IEEE P802.11
Wireless LANs

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| IEEE 802.11 Enhancements for Ambient Power (AMP) Communication CSD |
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Abstract

This document contains the Criteria for Standards Development document for the IEEE 802.11 AMP Communication project.

Rev 0: Initial draft framework.

Rev 1: Updated based on proposed modification by 11-23/1287r1.

Rev 2: Updated and motioned in November 2023 meeting.

Rev 3: WG Chair edits: As approved by WG11 with all change bars accepted, document dates updated, highlighting removed, minor grammatical edits before posting to 802 LMSC review.

Rev 4: Update with incorporating resolutions to comments from EC

# 1. IEEE 802 criteria for standards development (CSD)

The CSD documents an agreement between the WG and the IEEE 802 LMSC that provides a description of the project and the IEEE 802 LMSC's requirements more detailed than required in the PAR. The CSD consists of the project process requirements, 1.1, and the 5C requirements, 1.2.

## 1.1 Project process requirements

### 1.1.1 Managed objects

Describe the plan for developing a definition of managed objects. The plan shall specify one of the following:

1. The definitions will be part of this project. YES
2. The definitions will be part of a different project and provide the plan for that project or anticipated future project.
3. The definitions will not be developed and explain why such definitions are not needed.

### 1.1.2 Coexistence

A WG proposing a wireless project shall prepare a Coexistence Assessment (CA) document unless it is not applicable.

1. Will the WG create a CA document as part of the WG balloting process as described in Clause 13? YES
2. If not, explain why the CA document is not applicable.

## 1.2 5C requirements

### 1.2.1 Broad Market Potential

Each proposed IEEE 802 LMSC standard shall have broad market potential. At a minimum, address the following areas:

1. Broad sets of applicability.

*IoT networking has spread into nearly every aspect of life, and, as such, is a driver for economic growth, social cohesion/inclusion, and for the improvement of welfare and well-being. Disruptive solutions are however required to sustain this evolution. In this regard, explosive market growth is predicted for battery-free tags and sensors. AMP Communication addresses the main challenges to support the creation of battery-free devices via energy harvesting and thus maintenance-*

*free and sustainable networks, enabling IEEE 802.11based WLANs to strengthen its position in the market and remain at the forefront of IoT evolution.*

*The AMP Communication capability enhances a WLAN network with at least the following functions: IoT device identification and sensor data transmission [1].*

*The market for object identification is projected to reach USD 35.6 billion by 2030 from USD 14.5 billion in 2022 and it is expected to grow at a CAGR of 11.9% from 2022 to 2030 [3] . The market is expected to expand from an output of 18,836.5 million units in 2021 and surpass 49,116.4 million units by 2031 [3] . AMP Communications is a promising candidate technology to play a critical role in the market of object identification by potentially providing remote, automatic, omni-directional, highly efficient and reliable object identification. With these new characteristics, AMP Communication in an IEEE 802.11 WLAN can be further used in asset management in new markets such as smart agriculture where the coverage requirement is beyond the capability of current technologies.*

*AMP Communication can also be used for sensor networks [5] . The global industrial wireless sensor network (IWSN) market size is expected to reach USD 8,669.8 million by 2025, growing at a CAGR of 15.2% from 2019 to 2025, according to this study. The benefits offered by IWSN over wired networks, such as mobility, self-discovery capability, compact size, cost-effectiveness, and reduced complexity, are anticipated to play a significant role in increasing global demand. For example, the development of smart grid requires the sensor network to provide intelligent perception and data fusion. The combination of communication network and sensing technology applied in the power grid will develop towards the deep integration of sensing and communication. As one example, China’s State Grid invested more than 150 billion yuan ($22 billion) in the second half of 2022 in ultra-high voltage (UHV) power transmission lines. Millions of sensors and meters need to be deployed along these UHV power transmission lines to monitor temperature, humidity, etc., and detect fault operations, which creates a huge market for AMP Communication devices with unique features such as being maintenance-free and battery-less.*

*Therefore, an AMP Communication enabled WLAN can pave the way for the deployment of new sensors by significantly reducing both CapEx including deployment cost and OpEx including operation cost. In this regard, the largest growth of future AMP Communication enabled devices is foreseen in the next decade adding to the expected growth of the number of devices, the market demand for long term and maintenance-free device connection and the rise of new services and applications.*

1. Multiple vendors and numerous users.

*A wide variety of vendors are currently building numerous products for the Wireless Local Area Network (WLAN) marketplace and plan for more extensive products to support the IoT marketplace. It is anticipated that most of those vendors, and others, will participate in the standards development process and subsequent commercialization activities.*

*The number of annual shipments and the diversity of devices and use cases illustrate the number of users that are relying on IoT marketing extension and that can potentially use AMP Communication WLAN technology.*

*According to the AMP TIG/SG meeting attending history, it’s expected it’s expected there will be around 50 experts participating in the proposed amendment project, if approved.*

### 1.2.2 Compatibility

Each proposed IEEE 802 LMSC standard should be in conformance with IEEE Std 802, IEEE 802.1AC, and IEEE 802.1Q. If any variances in conformance emerge, they shall be thoroughly disclosed and reviewed with IEEE 802.1 WG prior to submitting a PAR to the IEEE 802 LMSC.

1. Will the proposed standard comply with IEEE Std 802, IEEE Std 802.1AC and IEEE Std 802.1Q? YES
2. If the answer to a) is no, supply the response from the IEEE 802.1 WG.

The review and response is not required if the proposed standard is an amendment or revision to an existing standard for which it has been previously determined that compliance with the above IEEE 802 standards is not possible. In this case, the CSD statement shall state that this is the case.

### 1.2.3 Distinct Identity

Each proposed IEEE 802 LMSC standard shall provide evidence of a distinct identity. Identify standards and standards projects with similar scopes and for each one describe why the proposed project is substantially different.

*This project will focus on enabling ambient power communication in IEEE 802.11 WLANs with an acceptable data rate by supporting at least one mode of data communication link for an ultra-low power device which operates with extremely low ambient power (e.g., radio waves with harvested power of 10 μW or even lower, etc.).*

*This project will also provide mechanisms for wireless power transfer to support RF energy harvesting with compliance with IEEE Std C95.1-2019.*

*There is no other IEEE 802.11 WLAN standard focusing on enabling ambient power communication in a WLAN and providing the mechanisms for positioning functions with ambient power communication other than this proposed amendment.*

### 1.2.4 Technical Feasibility

Each proposed IEEE 802 LMSC standard shall provide evidence that the project is technically feasible within the time frame of the project. At a minimum, address the following items to demonstrate technical feasibility:

1. a) Demonstrated system feasibility.

*The IEEE 802.11 AMP Topic Interest Group (TIG) and Study Group (SG) and the IEEE 802.11 Wireless Next Generation Standing Committee (SC) reviewed many presentations listing candidate features, technical feasibility analysis, and prototypes presentations which indicate that the proposed solutions are technically feasible. The AMP TIG has developed a technical report on supporting AMP devices in 802.11 WLANs in [1] to demonstrate the system feasibility.*

1. b) Proven similar technology via testing, modeling, simulation, etc.

*IEEE 802.11 is a mature technology which has a wide variety of legacy devices and a proven track record, with several billion devices shipping each year. The AMP function has been analyzed in [1]. The increased capabilities of IEEE 802.11 envisioned for the baseband and RF parts necessary to implement the proposed amendment are in line with the current progress in technology and not expected to impinge upon testability.*

### 1.2.5 Economic Feasibility

Each proposed IEEE 802 LMSC standard shall provide evidence of economic feasibility. Demonstrate, as far as can reasonably be estimated, the economic feasibility of the proposed project for its intended applications. Among the areas that may be addressed in the cost for performance analysis are the following:

1. a) Known cost factors.

*WLAN equipment and AMP devices are accepted by the market as having balanced costs. The development of supporting AMP communication in WLAN extends the WLAN network deployment scenario and will not disrupt the established balance.*

1. b) Balanced costs.

*Support of the proposed standard will likely require a manufacturer to develop a modified radio, modem, and firmware. This is similar in principle to the case of the IEEE 802.11ba-2021 amendment and capabilities as well as in previous extended capabilities of IEEE Std. 802.11 enhancements. The cost factors for these enhancements are well known and the data for this is well understood.*

1. c) Consideration of installation costs.

*The WLAN industry has been developing WLAN implementations for the IoT market for many years. The focus of this proposed amendment is on enabling AMP Communication operation in a WLAN. The proposed amendment has no known extra impact on installation costs for AMP communication enabled WLANs.*

*For WLAN devices with the AMP Communication capability only, the proposed amendment is not expected to impact installation costs.*

*In some cases, the AMP Communication capability is added to a legacy IEEE 802.11 device. The total cost is balanced and comparable to the cost of an initial IEEE Std. 802.11 WLAN installation.*

1. d) Consideration of operational costs (e.g., energy consumption).

*There are billions of WLAN systems in operation around the world. WLAN systems are recognized to provide a total cost of ownership (TCO) that provides significant operation cost benefits. This proposed amendment focuses on enabling AMP Communication in an IEEE 802.11 WLAN, enabling ultra low energy consumption and long-life cycle IoT applications. Battery-free AMP devices leverage ambient power sources and enable maintenance-free IoT network, reducing and in some cases eliminating human intervention. AMP Communication also supports improved environment protection via reducing usage of conventional batteries. This proposed amendment is not expected to markedly change today’s operation costs and indeed a goal is to improve the TCO via enabling reduced device energy consumption.*

1. e) Other areas, as appropriate.

None.

**References:**

1. 11-23-0436-00-0amp-technical-report-on-support-of-amp-iot-devices-in-wlan.docx
2. 11-22-0645-02-0wng-ambient-power-enabled-iot-for-wi-fi.pptx

1. <https://www.marketsandmarkets.com/Market-Reports/rfid-market-446.html?gclid=EAIaIQobChMI1KnTy-Tl-AIVydeWCh1CqArgEAAYASAAEgJhX_D_BwE>

1. <https://www.researchandmarkets.com/reports/4531980/indoor-positioning-and-navigation-market>.

1. <https://www.researchandmarkets.com/reports/4479733/industrial-wireless-sensor-network-iwsn-market>