

TIME-SENSITIVE NETWORKING

Brochure

WHAT IS TSN

Time-sensitive networking (TSN) is a set of standards developed by an IEEE 802.1 task group to bring industrial-grade robustness and reliability to Ethernet networks by providing protocols that support deterministic connectivity, time synchronization, traffic shaping, and traffic configuration. TSN enables interoperability among devices to create an open ecosystem where devices from different vendors can exist. It allows for real-time critical and non-critical traffic to exist on the same network. Industry 4.0 calls for convergence of Information Technology (IT) and Operational Technology (OT) networks which TSN can enable. The TSN standards support low-latency and deterministic applications in a variety of markets including industrial automation, vision, automotive, and transportation. TSN enables real-time connectivity for various Industrial applications such as machine-to-machine communications and provides predictable latency among multiple networked devices. TSN also allows devices from different vendors to easily intercommunicate, making large networks both flexible and scalable.

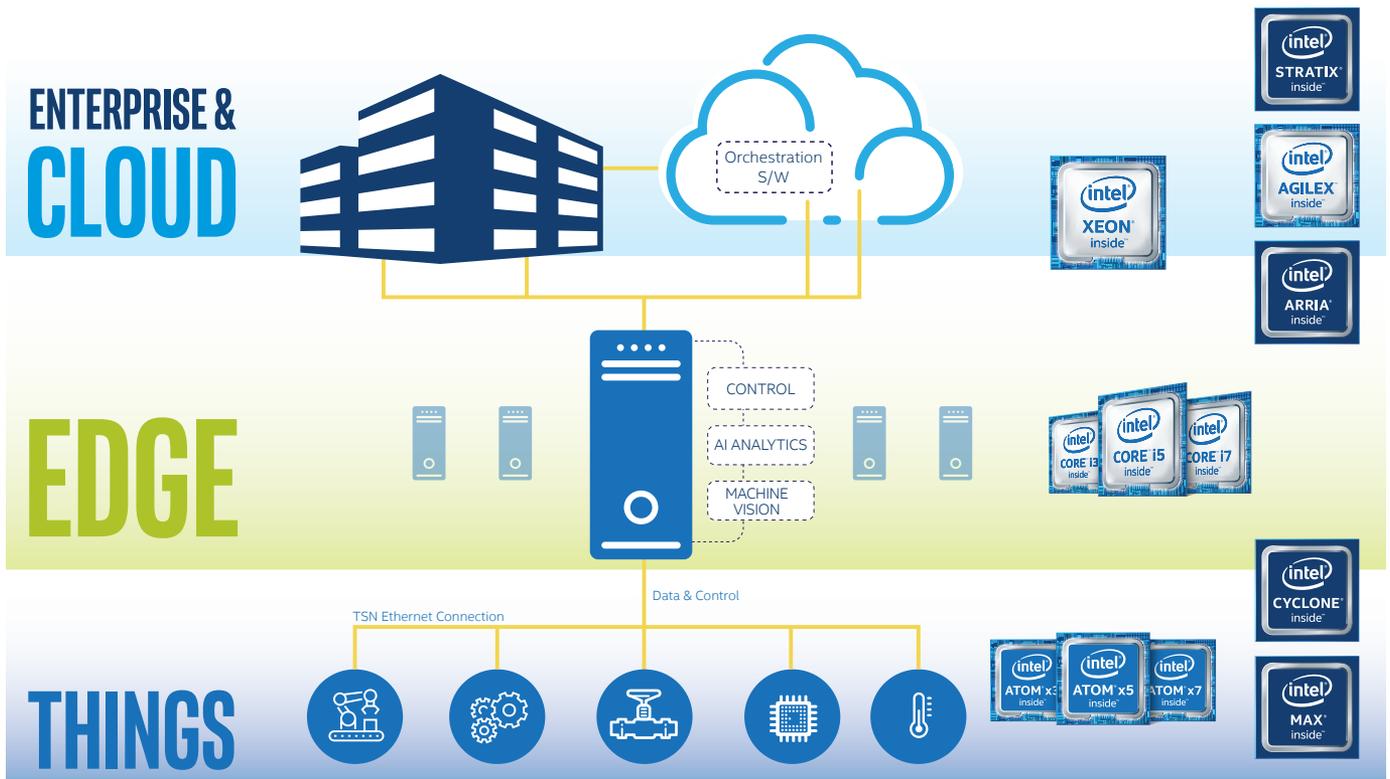
What is OPC UA?

- Open Platform Communications Unified Architecture (OPC UA) is an interoperability standard for machine-to-machine communications among equipment supplied by multiple hardware vendors. The standard provides for real-time data security and data-exchange reliability. OPC UA is also a platform that allows for hardware/software interoperability for machine-to-machine communication regardless of vendor.
- OPC UA provides cross-platform communication to the cloud, which includes:
 - Scalability: OPC UA can run on networked devices or applications.
 - Security: OPC UA addresses both IT and OT security issues
 - Flexibility: Advantage of being operating system (OS) and platform independent

Why TSN?

Benefits

- Time synchronization
 - A precise sense of time and communication distributed between different computing systems (e.g., sensors, actuators, and controllers, etc.)
- Traffic shaping
 - Network traffic can be optimized based on precise timing across the infrastructure (e.g., automation, control).
- Central automated system configuration
 - Distribute and configure devices as well as applications using software-defined networking (SDN)
- Open standards
 - TSN provides a foundation for interoperability among hardware and devices from different vendors in OT applications in the same way that Ethernet provides this foundation in the enterprise IT infrastructure
 - By using standard Ethernet components, TSN can also integrate with existing brownfield applications
 - OPC UA TSN is one standard solution for all applications.
- Future proof
 - TSN is already a comprehensive set of standards that can be implemented now and adapted over time as more standards are finalized.
 - TSN can provide high-bandwidth support from 10Gbps to 400Gbps.



Intel FPGA-Based Solutions for TSN

Intel® FPGAs provide multiple benefits for TSN applications. Hardware programmability allows for continuous design modifications and upgrades to achieve the exact specifications, desired performance, and programmability to future proof the design. Intel FPGAs permit fast adaptation to emerging standards, which can be implemented quickly to keep the business operations running. The Intel FPGA's ability to ingest data directly in nearly any format contributes to its low-latency capabilities, which can be critical in making real-time decisions for actions such as machinery re-calibration or automated safety shutdowns. Intel FPGAs can be deployed in various scenarios, for example in edge devices that require power efficiency or ruggedness. Equipment based on Intel FPGAs can be deployed in extreme temperatures for extended periods of time.

SOLUTIONS

Intel offers a complete solution that includes hardware and software for customers who would like to design their own TSN solution. This package includes the Intel Cyclone V SoC FPGA-based TSN switched-end points with TTTech's TSN IP integrated. There are no license fees or royalties associated with this solution. To build your own TSN solution:

- Order TSN-specific Cyclone V SoC from local Intel Sales or Intel approved distributors
(The ordering part numbers are the following: 5CSEBA6U19I7NTS, 5CSEBA6U23I7NTS, 5CSXFC6C6U23I7NTS)
- Download and install the TTTech TSN IP from Intel's webpage
(www.intel.com/fpga-industrial)
- Download and install the Intel Quartus Prime software
(www.intel.com/quartus)
- Design your TSN solution. Optionally, you can use Intel reference design and development boards.

Customers who would like to use other OPNs and custom build their TSN solution can:

- Order an Intel FPGA from local Intel Sales or Intel approved distributors
- Get TTTech ... (There may be license fees and royalties associated with this option)
- Download and install the Intel Quartus Prime software
(www.intel.com/quartus)
- Design your TSN solution. Optionally, you can use Intel reference design and development boards.

TSN IP

PARTNER	MODEL NUMBER/SKU	INTEL HARDWARE	DIMENSIONS	SPECIFICATIONS
TTTech	OPN: 5CSEBA6U19I7NTS OPN: 5CSEBA6U23I7NTS OPN: 5CSXFC6C6U23I7NTS	Cyclone® V SoC	19mm 23mm 23mm	<ul style="list-style-type: none"> • 3/5 port TSN Switched end point • 10/100/1000Mbps • TSN Standards supported: IEEE 802.1 AS, IEEE 802.1 Qbu, IEEE 802.1 Qbv, IEEE802.1 Qcc • Linux Kernel 4.9 • Cut-through support

SYSTEM ON MODULE

PARTNER	MODEL NUMBER/SKU	INTEL HARDWARE	DIMENSIONS	SPECIFICATIONS
EXOR	uS02, uS05	Cyclone V SoC	46 x 35 mm	<ul style="list-style-type: none"> • 3 port TSN switch • 10/100/100 Ethernet MAC

PCI EXPRESS* (PCIE*) NETWORKING INTERFACE CARD (NIC)

PARTNER	MODEL NUMBER/SKU	INTEL HARDWARE	DIMENSIONS	SPECIFICATIONS
Kontron	PCIE-0400-TSN	Cyclone V SoC	Half size, low profile Passively cooled	<ul style="list-style-type: none"> • 4 port TSN switch • 10/100/100 Ethernet • Host Interface PCIe Gen 1x4

STARTER KIT

PARTNER	MODEL NUMBER/SKU	INTEL HARDWARE	SPECIFICATIONS
EXOR	us05 Development Kit	Cyclone V SoC	<ul style="list-style-type: none"> • 4 Giga Ethernet ports - Includes three TSN port switch • microSOM us05 module
Kontron	Kbox C-102-2	6th Gen Intel® Core™ i5 i5-6442EQ: Quad-Core 1.9 GHz, 4 GB RAM, 128 GB solid state drive (SSD)	<ul style="list-style-type: none"> • 4 port 10/100/1000 Mbps TSN switch
TTTech	MFN 100	Intel Atom® E3940 and Intel Cyclone V	<ul style="list-style-type: none"> • 1 port Mbit/s SFP • 3 port 100/1000 Mbit/s RJ45 • 1 port 100/1000 Mbits/s Ethernet Console Port RJ45

All of our partner ecosystem solutions the following standards: IEEE 802.1 AS, Qbu, Qbv, Qcc

