Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**IEEE 802.16 Comments on P1900.7 PAR and 5C**
Date Submitted	**2011-03-16**
Source(s)	Phillip Barber Huawei Technologies Co., LTD. E-mail: pbarber@huawei.com
Re:	IEEE 802.16 Comments on P1900.7 PAR and 5C
Abstract	Comments and proposed modifications on the P1900.7 PAR and 5C
Purpose	To provide input on the proposed P1900.7 PAR and 5C
Notice	*This document does not represent the agreed views of the IEEE 802.16 Working Group or any of its subgroups*. It represents only the views of the participants listed in the "Source(s)" field above. It is offered as a basis for discussion. It is not binding on the contributor(s), who reserve(s) the right to add, amend or withdraw material contained herein.
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Explanation of How the Project
"Medium Access Control (MAC) Sublayer and Physical (PHY) Layer Specification for Fixed and Mobile Operation of White Space Dynamic Spectrum Access Radio Systems"
Meets the Five IEEE SCC41 Criteria for New Standards Projects

1. Broad market application

Each IEEE ComSoc DYSPAN-SC standard shall address a well defined problem or need, be commercially relevant, have applicability to multiple market segments if possible, and cater to an open market where many vendors can play and many users can benefit.

The proposed standard will enable various applications of white space dynamic spectrum access radio systems supporting fixed and mobile operation in frequency bands, such as TV bands and radiolocation service bands, subject to compliance to national and international radio regulations in these frequency bands. Examples of the potential applications are wide area connectivity, transportation logistics, land mobile connectivity, high speed vehicular broadband access, and maritime connectivity. The proposed standard will ensure interoperability between white space radios produced by different manufacturers.

2. Consistency

Each standard in the IEEE 1900 series of standards shall make a contribution to the P1900 family of standards and be developed to be consistent with other standards in the series.

The proposed standard is the first standard in the IEEE 1900 series of standards that will specify radio interface including medium access control (MAC) sublayer and physical (PHY) layer. The proposed standard will provide a means to support P1900.4a for white space management, P1900.5 for policy languages, and P1900.6 to obtain and exchange sensing related information (spectrum sensing and geolocation information).

3. Distinct Identity

Each IEEE ComSoc DYSPAN-SC standard shall have a distinct identity and does not substantially overlap and/or duplicate the work in other existing industry standards.

Currently, there are three standards/projects with a similar scope: ECMA-392 standard, IEEE P802.22 draft standard, and IEEE P802.11af draft standard. Also, IEEE standard 802.16h is related standard.

Compared to all these standards/projects, the proposed standard will provide a means to support collaboration with the IEEE 1900 series of standards, such as P1900.4a, P1900.5, and P1900.6.

The following table summarizes some of the PHY layer features of ECMA-392 standard, IEEE P802.22 draft standard, IEEE P802.11af draft standard, and IEEE 802.16h standard. Also it shows expected PHY layer features of the new standard.

PHY layer feature	ECMA-392	IEEE P802.22	IEEE P802.11af	IEEE 802.16h	New standard (expected)
Multichannel support	No	No	Yes (only ~~continuous~~ adjacent channels)	Yes (only ~~continuous~~ adjacent channels)	~~Yes (also discontinuous channels)~~TBD
Mobility support	Yes	No	No	Yes	Yes (up to 300 km/h)
Maximum throughput	31.56 Mbps	22.69 Mbps	---	~~134.4~~ Mbps	Up to several tens of Mbps
Typical range	---	17-33 km	---	10 km	Up to several tens of km
Channelization	6,7,8 MHz	6,7,8 MHz	5,10,20,40 MHz	~~1.5~~ to 28 MHz	TBD
Modulation	OFDM	OFDM	OFDM	~~SC,~~ OFDM	TBD

The following table summarizes some of the MAC sublayer features of ECMA-392 standard, IEEE P802.22 draft standard, IEEE P802.11af draft standard, and IEEE 802.16h standard. Also it shows expected MAC sublayer features of the new standard.

MAC sublayer feature	ECMA-392	IEEE P802.22	IEEE P802.11af	IEEE 802.16h	New standard (expected)
Multichannel support	No	No	No	No	Yes (also ~~discontinuous~~ non-adjacent channels)
Cellular topology support	No	~~No~~Yes	No	Yes	Yes
Mobility and handover support	No	No	No	Yes	Yes
Mesh topology support	Yes	No	Yes	No	Yes
Range for best MAC efficiency	---	17-33 km	Short and mid range	~~Several km~~	Up to several tens of km
Power efficiency	Yes	No	~~No~~Yes	Yes	Yes
Self-coexistence	Yes	Yes	Yes	Yes	Yes
Multiple access method	CSMA/CS, TDMA	OFDMA	CSMA/CS, TDMA	TDMA, OFDMA	TBD

The following table summarizes the cognitive features required for white space communication of ECMA-392 standard, IEEE P802.22 draft standard, IEEE P802.11af draft standard, and IEEE 802.16h standard. Also it shows expected cognitive features of the new standard.

Cognitive feature	ECMA-392	IEEE P802.22	IEEE P802.11af	IEEE 802.16h	New standard (expected)
Interface with	Yes	Yes	No	No	Yes

spectrum sensors					
Interface with geolocation device	No	Yes	~~No~~Yes	No	Yes
~~Quite~~ Quiet periods for spectrum sensing	Yes	Yes	No	No	Yes
Inter-system coexistence	No	No	No	No	Yes
Interface with TVWS database	Yes	Yes	Yes	No	Yes

It is beneficial to develop a new white space radio system standard because, compared to ECMA-392 standard, IEEE P802.22 draft standard, and IEEE P802.11af draft standard, it will have the following new features:

- Full mobility support including handover etc
- Support of cellular and mesh topologies
- ~~Power efficiency for mobile and low power users~~
- Multichannel support including support of non-adjacent channels
- Support of inter-system coexistence.

The new standard will enable efficient implementation of the following usage models as compared to ECMA-392 standard, IEEE P802.22 draft standard, and IEEE P802.11af draft standard:

- Wide Area Connectivity usage model due to simultaneous support of long range and high data rate by combining multiple channels (including non-adjacent channels)
- Transportation Logistics, Land Mobile Connectivity, and High Speed Vehicle Broadband Access usage models due to full mobility support ~~and support of cellular topology~~
- Maritime Connectivity usage model due to full mobility support and support of cellular and mesh topologies.

These usage models drive PHY and MAC layer requirements and parameters that ~~can not~~cannot be met by simple extensions or modifications of ECMA-392, IEEE P802.22 or IEEE P802af. Therefore, a new standards development effort is required.

IEEE 802.16h standard is designed for license-exempt operation and does not have cognitive features for dynamic spectrum access in white space frequency bands, such as, interface with geolocation device, TVWS database, and spectrum sensors, ~~quite~~ quiet periods for spectrum sensing, and support of inter-system coexistence. Compared to IEEE 802.16h standard, the new standard will have all cognitive features that are required for white space communication.

4. Achievable Scope

To make sure that a standard will be successful, for a IEEE ComSoc DYSPAN-SC project to be authorized, it is required to demonstrate that the problem can be solved technically and that the scope is achievable in a 48 month or less time-frame.

In IEEE ComSoc DYSPAN-SC ad-hoc on White Space Radio, the following topics have been studied in details:

- Usage models
- System requirements
- Missing points in other standards on white space radio
- Collaboration with white space networking / management standards
- Potential frequency bands for white space radio.

The proposed standard will define radio interface including MAC sublayer and PHY layer of white space dynamic spectrum access radio system supporting fixed and mobile operation in frequency bands, such as TV bands and radiolocation service bands, subject to compliance to national and international radio regulations in these frequency bands. The completion of ~~a draft for member ballot~~the project for submission to RevCom within 48 months is realistic.

5. Balanced and committed participation

To uphold the IEEE-SA principle of open, balanced, consensus-based, inclusive participation, a project requesting approval shall be scrutinized for balance in the participants. This means that a diversity of stakeholders should be represented. Also, to ensure successful and timely completion of the standard, the project team shall demonstrate commitment to get the standard completed.

Mailing list of IEEE ComSoc DYSPAN-SC ad-hoc on White Space Radio has around 70 members. During the IEEE ComSoc DYSPAN-SC ad-hoc on White Space Radio operation, the average number of participants has been around 20. Participants represent different interest categories including manufacturers, users, academic/research, and government.

1.1 Project Number: P1900.7

1.2 Type of Document: Standard

1.3 Life Cycle: Full Use

2.1 Title: Medium Access Control (MAC) Sublayer and Physical (PHY) Layer Specification for Fixed and Mobile Operation of White Space Dynamic Spectrum Access Radio Systems

3.1 Working Group: White Space Radio (ComSoc/DYSPAN/1900.7)
Contact Information for Working Group Chair
Name: Stanislav Filin
Email Address: sfilin@nict.go.jp
Phone: 81-90-6485-8930
Contact Information for Working Group Vice-Chair
None

3.2 Sponsoring Society and Committee: IEEE Communications Society/IEEE DYSPAN Standards Committee (ComSoc/DYSPAN)
Contact Information for Sponsor Chair
Name: Hiroshi Harada
Email Address: harada@nict.go.jp
Phone: 81-46-847-5074
Contact Information for Standards Representative
None

4.1 Type of Ballot: Individual

4.2 Expected Date of submission of draft to the IEEE-SA for Initial Sponsor Ballot: 6/2014

4.3 Projected Completion Date for Submittal to RevCom: 3/2015

5.1 Approximate number of people expected to be actively involved in the development of this project: 70

5.2 Scope: This standard specifies a radio interface including medium access control (MAC) sublayer and physical (PHY) layer of white space dynamic spectrum access radio systems supporting fixed and mobile operation in white space frequency bands, while avoiding causing harmful interference to incumbent users of these frequency bands. The standard provides means to support other related IEEE 1900 standards.

5.3 Is the completion of this standard dependent upon the completion of another standard: No

5.4 Purpose: This standard enables the development of cost-effective multi-vendor white space dynamic spectrum access radio systems capable of interoperable operation in white space frequency bands on a non-interfering basis to incumbent users in these frequency bands. This standard facilitates a variety of applications, including the ones capable to support high mobility, both low-power and high-power, short-, medium, and long-range, and a variety of network topologies. This standard is a baseline standard for a family of other standards that could be developed focusing on particular applications, regulatory domains, etc.

5.5 Need for the Project: White space dynamic spectrum access radio systems supporting fixed and mobile operation are expected to have broad international market potential. This standard will enable various applications of such radio systems by defining radio interface for white space frequency bands.

5.6 Stakeholders for the Standard: Stakeholders include wireless devices end users, regulators, operators, corporate users, and manufacturers.

Intellectual Property
6.1.a. Is the Sponsor aware of any copyright permissions needed for this project?: No
6.1.b. Is the Sponsor aware of possible registration activity related to this project?: No

7.1 Are there other standards or projects with a similar scope?: Yes
If Yes please explain:
More information is provided in Section 8.1.

ECMA-392 standard specifies local area network (LAN) based MAC and PHY for operation in TV white space.
and answer the following
Sponsor Organization: ECMA International
Project/Standard Number: ECMA-392
Project/Standard Date: December 2009
Project/Standard Title: MAC and PHY for Operation in TV White Space

IEEE P802.22 draft standard specifies MAC and PHY for point-to-multipoint wireless regional area networks comprised of a professional fixed base station with fixed and portable user terminals operating in TV white space.
and answer the following
Sponsor Organization: IEEE
Project/Standard Number: P802.22
Project/Standard Date: September 2004
Project/Standard Title: Standard for Information Technology -Telecommunications and information exchange between systems - Wireless Regional Area Networks (WRAN) - Specific requirements - Part 22: Cognitive Wireless RAN Medium Access Control

(MAC) and Physical Layer (PHY) specifications: Policies and procedures for operation in the TV Bands

IEEE P802.11af draft standard defines modifications to 802.11 MAC and PHY to meet the legal requirements for channel access and coexistence in the TV White Space.
and answer the following
Sponsor Organization: IEEE
Project/Standard Number: P802.11af
Project/Standard Date: December 2009
Project/Standard Title: 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: TV White Spaces Operation

IEEE standard 802.16h specifies improved mechanisms, as policies and medium access control enhancements, to enable coexistence among license-exempt systems based on IEEE Standard 802.16 and to facilitate the coexistence of such systems with primary users.
and answer the following
Sponsor Organization: IEEE
Project/Standard Number: 802.16h
Project/Standard Date: July 2010
Project/Standard Title: Standard for Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Part 16: Air Interface for Broadband Wireless Access Systems; Amendment 2: Improved Coexistence Mechanisms for License-Exempt Operation

7.2 International Activities
a. Adoption
Is there potential for this standard (in part or in whole) to be adopted by another national, regional or international organization?: Do Not Know
b. Joint Development
Is it the intent to develop this document jointly with another organization?: No
c. Harmonization
Are you aware of another organization that may be interested in portions of this document in their standardization development efforts?: Do Not Know

8.1 Additional Explanatory Notes (Item Number and Explanation)

The information provided below elaborates on the terms "White Space Dynamic Spectrum Access Radio System," “white space frequency bands,” and “white space”

The term Dynamic Spectrum Access is defined in IEEE standard 1900.1 as follows:

“**Dynamic spectrum access**: The real-time adjustment of spectrum utilization in response to changing circumstances and objectives.

NOTE--Changing circumstances and objectives include (and are not limited to) energy-conservation, changes of the radio's state (operational mode, battery life, location, etc.), interference-avoidance (either suffered or inflicted), changes in environmental/external constraints (spectrum, propagation, operational policies, etc.), spectrum-usage efficiency targets, quality of service (QoS), graceful degradation guidelines, and maximization of radio lifetime."

According to definition many types of radio systems are included into Dynamic Spectrum Access.

The scope of this standard is limited to a particular type of dynamic spectrum access radio system namely white space radio system.

The term "white space radio system" refers to a radio system that operates on a secondary basis in white space frequency bands. The term "white space frequency bands" refers to frequency bands in which radio regulations allow radio systems to operate in temporally unused parts of these frequency bands. Examples of white space frequency bands are TV bands and radiolocation service bands. The term "white space" refers to the temporally unused parts of the frequency bands.

The information provided below elaborates on the information provided in Section 7.1

~~With regard to ECMA-392, IEEE P802.22, IEEE P802.11af, and IEEE 802.16, physical layer features, MAC sublayer features, and cognitive features that are important for dynamic spectrum access in white space frequency bands have been analyzed. Below are the results of these analyses.~~

The proposed standard will support the other IEEE 1900 standards, such as P1900.4a for white space management, P1900.5 for policy languages, and P1900.6 to obtain and exchange sensing related information (spectrum sensing and geolocation information). Also, the proposed standard may support other standards, for example, P802.19.1 for white space coexistence.

With regard to ECMA-392, IEEE P802.22, IEEE P802.11af, and IEEE 802.16, physical layer features, MAC sublayer features, and cognitive features that are important for dynamic spectrum access in white space frequency bands have been analyzed. Below are the results of these analyses.

It is beneficial to develop a new white space radio system standard because, compared to ECMA-392 standard, IEEE P802.22 draft standard, and IEEE P802.11af draft standard, it will have the following new features:

- Full mobility support including handover etc
- Support of cellular and mesh topologies
- ~~Power efficiency for mobile and low power users~~
- Multichannel support including support of non-adjacent channels
- Support of inter-system coexistence.

The new standard will enable efficient implementation of the following usage models as compared to ECMA-392 standard, IEEE P802.22 draft standard, and IEEE P802.11af draft standard and would enable other relevant usage models:

- Wide Area Connectivity usage model due to simultaneous support of long range and high data rate by combining multiple channels (including non-adjacent channels)
- Transportation Logistics, Land Mobile Connectivity, and High Speed Vehicle Broadband Access usage models due to full mobility support ~~and support of cellular topology~~
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