Is Gigabit Industrial Ethernet adoption the key to achieving Industry 4.0 goals?

While there may still be some debate about what Industry 4.0 really means, there is no denying that greater interconnectivity of devices and increased network capability will be the key drivers behind achieving the goals it sets out.

John Browett, CLPA Europe General Manager, outlines the network requirements that will enable Industry 4.0.

As manufacturers examine future challenges around low volume production, increased customisation and increased competition, it is easy to understand why the concepts of Industry 4.0 have come to the fore.

Industry 4.0, combined with the Industrial Internet of Things (IIoT), not only holds the key to addressing many of these challenges, but also promises to deliver innovations that today's manufacturers have not even thought of yet.

Industry 4.0 can be defined as the combination of "cyber-physical" systems with the IIoT. Underpinning it are Ethernet and Internet-based technologies that provide the connectivity for everything to communicate with everything else, regardless of 'where' a device or system is physically, or, 'what' it actually is. Today, while we talk about high levels of interconnectivity, usually there are incompatibilities in networks and technologies that mean projects are divided into separate islands.

As we overcome these incompatibilities and drive ever greater levels of integration and interconnectivity, Industry 4.0 will allow production machines to provide more transparency and cooperate to a higher degree. Some say that this will ultimately lead to intelligent factories capable of autonomous production changeovers, reassignment of production equipment and perhaps even scaling their capacity as demand increases. By extension, this will also take in the Internet and collaboration with vendors and customers to a greater degree than is possible now.

None of this can happen, though, without the networks to carry the information between the places where it's needed, in real-time. Ethernet provides a good foundation for this infrastructure, but being able to deliver the necessary performance will require technology with greater capabilities than is common now. CC-Link IE, however, can meet all of these requirements today.

Gigabit Ethernet standard for automation

One of the key requirements of Industry 4.0 applications is the need to share large amounts of data from multiple devices in real-time. Hence bandwidth is critical to the successful operation of these systems. CC-Link IE is the world's first and only open gigabit Ethernet standard for automation. As such, it offers a performance increase of around 10 times compared to any other similar protocol today. Further, CC-Link IE has the highest bandwidth available at 1Gbps, delivering the performance needed to connect the most data-hungry processes together.

CC-Link IE is based on the Ethernet standard IEEE 802.3, and allows for ring, line and star topologies. In addition, the line and star topologies can be combined together to provide systems that offer the maximum application flexibility. The ring and line connections are particularly attractive, as they permit simple "daisy chaining" of devices, meaning the added cost and complexity of network switches can be avoided.

Addressing cyber security concerns

One of the key concerns related to the increasing adoption of industrial Ethernet is cyber security. While the use of Internet-based technologies has increased the possibilities of what can be achieved in manufacturing, it has also increased the threats.

Some industrial Ethernet protocols are based on a standard TCP/IP (UDP/IP) stack, which can arguably cause some security vulnerabilities. CC-Link IE combines the physical and data-link layers of the OSI hierarchy with an open protocol that extends from the network to application layers. The result is an open, but controlled knowledge base that CLPA partners are free to implement, but reduces the exposure to unauthorised use.

Another concern potential users may have regarding the protocol is its compatibility with TCP/IP (UDP/IP) traffic. While current network design practice encourages segmentation of networks for security and performance reasons, sometimes it's still necessary to support non-control related network traffic. CC-Link IE supports this with the capability to encapsulate TCP/IP (UDP/IP) packets for transmission across the network, thus allowing this traffic to "tunnel" through the CC-Link IE system.

CC-Link IE also allows considerable application flexibility by supporting multiple protocol types on the same network. This reduces costs and increases maintainability. In addition to the standard I/O control, it also offers safety (SIL3), motion control and energy management on the same cable. This allows the CLPA to offer a cost-effective, simplified, flat network architecture that meets the needs of nearly all applications in the discrete sector.

Speed and simplicity

When it comes to actually using the network, again, the emphasis is on simplicity. CC-Link IE's basic communication technique is based on a shared memory model. All the devices on the network occupy an area of the controller's memory. To communicate with them, it's only necessary to change the value of the data in the area corresponding to the relevant device. The network automatically handles the traffic via the standard "cyclic" (synchronous) communication.

The same process happens in reverse for communication to the controller from devices. For high priority, unscheduled events such as alarms, or lower priority non-cyclic transmissions such as diagnostic information, an alternative "transient" (asynchronous) communication method is available. The technology has been designed such that even high levels of transient traffic do not impact the deterministic regular cyclic communication, meaning normal system functions are not impaired and the scan cycle is completely deterministic.

Deterministic performance is achieved with a token passing method, allowing dependable system operation. In practice, this allows network update times to occur in a few tens of microseconds, depending on system size and configuration. CC-Link IE also offers the ability for redundant controllers, so even a controller failure will not necessarily result in lost production.

We can see, then, that CC-Link IE can help manufacturers reap the benefits of greater connectivity across their processes, with improved network performance delivering tighter control, greater data throughput at high speed, deterministic performance and inherent security. It is also set to play a key role as manufacturers push towards models of Industry 4.0 in order to address the production challenges of tomorrow.

Image caption: As the world's first and only open gigabit Ethernet standard for automation, CC-Link IE allows for large amounts of data to be shared with the highest bandwidth currently available.
[Source: CC-Link Partner Association Europe]

About the CC-Link Partner Association (CLPA)

The CLPA is an international organization founded in 2000 dedicated to the technical development and promotion of the CC-Link family of open automation networks. The CLPA's key technology is CC-Link IE, the world's first and only open gigabit Ethernet for automation and an ideal solution for Industry 4.0 applications due to its unmatched bandwidth. Currently the CLPA has over 2,900 member companies worldwide, with more than 1,600 certified products available from over 300 manufacturers. CC-Link is the leading open industrial automation network technology in Asia and is becoming increasingly popular in Europe and the Americas.

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