Time Sensitive Networking - Flexible Manufacturing

Time Sensitive Networking (TSN) is key for industrial applications such as process and machine control where low communication latency and minimal jitter are critical to meeting closed loop control requirements. TSN is the first fully open, standard and interoperable way to fulfill these requirements.

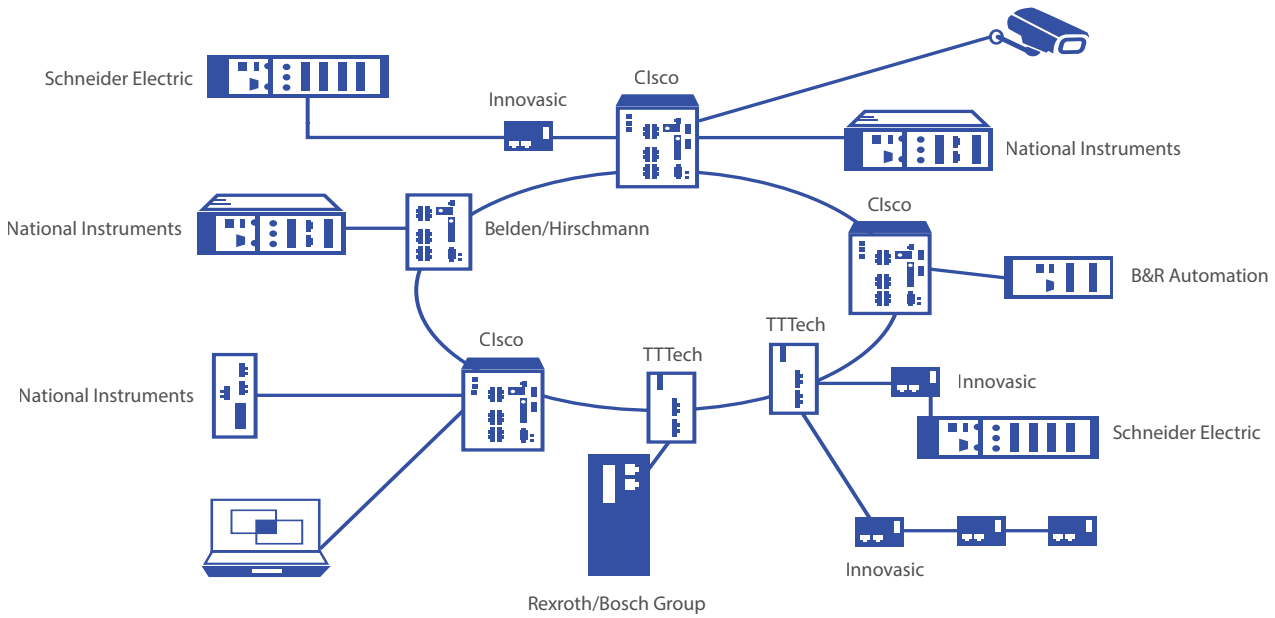
CHALLENGE

Manufacturing operations requires tight coordination of sensing and actuation to safely and efficiently perform closed loop control. Typically these systems have been deployed using non-standard network infrastructure or air-gapped (unconnected) standard networks. This approach makes devices and data much harder to access and creates a technical barrier to IIoT which is predicated on the ability to consume data anywhere throughout the infrastructure.

To address these needs of IIoT all the way to the control system, the IEEE organization has been working to update the standards for Ethernet and wireless (IEEE 802) to support time sensitive networking.

SOLUTION

TSN enables a single, open network infrastructure supporting multi-vendor interoperability through standardization and IT and OT convergence through guarantee of service. The technology will be used to support real-time control and synchronization of high performance machines over a single, standard Ethernet network. This testbed showcases an early implementation of TSN. As such, it will show the value of the technology as well as some of the challenges in implementations from a number vendors. This testbed will not only document the value of TSN, but will provide feedback to the relevant standards organizations on areas of further clarification or improvement.



TIME SENSITIVE NETWORKING - FLEXIBLE MANUFACTURING

Time Synchronization

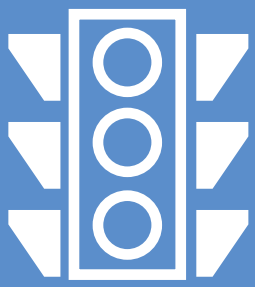
IEEE 802.1AS, IEEE 1588

Summary:
End-nodes and switches have a common understanding of time

Features:

- Synchronization of multiple systems with a precision below 1µs using packet based communication
- Synchronization is possible over very long distances without impact from signal propagation delay

Traffic Scheduling



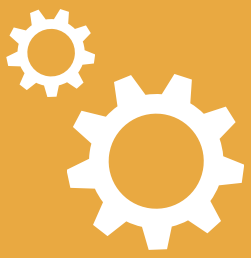
IEEE 802.1Qbv

Summary:
Packet transmission from a sender to a receiver is scheduled end-to-end and follows a repeating cycle

Features:

- Deterministic arrival of packets affording latency guarantees, extremely low jitter and virtually no packet loss
- Scalable design with ability to assure that multiple flows will not conflict

System Configuration



IEEE 802.1Qcc

Summary:
Consistent mechanism for network configuration to meet the needs of end application

Features:

- Standard mechanism for configuration of all network elements
- Configure "streams" between devices from any supplier

STANDARD	AREA	TITLE
IEEE 802. 1ASrev, IEEE 1588	Timing & Synchronization	Enhancements & Performance Improvements
IEEE 802. 1Qbu & IEEE 802. 3br	Forwarding & Queuing	Frame Preemption
IEEE 802. 1 Qbv	Forwarding & Queuing	Enhancements for Scheduled Traffic
IEEE 802. 1 Qca	Path Control & Reservation	Path Control & Reservation
IEEE 802. 1 Qcc	System Configuration	Enhacements & Performance Improvements
IEEE 802. 1Qci	Time Based Ingress Policing	Per-Stream Filtering & Policing
IEEE 802. 1 CB	Seamless Redundancy	Frame Replication & Elimination for Reliability
...	Additional Projects	Continual Evolution of the Standard

TIME SENSITIVE NETWORKING - FLEXIBLE MANUFACTURING

GOAL

To support real-time control and synchronization of high performance machines over a single, standard Ethernet network, supporting multi-vendor interoperability and integration.

TSN TESTBED FEATURES

- Combine different critical and best-effort traffic flows on a single network based on IEEE 802.1 Time Sensitive Networking (TSN).
- Demonstrate the real-time capability and vendor interoperability using standard, converged Ethernet.
- Show ability for IIoT to incorporate highly performance and latency sensitive applications.
- Provide integration points for smart edge-cloud control systems into IIoT infrastructure & application.
- Mixed reconfigurable manufacturing with robotics, multi-axis motion machines, vision, IO, and machine health/diagnostics.
- Integration at M2M level and IIoT level.

BENEFITS

- TSN will open up critical control applications such as robot control, drive control and vision systems to the Industrial Internet. This connectivity then enables customers, suppliers and vendors to more readily access data from these systems and to apply preventative maintenance and optimization routines to these systems.
- Support for rapid manufacturing reconfiguration reduces plant downtime.
- Increased uptime through integration of plant diagnostics.

MARKET SEGMENT

- Flexible Manufacturing providing tight coordination of multiple machines and Industrial-IoT (IIoT) integration.
- The TSN Testbed is envisioned to be useful for a wide range of applications, including Factory Automation, Utilities, Automotive, Transportation, Oil and Gas. The insights and concepts proven in this testbed may be replicated into a number of other testbeds in the future.

UPCOMING TESTING

- Establish TSN flows between various vendors
- Demonstrate TSN ability to protect critical flows from high-bandwidth traffic
- Gateway non-TSN traffic into TSN flows
- Test CUC to CNC APIs (TSN flow requirements)
- Test CNC to network Infrastructure (schedule distribution)
- Data consistency over OPC UA Pub-Sub over TSN

ABOUT IIC

The Industrial Internet Consortium is a global, member supported, organization that promotes the accelerated growth of the Industrial Internet of Things by coordinating ecosystem initiatives to securely connect, control and integrate assets and systems of assets with people, processes and data using common architectures, interoperability and open standards to deliver transformational business and societal outcomes across industries and public infrastructure.

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