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ALRAD
Instruments Ltd

Making a difference for over 50 years

HIGH SPEED INTERFACE TECHNOLOGIES FOR MACHINE VISION

MACHINE VISION CONFERENCE 2022

IAN ALDERTON - TECHNICAL SALES DIRECTOR – ALRAD INSTRUMENTS LIMITED

ALRAD Instruments Limited
Company Overview

Website
www.alrad.com

- Established 1970
- Providing high quality Components and Systems to the OEM market, Industry and research for the past 50 years
- Six Technology Divisions

Overview and Contents

ALRAD Instruments provides a very wide portfolio of Cameras for the Machine Vision and Automation Industries with interfaces including GigE, USB, CoaXPress, Cameralink, MIPI CSI-2 and FPD-Link III.
Our extensive portfolio can be found on: www.alrad.co.uk

This presentation focuses on the popular GigE interface and the growth in speed and resolution which can be achieved with the latest cameras, in particular the Emergent Vision range of High Speed cameras using the 10GigE, 25GigE, 50GigE and 100GigE Interface.

Contents:

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Introduction

This presentation focuses on the popular GigE interface and the growth in speed and resolution which can be achieved with the latest cameras using the 10GigE, 25GigE, 50GigE and 100GigE Interface options.

For many years the Machine Vision and Automation industry had been using camera resolutions typically between VGA (640 x 480 pixels) and 2 Megapixel resolution, however, a wider application base and increasing demand for high-speed solutions coupled with the availability of faster high resolution image sensors has led to a drive for manufacturers to develop a wide variety of new camera models with a range of interface options including GigE, USB, CoaXPress, Cameralink, MIPI CSI-2 and FPD-Link III.

In this presentation we will focus on the developments in Gigabit Ethernet (GigE) interface options, in particular for 10, 25, 50 and 100 GigE Vision.

Many GigE Vision solutions and accessories are available on the market today . Generally, cameras govern resolution and frame rate, which are defining factors in high-speed imaging applications. However, accessories and integration also play important roles in the image acquisition framework. A reputable machine vision technology company provides a complete acquisition solution and gives advice on well-tested architecture to deliver the performance necessary for ultra-high-speed applications.

100GigE maximum bandwidth is 100Gbps or 12,500 Mbytes/s, which is the industry’s fastest single link solution

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Industries

VR/AR

Vision-guided robots

Sports

Packaging

Flat panel display

Automotive manufacturing

Food and beverage

Volumetric capture

Transportation

Solar panels

Semiconductors

Medical imaging

Entertainment

Broadcast

Application Example: Virtual Reality Cameras

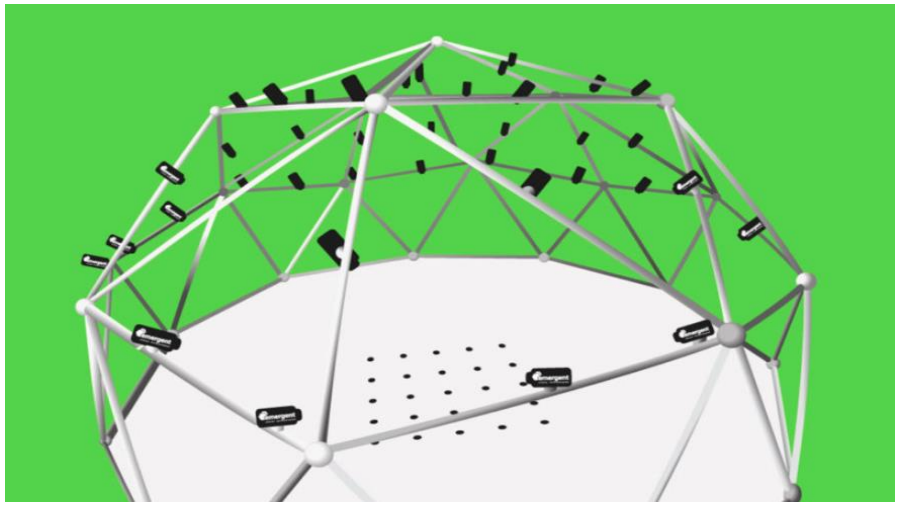
Virtual Reality, Augmented Reality, and Mixed Reality all have similar challenges, mainly the generation of 3D content.

These applications all require tight timing synchronisation between images captured from multiple camera sources.

Excellent image quality is required under a variety of lighting conditions. Some applications require high resolution images whilst maintaining an appropriate frame rate.

Camera setups can often span large areas including stadiums so the simplest options are preferred for system installation and maintenance.

Many cameras may be required to complete a system for an optimal experience.



Typical Applications:

- Virtual reality
- Augmented reality
- Mixed reality
- Volumetric capture
- 3D mapping

Application Example: Cameras for Sports Technology

The proverbial photo finish in professional sports is likely the most classic imaging application a camera could be used in. The availability of high-speed cameras opens the door to new possibilities from improving the fan experience to making the correct call with goal line technology, instant replays, digital umpire/referee, or detailed motion analysis.

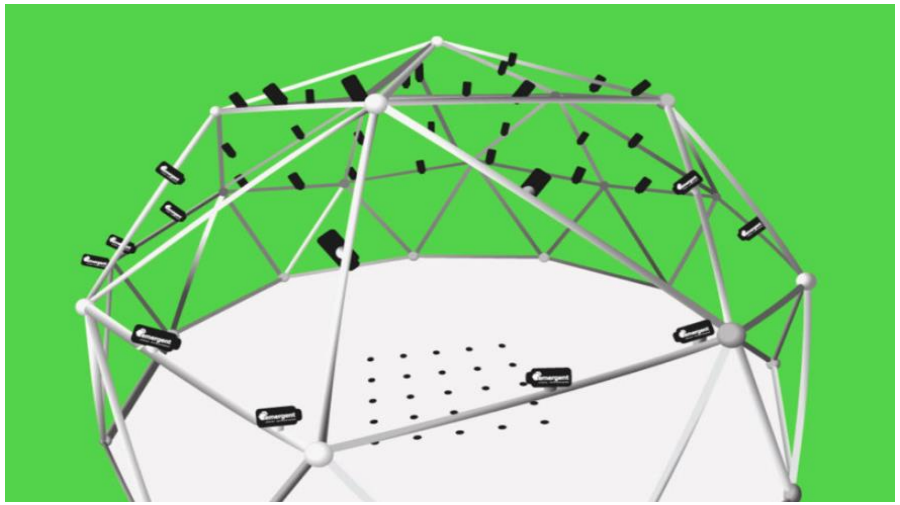
High resolution, high frame-rate 10,25, 50 and 100 GigE cameras are heavily used within sports applications and in particular those requiring long cable runs in stadiums or arenas where a simplified fibre interface can be used. These cameras have a small form-factor allowing placement where conventional broadcast cameras cannot be used.

Typical Applications:

- Broadcast
- Goal Line Technology
- Instant Replays
- Digital Umpires / Referee
- Swing/Throw Simulation

Application Example: Volumetric Capture Cameras

Volumetric capture is the process for capturing human performances in real-time to bring them into virtual worlds. This is achieved by using multiple accurately synchronized cameras to capture the environment from many angles. The captured data is then processed to form a 3D avatar of the subject that can be viewed from all angles.



The volumetric capture cameras from Emergent Vision have been used by many tier 1 companies who have created capture studios and laboratories with as many as 250 cameras in a system.

Typical Applications:

- Volumetric capture
- 3D mapping

Application Example: Cameras for Inspection & Automation

High-speed GigE Vision cameras are used in a wide range of inspection and automation applications and provide new opportunities for those looking to achieve higher productivity, better quality and safety control, or to improve automation tasks.

Both area-scan and line-scan cameras are provided for all inspection and automation requirements.
The area-scan cameras utilise the latest sensors from Sony, AMS, and Gpixel. Features include high resolution, low noise, and high frame rates.

The line-scan cameras come with a horizontal image resolution of 8192 effective pixels and a line rate of Single Line – 137KHz, Trilinear – 45KHz for the 10 GigE PACE cameras, and a line rate of: Single Line – 200KHz, Trilinear – 66KHz for the 25 GigE ACCEL LB-8K camera. **

Typical Applications:

- Volumetric capture
- 3D mapping

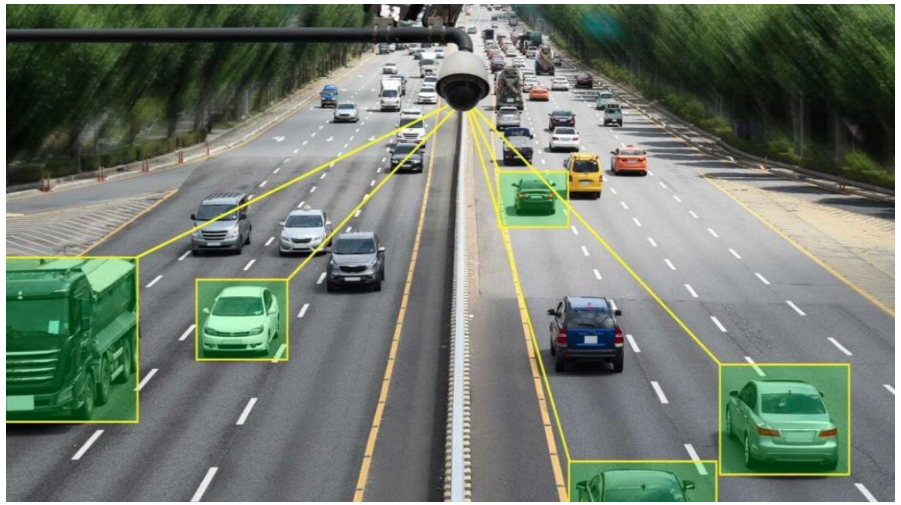
Application Example: Cameras or ITS / Traffic

High-speed machine vision cameras offer many benefits for ITS and traffic applications. These cameras deliver reliable, high quality image data under challenging conditions for applications such as highway monitoring, open-road tolling and law enforcement.

Almost all transportation and traffic related imaging systems are used outdoors, with tough conditions from darkness to bright sun light with strong shadows, Emergent Vision cameras offer low noise image signals even under low light conditions, high dynamic range for scenes with bright sunlight and shadows simultaneously, as well as smear-free captures of even fast moving objects.

Detailed Applications:

- Open Road Tolling
- Automatic Number Plate Recognition (ANPR)
- Law-Enforcement
- Monitoring and Transportation
- Rail and Road



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Comparison

Popular interfaces

USB 2.0 40-60 Mbytes/s, 1 cable 5M
Firewire 64 Mbytes/s 1 cable 4.5M
USB 3.0 350 Mbytes/s, 1 cable 8M
GigE 100 Mbytes/s, RJ45 1 cable 100+M
Camera Link Base 255 Mbytes/s, 1 cable 10M
Camera Link Medium 510 Mbytes/s, 2 cables 10M
Camera Link Full 680 Mbytes/s, 2 cables 5M
Camera Link Deca 850 Mbytes/s, 2 cables 4.5M
USB 3.1 G1 400 Mbytes/s, 1 cable 5M
USB 3.1 G2 900 Mbytes/s, 1 cable 5M
CXP-6 765 Mbytes/s, 1 co-axial cable 35M
4x CXP-6 3125 Mbytes/s, 4 co-axial cable 35M
CXP-12 1562 Mbytes/s, co-axial cable 30M
10GigE 1250 Mbytes/s, RJ45 Cat 6 or SFP Fibre up to 10Km
25GigE 3125 Mbytes/s SFP Fibre up to 10Km
100GigE 12,500 Mbytes/s, optical which is the industry's fastest single link solution

Benefits of 10, 25 GigE Vision VS USB CL & CXP

	USB 3.1 g1	USB 3.1 g2	Camera Link	CXP6 x1	CXP12 x1	10GigE	25GigE	Winner
Bandwidth	400MB/s	900MB/s	680MB/s	765MB/s	1562MB/s	1250MB/s	3125MB/s	25GigE (vs CXP12) 10GigE (vs CXP6)
Cable Length	5m	1m	10m	72m	30m	10kms[1]	10kms[1]	10/25GigE
Standard Support	Good	Good	Good	Good	Good	Excellent	Excellent	10/25GigE
Industry Adoption[3]	Good	Poor	Fair/Poor	Fair/Poor	Fair/Poor	Excellent	Excellent	10/25GigE
CPU Usage	Low	Low	Low	Low	Low	Low[2]	Low[2]	10/25GigE[4]
Latency/Jitter	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent[2]	Excellent[2]	10/25GigE[4]
Price Performance	Fair	Fair	Fair	Fair	Fair	Excellent	Excellent	10/25GigE

[1] Dependent on the low-cost accessory options chosen.

[2] Using Mellanox' VMA or Myricom's MVA

[3] Measured across all industries since this drives pricing/availability/etc

[4] Tie

Benefits of 10, 25, 50 and 100GigE Vision

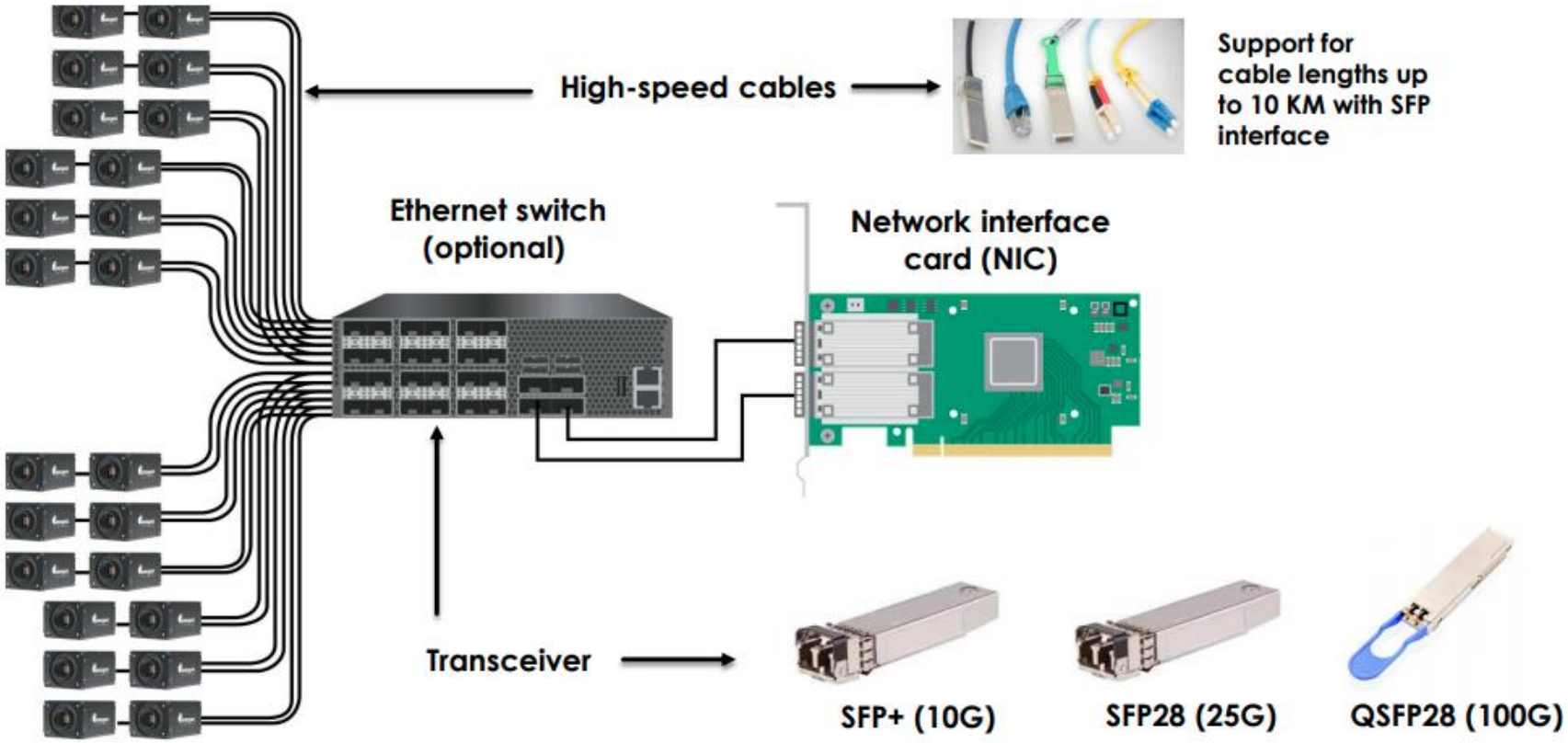
With demand for high-speed solutions driving machine vision applications, integrators have many choices when it comes to components: Frame grabbers are one option. However, by making changes at the driver level — alongside existing highspeed network card technologies — it is possible to achieve 100GigE speeds and beyond with equal performance and lower costs.

The key benefits of 10, 25, 50, and 100GigE Vision:

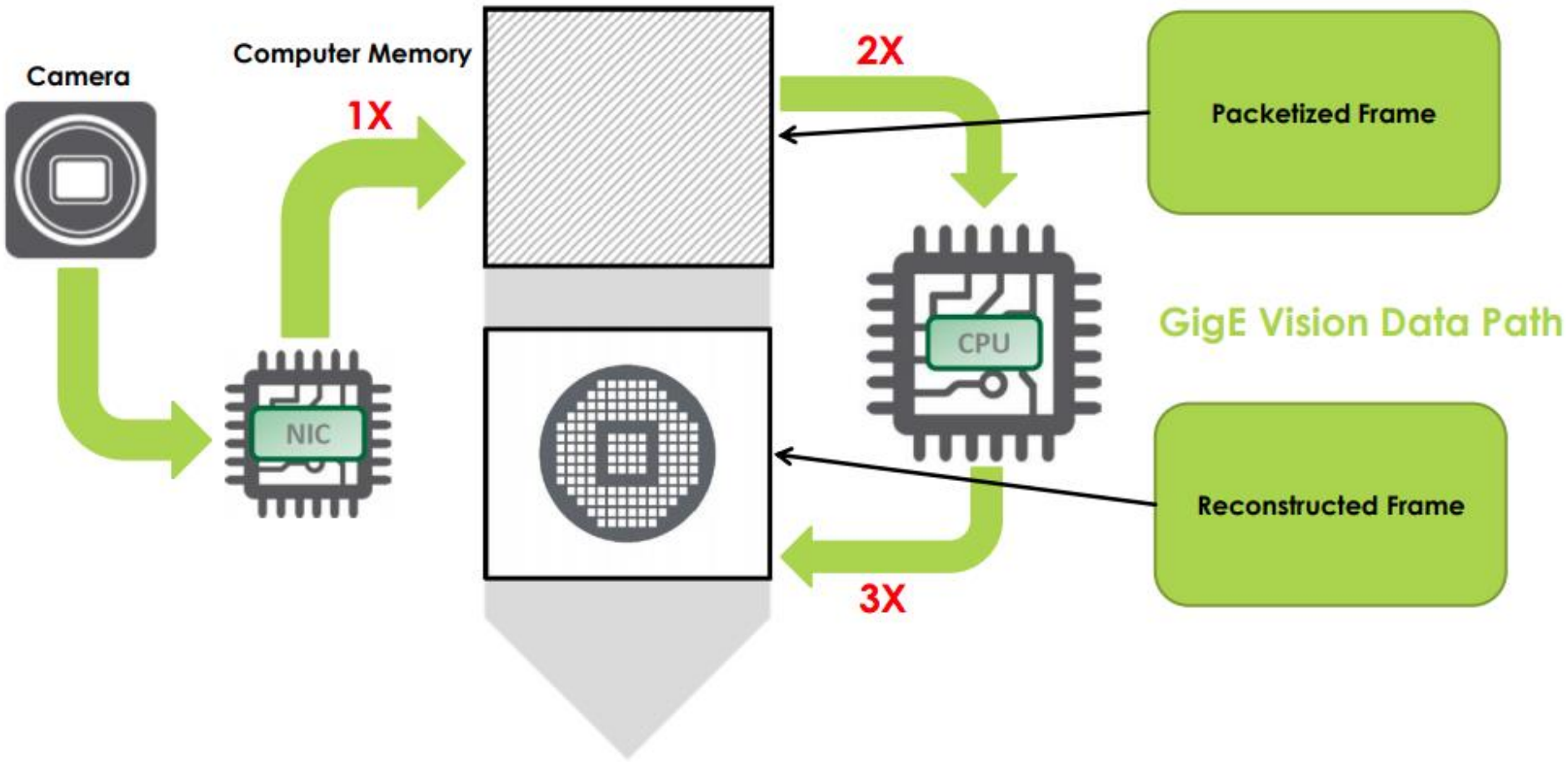
- Ultra high data/frame rates
- Many standard accessory and cabling options to cover any length
- Camera synchronization with PTP
- Camera multiplexing and multicasting
- Low CPU overhead, low latency, and low jitter
- Strong cross-Industry acceptance due to IEEE standardization
- Very competitive cost/performance
- GigE Vision has easily become the dominant machine vision camera interface
- Available NOW!

100GigE maximum bandwidth is 100Gbps or 12,500 Mbytes/s, which is the industry's fastest single link solution

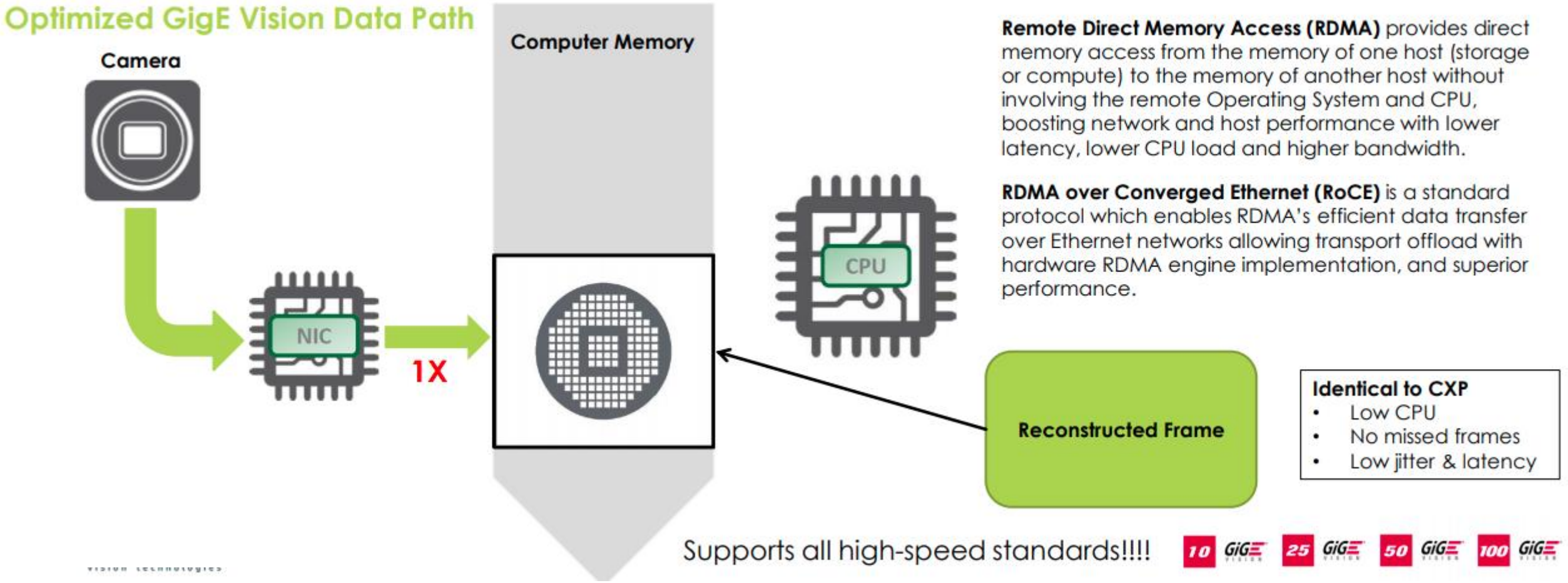
Typical Multi-Camera set up



Conventional GigE



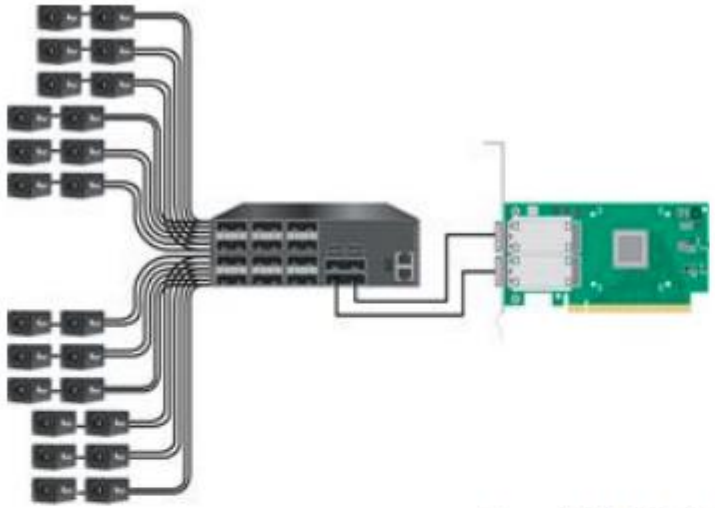
Optimised GigE with RoCE / RDMA



Remote Direct Memory Access (RDMA) provides direct memory access from the memory of one host (storage or compute) to the memory of another host without involving the remote Operating System and CPU, boosting network and host performance with lower latency, lower CPU load and higher bandwidth.

RDMA over Converged Ethernet (RoCE) is a standard protocol which enables RDMA's efficient data transfer over Ethernet networks allowing transport offload with hardware RDMA engine implementation, and superior performance.

Application Example 1

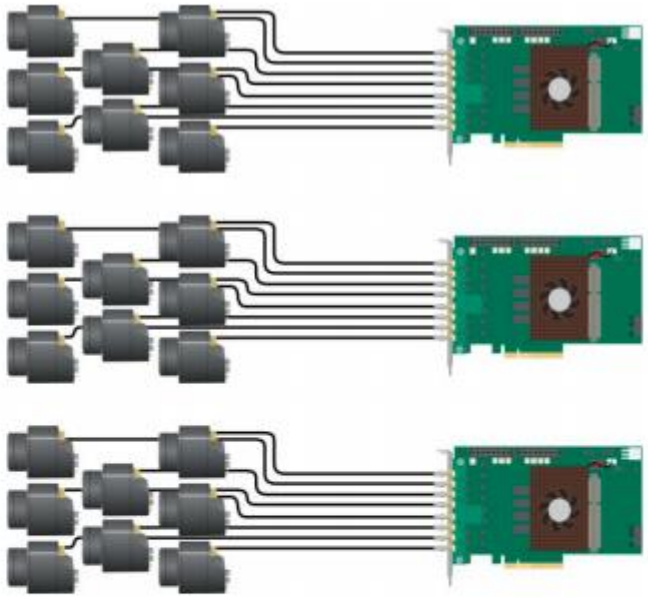


24x 10GigE cameras

Switch

Dual 100G NIC

GiGE VISION



24x CXP cameras

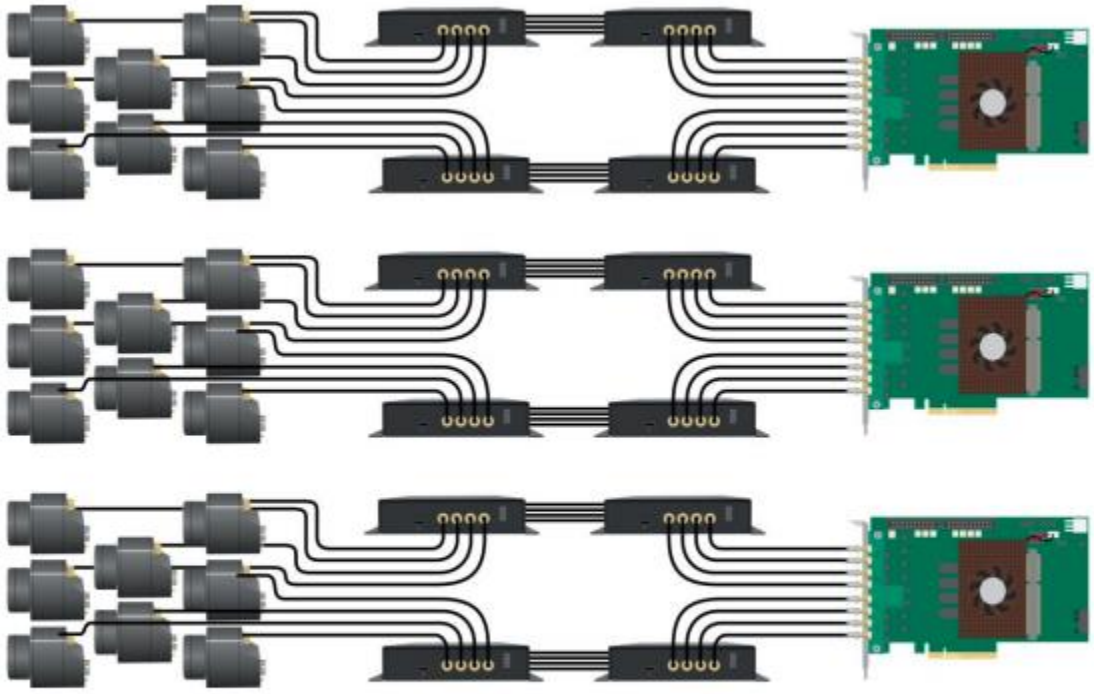
3x CXP frame grabbers

CoaXPress®

Application Example 1

CoaXPress®

Fiber option

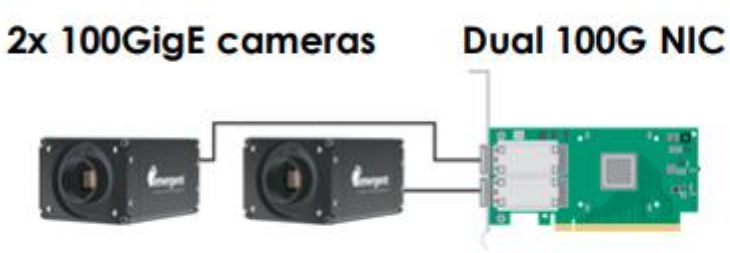


24x CXP cameras

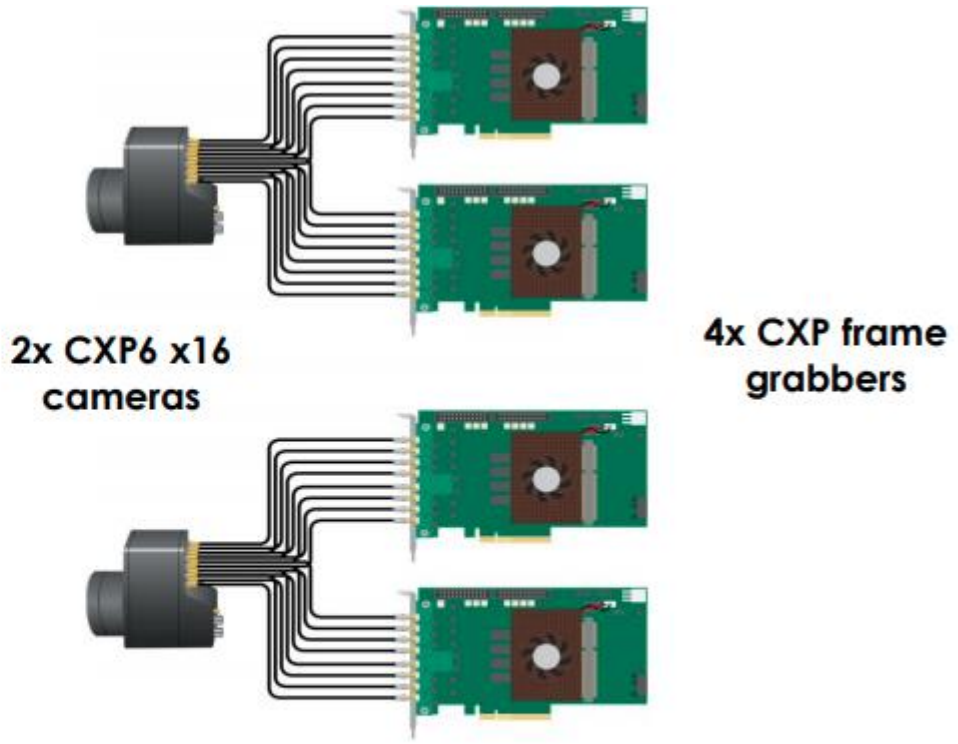
12x fiber adapters

3x CXP frame grabbers

Application Example 2



GiGE VISION

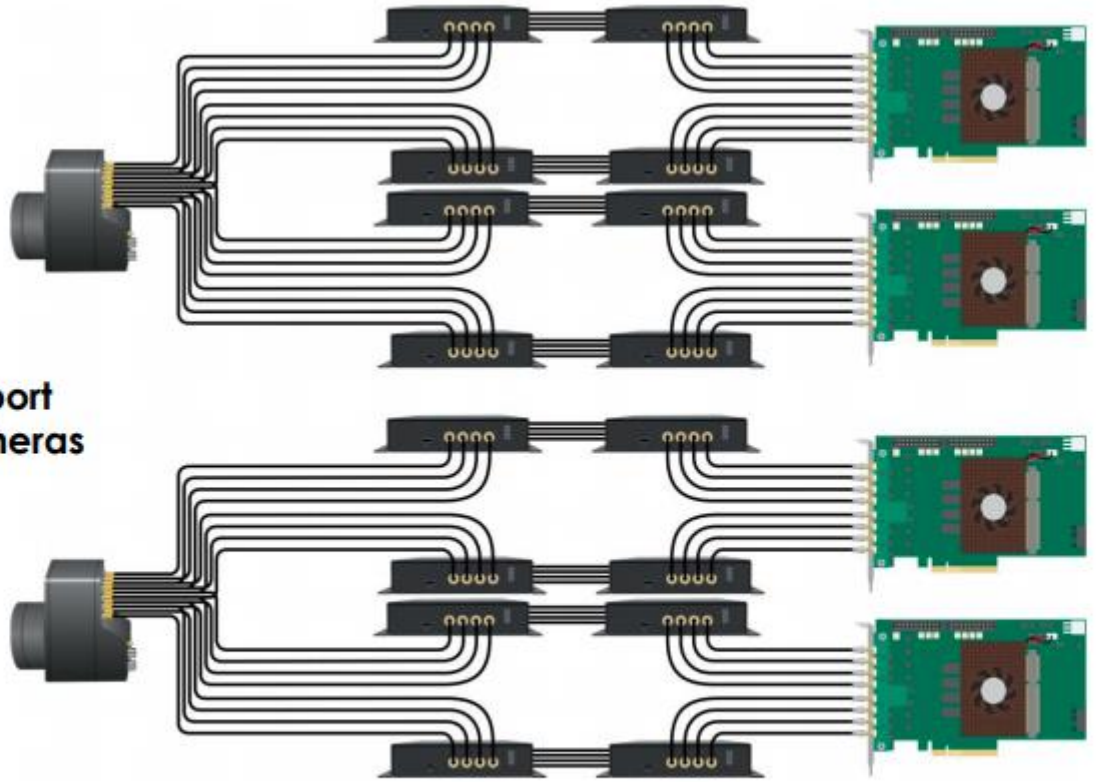


CoaXPress®

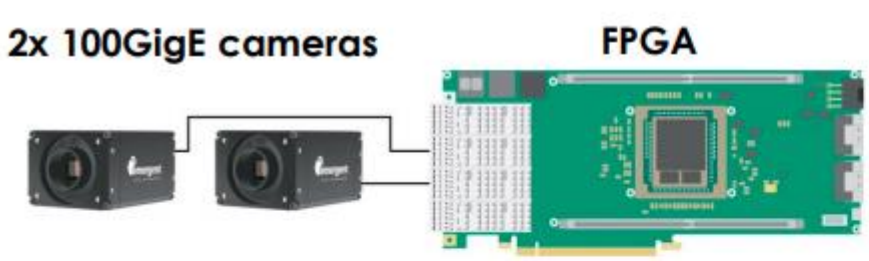
Application Example 3

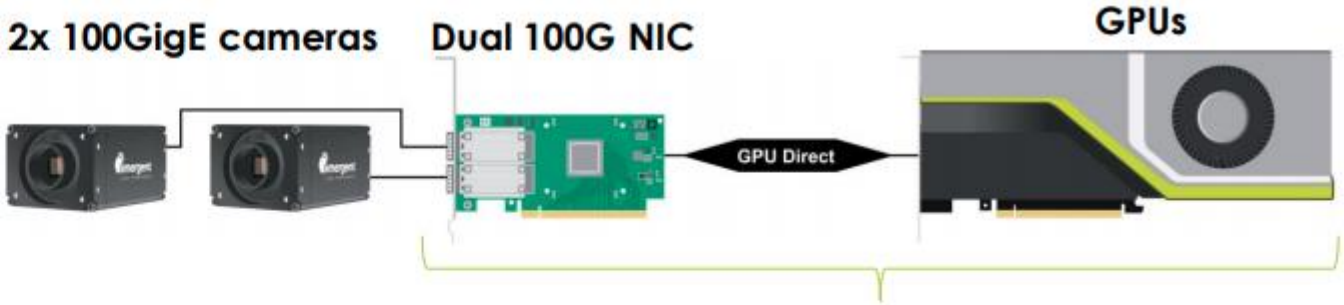
CoaXPress®

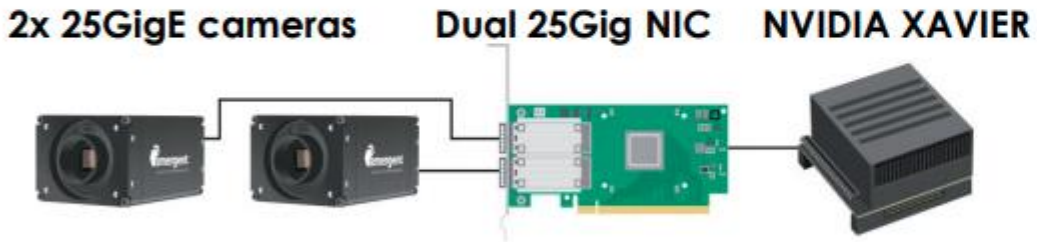
Fiber option

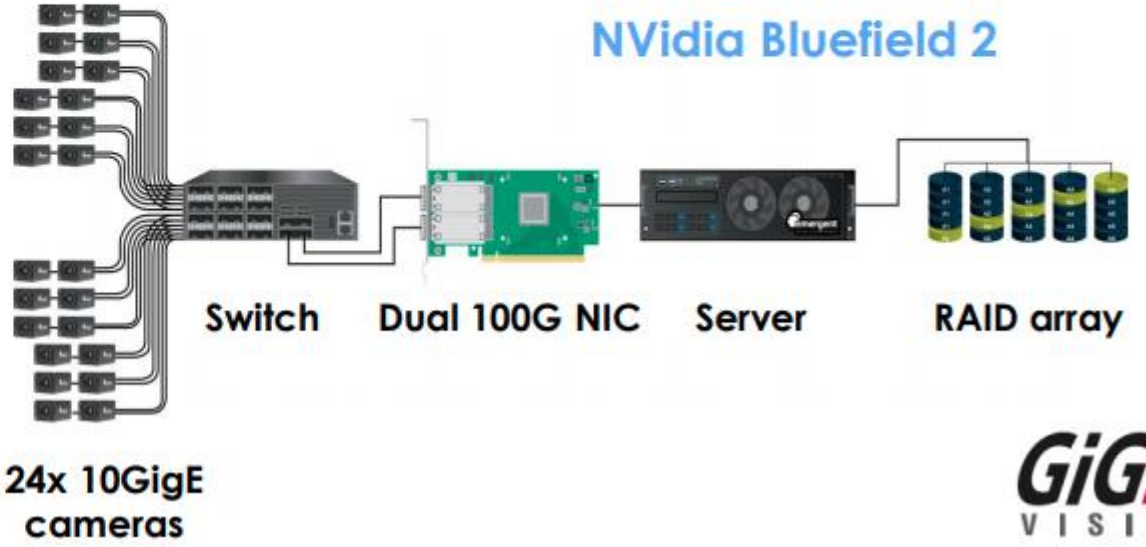


Additional GigE System Examples





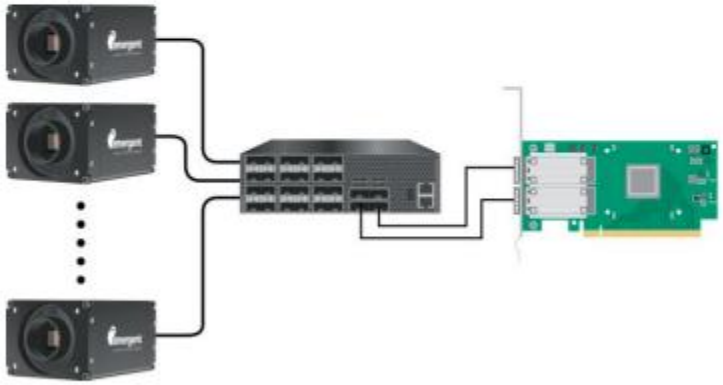




Triggering Options

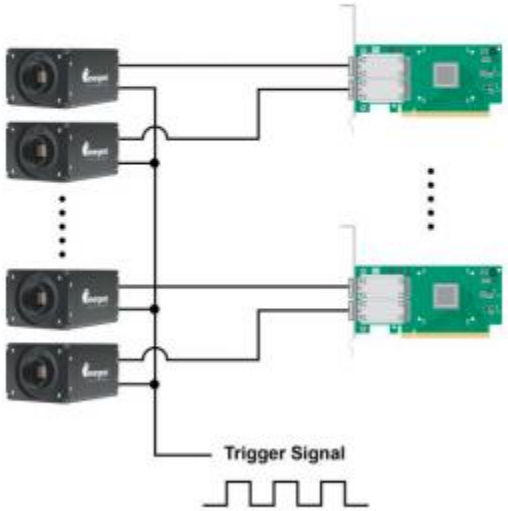
P2P – IEEE 1588

The availability of affordable Ethernet switches provides systems designers with a simple way to enable IEEE1588 Precision Time Protocol (PTP) on multi-camera systems for multi-camera synchronization to 1us.



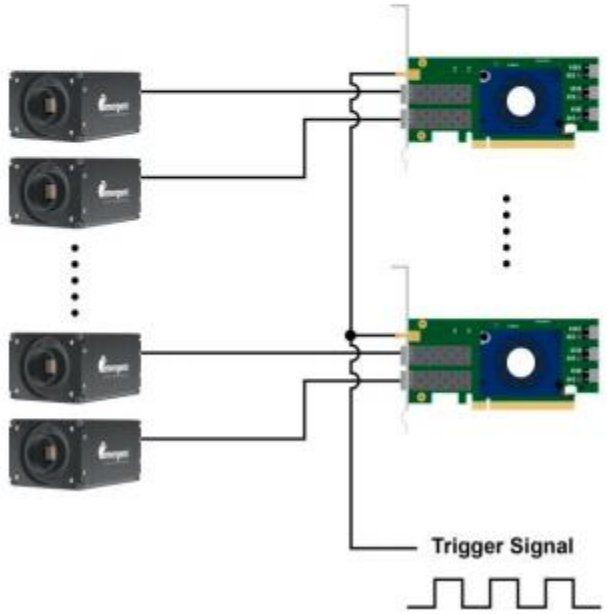
Hardware @ camera

Trigger pulse goes directly into camera.



Hardware @ PC/NIC

Trigger pulse goes into NIC (through front panel SMB connector) and NIC sends command up the same Ethernet wire to camera. Same as CXP.



Comparing Solutions – 24 x 10G

GiGE VISION®

CoaXPress®

24 x 10G Camera System

12M x 60fps x 8bit 5.76Gbps/camera

Application 1	10GigE	CXP6	Comparison
Cameras	24	24	Same
NICs/Grabbers	1 (Dual 100Gig)	3 (CXP6 Octal)	+2
Switch	1 (SN2010)	0	-1
10G SFP+ Transceivers	48	48	Same
Fiber	24	24	Same
CXP Fiber Adapters Channels	0	12	+12

Comparing Solutions – 2 x 100G

GiGE VISION®

CoaXPress®

Application 2	100Gig	CXP6	Comparison
Cameras	2	2	Same
NICs/Grabbers	1 (Dual 100Gig)	4 (CXP6 Octal)	+3
CXP Fiber Adapters Channels	0	16	+16

2 x 100G Camera System

21M x 530fps x 8bit 89Gbps/camera

10GigE – New High Speed Camera Interfaces

10 GigE Area Scan Cameras – HR & HT Series

- 10GigE SFP+ interface / 10GBaseT – RJ45 interface
- 0.5 to 50 Megapixel
- Frame rates up to 1,586 fps
- Latest CMOS sensors from Sony and AMS
- Multi-camera synchronization at <1µs
- Visible, near-infrared and polarized options available
- Optional IP67 housing

10 GigE Line Scan Cameras – Pace Series

- 10GigE SFP+ or RJ45 10GBaseT interface
- Gpixel GL0816 CMOS sensor
- 8K resolution
- Single line – 137KHz – 8K, Trilinear – 45KHz – 8K

25GigE – New High Speed Camera Interfaces

25 GigE Area-Scan Cameras – BOLT Series

- 25GigE SFP28 interface
- 0.5 to 65 Megapixels
- Frame rates up to 1594.7 fps
- Latest CMOS sensors from Sony, AMS, and Gpixel
- Low CPU overhead, latency, and jitter
- Optional IP67 housingv

25 GigE Line-Scan Cameras – ACCEL Series

- Gpixel GL0816 CMOS sensor
- 25GigE SFP28 interface
- 8K resolution
- Single Line – 200KHz, Trilinear – 66KHz

50GigE – New High Speed Camera Interfaces

50 GigE Area Scan Cameras – Xtreme Series

- QSFP28 – 50GigE interface
- 21 to 103.7 Megapixels
- Frame rates up to 300 fps
- Latest CMOS sensors from Gpixel
- Low CPU overhead, latency, and jitter
- Optional IP67 housing

100GigE – New High Speed Camera Interfaces

100 GigE Area Scan Cameras – Zenith Series

- QSFP28 – 100GigE interface
- 21 to 103.7 Megapixels
- Frame rates up to 600 fps
- Latest CMOS sensors from Gpixel
- Low CPU overhead, latency, and jitter
- Optional IP67 housing

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GigE –Cameras on Short Delivery

10GigE

HR-12000-S: 10GigE area scan camera with Sony IMX253 12 MP CMOS image sensor that reaches up to 80 fps. Available in monochrome, colour, and polarized versions.

LR-8KG: 10GigE line scan camera with Gpixel GL0816 8192 horizontal pixel CMOS image sensor that reaches up to 137KHz in single line scan mode. Available in monochrome and colour versions.

25GigE

HB-25000-SB: 25GigE area scan camera with Sony S IMX530 24.47 MP CMOS image sensor that reaches up to 98 fps. Available in monochrome and colour versions.

HB-65000-G: 25GigE area scan camera with Gpixel GMAX3265 65 MP CMOS image sensor that reaches up to 35 fps. Available in monochrome and colour versions.

100GigE

HZ-100-G: 100GigE area scan camera Gpixel GMAX32103 100 MP CMOS image sensor that reaches up to 24 fps. Available in monochrome and colour versions.

HZ-65000-G: 100GigE area scan camera Gpixel GMAX3265 65.4 MP CMOS image sensor that reaches up to 71 fps. Available in monochrome and colour versions.

Software

- **eCapture**

  Free viewer software provides control of all camera functions for preview, capture and save. Advanced functions include area of interest (AOI), integration control, and standard pre-processing such as brightness, gamma, frame rate control, and more.

- **eSDK**

  Allows end-users, system integrators, or OEMs to integrate their Emergent Vision Technologies cameras into their own software and equipment. Free C++ development kit and source code examples.

- **eCapture Pro**

  Full turnkey software for various applications such as AOI and Volumetric Capture for customers with limited development resources or no expertise in ultra-high speed vision technologies.

- **3rd Party compliant**

  Emergent Vision Technologies cameras can also be used with any GigE Vision compatible software including Norpix StreamPix, MVTec Halcon, and Cognex VisionPro.

- **OS support**
  Compatible with Windows and Linux

eCapture Pro

ALRAD GigE Portfolio

ALRAD Instruments provides a very wide portfolio of Cameras for the Machine Vision and Automation Industries with interfaces including GigE, USB, CoaXPress, Cameralink, MIPI CSI-2 and FPD-Link III. Our extensive portfolio can be found on: www.alrad.co.uk

In addition to the Emergent Vision Technologies High-Speed 10, 25, 50 and 100 GigE Vision cameras, we also offer a wide range of standard GigE Vision cameras covering the full spectrum from Ultraviolet through Visible, Near Infrared (NIR) to Shortwave Infrared (SWIR):

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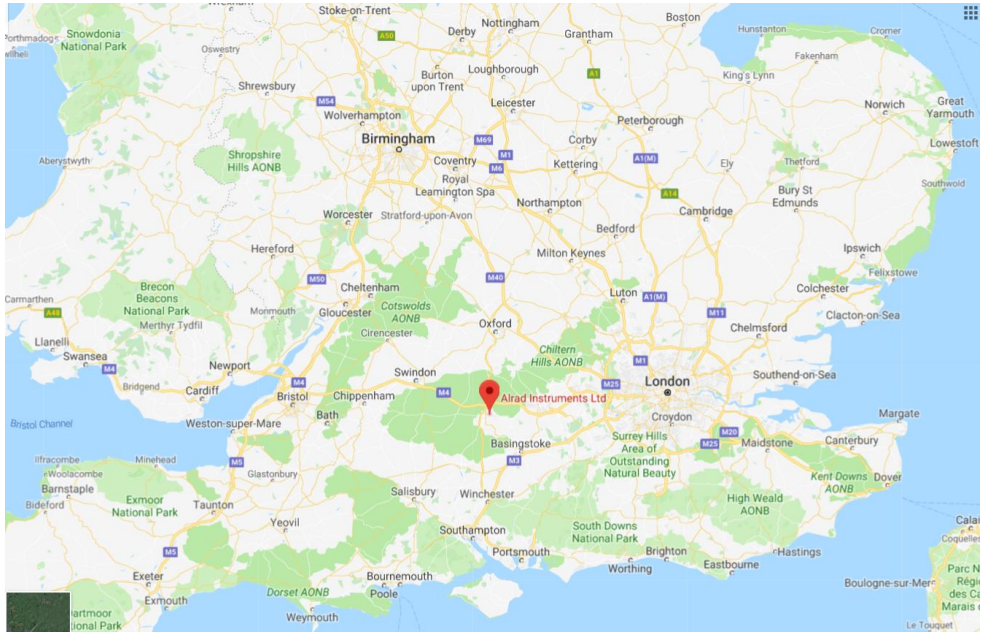

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Thank You

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