

This document contains supplemental information referenced by the European Commission's 'Rolling Plan for ICT Standardisation'.

IEEE Standards Activities for Intelligent Transportation Systems (ITS)

Overview

The transportation sector is undergoing a massive transformation through electrification and automation. Autonomous vehicles will open up new opportunities for Mobility-as-a-Service (MaaS).

IEEE has standards activities in support of this transformation, covering:

- Intra-vehicle communication
- V2x-wireless communication
- Smart grid integration of electric vehicles
- Charging infrastructure for electric vehicles
- Automotive sensors
- Safety
- Trustworthiness

As part of the global technology ecosystem, the IEEE Vehicular Technology Society Intelligent Transportation Systems (VTS/ITS) collaborates and coordinates with many other organizations, in particular the Computer Society, the Communication Society and the Instrumentation and Measurement Society.

IEEE VTS/ITS 1609 and other working group experts participate in the exchange of IEEE draft documents with ETSI TC ITS to facilitate the evolution of ETSI ITS G5.

In addition to the standards and topical areas cited above, IEEE groups also consider artificial intelligence issues for autonomous vehicles. AI topics also correlate with the IEEE P7000 series of standards projects addressing ethical considerations for AI and autonomous systems.

Some Highlights

- IEEE 802.3 (Ethernet) standards evolve to support high bitrates and Time Sensitive Networking (TSN) in a vehicle.
- IEEE 802.11 (WLAN) standards have been optimised as the physical layer for mission critical communication and ad-hoc networking between vehicles and vehicles and the infrastructure in the dedicated 5.9 GHz spectrum (IEEE 802.11p). The work on the next generation of IEEE 802.11p. 802.11bd will support many more use cases. NOTE: ETSI ITS G5 relies on IEEE 802.11p and will benefit from 802.11bd..
- The IEEE WAVE standard (Wireless Access in Vehicular Environments) adds a whole protocol stack on top of IEEE 802.11p and bd, respectively. IEEE 1609.2 standardises a PKI based security architecture and security functions for V2X. NOTE: ETSI ITS-G5 and IEEE WAVE coordinate to harmonize security features for V2X.

- Charging communication: IEEE 1901 provides broadband over powerline communications to be used in charging electric vehicles (EVs), and IEEE 2030.1.1 on DC quick charging.
- IEEE P2020 standardises a suite of objective and subjective test methods for measuring automotive camera image quality attributes, and tools and test methods to facilitate decision making among OEM and Tier 1 system integrators and component vendors regarding automotive ADAS image quality.
- A Formal Model of Safe Automated Vehicle Decision Making will be standardised in P2846.
- P2851 defines a data format with which results of safety analyses (such as FMEA, FMEDA, FMECA, FTA) and related safety verification activities - such as fault injection - executed for IPs, SoCs and mixed signal ICs can be exchanged and made available to system integrators. Goal of the standard is to provide a common ground for EDA, SoC and IP vendors in needs of developing tools, SoC and IP for safety critical applications.
- P2418.4 provides a common framework for distributed ledger technology (DLT) usage, implementation, and interaction in connected and autonomous vehicles (CAVs).
- The IEEE P7000 standards family addresses ethical considerations in a broad range of artificial intelligence/autonomous system uses, including vehicular contexts.

Relevant Standards Activities

Approved Standards*

- IEEE 802.11-2012, IEEE Standard for Information Technology-- Telecommunications and information exchange between systems--Local and metropolitan area networks--Specific requirements--Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications
NOTE: The original IEEE 802.11p-2010, which added *Wireless Access in Vehicular Environments*, has been superseded by IEEE 802.11-2012 in which the content is now incorporated.
- IEEE 802.15.4-2015, IEEE Standard for Low-Rate Wireless Networks
- IEEE 802.20-2008, IEEE Standard for Local and metropolitan area networks--Part 20--Air Interface for Mobile Broadband Wireless Access Systems Supporting Vehicular Mobility--Physical and Media Access Control Layer Specification
- IEEE 1512-2006, IEEE Standard for Common Incident Management Message Sets for Use by Emergency Management Centers
- IEEE 1512.1-2006, IEEE Standard for Common Traffic Incident Management Message Sets for Use by Emergency Management Centers
- IEEE 1512.3-2006, IEEE Standard for Hazardous Material Incident Management Message Sets for Use by Emergency Management Centers
- IEEE 1609.0-2013, IEEE Guide for Wireless Access in Vehicular Environments (WAVE)--Architecture
- IEEE 1609.2-2016, IEEE Standard for Wireless Access in Vehicular Environments--Security Services for Applications and Management Messages
- IEEE 1609.2a-2017, Standard for Wireless Access in Vehicular Environments--Security Services for Applications and Management Messages Amendment
- IEEE 1609.3-2016, IEEE Standard for Wireless Access in Vehicular Environments (WAVE)--Networking Services
- IEEE 1609.4-2016, IEEE Standard for Wireless Access in Vehicular Environments (WAVE)--Multi-channel Operation
- IEEE 1609.11-2010, IEEE Standard for Wireless Access in Vehicular

Environments (WAVE)--Over-the-Air Electronic Payment Data Exchange Protocol for Intelligent Transportation Systems (ITS)

- IEEE 1609.12-2016, IEEE Standard for Wireless Access in Vehicular

Environments (WAVE)--Identifier Allocations

- IEEE 1616-2004, IEEE Standard for Motor Vehicle Event Data Recorders (MVEDRs)
- IEEE 1616a-2010, IEEE Standard for Motor Vehicle Event Data Recorders (MVEDRs)--Amendment 1: Motor Vehicle Event Data Recorder Connector Lockout Apparatus (MVEDRCLA)

Standards on charging communication

- IEEE 1901-2010, IEEE Standard for Broadband over Power Line Networks: Medium Access Control and Physical Layer Specifications

DC Quick Charger for Use with Electric Vehicles

- IEEE 2030.1.1-2015 IEEE Standard Technical Specifications of a

Current New or Revision Projects*

- IEEE P802.3ch, Standard for Ethernet Physical Layer Specifications and Management Parameters for Greater Than 1 Gb/s Automotive Ethernet

- IEEE P802.11bd, Standard for Information technology--Telecommunications and information exchange between systems Local and metropolitan area networks--Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment: Enhancements for Next Generation V2X. NOTE: ETSI G5 relies on IEEE 802.11p and will benefit from 802.11bd.

- IEEE P1609.0, Draft Guide for Wireless Access in Vehicular Environments (WAVE)--Architecture
- IEEE P1609.2a, Draft Standard for Wireless Access in Vehicular Environments--Security Services for Applications and Management Messages Amendment--Certificate Management
- IEEE P1609.2b, Standard for Wireless Access in Vehicular Environments-- Security Services for Applications and Management Messages Amendment
- IEEE P1609.2.1, Wireless Access in Vehicular Environments (WAVE)-- Certificate Management Interfaces for End-Entities
- IEEE P1609.3, Standard for Wireless Access in Vehicular Environments (WAVE)-Networking Services
- IEEE P1609.6, Draft Standard for Wireless Access in Vehicular Environments (WAVE)--Remote Management Service
- IEEE P1609.12, Draft Standard for Wireless Access in Vehicular Environments --Identifier Allocations

Circuits and Electronic Design

- IEEE P1800, Standard for SystemVerilog--Unified Hardware Design, Specification, and Verification Language
- IEEE P1800.2, Standard for Universal Verification Methodology Language Reference Manual
- IEEE P1801, IEEE Draft Standard for Design and Verification of Low Power, Energy Aware Electronic Systems

Automotive Sensors

- IEEE P2020, Standard for Automotive System Image Quality

Charging

- IEEE P2030.1.1, Standard Technical Specifications of a DC Quick and Bi-directional Charger for Use with Electric Vehicles

Autonomous vehicles - IEEE 2040 series of projects* including:

- IEEE P2040, Standard for Connected, Automated and Intelligent Vehicles: Overview and Architecture
- IEEE P2040.1, Standard for Connected, Automated and Intelligent Vehicles: Taxonomy and Definitions
- IEEE P2040.2, Standard for Connected, Automated and Intelligent Vehicles: Testing and Verification

Drones

- IEEE P2025.1, Standard for Consumer Drones: Taxonomy and Definitions
- IEEE P2025.2, Standard for Consumer Drones: Privacy and Security

Safety

- P1228: Standard for Software Safety
- P2846, Draft Standard for a Formal Model of Safe Automated Vehicle Decision Making
- P2851, Draft Standard for the Exchange/Interoperability Format for Safety Analysis and Safety Verification of IP, SoC and Mixed Signal ICs

Security

- IEEE P2418.1: Standard for the Framework of Blockchain Use in Internet of Things (IoT)
- IEEE P2418.2: Standard Data Format for Blockchain Systems
- IEEE P2418.4, Standard for a common framework for distributed ledger technology (DLT) usage, implementation, and interaction in connected and autonomous vehicles (CAVs)

Artificial Intelligence

- IEEE P2807, Framework of Knowledge Graphs
- IEEE P2807.1, Standard for Technical Requirements and Evaluating Knowledge Graphs
- IEEE P2830, Standard for Technical Framework and Requirements of Shared Machine Learning
- IEEE P2841, Framework and Process for Deep Learning Evaluation
- IEEE P3652.1, Guide for Architectural Framework and Application of Federated Machine Learning
- P3333.1.3, Standard for the Deep Learning-Based Assessment of Visual Experience Based on Human

Factors

Trustworthiness

- IEEE P7000, Model Process for Addressing Ethical Concerns During System Design
- IEEE P7001, Transparency of Autonomous Systems
- IEEE P7002, Data Privacy Process
- IEEE P7003, Algorithmic Bias Considerations
- IEEE P7006, Standard for Personal Data Artificial Intelligence (AI) Agent
- IEEE P7007, Ontological Standard for Ethically Driven Robotics and Automation Systems
- IEEE P7008, Standard for Ethically Driven Nudging for Robotic, Intelligent and Autonomous Systems
- IEEE P7009, Standard for Fail-Safe Design of Autonomous and Semi-Autonomous Systems

IEEE Industry Connection Program

Communication

- IC13-004 IEEE SA Ethernet & IP @ Automotive Technology Day
- IC15-005 New Ethernet Applications
- IC17-001 IEEE 802 Network Enhancements for the Next Decade
- IC17-015 Optical Networks 2020

Trustworthiness

- IC16-002 The Global Initiative on Ethics of Autonomous and Intelligent Systems
- IC17-002 Digital Inclusion, Identity, Trust, and Agency (DIITA)
- IC17-006 Big Data Governance and Metadata Management
- IC18-004 Ethics Certification Program for Autonomous and Intelligent Systems (ECPAIS)

- IC19-001 Global Initiative to Standardize Fairness in the Trade of Data

More information is available at <https://standards.ieee.org/>

*NOTE: Draft standards projects, once approved, are often revised and/or used as the base for new projects. The status of these projects is updated periodically. For the most up-to-date status, please see the following link: [<https://standards.ieee.org/project/index.html>](https://standards.ieee.org/project/index.html)

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