IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| IEEE 802.11az NGP CSD update | | | | |
| Date: 2017-09-01 | | | | |
| Author(s): | | | | |
| Name | Affiliation | Address | Phone | Email |
| Jon Rosdahl | Qualcomm | 10871 N 5750 W Highland, UT 84003 | +1-801-492-4023 | jrosdahl@qti.qualcomm.com |
| Su Khiong Yong | Apple |  |  | skyong@apple.com |
| Jonathan Segev | Intel Corporation |  | +972-54-2403587 | [jonathan.segev@intel.com](mailto:jonathan.segev@intel.com) |

Abstract

This is the IEEE 802.11az Next Generation Positioning (NGP) updated CSD.

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

The CSD documents an agreement between the WG and the Sponsor that provides a description of the project and the Sponsor's requirements more detailed than required in the PAR. The CSD consists of the project process requirements, 0, and the 5C requirements, 0.

## 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 demonstrate coexistence through the preparation of a Coexistence Assurance (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:

a) Broad sets of applicability.

According to an ABI market forecast1 the number of Indoor Location installations is expected to rise from $10B in 2014 to $80B by 2018; this increase will be associated with the expansion of various market segments for accurate positioning:

* Indoor location revenues for in-store analytics expected to rise from tens of millions of dollars in 2014 to more than $1.8B by 2018.
* Hyperlocal customer incentive programs expected to increase from tens of millions of dollars in 2014 to almost $1.5B by 2018, indirectly driving product revenue.
* Mobile search market expected to rise from a few million of dollars in 2014 to roughly $1B in 2018.

(All dollar amounts are in USD)

According to another market forecast2, the year over year market up to 2018 for 802.11 based positioning technology within the mobile device segment is expected to grow by roughly 15% for AP to STA usages, and with peer to peer usages to grow by 50% year over year for the same period.

The enhancements of the proposed amendment are set to fortify and better position 802.11 based technology to support this.

b) Multiple vendors and numerous users.

A wide variety of vendors currently build numerous products for the Wireless Local Area Network (WLAN) marketplace. According to ABI research the market size for indoor location is expected to increase by a factor of ten compared to 2013 while the number of devices is expected to rise by a factor of eight4. According to the same report, many of the current players in the indoor location market are also vendors in the WLAN segment and thus it is anticipated that a substantial proportion of those vendors, and others, will participate in the standards development process and subsequent commercialization activities for WLAN indoor location.

### 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 Sponsor.

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 a WLAN that can efficiently support positioning services beyond those offered by the Fine Timing Measurement (FTM) protocol7 specified in IEEE P802.11 (known as REVmc) for High Throughput (HT), Very High Throughput (VHT) and Directional Multi Gigabit (DMG) STAs plus PHYs under concurrent development (e.g., within High Efficiency (HE) and Next Generation 60 GHz task groups). This project shall enable determination of absolute and relative position with better accuracy than the FTM protocol executing on the same PHY-type. This project shall optimize system level performance attributes like wireless medium usage, power consumption and scalability to dense deployments. This project will also define modifications that enable secured exchange of measurement and positioning information [reference 13 and reference 14].

There is no other WLAN standard focusing on expanding the available positioning services and significantly improving existing positioning service scalability and performance other than this amendment.

This amendment will differentiate itself from other IEEE 802 wireless standards via the title which highlights that the scope of the amendment is positioning enhancements.

### 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:

a) Demonstrated system feasibility.

802.11 based devices implementing the Fine Timing Measurement (FTM) procedure standardized as part of IEEE P802.11 (known as REVmc) already exist11. In Line of Sight (LoS) environments these devices are capable of estimating their position accurately. However in Non-Line of Sight (NLoS) environments, the accuracy is degraded. It is expected that the positioning mechanisms developed as part of this amendment will use information available in existing 802.11 PHY protocol data units or augment it with additional information, in order to estimate a more accurate position even in NLoS environments.

A number of submissions have been made to Wireless Next Generation (WNG), REVmc, TGah and NGP outlining techniques to improve accuracy in NLoS and other environments8,9,10,12; enhance scalability in dense deployments5,6,8,9; and reduce power consumption5,9 and wireless medium usage5,8,9. These submissions demonstrate that it is feasible to improve performance of the positioning protocol and accomplish the goals of this project.

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 billions of devices shipping each year. The principle of extending the IEEE 802.11 PHYs and MAC with new capabilities is also well established by previous amendments within IEEE 802.11, e.g., adding the FTM protocol to REVmc.

This project builds on the broad knowledge base and system design experience underpinning available IEEE 802.11 devices. The experience gained in the development and deployment of Multiple-Input/Multiple-Output (MIMO) and FTM-enabled IEEE 802.11 devices are applicable to the development of this project. For example, multiple antenna systems, channel estimation, and first-path estimation allow reuse of IEEE 802.11-based technologies and testing.

Specifically, but without attempting to constrain the technology ultimately selected and refined by the task group, the technology requirements:

* of reference 5 are AP-to-AP transmissions snooped by clients with an alternative positioning computation engine, which is straightforward extension of the existing FTM protocol and positioning computation engine respectively
* of reference 9 are transmission/reception from multiple antennas and channel phase estimation, which are established capabilities of HT and VHT devices, and these have established feasibility3.

Lastly, the increased capabilities envisioned for the baseband, RF parts and positioning computation engine necessary to implement the amendment are in line with the current progress in technology, and are not expected to impinge 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:

a) Balanced costs (infrastructure versus attached stations).

1. WLAN equipment is accepted as having balanced costs. The development of wireless capabilities to enhance the positioning services offered by of WLAN network deployments and improve system level performance will not disrupt the established balance.
2. b) Known cost factors.

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 changes required to support FTM for HT and VHT and DMG STAs developed under IEEE P802.11 (known as REVmc). The cost factors for these transitions are well known and the data for this is well understood.

c) Consideration of installation costs.

The FTM protocol enables more use cases when APs have their geographic and civic location configured, including AP height above floor. Depending on technologies ultimately selected and refined by the task group, orientation of the AP might need to be configured also. Achieving maximum non-AP device geolocation accuracy might require greater accuracy in the AP’s configured geolocation. These configuration tasks are expected to have a minor impact on installation costs.

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 a significant operation cost benefits. This amendment is not expected to change today’s operation costs.

This amendment is targeting to maintain (or reduce) power consumed by devices executing the positioning protocol, as specified in the PAR.

e) Other areas, as appropriate.  
  
None

## References

1. “Indoor Location In Retail: Where Is The Money?”, by ABI Research, March 2013
2. “Smartphone Indoor Location Technologies”, by ABI Research, June 2013
3. “Indoor Location Positioning Technology: Research, Start-ups and Predictions”, by Grizzly Analytics Market Research, March 2013
4. “Indoor Location Technology OEMS”, by ABI Research, Sep. 2013
5. 11-13/72r1, “[Client Positioning using Timing Measurements between Access Points](https://mentor.ieee.org/802.11/dcn/13/11-13-0072-01-000m-client-positioning-using-timing-measurements-between-access-points.pptx)”, by Erik Lindskog (CSR Technology) et al.
6. 11-14/1235r0, “[Scalable Location](https://mentor.ieee.org/802.11/dcn/14/11-14-1235-00-0wng-scalable-location.pptx)”, by Brian Hart (Cisco Systems) et al.
7. 11-12/1249r4, “[CIDs 46,47,48 Regarding Fine Timing Measurement](https://mentor.ieee.org/802.11/dcn/12/11-12-1249-04-000m-802-11-2012-cid-46-47-48.doc)”, by Carlos Aldana (Qualcomm) et al.
8. 11-14/1464r2, “[Next Generation Positioning Overview and Challenges](https://mentor.ieee.org/802.11/dcn/14/11-14-1464-02-0wng-ng-positioning-overview-and-chalanges.pptx)”, by Jonathan Segev (Intel) et al.
9. 11-14/1263r2, “[Direct Finding Positioning for 802.11](https://mentor.ieee.org/802.11/dcn/14/11-14-1263-00-0wng-direct-finding-positioning-for-802-11.ppt)”, by James Wang (MediaTek) et al.
10. 11-11/1033r0, “[Advantages of Location in Challenging Environments](https://mentor.ieee.org/802.11/dcn/11/11-11-1033-00-00ah-location.ppt)”, by Russ Markovsky (Invisitrack) et al.
11. “Next Generation Indoor Positioning System Based on WiFi Time of Flight”, by Leor Banin, Uri Schatzberg, and Yuval Amizur, 26th International Technical Meeting of the Satellite Division of The Institute of Navigation, Nashville TN, September 16-20 2013
12. 11-15/110r1, “[NGP for 60GHz](https://mentor.ieee.org/802.11/dcn/15/11-15-0110-01-0ngp-ngp-for-60ghz.pptx)”, by Amichai Sanderovich (Qualcomm) et al.
13. 11-17/120r2, “Secured Location Threat Model”, by Benny Abramovsky (Intel) et al.
14. 11-17/1122r0, “CP-replay Threat Model for 11az”, by Mingguang Xu (Apple) et al.