

# Utilizing White Spaces for broadband access

## Where do we go from here?

Fanny Mlinarsky

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# Speakers

- **Fanny Mlinarsky – Moderator**
  - President and CTO, **octoScope**
  - State of the industry and standards
- **Rick Rotondo**
  - VP Marketing and CO-Founder, **Spectrum Bridge**
  - Flexible uses and novel licensing models in White Space
- **Chris Whiteley**
  - Director of Business Development, **xG Technologies**
  - VoIP over White Space and other BWA applications

# Introducing TV White Spaces

- **November 4, 2008** FCC approved Report & Order 08-260, allowing unlicensed use of TV band spectrum
- Ofcom (UK) is in the process of making this Digital Dividend band available
- EU has conducted a consultation on the band
- China TV band regulations expected in 2015



**TVBD** = TV Band Device

# 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>

June 12, 2009 transition from analog to digital TV freed up channels 52-69 (above 692 MHz) thanks to higher spectral efficiency of digital TV

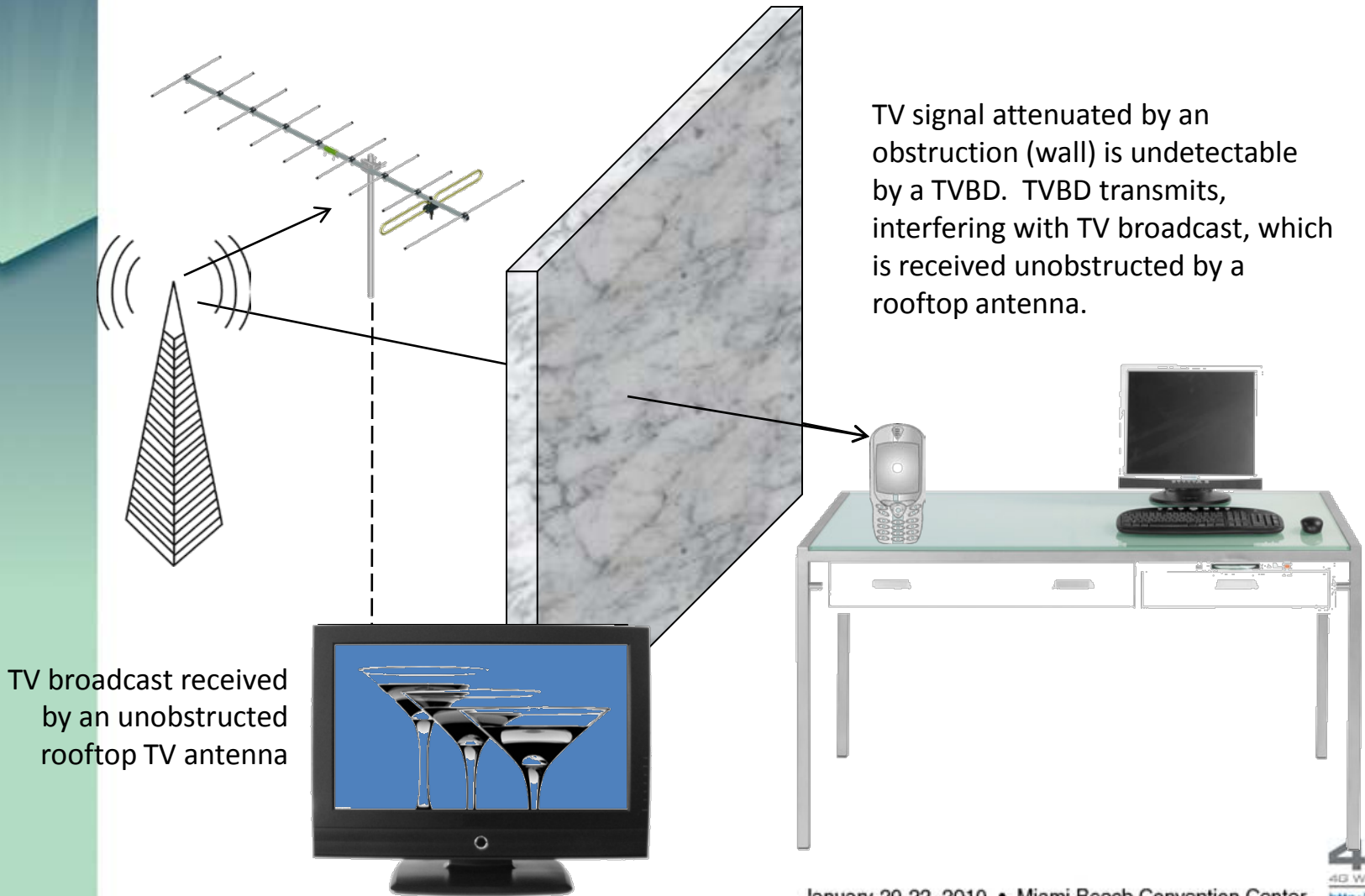
# FCC Rules

- TVBDs require geolocation capability and Internet access to a database of protected radio services. The TVBDs must first access the database before operating.
- Fixed devices can operate on any channel between 2 and 51, except 3, 4 and 37
- Channels 2 – 20 are restricted for use by fixed devices to protect wireless microphones
- Fixed and personal portable devices must sense TV broadcasting and wireless microphone signals

**May not happen!**



# Hidden Node Scenario



# Standards Organizations Involved

- **IEEE 802.11af** – formed in January 2010 to adapt 802.11 to TV band operation
- **IEEE 802.16h** – originally organized to adapt 802.16 to the 3650-3700 MHz contention band (see next slide), now also working on TV band operation of 802.16
- **IEEE 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.



# Lightly Regulated 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 – TVBD Amendment

- The goal is to keep new amendment as simple as possible – a few changes to make .11 work in TV bands; capitalize on work already done in 802.11y
- About 15 pages / 2 years to approval
  - Use the OFDM PHYs with 5-, 10- and 20-MHz channel widths to specify the basis for a system that the regulators can approve for operation in the TV white spaces bands.*
- Focus engineering effort on well defined regulatory domains (Canada, US, EU,...)



# 802.11af Deployment Scenarios

- Re-banding of the popular 802.11 systems
- 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



# SDR Forum Efforts

- In Home Networking
- WhiteFi (rural ISP service)
- Wireless Control/Sensors (e.g. Smart Grid)
- Secondary Broadcast
- Microcell Broadcast
- Military Equipment
- Public Safety Equipment
- WiFi on Steroids
- Body Area Networks
- Sensor Networks
- TVBD to WiFi Gateway
- Low Data Rate devices with intermittent use

SDR Forum is working with the FCC on test and measurement methodology for white spaces

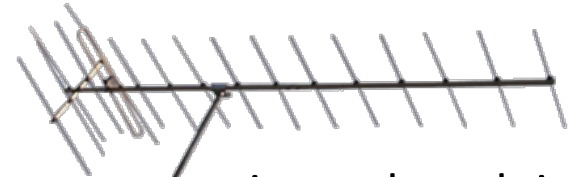
← Use case scenarios the SDR Forum is currently studying

# Other Standards Organizations

- 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.cognea.org>)
- Project/Standard Number: TC48-TG1
- Project/Standard Date: Expected release of first edition by ECMA: Dec 2009.
- Expected adoption by ISO/IEC: Oct. 2010

# VHF/UHF Beach-front Property?

- Lower frequencies experience lower attenuation in free space and through obstructions, e.g. buildings
- However, when propagating through metal frames in modern buildings, Fresnel zone gets constricted and attenuation is introduced



Antenna – optimum length is a multiple of  $\frac{1}{4}$  wavelength

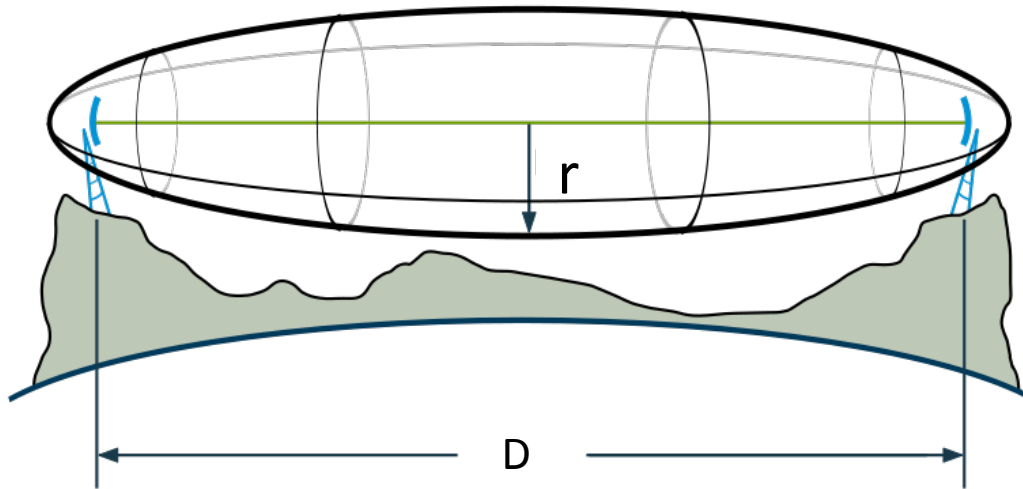
3.3 feet for 70 MHz

4" for 700 MHz

1" for 2.4 GHz

Longer antennas required for UHF may be problematic for handheld devices

# Antenna Fresnel Zone



$$r = 72.05 \sqrt{\frac{D}{4f}}$$

r = radius in feet

D = distance in miles

f = frequency in GHz

- **Fresnel zone** is the shape of electromagnetic signal and is a function of frequency
- Constricting the Fresnel zone introduces attenuation and signal distortion

**Example:** D = 0.5 mile

r = 30 feet for 700 MHz

r = 16 feet for 2.4 GHz

r = 10 feet for 5.8 GHz

# What's to Come...

- Products expected in about 2 years
- Wi-Fi may be the first protocol to make use of white spaces



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# Q & A

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# To Learn More...

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

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