**Criteria for Standards Development - P802.22, Revision to IEEE Std. 802.22-2011**

# 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, 1.1, and the 5C requirements, 1.2.

## Project process requirements

### 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.
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.

*Ans: a)* The definitions will be part of this project.

### 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/no)
2. If not, explain why the CA document is not applicable.

*No, the CA document will not be provided. It is not applicable in this case. SOS is a passive sensing only system.*

**1.2 - 5C Requirements**

**1.2.1. Broad Market Potential**

**a) Broad sets of applicability**

Recenty, FCC, NTIA and other regulators have broadened their horizons for cooperative spectrum sharing approaches in order to optimize spectrum utilization. For example see the PCAST Report [1] - Realizing Full Potential of Government Held Spectrum. FCC/ NTIA are in the process of opening new spectrum bands which specifically require multi-levels of regulated users to share the spectrum utilizing cognitive radio behavior. For our purposes, we define spectrum sharing as a mechanism which ensures that primary services are protected from interference while allowing other opportunistic devices to share the spectrum.

This emphasis on greater spectrum efficiencies, spectrum sharing and spectrum utilization requires not only database driven configuration of the radios, but systems that can provide spectrum occupancy at a particular location and at a particular time.

Since 2005, the 802.22 Working Group has been developing cognitive radio technologies which include spectrum sensing, cognitive radio messaging and control as well as spectrum management. The Spectrum Occupancy Sensing (SOS) Project plans to extract and re-structure these functions, in order to create a stand-alone system.

SOS has many applications which include:

1. On-demand spectrum survey and report
2. Spectrum measurement collaboration
3. Spectrum planning
4. Spectrum mapping
5. Deployment coverage analysis
6. Terrain and topology - shadowing and fading analysis
7. Quantification of the available spectrum through spectrum observatories
8. Complement the database access for spectrum sharing by adding in-situ awareness and faster decision making.
9. Space-Time-Frequency spectrum hole identification and prediction where non-time-sensitive tasks can be performed at certain times and at certain locations, when the spectrum use is sparse or non-existent
10. Identification and geolocation of interference sources.

The SOS systems may be deployed to characterize many bands such as VHF/ UHF, L, S, C and X bands.

**b) Multiple vendors and numerous users**

The applications listed in Setion a) are useful for a diverse community of users which include but not limited to spectrum access database providers, new equipment vendors, manufacturers and users of semiconductor, enterprise networking devices, consumer electronic devices, mobile devices, wireless internet service providers etc.

**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.

Ans: The revision will be compatible with IEEE 802 family of standards, specifically 802 overview and architecture, 802.1 including 802.1AC and 802.1Q.

**1.2.3. Distinct Identity**

**a) Substantially different from other IEEE 802 standards**

The proposed SOS effort will produce a new IEEE Std. 802.22.3. This effort will benefit many other projects within the 802 community which are engaged in creating standards for spectrum sharing.

Since 2005, the 802.22 Working Group has been developing cognitive radio technologies which include spectrum sensing, cognitive radio messaging and control as well as spectrum management. The Spectrum Occupancy Sensing (SOS) Project plans to bring out these functions, in order to create a stand-alone system.

There are no completed or on-going similar activities similar to the proposed SOS project within the IEEE 802 community. However, there are a few other similar standards in this space which are listed below.

1. IEEE Std. 1900.6-2011: IEEE Standard for Spectrum Sensing, Interfaces and Data Structures for Dynamic Spectrum Access and other Advanced Radio Communications Systems
2. IEEE P1900.6a: IEEE Draft Standard for Spectrum Sensing Interfaces and Data Structures for Dynamic Spectrum Access and other Advanced Radio Communication Systems Amendment: Procedures, Protocols and Data Archive Enhanced Interfaces

Below is the summary of how the proposed Standard is likely to be different from these on-going or completed projects:

1. The Spectrum Occupancy Sensing (SOS) Project plans to bring out functions and messaging already contained in the IEEE Std. 802.22-2011 and create a stand-alone system. In that sense, this effort is unique.
2. This standard will leverage work done in other standards such as IEEE Std. 1900.6-2011 as well as emerging P1900.6a Standard.
3. This standard will specify interfaces and primitives to connect to various database services for TV Bands and other spectrum sharing bands utilizing protocols such as the IETF Protocol to Access White Spaces (IETF PAWS).
4. This standard will specify the attributes of the Spectrum Occupancy Sensing (SOS) entity and provide informative annex on fusion algorithms to be able to coalesce sensing information from a wide variety of disparate sensors with varying degrees of capabilities.

**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**

Spectrum sensing, has been a focus of research and investigation since many years. Over the last few years more than \_\_\_\_\_\_\_\_\_\_\_\_ research papers have been written on spectrum sensing. Companies such as NICT, ETRI, BAE Systems, Shared Spectrum Company, Microsoft etc. have built spectrum sensing hardware implementations, prototypes as well as products.

The IEEE 802.22 Working Group devoted significant time and effort in formulating spectrum sensing techniques. More than ten companies contributed to this effort. Based on extensive real time waveform samples of signals, various spectrum sensing algorithms were formulated and tested through extensive modelling and simulations.

Regulators around the world have realized that spectrum sensing can be very useful, and it can provide value-added information to the database service.

**b) Proven similar technology via testing, modeling, simulation**

The IEEE 802.22 Working Group devoted significant time and effort in formulating spectrum sensing techniques. More than ten companies contributed to this effort. Based on real time waveform samples of signals, various spectrum sensing algorithms were formulated and tested through extensive modelling and simulations.

Companies such as Microsoft, have established spectrum observatories that are continuously monitoring the spectrum at certain locations and reporting the findings onto their website [2]. Such spectrum observatories have also been established in Universities such as Illinois Institute of Technology (IIT) where the effort has been funded by Government institutions like the National Science Foundation (NSF) in the United States. Some other companies such as Shared Spectrum have demonstrated their spectrum sensing systems and deployed it for many applications that require spectrum management.

Hence SOS is clearly feasible technically.

**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**

The proposed SOS system has many applications that can directly enhance the performance of the commuications systems, especially the ones involved in spectrum sharing. The SOS system can be adopted by database service providers for better in-situ awareness, it can be used by the Wireless Internet Service Providers for network deployments, or it can also be used generically by the users who are interested in finding out the overall spectrum utilization at a particular time and place. Such an SOS may also be used by the Governments to monitor cross-border interference as a result of spectrum sharing in the neighboring country.

Hence, given that the proposed SOS system has so many applications the cost is likely to be divided to reach the economies of scale.

**b) Known cost factors**

The spectrum sensing techniques and implementations have evolved substantially in the last few years. Originally, the focus was on creating sensing techniques to detect weak signals in noise. This meant that expensive sensors and electronics had to be used. However, it is not necessary to use expensive sensors that can detect and characterize weak signals in the noise all the time. For example, simple measurements such as Received Signal Strength Indicator (RSSI) on various channels can also tell the system, the channel quality and signal strength at that location.

The SOS plans to use measurements from dedicated sensors as well as non-dedicated sensors and even available radios which can once in a while provide local measurements to the system to estimate the coverage and spectrum occupancy. Such a network of distributed heterogeneous spectrum sensors is very likely to allow the SOS to reach economies of scale.

The sensing information would be periodically sent through whatever transport mechanism that is available, including wire and wireless. The cost factors for these systems are pretty well known.

Hence the proposed SOS system is likely to have known cost factors.

**c) Consideration of installation costs**

Installation costs for the SOS system are likely to be similar to, or even smaller than the installation costs of the radios. This is because, such a service of passive sensors is really a value added service, and does not have to guarantee that the link is always closed. In addition, such a service may also end up utilizing the existing radio network that is already deployed.

**d) Consideration of Operational Costs**

The proposed SOS system has many applications that can directly enhance the performance of the commuications systems, especially the ones involved in spectrum sharing. Also, such a service of passive sensors is really a value added service, and does not have to guarantee that the link is always closed or meet the quality of service requirements for that the radios have. Hence once the spectrum sensors are deployed, the operational cost to service them and maintain them is not that significant.

**e) Other areas, as appropriate.**

None

***References***

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[2] Microsoft Spectrum Observatory - <http://observatory.microsoftspectrum.com/>

[3] C. M. Spooner, A. N. Mody, J. Chuang, M. P. Anthony, “Tunnelized Cyclostationary Processing: A Novel Approach to Low Energy Spectrum Sensing,” IEEE MILCOM 2013.

[3] **Chunyi Song**, Matsumura Takeshi and Hiroshi Harada, “A Prototype of TV White Space Spectrum Sensing and Power Measurement,”***IEICE Trans. on Communications***, VOL.E97-B, NO.2, pp 314-325, Feb. 2014.

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[5] **Chunyi Song** and Hiroshi Harada, “Proposal and Hardware Performance of an Enhanced Feature Detection Method for OFDM Signals of Digital TV Standards,”***IEICE Trans. On Communications****,* VOL.E96-B, NO.3, pp.875-884, March 2013.

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[11] FCC 3.5 GHz Workshop - <http://www.fcc.gov/events/35-ghz-workshop>