It's time for factories to become a whole lot smarter

An increasingly higher number of businesses are setting up cutting-edge machines, robots and sensors and connecting them in their manufacturing facilities. To operate these automation products effectively and smoothly run any process by leveraging the Industrial Internet of Things (IIoT), it is crucial to implement suitable, advanced network technologies. Only in this way, it is possible to achieve fast cycle times and the creation of interconnected smart factories. The state-of-the-art solution required is Time-Sensitive Networking (TSN).

Thomas J. Burke, Global Strategic Advisor at CC-Link Partner Association (CLPA) Americas, looks at how TSN can address the needs of IIoT-driven factories of the future and support manufacturers.

Smart, interconnected factories can help manufacturing industries from any sector to boost their productivity, efficiency, product quality and consistency. In particular, a recent analysis from Deloitte and the Manufacturer's Alliance for Productivity and Innovation (MAPI) showed how smart manufacturing initiatives can increase productivity, throughput and factory capacity by approximately 10%.[1] This is possible by having machinery and equipment that can improve industrial processes through automation, communications and self-optimization.

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 information technology (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 prioritize 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 optimize 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

[1]Wellener, P., Shepley, S. et al. (2019). Manufacturing goes digital: Smart factories have the potential to spark labor productivity. Available at: https://www2.deloitte.com/us/en/insights/industry/manufacturing/driving-value-smart-factory-technologies.html [Accessed: April 22, 2020]

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 prioritized.

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 define 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 optimize 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 in 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.

For example, recent studies found that TSN could outperform TCP and other solutions maintaining extremely low latencies on highly congested networks. More precisely, it could maintain a 2 ms latency on a trunk link connecting two switches characterized by a 95% capacity (or congestion) even when transmitting frames with high payload sizes of 200 bytes.[2]

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.

[2] Smith Jr, M. E. (2018). Evaluation of IEEE 802.1 Time Sensitive Networking Performance for Microgrid and Smart Grid Power System Applications (Doctoral dissertation, University of Tennessee).

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

- ENDS -

CLPA298 Smart Factory & TSN

Image Captions:

Image 1: Now, during the fourth industrial revolution, the implementation of automation and network technologies is essential for businesses to remain competitive.

Image 2: Organisations such as the CC-Link Partner Association (CLPA) are helping businesses to become highly connected by developing open networks, thus facilitating multi-vendor and multi-platform interoperability.

Keywords: CC-Link Partner Association (CLPA), Industrial Internet of Things (IIoT), Time-Sensitive Networking (TSN), networking technology.

About The CC-Link Partner Association (CLPA)

The CLPA is an international organisation founded in 2000, now celebrating its 20th Anniversary. Over the last 20 years, the CLPA has been 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 the leading solution for Industry 4.0 applications. Currently the CLPA has almost 3,800 member companies worldwide, and more than 2,000 compatible products available from over 340 manufacturers. Around 30 million devices using CLPA technology are in use worldwide.

Further Information:
Website: am.cc-link.org/en
LinkedIn: https://www.linkedin.com/company/clpa-americas
Twitter: https://twitter.com/CC_LinkNews
YouTube: https://www.youtube.com/c/cclinkpartnerassociation

Editorial contact: DMA Europa Ltd. : Anne-Marie Howe
Tel: +44 (0)1562 751436 Fax: +44 (0)1562 748315
Web: www.dmaeuropa.com
Email: anne-marie@dmaeuropa.com
Address: Europa Building, Arthur Drive, Hoo Farm Industrial Estate, Kidderminster, Worcestershire, DY11 7RA, UK

Reader contact: CC-Link Partner Association : Thomas Burke
Tel: (847) 478-2100 Fax:
Web: am.cc-link.org/en/
Email: Tom.Burke@cclinkamerica.org
Address: 500 Corporate Woods Parkway, Vernon Hills, IL - 60061