Global Symposium for Regulators

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

Peter Flynn, External Affairs Director, White Space Alliance
Business Development Manager, Texas Instruments
Peter.Flynn@WhiteSpaceAlliance.org
Dr. Apurva N. Mody, Chairman, IEEE 802.22 Working Group
apurva.mody@ieee.org

*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

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IEEE and IETF Spectrum Sharing Standardization Activities

Title	Contributor
• IEEE 802.11af (Wireless Local Area Networks)	Rich Kennedy (IEEE 802.11af WG)
• IEEE 802.22 (Wireless Regional Area Networks and Enabling Technologies)	Apurva N. Mody (IEEE 802.22 WG)
• WSA WiFar™ International Standard	Mody, Reede, Pyo, Flynn, et.al.

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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

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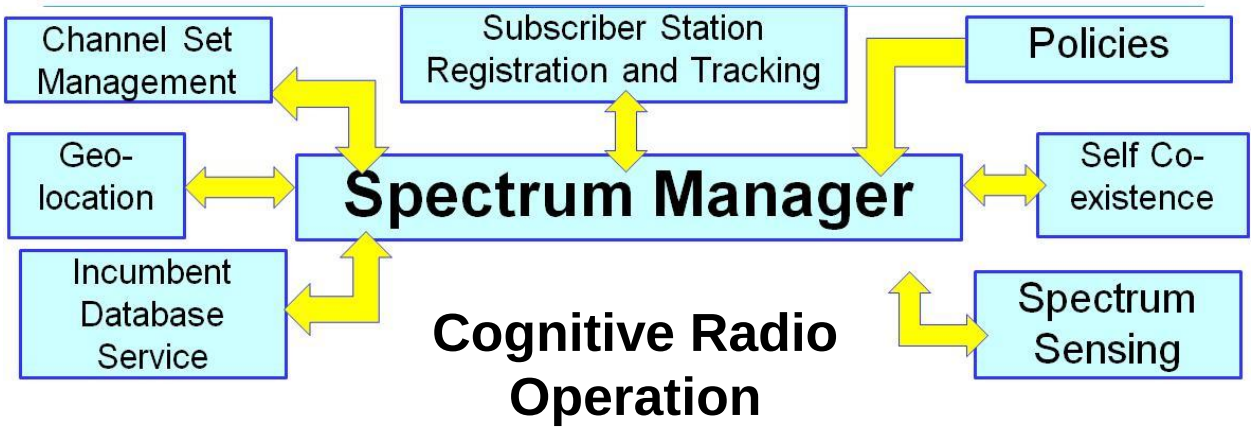
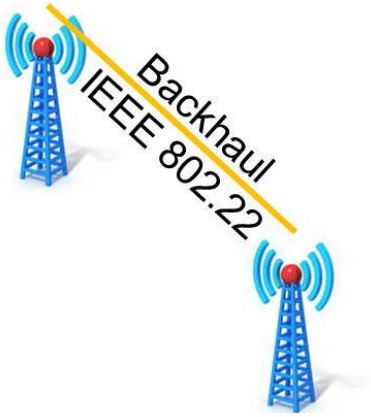
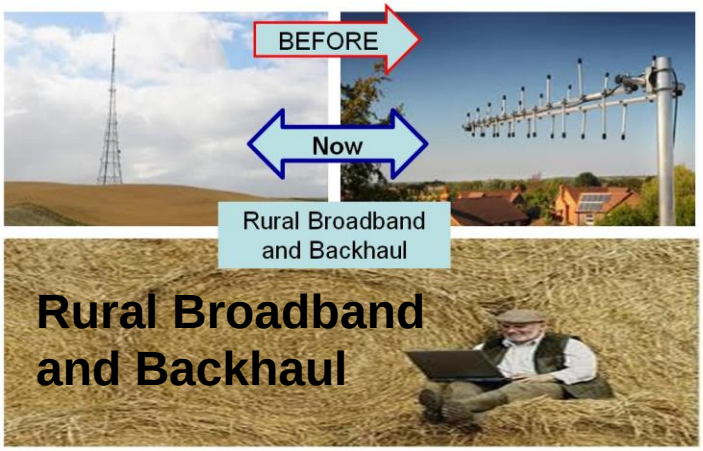
Contributor: Rich Kennedy, Chairman, IEEE 802.11AF Task Group. r.kennedy1000@gmail,com, www.ieee802.org/11

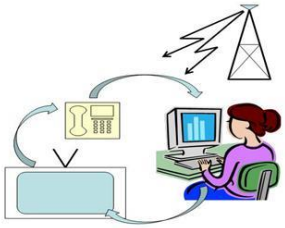
IEEE 802.22 (Wi-FAR™) Operation and Applications





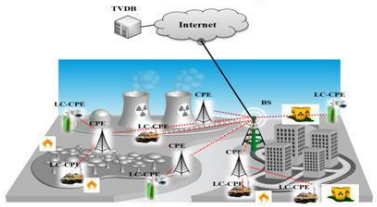


Triple play

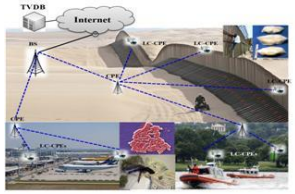


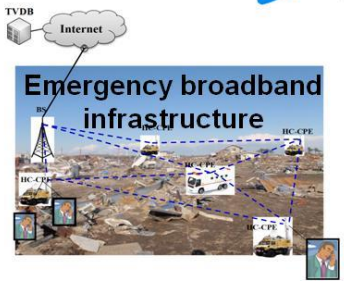
Cellular offload

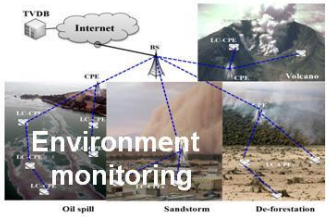
Critical infrastructure monitoring



Border protection







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

Source: WhiteSpace Alliance. www.WhiteSpaceAlliance.org

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

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IEEE and IETF Spectrum Sharing Standardization Activities

Title	Contributor
• IEEE 802.15.4m (Wireless Personal Area Networks)	Clint Powell (IEEE 802.15 WG)
• IEEE 802.19.1 (Coexistence)	Stanislav Filin (IEEE 802.19.1 WG)
• IETF Protocol to Access White Spaces	John Malyar , Gabor Bajko (IETF PAWS)
• P1900 Standardization Activity (Dynamic Spectrum Access Networks)	Hiroshi Harada, Matthew Sherman (IEEE DySPAN - SC)

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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

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Contributor: Clint Powell, IEEE 802.15.4m Task Group.
cpowell@ieee.org, www.ieee802.org/15

P802.15.4m

Depiction of Smart Utility Usage Model Utilizing TVWS*

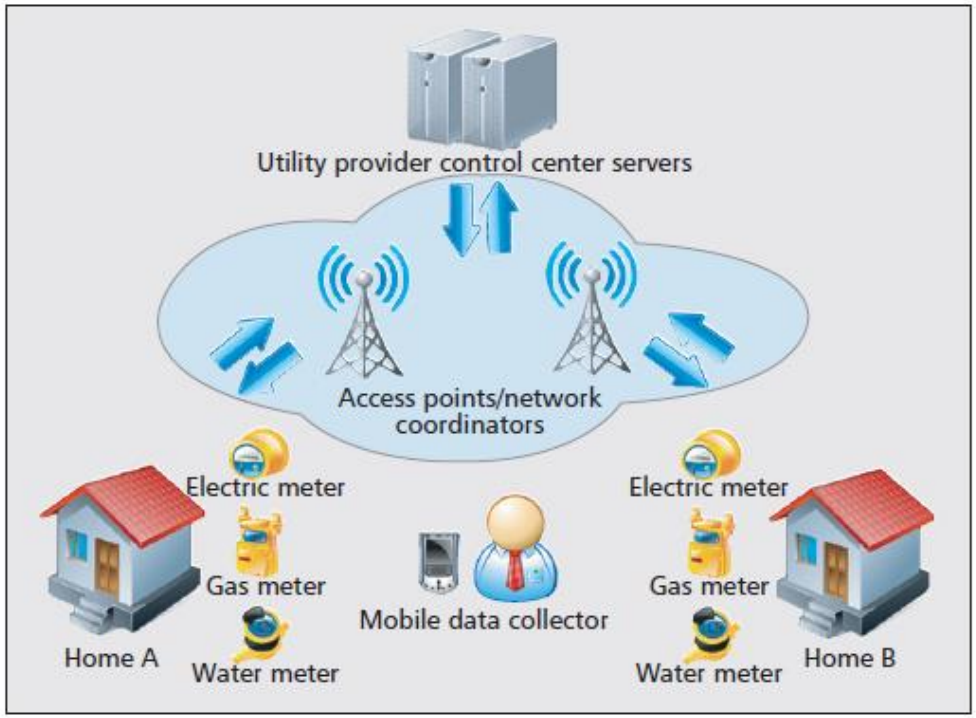

***figure from "Cognitive Communication in TV White Spaces: An Overview of Regulations, Standards, and Technology", IEEE Communications Magazine, July 2013.**

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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**

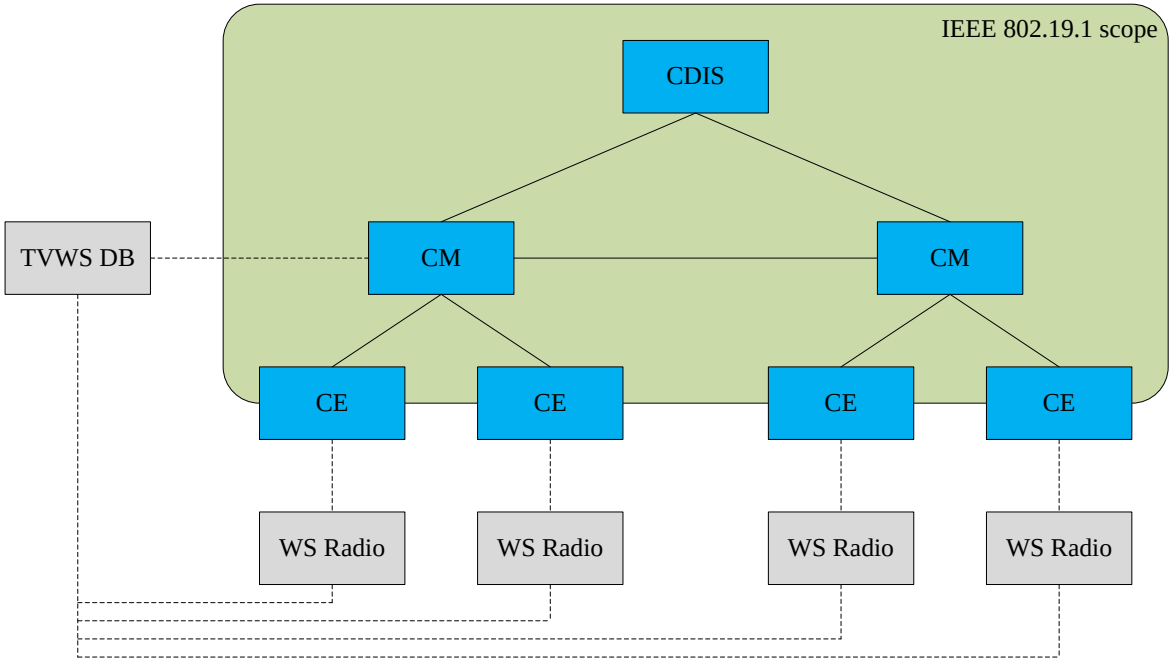
  November 2013: WG letter ballot finished with 91% approval rate
  December 2013: Sponsor Ballot started

Contributed by – Stanislav Filin and Steven Shellhammer:
sfilin@ieee.org, sshellha@qti.qualcomm.com, www.ieee802.org/19

IEEE 802.19.1 - Coexistence

System Architecture

CDIS – Coexistence Discovery and Information Server
CM – Coexistence Manager
CE – Coexistence Enabler



Interface defined in IEEE 802.19.1
Interface not defined in IEEE 802.19.1

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/
  - Home to the IEEE 1900 working groups
  - "Owns" the P1900 series of standards…
- Scope (from 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

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IEEE Dynamic Spectrum Access Networks –Standards Committee (DySPAN-SC) Organization

IEEE 1900.1: Standard Definitions and Concepts for Spectrum Management and Advanced Radio System Technologies

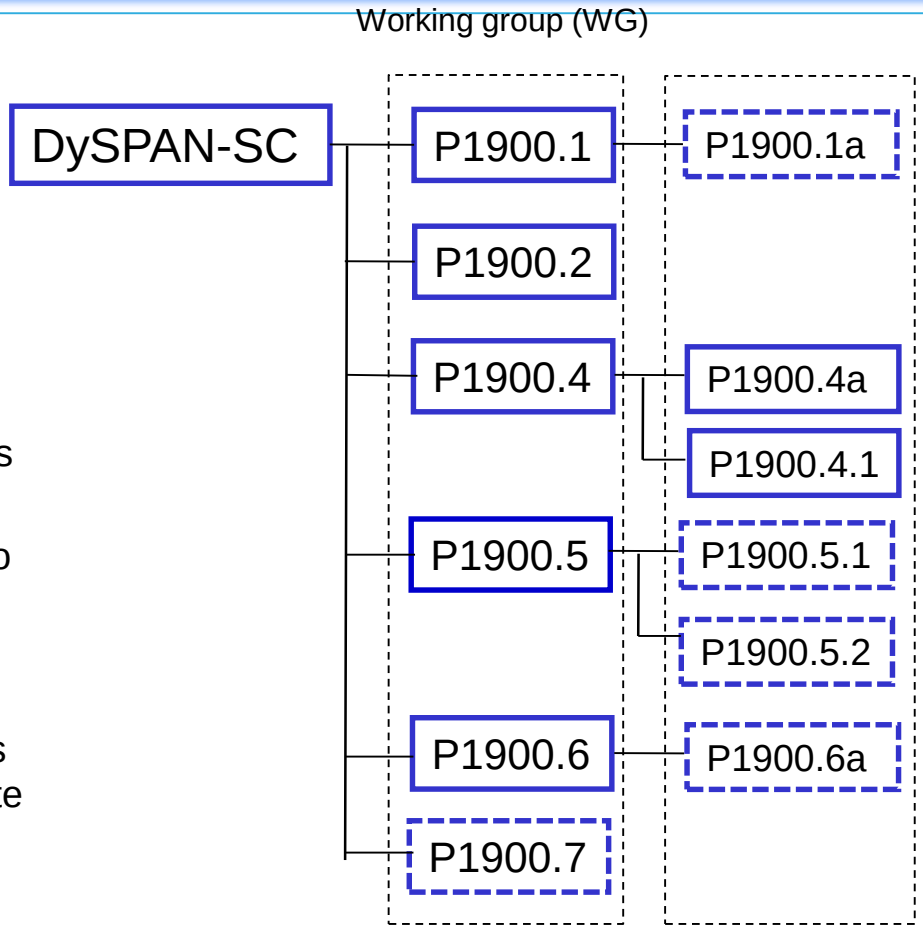
IEEE 1900.2: Recommended Practice for Interference and Coexistence Analysis

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 1900.5: Standard on Policy Language and Policy Architectures for Managing Cognitive Radio for Dynamic Spectrum Access Applications

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



Derived from: Order of Business for 8th General Meeting of IEEE DySPAN. DCN: SC-13-0038-00-MTNG
//mentor.ieee.org/dyspan-sc/dcn/13/sc-13-0038-00-MTNG-august-2013-arlington-meeting-order-of-business.ppt

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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
  - http://www.rfc-editor.org/rfc/pdfrfc/rfc6953.txt.pdf
- Latest Version of the Draft Protocol
  - http://www.ietf.org/id/draft-ietf-paws-protocol-07.txt

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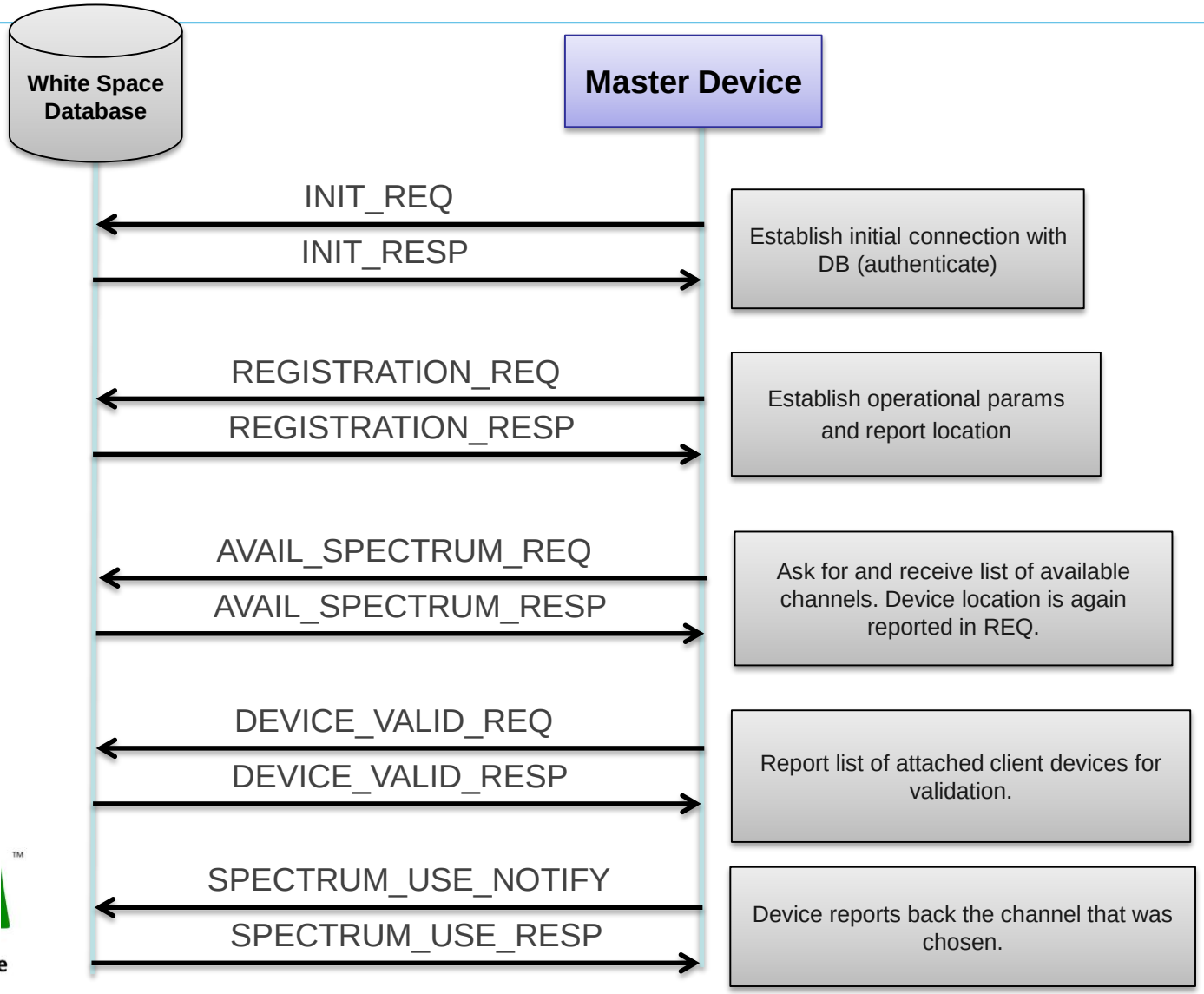
Contributors: John Malyar, IETF PAWS, jmalyar@iconectiv.com
Gabor Bajko, Chair, IETF PAWS, gabor.bajko@nokia.com

IETF PAWS Protocol



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