How Time-Sensitive Networking Is Revolutionizing the Manufacturing Industry

The world today is witnessing a new age of digital transformation that will also require manufacturers to rethink their existing business models and corresponding industrial automation infrastructures. To remain relevant and competitive in the age of “Industry 4.0”, manufacturers need to do more than simply adopt digital technologies and deploy pre-defined processes in isolated islands of automation as they have done in the past. The future of industry rests on understanding what’s driving this new wave of digitization, how our current model of industrial automation is changing, and embracing what the future holds.

Vision of Smart Manufacturing: Service / Demand-Oriented

Manufacturing strategies are evolving. In light of customers’ diversified demands, companies want to facilitate customers’ needs while increasing operational efficiency. In the past, companies start their production based on the sales forecast and then try to get their product on shelves for their customers. An increase in production to meet demands mean that companies need to duplicate the same production lines to fulfill the demand. What if customers want different color variations of the product? How can companies respond to satisfy ever fast-changing customers? Here comes a new manufacturing strategy. In the future (or now), companies hope to have higher productivity while fulfilling various needs. Manufacturing is evolving from “Do a THING for all of us” to “Do our THINGS for all of us when we needed”.

The vision of tomorrow’s smart manufacturing is to intelligently connect people, things and business to enable end-to-end “Right-time” and “Autonomous” communication, collaboration, reaction, adaptation and optimization.
Envisioning the Future: Tomorrow’s Purdue Model

The traditional Purdue model, as represented by the “automation pyramid,” outlines different layers of network communication that remain fragmentary and potentially unreliable and difficult to maintain, particularly in the long run. Calls within the industry have been made to transform it to an “autonomous pyramid” that is capable of responding to market and business conditions in real-time. In this newly envisioned architecture, isolated islands of automation and network data flows are able to communicate with each other through a common semantic and seamlessly connected infrastructure.

It seems that manufactures can realize their vision of smart manufacturing through implementing one unified network infrastructure with the autonomous pyramid of Purdue Model. However, there are several fundamental challenges to moving forwards. For instance, network administrators start to think how to make sure data transparency while keeping the required deterministic? How to deal with existing installed-base? How to make sure decisions/actions are taken just in time, just in sequence to/from right people? How to make it as easy as possible to simplify the complexities and enable easy-to-plug?

This is why Time-Sensitive Networking comes in.

Determining Time-Sensitive Networking

To enable truly converged networks that can stream real-time controls, as well as audio/video in industrial facilities, the Time-Sensitive Networking (TSN) task group of the IEEE 802.1 working group is defining a set of standards for the deterministic data transmission over Ethernet networks. As a collection of standards, Time-Sensitive Networking is more like a tool box than an all-in-one solution; you need to understand what “tools” are available and how each tool works in order to determine which tools are appropriate for your application. The standards defined by the IEEE 802.1 working group are
the base technologies to build the TSN infrastructure. According to the network requirements, various combination of the base technologies can be used to build the TSN infrastructure. According to the network requirements, various combination of the base technologies can be used to build the appropriate infrastructure for specific application (e.g. TSN profile for IA defined by IEC/IEEE 60802 Joint Project).

**IEEE 802.1 TSN Progress**

**Coming Together for Industry 4.0**

Time-Sensitive Networking technologies offer a scalable, predictable approach to deterministic networking over standard Ethernet. But since TSN is more of a toolbox than comprehensive solution, system integrators must ultimately rely on independent vendors and multiple protocols to satisfy the specific requirements for each industrial application. This predicament is precisely why interoperability is the key to ensuring the success of TSN adoption. Ultimately, a unified infrastructure based on Time-Sensitive Network fundamentally requires interoperability on two critical fronts:

1. Common architecture that is TSN-compliant for Layer 2 networking and messaging
2. Common semantics for communication across multiple protocols

Recognizing the benefits of Industry 4.0 and the future of smart manufacturing, global standards organizations, working groups, and independent vendors are putting their “best effort” into building a common infrastructure and enabling interoperability so that machine-to-machine collaboration, data access from cells, and more applications can be realized.
Harmonization – Open Std., Open Platform, Unified Language

On unified network infrastructure should include the following attributes:

- Vendor-independent and speaking the same language
- A flexible topology and open the possibility to a variety of new applications
- “Data” accessed from cloud to field directly
- Easy to maintain and realizing “plug-n-produce”

Your Unified Foundation for Success

Whether you are seeking to improve asset utilization or tap into new business opportunities by providing products as a service, the current wave of digital transformation promises to revolutionize the manufacturing sector in the coming years. However, the ability to take full advantage of the Industrial Internet of Things requires high-bandwidth, low-latency, deterministic networking to enable real-time communications for industrial control systems. Today, the arrival of Time-Sensitive Networking means that standard Ethernet technologies are able to provide deterministic services, evolving beyond their traditional limitations of best-effort communications. With TSN, manufacturers no longer need to confine their applications to isolated islands of automation and control systems. Instead, industrial applications can look forward to an integrated future new bilateral communication flows that transcend the horizontal and vertical compartments of the traditional Purdue model.

Indeed, as international standards organizations and device vendors like Moxa continue to coalesce around TSN, standard Ethernet is well positioned to become the future foundation of industrial networking in the IIoT era.