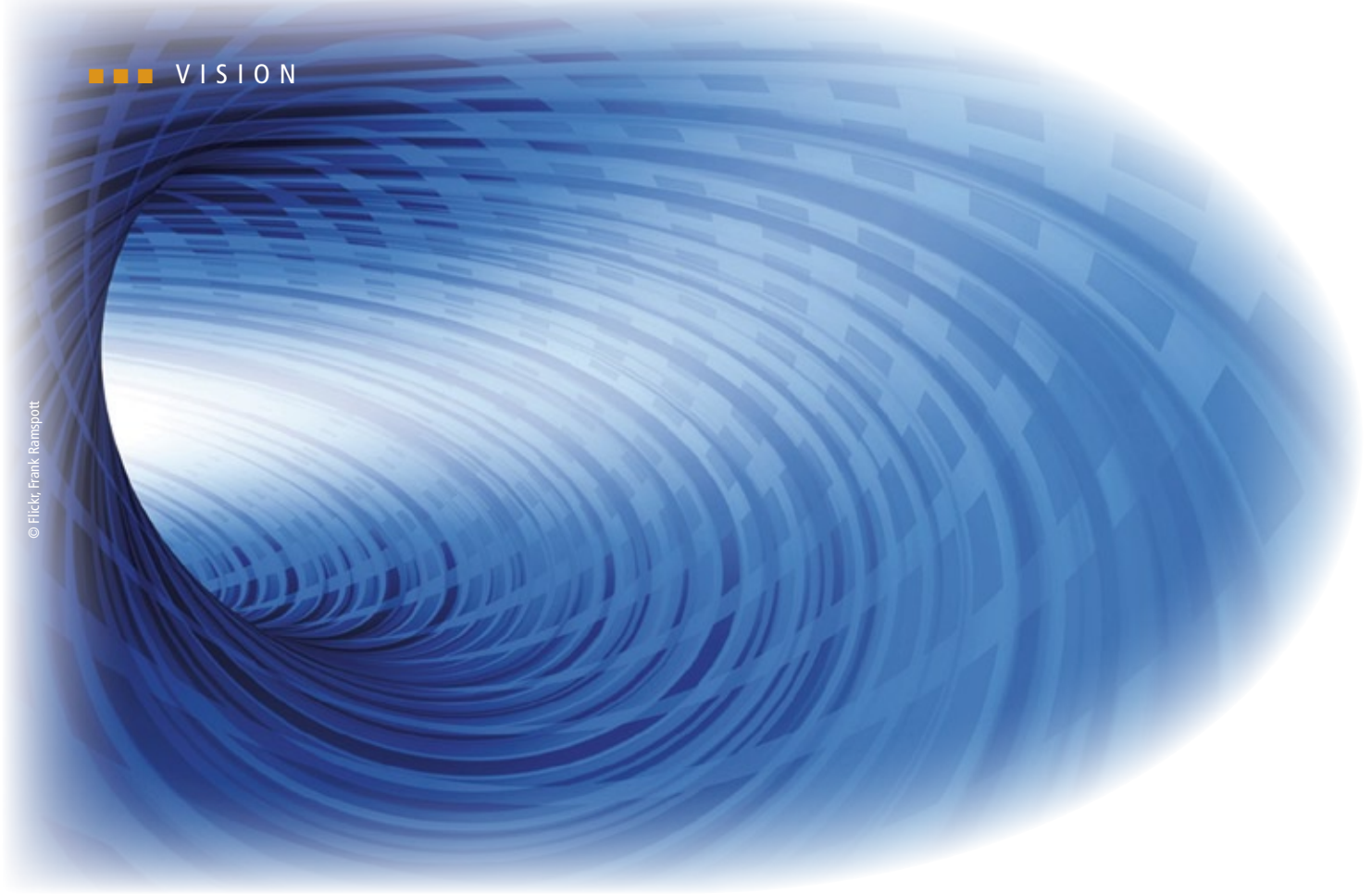

Extended Range, Lowered Cost

Next Generation Camera Interface: HSLink

Continual growth in the bandwidth requirements of vision system cameras has prompted the creation of a new camera interface standard targeting wide applicability at lowered cost. The HSLink interface takes key features of Camera Link and adds enhancements to match the needs of modern machine vision systems. Initially developed by Dalsa, the HSLink interface is now in the process of becoming an open industry standard.

With increasing resolution and faster frame rates, cameras for machine vision systems have steadily increased their need for bandwidth. Many cameras are now available that send more than 1 Gbyte/second to a frame grabber or image processor. The popular Camera Link interface, however, tops out at 850 Mbytes/second and 10G Ethernet interface can only manage 1.2 Gbytes/second. Extending either of these interfaces through increased parallelism will prove a costly option.

Scaling up to 6 Gbytes/sec

To address this shortfall, Dalsa has developed a new interface – HSLink – that can scale up to 6 Gbytes/second. The intent in developing HSLink went beyond attaining simple performance increases; however, it sought to address a wide range of vision system developer needs in terms of functionality, development costs, and service life. Dalsa also seeks to evolve HSLink into an open industry standard and has proposed that the Automated Imaging Association's Camera Link Committee take over the standards development process.

Long-term and Cost-effective

Two fundamental principles guided the development of HSLink. One was to ensure that the standard could evolve to meet the needs of vision systems for decades to come. The other was to make the interface easy to implement in a cost-effective manner for a wide range of camera systems from 100 Mbyte/s to 6Gbyte/s, line scan to CMOS windowed area array. The technical details of HSLink reflect these principles.

Beyond Bandwidth

HSLink's top-level protocol builds the four Camera Link message types – trigger, CC lines with expanded functionality called general-purpose I/O (GPIO), serial command channel, and video data – into a single prioritized stream. The camera's or frame-grabber's Camera Link Signaling Layer connects directly to an HSLink IP core, which in turn drives the PHY

layer hardware (fig. 1). This re-utilization of Camera Link signals helps ease migration to HSLink systems by design teams already familiar with Camera Link.

The IP core does more than simply replicate Camera Link functionality onto a different cabling system, however. It also implements reliability and utility extensions. One critical reliability extension is support for hardware-based error detection and data resend. The hardware basis minimizes buffer memory requirement and allows the full interface to fit within an FPGA without needing external memory, minimizing implementation cost.

A second reliability feature is the utilization of two-of-three voting for critical real-time control messages that cannot tolerate a resend. The trigger, GPIO, and handshaking commands are each only a few bytes long. HSLink sends the command data three times within a message and the receiver compares the three data sets to detect and correct any single-bit errors in the message.

Added utility features include integrated real-time triggering (3.2-nanosecond jitter) that eliminates the need for a separate trigger cable. The protocol also supports data forwarding, which allows multiple frame grabbers to connect to a single camera and share the data stream. This feature simplifies the use of multiprocessing to handle high-bandwidth camera data. The protocol also supports the insertion of intermediate devices between the camera and frame grabber, such as data concentrators. The protocol supports connecting as many as 64 cameras to a single frame grabber.

Physical Layer Supports Industry Standards

The HSLink physical layer (PHY) utilizes industry-standard serdes devices with 8b/10b encoding. This approach provides several benefits. One is lowered implementation cost; device developers can choose from a wide range of supplier options without needing to worry about interoperability with products from other vendors. The use of 8b/10b encoding also allows HSLink to have a longer reach than Camera Link. Stock serdes devices readily support cable lengths of at least 15 m, with 20 m common.

The HSLink interface was designed for scalability, allowing it to provide a consistent, cost-effective control interface for cameras with bandwidth needs below 300 Mbytes/second to as high as 6,000 Mbytes/second. Entire camera families can utilize HSLink effectively, simplifying vendor development and support efforts as well as system integration, maintenance, and upgrading. The use of standard serdes devices also decouples the protocol from the physical layers. This decoupling ensures that HSLink will readily scale to higher bandwidths as serial interfaces evolve, such as migration to optical fibers.

The currently-defined cabling for the HSLink interface is also scaleable, allowing system integrators to minimize cable costs for a given installation. An HSLink connection provides a 300 Mbyte/second uplink control channel from frame-grabber to camera, a similar downlink control channel from the camera, and from one to 20 300-Mbyte/second video data lanes. The lowest-bandwidth implementation of HSLink allows use of a single InfiniBand cable (two twisted pairs) as a low-cost solution, with one twisted pair carrying both the downlink channel and the video lane. The physical layer can be integrated into an FPGA for extremely small and cost effective camera implementations. Dual-IB-cable implementations extend the data bandwidth to 600 Mbytes/second. Higher bandwidth implementations can use CX4 thumbscrew cables or Infiniband 12x cables.

Open Standard Intended

Dalsa intends HSLink to be open to the entire machine vision industry. Efforts are underway to turn HSLink into an open industry standard; meanwhile several companies have joined Dalsa in supporting HSLink in their new designs. None of the technology that Dalsa has developed for the interface, including the HSLink IP core, requires license or royalty fees and the PHY devices are widely available. HSLink is thus well positioned to be the next-generation interface for machine vision systems.

▶ **Author**
Mike Miethig,
Standard Products Electronic Group Manager

▶ **Contact**
Dalsa, Waterloo, Ontario, Canada
Tel.: +1 519 886 6000
Fax: +1 519 886 2317
mike.miethig@dalsa.com
www.dalsa.com/hslink

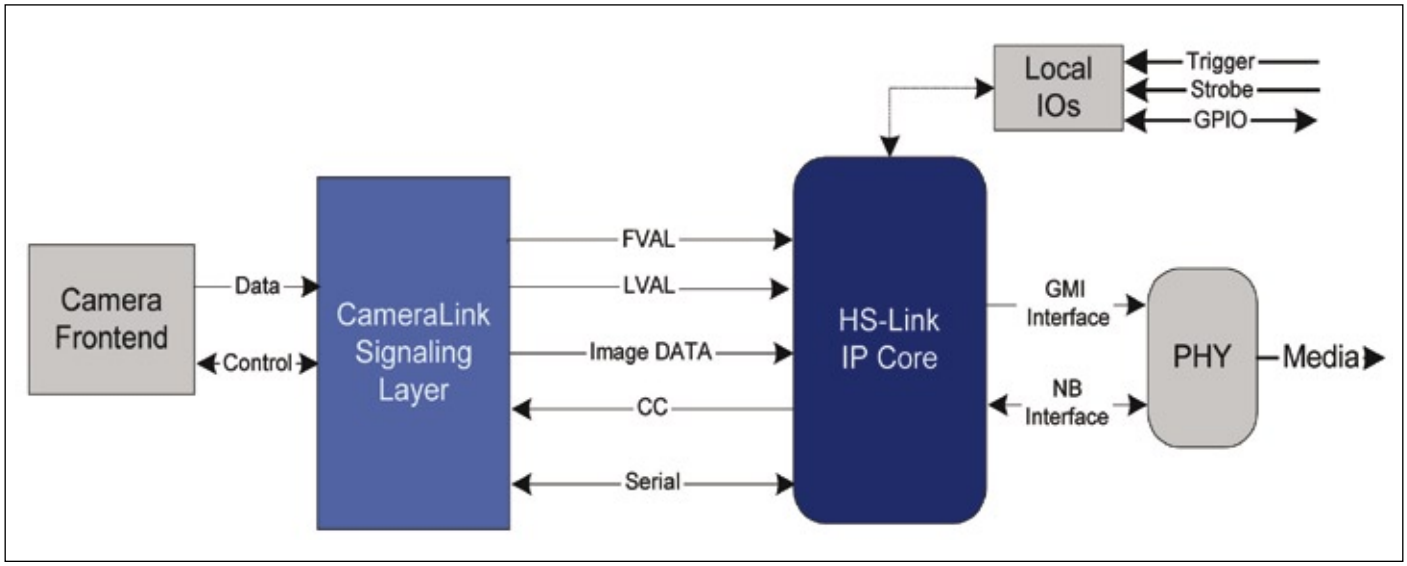

Fig. 1: The HSLink interface takes Camera Link signaling and creates a single, unified channel carrying control, trigger, I/O and video data between camera and frame grabber