WLAN in the TV Bands and Other White Spaces

IEEE P802.11af

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Outline

- Origins
- Market timing
- Technology
- Futures
- Definitions
- References

Origins – Regulatory (US)

- **FCC 02-380** Additional Spectrum for Unlicensed Devices below 900 MHz
- **FCC 03-108** Cognitive Radio NPRM
- **FCC 04-186** Unlicensed Operation in the TV Broadcast Bands
- **FCC 08-260** 2nd Report and Order and Memorandum Opinion and Order (FCC Part 15 subpart H)
- **FCC 10-174** 2nd Memorandum Opinion and Order
- **FCC 12-118** Broadcast Television Spectrum Incentive Auction NPRM

Origins – Regulatory (Canada)

- **Licensed**
  - **RSS-196:** Point-to-Multipoint Broadband Equipment Operating in the Bands 512-608 MHz and 614-698 MHz for Rural Remote Broadband Systems (RRBS) (TV Channels 21 to 51)
  - **SRSP-300.512:** Technical Requirements for Remote Rural Broadband Systems (RRBS) Operating in the Bands 512-608 MHz and 614-698 MHz (TV Channels 21 to 51)
- **Unlicensed**
  - Currently working on rules similar to the FCC

Origins – Regulatory (EU)

- **EN 301 598 -** White Space Devices (WSD); Wireless Access Systems operating in the 470 MHz to 790 MHz frequency band; Part <x>: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive (2012 -)
  - Ofcom driving; will use v1 as their Voluntary National Standard (VNS)
  - ECC Report 159 sets technical and operational requirements for using TVWS by cognitive radios in EU
  - CEPT SE43 Cognitive Radio Systems – White Space

Origins - Standards

- **P802.22 -** WRAN: Wireless Regional Area Networks (2004 – 2011)
  - Spun off from 802.18 RR-TAG
- **P802.11y** - Lightly-licensed, “contention-based” operation in the 3650 to 3700 MHz band (2006 – 2009)
  - Peter Ecclesine (Cisco Systems was Chair; I was Secretary)
- **P802.11af -** Unlicensed WLAN operation in the TVWS (2009 -)
  - I started this group and am the Chair; Peter is Vice-chair and Editor)
- **P802.19.1** – Coexistence mechanisms for the TVWS (2009 -)
- **IETF PAWS -** Developing the device to database protocol

TVWS Market Timing (NA &EU)

- **US**
  - Rules are in place (CFR 47 Part 15 subpart H)
  - 2 of 10 databases approved (SpectrumBridge & Telcordia)
  - TGaf will finish early 2014; IETF PAWS 2014
  - Incentive auctions, nationwide TVWS spectrum allocation scheduled for 2014
- **Canada**
  - Rural licensed devices on the market today

TVWS Market Timing (Other)

- **Japan**
  - Trials started; 2014 rollout planned
- **Korea**
  - Trials in progress; 2014 rollout planned
  - Rules expected to be similar to FCC
- **Singapore**
  - Trials almost complete; plan 2013 commercialization
  - Want to provide database for all Asia

Technology (FCC)

- **Geo-location database enabled spectrum sharing**
  - TV broadcasters and licensed microphones have primary allocation
    - FCC currently reconsidering how the microphones are treated
    - Expanded beyond broadcast usage; theaters, churches, etc.
  - Unlicensed microphones are now Part 15 devices
    - Cannot interfere with primary allocation devices
    - Must accept interference
- **FCC requirements for TVBDs**
  - Fixed devices must register in the database
  - Only Master devices (see Part 15.202 for definition) will access the database to get channel allocations, time of operation
  - Master devices must check with the database every 24 hours, or if they move ±50 meters from position of last database access
  - Client devices are enabled by Master devices; must check every 60 seconds for enabling signal; must cease transmissions if they cannot hear a Master device

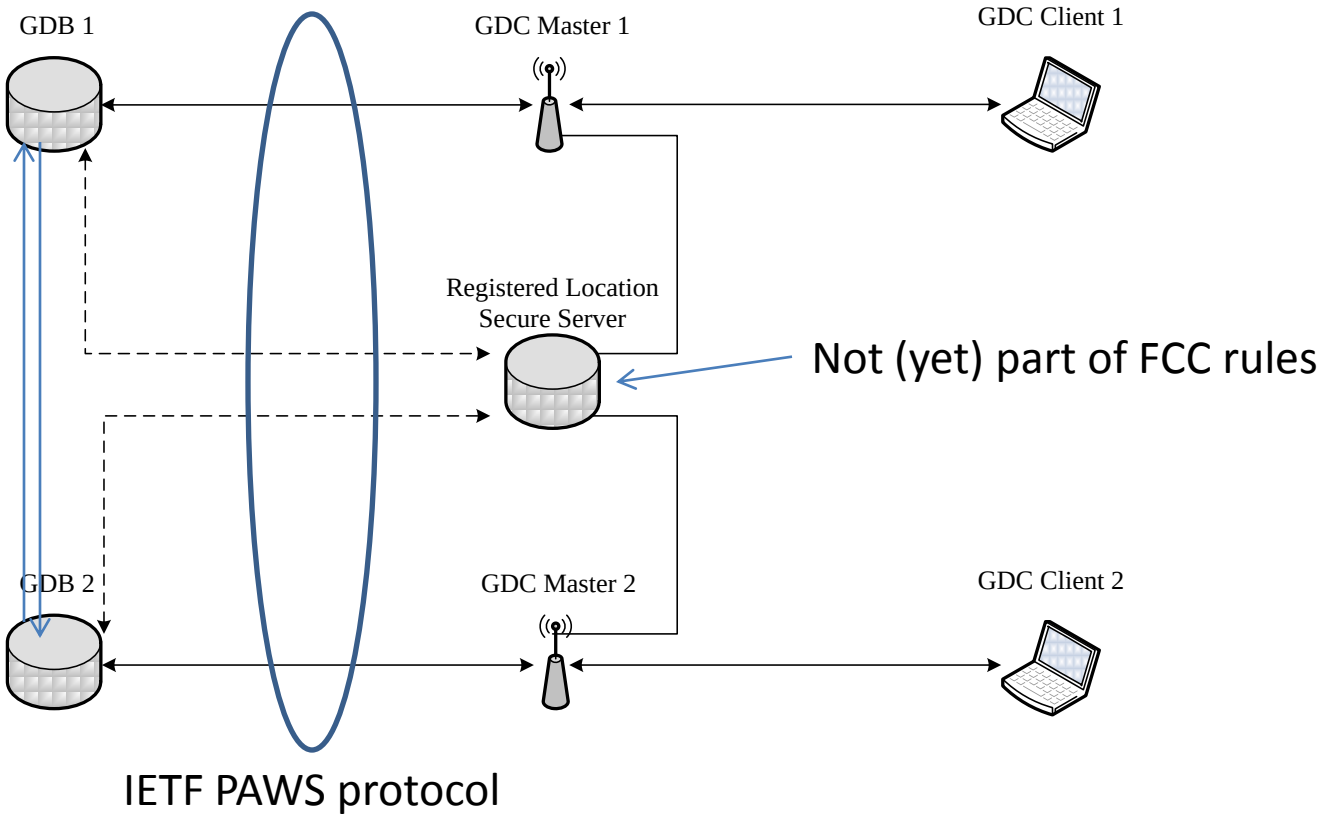
TVDB Transmitter Characteristics

- **High-power fixed devices**
  - 4W EIRP (1 W conducted)
  - Must have unoccupied adjacent channels
- **Personal/portable devices**
  - The maximum conducted output power over the TV channel of operation shall not exceed 100 mW; except that for personal/portable TVBDs that do not meet the adjacent channel separation requirements, the maximum conducted output power shall not exceed 40 mW. If transmitting antennas of directional gain greater than 0 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 0 dBi.
- **HAAT Limits**
  - Maximum permissible HAAT for fixed device antennas is the 76 meter site HAAT limit plus the 30 meter maximum antenna height AGL, or 106 meters (348 feet)

Technology (non-FCC)

- **Ofcom rules (soon to be ETSI rules) differences**
  - Still under development
  - Database must be checked every hour
  - Proxy servers (Registered Location Secure Server) may relay database information to Master devices (see diagram)
  - Database has “Kill Switch” to enable quick channel clearing

TVBDs in a TVWS Network



GDC = Geo-location Database Controlled

GDB = Geo-location Database

IEEE 802.11af Technology

- **Designed for mass-market appeal**
  - Primary drivers are Enterprise and Consumer device and software makers: Cisco, RIM, LG, Qualcomm, Broadcom, CSR and Marvell; Google and Microsoft
- **PHY design helps with limited availability of unused channels in many markets; consumer pricing**
  - Two TX/RX chains enable bonding non-contiguous channels
  - Based on 802.11ac; will require minor changes to include in chipsets shipping multiple billion per year
    - Economies of scale will keep device cost low
- **Extensible for spectrum sharing in other bands**
  - Plan to apply for PAR change after 3550 to 3650 MHz band NPRM

Futures

- **President's Council of Advisors on Science and Technology (PCAST) Report on shared spectrum**
  - Review of federally licensed spectrum for sharing of at least 1000 MHz
- **European Commission - Promoting the shared use of radio spectrum resources in the internal market**
  - Review of licensed spectrum for sharing of at least 1200 MHz
- **NPRM on unlicensed sharing of 3550 to 3650 MHz band**
  - FCC will release before the end of 2012

Definitions

Master Device

- A TVBD operating in master mode.
- **Master mode:** An operating mode in which the TVBD has the capability to transmit without receiving an enabling signal. The TVBD is able to select a channel itself based on a list provided by the database and initiate a network by sending enabling signals to other devices. A network always has at least one device operating in master mode.

Personal/Portable Device

- A TVBD that transmits and/or receives radiocommunication signals while in motion or at unspecified locations that may change.

Mode I Operation

- Operation of a personal/portable TVBD operating only on the available channel identified by either the fixed TVBD or Mode II TVBD that enables its operation. Mode I operation does not require use of a geo-location capability or access to the TV bands database and requires operation in client mode.

Mode II Operation

- Operation of a personal/portable TVBD whereby the device determines the available channels at its location using its own geolocation and TV bands database access capabilities. Devices operating in Mode II may function as master devices.

References

Documents and Websites

- FCC 04-186
  - http://www.techlawjournal.com/topstories/2004/20040513.asp
- FCC 08-260
- P802.11y Explained
- FCC Part 15 Subpart H TVWS rules
- FCC 12-36 [includes HAAT changes]
- FCC 12-118 [Spectrum Auctions, TV band repacking, TVWS]
- FCC documents for TV band device testing
- Showmywhitespace.com
- Channel Calculations for White Spaces Guidelines
- US Metro white space April and September 2011

Documents and Websites [2]

- Industry Canada RSS-196
- Industry Canada SRSP-300.512
- CEPT SE43 Cognitive Radio Systems – White Space
- ECC Report 159 Technical and operational requirements for the possible operation of cognitive radio systems in the “White Spaces” of the frequency band 470-790 MHz
- Draft ECC Report 185 Further definition of technical and operational requirements for the operation of white space devices in the band 470-790 MHz
- Draft ECC Report 186 Technical and operational requirements for the operation of white space devices under geo-location approach