High-Bandwidth Multicamera Systems with PCIe Backbone:

Snapshot and Outlook to Technologies and Applications

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Content

- XIMEA Company Overview
- Cameras & Embedded Systems
  - Challenges & Applications
- Existing imager interfaces
- PCIe does it all

XIMEA: SRO, GmbH, Corp

XIMEA s.r.o.
Slovakia, Marianka

Research and Development, Production

XIMEA GmbH
Germany, Münster

Management, Marketing, International Sales

XIMEA Corp.
USA, Denver

Sales South and North America

Company facts - What we do

- Development, manufacturing and support for ultimate imaging and vision products
- All tooling capabilities in-house
- Standard products and custom designs
- Increasing general success through sustainable partnerships

• Company Products

• Customers

Embedded & Multi-Camera Systems

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Applications









Mapping/Survey – Autonomous Vehicles

Street Level

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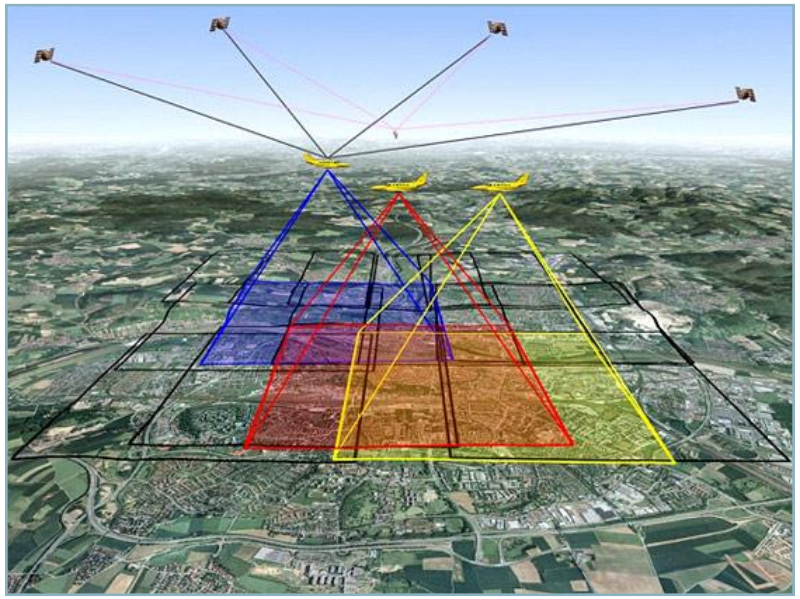


Aerial/orbital

- High resolution
- High speed
- Real time processing or saving
- Multi-camera
- Small components

Augmented & Virtual Reality

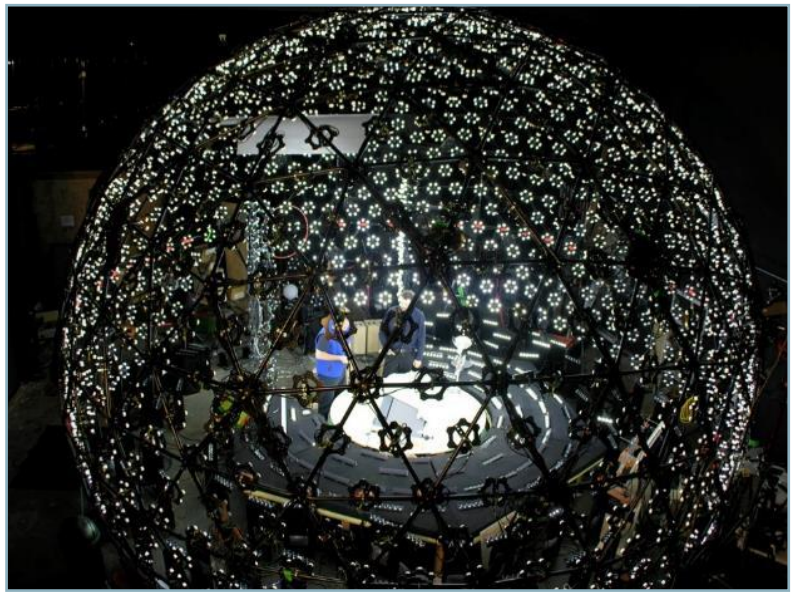
Nokia Ozo

Facebook Surround 360

XIMEA 360° Demo

- High resolution
- High speed
- Multi-camera
- Small components
- Power consumption and dissipation

Performance Capture



Motion Capture

Face Capture

- High resolution
- High speed
- Multi-camera
- Small components
- Long cables

© USC, Institute for Creative Technologies

Wearables

- High speed
- Multi-camera
  - NIR + color
  - XDR
- Small components
- Real time processing

Challenges

- Bandwidth
  - Multi camera systems
  - High resolution, high frame rate
- Cabling
  - Long distances
- Size
  - Smaller is always better
- Synchronization
- Processing
  - Real time
  - Saving

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Existing Interfaces

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Existing camera interfaces

- Ethernet
- USB
- Camera Link / CoaXPress
- PCI Express

Ethernet

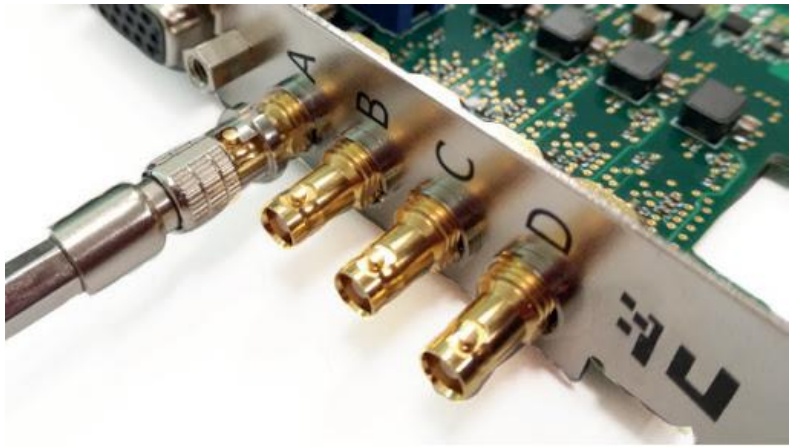
- Pros
  - Industry standard cables & software (GigE)
    - Hubs & switches easily available
  - Long cable lengths
  - Inexpensive
- Cons
  - Bandwidth is low

USB

- Pros
  - Industry standard cables
    - Hubs easily available
  - Better-ish bandwidth
  - Long-ish cable lengths
  - Inexpensive
- Cons
  - Multi-camera systems require multiple controllers
  - Not all controllers compatible with all cameras

Camera Link & CoaXPress

- Pros
  - Simple cables
  - Long cable lengths
  - High bandwidth
    - Expandable to achieve higher bandwidth
- Cons
  - Cameras require interface cards
  - Price



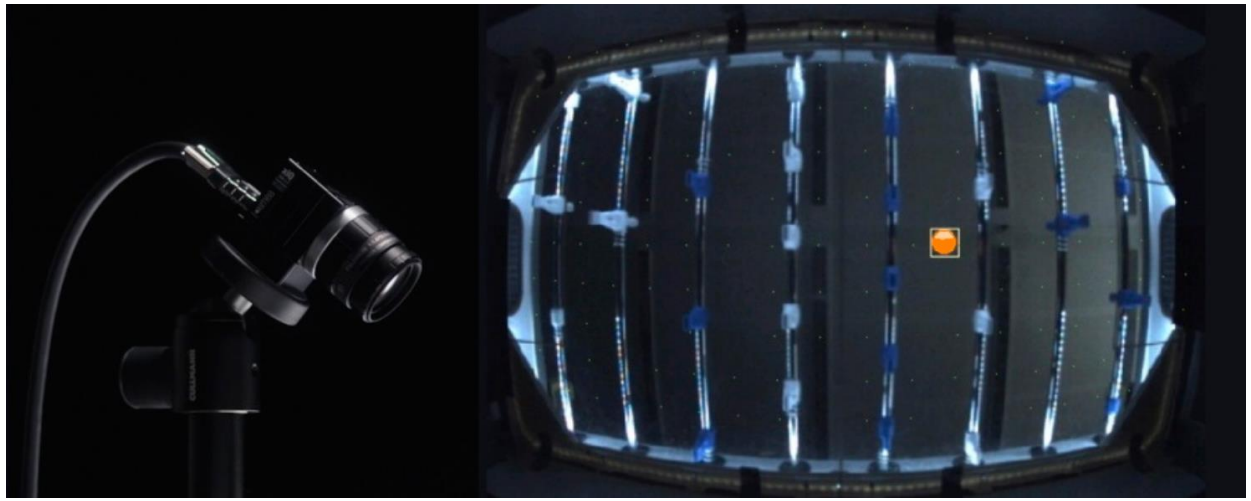
Peripheral Component Interconnect Express (PCIe)

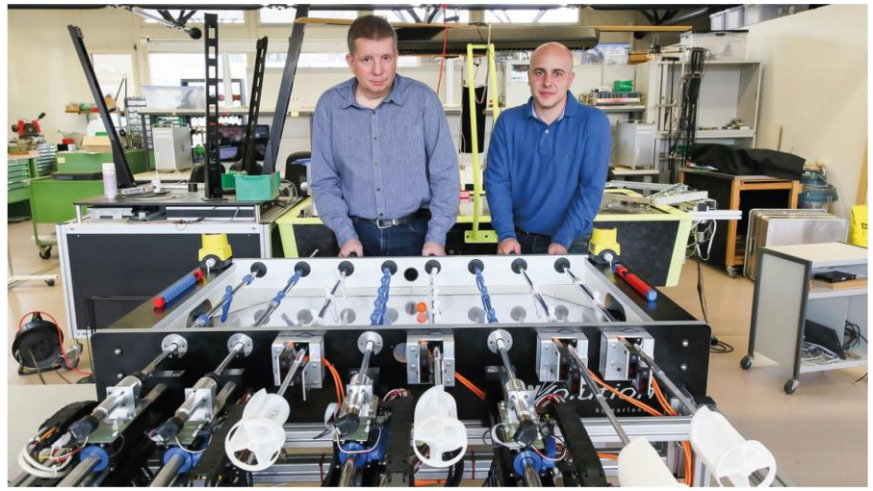
- Pros
  - Interface card is simply a cable adapter – nearly all computers have a PCIe backbone in place
  - Highest bandwidth
    - Single cable up to 64Gbps
  - No latency
    - Direct to RAM
  - Long cable lengths
- Cons
  - Price
  - Cabling is non standard

Computing

Processing/Saving

- Must be small
- Real time processing
  - AI
- Saving data at high data rates is often non-trivial in execution



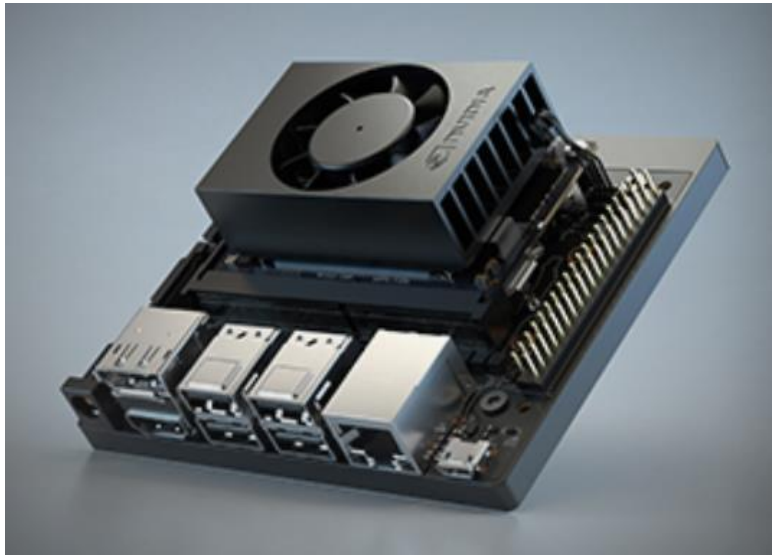


Intel products

- NUC platform
  - Often limited in PCIe connectivity
- COM Express
  - Much better for custom developments

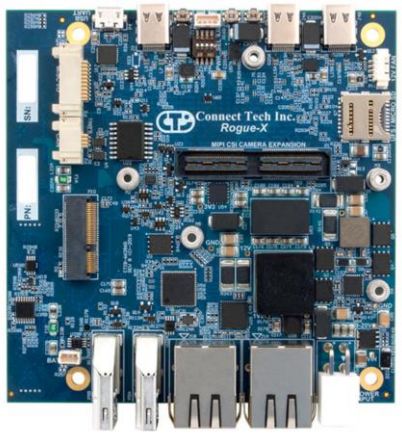
Nvidia computing

- High processing capability
- Variable PCIe bus input
  - Nano has only 2 lanes exposed
  - Jetson has 4
  - Xavier has 16
  - Already a new one on the way



Carrier boards

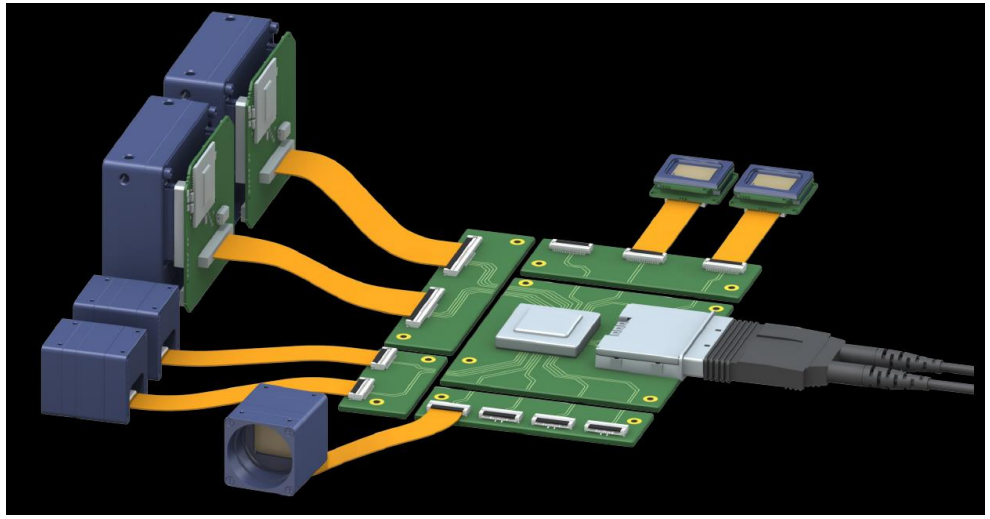
- Allow custom implementation of computing platforms
  - PCIe, USB interfaces
- XIMEA + 3rd party suppliers



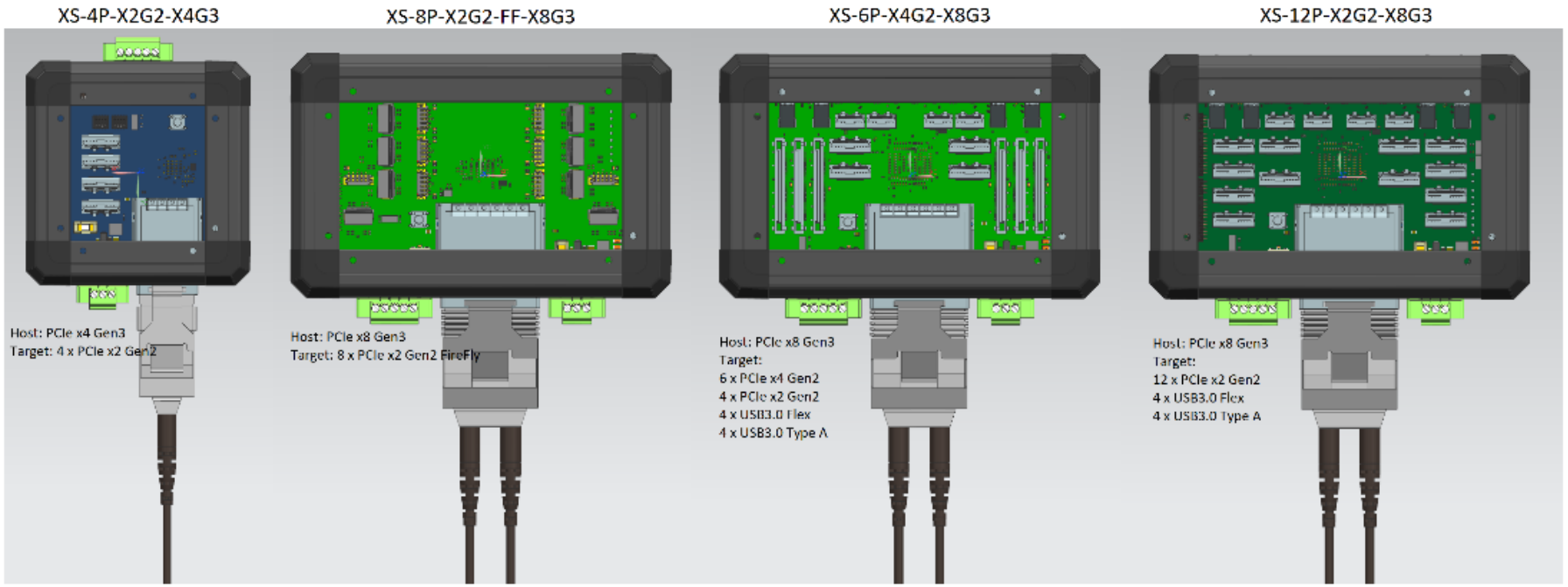
PCIe

PCIe Switch for multi-camera systems

- Allows multiple cameras to input data through one cable/connection

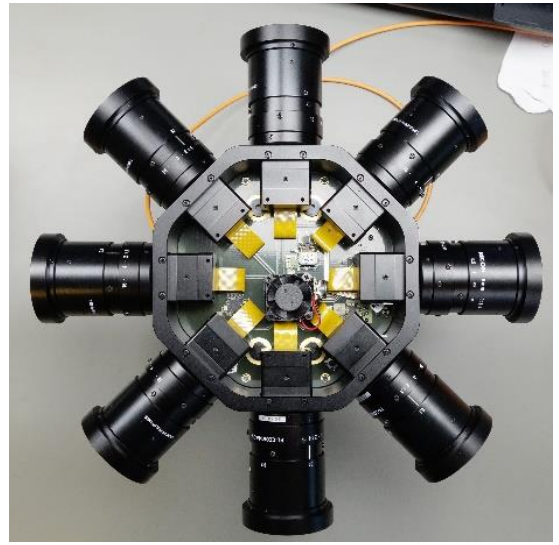


PCIe Switch



XIMEA Standard switches

XIMEA 360 switch



XIMEA XEC2 Jetson Carrier board

- Features
  - Multiple camera connections
    - PCIe (with switch)
    - USB
  - Peripheral interfaces
    - HDMI
    - USB (2&3)
    - Wifi
    - GPIO
    - IMU

Examples of setups and configurations for Embedded vision systems

Drone Concept

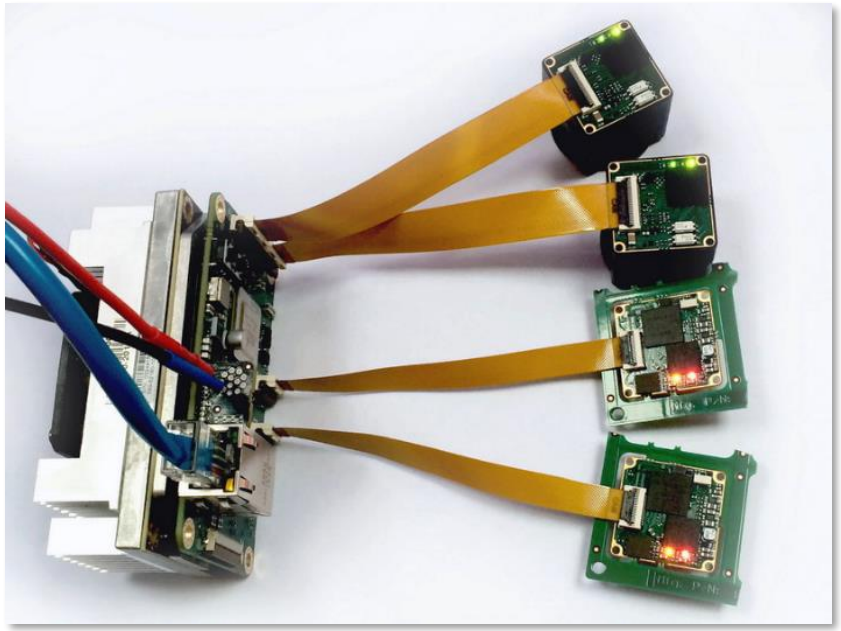
4 + 1 XIMEA cameras

XIMEA high resolution camera

Miniature cameras with fast speed

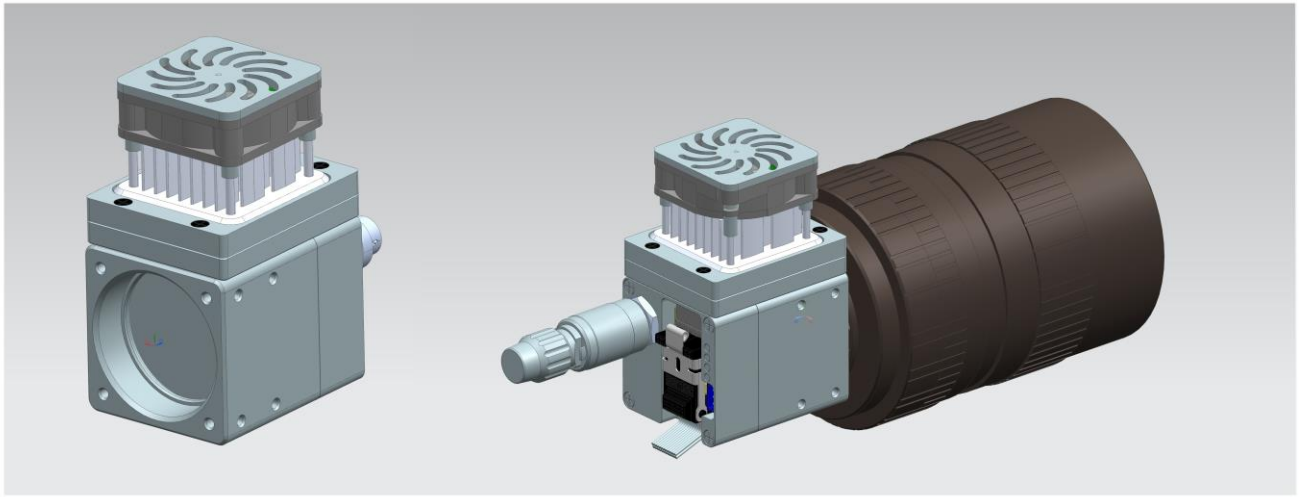
PCIe does it all!

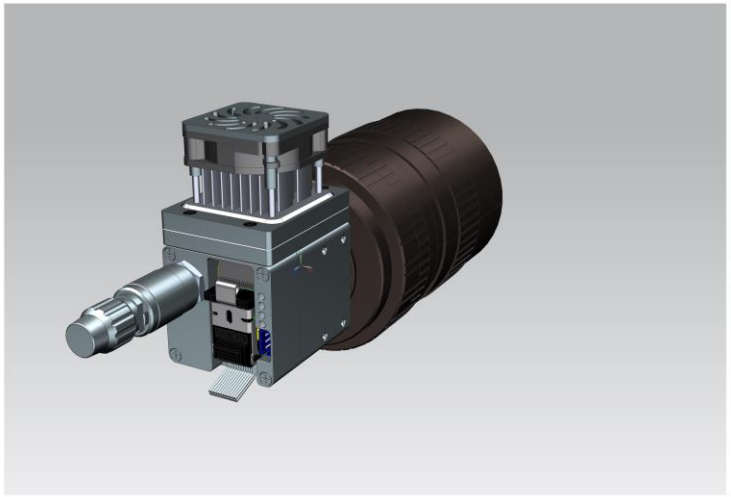
- Minimizes latency and CPU overhead
- Seamlessly delivers image data directly to the host memory via Scatter/Gather DMA
- Supports distances from millimeters to hundreds of meters
- Aggregation of multiple imagers into one wire/fiber
- Upcoming PCIe generation(s) for still higher speeds
- Ultimate Camera Interface for high throughput sensors and multi camera systems



Future directions

- Gen4 is readily available in PCs
  - 16Gbps per lane
- Faster sensors always coming out
- New cabling utilizing Firefly





Further information

- 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
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Thanks for your attention!

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