Smart factories just got a whole lot smarter, and it's about time...

As Industry 4.0 drives the adoption of cutting-edge machines, robots and sensors in manufacturing, network technologies that facilitate their communications to create an interconnected smart factory become even more crucial. Time-Sensitive Networking (TSN) offers a key tool to futureproof industrial Ethernet for the Factories of the Future.[1]

John Browett, General Manager of CLPA Europe, looks at how TSN can address the needs of Industry 4.0 and support manufacturers

The Smart Factory envisioned by Industry 4.0 can help manufacturing industries from any sector to boost their productivity, efficiency, product quality and consistency. This is possible by having machinery and equipment that can improve industrial processes through automation, communications and self-optimisation.

To do so, large volumes of data need to be gathered from a broad range of operational technology (OT) systems, processed efficiently – ideally via edge computing, and then transmitted to top floor IT infrastructures. Therefore, Smart Factories need a networking technology that does more than handling increasingly greater data traffic.

The network of the future must be able to bridge IT and OT. In order to successfully merge field and higher enterprise levels, smart industrial networks should be able to prioritise any time-critical control messaging, as well as assign bandwidth in a faster, more controlled and accurate manner.

All these aspects are particularly challenging for most industrial Ethernet networks currently available. In particular, within the field level, traditional industrial Ethernet networks often use bandwidth hungry overprovisioning approaches to transfer both time-critical and non-urgent data.

They may also work on nonstandard "Best Effort" data delivery systems to optimise determinism. These use Class of Service (CoS) mechanisms to guarantee Best Effort bounded end-to-end latency of time-sensitive data traffic. However, CoS could also be responsible for the delay of urgent process data in these set-ups. In fact, when the transmission of a non-urgent message is underway, time-critical messages are assigned to a queue and can no longer be prioritised.

A call for change in traffic scheduling

TSN technology can address these issues by offering an Ethernet standard that implements deterministic capabilities on an ISO/OSI (International Standards Organization/Open Systems Interconnection) Data Link Layer. More precisely, the Institute of Electrical and Electronics Engineers (IEEE) standards 802.1 governing TSN functionalities defines a number of traffic shaping and scheduling tools that guarantee the efficient delivery of any kind of data on an Ethernet network.

A key element, defined in IEEE 802.1Qbv, is TSN's Time- Aware Scheduler (TAS). This is a gate driver that priorities Ethernet frames on the basis of their transmission time. When urgent cyclic data need to be transferred, TAS temporarily interrupts the transmission of non-urgent traffic. As a result, time-sensitive data can be delivered within the reserved time slots for high-priority traffic.

IEE802.1Qbv also specifies a length-aware scheduling mechanism to optimise bandwidth usage. When the scheduler receives a message that needs to be transmitted, the overall length of the frame is checked. If the frame can fit without affecting high priority traffic, the scheduler sends this information. If not, the message is queued or, as defined by IEEE 802.1Qbu and IEEE 802.3br, can be transmitted into two separate parts (frame pre-emption).

Thanks to these different IEEE 802.1 sub-standards and tools, TSN can –enhance the reliability of traditional industrial Ethernet protocols, and tailor both bandwidth and latency based on the specific application requirements. Consequently, critical and non-critical data traffic can efficiently coexist.

Leading the way in TSN implementation

The established open industrial Ethernet technology CC-Link IE has adopted TSN. The resulting solution, CC-Link IE TSN, combines the benefit of a well-developed open Ethernet framework with Gigabit bandwidth along with the added capabilities of IEEE 802.1 TSN technologies.

The system is built around ISO/OSI Layers 3 to 7, and adopts IEEE 802.1AS and IEEE 802.1Qbv standards concerning synchronisation and scheduled traffic.

By choosing the CLPA and its technologies, such as CC-Link IE TSN, end users can rely on network solutions at the forefront of automation. Industries can adapt to growing manufacturing demands and more easily turn their factories into smart, interconnected systems.

[1]'Factories of the Future' is the European Union's €1.15 billion public-private partnership (PPP) for advanced manufacturing research and innovation. It is the European Union's main programme for realising the next industrial revolution: materialising Factories 4.0. EFFRA

Image 1: The Smart Factory envisioned by Industry 4.0 can help manufacturing industries from any sector to boost their productivity, efficiency, product quality and consistency.

Image 2: Time-Sensitive Networking (TSN) offers a key tool to futureproof industrial Ethernet for the Factories of the Future.

About The CC-Link Partner Association (CLPA)

The CLPA is an international organisation 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 TSN, the world's first open industrial Ethernet to combine gigabit bandwidth with Time Sensitive Networking (TSN), making it an ideal solution for Industry 4.0 applications. Currently the CLPA has over 3,600 member companies worldwide, with more than 1,900 certified products available from over 300 manufacturers.

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