

Proposal for an Automotive Time Synchronization Profile Amendment to IEEE Std. 802.1DG



***Japan
Automotive
Software
Platform
and
Architecture***

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Purpose and Context of the IEEE 802.1DG Amendment

Objective of Amendment

Defines a normative automotive time synchronization profile missing in IEEE 802.1DG to improve network precision.

Challenges Addressed

Fragmented implementations and lack of interoperability increase costs among car manufactures and suppliers in automotive systems.

Design Principles

Maintains backward compatibility and avoids new mechanisms by defining clear constraints tailored for automotive use.

Industry Integration

Ensures smooth coexistence with non-IEEE ecosystems like AUTOSAR and AVnu, enabling heterogeneous environment integration



Lack of Time Sync Standardization

IEEE 802.1DG lacks specific guidance on configuring time synchronization for automotive use, causing stakeholder fragmentation.

Impact on Vehicle Systems

Time offsets between Electronic Control Units (ECUs) and sensors can degrade perception accuracy and control stability in Advanced Driver Assistance Systems (ADAS).

Challenges in Software-Defined Vehicles

Stable time synchronization is essential as ECUs get replaced or upgraded in Software-Defined Vehicles to maintain system reliability.

Need for Standardized Automotive Profile

Without a unified time sync profile, Car Manufacturers rely on proprietary solutions, increasing validation effort and reducing interoperability.

Safety and Determinism

Time synchronization ensures deterministic behavior critical for safety compliance and fault analysis in automotive systems.

Static Network Design

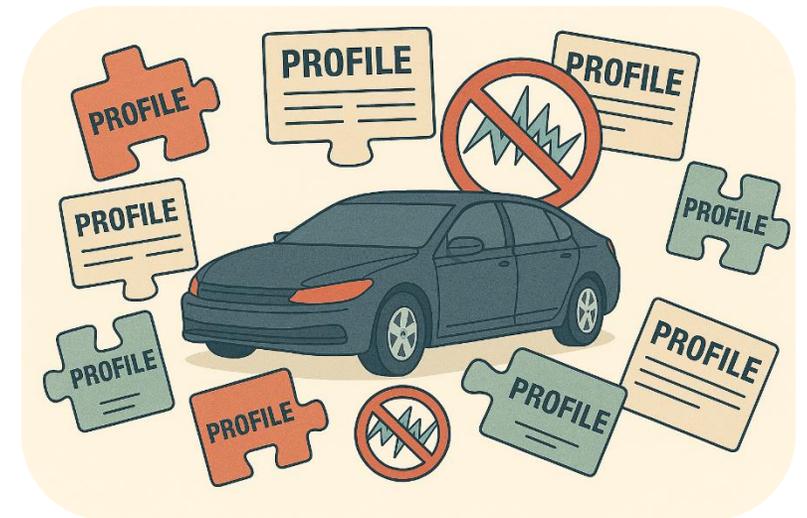
Automotive networks use fixed topologies, enabling simplified time synchronization without dynamic changes common in enterprise networks.

Scalability and Architecture

A common time base supports scalable domain-based and zonal architectures for efficient sensor fusion and coordinated actuation.

Lifecycle and SDV Coherence

Time synchronization must remain consistent across software updates, hardware changes, and post-production sensor additions.



Defined Scope of the Proposed Amendment

Exclusive Scope to IEEE Std 802.1DG

The amendment applies only to IEEE Std 802.1DG, focusing on the automotive TSN profile without changing the base IEEE Std 802.1AS.

Ensuring Backward Compatibility

Limiting scope ensures backward compatibility and prevents unintended effects on non-automotive IEEE 802.1AS implementations.

Optional for Non-Automotive Users

The amendment is optional for non-automotive TSN deployments, preserving existing enterprise and industrial network behaviors.

Alignment with IEEE Best Practices

The clear, focused scope aligns with IEEE best amendment practices, reducing risk and complexity for acceptance.

Standards Compliance

Ensures compatibility with IEEE Std 802.1AS-2011 and existing automotive silicon and software stacks.

Minimized Implementation Complexity

Removes unnecessary optional features to reduce resource use and validation effort in static in-vehicle networks.

Interoperability Focus

Supports coexistence between IEEE and non-IEEE ecosystems like AUTOSAR and AVnu automotive profiles.

Safety and Predictability

Prioritizes deterministic and safety-conscious network behavior over dynamic optimization.

In-Vehicle Network Structure

Automotive networks include multiple ECUs connected via domain or zonal switches, centralized by a compute ECU.

Unified gPTP Domain

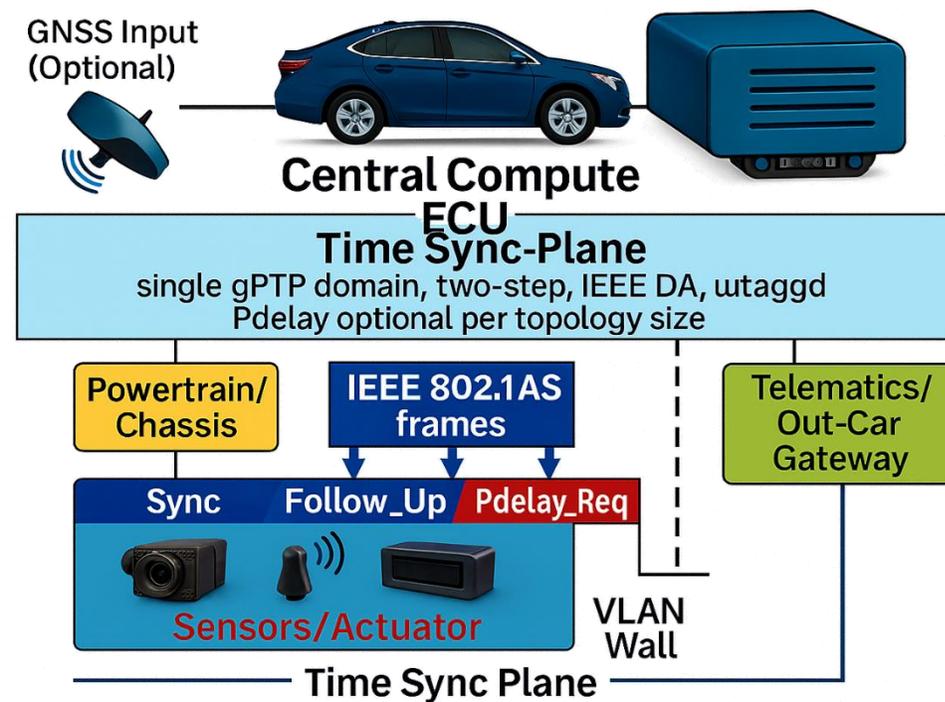
A single gPTP domain with domainNumber zero is used to maintain one unified time base across the vehicle.

Peer Delay Mechanisms

Optional Peer Delay mechanisms are used based on topology size and link characteristics for accurate timing.

Normative Profile Benefits

The profile provides clear guidance to implementers promoting consistency across different vendor products.



Static Grandmaster Configuration

Automotive networks use fixed grandmaster clock selection, determined during system design to ensure reliability.

Exclusion of BMCA

The Best Master Clock Algorithm is excluded to reduce complexity, protocol traffic, and avoid startup ambiguity.

Safety and Predictability

Static configuration aligns with safety practices, enhancing predictability and interoperability in automotive systems.

gPTP Message Restrictions

Announce and Signaling messages are prohibited and must be discarded if received to reduce protocol complexity.

Sync and Follow_Up Compliance

Sync and Follow_Up messages must comply fully with IEEE Std 802.1AS-2011 for standards conformance.

VLAN Tagging Constraints

Time synchronization messages shall not be VLAN-tagged to simplify network configuration and prevent interference.

Compatibility Considerations

Implementations may accept VLAN-tagged gPTP frames for compatibility, but it is not mandatory.

Flow Control Management

PAUSE frames are not transmitted or processed to avoid disrupting time synchronization in the system.

Performance Flexibility

The amendment avoids fixed transmission intervals, allowing flexibility for different automotive performance needs.

OEM Parameter Discretion

OEMs retain control over specific performance parameters to accommodate diverse operating environments and use cases.

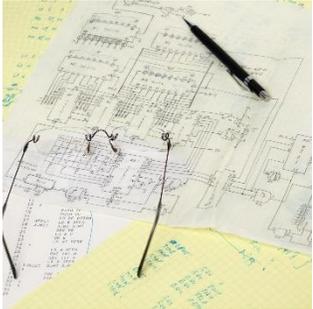
Industry Adoption Balance

Separating core requirements from configurable settings enables broad adoption without excessive constraints.



Normative Content Definition

Normative sections specify mandatory behaviors and constraints critical for interoperability in technical standards.



Informative Content Purpose

Informative sections provide explanatory text, examples, and design rationale to support understanding without mandates.



Scope and Implementation Freedom

Car Manufacture-specific processing and tuning are excluded from normative content to preserve implementation freedom where interoperability is unaffected.

Harmonious Coexistence

The amendment is designed to coexist with existing standards without altering base protocols, ensuring compatibility.

Alignment with IEEE Profiles

It aligns with IEEE Std 802.1DG usage profiles and preserves IEEE Std 802.1AS-2020 base protocol integrity.

Compatibility with Automotive Ecosystems

Facilitates coexistence with AUTOSAR and AVnu automotive profiles by aligning core assumptions like static topology.

Maintaining Broad Applicability

The amendment does not affect non-automotive TSN profiles, maintaining the broad applicability of IEEE 802.1 standards.

Addressing Standards Gap

The proposal targets a key gap in IEEE 802.1DG by defining a specific automotive time synchronization profile.

Collaborative Working Group

Next step involves presenting the amendment to IEEE 802.1 Working Group and forming a dedicated drafting team.

Stakeholder Engagement

Feedback will be gathered from car manufacturers, Tier-1 suppliers, and other stakeholders to refine the specification.

Enhancing Network Safety

The amendment aims to improve deploy ability, interoperability, and safety of automotive TSN networks while maintaining compatibility.

The candidate of Editor

Nakao-san, who has the long career of automotive industry and is a good English speaker, is the representative of Automotive Industry to define this amendment. He is currently in the academic world and has no problems with neutrality/

At the next interim in May

We will propose the PAR&CSD draft at the next interim.

Totally 3 years plan (tentative)

