Global Symposium for Regulators

Capitalizing on the potential of the digital world
2014 – Manama, Bahrain

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*These are authors’ s personal view-points and do not represent the viewpoints of any other organization
Spectrum Sharing, A Digital Opportunity

- **Developed Countries**: More than 500 MHz of spectrum will be required before 2020 to support emerging wireless broadband services and applications.

- **Developing Countries**: Cost effective broadband access is still a challenge in rural areas and developing countries.

- **Spectrum sharing** can create tomorrow’s spectrum super-highways. It supports licensed, license-exempt and hierarchical access business models.

- **Technologies and Standards** supporting Cognitive Radios, and Database enabled spectrum access exists.

- **Regulations** to support spectrum sharing need to be developed.
# IEEE and IETF Spectrum Sharing Standardization Activities

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<td><strong>IEEE 802.11af (Wireless Local Area Networks)</strong></td>
<td>Rich Kennedy (IEEE 802.11af WG)</td>
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<tr>
<td><strong>IEEE 802.22 (Wireless Regional Area Networks and Enabling Technologies)</strong></td>
<td>Apurva N. Mody (IEEE 802.22 WG)</td>
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<td><strong>WSA WiFar™ International Standard</strong></td>
<td>Mody, Reede, Pyo, Flynn, et.al.</td>
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IEEE 802.11AF Wireless Local Area Networks

• Based on the IEEE 802.11ac physical layer,
  – supports multiple concurrent downlink transmissions
  – utilizing MU MIMO (multi-user multiple-input, multiple-output)
• More efficient spectrum use with smart antenna technology, enables
  – Higher system capacity (up to 11Mbps/ch?)
  – Reduced latency with simultaneous user transmissions
• Supports operation in unused TV channels (VHF and UHF)
  – Wide area Access Points (AP) (up to 1km?)
• Multiple operating modes in 6, 7 and 8 MHz channels
  – Support for multiple and non-contiguous channels

Contributor: Rich Kennedy, Chairman, IEEE 802.11AF Task Group. r.kennedy1000@gmail.com, www.ieee802.org/11
IEEE 802.22 (Wi-FAR™) Operation and Applications

Cognitive Radio Operation

Channel Set Management
Geo-location
Incumbent Database Service

Subscriber Station Registration and Tracking

Policies
Self Co-existence
Spectrum Sensing

IEEE 802.22 can support many other applications such as smart grid, wireless access to oil rigs as well as remote medical services.

Conclusions

• Spectrum sharing can benefit developed and developing countries

• White Space solutions will provide ubiquitous wireless connectivity

• Supports licensed, license-exempt and hierarchical access models

• Technologies and Standards exist today

• TV band Devices are available today

• Regulators need to establish a balance between Exclusive Licensed bands and Shared Unlicensed bands in order to achieve the maximum economic benefit from both.

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Additional Reference Material
### IEEE and IETF Spectrum Sharing Standardization Activities

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<td>Clint Powell (IEEE 802.15 WG)</td>
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<td>John Malyar, Gabor Bajko (IETF PAWS)</td>
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<td>P1900 Standardization Activity (Dynamic Spectrum Access Networks)</td>
<td>Hiroshi Harada, Matthew Sherman (IEEE DySPAN - SC)</td>
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IEEE 802.15.4m – Wireless Personal Area Networks

- **Project Title**
  IEEE Standard for Local and Metropolitan Area Networks Part 15.4: Low Rate Wireless Personal Area Networks (LR-WPANs) Amendment 6: TV White Space Between 54 MHz and 862 MHz Physical Layer

- **Intro of Draft**
  This amendment specifies alternate PHYs in addition to those of IEEE Std 802.15.4-2011. In addition to the new PHYs, the amendment also defines those MAC modifications needed to support their implementation.

  The alternate PHYs support principally outdoor, low-data-rate, wireless, TV White Space network (TVWS) applications under multiple regulatory domains. The TVWS PHYs are as follows:
  - Frequency shift keying (TVWS-FSK) PHY
  - Orthogonal frequency division multiplexing (TVWS-OFDM) PHY
  - Narrow Band Orthogonal frequency division multiplexing (TVWS-NB-OFDM) PHY

  The TVWS PHYs support multiple data rates in bands ranging from 54 MHz to 862 MHz

Contributor: Clint Powell, IEEE 802.15.4m Task Group.  
cpowell@ieee.org, www.ieee802.org/15
Depiction of Smart Utility Usage Model Utilizing TVWS*

IEEE 802.19.1 - Coexistence

- **Project Title**
  Draft Standard for TV White Space Coexistence Methods

- **Project Scope**
  The standard specifies radio technology independent methods for coexistence among dissimilar TV Band Devices (TVBDs) and dissimilar or independently operated networks of TVBDs.

- **Project status**
  November 2013: WG letter ballot finished with 91% approval rate
  December 2013: Sponsor Ballot started

Contributed by – Stanislav Filin and Steven Shellhammer:
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System Architecture
CDIS – Coexistence Discovery and Information Server
CM – Coexistence Manager
CE – Coexistence Enabler
IEEE Dynamic Spectrum Access Networks – Standards Committee (DySPAN-SC) Organization

• IEEE Dynamic Spectrum Access Networks (DySPAN) Standards Committee (DySPAN-SC)
  – Originated as IEEE P1900 -> IEEE SCC 41 -> DySPAN-SC
  – [http://grouper.ieee.org/groups/dyspan/](http://grouper.ieee.org/groups/dyspan/)
  – Home to the IEEE 1900 working groups
  – “Owns” the P1900 series of standards…

• Scope (from [http://grouper.ieee.org/groups/dyspan/](http://grouper.ieee.org/groups/dyspan/))
  – dynamic spectrum access radio systems and networks with the focus on improved use of spectrum
  – new techniques and methods of dynamic spectrum access including the management of radio transmission interference, and
  – coordination of wireless technologies including network management and information sharing amongst networks deploying different wireless technologies

Contributors: Hiroshi Harada, Chair, IEEE P1900 Working Group, harada@ieee.org, Matthew Sherman, Chair, IEEE P1900.5 Task Group, shermanmjs@ieee.org
IEEE Dynamic Spectrum Access Networks – Standards Committee (DySPAN-SC) Organization


IEEE 1900.2: Recommended Practice for Interference and Coexistence Analysis

IEEE 1900.4: Standard for Architectural building blocks enabling network-device distributed decision making for optimized radio resource usage in heterogeneous wireless access networks


IEEE 1900.6: Standard on interfaces and data structures for exchanging spectrum sensing information for dynamic spectrum access systems

IEEE 1900.7: Standard on radio interface for white space dynamic spectrum access radio systems supporting fixed and mobile operation


WhiteSpace Alliance

Hiroshi Harada, Chair, IEEE P1900 Working Group, harada@ieee.org
IETF PAWS

• IETF is defining a Protocol to Access Spectrum Database in PAWS (Protocol to Access White Space) WG
  – http://tools.ietf.org/wg/paws/

• Use Cases and Requirements: RFC6593

• Latest Version of the Draft Protocol

Contributors: John Malyar, IETF PAWS, jmalyar@iconectiv.com
Gabor Bajko, Chair, IETF PAWS, gabor.bajko@nokia.com
IETF PAWS Protocol

White Space Database

- INIT_REQ
- INIT_RESP
- REGISTRATION_REQ
- REGISTRATION_RESP
- AVAIL_SPECTRUM_REQ
- AVAIL_SPECTRUM_RESP
- DEVICE_VALID_REQ
- DEVICE_VALID_RESP
- SPECTRUM_USE_NOTIFY
- SPECTRUM_USE_RESP

Master Device

- Establish initial connection with DB (authenticate)
- Establish operational params and report location
- Ask for and receive list of available channels. Device location is again reported in REQ.
- Report list of attached client devices for validation.
- Device reports back the channel that was chosen.