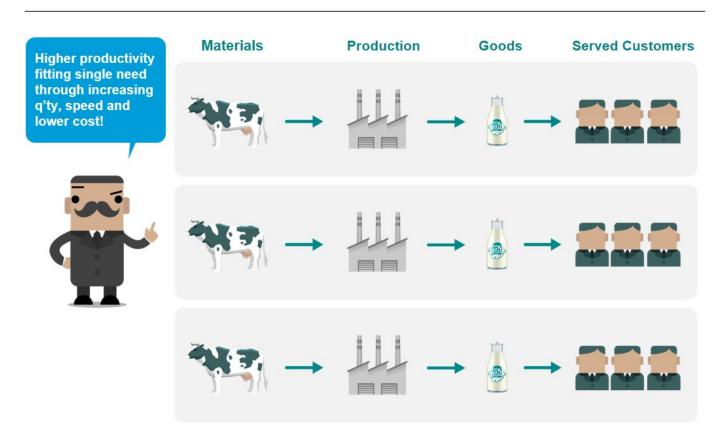
How Time-sensitive Networking IS Revolutionizing Smart Manufacturing

A new age in digital transformation is requiring manufacturers to rethink theri rexisting business models and corresponding infrastructure. To remain relevant and cometitive in the age of industry 4.0, manufacturers need to do more than simply adopt digital technologies and delpoy predefined processes in isolated islad of automation as they have done in the past. The future

of industry rests on understanding what is driving this new wave of digitization, how our current model of indsturail automation is

changing and embracing what the future holds.



A Vision for Smart Manufacturng: Service- and Demand-oriented

Manufacturing strategies are always evolving. With increasingly diversified customer demands, companies are constantly looking

for ways to cater to customers needsm while also increasing operational efficiency. In the past cmpanies would plan their

production based on the sales forecast and get their product on the sevles as soon as possible. To keep up with an increasing

production quantity, companies would duplicate the same production lines as a means to efficiently and quickly satisfy the rising

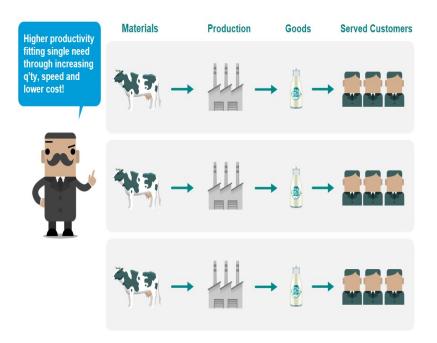
demand. This method works well when mass producing a single, defined product. But what if customers want different cariations

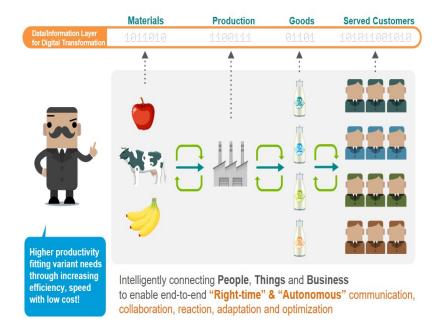
of the same product? How can companies address these dynamic, fast-changing customer needs? These conditions call for

rethinnking existing manufacturing strategies. Companies increasingly aim to achieve higher productivity while fulfilling the various

needs of their customers at the same time. In response, manufacturing methods are slowly evolving from mass producing a

single product with set specifications to an on-demand manufacturing approach based on customer's requirements.



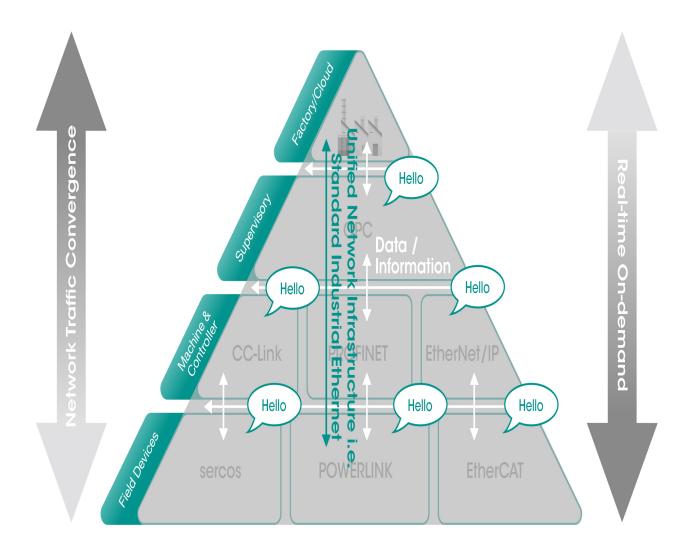


The vision of tomorrow's smart manufacturing is one of intelligently connecting people, things, and businesses to enable timesensitve and autonomous end-to-end communication, collaboration, reaction, adaptation and optimization.

Envisioning the Future: The Purdue Model of Tomorrow

The traditional Purdue model, as represented by the "automation pyramid", outlinse different layers of network communication that remain fragmentary and are both costly and difficult to maintain throughout a system's entire life cycle

Calls within the industry have been made to transofrm the current model into an "autonomous pyramid" that is capable of responding to market and business conditions in real time. In this newly envisioned architecture, isolated island of automation and network data flows are able to communicate with each other through a common semantic and seamlesslyconnected infrastructure.



By implementing the autonomous pyramid of the Purdue model, manufacturers can realize their vision of smarkt manufacturing

through one unified network infrastrucutre. However, several fundamental challanges arise. For instance, in a unified network

infrastrucutre where all data flows through a single channel, network administrators need to make sure that this increased

transparency does not impact deterministic data processing. Additionally how can administrators guarantee the correct flow of

information so that the right decisions and actions can be taken in time?

This is where TIme-sensitive Networking (TNS) comes in.

Determining Time-sensitive Networking

To realize truy converged and interoperable networks that can simulatneously process critical and noncritical application data in a single industrial environment, the Time-sensitive Networking (TSN) Task Group of the IEEE 802.1 Working Group is defining a set

of standards for enabling the deterministic transmission of data over standard Ethernet networks. This added layer of functionality

future-proofs longstanding Ethernet Technology and extends its use in a vast array of new applications

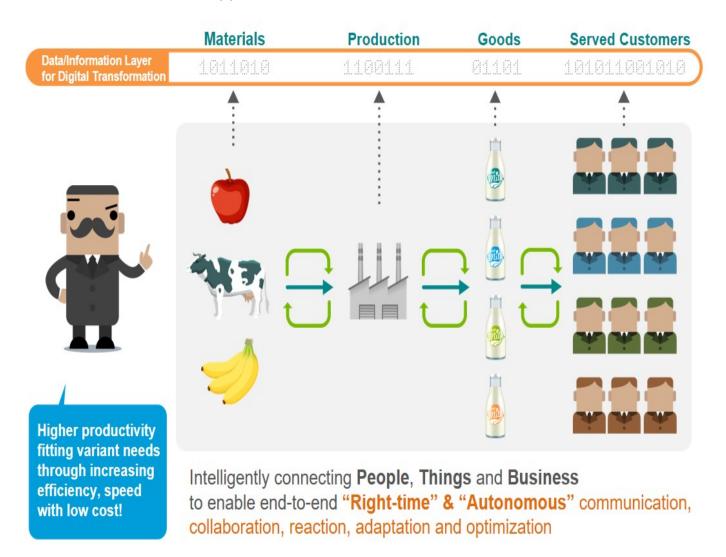
As a collection of standards, the concept of Time-sensitive Networking is more like a tool box than an all-in-one solution; you

need to understand what "tools" are available and how each tool works in order to determine which tools are appropriate for your application

Depending on the application requirements, various combinations of these tools can be put together to build infrastructure for

specific need or purposes. For example, one TSN profile being defined by the IEC/IEEE 60802 Joint Project aims to provide a

guidline on what standards to choose from the toolbox and how they can be used in industrial auttomation applications



From an overarching perspective, all standards in the toolbox can be categorized into one of the following apsects of TSN:

1. Time synchronization

As the name suggests, "Time-sensitive Networking" focuses on stablishing a common time reference between all devices within a unified and interoperable infrastructure, which forms the foundation of its entire operations.

2. Bounded low latency

By adopting the concept of non-negotiable time period allocation for end-to-end transmissions, these components ensure deterministic data transmission over the network.

3. Ultra reliability

To implement and maintain all aspect of a deterministic networking environment, a set of components has been defined to ensure optimal reliability and security

4. Resource management

When the network and applications become more converged and larger in scale, additional tools are required for provide better manageability and visibility

Besides providing the standard Ethernet hardware for creating unified infrastructure that conform to TSN standards, Moxa has

been actively participating in cross-vendor TSN plugtests and testbeds around the world, such as the ones hosted by the Edge

Computing Consortium (ECC), Labs Network Industrie 4.0, the Industrial Internet Consortium (IIC) and the Allience of Industrial

Internet (AII). Moxa is also one of the initial supporters of the OPC Foundation Field Level Communications (FLC) initiative to

promote the development of TSN technology. TSN is briningn together many different industry organizations and market leaders

under a common goal to realize the full potential of Industry 4.0 and the promise of digitization.

For more information about TSN and its applications, download our white paper.