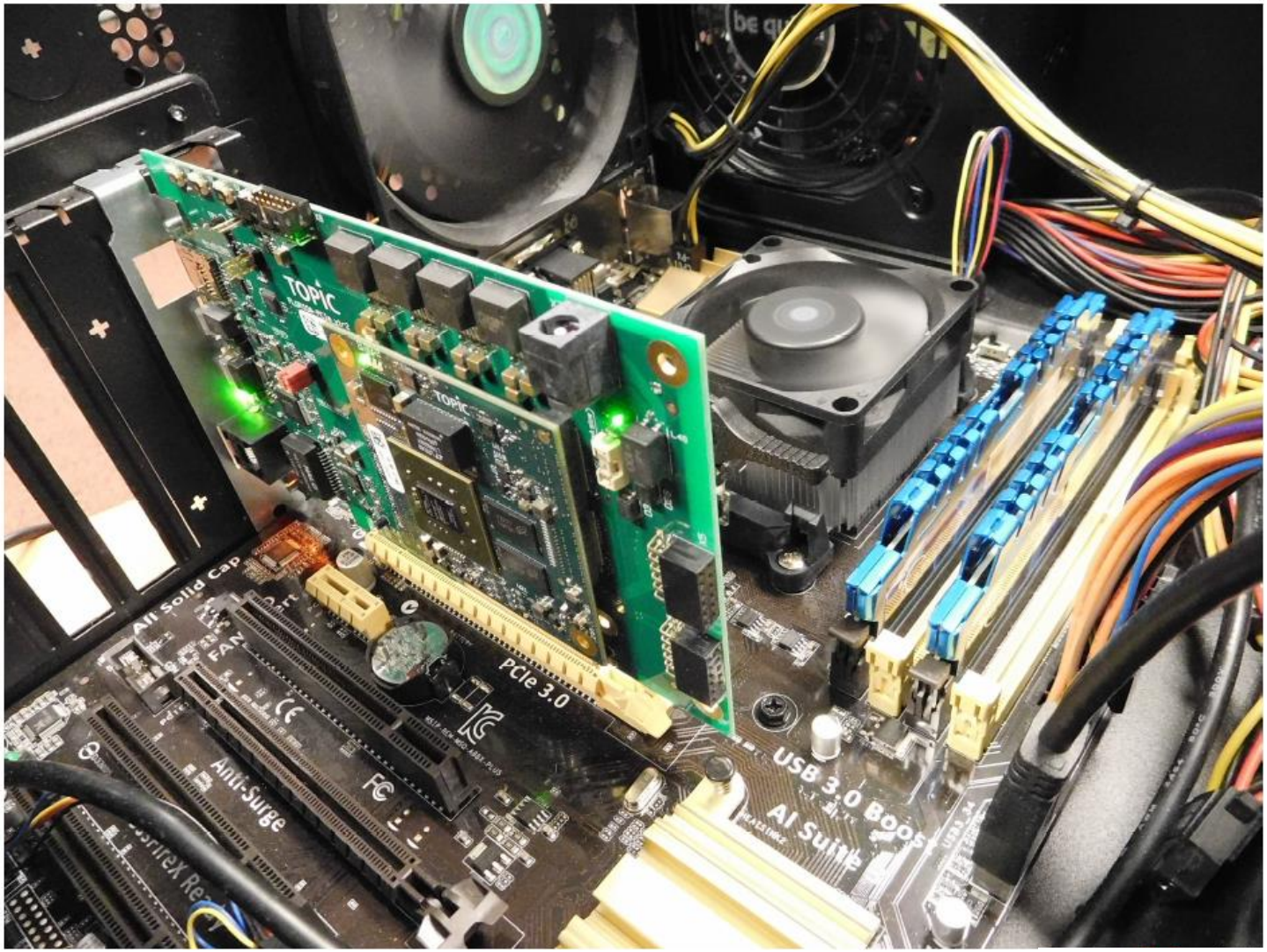
XILINX ALLIANCE PROGRAM PREMIER

XILINX ALL PROGRAMMABLE.

Step 2: Prototype

- Evaluation board
- System on Module
- Operating system
- Software
- FPGA logic
- Close to final product

Step 2: Prototype

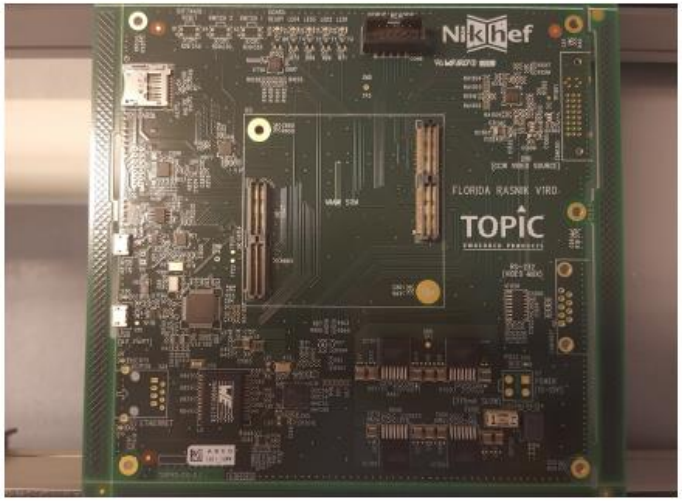


TOPIC EMBEDDED PRODUCTS

XILINX ALLIANCE PROGRAM PREMIER

XILINX ALL PROGRAMMABLE.

Step 3: Hardware Production



- Board design
- Test
- Production

System-on-Module: Miami

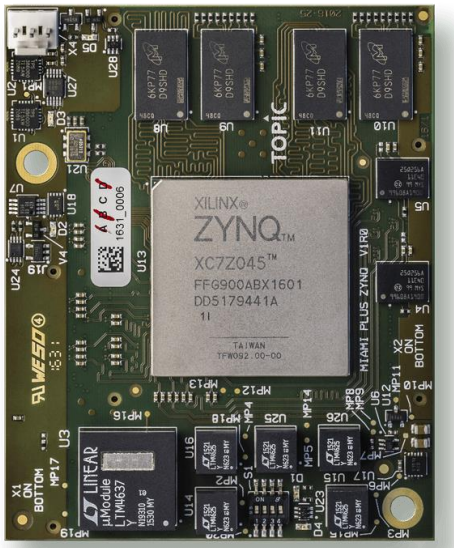
- 7015, 7030, Kintex, MPSoC
- RAM, flash
- High speed I/O
- Full Linux BSP
- Reference designs
- Single power supply

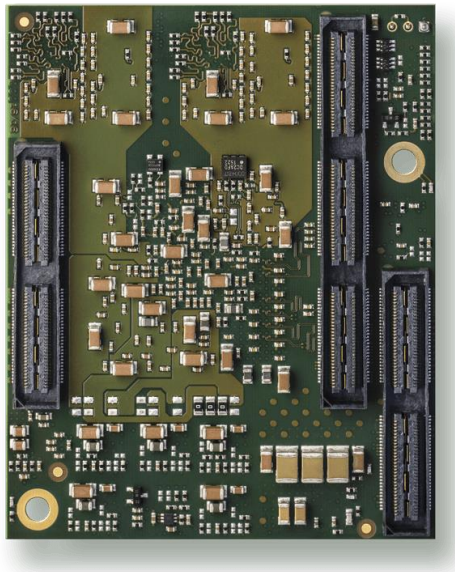
TOPIC EMBEDDED PRODUCTS

XILINX ALLIANCE PROGRAM PREMIER

XILINX ALL PROGRAMMABLE.

Miami Plus





- 7035, 7045, 7100, UltraScale
- RAM, flash
- More high speed I/O
- Full Linux BSP
- Reference designs
- FAN control
- Single power supply

TOPIC EMBEDDED PRODUCTS

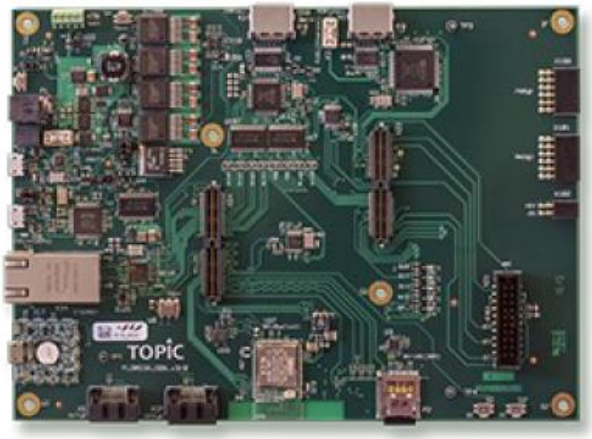
XILINX ALLIANCE PROGRAM PREMIER

XILINX ALL PROGRAMMABLE.

Miami SOM Benefits

- Extensive qualification tests
  - Temperature and humidity: IEC 60068-2-38:2009
  - EMC: EN 55032
  - EMI: IEC 61132, EN 61326, IEC 55024
  - Shock: MIL-STD-202F (method 204D)
  - Vibration: MIL-STD-202F (method 213B)
- Linux boot time less than 2 seconds
- FPGA boot time < 50ms
- Guaranteed life-cycle support: at least 10 years
- Ruggedized interconnects
- Completely integrated selftest capabilities
- On-board, autonomous voltage and current monitoring
- Programmable voltage suppliers for I/O banks
- Secure storage vault (clone protection and authentication)
- Proven track record in industrial, scientific and medical devices

Florida

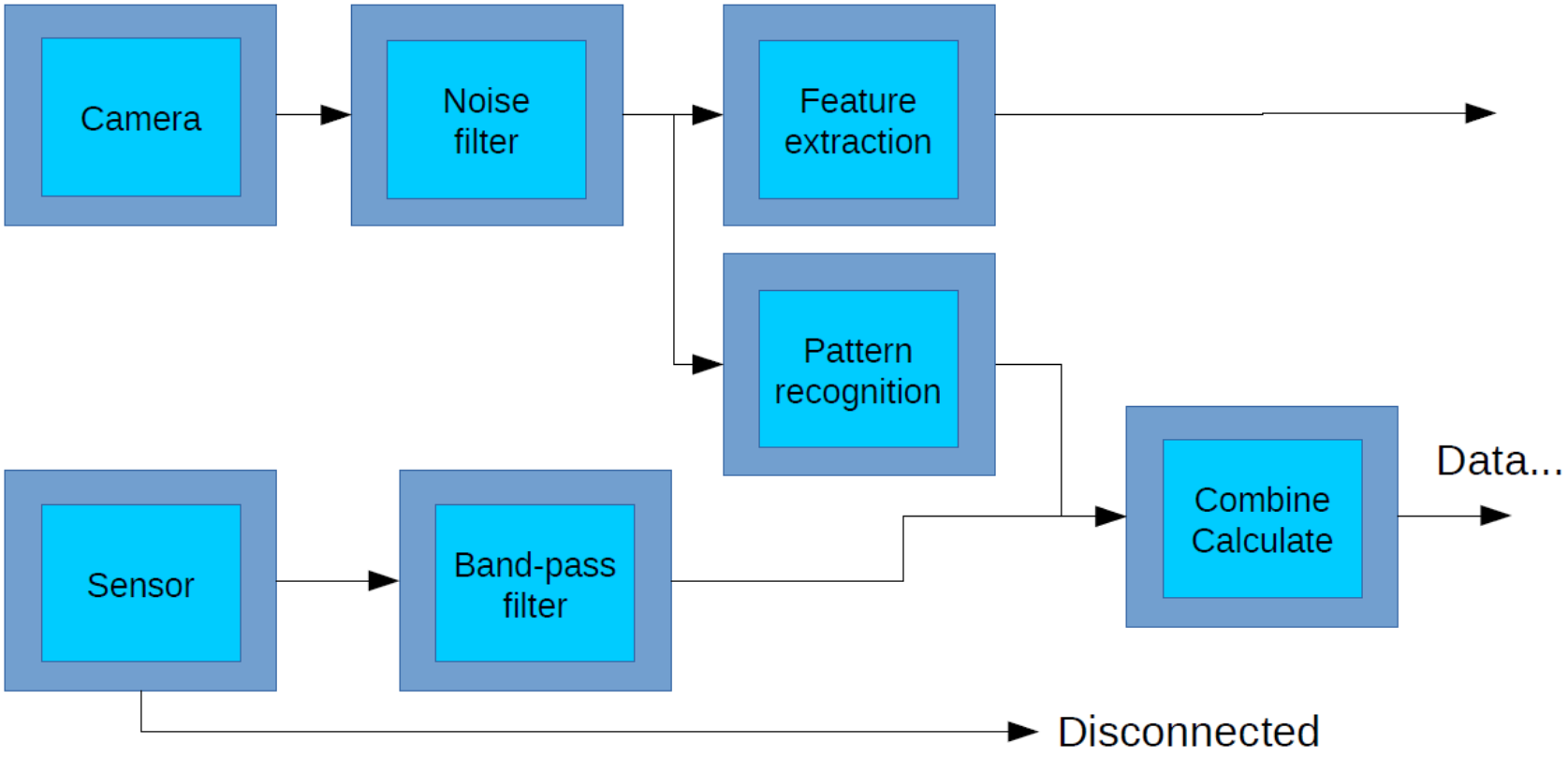


- For Miami SoMs
- USB OTG, SD, Ethernet, JTAG, PMOD
- PCIe
- SATA, power, battery, HDMI in, HDMI out, WiFi

Tooling

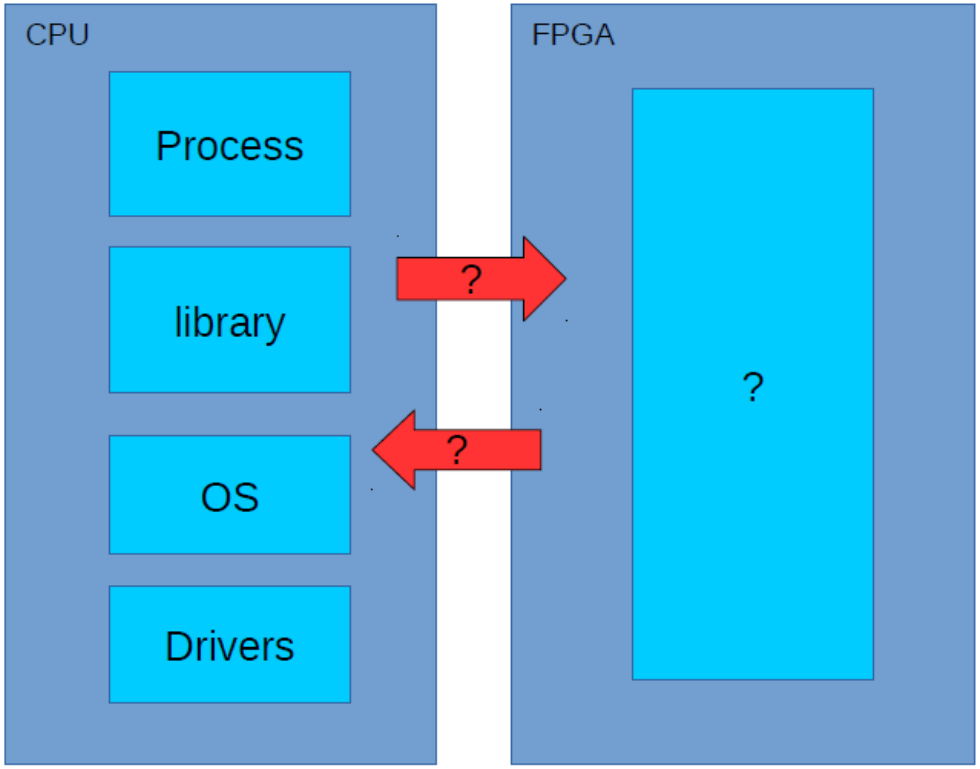
- Maintained Linux BSP
  - Available from GitHub (meta-topic)
  - Yocto and OpenEmbedded support
  - BSP support for all Florida and Miami peripherals
  - Built-in Support for Qt, Java, GTK-based desktop
  - Continuous mainlining effort
- Vivado FPGA development
  - Miami and Florida board configuration integration
- Dyplo
  - Operating system style infrastructure on FPGA
  - FPGA programming from software
  - High-level synthesis support (C/C++ to logic)
  - Seamless PCIe and AXI support

Processing Pipeline



FPGA Programming

- VHDL
- Verilog
- Synthesize
- Place & Route
- DMA
- AXI, PCIe
- Synchronization
- IPC



Dyplo

DYnamic Process LOader

Providing developers the ability to connect to various processing units of choice while dynamically loading, distributing and controlling tasks

TOPIC EMBEDDED PRODUCTS

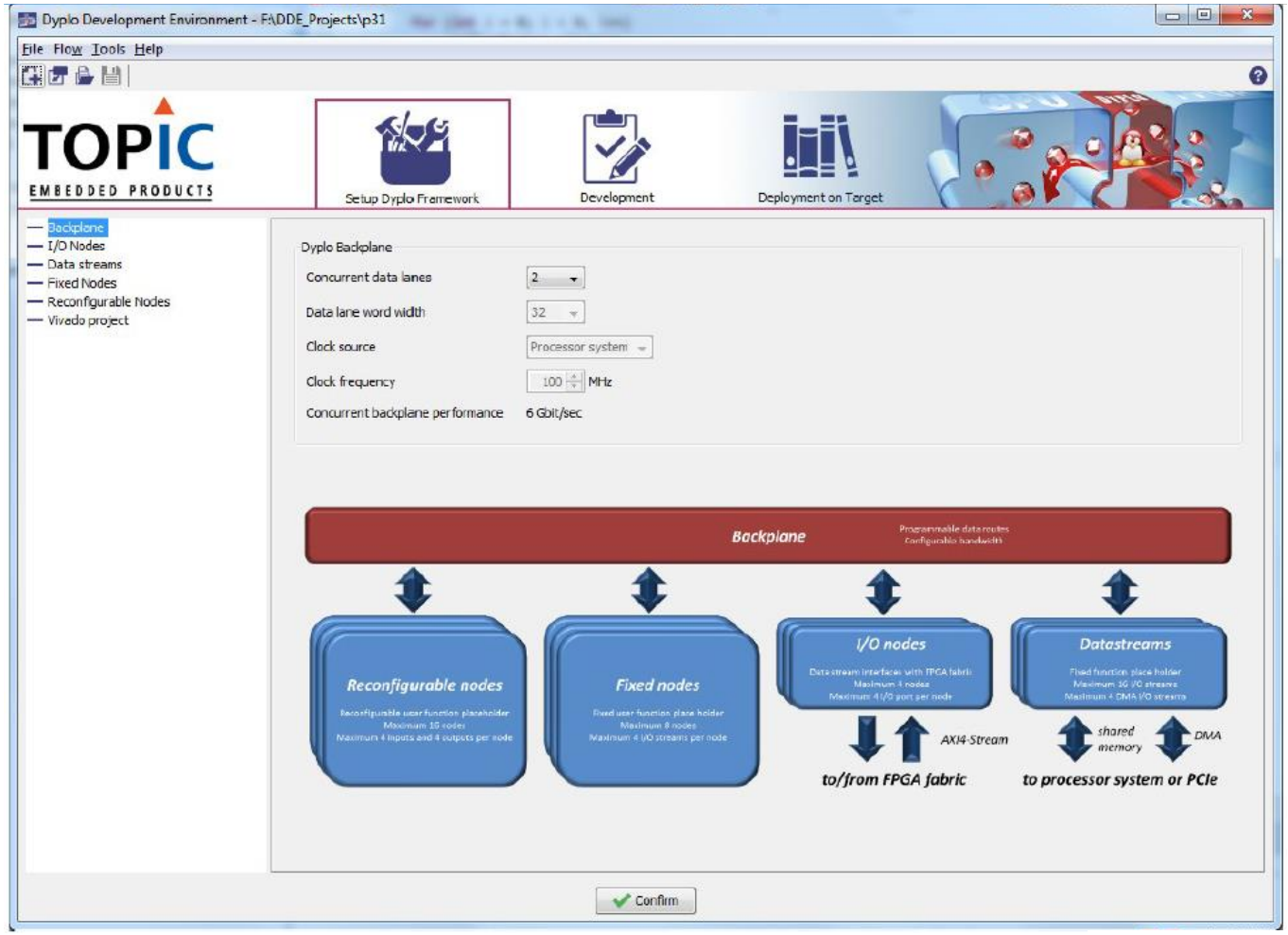
XILINX ALLIANCE PROGRAM PREMIER

XILINX ALL PROGRAMMABLE.

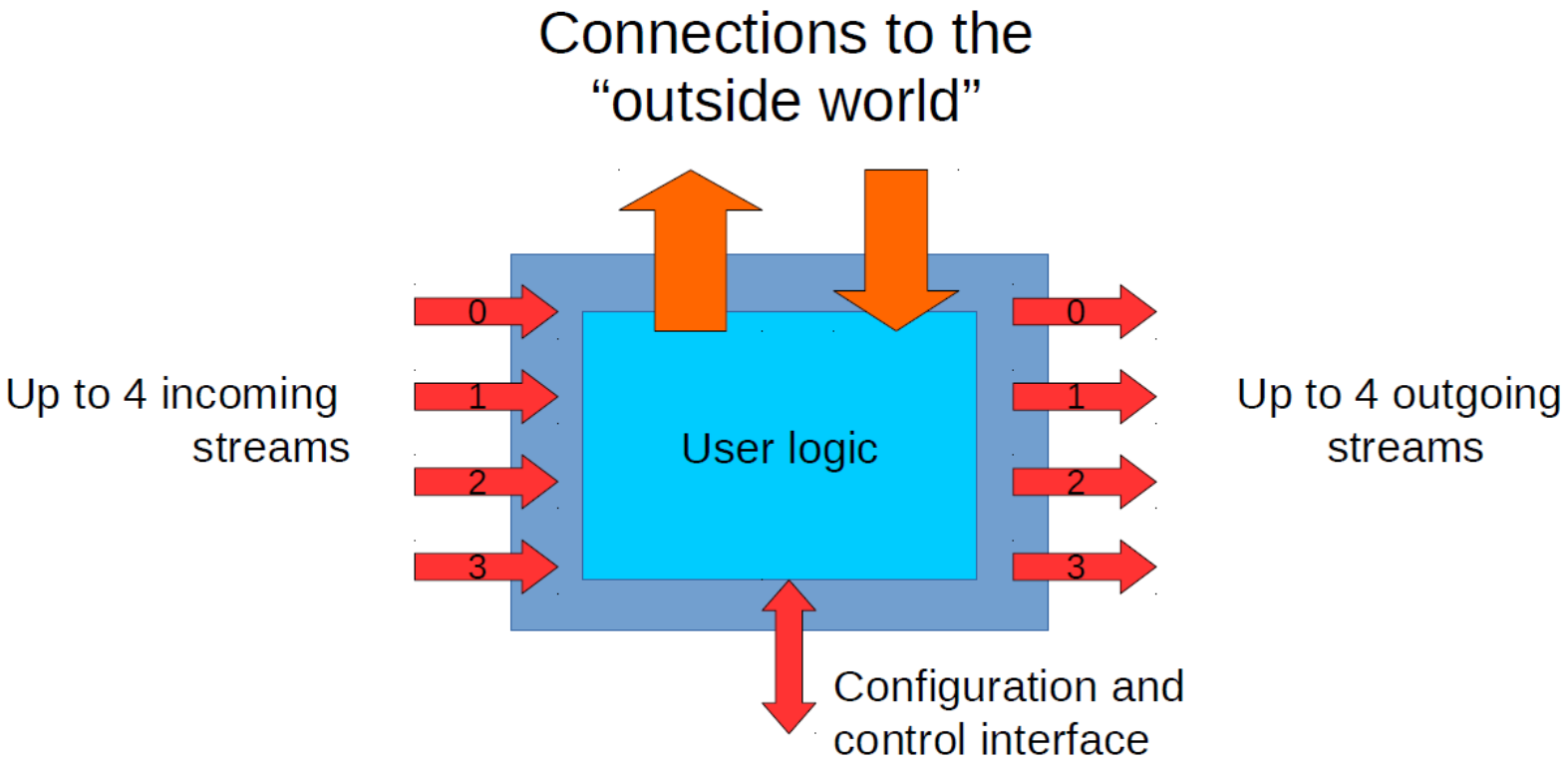
Dyplo Benefits

- Integrated runtime reconfiguration:
  - Runtime: re-use of FPGA logic
  - Design time: faster development, shorter development cycles, flexibility of programming
  - End result: less logic
- Easy data-transfer between CPU and FPGA
  - Fully runtime configurable
- FPGA programming also for software engineers
- Integration of (own) IP blocks
- Toolkit for multiple and variable platform combinations
- Iterative results enabling implementation improvements

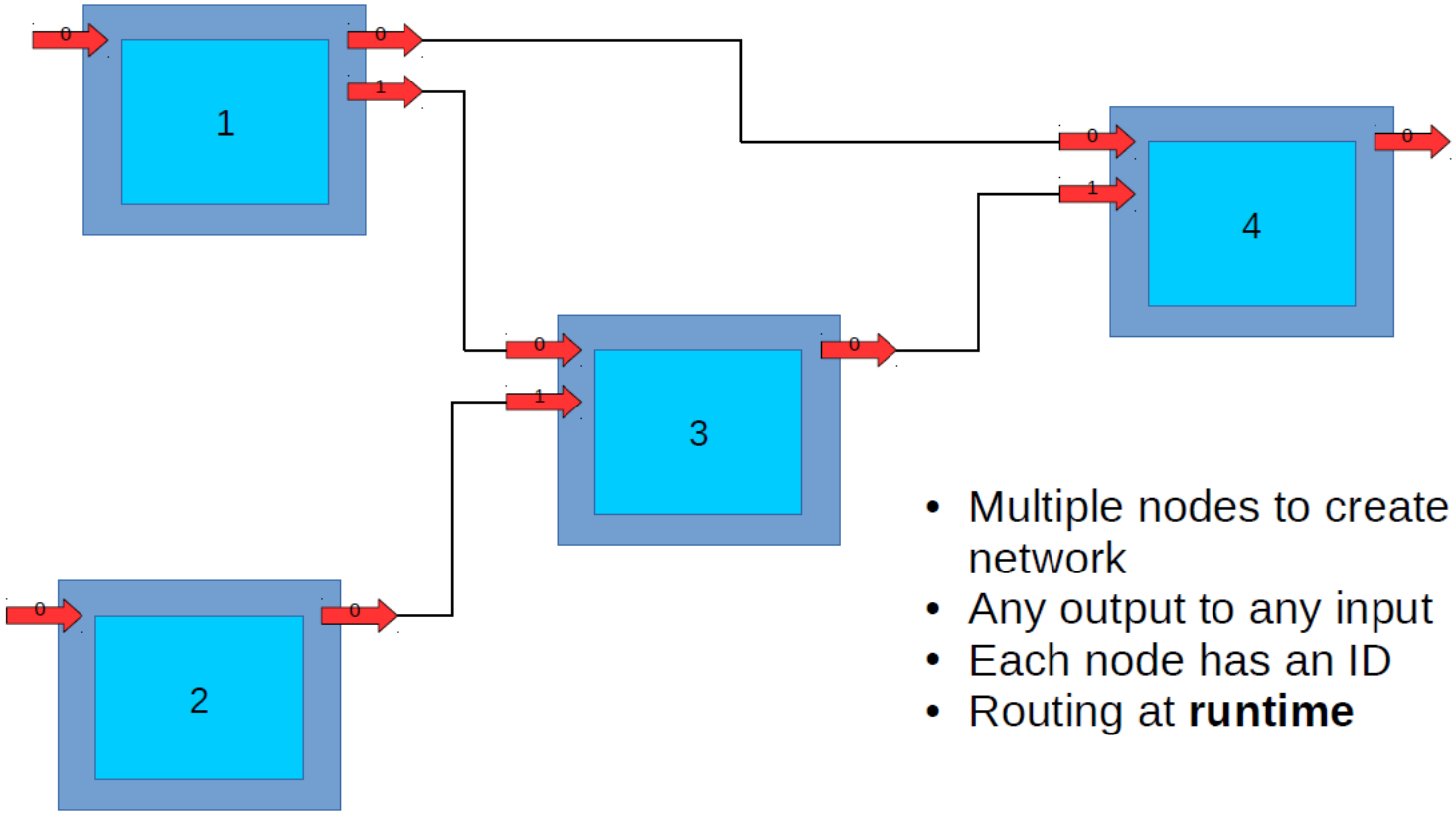
Development Environment



Dyplo Node



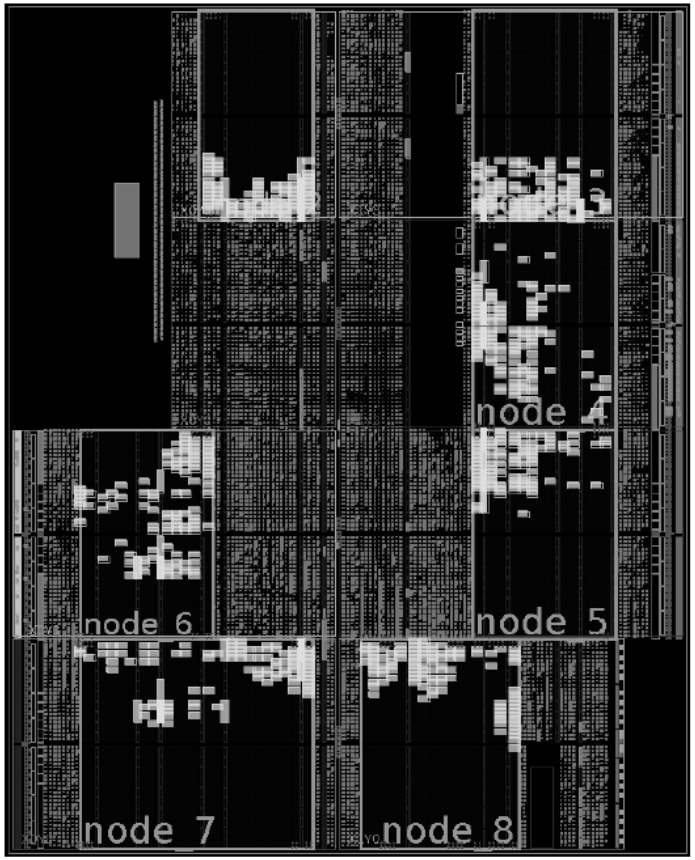
Dyplo Network



- Multiple nodes to create a network
- Any output to any input
- Each node has an ID
- Routing at **runtime**

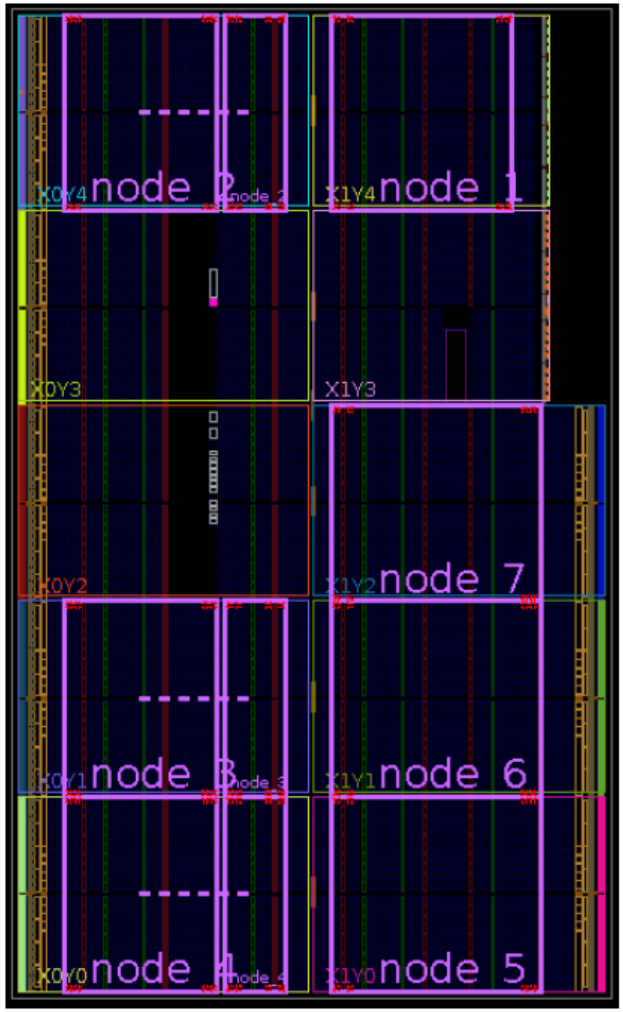
Dyplo “PR” Node

- PR = Partially Reconfigurable
- Resources set during (static) configuration
- Like RAM:
  - Unlimited programming cycles
  - Fast programming (transfer speed)
  - Never “empty”
- “Fixed-size shared library”



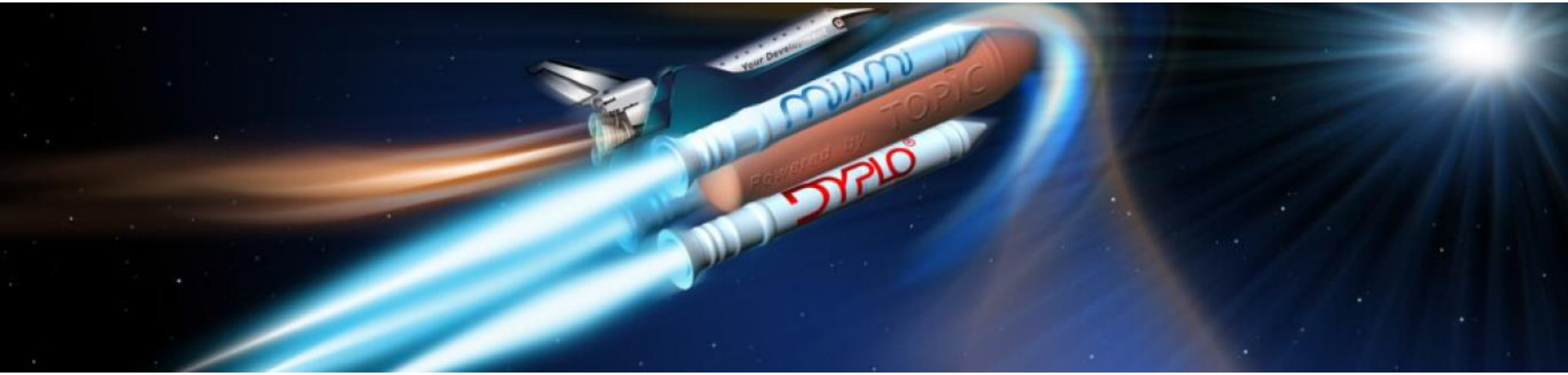
Dyplo “PR” Node

- Programming does not “disturb” other nodes
- Only access to Dyplo infrastructure
  - No access to I/O pins for example
  - But can “talk” to other Dyplo nodes that can!
- Functionally equivalent to “fixed” node



Dyplo

Accelerate you development



TOPIC EMBEDDED PRODUCTS

XILINX ALLIANCE PROGRAM PREMIER

XILINX ALL PROGRAMMABLE.

Lessons Learned

- Software first
  - Often more effort spent on software development than any other subsystem.
  - Have it ready before the hardware (and logic) designs are finalized.
  - Clear hardware requirements and interaction.
  - Early risk (and cost) reduction.
  - Small hardware changes, big gains.
- Prototype everything
  - (Again) reduce risk
  - Use evaluation boards and modules
  - Clear requirements and interaction
  - Small changes can make a big difference
- Use existing infrastructure
  - Operating system
    - There are reasons they exist
  - Support
    - Fall back on know-how of partners and suppliers
  - Dyplo
    - No need to write drivers

Conclusion

- The Embedded Vision market is growing fast
- Xilinx is the best platform for Embedded Vision for…
  - Any-to-Any Connectivity
  - Sensor Fusion
  - Real-Time Analytics at the Edge
- Multi Camera Vision, OpenCV and Machine Learning key trends
- TOPIC & Xilinx Make Embedded Vision Development Easy
  - DYPLO
  - Miami SOM
  - Florida Carrier Board

Email: embedded-vision@xilinx.com for this presentation

Empowering Product Creators to Harness Embedded Vision

The Embedded Vision Alliance (www.Embedded-Vision.com) is a partnership of 50+ leading embedded vision technology and services suppliers

Mission: Inspire and empower product creators to incorporate visual intelligence into their products

The Alliance provides low-cost, high-quality technical educational resources for product developers

Register for updates at www.Embedded-Vision.com

The Alliance enables vision technology providers to grow their businesses through leads, ecosystem partnerships, and insights

For membership, email us: membership@Embedded-Vision.com

Join us at the Embedded Vision Summit

May 1-3, 2017—Santa Clara, California

The only industry event focused on enabling product creators to create "machines that see"

- *"Awesome! I was very inspired!"*
- *"Fantastic. Learned a lot and met great people."*
- *"Wonderful speakers and informative exhibits!"*

Embedded Vision Summit 2017 highlights:

- **Inspiring keynotes** by leading innovators
- High-quality, practical **technical, business and product talks**
- Exciting **demos** of the latest apps and technologies

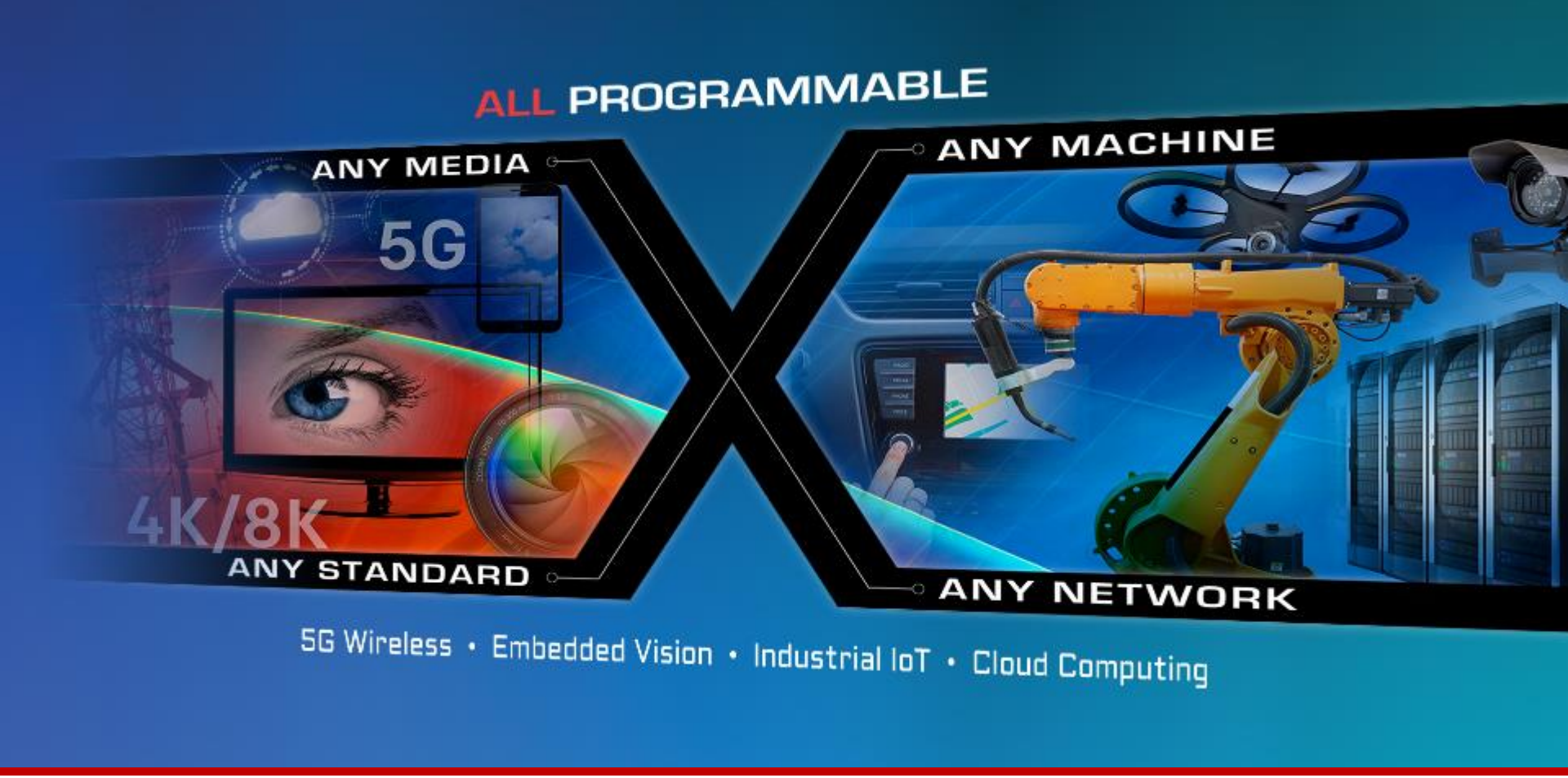
Visit www.EmbeddedVisionSummit.com to sign up for updates

For a copy of today's presentation with URLs to learn more about the solution providers presented, email a request to:

embedded-vision@xilinx.com

Xilinx Vision with Precision Webinar Series

- Monitoring Things: Medical Imaging
- Perceiving Environment / Taking Action
  - *ADAS and the Road to Autonomous Vehicles*
  - *Drones & Other Vision Guided Robotics*
  - *Augmented, Virtual and Mixed Reality*



XILINX
ALL PROGRAMMABLE

Vision with Precision Webinar Series

Medical Imaging

Aaron Behman, Xilinx
Mike Looijmans, TOPIC Embedded Products