

Real-Time Course 100 Topic 04

Time-Sensitive Networking (TSN) Overview

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Real-Time 100 Title

Real-Time 100 – Course Agenda

Topic 1: Introduction: Real-Time Computing

Topic 2: Linux Based Real-Time System

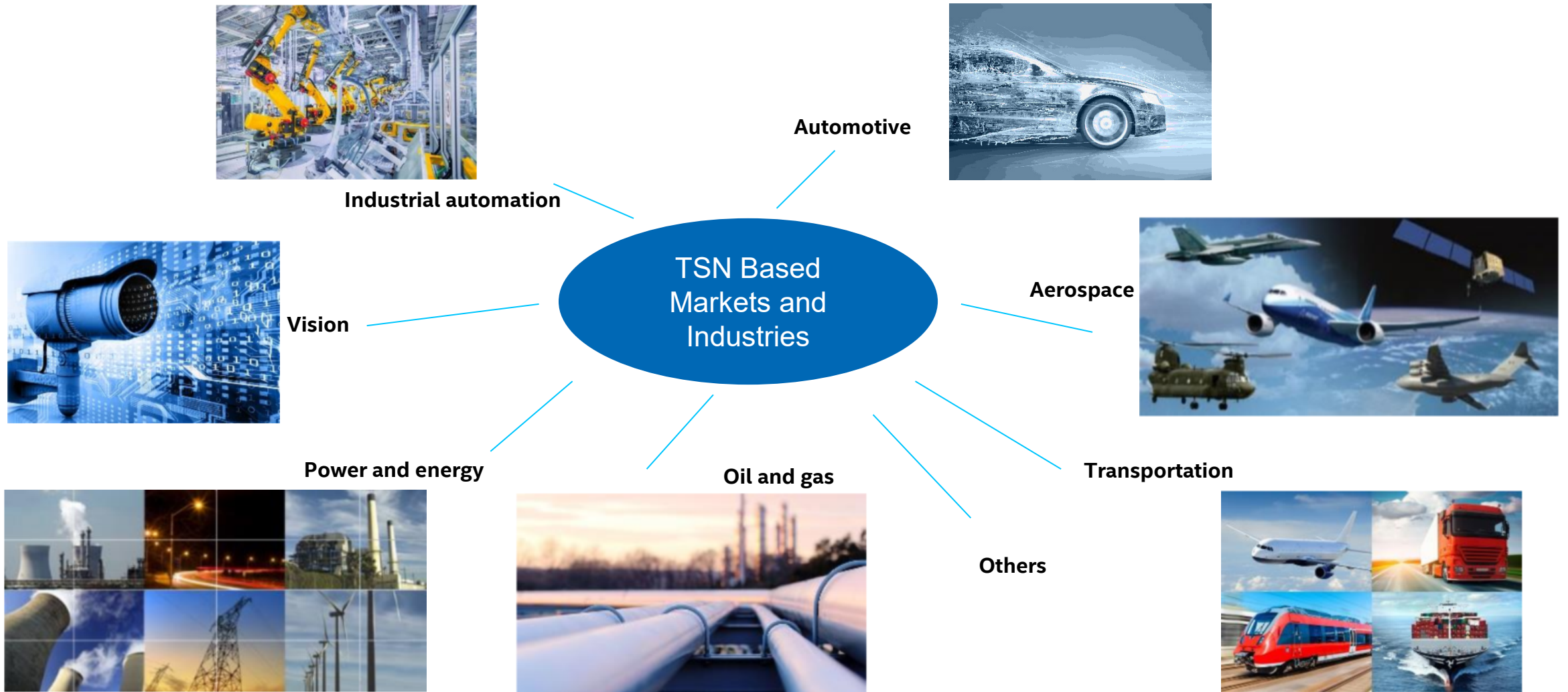
Topic 3: Intel® Time Coordinated Computing (Intel® TCC)

Topic 4: Time-Sensitive Networking (TSN) Overview

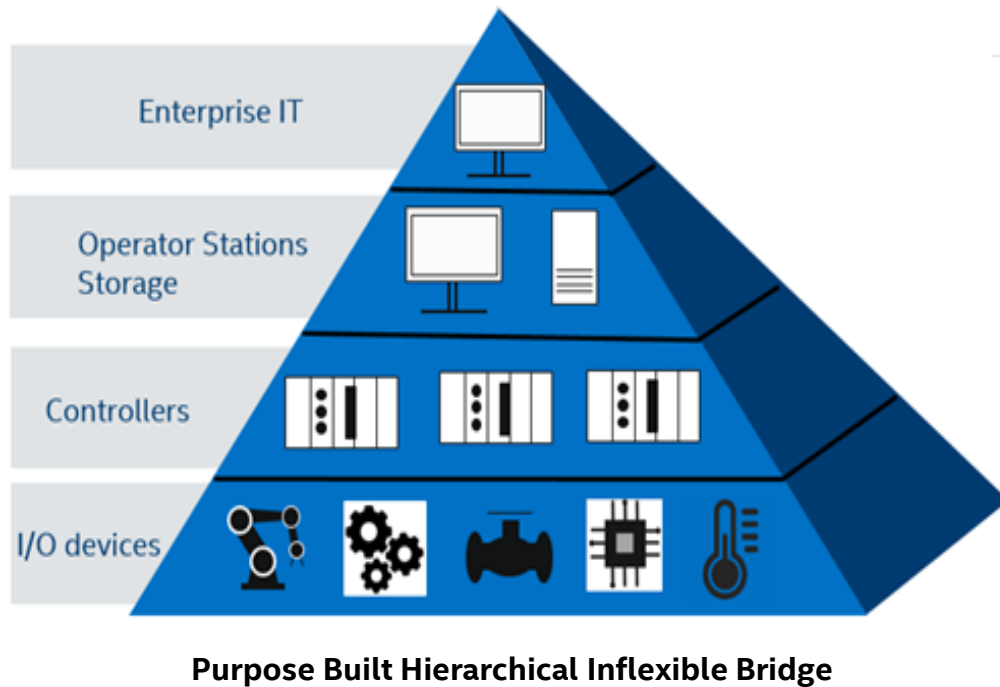
Topic 5: Intel® Edge Controls for Industrial (Intel® ECI)

Topic 6: Workload Consolidation in IIoT

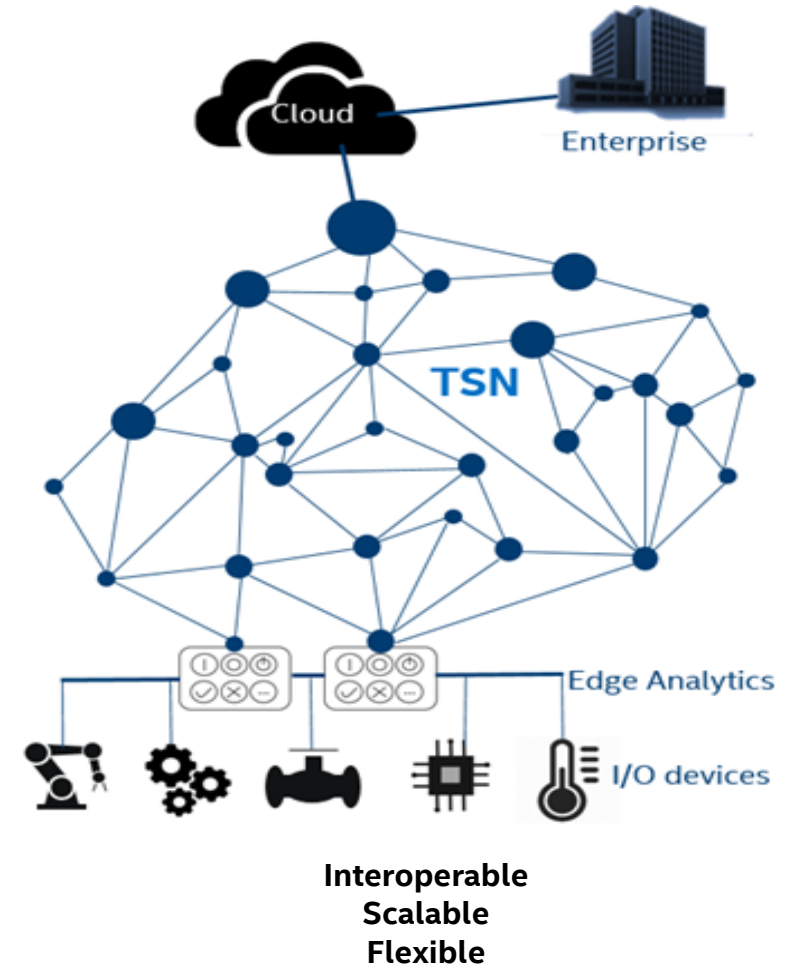
TSN Scales Across Multiple Markets



Transformation to Industry 4.0



Transformation





What is Time Sensitive Networking?

- Time-Sensitive Networking (TSN) is a set of IEEE 802.1 Ethernet standards that are defined by the IEEE TSN task group
- Based on standard Ethernet networks to support time-sensitive applications
- Supports time synchronization, timeliness for ultra-reliable low-latency, as well as traffic scheduling
- Intel is working with industry forums-Avnu Alliance, IEEE, IETF, IIC etc. to ensure interoperability and development of best practices in implementation for each application market



Why TSN?

Secure and reliable delivery of data



Guaranteed latency for data delivery



Converged networks save operating costs



Industrial Networking Compatibility and increased bandwidth



Open Ecosystem



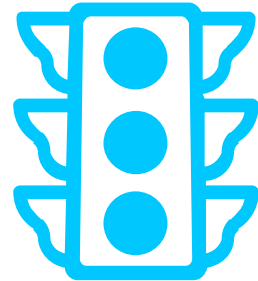
Core Elements of TSN

TIME SYNCHRONIZATION



A distributed, precise sense of time between different computing systems (e.g., sensors, actuators, and controllers)

TRAFFIC SHAPING



Based on precise timing, network infrastructure handles traffic (e.g., automation, control) in a timely manner

HIGH AVAILABILITY ULTRA RELIABILITY



Reliability in the network, protection from errant devices and backup for network timing primary

SYSTEM CONFIGURATION



Automated configuration of devices as well as applications using SDN approaches

TSN Standards

TIME SYNCHRONIZATION	TRAFFIC SHAPING	REDUNDANCY	SYSTEM CONFIGURATION
End nodes share a common understanding of time	Packet transmissions are deterministic and prioritized	Path control and reservation allow for robust networks	Consistent network configuration for all network elements
<p>Key Benefits:</p> <ul style="list-style-type: none"> • Synchronization of multiple devices with precision below 1 μs for packet-based communications • Long distance comms enabled without signal propagation delay 	<p>Key Benefits:</p> <ul style="list-style-type: none"> • Deterministic arrival of packets provides latency guarantees and minimal jitter/packet loss • Scalability and assurance that packet transmissions will not conflict 	<p>Key Benefits:</p> <ul style="list-style-type: none"> • Path control and reservation assure necessary network performance • Frame replication and elimination for multiple potential packet paths 	<p>Key Benefits:</p> <ul style="list-style-type: none"> • Configuration of data streams from multiple suppliers • Interoperability with existing networks
<p>IEEE Standards:</p> <ul style="list-style-type: none"> • 802.1 AS • 1588(Legacy) 	<p>IEEE Standards:</p> <ul style="list-style-type: none"> • 802.1 Qcr • 802.1 Qch • 802.1 Qbu • 802.1 Qbv • 802.1 br 	<p>IEEE Standards:</p> <ul style="list-style-type: none"> • 802.1 Qca • 802.1 QB • 802.1 Qci 	<p>IEEE Standards:</p> <ul style="list-style-type: none"> • 802.1 Qat • 802.1 Qcc • 802.1 CS

Value Proposition of Intel TSN Products

Offers a comprehensive portfolio of products (IA products, FPGAs, ASICs) for different customer requirements, supported through a world-wide sales organization.

Open-source reference software optimized for Intel TSN Hardware including demo and sample applications to ease RT development.

Comprehensive ecosystem of partners and testbeds available in different GEOs to support development of products with TSN.

Leadership positions in TSN industrial forums to guide the development of TSN standards, providing voice to comprehensive customer requirements.

Summary

The origin and background of TSN

The specific content of TSN

Detail of TSN standards

Intel TSN products



Quiz

1. What are the key elements of TSN? ()

(a) time synchronization (b) traffic shaping (c) high availability (d) system configuration

2. What accuracy can TSN clock synchronization achieve? ()

(a) second accuracy (b) millisecond accuracy (c) microsecond accuracy or better

3. Which of the following standard specifies gate control lists to enhance traffic scheduling? ()

(a) 802.1 Qav (b) 802.1 Qbv (c) 802.1 Qbu (d) 802.1 AS

4. Which of the following standard specifies the timing and synchronization protocol for time-sensitive applications? ()

(a) 802.1 Qav (b) 802.1 Qbv (c) 802.1 Qbu (d) 802.1 AS

5. Which of the following Intel Ethernet Products support TSN? ()

(a) I210 Ethernet Controller (b) I225/I226 Ethernet Controller

(c) TGL integrated Ethernet Controller (d) EHL integrated Ethernet Controller

The image features a blurred background of an industrial manufacturing facility, likely a semiconductor fab, with various pieces of machinery and equipment. The Intel logo is prominently displayed in the center, consisting of a small blue square above the word "intel" in a bold, black, lowercase sans-serif font, followed by a registered trademark symbol (®).

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