High Speed Interfaces for Machine Vision

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euresys
Empowering Computer Vision

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Workshop 2023
ePicture This

Organized by Penta projects:
2020005 Mantis Vision
2021004 Imagination

Penta Xecs EURIPIDES² European Smart Electronic Systems Aeneas

Overview

- What is Machine Vision?
- Machine Vision & Standards
- High-speed Interface Standards
  - Camera Link
  - CoaXPress
  - Camera Link HS
  - GigE Vision
  - USB3 Vision
- Interface Standards Comparison
- BONUS: Universal software interface => GenICam

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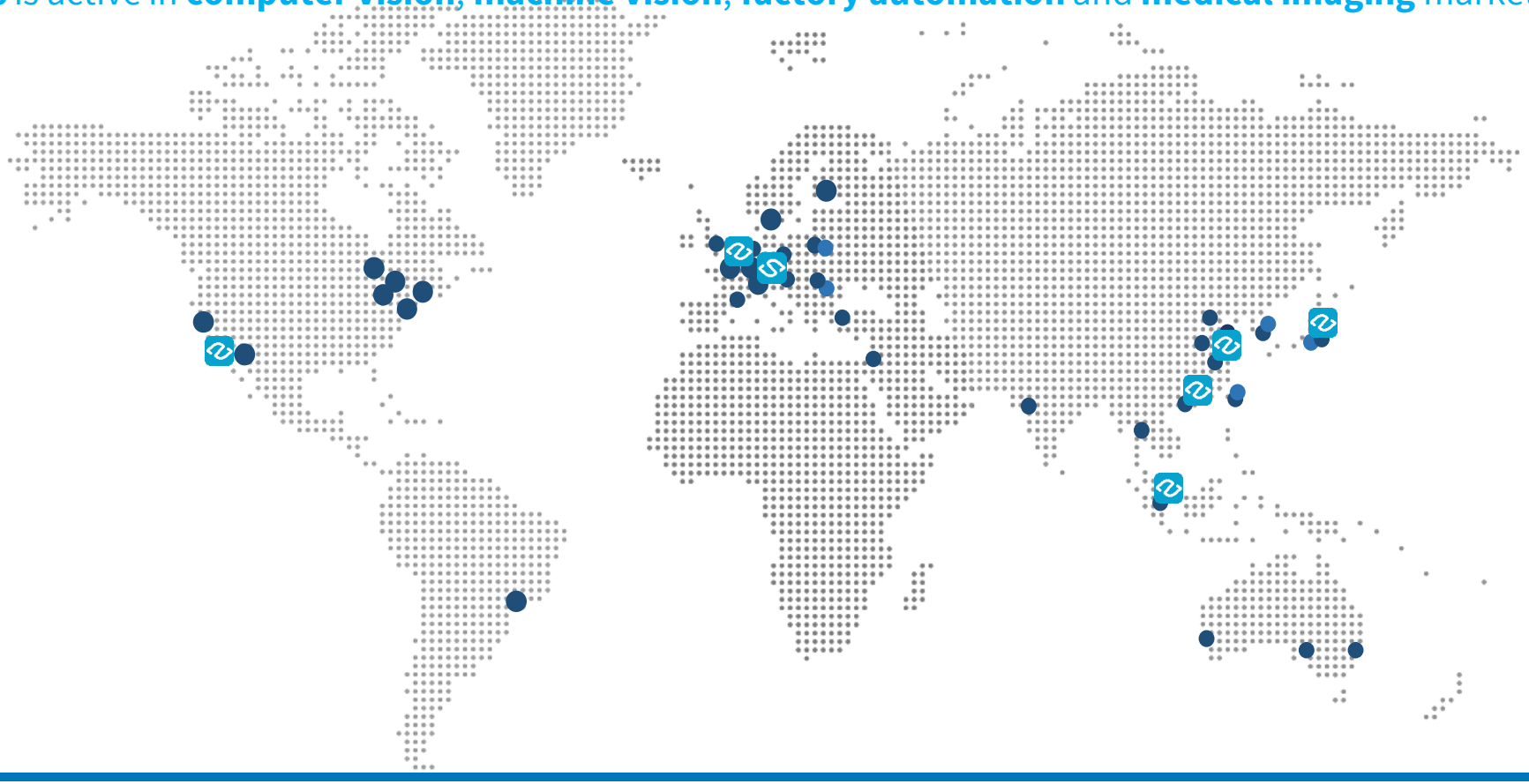
Euresys is a leading and innovative high-tech company, **designer and provider of image and video acquisition components, frame grabbers, FPGA IP cores and image processing software**.

Euresys is active in **computer vision**, **machine vision**, **factory automation** and **medical imaging** markets.



Member of:

JIIA

emva
european machine vision association

CMVU 机器视觉产业联盟
China Machine Vision Industry Union

&

GiGE VISION

CoaXPress®

Technical Committees

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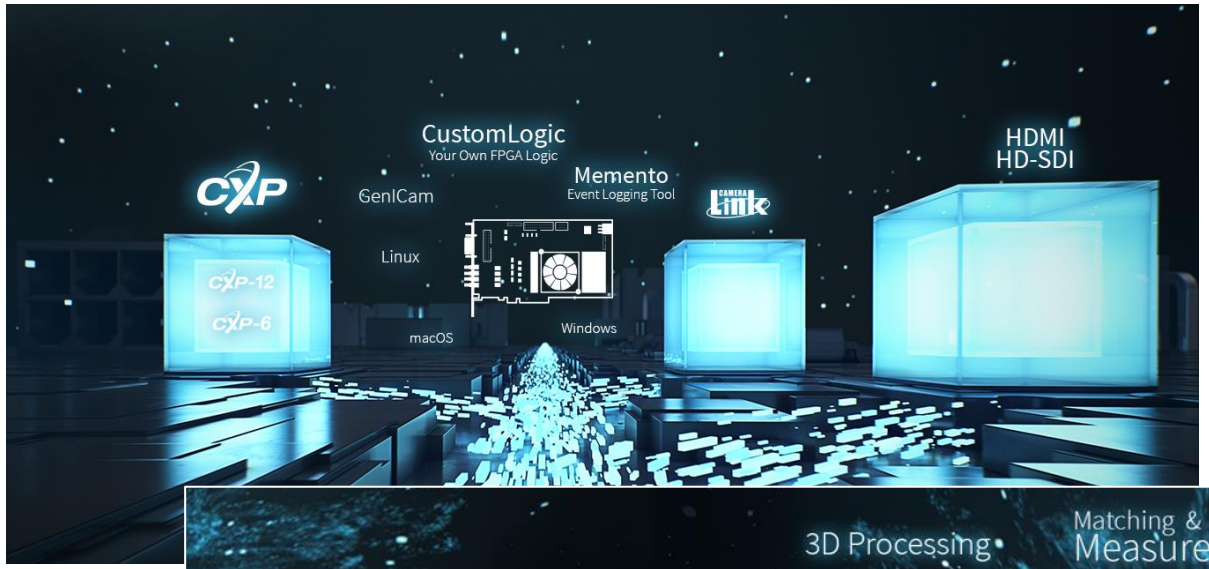
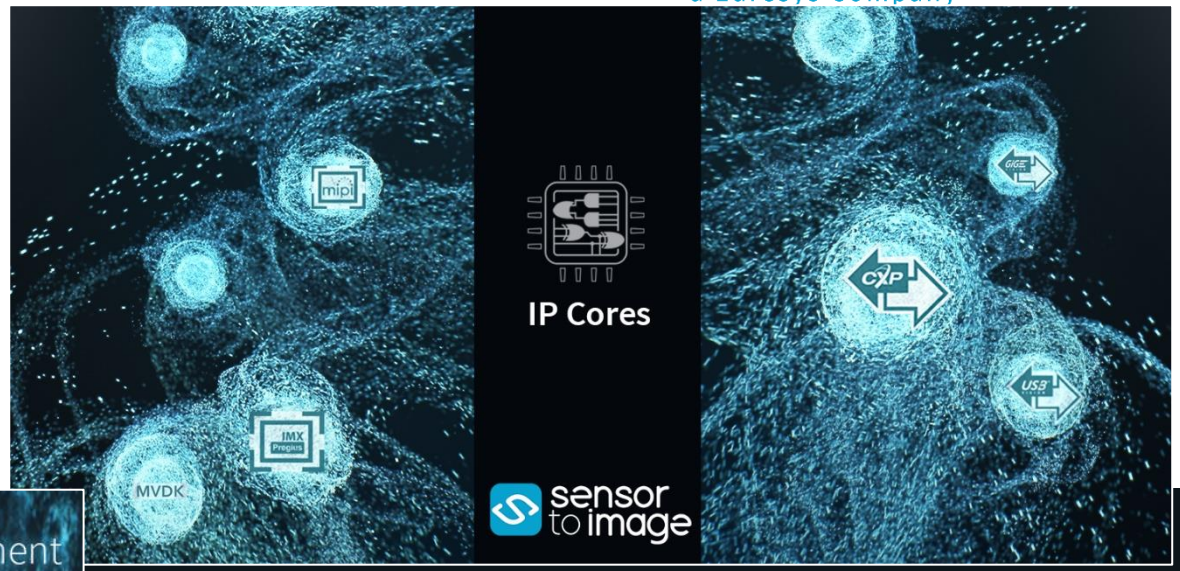
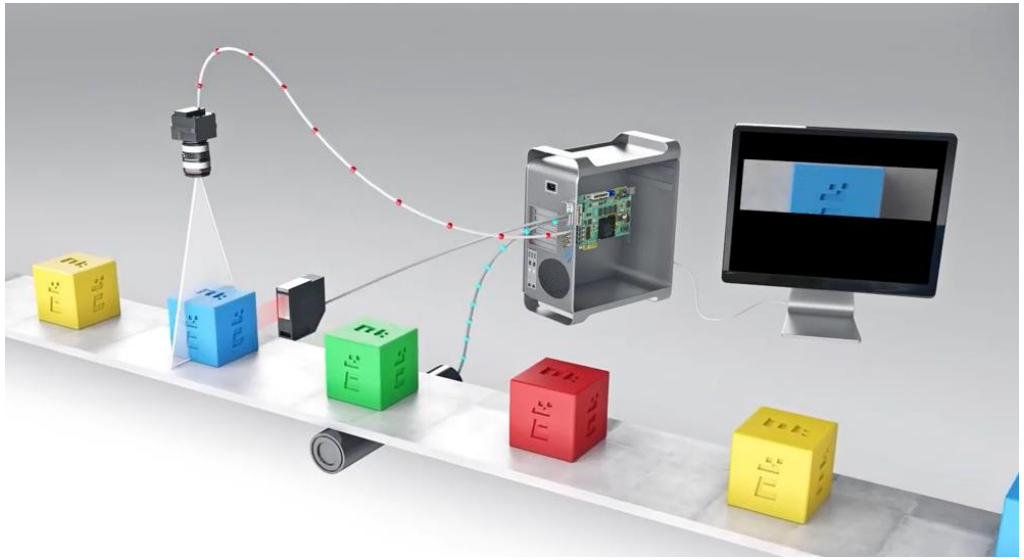




What is Machine Vision?

"Machine Vision is an especial case of the Computer Vision field where a computer vision system is integrated into a machine to automate its process"



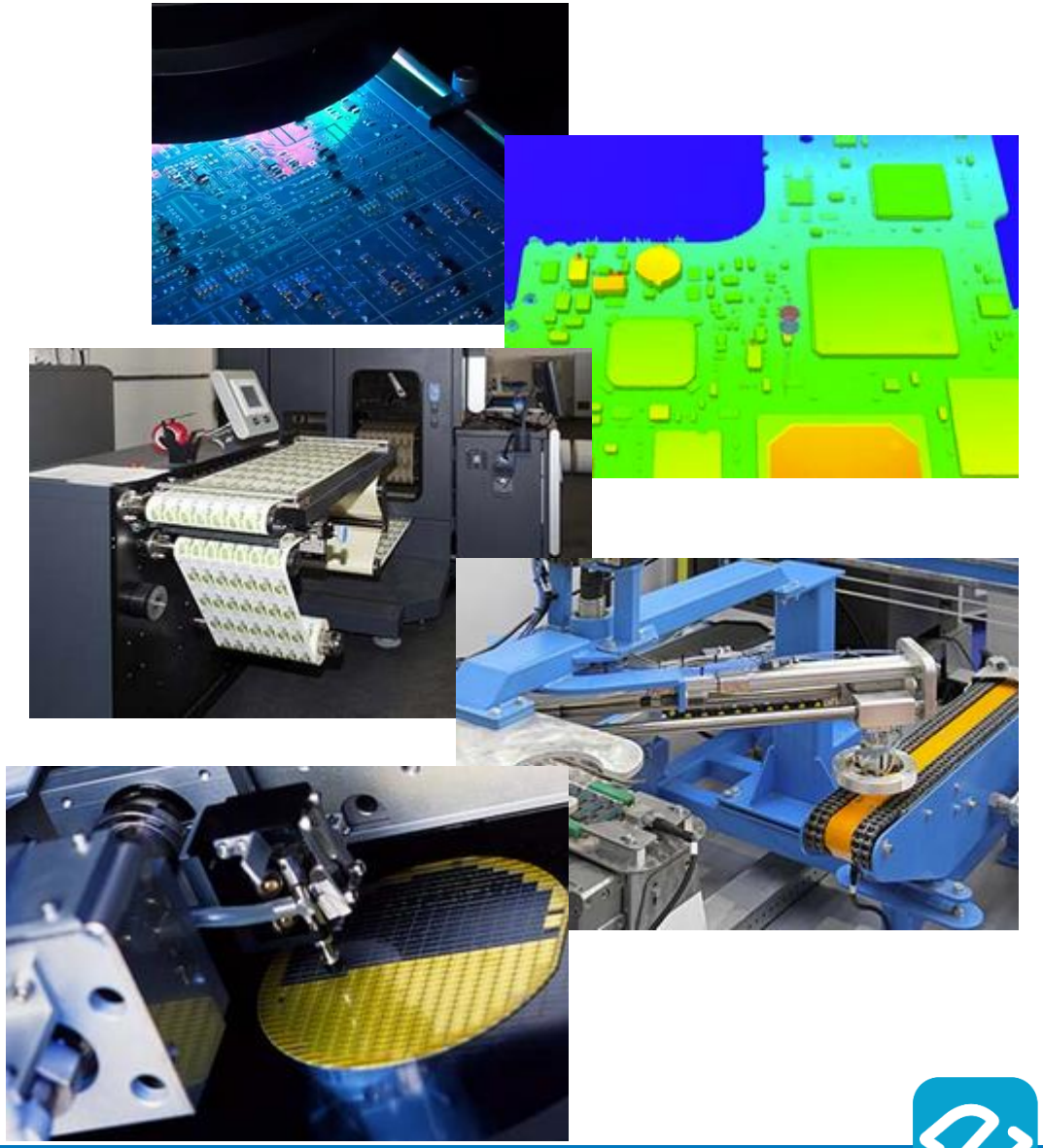
What is Machine Vision?

Goals:

- Quality, repeatability, and speed

Typical Applications:

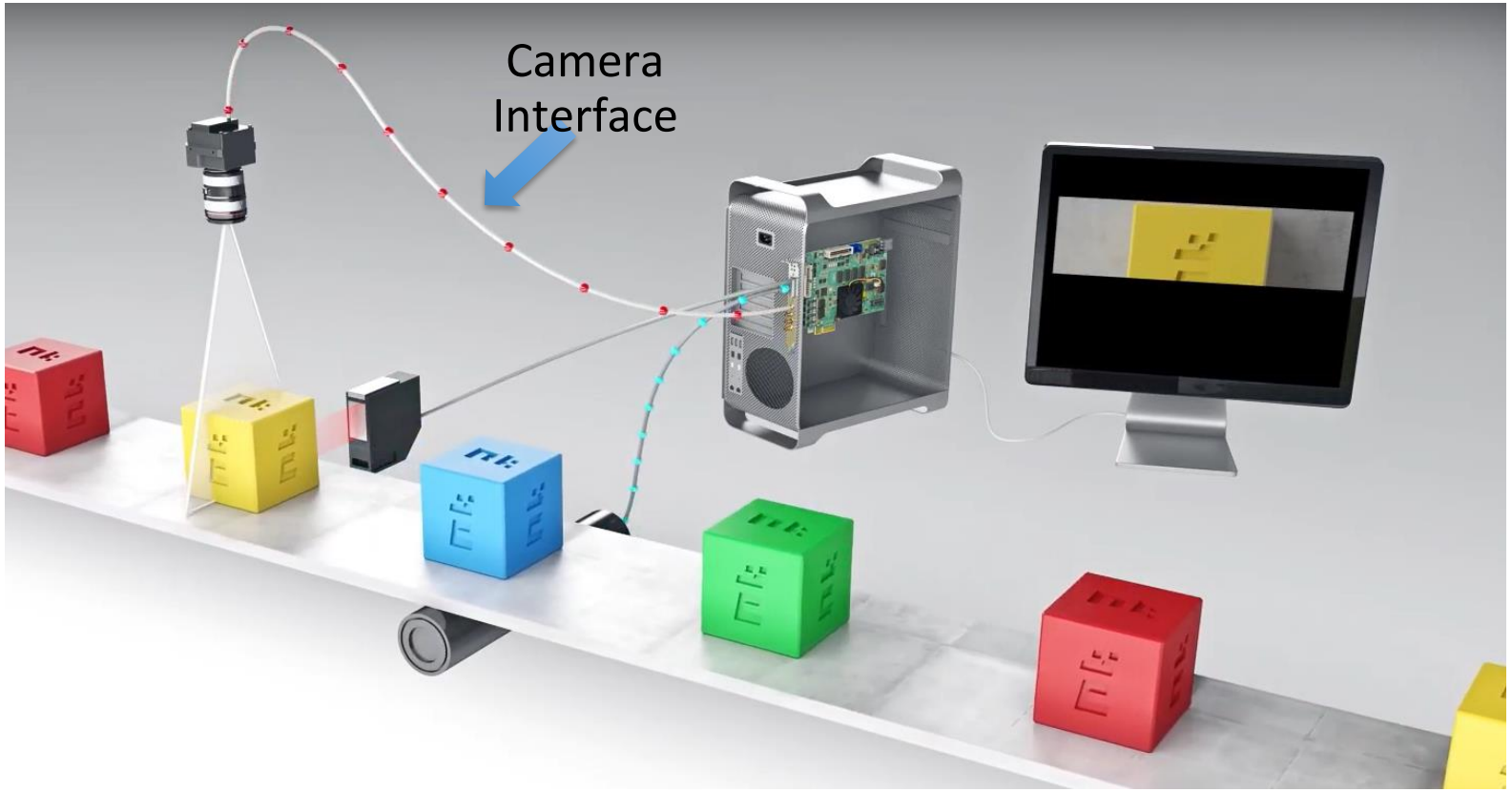
- AOI, 3D SPI, BGA ball inspection
- Flat Panel Display inspection
- PCB alignment
- Pick and place
- Wire and die bonding
- LED inspection
- Printing and packaging
- Food inspection and sorting
- Glass inspection
- Surface inspection



Machine Vision & Standards

The use of products compliant to international standards
is key to guarantee the interoperability between components
from different manufactures

High-speed Interface Standards



- Transfer images to the host PC
- WR/RD camera registers
- Control acquisition (triggers)
- (Optional) Transfer camera events/alarms
- (Optional) Power the camera

- Standard association: A3 (October 2000)
- Max bandwidth: 850 Mbytes/s @ 80-bit mode (2x cables)
- Max cable reach: 7 m
- Receiver type: Frame grabber
- Power over Cable: Yes
- Camera trigger: 4 direct signals
- Roadmap: None

Source: www.adimec.com

Source: www.stemmer-imaging.com

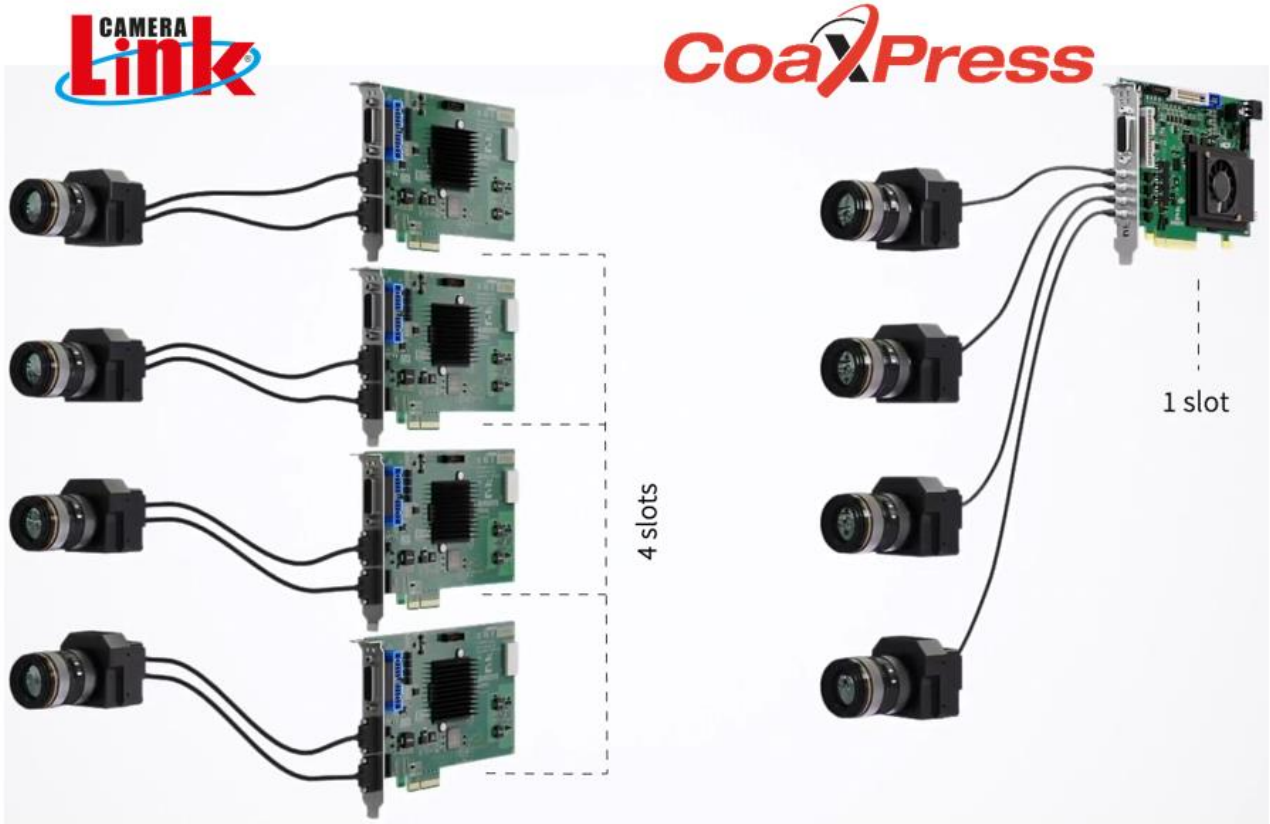
Source: www.euresys.com

CoaXPress®

- Standard association: JIIA (December 2010)
- Max bandwidth: 1250 Mbytes/s (1x cable @ CXP-12)
  5000 Mbytes/s typical (4x cables @ CXP-12)
- Max cable reach: 40 m (coax) / 40 km (fiber)
- Receiver type: Frame grabber
- Power over Cable: Yes (coax)
- Camera trigger: Packet based (2 ns precision)
- Roadmap: 2500 Mbytes/s (coax)
  3125 Mbytes/s (fiber)
  6250 Mbytes/s (fiber)

Source: www.fs.com

Source: www.euresys.com



3400 Mbytes/s (7 m)

5000 Mbytes/s (40 m)

CAMERA Link HS®

- Standard association: A3 (May 2012)
- Max bandwidth: 1200 Mbytes/s (1-lane @ C3)
  8400 Mbytes/s typical (7-lane cable @ C3)
- Max cable reach: 15 m (copper) / 5 km (fiber)
- Receiver type: Frame grabber
- Power over Cable: No
- Camera trigger: Packet based (3.2 ns precision)
- Roadmap: 3125 Mbytes/s (fiber)
  6250 Mbytes/s (fiber)

Source: www.alysium.com

- Standard association: A3 (May 2006)
- Max bandwidth: 1100 Mbytes/s (1x cable @ 10G)
- Max cable reach: 100 m (CAT-5e) / 5 km (fiber)
- Receiver type: Common PC interface
- Power over Cable: Yes
- Camera trigger: Packet based (PTP precision)
- Roadmap: 3125 Mbytes/s (25G)
  RoCE v2 (RDMA)

Source: www.fs.com

- Standard association: A3 (January 2013)
- Max bandwidth: 400 Mbytes/s (SuperSpeed Gen1)
- Max cable reach: 3 m (copper) / 100 m (AOC)
- Receiver type: Common PC interface
- Power over Cable: Yes
- Camera trigger: Packet based
- Roadmap: 800 Mbytes/s (SuperSpeed+ Gen2x1)
  1600 Mbytes/s (SuperSpeed+ Gen2x2)
  Thunderbolt

Source: www.alysium.com

Interface Standards Comparison

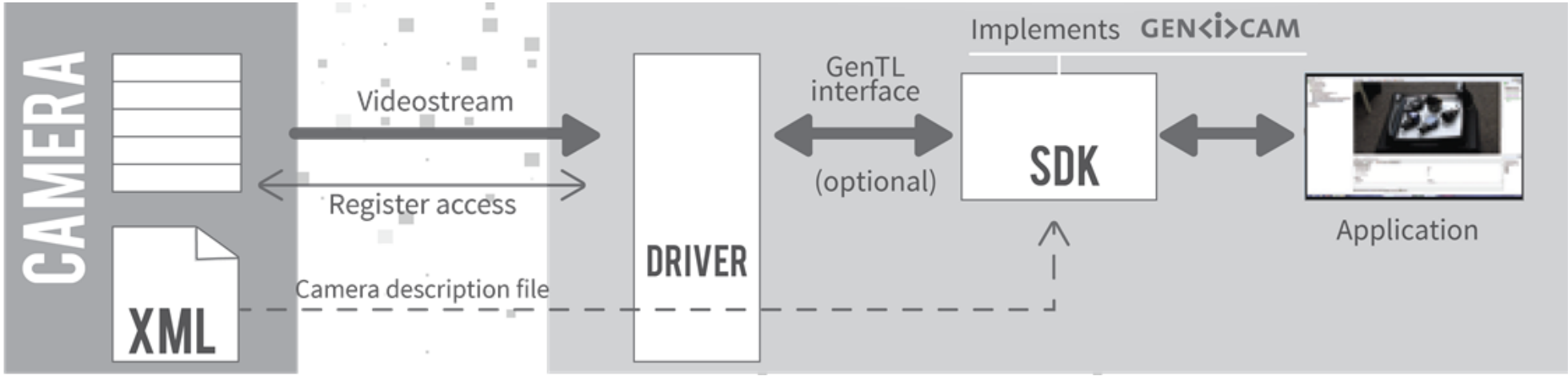
	High Bandwidth	Max Cable Reach	Low Latency	High Trigger Precision	Low CPU Load	Low System Cost	Popularity
Camera Link	✓✓	✓	✓✓✓✓✓	✓✓✓✓✓	✓✓✓✓✓	✓✓✓	✓✓✓
CoaXPress	✓✓✓✓,✓	✓✓✓✓✓	✓✓✓✓	✓✓✓✓	✓✓✓✓✓	✓✓	✓✓
Camera Link HS	✓✓✓✓✓	✓✓✓✓	✓✓✓✓	✓✓✓	✓✓✓✓✓	✓	✓
GigE Vision	✓✓✓	✓✓✓✓	✓✓	✓✓	✓	✓✓✓✓	✓✓✓✓✓
USB3 Vision	✓	✓✓	✓	✓	✓✓	✓✓✓✓✓	✓✓✓✓

BONUS

Universal software interface => GenICam

GEN<i>CAM

- EMVA (September 2006)
- Genicam support for camera control and image acquisition
  - GenAPI: camera and frame grabber control API
  - GenTL: image delivery API, camera communication API



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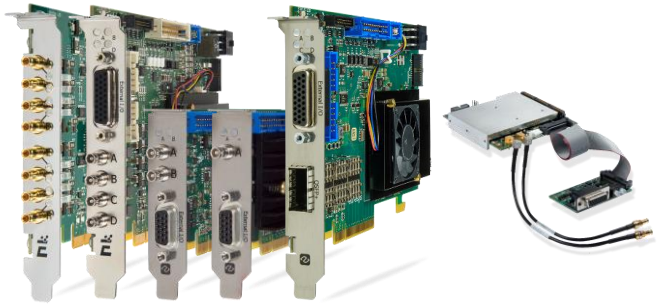
Frame Grabbers



CoaXPress

CAMERA Link

Standard IPs

CoaXPress IP Core
COAXPRESS IP CORE FOR FPGA

CoaXPress-over-Fiber Bridge IP Core
COAXPRESS-OVER-FIBER BRIDGE IP CORE FOR FPGA

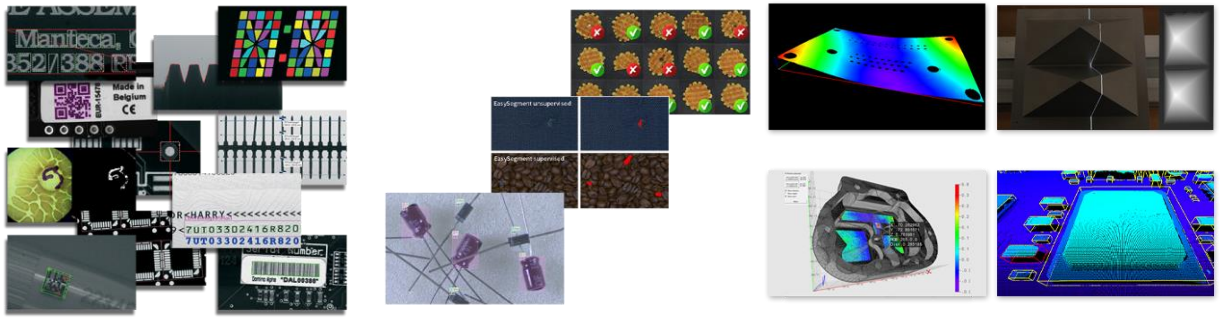
GigE Vision IP Core
GIGE VISION IP CORE FOR FPGA

USB3 Vision IP Core
USB3 VISION IP CORE FOR FPGA

IMX Pregius IP Core
IP CORE FOR SONY PREGIUS SUB-LVDS IMAGE SENSORS

MIPI CSI-2 Receiver IP Core
IP CORE FOR MIPI CSI-2 IMAGERS

Image Processing Libraries



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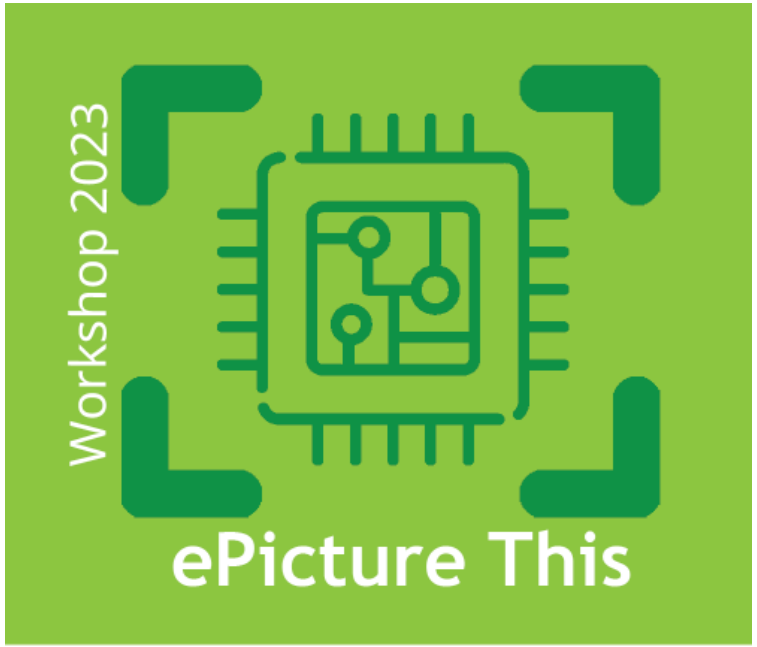

an initiative by PENTA label projects
MANTIS and IMAGINATION with AENEAS support

THANK YOU

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