TN1 FUNCTION MODULE

TSN Ethernet Switched End Point (TSN-SE)

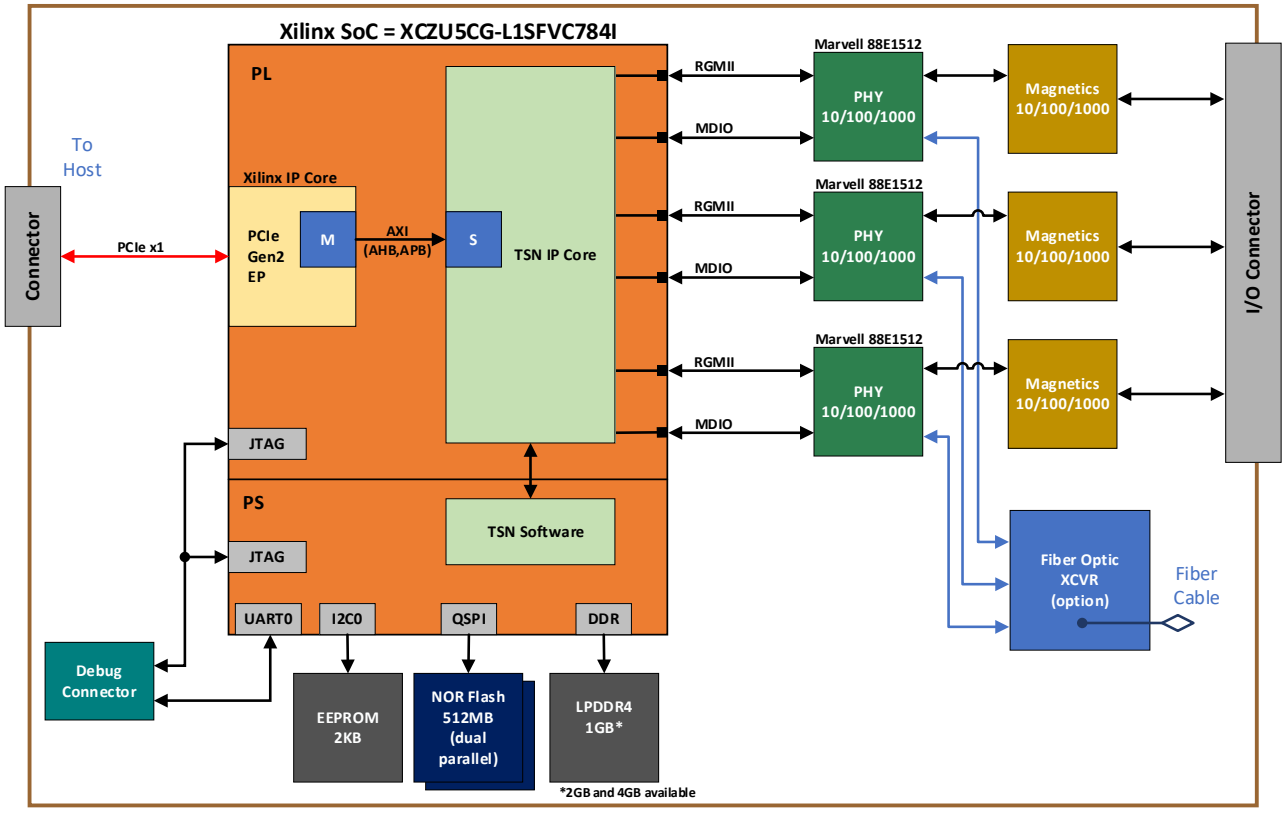
Description

Time-Sensitive Networking (TSN) is a suite of IEEE 802.1 standards designed to enable deterministic, real-time Ethernet communications across industries ranging from Automotive, Aerospace, and Industrial to Medical and Governmental. These standards generally fall into three categories:

- **Time Synchronization** (IEEE 802.1AS)
- **Scheduling and Traffic Shaping** (IEEE 802.1Qav, IEEE 802.1Qbv)
- **Selection of Communications Paths and Fault Tolerance** (IEEE 802.1CB FRER)

Recognizing that each industry defines its own TSN "profile" (e.g., IEEE 802.1DP for Aerospace or IEEE 802.1DG for Automotive), NAI's TN1 Ethernet Switched End Point (EP) module seamlessly incorporates these capabilities into the NAI Configurable Open Systems Architecture™ (COSA®). Built on the Xilinx XCU5CG-L1SFVC784I SoC, the TN1 module leverages DornerWorks-developed TSN IP to deliver reliable, high-precision Ethernet functionality. A dedicated TN1 software driver communicates over a PCIe x1 link to an SBC processor, providing a flexible foundation for synchronized, scheduled, and robust data transmission.

As TSN-based digital backbones continue to gain traction, the TN1 module enables straightforward system expansion and supports advanced applications—such as flight control, situational awareness, and data synchronization—while simplifying future scalability. For information regarding specific OS and RTOS compatibility, please contact the factory.



TN1 Simplified Block Diagram

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TN1 TSN-EP Specifications*

PHYSICAL LAYER	Description	Noted/Status/Comments
Ethernet	10/100/1000BASE-T	Single Channel, dual-redundant; tri-redundant capable
TSN GOVERNING SPECS	**Description**	**Noted/Status/Comments**
IEEE 802.1AS -2020	Standard for Local and Metropolitan Area Networks—Timing and Synchronization for Time-Sensitive Applications (gPTP).	Spec released / supported. Primary TSN time synchronization mechanism for many emerging industry profiles (e.g., Aerospace via IEEE 802.1DP/SAE-AS6675, Automotive via IEEE 802.1DG).
IEEE 802.1DP -xxxx	TSN Profile for Aerospace Applications	DRAFT: Not released—final publication date TBD. Developed in parallel with SAE-AS6675. Aims to define a TSN profile suited for avionics system use cases (e.g., AS6509 CAIN).
SAE-AS6675	TSN Profile for Aerospace Applications, jointly developed with IEEE 802.1DP.	DRAFT: Not released—final publication date TBD. Establishes Aerospace TSN requirements in coordination with IEEE 802.1DP.
IEEE 802.1DG-2022	TSN Profile for Automotive In-Vehicle Ethernet Communications.	Spec approved / published in 2023. Progressed beyond draft status; defines TSN configurations for automotive networks.
IEEE-1722-2016	Audio Video Transport Protocol (AVTP) for Time-Sensitive Applications. Defines the Layer 2 protocol used by IEEE	Spec released. Contact factory for additional support details.
IEEE 1588-2019	Precision Clock Synchronization Protocol for Networked Measurement and Control Systems (PTP).	Reference Only: Widely implemented since 2002. 802.1AS-2020 extends IEEE 1588 for TSN-specific enhancements. Interoperability with 802.1AS is not guaranteed without careful design. Many TSN-enabled devices support some form of IEEE 1588, though full 802.1AS-2020 compliance may require additional hardware/software considerations.
STANDARDS SUPPORTED	**Description**	**Noted/Status/Comments**
802.1Qav	Forwarding and Queuing Enhancements for Time-Sensitive Streams (aka Credit-based traffic shaper)	Spec released / supported. Implements traffic shaping via priority classes and a “leaky bucket” style credit-based algorithm. Reduces buffering in receiving bridges/endpoints.
802.1Qbv	Traffic Scheduling: Time-Aware Shaper (TAS)	Spec released / supported. Implements a time-division multiple access (TDMA) scheme by segmenting network traffic into repeating time cycles.
802.1CB	Frame Replication and Elimination for Reliability (FRER)	Spec released / supported. Offers seamless redundancy by sending duplicate frames over disjoint network paths, eliminating single points of failure.
802.1AS-2020	Governing Timing and Synchronization (gPTP).	Spec released / supported.
Dual Grand Master	Redundancy scheme for timing master sources.	Spec released / supported. Allows multiple concurrent master clocks to enhance availability and fault tolerance in time synchronization.
802.1AS-2020 Slave	gPTP slave/receiver implementation.	Spec released / supported.
802.1AS-2020 Master	gPTP master/transmitter implementation.	Spec released / for REF ONLY / Support TBD
802.1Qcc	An amendment enhancing the Stream Reservation Protocol (SRP).	Improves scalability, configuration, and management of time-sensitive streams in networked systems. YANG data model supported.
802.1Qcp	An amendment adding YANG models for managing bridge configurations, streamlining automation and control of VLANs and other bridging features.	YANG data model supported.
MODULE LEVEL	**General Specifications**	**Noted/Status/Comments**
Power:	5 VDC / 1200 mA (est., max.)	
Isolation:	Signals are transformer isolated	
Weight:	1.5 oz. (42 g)	

**All specifications are subject to change without notice. All product and company names are trademarks or registered trademarks of their respective holders*

Features & Capabilities

- **Path to DO-178/254 Safety Certification**
  - Supports TSN and UDP protocols using an FPGA-based network adapter
  - Deterministic mission/safety-critical data routing
- **MOSA-Aligned Ethernet Endpoint**
  - Supports hardware, software, and firmware portability
  - Compatible with RTOS and OS-independent implementations
  - Offers FPGA-based configurability for future network enhancements
- **Intelligent TSN Ethernet Endpoint Adapter**
  - Provides advanced Ethernet stack management
  - Significantly reduces application processor overhead

For more details, refer to the 2024 IEEE Digital Avionics Systems Conference (US Army Aviation, DornerWorks & NAI) paper “” Adoption of Evolving Network Standards to MOSA Using FPGA Certifiable Network Adaptors | IEEE Conference Publication | IEEE Xplore”, or contact NAI for a copy.

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