
# High-end Multi-camera Technology, Applications and Examples

ximea

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# Overview

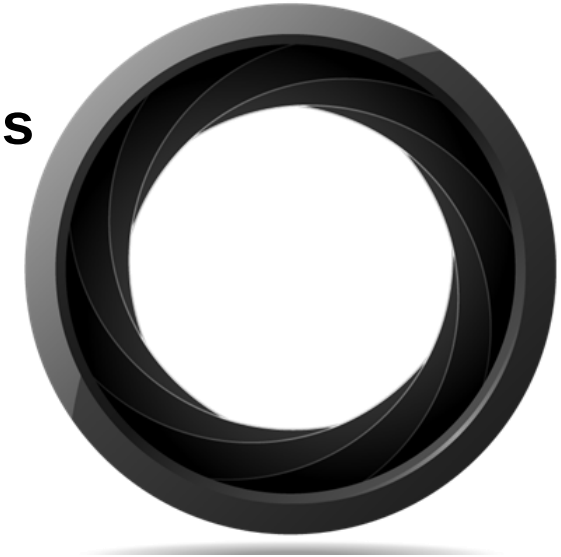
- XIMEA Quick Intro
- Multi-camera Applications
- Technologies to Build a Multi-camera System
- Advantages of PCI Express as an Interface
- Multi-camera System Architecture Based on XIMEA's PCIe Components
- Examples of Multi-camera systems and Performance

# XIMEA Quick Intro

# XIMEA Quick Intro

- Versatile camera manufacturer for more than 25 years
- Recognized as an innovator in machine vision and imaging markets
- Located in Germany, Slovakia and USA
- 50% standard and 50% custom/OEM products:
  - Sensor resolutions from VGA to 50 Mpix
  - Frame rates up to 3500 fps
  - API/SDK support for variety of operating systems and hosts
  - Multiple interfaces, short/medium/long distances
  - Extremely compact camera arrangements
  - Aggregation of data from multiple imagers into a single cable

# Multi-camera Applications and Technologies

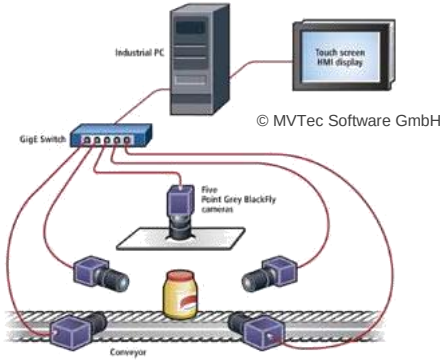


# Multi-camera Arrangements

- Inside-out
  - Ozo, Cyclomedia
- Outside-in
  - Stadiums, 3D scanning, Photogrammetry
- Array
  - Lytro
- Cluster - multiple groups of a few cameras each
  - ir-ltd, several groups of 3-4 cameras

# Multi-camera Applications

- A few cameras: **2…6 cameras**
  - Factory automation
  - UAV payloads
  - Stereo vision, face/motion capture



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# Multi-camera Applications

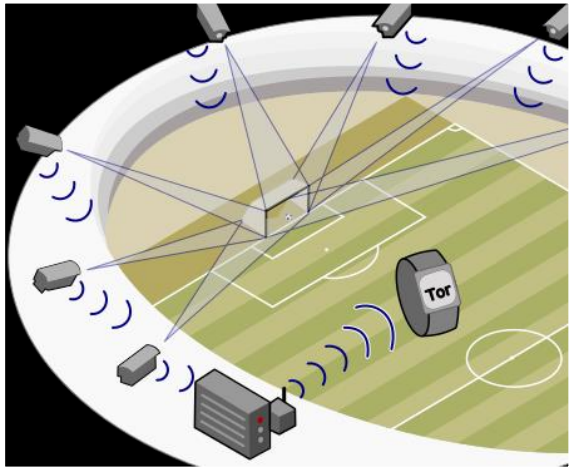
- Several cameras: **5…12 cameras**
  - Cyclorama imaging
  - ADAS
  - 360° spherical imaging

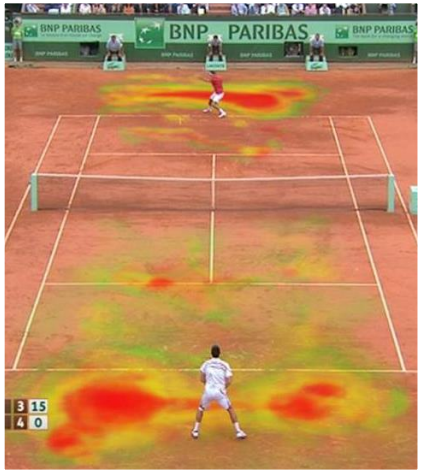
© Cyclomedia

**Nokia Ozo**

# Multi-camera Applications

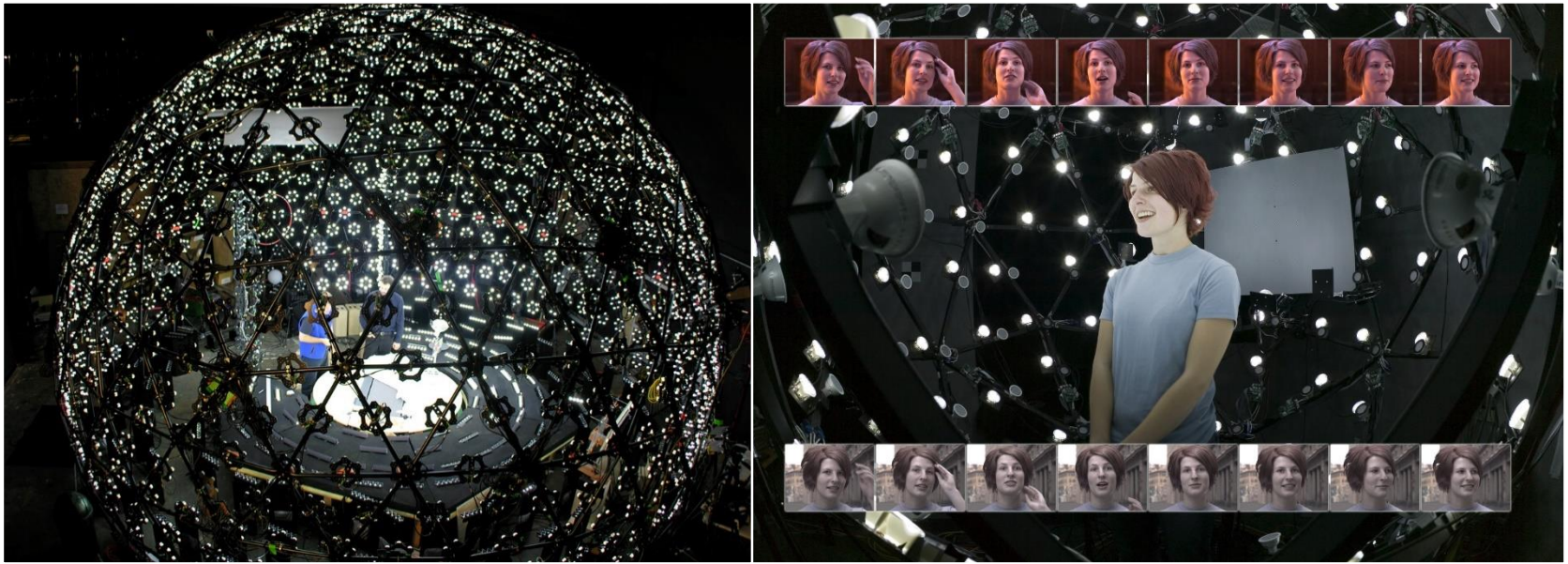
- Multiple cameras: **12…50+ cameras**
  - Sports, goal lines, ball trajectories



# Multi-camera Applications

- Multiple cameras: **12…50+ cameras**
  - 3D scanning rigs and photogrammetry



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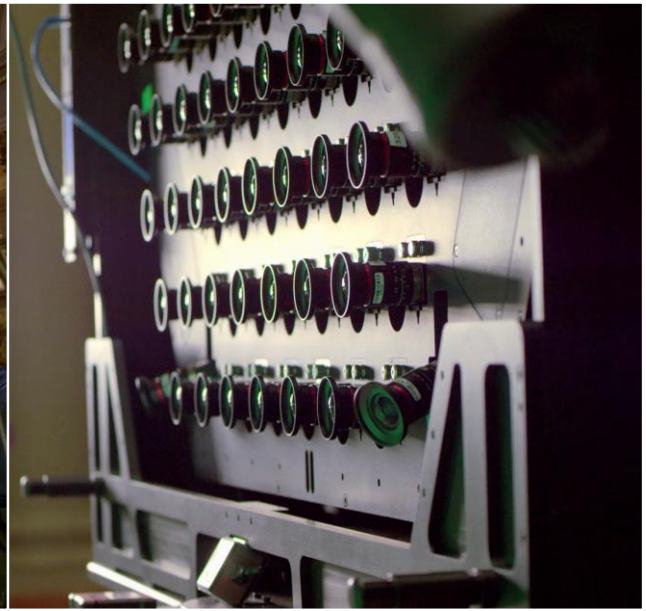
# Multi-camera Applications

- Multiple cameras: **12…50+ cameras**
  - AR/VR capturing



© Lytro, www.lytro.com

# Typical Multi-camera Application Requirements

- Camera resolutions 3 to 50 Mpix, and more
- Number of cameras per system from 2 to more than 100
- Frame rates per camera from 10 fps to 240 fps and even higher
- Distance between cameras and the host from few centimeters to hundreds of meters
- Triggering and synchronization:
  - Master-slave
  - External, genlock

# Architecture Challenges of Multi-camera Deployment

- Delivery of data from multiple high-end cameras to processor
  - Multi-gigabit data rates
  - Multiple cables, multiple interface cards/controllers
  - Bottlenecks and congestions in the PC host infrastructure
- High-bandwidth storage for real-time recording
  - E.g. 120x 12 Mpix cameras @ 60 fps requires >86 GB/s bandwidth!!!
- In some cases (lossless) compression is required, which adds processing demands

# Speed. Distance. Freedom.

## Cameras with 64Gbit/s PCI Express interface

# Advantages of PCIe as a Camera Interface

- Scalable bandwidth 5…64 Gbit/s
- Multiplexing several camera data streams into one cable
- Heterogeneous downstreams, homogeneous upstream
- Support for different cables:
  - Compact connectors with transceivers (FireFly)
  - Fiber optic up to 300 m, mil-spec MTP
  - Copper cables up to 7 m
- Minimal latencies for image delivery
- Widely available on various computing platforms:
  - PC (NUC, ComExpress), ARM (Jetson TX1/2, Snapdragon, Freescale)

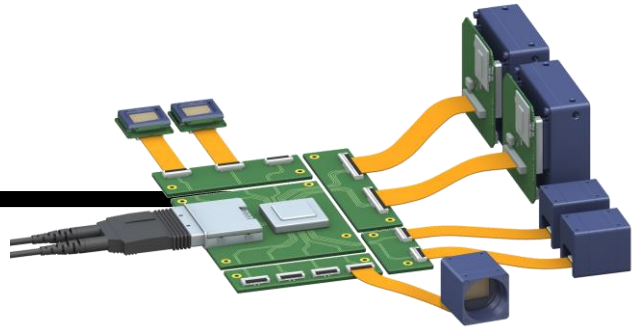
# xPlatform – Multi-camera Technology


xPlatform

# xPlatform definition

- PCIe and USB 3.1 Cameras:
  - xiX, xiB, xiQ, xiC


- PCIe Aggregation Technology:
  - xSwitch



# XIMEA Cameras

- Variety of form factors
  - Board level, compact, full-frame
- Range of sensor resolutions, pixel sizes and framerates
  - VGA … 50Mpix
  - 2.5 to 10 µm
  - 3500 @ HD resolution
- Lens interfaces
  - M12 (S-mount)
  - C/CS-mount
  - Active Canon EF

# XIMEA Cameras – xiX Small Form Factor

- PCIe Gen2 x2, C/CS-mount (26.4 x 26.4 x 30.9)
- Sony Pregius and fast CMOSIS CMV sensors,
- Up to 1.1” optical format
- 2 PCIe lanes for up to 10 Gbit/s bandwidth
- Standard C-mount, convertible to CS-mount
- Board-level version available

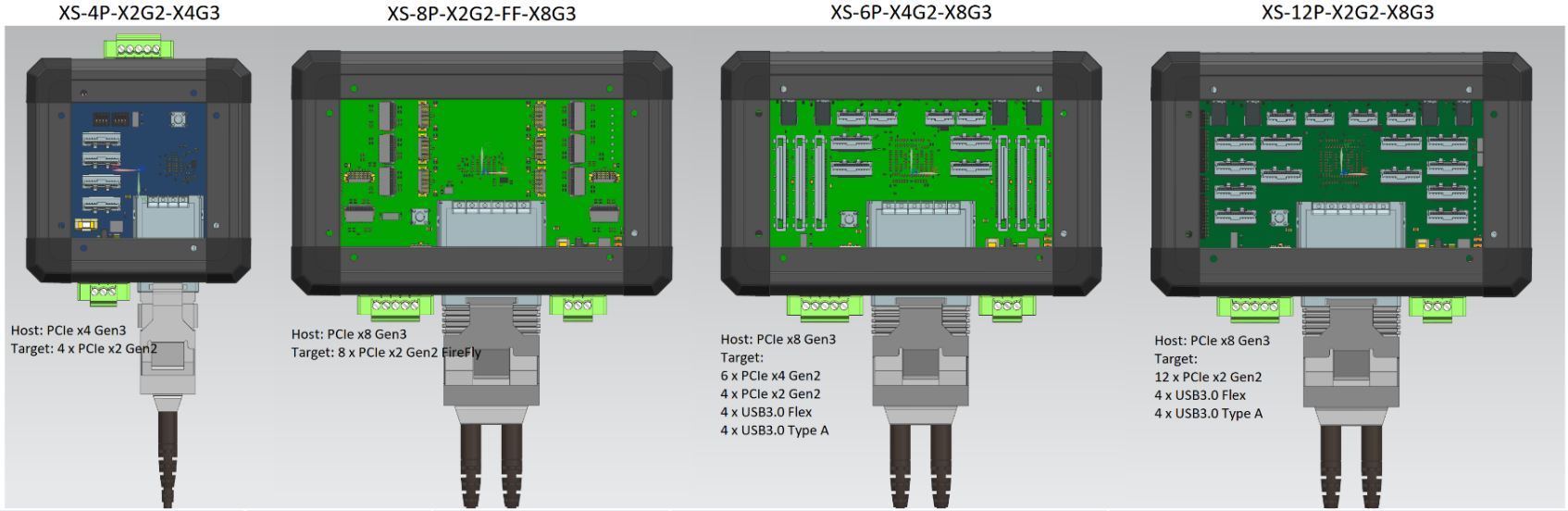

- Sensors: 2.3, 3.1, 5.0, 8.9 and 12.4 Mpix, b/w and color
- Frame rates: 2.3 Mpix @ 166 fps to 12.4 Mpix @ 69 fps

# XIMEA Cameras – xiX Large Form Factor

- PCIe Gen2 x4, Canon EF-mount (60 x 60 x 33.6)
- Integrated active Canon EF lens adapter for dynamic control of aperture and focus
- Large format CMOS sensors
- 4 PCIe lanes for up to 20 Gbit/s bandwidth
- Board-level version available


- Sensors: 12, 20 and 48 Mpix, b/w and color
- Frame rates: 12 Mpix @ 133 fps to 48 Mpix @ 30 fps

# xSwitch – Generic configurations



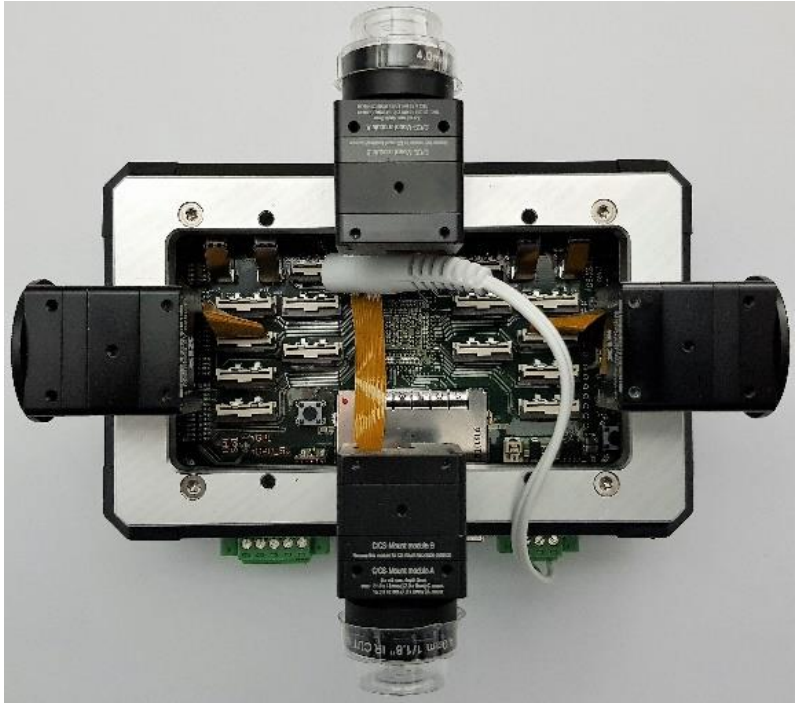

| Model | Upstream | Downstream X4G2 | Downstream X2G2 | Downstream X2G2 FireFly | Downstream USB 3.0 Type-A | Downstream USB 3.0 Flex |
|---|---|---|---|---|---|---|
| XS-4P-X2G2-X4G3 | PCIe X4G3 | - | 4 | - | - | - |
| XS-6P-X4G2-X8G3 | PCIe X8G3 | 6 | 4 | - | 4 | 4 |
| XS-8P-X2G2-FF-X8G3 | PCIe X8G3 | - | - | 8 | - | - |
| XS-12P-X2G2-X8G3 | PCIe X8G3 | - | 12 | - | 4 | 4 |

# xPlatform Demonstrators - 360° rig

- 8x 3 Mpix cameras IMX253, each streaming at 218 fps
- All aggregated into one x4G3 32 Gb/s fiber cable
- Up to 100 m cable length

# xPlatform Demonstrators – Generic xSWITCH-L

- 12 PCIe X2G2 ports total, populated with:
  - 4x MX050CG-SY-X2G2-FL,
  - 10 cm PCIe X2G2 flex cables
  - 4x 5.0M Pix at 165 fps each
  - Compact S-mount optics
  - Master-slave hardware synchronization via xSWITCH
  - Aluminum enclosure



# xPlatform Deployment Examples

- Customer A:
  - 60x 12 Mpix cameras @ 300 fps
    + RAW recording
- Customer B:
  - 24x 12 Mpix cameras @ 10 fps, over one xSwitch
- Customer C:
  - Scalable rig cluster, each 6x 12 Mpix @ 60 fps, over one xSwitch
    + RAW recording
- Customer D:
  - 120x 12 Mpix cameras @ 60 fps, one xSwitch per 6 cameras
    + RAW recording

# Resources

- xiX infographics
  https://www.ximea.com/files/brochures/xiX%20Infographic.pdf
- xiX brochure
  https://www.ximea.com/files/brochures/xiX-OEM-cameras-for-integration-2017-brochure-HQ.pdf
- xiSwitch infographics
  https://www.ximea.com/files/brochures/xiSWITCH%20Infographic.pdf
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- Explanatory diagram
  https://www.ximea.com/support/attachments/download/8875/MX-X2G2-FL_Diagram.pdf
- PCIe page
  https://www.ximea.com/en/pci-express-camera/pcie-camera-zone
- Software related
  https://www.ximea.com/support/wiki/apis/Linux_ARM_Support

# Speed. Distance. Freedom.

## Cameras with 64Gbit/s PCI Express interface

Thank you for your attention

Questions?

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