



## **Time Sensitive Network (TSN) Protocols And use in EtherNet/IP Systems**

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## Agenda

# Time Sensitive Network (TSN) Protocols and use in EtherNet/IP Systems

1. Objective and Industrial Application requirements
2. IEEE Time-Sensitive Networks Initiatives
3. TSN Systems perspective
4. Summary

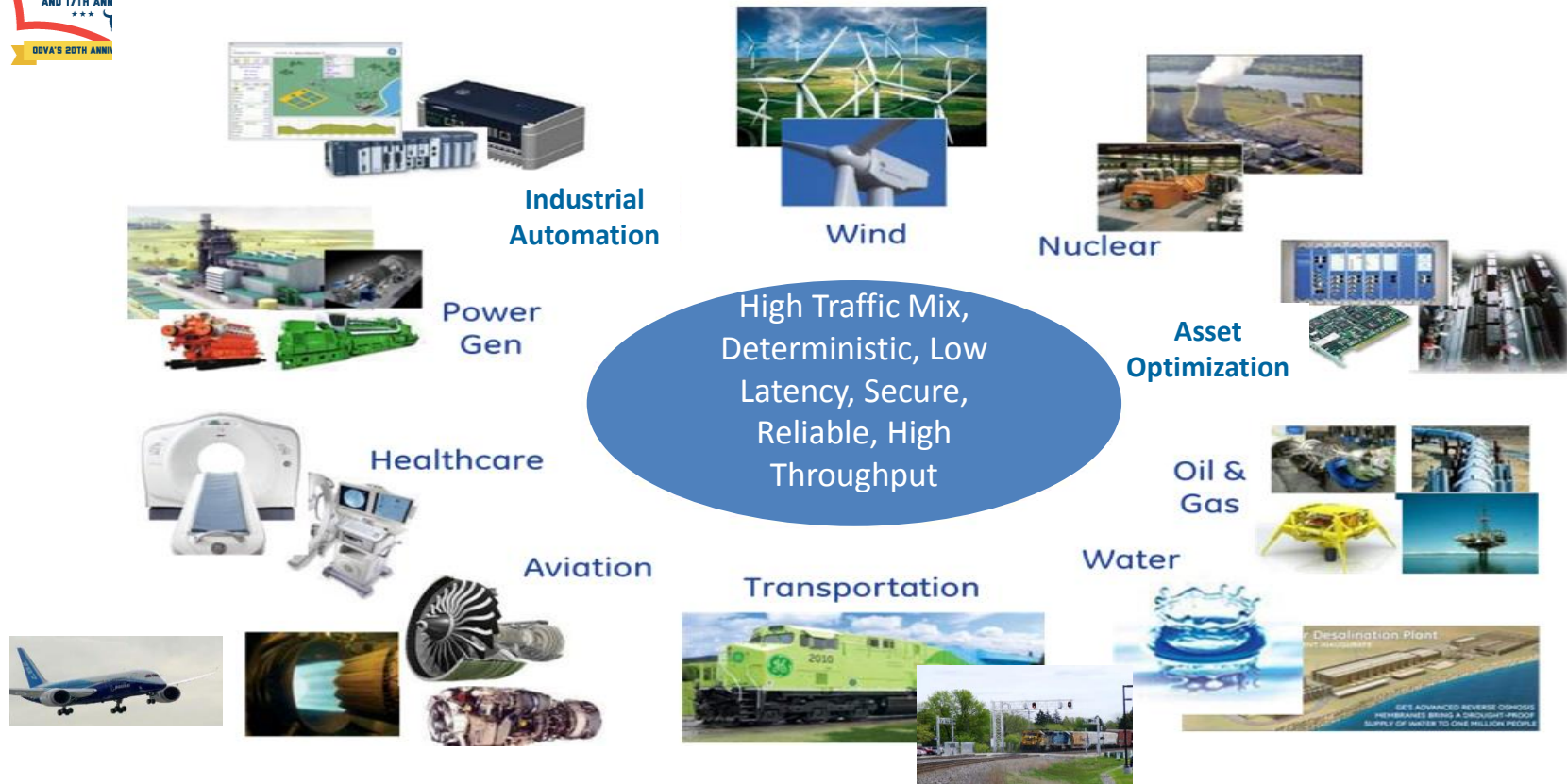


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# Industrial Implies a Diverse Set of Applications





# Industrial Application Requirements

Requirement	Benefit
<b>Time synchronization</b>	Enables common clock for transmission scheduling, correlated I/O, etc.
<b>Latency provisions</b>	Enables deterministic control loops
<b>Reserved bandwidth</b>	Enables applications to operate reliably in the presence of network congestion or network component failures
<b>Redundancy</b>	Enables fault tolerance due to component failures, etc.
<b>Converged network</b>	Enables coexistence with best effort traffic and potentially multiple industrial protocols
<b>Topology flexibility</b>	Enables common industrial network topologies including line, ring, tree
<b>Scalability</b>	Can grow from small systems to large systems (in both node and stream count)
<b>Security</b>	Support safely integrating into IIoT systems



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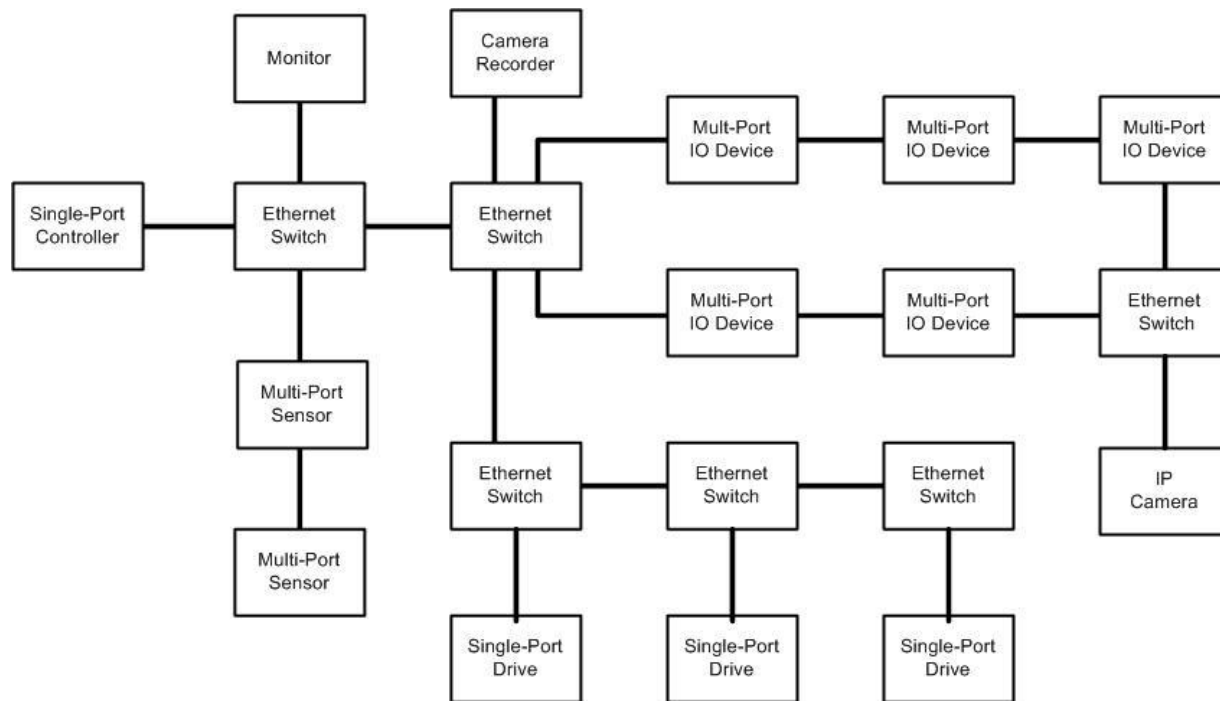
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# IEEE Time-Sensitive Networks Overview

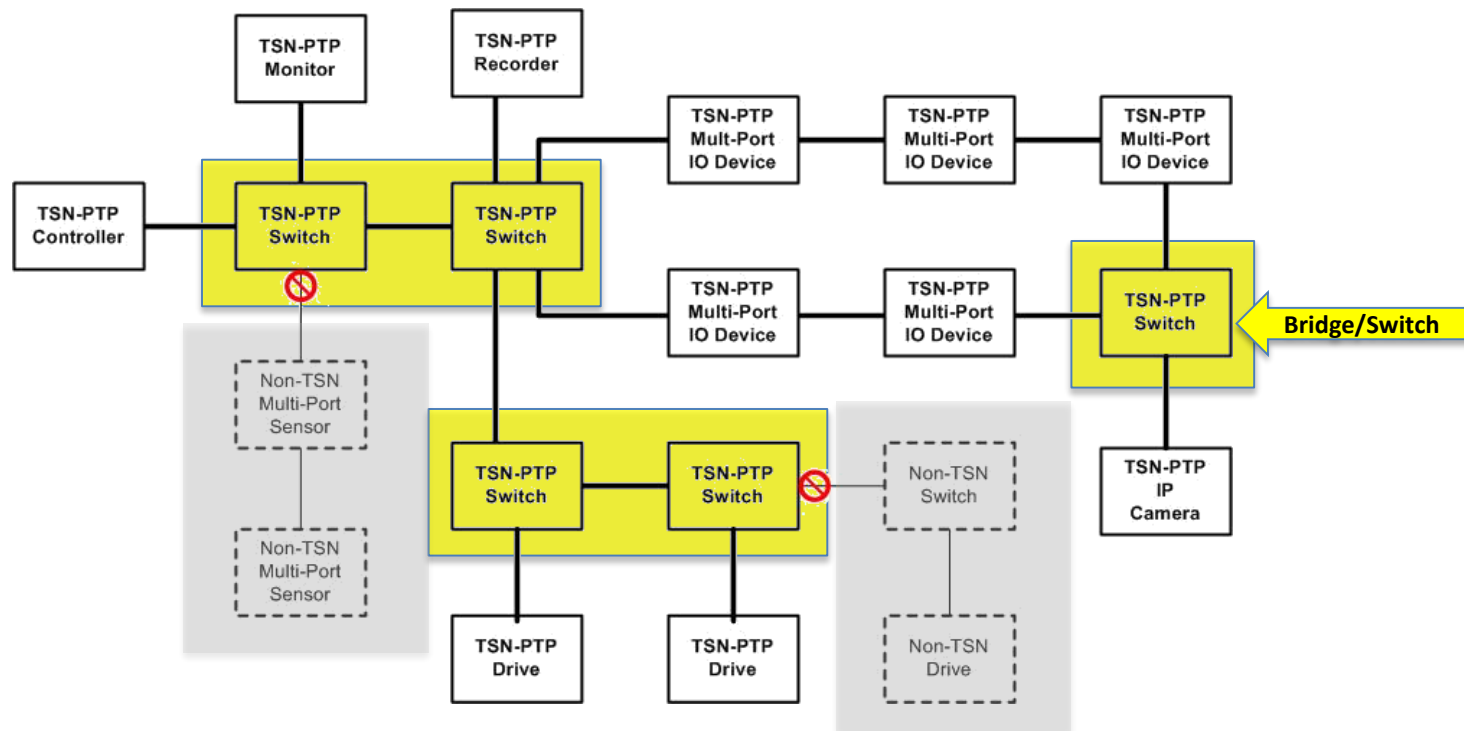
Standard	Area	Title
IEEE 802.1ASrev, IEEE 1588	Timing & Synchronization	Enhancements and Performance Improvements
IEEE 802.1Qbv	Forwarding and Queuing	Enhancements for Scheduled Traffic – Time-Aware Traffic Shaping
IEEE 802.1Qbu & IEEE 802.3br	Forwarding and Queuing	Frame Preemption and Interspersing Express Traffic
IEEE 802.1Qca	Path Control and Reservation	Path Control and Reservation
IEEE 802.1Qcc	Central Configuration Method	Enhancements and Performance Improvements
IEEE 802.1Qci	Time Based Ingress Policing	Per-Stream Filtering and Policing
IEEE 802.1CB	Seamless Redundancy	Frame Replication & Elimination for Reliability

# EtherNet/IP System

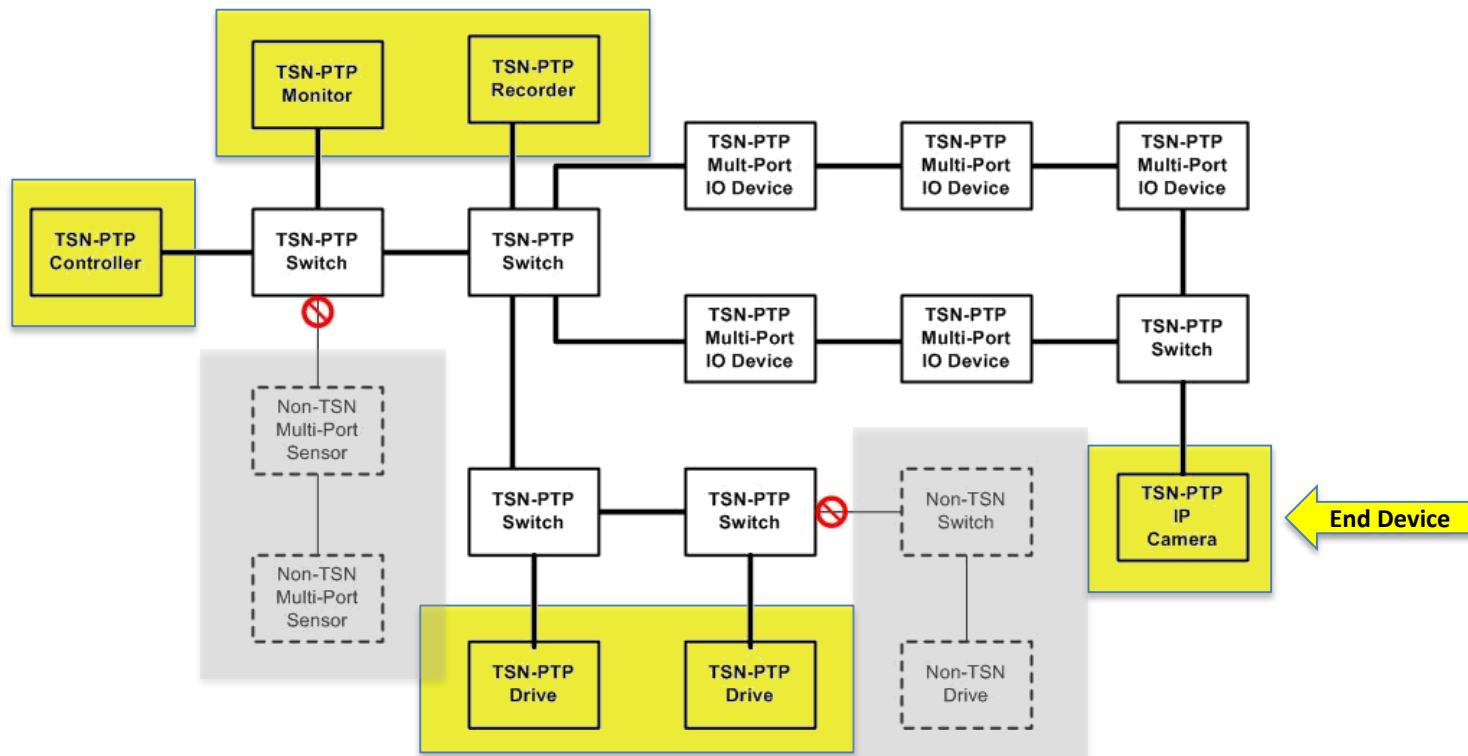




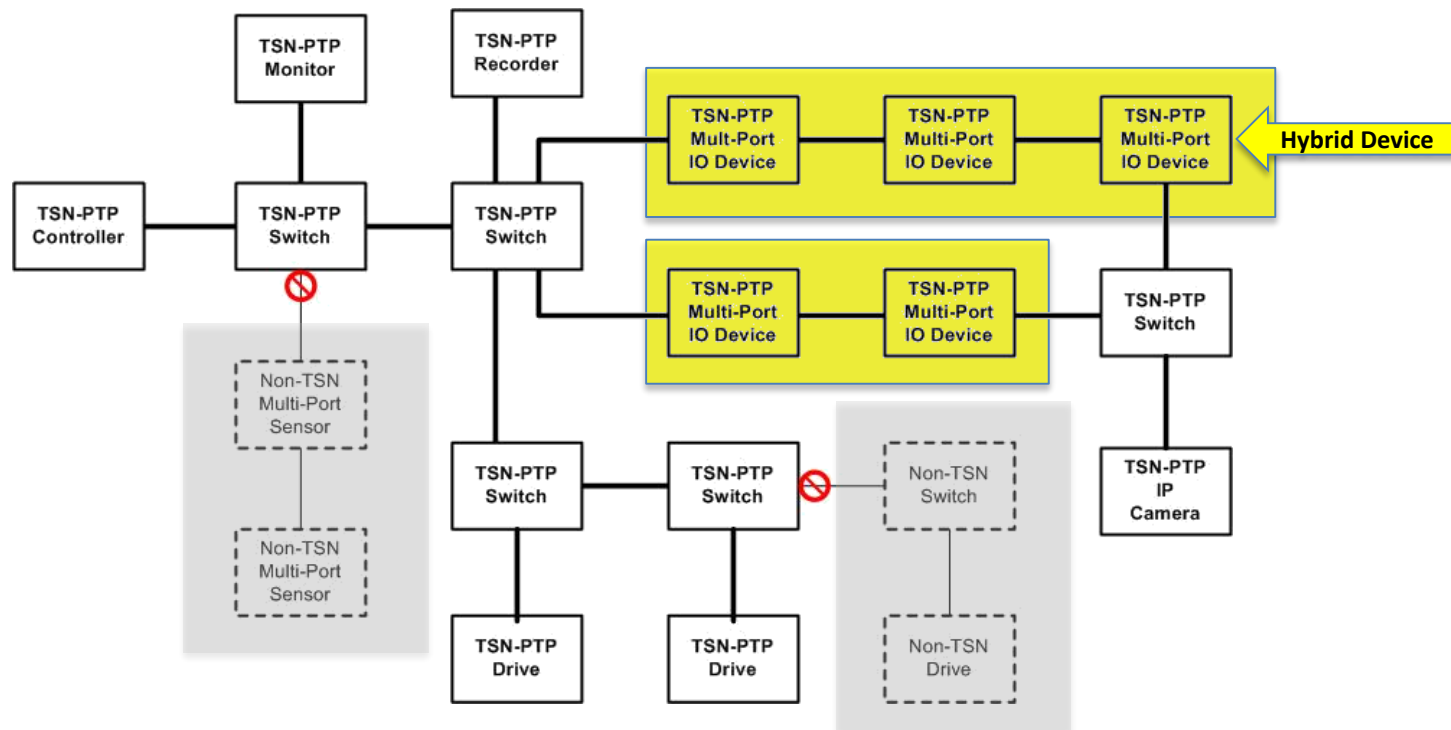
# TSN and Time Synchronization



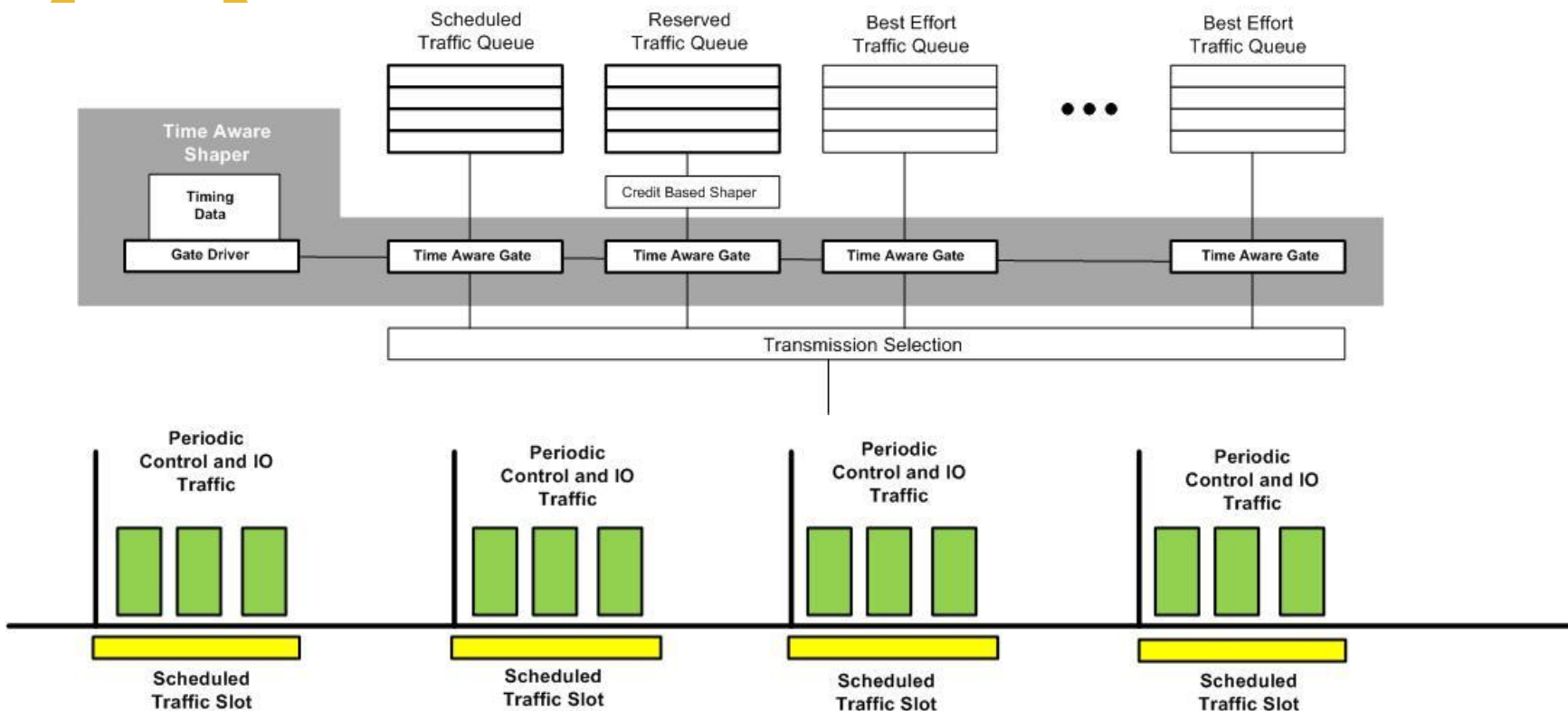
# TSN and Time Synchronization



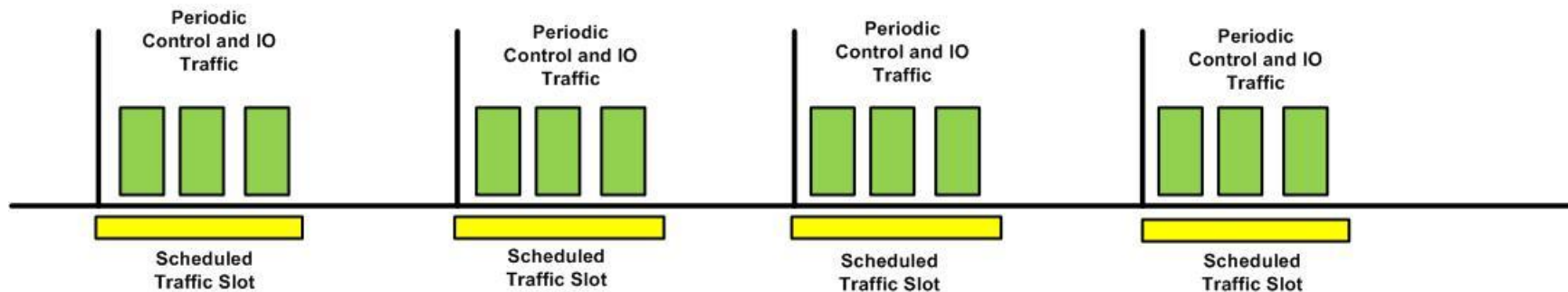
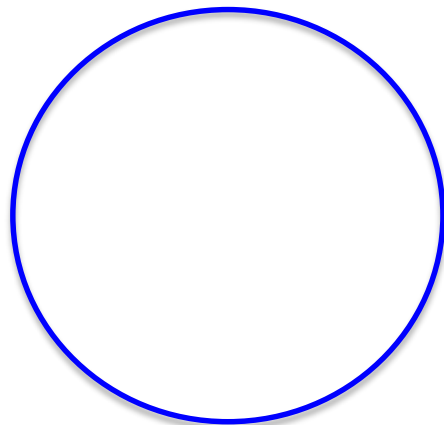
# TSN and Time Synchronization



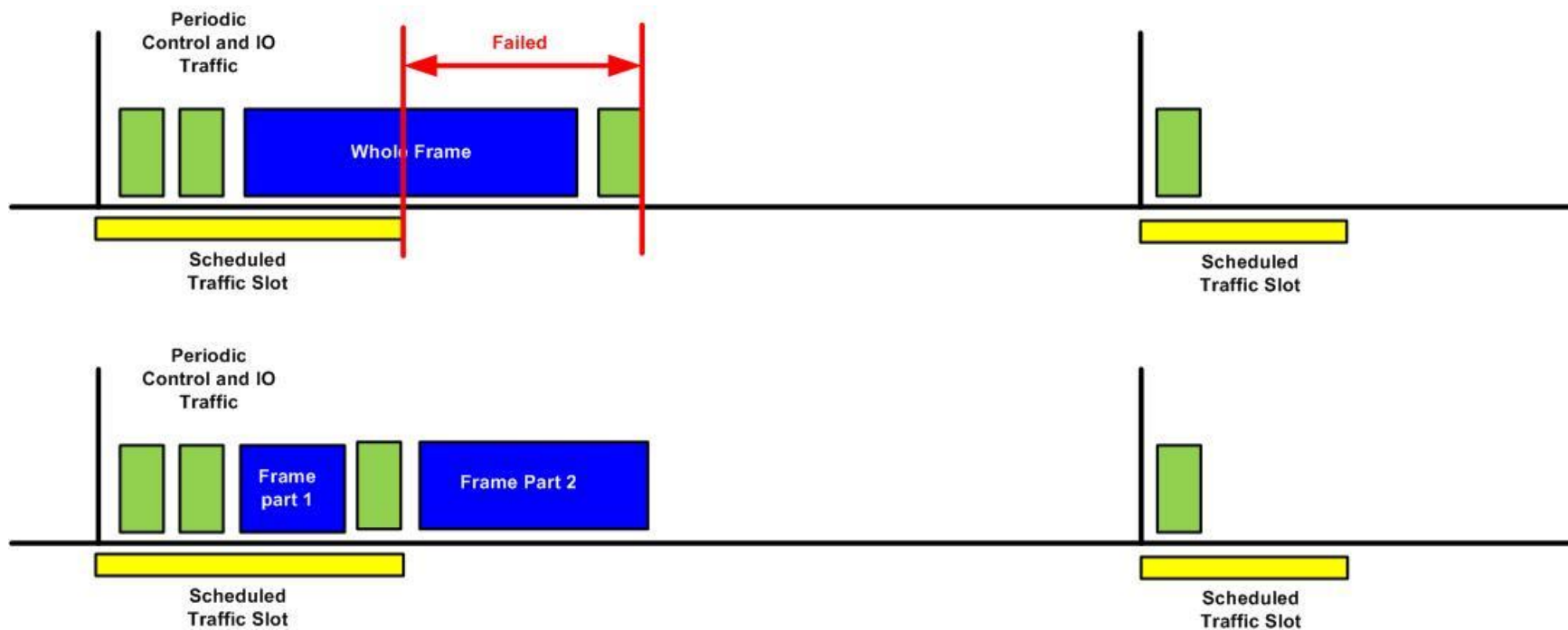
# Time Aware Traffic Shaping



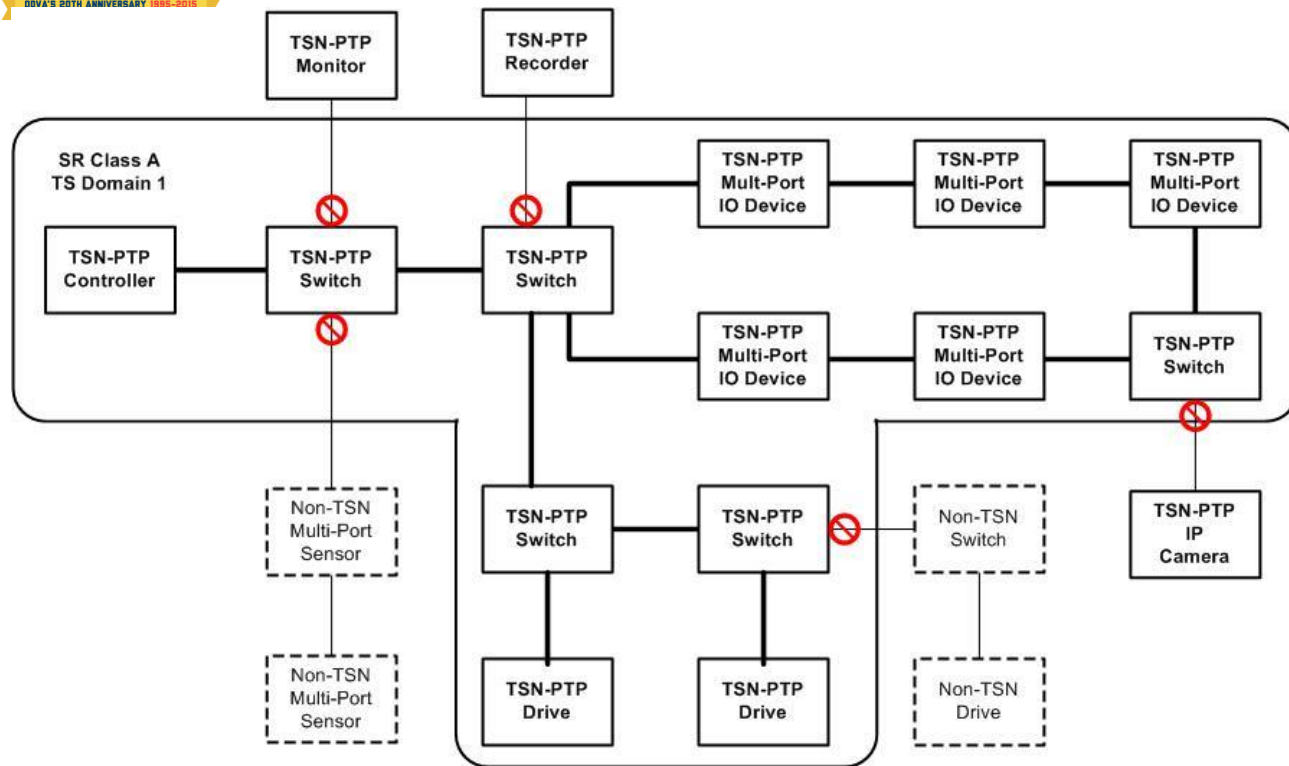
# Frame Preemption



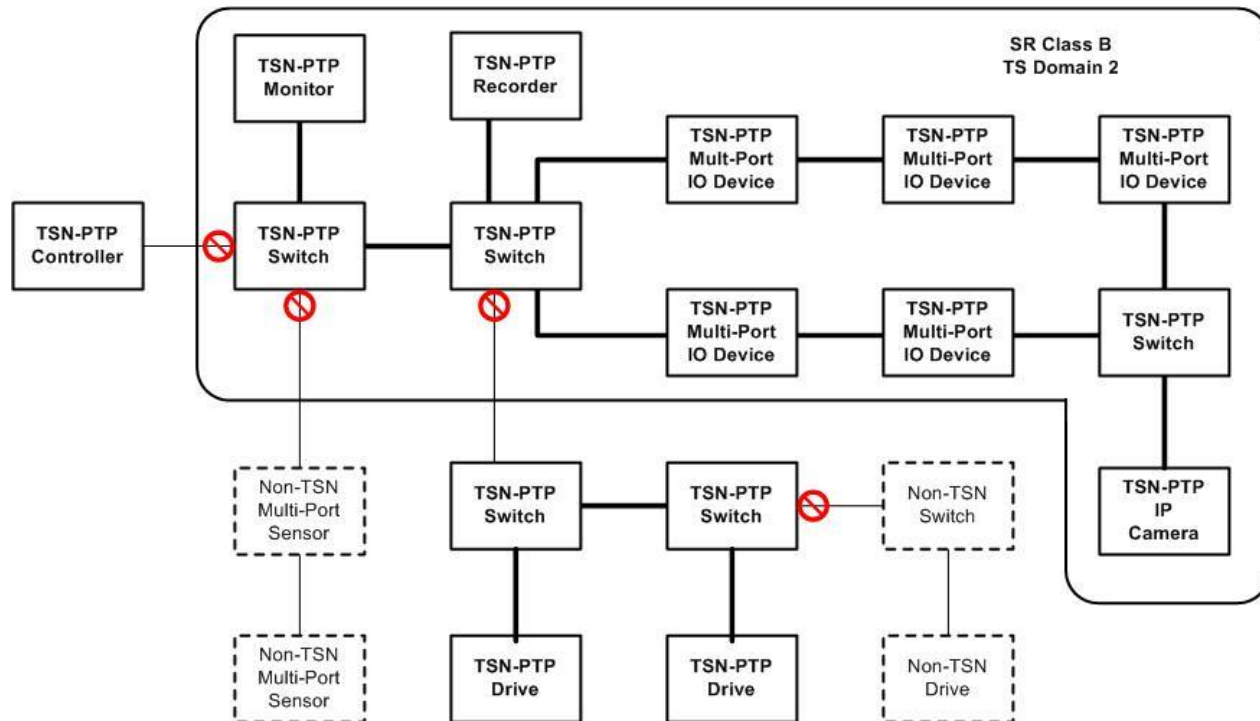
# Frame Preemption



# Stream Reservation Protocol – SR Class A

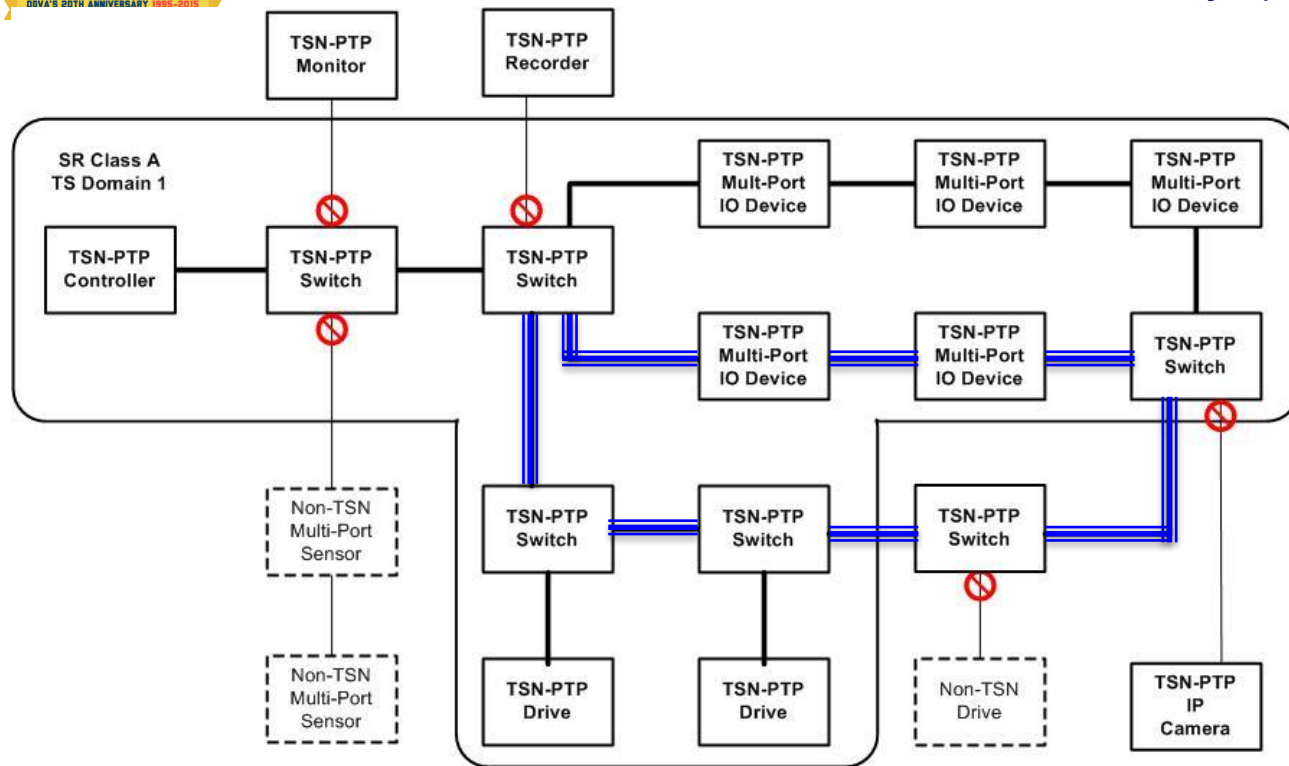


## Stream Reservation Protocol – SR Class B

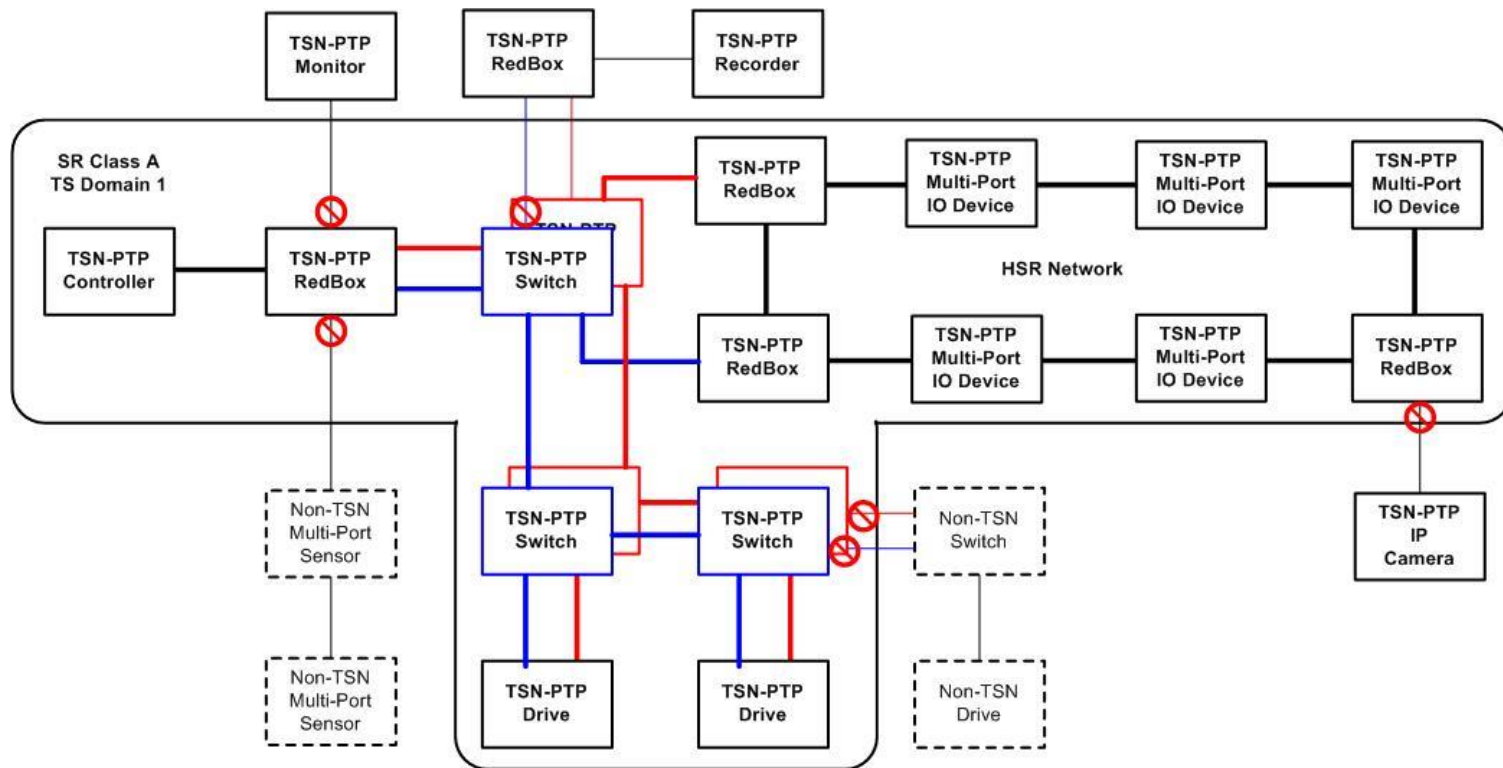




## Path Control and Redundancy (Seamless) - .1CB



## Path Control and Redundancy (Seamless) – PRP/HSR





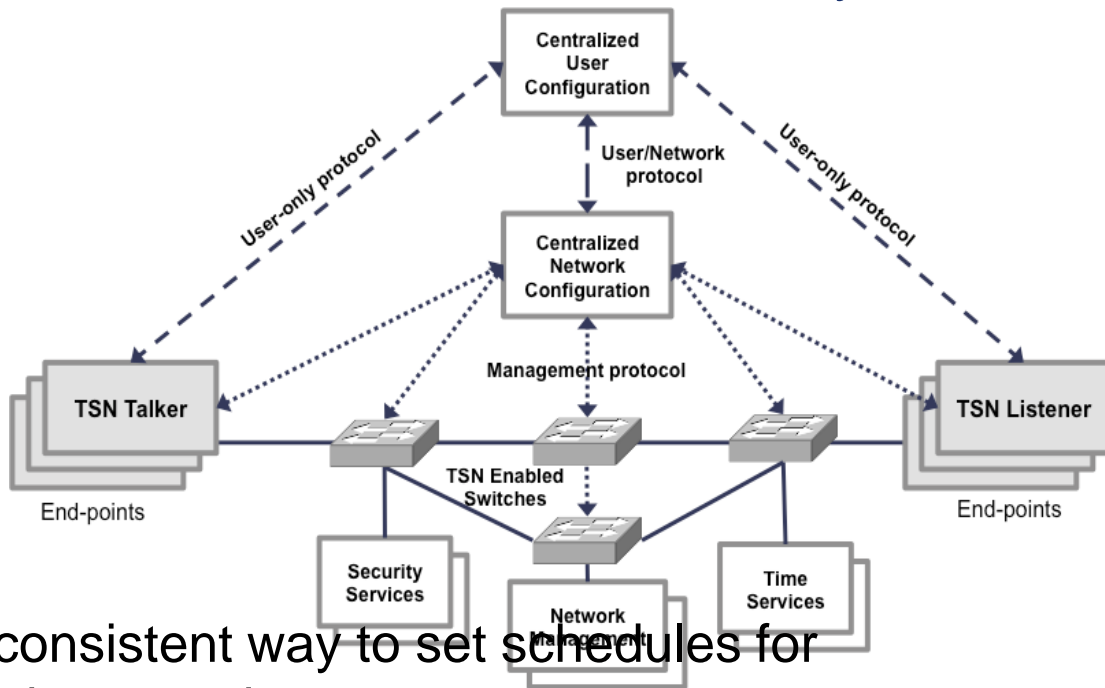
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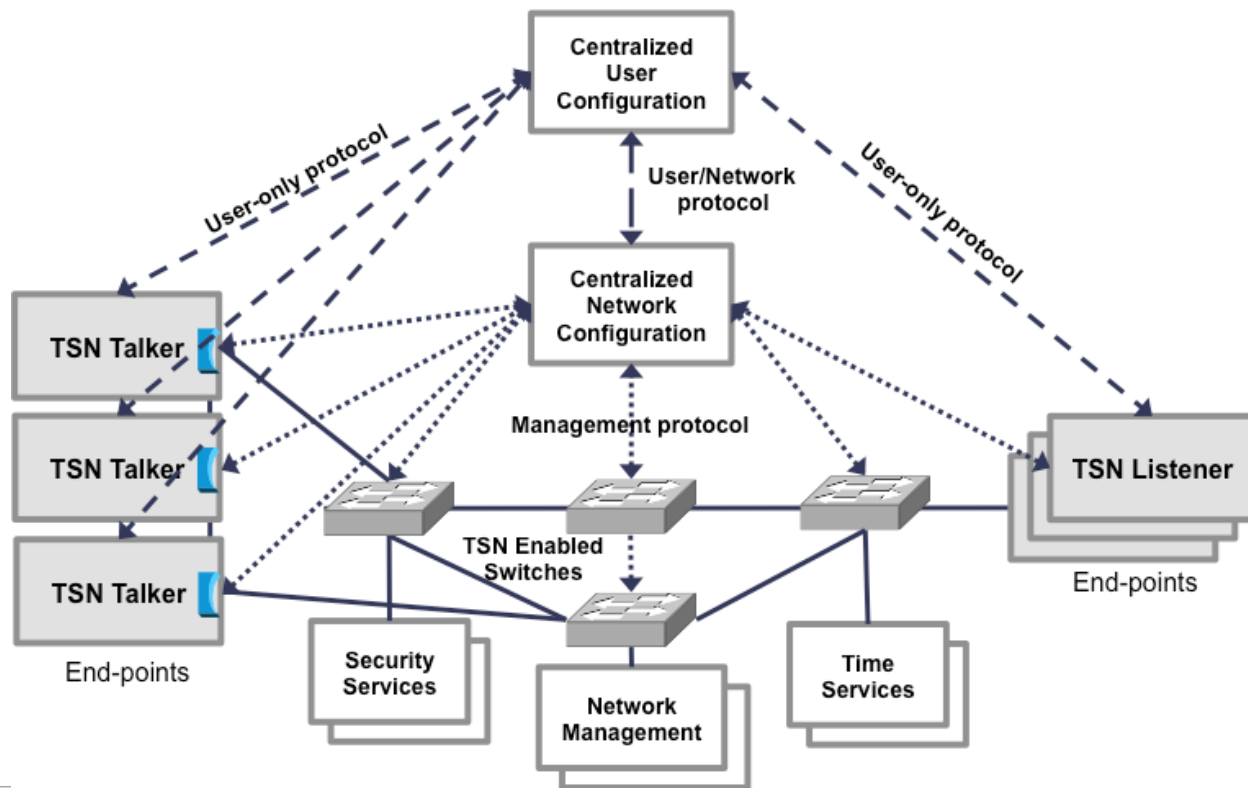
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## TSN System

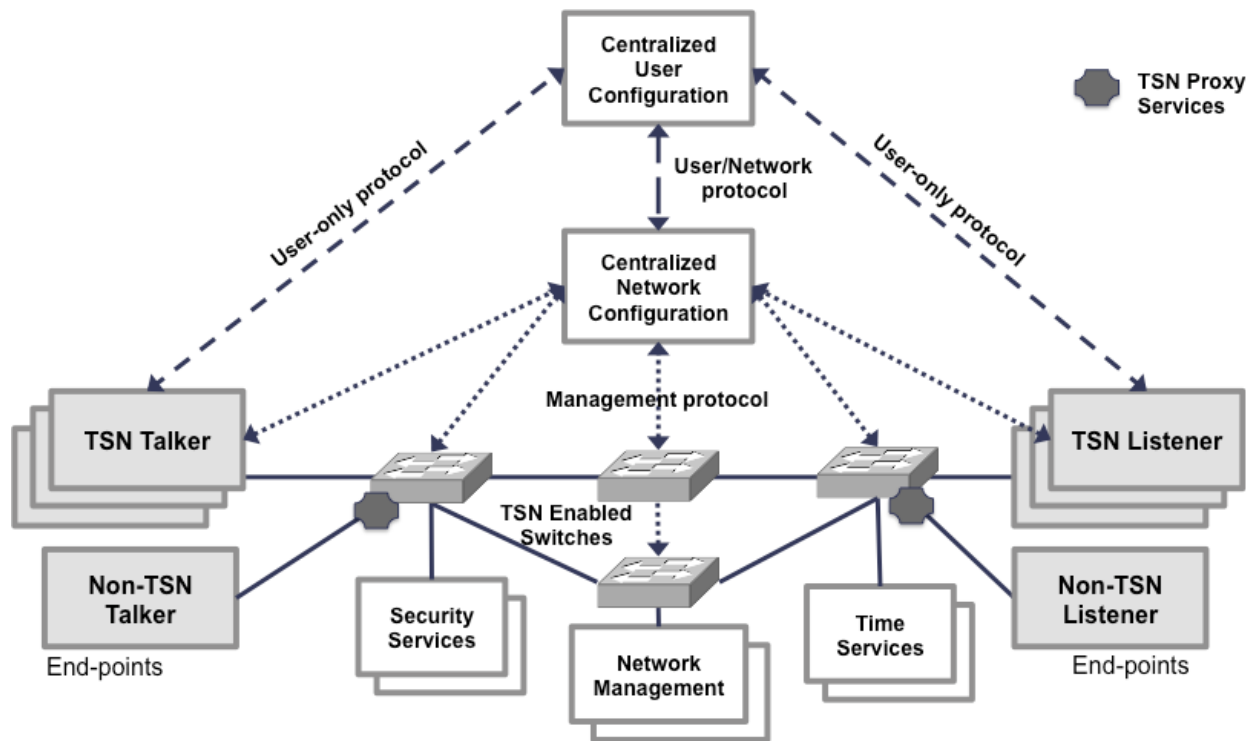
- **Summary:** Distribute schedules to TSN network elements
  - Schedule to be read / written in switches is in a standard format
  - Defines format of schedule
  - Improved performance and scalability to previous SRP
- **Relevance:** Allows standard, consistent way to set schedules for TSN traffic in switches from various vendors.



# TSN System with Bridging TSN End-points



# TSN System with Non-TSN End-points





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## Summary

**We think the ODVA should review the TSN technology for potential adoption. Some of the enhancements, in particular those around time synchronization, may require changes or enhancements to ODVA capabilities such as CIP Sync. But, the benefit of the technology to the vendors, customers and overall industrial ecosystem are significant and warrant the work to change or enhance ODVA standards and products to use TSN.**





THANK YOU