

**IEEE P802.11af:
A Regulatory Primer**

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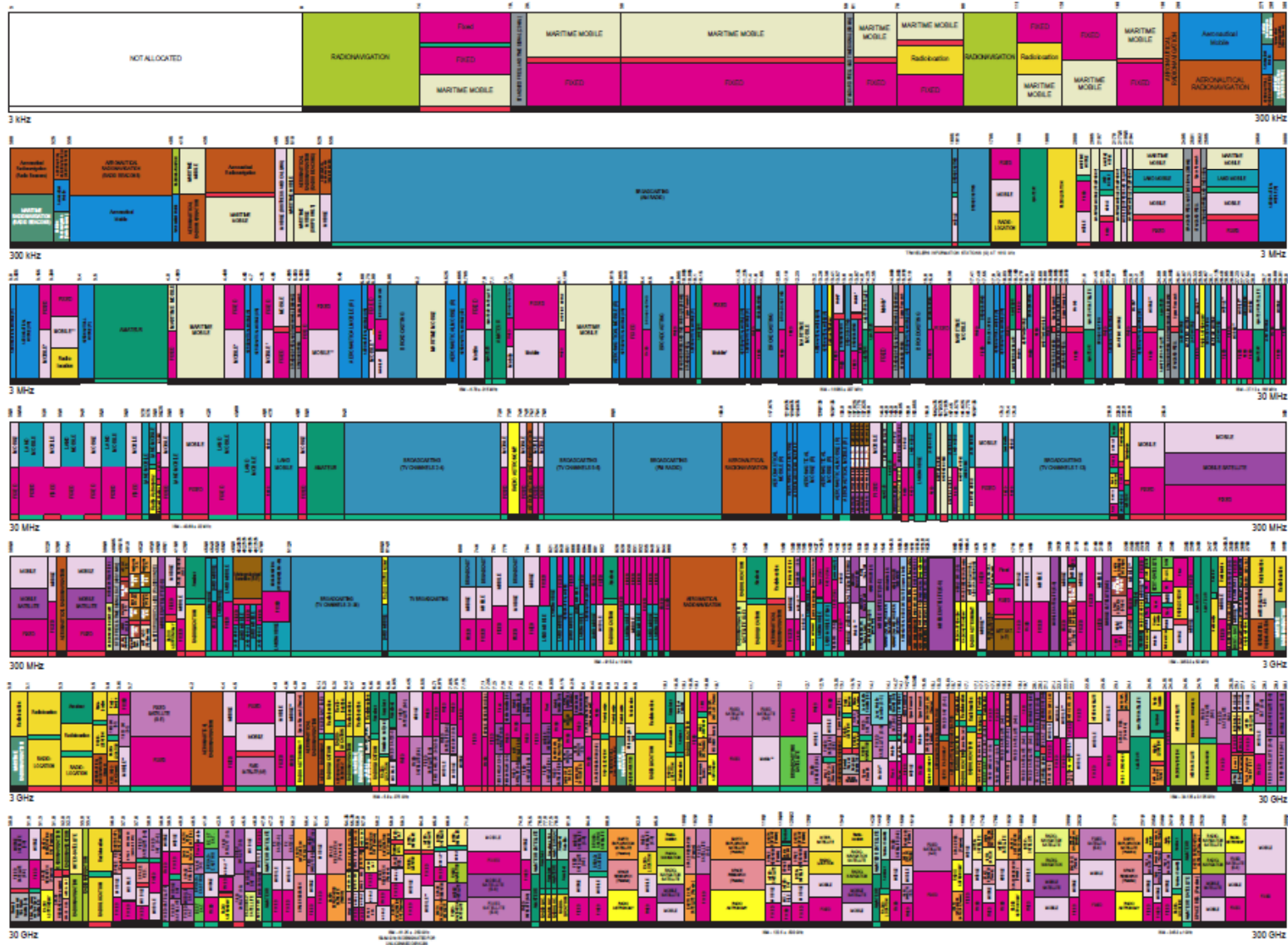
Agenda

- **Historical 802.11 Regulatory Amendments**
- **History: P802.11y**
- **P802.11af**
- **TV Bands Regulatory Requirements**
- **FCC Part 15.700**
- **Other Regulatory Domains**
 - Canada
 - EU
 - Singapore
 - Japan
 - China

Introduction

- **Explosion of wireless applications and devices creates multiple problems for regulators**
 - Where do we find more usable spectrum now! to avoid congestion?
 - How do we guarantee compliance without adding enforcement resources to deal with interference?
- **More spectrum**
 - There is no more (see next slide)
- **Rebanding or sharing are the only options**
 - Rebanding is costly and disruptive
 - Sharing could introduce unwanted interference

TV WHITE SPACES WORKSHOP



P802.11af

A Regulatory Driven Amendment

- **Policy Statement FCC 00-401 & NPRM FCC 00-402 (November 2000)**
 - Recognize the need to share spectrum to support wireless applications
 - Examine how to remove regulatory barriers for efficient spectrum sharing
 - Enable development of methods for opening licensed bands for sharing
- **FCC ET Docket 02-380: Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band**
 - FCC 02-328 Notice of Inquiry (December 2002)
- **FCC ET Docket 04-186: Unlicensed Operation in the TV Broadcast Bands**
 - FCC 04-113 Notice of Proposed Rule Making (May 2004)
 - FCC 06-156 First Report & Order and Further Notice of Proposed Rule Making (October 2006)
 - FCC 08-260 Second Report & Order and Memorandum Opinion and Order (November 2008)
 - Received 17 Petitions for Reconsideration

Historical 802.11 Regulatory Amendments

- **General**
 - 802.11a [FCC Part 15.407; ETSI EN 301 893]
 - 802.11b/g [FCC Part 14.247; ETSI EN 300 328]
- **802.11h**
 - DFS/TPC [ETSI EN 301 893]
- **802.11j**
 - Japan 5 GHz band [ARIB STD T-71]
- **802.11y**
 - US 3650 – 3700MHz; contention-based protocol [FCC Part 90, Subpart Z]

P802.11y – The Model for TVWS

- **The FCC authorized sharing in the 3650 – 3700 MHz band based on the use of Contention Based Protocols (FCC 05-56)**
- **Task Group ‘y’ developed an enablement scheme that requires devices operating in an 11y network to hear and decode an enabling beacon in order to transmit**
- **The FCC adopted parts of the 11y CBP for use in the sharing of the TV bands**
- **Unfortunately, the US border limitations and protection zones (for grandfathered FSS and federal government stations) made commercialization of this band daunting, and dedicated silicon was never produced**
- **Much of the TVWS rules have a basis in IEEE Std 802.11y-2008**

TV Bands Regulatory Goals

- **These [FCC] rules are primarily intended to ensure the efficient sharing of the TV Bands while protecting incumbent users**
- **The FCC has enabled this band for TVBDs if and only if the licensed users' interests are protected**
 - We must not interfere
 - Mitigation of any interference issue should not increase the enforcement requirements for the Commission
- **The National Broadband Plan looks to enable an additional 500 MHz of spectrum for wireless broadband**
 - The President has issued a memorandum directing the FCC to “buy back” 120 MHz of spectrum from the TV broadcasters
 - This could severely impact the available white spaces available for unlicensed use

FCC Part 15.700

Some Important Definitions

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.

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.

TV bands database

A database of authorized services in the TV frequency bands that is used to determine the available channels at a given location for use by TVBDs.

Interference Avoidance Mechanisms

- **Fixed devices must access a TV bands database over the Internet to determine the TV channels that are available at their geographic coordinates prior to their initial service transmission at a given location. Operation is permitted only on channels that are indicated in the database as being available for TVBDs.**
- **Mode II personal/portable devices must access a TV bands database over the Internet to determine the TV channels that are available at their geographic coordinates prior to their initial service transmission at a given location.**
- **Personal/portable devices operating in Mode I shall obtain a list of channels on which they may operate from a master device.**

TV Bands Database

- **“To determine and provide to a TVBD, upon request, the available TV channels at the TVBD’s location. Available channels are determined based on the interference protection requirements...”**
- **“To register the identification information and location of fixed TVBDs.”**
- **“To register protected locations and channels as specified ... that are not otherwise recorded in Commission licensing databases.”**

Spectrum Sensing

- **TVBDs must be capable of detecting ATSC digital TV, NTSC analog TV and wireless microphone signals using analog or digital modulation methods. The required detection thresholds are:**
 - ATSC signals: -114 dBm, averaged over a 6 MHz bandwidth;
 - NTSC signals: -114 dBm, averaged over a 100 kHz bandwidth;
 - Wireless microphone signals: -114 dBm, averaged over a 200 kHz bandwidth

FCC 08-260 Requirements

- **Fixed operation: channels 5-13, 14-36, 38-51**
- **Fixed and portable operation: channels 22-36, 38-51**
- **Fixed: maximum EIRP: 4 W**
 - directional antenna, 10-30 m above ground
 - Channels to be avoided: $N, N\pm 1$ (N being occupied by incumbent)
- **Personal/portable: maximum EIRP: 100 mW**
 - channels to be avoided: $N, N\pm 1$ (40 mW allowed on $N\pm 1$)
- **RF mask:**
 - Adjacent channels: 55 dB below the highest average power density in band (averaged over 100 kHz BW)
 - Alternate channels and beyond: Section 15.209 on out-of-band emission limit
 - Tighter limits for channels 36-37-38 (radioastronomy)
- **IEEE P802.22 Working Group has been developing a Standard that Supports Fixed and Portable Operation in TVWS.**

FCC 08-260 Requirements [2]

TV channel availability at the terminal location determined by either:

- **Geolocation (± 50 m) and TV bands incumbent database access (queried at least once a day)**
 - Minimum distance to TV protected contour:
 - Co-channel: 14.4 km (10-30 m antenna height)
 - Adjacent channel: 0.74 km (10-30 m antenna height)
 - Minimum distance to wireless microphone operation:
 - 1 km (broadcasters request 4 km)
- **Spectrum sensing for all incumbent operations**

FCC 08-260 Requirements [3]

- **Spectrum sensing:**
 - Detection thresholds:
 - ATSC signals: -114 dBm averaged over 6 MHz
 - NTSC signals: -114 dBm averaged over 100 kHz
 - Wireless microphone signals: -114 dBm averaged over 200 kHz
(*Levels referenced to a 0 dBi omnidirectional sensing antenna gain and 0 dB coupling and cable loss*)
 - TV channel availability check time:
 - TV signals: 30 s maximum time interval
 - W-microphone : 30 s maximum time interval
 - TV channel in-service monitoring:
 - 60 s maximum time interval (**broadcasters request 2 s**)
 - Channel move time:
 - after detection of incumbent, transmission must cease within 2 s

Other Regulatory Domains

Canada

TV White Spaces for Rural Access

- **RSS196:** 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)
 - Maximum bandwidth in a 6 MHz channel: 6 MHz
 - Maximum contiguous 6 MHz channels: 2 (12 MHz)
 - Minimum bandwidth in a 6 MHz channel: 500 kHz
 - Base station
 - Average tx output power: ≤ 125 watts
 - Average tx power spectral density: ≤ 14 dBW/100 kHz
 - Subscriber equipment
 - Average tx output power: ≤ 1 watt
 - Average tx power spectral density: ≤ -7 dBW/100 kHz
- **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)**

The EU and the UK

- **The UK**
 - Digital Dividend set for January 1, 2012
 - Ofcom consultations attempt to define how it will be done
 - Digital Dividend: Geolocation for Cognitive Access
 - Digital dividend: 600 MHz band and geographic interleaved spectrum
 - Digital Dividend Review: geographic interleaved awards 470 - 550 MHz and 630 – 790 MHz
- **EU efforts aimed at consistency across the EU**
 - SE43 specifying cognitive access; sensing and geolocation

Singapore

- **White Spaces Consultation and Test Plan:**
Television Band Devices (TVBDs) Accessing VHF and UHF Bands in Singapore

TVBD Parameter for Detection	Value
Sensitivity (assuming 0 dBi antenna)	-120dBm
Transmit Power	4dBm adjacent channel 17dBm (N+2...)
Transmit-power	Required
Bandwidth	Unlimited
Out-of-band-performance	< -48dBm
Time between sensing	< 1second
Maximum Continuous transmission	400 milliseconds
Minimum pause after transmission	100 milliseconds

TVBD Parameter for Geo-location	Value
Location accuracy	< 50m
Transmit Power	As specified in database
Transmit-power	Required
Bandwidth	Unlimited
Out-of-band-performance	< -48dBm
TVBD Refresh rate	1 second
Database refresh rate	24 hours
Maximum Continuous transmission	400 milliseconds
Minimum pause after transmission	100 milliseconds

Other Asia

- **Japan**
 - Digital TV transition in 2012
 - Active in P802.11af and P1900.4
- **China**
 - Digital TV transition in 2015