



# White Spaces Regulations and Standards

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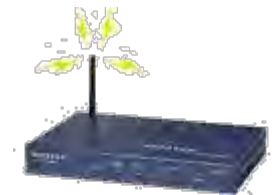
SEPTEMBER 24, 2010

## FCC to Open Unused TV Airwaves, Extending Wi-Fi's Possibilities

- Sep 23, 2010 The FCC reaffirmed a 2008 decision to open the broadcast airwaves
- Enables Wi-Fi networks with longer range
  - Microsoft reports achieving a mile of operating range on their Redmond, Wash., campus
- Broadcasters and wireless microphone operators expected to resume the law suit filed against the FCC in 2009 to stop new uses of the TV spectrum

# Introducing TV White Spaces

- Spectrum under 3 GHz has significant unused capacity
  - Average occupancy over various locations studied is 5.2% and the maximum occupancy is 13.1% (in New York City)
  - Shared Spectrum Company, NSF funded measurements, <http://www.sharespectrum.com/measurements>
- Only 10% of Americans receive broadcast TV
  - J. H. Snider and Max Vilimpoc, "Reclaiming the vast wasteland" <http://vilimpoc.org/research/policy/Issue-Brief-12-Unlicensed-Sharing-of-Broadcast-Spectrum.pdf>
- The economic potential for the TV white spaces was estimated at \$100 billion
  - R. Thanki, "The economic value generated by current and future allocations of unlicensed spectrum," [http://www.ingeniousmedia.co.uk/websitefiles/Value\\_of\\_unlicensed\\_-\\_website\\_-\\_FINAL.pdf](http://www.ingeniousmedia.co.uk/websitefiles/Value_of_unlicensed_-_website_-_FINAL.pdf)
- Modern technology allows effective sharing of sparsely used TV broadcast spectrum
- In 2004, the FCC started investigating the potential of allowing operation of unlicensed 2-way data communications in the TV broadcast VHF and UHF bands



**TVBD**  
TV Band Device

# History and Regulatory Landscape

- NPRM in May 2004
  - [http://hraunfoss.fcc.gov/edocs\\_public/attachmatch/FCC-04-113A1.pdf](http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-04-113A1.pdf)
- November 4, 2008 FCC approved Report & Order 08-260, allowing unlicensed use of TV band spectrum
  - [http://hraunfoss.fcc.gov/edocs\\_public/attachmatch/DA-01-260A1.pdf](http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-01-260A1.pdf)
- February 17, 2009, the FCC released the final rules for “Unlicensed Operation in the TV Broadcast Bands”
  - <http://edocket.access.gpo.gov/2009/pdf/E9-3279.pdf>
- Ofcom (UK) is in the process of making this Digital Dividend band available
  - <https://mentor.ieee.org/802.18/dcn/09/18-09-0059-00-0000-ofcom-update-on-the-digital-dividend.ppt>
- ECC of CEPT in Europe is conducting consultation on the band
  - <http://www.ero.dk/D9634A59-1F13-40D1-91E9-DAE6468ED66C?frames=no&>
  - Requirements for operation of cognitive radio systems in the "white spaces" of the frequency band 470-790 MHz
  - Consultation closes 11/30/10
- China TV band regulations expected in 2015

ECC = Electronic Communications Committee

CEPT = European Conference on Postal and Telecommunications

NPRM = Notice of Proposed Rule Making

# Frequency Allocation of TV Channels

	Channel #	Frequency Band	
Fixed TVBDs only	2-4	54-72 MHz	VHF
	5-6	76-88 MHz	
	7-13	174-216 MHz	
	14-20	470-512 MHz**	UHF
	21-51*	512-692 MHz	

\*Channel 37 (608-614 MHz) is reserved for radio astronomy

\*\*Shared with public safety

<http://www.fcc.gov/mb/engineering/usallochrt.pdf>

Transition from NTSC to ATSC (analog to digital TV) in June 12, 2009 freed up channels 52-69 (above 692 MHz)

# Unlicensed Bands and Services

Frequency range	Bandwidth	Band	Notes
433.05 – 434.79 MHz	1.74 MHz	ISM	Europe
420–450 MHz	30 MHz	Amateur	US
868-870 MHz	2 MHz	ISM	Europe
902–928 MHz	26 MHz	ISM-900	Region 2
2.4–2.5 GHz	100 MHz	ISM-2400	International allocations (see slides 7, 8 for details)
5.15–5.35 GHz	200 MHz	UNII-1,2	
5.47–5.725 GHz	255 MHz	UNII-2 ext.	
5.725–5.875 GHz	150 MHz	ISM-5800 UNII-3	
24–24.25 GHz	250 MHz	ISM	US, Europe
57-64 GHz 59-66 GHz	7 GHz	ISM	US Europe

TVB

Medical devices  
Remote control

RFID and other  
unlicensed services

Smart meters, remote  
control, baby  
monitors, cordless  
phones

802.11b/g/n, Bluetooth  
802.15.4 (Bluetooth,  
ZigBee), cordless phones

802.11a/n, cordless phones

Emerging 802.11ad  
802.15.3c, ECMA-387  
WirelessHD

Americas, including US and  
Canada; Australia, Israel

European analog of  
the ISM-900 band

ISM = industrial, scientific and medical  
UNII = unlicensed national information infrastructure

# Operation in TV Bands – Latest Rules

*Access based on geo-location & database  
or spectrum sensing*



Fixed

For fixed TVBDs max output  
power < 4 Watts EIRP

Must access a TV bands  
database over the Internet to  
determine channel availability



Personal /portable

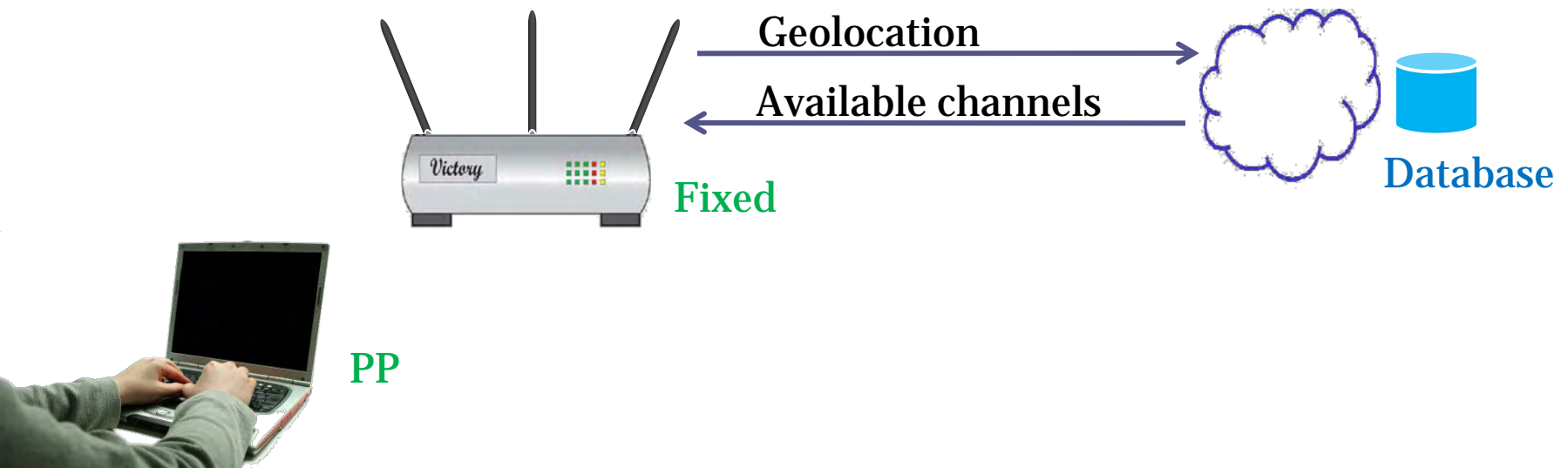
For PP TVBDs max output  
power < 100 mW EIRP on non-  
adjacent channels and < 40 mW  
EIRP on adjacent channels

Mode I: obtain a list of available  
channels from a master device

Mode II: incorporate geo-  
location capability

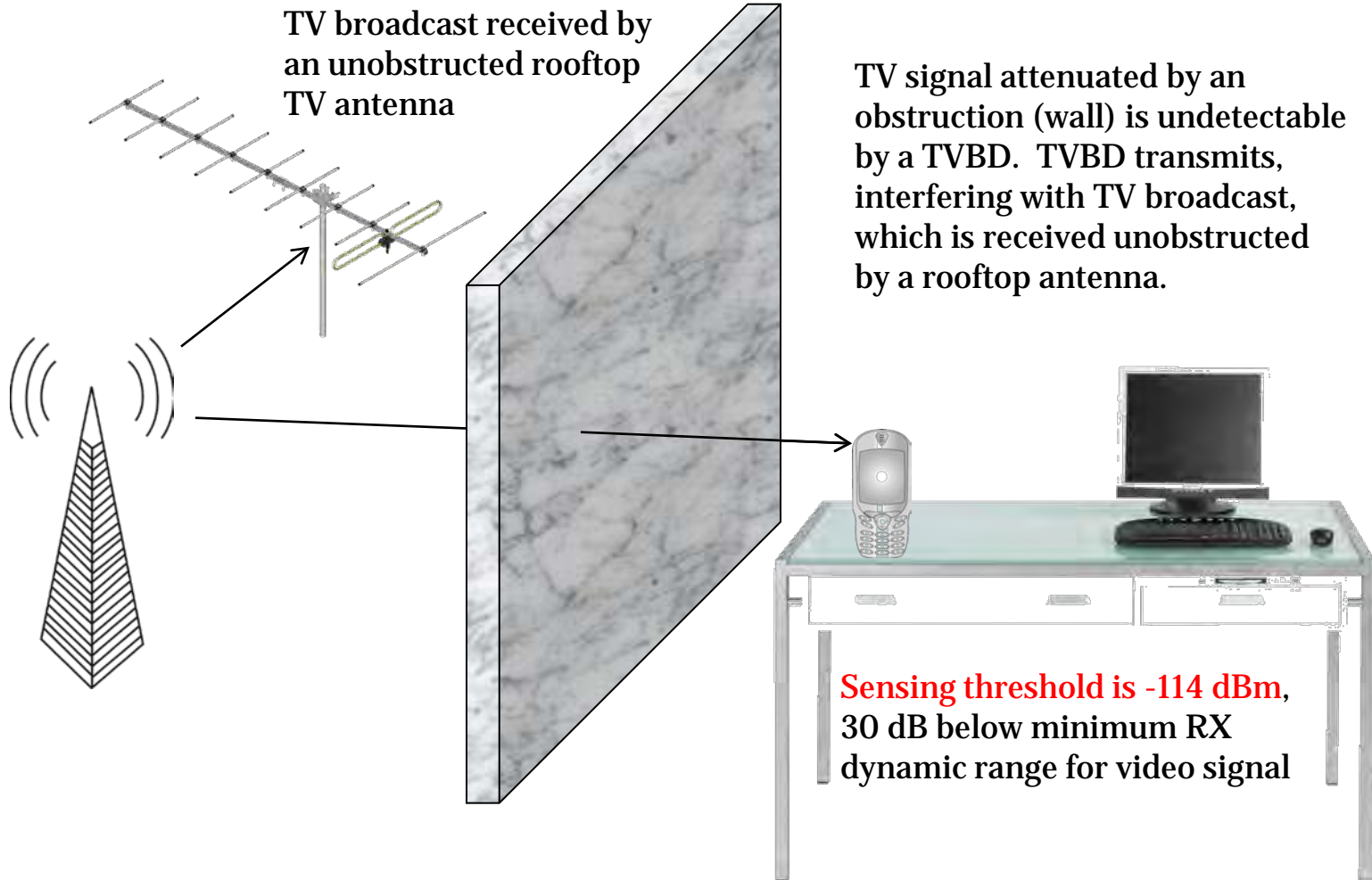
# Database

- Fixed TVBDs require geolocation capability and Internet access to a database of protected radio services.
- *White Spaces Database Group* was started by Google and other companies to create and standardize the database.





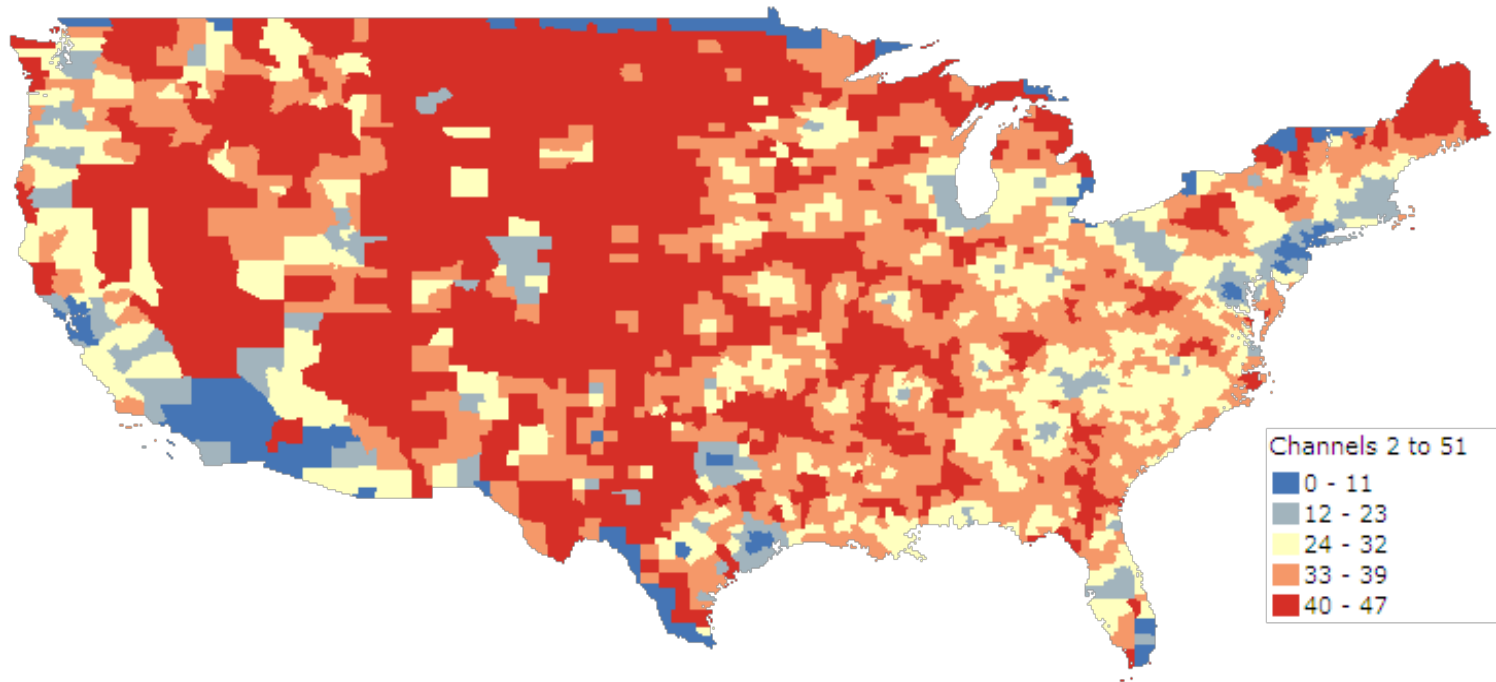
# Spectrum Sensing



**Sensing threshold is -114 dBm, 30 dB below minimum RX dynamic range for video signal**

# Taking Advantage of TV White Spaces

- Channel availability based on the geolocation query of TV band internet database



Source: Rick Tornado, Spectrum Bridge

# IEEE TV Band Related Standards

- **802.11af** – formed in January 2010 to adapt 802.11 to TV band operation
- **802.16h** – originally organized to adapt 802.16 to the 3650-3700 MHz contention band now working on TV band operation of 802.16
- **802.22** – cognitive radio approach
  - Regional Area Networks group that guided the FCC in the recent TV band regulations
  - Uses spectrum sensing and location information to determine whether given transmit frequencies and power levels will cause harmful interference to licensed services.
- **802.19** TAG – defines coexistence among dissimilar networks that will operate in the TV band
- **SCC 41** – defines layers above the MAC and PHY for dynamic spectrum access networks

# Contention Band

- March 2005 FCC offered 50 MHz 3650 to 3700 MHz for *contention-based protocol*
  - 802.11y and 802.16h are expected to share this band
  - 21<sup>st</sup> century regulation geared for digital communications
    - multiple services to share the band in an orderly way
- ❖ **300 Million licenses one for every person or company**
  - ❖ **\$300 per license for 10 years**
  - ❖ **Registered stations (base stations): 1 W/MHz, ~15 km**
  - ❖ **Unregistered stations (handsets, laptops): 40 mW/MHz, 1-1.5 km**

# 802.11af

IEEE P802.11af™/D0.05, August 2010  
(Draft Amendment to IEEE P802.11mb/D5.0)



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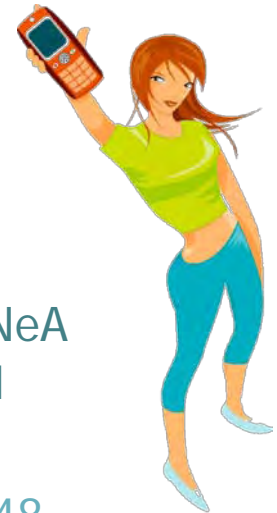
**IEEE P802.11af™/D0.05**

**Draft Standard for Information Technology—**

- Re-band the popular 802.11 systems; capitalize on work already done for 802.11y
  - Use 5, 10, 20 and 40 MHz wide channels
  - FCC EIRP: 4 W, 100 mW, 50 mW
- Possible deployment scenarios
  - Indoor (< 100 m): like present WLAN
  - Outdoor (< 5 km): comparable to the range of typical urban model
- Database is considered out of scope of 802.11af

# Ecma and CogNeA TV Band Standard

- Ecma International TC48-TG1 is developing PHY-MAC and coexistence protocols for wireless networks in the TV band <http://www.ecma-international.org/memento/TC48-TG1.htm>
- Sponsor Organization: Ecma International (<http://www.ecma-international.org> ) and CogNeA (<http://www.cogneat.org> )
- CogNeA and Ecma TC48-TG1 standard
  - CogNeA is an industry alliance formed in 2008 to develop a specification for white spaces.
  - In March 2009 the draft/early specification developed by CogNeA was transferred to the Technical Committee 48 – Task Group 1 (TC48-TG1) within Ecma-International
  - <http://www.ecma-international.org/publications/files/drafts/tc48-tg1-2009-132.pdf>



## Future of TV Band Use

- Dynamic spectrum market with the database access capability
  - Buy spectrum for a slice of time/space/band
- Protocol? Contention-based Wi-Fi?
  - Currently no plans to regulate by the FCC
- Technology must evolve to make flexible use of available channels up to 6 GHz
  - RF front end technology still not ready for this

## To Learn More...

- Articles, white papers, test reports and presentations
  - <http://www.octoscope.com/English/Resources/Articles.html>

- Contact

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