

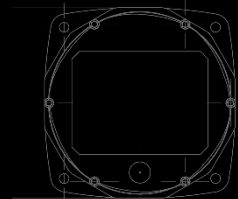
High-Bandwidth Multicamera Systems with PCIe Backbone:

Snapshot and Outlook to Technologies and
Applications

Kevin Toerne

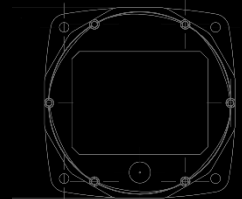
• Content

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



• XIMEA Company Overview

- CEOs: Maxim Larin, Vasant Desai
- Business Field: Industrial / scientific cameras
- Foundation: 1992



• Locations



XIMEA s.r.o.
Slovakia, Marianka

Research and Development, Production



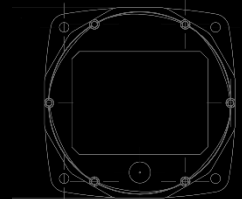
XIMEA GmbH
Germany, Münster

Management, Marketing, International Sales



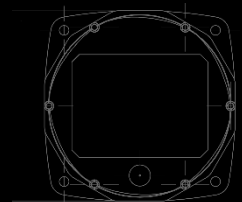
XIMEA Corp.
USA, Denver

Sales South and North America



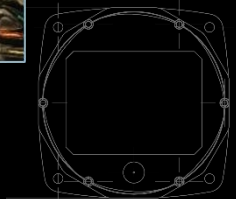
• Company Facts

- ✓ 100% privately owned Self funded without bank loans, angels or asset leasing
Machinery, company ground, buildings and production plant are owned by XIMEA
- ✓ ISO certified ISO 9001 and ISO 14001 certified
- ✓ Diversified Revenue is 50% product and 50% project (OEM) based
- ✓ Modern premises German and Slovakian premises mark modern, sustainable buildings in great environments



• Company facts – What we do

- Project realization as our clients' partner, focusing on their individual needs
- Development, manufacturing and support for ultimate imaging and vision products
- One stop shop: Designing concepts, electronics, mechanics, optics, firmware and software
- All tooling capabilities in-house
- Accompaniment of project implementation
- Standard products and custom designs
- Increasing general success through sustainable partnerships



- Company Products



xiB



xiD



xiRAY



xiC



xiX



xiB-64



xiJ



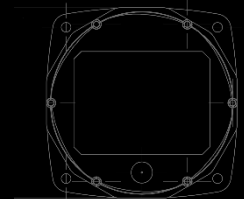
xiQ



xiSPEC



xiMU



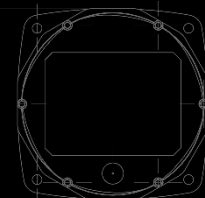
- Customers



Cameras & Embedded Systems

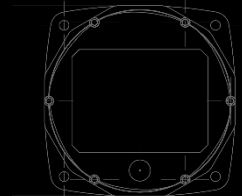
Challenges

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



Existing camera interfaces

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



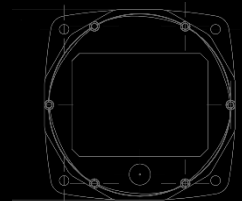
• Ethernet

• Pros

- Industry standard cables & software (GigE)
 - Hubs & switches easily available
- Long cable lengths
- Inexpensive

• Cons

- Bandwidth is low



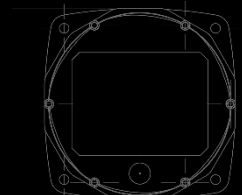
• USB

• 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



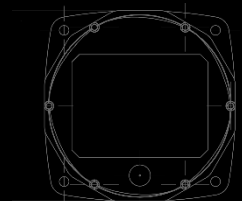
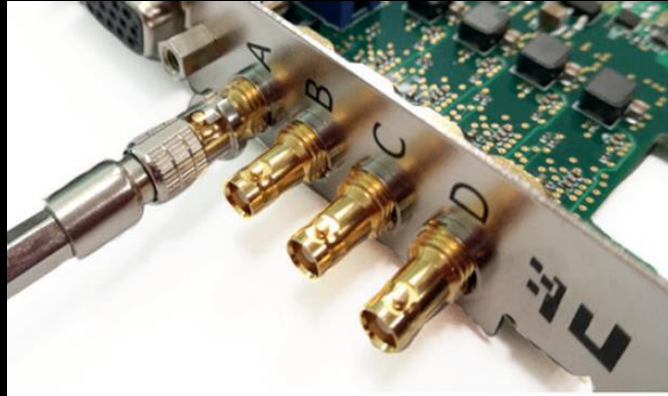
• Camera Link & CoaXPress

• Pros

- Simple cables
- Long cable lengths
- High bandwidth
 - Expandable to achieve higher bandwidths

• Cons

- Cameras require interface cards
- Price



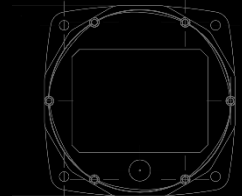
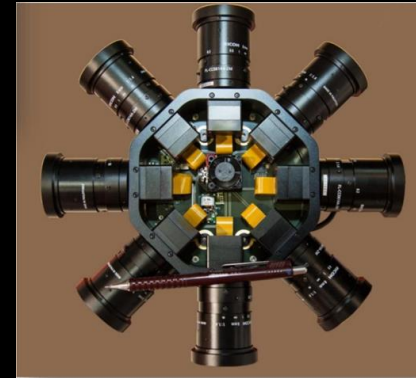
• PCI Express

• Pros

- Highest bandwidth
 - Single cable up to 64Gbps
- Long cable lengths
- No latency
 - Direct to RAM, then CPU/GPU
- Interface card is simply a cable adapter – nearly all computers have a PCIe backbone in them

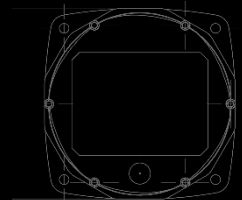
• Cons

- Price
- Cabling is non-standard

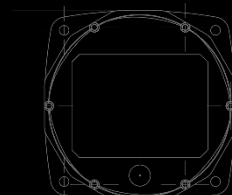


- Implementations

- Applications
- Computing platforms
 - CPU & GPU
 - Hard drives
 - Nvidia
 - ComExpress



- Applications

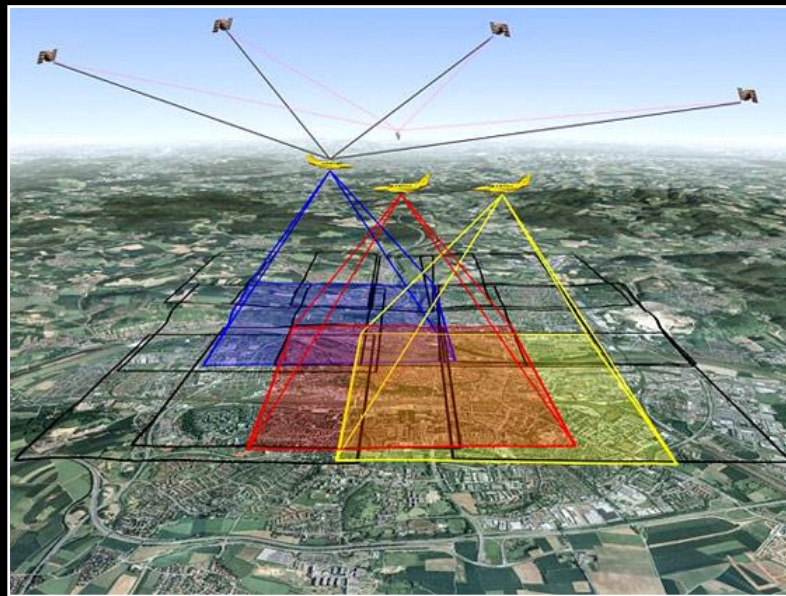


- Mapping & Survey

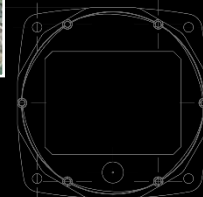


Street Level

© Cyclomedia



Aerial/orbital



- Applications: AR/VR



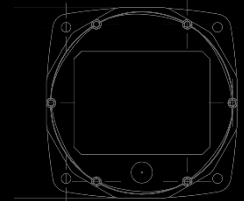
Nokia Ozo



Facebook Surround 360



XIMEA 360° Demo



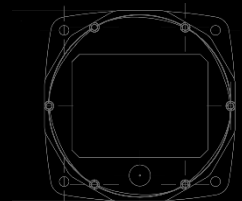
- Applications: Performance Capture



Motion Capture

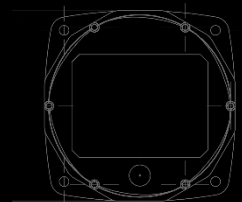


Face Capture

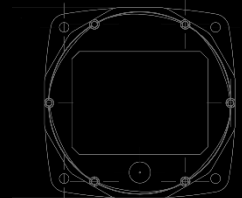


• Embedded computing

- Must be small
- Computing speed and power consumption are often variable requirements
 - Processing and power consumption are antithetical
- Saving data at high data rates is often non-trivial in execution

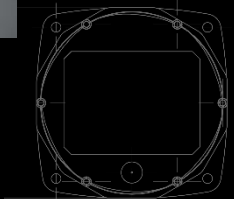
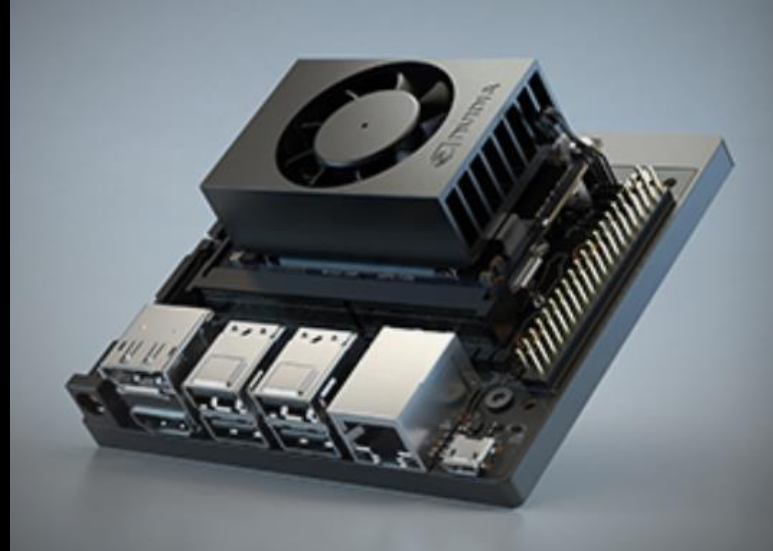


- Intel products
-
- NUC platform
 - Often limited in PCIe connectivity
 - COM Express
 - Much better for custom developments

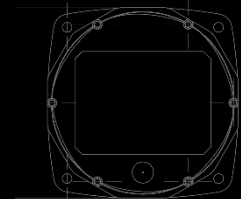


• Nvidia products

- 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



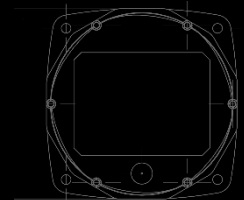
- Carrier boards
- Allow custom implementation of computing platforms
 - PCIe, USB interfaces
- XIMEA + 3rd party suppliers



• XIMEA XEC2 Jetson Carrier board

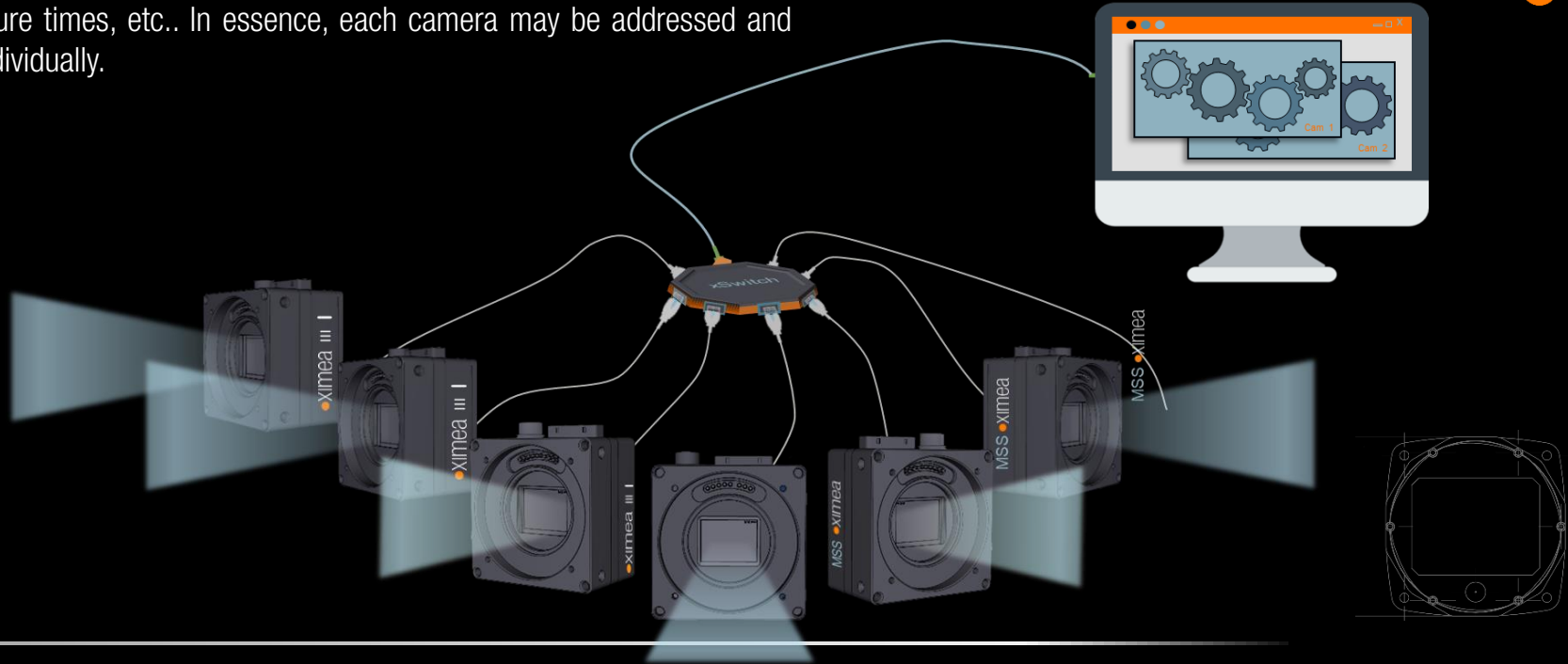
• Features

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

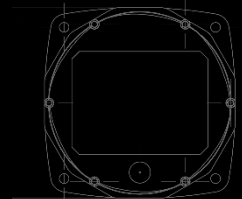
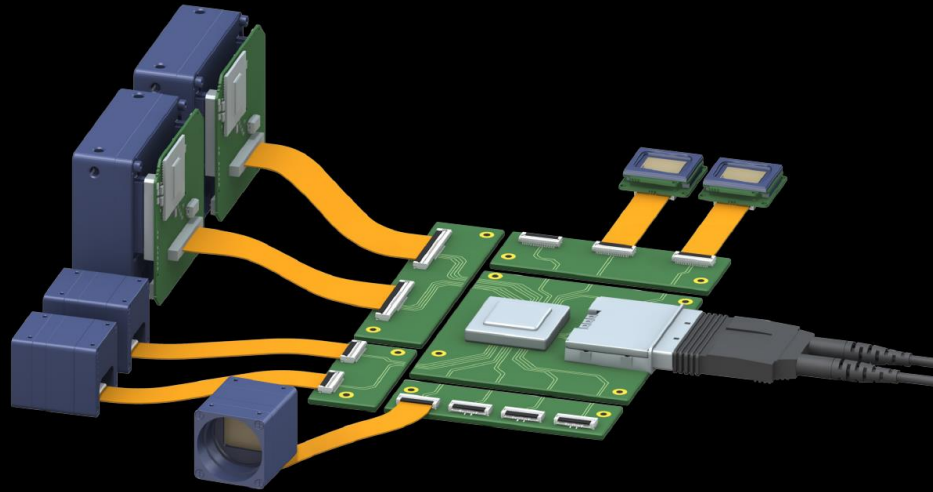


• Multi-camera system

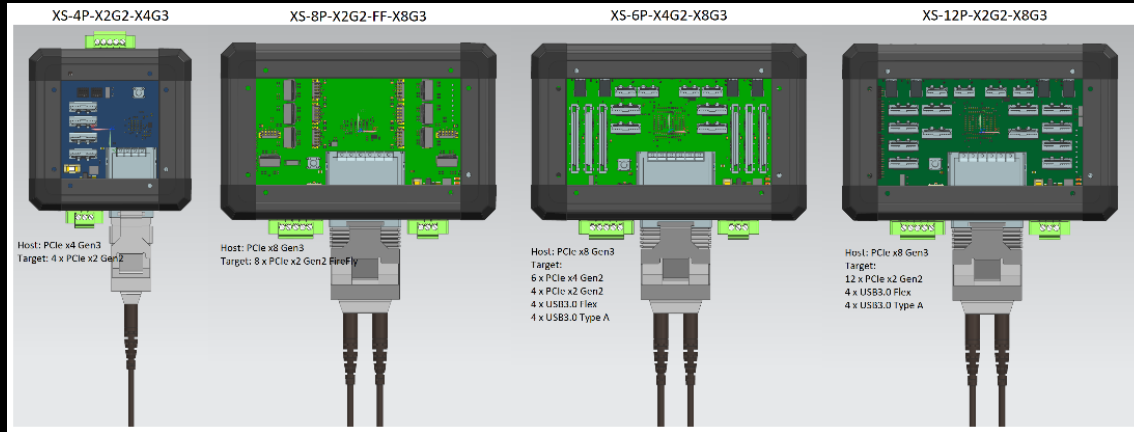
Multi sensor systems are systems having more than one camera. They can include any mix of wavelengths, resolutions, fps, trigger, exposure times, etc.. In essence, each camera may be addressed and set individually.



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

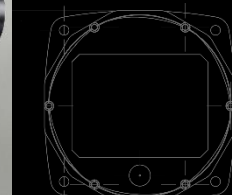
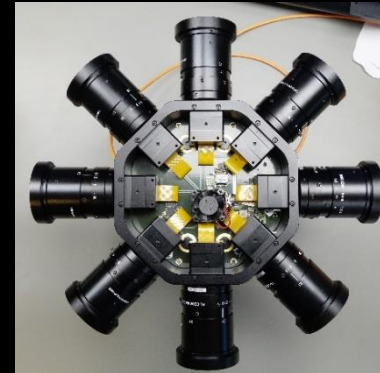


- PCle Switch



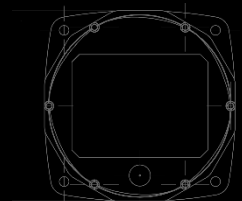
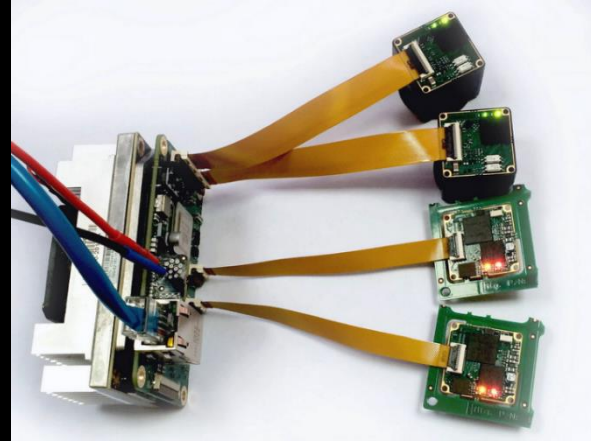
XIMEA Standard switches

XIMEA 360 switch



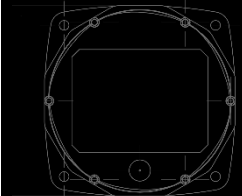
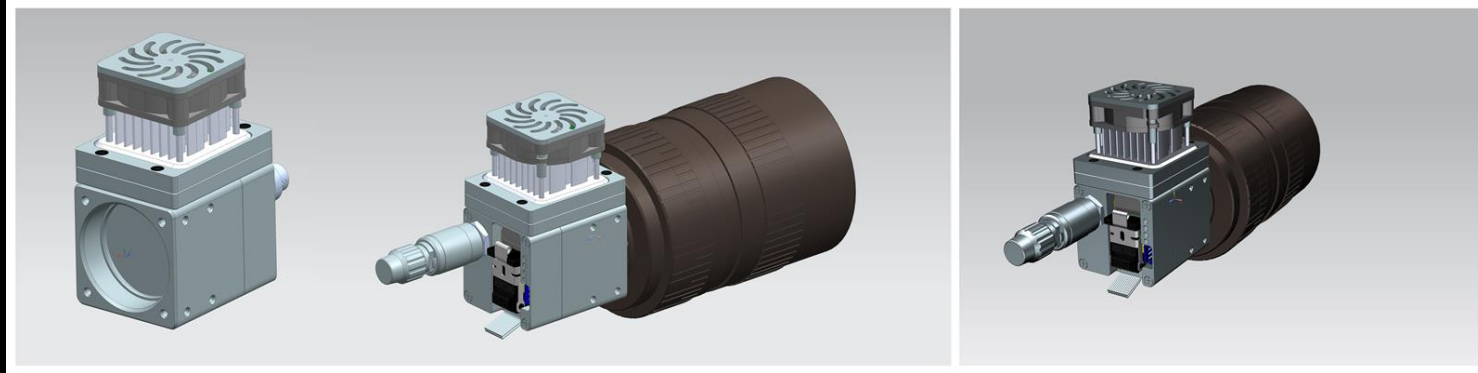
• PCIe does it all !

- 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
- Thin to none SW stack
- Upcoming PCIe generation(s) for still higher speeds
- Ultimate Camera Interface for high throughput sensors and multi camera systems



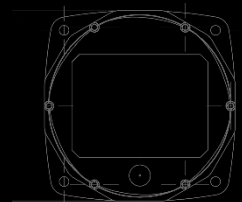
• Future directions

- 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>
- xiSwitch infographics
<https://www.ximea.com/files/brochures/xiSWITCH%20Infographic.pdf>
- XIMEA Embedded vision home
<https://www.ximea.com/embedded-vision/systems>



Thanks for your attention!
