



[EVT-AN03-10G-FAQ]

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FAQ

What is 10GigE?

10GigE (a.k.a. 10 Gigabit Ethernet) is the successor to 1GigE (1 Gigabit Ethernet) which is the leading interface for machine vision applications. 10GigE, as the successor, provides all the same benefits of 1GigE but with a ten-fold increase in data-rate which leads to a ten-fold increase in frame rate. 10GigE, as with 1GigE, is an industry standard which has been around for years and is managed/produced by the IEEE 802.3 working group. The standard is used in applications such as telecom, data communications, industrial, military, etc, and now we leverage the benefits of this globally accepted cross-industry technology for machine vision applications.



Does GigE Vision work for 10GigE?

Yes. GigE Vision (the machine vision specific interface standard) regardless of its version supports Emergent 10GigE cameras. The later versions add some additional 10GigE specific elements which are not critical for the operation of Emergent 10GigE cameras with various GigE Vision compliant software such as NI Labview, MVTec Halcon, Norpix StreamPix, etc.



What is the bandwidth of 10GigE?

The maximum bandwidth available for 10GigE is 10Gbps or 1,250 Mbytes/s. The usable bandwidth is around 9.5Gbps or 1,180 Mbytes/s.



What are the cable options for 10GigE and what is the max cable length?

One of the most important benefits of using a strong standard such as 10GigE is the wide variety of components made available by multiple companies across multiple industries. Cabling options are no exception. The two main connector options are SFP+ and RJ45. RJ45 is a good option for shorter cable lengths since the power consumption of such a solution can add an additional 2W of power for running the full 100m which becomes a bit of a problem as we attempt to make cameras more compact. SFP+ is the most flexible option and is conscious of keeping power consumption to a minimum.

Using the SFP+ interface provides primarily three options which cover the cable length requirements of all applications. The first and least expensive option is Direct Attach which is a copper based passive solution and the cable lengths for these single piece cables range from 1m to 10m. The second option utilizes SFP+ multi-mode fiber modules/transceivers and LC-LC multi-mode fiber cables and the cable lengths for this three-piece cable range from 1m to 300m. The third option utilizes SFP+ single-mode fiber modules/transceivers and LC-LC single-mode fiber cables and the cable lengths for this three-piece cable range from 1m to tens of Kilometers.

The price range for these cabling options is very reasonable since they are used across multiple industries in massive volumes unlike for some interface technologies which use cabling options specific to machine vision.



What are the cost implications for 10GigE?

As mentioned, components for 10GigE machine vision applications are used across multiple industries which allows suppliers of such technologies to deal in volumes which in turn leads to lower cost - far more-so than machine vision specific interfaces and technologies who also find themselves scrambling around trying to find components to fit the application of if available then sometimes only one or a few providers are in play which allows them to dictate the price.

Further, the adoption rate of 10GigE is forecast to improve dramatically over the next few years to the point of largely dominating data center applications which in turn drives prices down.

For the cameras, the price scales with performance. For a comparable USB3 camera offering the Cmosis CMV4000 the Emergent HS-4000 does incur a higher cost but the HS-4000, with the 10GigE interface, provides a doubling of frame rate in default pixel formats and a tripling of frame rate in other pixel formats such as Bayer interpolated formats and this is due to the three-fold increase in usable bandwidth of 10GigE over USB3.



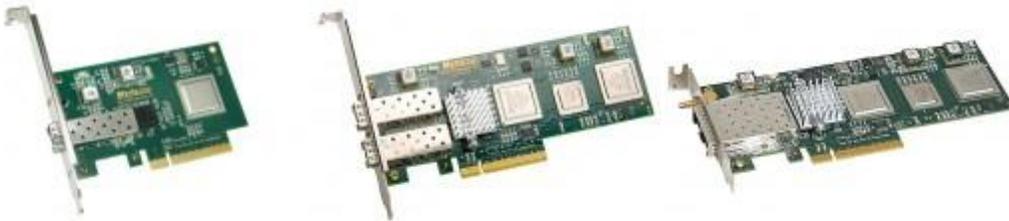
What is the power consumption for 10GigE?

Power consumption of Emergent cameras is around 9W. In comparison to USB3 cameras with the same sensor this is approximately three-fold which is easily attributed to the fact that the usable data rate is also three-fold. Some argue that 10GigE is generally more power hungry but the reality is the bulk of the power consumption for a fully featured camera such as the HS-4000 is attributed to the FPGA power consumption (related to image manipulation) and NOT related specifically to the interface technology. As one would expect, higher power can lead to higher case temperature. The thermal design of Emergent cameras has been optimized to ensure the case temperature is kept within comparable levels to other machine vision cameras and in some cases the temperature is even lower than existing lower speed cameras.

What is Myricom's MVA and how does it impact performance?

This is a very important topic and Emergent and Myricom Inc. have partnered to provide an optimal solution for Machine Vision applications. Myricom supplies their NICs pre-programmed with MVA and are available direct from Emergent. Please see also: <http://www.emergentvisiontec.com/material/datasheets/EVT-AN02-MVA.pdf>

- Extremely low CPU utilization (2% single CPU core overhead for a 9Gbps video stream)
- Extremely low latency (please see section below for test results)
- Extremely low jitter (please see section below for test results)



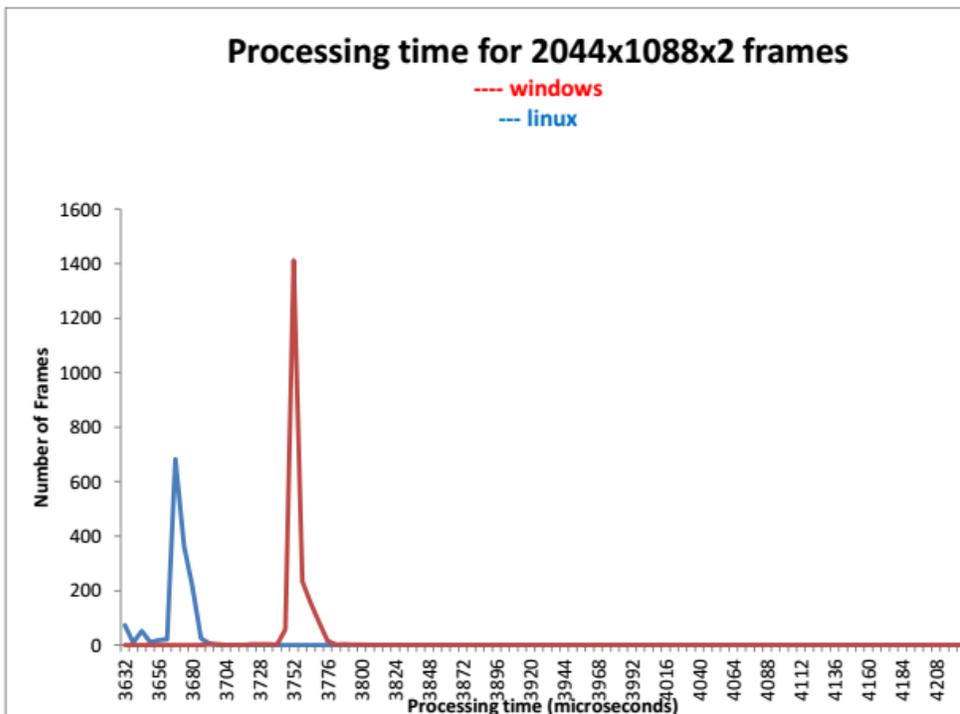
What is the benefit of using 10GigE for my application?

- Ultra high data/frame rates
- A large number of accessory and cabling options to cover any length
- Camera network support and accurate multi-camera synchronization methods
- Low CPU overhead, low latency, low jitter using Myricom's MVA.
- Very competitive cost/performance which will only get better as 10GigE is further adopted
- Industry acceptance due to IEEE and AIA standardization



What is the jitter and latency of 10GigE? How does this compare to 1GigE?

Utilizing Myricom's MVA we obtain the results below. With a theoretical transfer time of 3595us at 10Gbps line rate ($2044 \times 1088 \times 2 \text{ bytes} \times 8 \text{ bits} / 10 \text{ Gbps} = 3595 \text{ us}$) we achieve the following results on Windows and Linux based on a 3000 frame sample size. Latency is naturally a function of image size so just by virtue of running at 10G rates compared to 1G rates already provides a ten-fold improvement in latency. We then shift our attention to the added (or overhead) contribution of latency which we can see by subtracting the theoretical from the actual which is seen as the mean of the two histograms below such that on Windows $3752 \text{ us} - 3595 \text{ us} = 157 \text{ us}$ added latency which is extremely good for Windows. For Linux we get even better $3665 \text{ us} - 3595 \text{ us} = 70 \text{ us}$ added latency. The standard deviation and thus jitter is also seen to be extremely good at about $\pm 30 \text{ us}$ and $\pm 15 \text{ us}$ respectively for Windows and Linux. Using Myricom's MVA, 10GigE bests 1GigE and many other interface technologies that rely on cooperation by the operating system - even if said technologies include the most currently advanced driver technologies. Thus for top performance, use Emergent cameras with Myricom MVA with the Myricom solution incurring only a modest cost increase.



How does 10GigE compare with other interfaces?

Emergent 10GigE cameras, coupled with Myricom's MVA, equals or out-performs other interfaces in every technical category and its price performance is in line with the best. With MVA, all the shortcomings associated with 1GigE w.r.t. CPU utilization, latency and jitter are obliterated. Industry acceptance is very good and will only get better.

	1394-B	GigE	USB 2.0	USB 3.0	Camera Link	10GigE	Winner
Bandwidth	80MB/s	100MB/s	40MB/s	440MB/s	680MB/s	1180MB/s	10GigE
Cable Length	10m	100m	5m	3m	10m	10/300/Kms ¹	10GigE
Standard Support	Poor	Excellent	Poor	Good	Good	Excellent	10GigE ²
Industry Adoption	Fair	Excellent	Fair	Excellent	Fair	Excellent	10GigE ²
CPU Usage	Low	Medium	High	Low	Low	Low ³	10GigE ²
Latency/Jitter	Good	Poor	Fair	Excellent	Fair	Excellent ³	10GigE
Price Performance	Good	Good	Good	Excellent	Fair	Excellent	10GigE

¹ Dependent on the accessory options chosen.

² Tie.

³ Using Myricom's MVA

What operating systems are supported?

Emergent's solution supports Windows 7/8 and Ubuntu Linux 12.04 LTS with both our eCapture viewer software and our eSDK.



Will 10GigE cameras work with GigE Vision compatible software?

Yes. As long as the 10GigE camera follows the GigE Vision standard.



What off the shelf components are available for 10GigE?

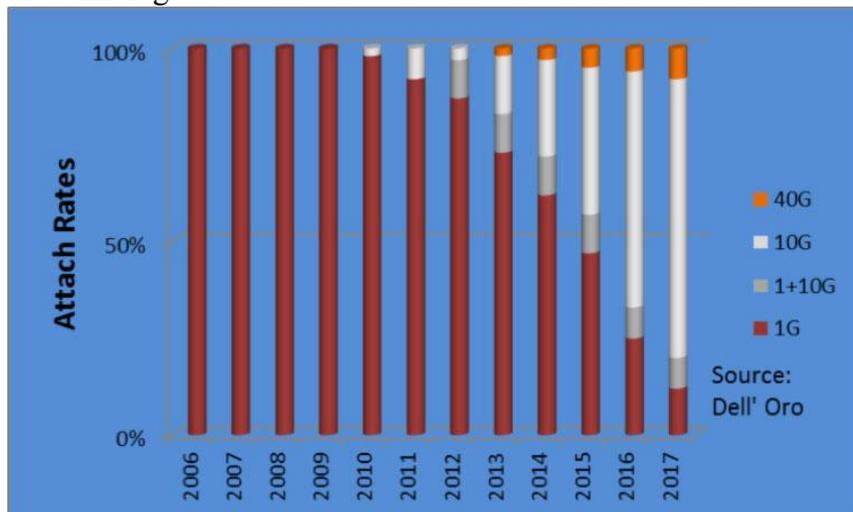
Cables, switches, network interface cards - to name a few.

A number of companies are getting on board with industrial modules and chassis blades with SFP+ interfaces which lends itself very nicely to a scalable and distributed processing architecture.



Where will 10GigE be in the future?

The chart below (courtesy of Dell) shows very clearly 10GigE adoption for data center applications. Note also how 40G will start to creep in in the later part of the decade. It is expected that this trend will apply to machine vision applications as well as price per port will continue to drop as will power consumption as more ASIC companies advance their technologies.



Comparison of 10GigE and the future USB 3.1?

If and when USB 3.1 comes out it will incur the same cost for performance as for 10GigE. You will get the increased performance. You will pay more for it. Power consumption will be higher. As mentioned, it is not yet a standard and meanwhile 10GigE is and will continue to capitalize on the standardization and constant 10GigE infrastructure advancements across the multiple industries it serves.

How can I synchronize multiple cameras?

Please see:

<http://www.emergentvisiontec.com/material/datasheets/EVT-AN01-SYNC.pdf>

In addition, Emergent offers the standard GPIO accessory options to allow the user to trigger the cameras via external hardware triggering through some user provided hardware pulse/edge.

What software can I use for my 10GigE camera?

Generally, any GigE Vision compatible software should work with Emergent cameras by virtue of Emergent cameras being certified as GigE Vision compliant by the AIA. We have tested with a few such 3rd party software such as NI Vision Acquisition Toolbox, MVTec Halcon, Norpix StreamPix 6. Emergent also offers free software with a camera purchase: eCapture is our free viewer software, and eSDK is our C++ SDK for easy application development.

What computers support 10GigE?

Supermicro has a number of computer mother boards which have SFP+ or 10GBaseT/RJ45 interfaces. The majority of computers that have an available PCIe x8 or x16 slot will support the Myricom NICs in a variety of operating systems. Very simple and inexpensive mini-desktops by Acer have an available x16 PCIe slot and can be used for development. The final system would only depend on how much image processing is required and at what data/frame rate. For processor intensive applications, GPU/Video cards by NVidia running CUDA can be employed. Since the data arriving from the Myricom NICs comes with extremely low overhead this allows the system to easily transfer this data to a GPU for further processing.



What 10GigE accessories does Emergent offer?

Emergent provides all the fundamental accessories required to develop your system and application.

We provide all SFP+ cabling options you may need such as Direct Attach cables (ie. 10G-SFPDA-3M), Optical transceivers (ie. 10G_XCVR_SR = multi-mode or "short reach", 10G_XCVR_LR = single-mode or "long reach") and LC-LC fiber cable for both multi-mode and single-mode applications. Single mode fiber is generally for long distance applications beyond 300m so please contact Emergent with your requirements).

We provide single, and dual port 10G Network Interface cards from our partner Myricom Inc.

We also provide the specialized 10G Sync NIC by Myricom mentioned in the above EVT-AN01-SYNC app note.

Lastly, we provide GPIO and power supply options to complete your integration needs.

We are a one-stop shop for your 10GigE machine vision application needs.



What is the maximum frame rate I can achieve with my Emergent camera?

Emergent has developed an accurate frame rate calculator tool which is available on our website.

Please see:

<http://www.emergentvisiontec.com/material/datasheets/EVT-FRAME-RATE-CALCULATOR.xlsx>



Document History

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1.01	1 June 2014	Initial Version

