

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

IEEE Standards Activities in 5G

Overview

IEEE-SA provides a global, open, and collaborative platform for wireless communities that engage in, and enable the development of new, innovative, and relevant use cases and standards which, in turn, accelerate the time to market of consensus-developed technologies with regards to fifth-generation wireless systems (5G) and beyond.

Specific areas of focus include:

- Mobile broadband network evolution
- Technology interoperability
- Enabling IoT and Smart Cities (including public safety)
- Connected vehicles

Inclusive to this is the ability to support addressing the following technological considerations:

- Convergence of fixed, mobile, and broadcast services
- Multi-tenancy models
- Sustainability, scalability, security, and privacy management
- Spectrum
- Software enablement for Software-defined Networking (SDN), Network Function Virtualization (NFV), Mobile Edge, Fog Computing, and Virtualization

IEEE has many efforts underway to develop and mature standards in support of the next generation communications technologies for enhanced mobile broadband, massive machine type communications, and ultra-reliable and low latency communications. These include both licensed and unlicensed band initiatives. Next generation wireless standards for unlicensed spectrum include the following:

- [IEEE P802.11ax](#), 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 Amendment Enhancements for High Efficiency WLAN, is an extension of the current WLAN standards by improving aggregated throughput with high user density. IEEE P802.11ax targets Mid Band, sub 6 GHz unlicensed spectrum.
- [IEEE P802.11ay](#), 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-- Amendment: Enhanced Throughput for Operation in License-Exempt Bands Above 45 GHz, targets bonding 2 GHz channels to achieve extremely high point to point throughput in excess of 20Mbps. IEEE P802.11ay is implemented in the unlicensed millimeter wave band (60 GHz).

In addition, IEEE developed IEEE 802.11p/1609 to enable vehicle-to-everything (V2X) communication for the automotive sector.

IEEE standards and ongoing activities in support of various wireless technologies include:

- [IEEE P1914.1](#), IEEE Draft Standard for Packet-based Fronthaul Transport Networks
- [IEEE P1914.3](#), IEEE Draft Standard for Radio over Ethernet Encapsulations and Mappings
- [IEEE 1588](#), IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems; enables phase synchronous wireless networks, such as Long-Term Evolution Time Division Duplex (LTE TDD)
- IEEE 802 access network:
 - [IEEE P802.1CF](#), IEEE Draft Recommended Practice for Network Reference Model and Functional Description of IEEE 802 Access Network
 - IEEE P802.CM-2018, IEEE Approved Draft Time-Sensitive Networking for Fronthaul
- Tactile Networking:
 - [IEEE P1918.1](#) covers application scenarios, architecture and functions,
 - [IEEE P1918.1.1](#) specifies Haptic Codecs for the Tactile Internet
- Radio Regulatory Technical Advisory Group (IEEE 802.18) and Wireless Coexistence (IEEE 802.19)

Relevant Standards Activities

IEEE Standards Series*

- IEEE 802.1 series on media access control (MAC), including:
 - [IEEE P802.1CF](#), IEEE Draft Recommended Practice for Network Reference Model and Functional Description of IEEE 802 Access Network
- IEEE 802.3 series on Ethernet
- IEEE 802.11 series on Wireless LAN
- IEEE 802.15 series on Wireless Personal Area Networks
- IEEE 802.16 Broadband Wireless Access
- IEEE 802.18 Radio Regulatory Technical Advisory
- IEEE 802.19 Wireless Coexistence
- IEEE 802.21 series on Media Independent Handover Services
- IEEE 802.22 series on Cognitive Wireless RAN Medium Access Control (MAC) and Physical Layer (PHY)

Specifications

- IEEE 1900 series on Dynamic Spectrum Access
- IEEE 1903 series on Next Generation Service Overlay Network (NGSON), including:
 - [IEEE 1903-2011](#), IEEE Standard for the Functional Architecture of Next Generation Service Overlay Networks
 - [IEEE P1903.1-2017](#), IEEE Draft Standard for Content Delivery Protocols of Next Generation Service Overlay Network (NGSON)
 - [IEEE P1903.2-2017](#), IEEE Draft Standard for Service Composition Protocols of Next Generation Service Overlay Network (NGSON)
 - [IEEE P1903.3-2017](#), IEEE Draft Standard for Self-Organizing Management Protocols of Next Generation Service Overlay Network (NGSON)

- IEEE 1904 series, including:
 - [IEEE P1904.1](#)/Conformance 03-2014 (Conformance to IEEE 1904.1-2013), IEEE Draft Standard for Conformance Test Procedures for Service Interoperability in Ethernet Passive Optical Networks, IEEE Std 1904.1™ Package C
 - [IEEE P1904.2](#), IEEE Draft Standard for Management Channel for Customer-Premises Equipment Connected to Ethernet-based Subscriber Access Networks
 - IEEE P1904.3, IEEE Draft Standard for Radio Over Ethernet Encapsulations and Mappings
- IEEE 2030 series on the Smart Grid, including electric vehicle infrastructure, including:
 - [IEEE 2030-2011](#), IEEE Guide for Smart Grid Interoperability of Energy Technology and Information Technology Operation with the Electric Power System (EPS), and End-Use Applications and Loads
 - [IEEE 2030.2-2015](#), IEEE Guide for the Interoperability of Energy Storage Systems Integrated with the Electric Power Infrastructure
 - [IEEE 2030.3-2016](#), IEEE Standard Test Procedures for Electric Energy Storage Equipment and Systems for Electric Power Systems Applications
 - IEEE P2030.5-2018, IEEE Draft Standard for Smart Energy Profile Application Protocol

Other Standards and Standards Projects under Development*

- [IEEE P149](#), IEEE Draft Recommended Practice for Antenna Measurements
- [IEEE P211](#), IEEE Draft Standard Definitions of Terms for Radio Wave Propagation
- [IEEE P269](#), IEEE Draft Standard for Measuring Electroacoustic Performance of Communication Devices
- [IEEE P287.1](#), IEEE Draft Standard for Precision Coaxial Connectors at RF, Microwave and Millimeter-wave Frequencies
- [IEEE 1076](#), IEEE Standard VHDL Language Reference Manual
- [IEEE P1451-99](#), IEEE Draft Standard for Harmonization of Internet of Things (IoT) Devices and Systems
- IEEE 1528, IEEE Recommended Practice for Measurement Procedures for the Assessment of Specific Absorption Rate (SAR) of Human Exposure to Radio Frequency Fields from Hand-Held and Body-Worn Wireless Communication Devices (Frequency Range of 4 MHz to 10 GHz)
- [IEEE P1589](#), IEEE Draft Standard for an Augmented Reality Learning Experience Model
- [IEEE 1647](#), IEEE Standard for the Functional Verification Language 'e'
- [IEEE 1652-2016](#), IEEE Standard for Translating Head and Torso Simulator Measurements from Eardrum to Other Acoustic Reference Points
- IEEE 1666, Modeling of 5G design at pre-implementation level
- [IEEE 1666.1-2016](#), IEEE Standard for SystemC[®] Analog/Mixed-Signal (AMS) Extensions Language Reference Manual
- [IEEE 1685-2014](#), IEEE Standard for IP-XACT, Standard Structure for Packaging, Integrating, and Reusing IP within Tool Flows
- [IEEE 1720-2012](#), IEEE Recommended Practice for Near-Field Antenna Measurements
- [IEEE 1734-2011](#), IEEE Standard for Quality of Electronic and Software Intellectual Property used in System and System on Chip (SoC) Designs
- [IEEE 1735](#), IEEE Recommended Practice for Encryption and Management of Electronic Design Intellectual Property (IP)
- [IEEE P1765](#), IEEE Draft Trial-Use Recommended Practice for Estimating the Uncertainty in Error Vector Magnitude of Measured Digitally Modulated Signals for Wireless Communications

- [IEEE P1770](#), IEEE Draft Recommended Practice for The Usage of Terms Commonly Employed In the Field of Large-Signal Vector Network Analysis
- [IEEE 1785.2-2016](#), IEEE Standard for Rectangular Metallic Waveguides and Their Interfaces for Frequencies of 110 GHz and Above—Part 2: Waveguide Interfaces
- IEEE 1800, IEEE SystemVerilog Language Working Group
- [IEEE 1800.2-2017](#), IEEE Standard for Universal Verification Methodology Language Reference Manual
- [IEEE P1801](#), IEEE Draft Standard for Design and Verification of Low Power, Energy Aware Electronic Systems
- [IEEE P1857.6](#), IEEE Draft Standard for Digital Media Content Description
- [IEEE P1857.9](#), IEEE Standard for Immersive Visual Content Coding
- [IEEE 1903-2011](#), IEEE Standard for the Functional Architecture of Next Generation Service Overlay Networks
- [IEEE 1905.1-2013](#), IEEE Standard for a Convergent Digital Home Network for Heterogeneous Technologies
- [IEEE 1905.1a-2014](#), IEEE Standard for a Convergent Digital Home Network for Heterogeneous Technologies Amendment 1: Support of New MAC/PHYs and Enhancements
- IEEE P1908.1, IEEE Draft Virtual Keyboard Standard for Indic Languages
- [IEEE P1910.1](#), IEEE Draft Standard for Meshed Tree Bridging with Loop Free Forwarding
- [IEEE P1911.3](#), IEEE Draft Standard for HDBaseT 5Play
- [IEEE P1912](#), IEEE Draft Standard for Privacy and Security Architecture for Consumer Wireless Devices
- [IEEE P1913](#), IEEE Draft Software-Defined Quantum Communication
- [IEEE P1914.1](#), IEEE Draft Standard for Packet-based Fronthaul Transport Networks
- [IEEE P1915.1](#), IEEE Draft Standard for Software Defined Networking and Network Function Virtualization Security
- [IEEE P1916.1](#), IEEE Draft Standard for Software Defined Networking and Network Function Virtualization Performance
- [IEEE P1917.1](#), IEEE Draft Standard for Software-Defined Networking and Network Function Virtualization Reliability
- [IEEE P1918.1](#), IEEE Draft Tactile Internet: Application Scenarios, Definitions and Terminology, Architecture, Functions, and Technical Assumptions
- [IEEE P1918.1.1](#), IEEE Draft Haptic Codecs for the Tactile Internet
- [IEEE P1920.1](#), IEEE Draft Aerial Communications and Networking Standards
- [IEEE P1921.1](#), IEEE Draft Standard for Software-Defined Networking (SDN) Bootstrapping Procedures
- [IEEE P1930.1](#), IEEE Draft Recommended Practice for Software Defined Networking (SDN) based Middleware for Control and Management of Wireless Networks
- [IEEE 1931.1](#), IEEE Draft Standard for an Architectural Framework for Real-time Onsite Operations Facilitation (ROOF) for the Internet of Things
- [IEEE P2061](#), IEEE Draft Standard for an Architecture for Low Mobility Energy Efficient Network for Affordable Broadband Access
- [IEEE P2413](#), IEEE Draft Standard for an Architectural Framework for the Internet of Things
- [IEEE P3333.2.4](#), IEEE Draft Standard for Three-Dimensional (3D) Medical Simulation

**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>>*