

The logo for FRAMOS, consisting of the word "FRAMOS" in white capital letters on a dark blue square background.

FRAMOS



10GigE INCREASES FAIRNESS IN SPORTS

Quick, affordable and via a single cable

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Was the ball really in the net? Was the tennis shot out? What exactly did the baseball stroke look like in slow motion? – 10GigE cameras are being used to answer these questions in sports and entertainment. The high-speed industrial cameras are more affordable and smaller than the classic broadcasting solutions and deliver the necessary Full HD and 4K UHD resolution. The main advantages of 10GigE cameras lie in the superb image quality and speed, the simplified cabling and reduced susceptibility to errors as well as the synchronization and data processing directly via a connected PC. The result: improved tracking options for sports event organizers and detailed, data-based reporting.

01 | GOAL LINE MONITORING

It's the nightmare of every soccer fan and referee. The ball flies toward the goal, is almost in, but a quick defender kicks it out again right at the "goal-mouth". So did the ball cross the goal line or not? A visual judgment is often not enough to make a valid statement, TV cameras are positioned at the wrong angle, the goalkeeper says yes, the defender swears no – the referee often has only a 50/50 chance, at best, of making the right decision. This is where high-speed cameras can help, especially 10GigE cameras installed parallel to the goal line. They monitor the goal and the approaching ball with Full HD resolution (1920 x 1080) and, depending on the lighting conditions, at frame rates of up to 300 frames per second. The high resolution corresponds to television quality with high image sharpness. The high frame rates enable fast-moving scenes to be captured with fast time resolution and without the typical motion distortion. The instant replay and precise evaluation of the goal area immediately show whether the ball crossed the goal line, even momentarily before being kicked out again.

This information can be passed to the referee almost in real time to ensure the game progresses fairly.

Fewer tangled cables and fast installation for less money

Sports organizers and broadcasters who choose Camera Link or CoaXPress camera systems over 10GigE often must contend with piles of cables, additional interface cards and frame grabbers which increase costs and complexity. The systems were also prone to errors due to the integration of cables, cameras, frame grabbers and converters of many different suppliers, a large number of transfer points and connected components. A trained engineer is needed on site to get the system up and running and to repair it again in the event an error occurs.



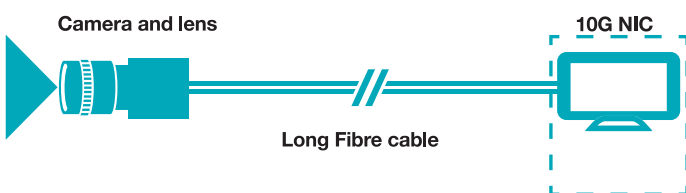
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When using 10GigE cameras, such as those from Emergent Vision Technologies, a single fiber optic cable with SFP+ connection is used to connect the camera to a PC fitted with a 10G network interface card (NIC). Without the need for additional frame grabbers, it connects the camera at the goal to the broadcast van or playback station over a typical distance of 1 to 2 kilometers. Distances of up to 10 kilometers are possible with an SFP+ fiber optic connection. Two 10GigE cameras, one for each goal, are sufficient for proper monitoring and evaluation. The costs of a 10GigE camera system are significantly lower due to the smaller number of installed components and fewer cables. The Ethernet solution can also be used with other standard 10G network products, which are inexpensive to buy. As only one transmission protocol is used, the error rate is also significantly reduced. One on-site technician instead of an engineer is sufficient to maintain the system and fix any errors. The time spent commissioning and servicing the camera system is also significantly reduced. The large quantity of data generated by the 10GigE cameras would exceed the processing power of commercially available PCs. Processing the data via the NIC cards integrated into the PC enables CPU usage to be reduced below 1%. Small latencies of between 5 and 50 μ s ensure flicker-free and instantaneous playback of the goal scene and in time-critical broadcasting applications.

In particular, cameras with quality sensors, such as second generation SONY CMOS Global Shutter sensors, achieve excellent values in terms of dynamics and quantum efficiency even at high speeds and exhibit low noise behavior. At the present time, sensors from CMOSIS are a very good choice for applications that focus on maximum speed and make slight allowances for image quality.



02 | BALL TRACKING

In the same way that the soccer referee assesses the validity of a goal, in tennis it is the line judge who decides whether a ball is out or has landed just on the line. The immediate tracking of a ball and its exact position at a certain time is equally important for:

- the management of live broadcasts
- the coordinated production of sports programs
- accurate video management
- digital production for online reporting
- coaching of athletes with motion analyses
- evaluation of research trials on sports equipment in the development phase

Timing and synchronization of the cameras are the main criteria for precise tracking of a ball and therefore decisive factors for building up the necessary multi-camera system. The ball never flies in a straight line, but creates arcs and angles. In order to calculate the exact shot, trajectory and speed, detailed motion data in combination with exact timing are essential.



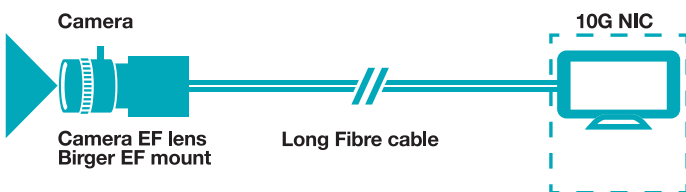
In typical 10GigE systems, such as those with 10GigE cameras from Emergent Vision Technology and the NICs, integrated IRIG modules provide a stable and steady time reference. With these time references, the NICs work as masters to trigger all connected cameras and add time stamps to the images taken before they are transferred to the PC with low CPU usage and very low latency. The IRIG standard has been used for the timing mechanisms over large distances since 1960. The dual sync NICs were originally developed for financial and stock exchange transactions

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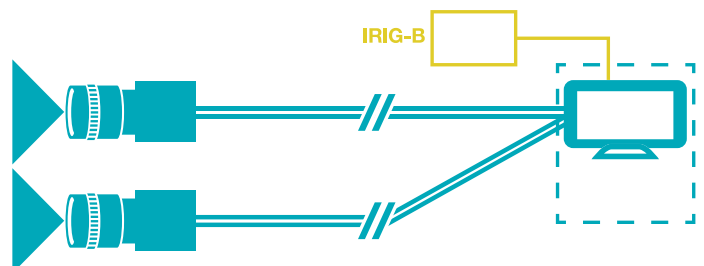
and have a timestamp precision of 1000 ns at a resolution of 500 ns. Thanks to minimized network delays, they are extremely accurate. IRIG modules and dual sync cards provide maximum synchronization precision when used in combination. The IRIG encoder renders previously required expensive switches obsolete and simultaneously eliminates a further source of errors. The usually pre-integrated IRIG encoder only has to be connected to the NIC for this purpose and can be used with all types and lengths of cable.



03 | BIRD'S-EYE VIEW BROADCASTING

The detailed observation of goals, lines or trajectories are important, but so too is the overall bird's eye view of the game. Monitoring whole pitches or wide overview scenes is often very complicated to control with conventional TV cameras. Remote control functionalities are not always available, meaning that additional hardware interfaces from third-party providers are usually required. That is expensive and poses the risk of additional sources of error. A camera operator also has to be present on site. Apart from these cost factors, 4K-capable television cameras are usually expensive and bulky. The 10GigE cameras on the other hand are compact and can be installed permanently outdoors inside a weatherproof housing.

Precise synchronization – programmable and “from a single source” The camera synchronization can be programmed and controlled via the camera SDK. The timing delays between the cameras are automatically corrected by the hardware and software. All cameras are therefore synchronized. When using several PCs, the standard network can be used for the transmission and controlling of the time stamp between the master and slave units. Combined with the various cable options, the IRIG referencing is the most flexible solution for synchronized high-speed applications such as Ball Tracking in terms of cost and performance.



Compared to Camera Link and CoaXPress solutions, the advantage of 10GigE setups, such as Emergent Vision Technology cameras with NICs and integrated IRIG encoders, is that several cameras can be connected directly to the processing PC. Depending on the setup required, 2 or 4 cameras on a single NIC card and up to 4 NIC cards – i.e. up to 16 cameras – can be controlled by a single PC. The frame rates depend entirely on the performance of the camera and can be achieved with low CPU usage and very low latencies.

10GigE camera systems offer a simple remote control solution for an affordable price-performance ratio. To this end, the 10GigE camera equipped with a Canon EF lens with Birger mount is installed in an exposed position above the action, e.g. on the stadium roof. The

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10GigE cameras with the newest generation of sensors, such as the Sony IMX 253 or IMX 255, achieve 4K UHD resolution (3840 x 2160) and the next-generation in TV quality. Settings such as trigger time points, frame rate, lens zoom, focus and aperture can be controlled remotely from the connected PC without the need for an additional camera operator. With up to 93 fps at 4K resolution, both time lapse and slow-motion playback are possible. The simple setup with camera including lens, cable, NIC and processing PC keeps costs low and need no further components or additional personnel.

The most important advantages of 10GigE technology in broadcasting

The three examples show how modern 10GigE industrial cameras help to implement state-of-the-art broadcasting solutions. The excellent image quality with Full HD and 4K UHD resolution, even in fast motion sequences, as well as the precise synchronization of several cameras, are the most important criteria for carrying out detailed analyses such as Goal Line Tracking or Ball Tracking and ensuring television audience viewing pleasure. The compact size also plays a big role as does the simple rehousing of the cameras. Goal line cameras or overview cameras are permanently installed in the stadium all year round and have to withstand wind and weather. The simple cabling plays a big role, both in outdoor installation and in the composition and implementation of the system. No further interfaces or frame grabbers are required, which significantly reduces the risk of errors. All of this has an impact on the costs, which are much lower than those of classic broadcasting systems. High quality, simple implementation and use combined with low costs make 10GigE an unbeatable solution for the realization of sophisticated broadcasting systems, even in synchronized multi-camera systems.

ABOUT FRAMOS | For FRAMOS, imaging is not just a technical discipline, it is also a fascination, the future and our mission.

Since its foundation in 1981, FRAMOS has established itself as a leading provider of technology for industrial, scientific and medical imaging. Suppliers, system integrators and researchers can use the imaging technologies to their benefit at our main headquarters in Munich and five additional branch offices worldwide. Our team, with more than 100 employees, offers a comprehensive range of imaging components, technical consulting and support. Thanks to our many years of experience in the sector, we can also offer engineering solutions for both customized camera developments and complete turnkey solutions. The spirit of innovation and development, which existed right from the very outset, is still lived out in our company today.