



Spectrum Issues – Recent Rulemakings



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Note: The views expressed in this presentation are those of the author and may not necessarily represent the views of the Federal Communications Commission

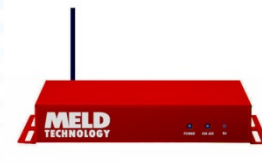


White Space Devices



Progress on White Space in the TV Bands (Unlicensed)

- Adopted final rules in 2012
 - Fixed & Personal Portable devices
 - Rely on geolocation database
- Updated rules adopted August, 2015 (ET Dkt No. 14-165)
 - Implement incentive auction changes
- Eleven devices approved:
 - Adaptrum, Koos Technical Services, Meld, Carlson, Redline, 6harmonix, Metric Systems, Runcom
 - All fixed devices, designed for professional installation - location entered manually
 - All are generic boxes with an input for a digital signal (voice, video, data).
- Databases approved:
 - Spectrum Bridge, iconectiv (formerly Telcordia), Google, Key Bridge Global and LStelcom
- IEEE 802.11af standard approved - Dec. 2013
- Strong international interest



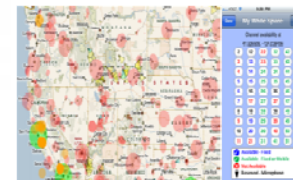
Meld



Carlson



Adaptrum



Spectrum
Bridge



iconectiv



Wireless Cameras Cover Park
in Wilmington NC



White Space Device Basics

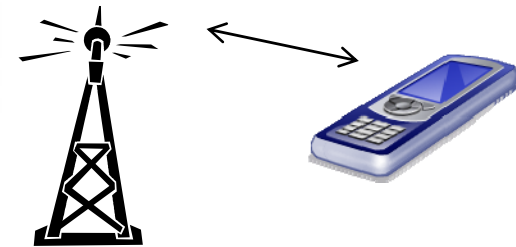
● Fixed Devices

- Power limit: 4 Watts EIRP; 10 watts EIRP in less congested areas
- May operate on channels 2-51
 - Upper limit will change after incentive auction
- Incorporated geolocation or professional installation
- Device checks database for available channels

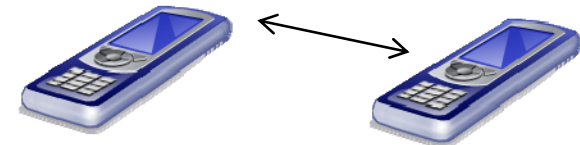


● Personal/Portable Devices

- Power limit: 100 mW, except 40 mW when inside adjacent TV channel contour
- May operate on channels 14-51
 - Upper limit will change after incentive auction
- Device must check fixed (master) device or data base for permissible channels



Mode 1: Portable device obtains location/channels from fixed device



Mode 2: Portable device uses its own geolocation/data base access capability



Incentive Auction Band Plan

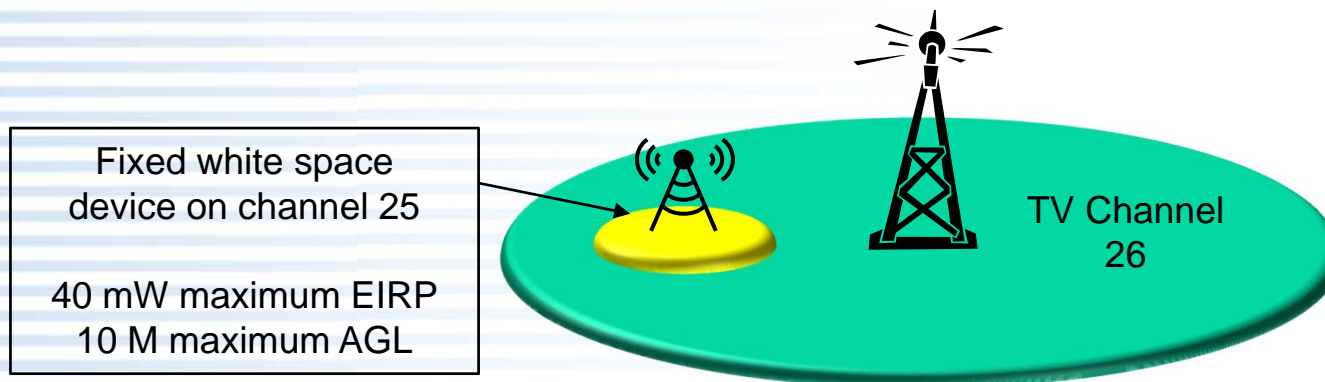
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	700 MHz UL				
2	42	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	11	A	B	11	A	B	700 MHz UL					
3	48	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	7	A	B	C	11	A	B	C	700 MHz UL				
4	60	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	9	A	B	C	D	11	A	B	C	D	700 MHz UL				
5	72	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	11	A	B	C	D	E	11	A	B	C	D	E	700 MHz UL				
6	78	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	7	A	B	C	D	E	F	11	A	B	C	D	E	F	700 MHz UL			
7	84	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	3	A	B	C	D	E	F	G	11	A	B	C	D	E	F	G	700 MHz UL		
8	108	21	22	23	24	25	26	27	28	29	30	31	32	11	A	B	3	37	3	C	D	F	F	G	H	11	A	B	C	D	E	F	G	H	700 MHz UL		
9	114	21	22	23	24	25	26	27	28	29	30	31	7	A	B	C	D	3	37	3	E	F	G	H	I	11	A	B	C	D	E	F	G	H	I	700 MHz UL	
10	126	21	22	23	24	25	26	27	28	29	9	A	B	C	D	E	F	3	37	3	G	H	I	J	11	A	B	C	D	E	F	G	H	I	J	700 MHz UL	
11	138	21	22	23	24	25	26	27	11	A	B	C	D	E	F	G	H	3	37	3	I	J	K	11	A	B	C	D	E	F	G	H	I	J	K	700 MHz UL	
12	144	21	22	23	24	25	26	7	A	B	C	D	E	F	G	H	I	J	3	37	3	K	L	11	A	B	C	D	E	F	G	H	I	J	K	L	700 MHz UL



TV Band Rule Changes

Fixed Devices

- Allow fixed white space devices to operate:
 - Adjacent to occupied TV channels at 40 mW and antenna heights of 10 meters above ground level or less (*i.e.*, within the adjacent TV station contour)
 - Consistent with rule for Personal/Portable devices

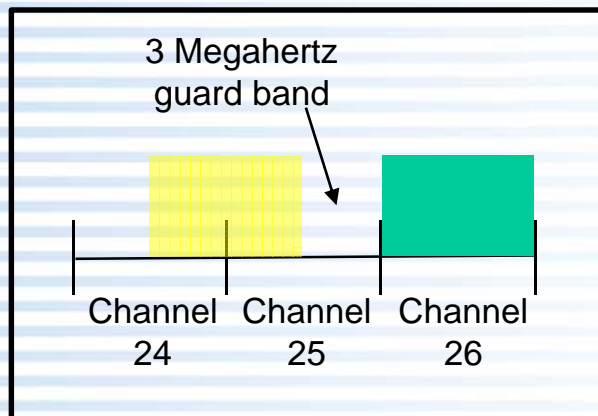
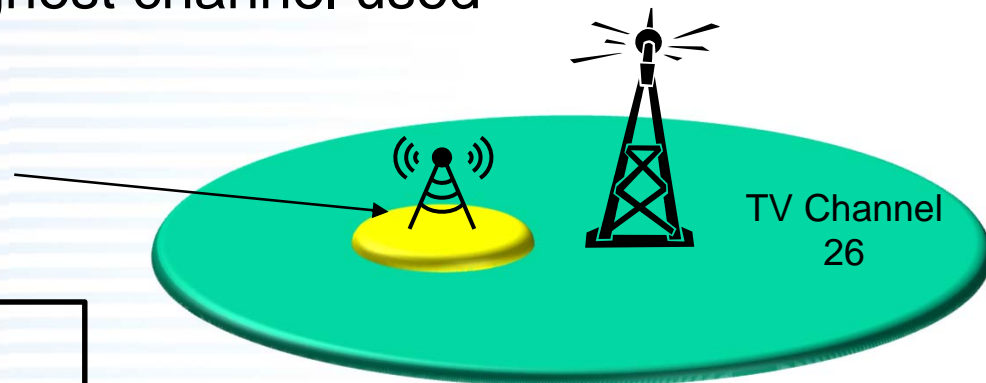




TV Band Rule Changes Fixed Devices (cont'd)

- On two contiguous vacant TV channels at 100 mW and antenna heights of 10 meters above ground level or less
 - Must leave at least 3 megahertz guard band at edge of lowest and highest channel used

Fixed white space device straddling channels 24 and 25





TV Band Rule Changes Fixed Devices (cont'd)

- By bonding contiguous or non-contiguous channels
 - Explicitly allowed by rules
- At up to 10 W EIRP in areas with fewer than 50 percent occupied TV channels
 - Less congested areas
 - Antenna height limited to 10 m AGL
- On TV channels 3 and 4, where available



TV Band Rule Changes

All Devices

- Allow fixed and personal/portable devices to:
 - Operate closer to co- and adjacent-TV channels
 - Separation distance scaled to EIRP and antenna height
 - Scaled in 4 dB increments
 - 40 mW device at 3 meters AGL – 1.3 km separation from TV contour (previous rules required 4 km)
 - Use location technologies with a lower degree of accuracy than ± 50 meters
 - Device must estimate location error with 95% confidence level and pass that parameter to database
 - Consistent with ETSI standard
 - Operate on two vacant channels above and below channel 37 now reserved for wireless microphones



TV Band Rule Changes Personal/Portable Devices

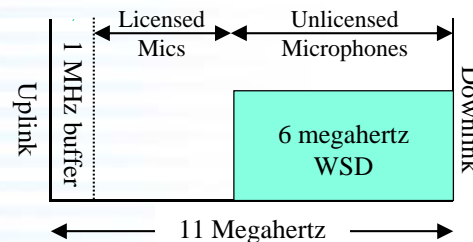
- Expands usable channels available for personal/portable devices down to channel 14
 - Previous cut-off was channel 21
 - Must protect land mobile operations in 11 cities where allocated and at waived locations



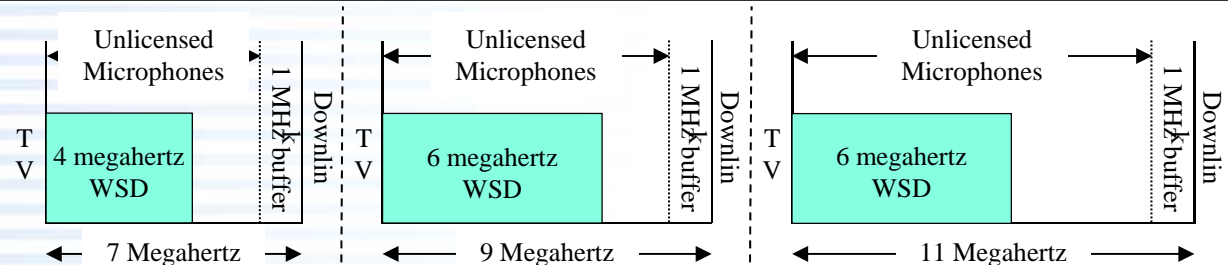
600 MHz Band

- White space devices may operate:
 - With up to 10 W at specified distances from 600 MHz licensees' service areas
 - Operation permitted until 600 MHz licensee informs white space database it is commencing operation
 - In Duplex Gap and Guard Band
 - Up to 40 mW EIRP

Duplex Gap



Guard Band Options





Channel 37

- Fixed and personal/portable white space devices may operate on channel 37
 - Up to 4 watts EIRP, but maximum power will be dictated by the band plan after auction
 - Subject to separation distance from wireless medical telemetry facilities
 - 380 meters for 40 mW personal/portable device
 - Terrain dependent exclusion zones around radio astronomy facilities
- Consistent emission mask across entire band
 - Removes stringent mask into channel 37



Unlicensed Wireless Microphones

- Codify rules for unlicensed wireless microphones in Part 15*
 - TV Band
 - Up to 50 mW EIRP
 - Adopt ETSI emission mask
 - No longer reserve two channels around channel 37 for wireless microphones
 - No longer permit unlicensed wireless microphones to register for protection
 - 600 MHz band
 - Duplex gap and guard band – 20 mW EIRP
 - Service band – 50 mW EIRP
 - During post-auction transition period
 - At specified separation distances from licensees' service area
 - Access database to determine usable channels

* Licensed wireless microphone rules addressed in separate wireless microphone R&O



Database Procedures

- 600 MHz licensees provide areas where they commence operations
- Health care facilities provide location information
- Add radio astronomy exclusion areas
- Unlicensed microphones must register if operating in duplex gap or guard bands
- Require databases to “push” information to white space devices
 - Changes in channel availability in areas where licensed wireless microphones reserve channels



Transition Dates

- Based on publication date in Federal Register
 - Report and Order has not yet been published
- Push notification
 - New certification applications comply within 6 months
 - Imported and marketed devices comply within 9 months
 - Devices not compliant cease operating within 1 year
- Wireless microphones
 - Operation under current waiver permitted for up to 39 months after release of channel reassignment PN
 - New certification applications comply 9 months after release of channel reassignment PN or no later than 24 months, whichever occurs first
 - Manufacturing and marketing of noncompliant microphones must cease 18 months after release of reassignment PN or no later than 33 months, whichever occurs first



Database Issues

(NAB Petition)

- NAB filed Emergency Motion for Suspension of Operations and Petition for Rulemaking
 - March 19, 2015; RM-11745
 - Claims the databases are filled with inaccurate data
 - Seeks to:
 - Amend rules to require devices to have incorporated geo-location capability; eliminate professional installer option
 - Incorporate accountability measures into the rules to ensure the integrity of registration data
 - Suspend operation of databases and conduct rulemaking to incorporate suggested changes



Database Issues

(NAB / Manufacturer Agreement)

- NAB and white space device equipment manufacturers submitted a letter on July 17, 2015
 - Recommend that all TV band devices incorporate automatic geolocation capability or be under the control of a device that includes that capability
 - Transition provisions
 - Existing inventory should be grandfathered
 - Existing devices can continue to operate and be deployed during this transition
 - New requirements would apply to all TV Band devices manufactured either one year after rules are adopted or January 31, 2017, whichever is later
 - Urge that equipment changes that only add geolocation to an existing TVWS equipment authorization be treated as a permissive change



Wireless Microphones



More Spectrum Needed for Wireless Microphones

- Incentive auction will reduce amount of TV band spectrum available for wireless microphones
 - Wireless Microphone Report and Order adopted August 2015 (GN Dkt No. 14-166)

Bands available for wireless microphones (Pre R&O)

Frequency Band	Licensed/unlicensed	Rule Part
26.1-26.48 MHz (VHF)	Licensed	Part 74
161.625-161.775 MHz (VHF)	Licensed	Part 74
Portions of 169-172 MHz band (VHF)	Licensed	Part 90
88-108 MHz (FM)	Unlicensed	Part 15
450-451, 455-456 MHz (UHF)	Licensed	Part 74
54-72, 76-88, 174-216, 470-608, 614-698 MHz (VHF and UHF)	Licensed and unlicensed	Part 74 and Part 15 (waiver)
944-952 MHz (UHF)	Licensed	Part 74
902-928 MHz, 2.4 GHz, 5 GHz (ISM bands)	Unlicensed	Part 15
1920-1930 MHz (unlicensed PCS)	Unlicensed	Part 15
Ultra-wideband (3.1-10.6 GHz)	Unlicensed	Part 15



Band Specific Changes

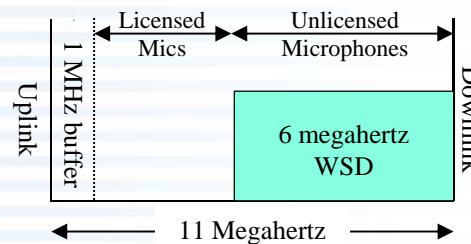
- VHF TV band
 - 50 mW maximum EIRP
 - Previously was 50 mW conducted power
- VHF and UHF TV bands
 - Permit closer co-channel operations by licensed wireless microphone operators when:
 - TV signal is lower than -84 dBm / 6 megahertz
 - Indoor locations only
 - No itinerant usage
 - Location not being used for over the air TV reception
 - Operator must have professional qualifications for evaluating TV signal strength
 - ETSI emission mask for analog and digital microphones



600 MHz Band

● Duplex Gap

- Eligibility for use of 4 megahertz extended to all Part 74 eligible users



- Disclosure requirements
 - To be developed by Commission
 - Must be displayed by anyone selling or leasing 600 MHz band microphones



600 MHz Band (cont'd)

- Transition dates (based on publication date in Federal Register – Not yet published)
 - Same time frames as for unlicensed wireless microphones
 - Operation under current waiver permitted for up to 39 months after release of channel reassignment PN
 - New certification applications comply 9 months after release of channel reassignment PN or no later than 24 months, whichever occurs first
 - Manufacturing and marketing of noncompliant microphones must cease 18 months after release of reassignment PN or no later than 33 months, whichever occurs first
 - Microphones must cease operation if they would cause harmful interference to any 600 MHz licensee



169-172 MHz Band

- Created several new channel centers to facilitate use of microphones with 200 megahertz bandwidth
 - Previously limited to 54 megahertz bandwidth
- Emissions subject to ETSI mask



900 MHz Bands

(944-952 MHz, 941-944MHz, 952-960 MHz)

- All Bands
 - Expand eligibility to all Part 74 eligible users
 - Require use of ETSI emission mask
 - Effective 9 months after release of channel reassignment PN
- 941.5-944 MHz, 952.85-956.25 MHz, and 956.45-959.85 MHz bands
 - New bands for Part 74 eligible users
 - Same technical rules as 944-952 MHz band



1425-1535 MHz Band

- Limited use for licensed microphones on secondary basis to Aeronautical Mobile Telemetry operations
- Eligibility limited to professional users
- Require use of ETSI emission mask
- 250 mW maximum conducted power
- Use restricted to specific fixed locations where large numbers of microphones are needed and other spectrum resources are insufficient
- Coordination with AFTRCC required
- Authentication and location verification required prior to operating
- Microphones must be tunable across entire band
- Use limited to no more than 30 megahertz
- Coordination and authentication details to be worked out



6875-7125 MHz Band

- Permit BAS and CARS eligible users to operate wireless microphones on licensed secondary basis
 - Limited to two 25 megahertz channels at the top and bottom of band
 - 6875-6900 MHz
 - 7100-7125 MHz
 - Coordination required through SBE
 - Use of ETSI emission mask required



ISM and Other Bands

- Commission declined to make any rule changes to accommodate wireless microphones in the following bands:
 - 902-928 MHz (ISM Band)
 - 2.4 GHz (ISM Band)
 - 5 GHz (ISM Band)
 - 26.1-26.48 MHz (Maritime Band)
 - 88-108 MHz (FM Radio Band)
 - 161.625-161.775 MHz (Land Mobile Band)
 - 450-451 MHz, 455-456 MHz (Land Mobile Band)
 - 3.1-10.6 GHz (Ultrawideband)

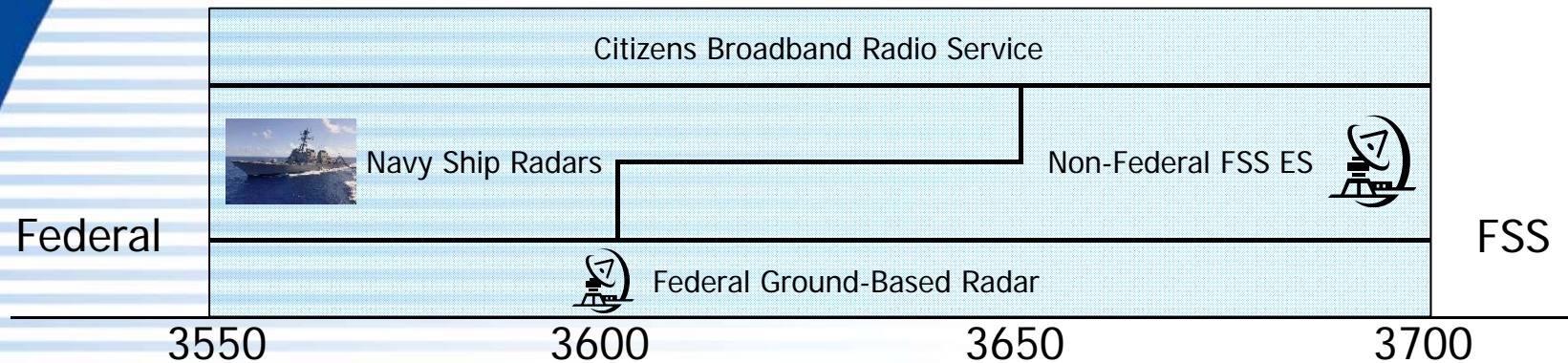


3500 MHz Band

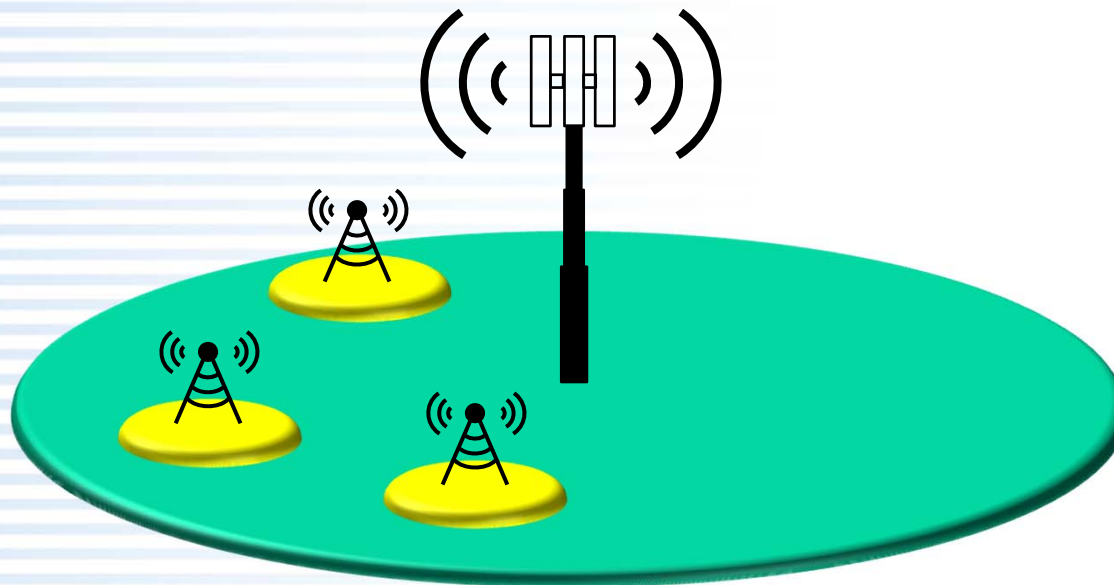


Citizens Broadband Radio Service

Report & Order Adopted April 17, 2015 (GN Dkt No. 12-354)



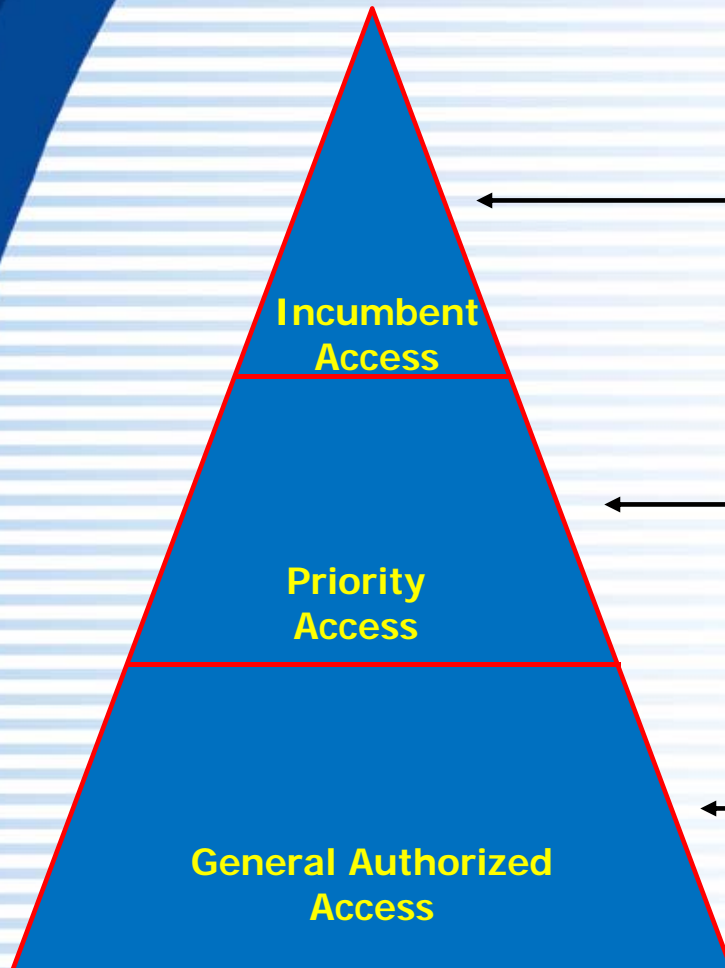
150 MHz
of
contiguous
spectrum



Dynamic
spectrum
access
for small
cells



Three Tier Access



Incumbent Access: Includes authorized federal radar and radiolocation systems and grandfathered non-federal Fixed Satellite Service (FSS) users currently operating in the 3.5 GHz Band.

Priority Access License (PAL): Authorize certain users to operate with some interference protection in portions of the 3.5 GHz Band at specific locations

General Authorized Access (GAA): Users authorized to use the 3.5 GHz Band opportunistically. GAA users required to accept interference from Incumbent and Priority Access tier users.

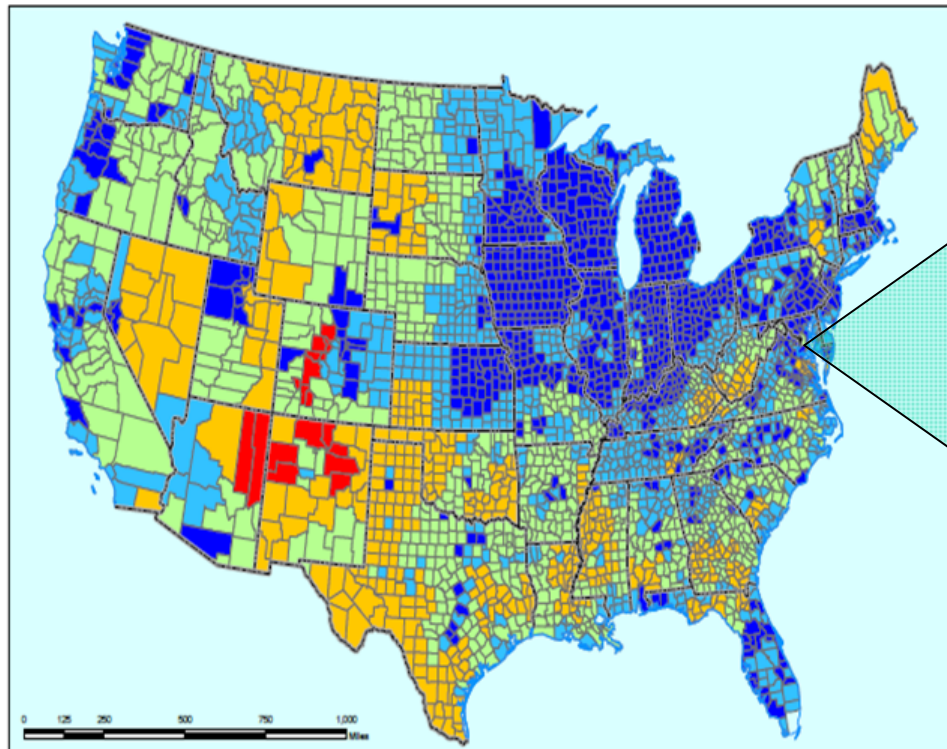


License Areas

PALs licensed by census tract

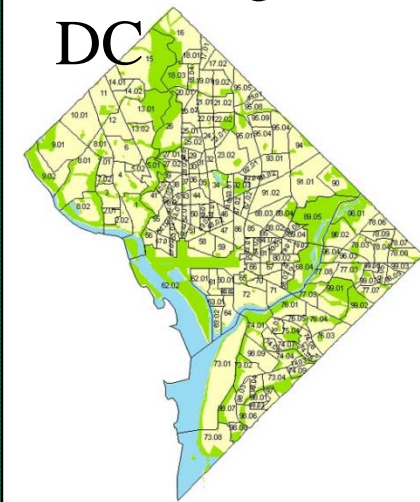
- Over 74,000 census tracts in U.S.
- May aggregate census tracts

U.S. Census Tracts



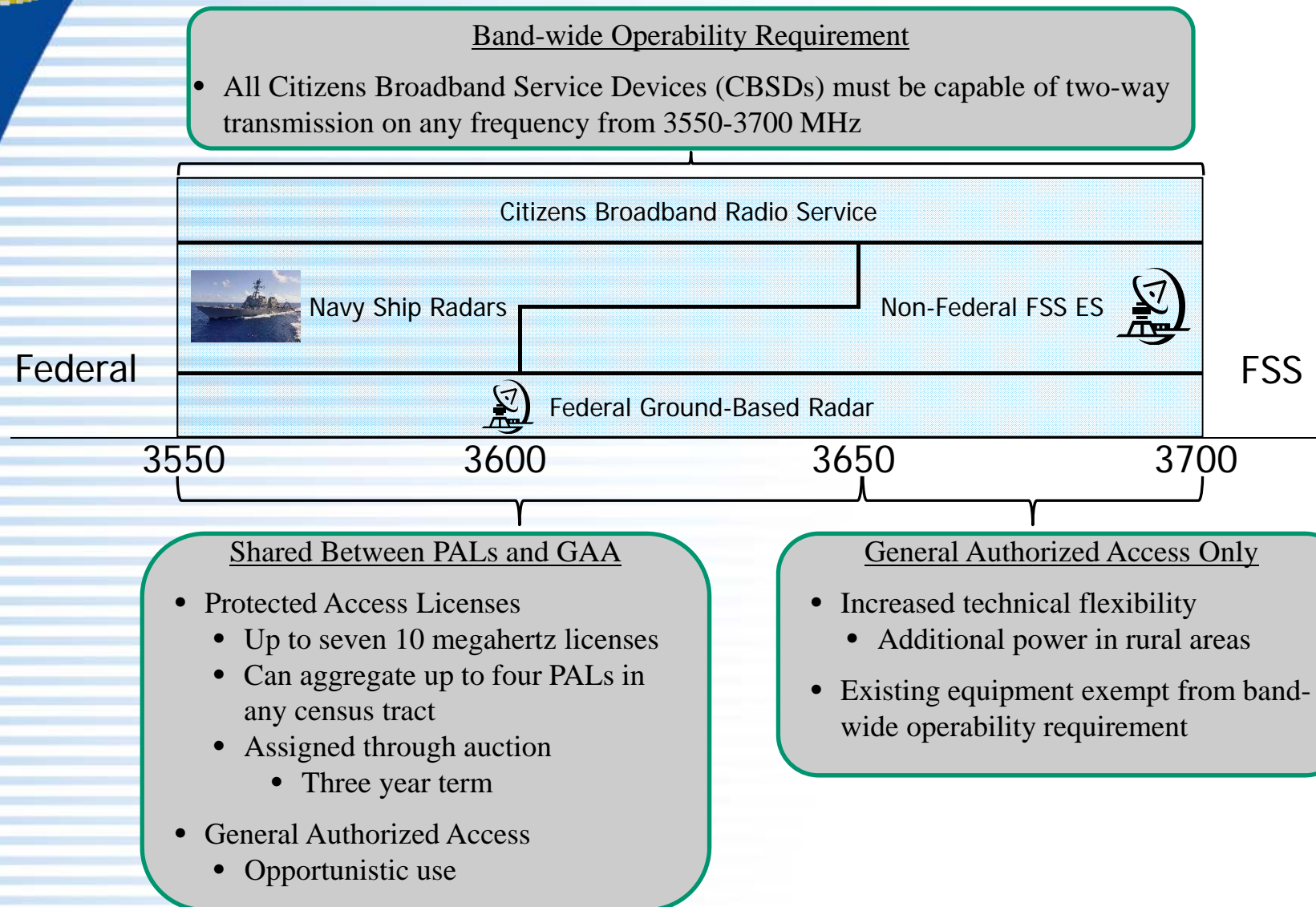
Washington

DC





Protected Access vs General Authorized Access





Incumbent Protection

Protection of Federal Systems at 3550-3650 MHz

- Phase 1 - Exclusion zone near coastlines
- Phase 2 - Environmental sensing capability
 - Exclusion zone \Rightarrow protection zone



Proposed exclusion zone
Adopted exclusion / protection zone

Protection of Non-Federal Systems at 3600-3700 MHz

- Incumbent terrestrial broadband licensees (3650-3700 MHz) grandfathered for five+ years
- Grandfathered FSS (3600-3700 MHz) register with FCC yearly
 - Protection based on operating parameters
 - FNPRM explores additional protection

APPENDIX F: Protection Zones For Grandfathered FSS And Federal Government Stations
Protection Zones: 3650 to 3700 MHz

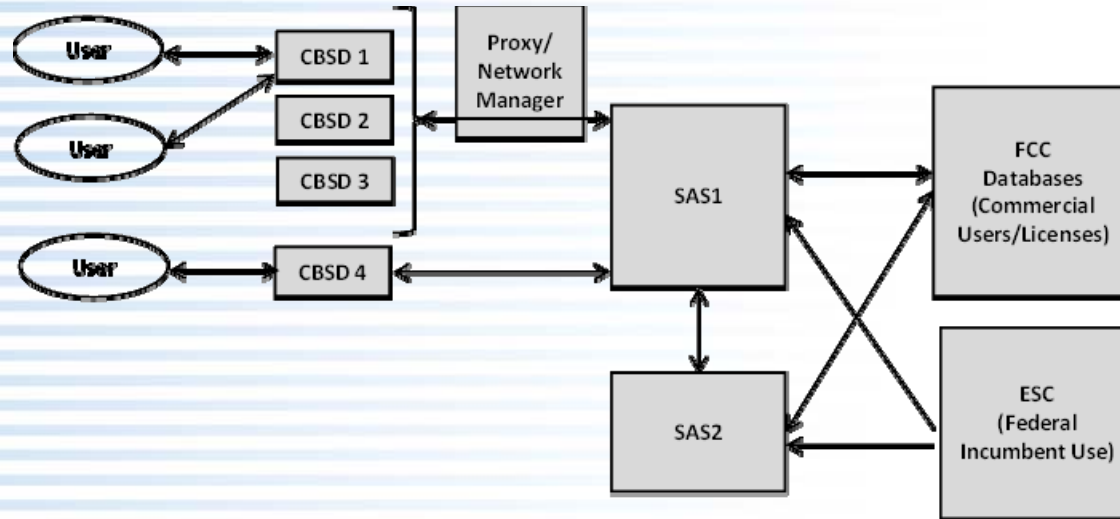


Three Federal radar sites protected via 80 km exclusion zone.



Spectrum Access System (SAS)

A next generation sharing system building on white spaces



SAS Functions

- Determine available frequencies at a location and assign them to CBSDs
- Determine maximum permissible power level for CBSDs at a location
- Register and authenticate CBSDs
- Enforce Exclusion and Protection Zones
- Protect PALs from IX from other users
- Facilitate coordination between GAAs
- Ensure secure and reliable transmission of information between the SAS, ESC, and CBSDs
- Protect Grandfathered Wireless Broadband Licensees
- Facilitate coordination and information exchange between SASs



Technical Rules

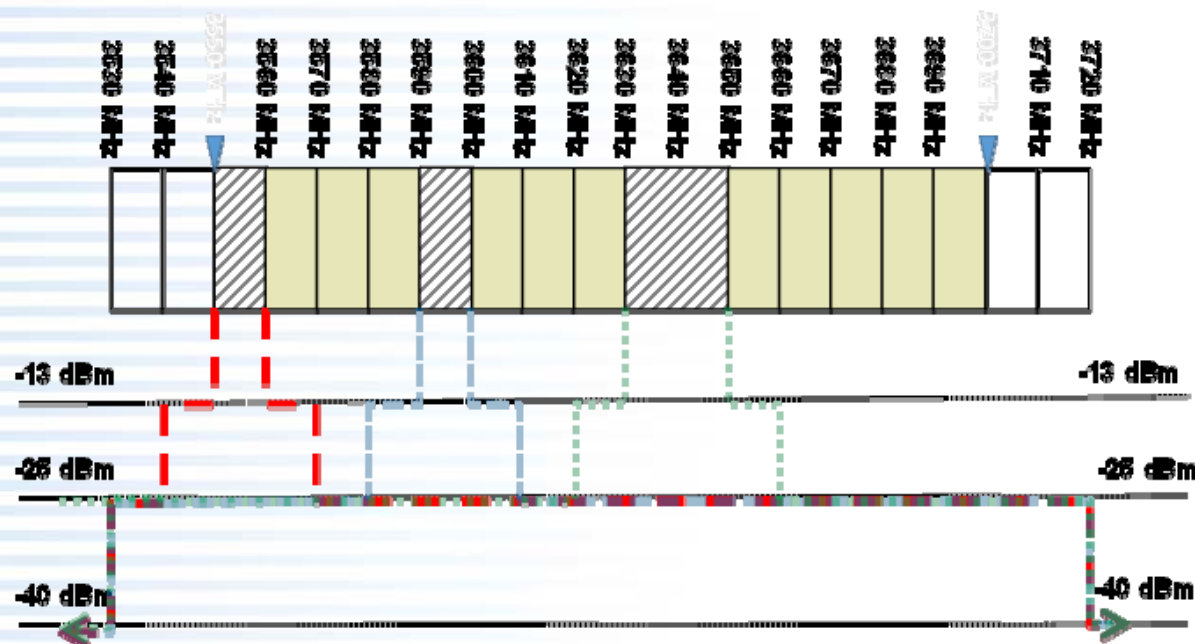
● CBSD categories and power requirements

CBSD Category	Maximum Conducted Power (dBm/10 MHz)	Maximum EIRP (dBm/10 MHz)	Maximum Conducted PSD (dBm/MHz)	CBSD Installations	Operations in 3550-3650 MHz	Operations in 3650-3700 MHz
Category A	24	30	14	- Indoor - Outdoor max 6m HAAT	Everywhere Outside DoD Protection Zone	Everywhere Outside FSS and DoD Protection Zone
Category B (Non-Rural)	24	40	14	- Outdoor only - Professional Installation	Outside DoD Protection Zone & requires ESC approval	Everywhere Outside FSS Protection Zone and DoD Protection Zone
Category B (Rural)	30	47	20	- Outdoor only - Professional Installation	Outside DoD Protection Zone & requires ESC approval	Everywhere Outside FSS Protection Zone and DoD Protection Zone



Technical Rules (cont'd)

- Out of band emission limits
 - From 0 to 10 megahertz from the SAS assigned channel edge: -13 dBm/MHz
 - Beyond 10 megahertz from the SAS assigned channel edge down to 3530 MHz and up to 3720 MHz: -25 dBm/MHz
 - Below 3530 MHz and above 3720 MHz: -40 dBm/MHz





Technical Rules (cont'd)

- Received signal strength level
 - Aggregate received signal level at PAL license boundary: -80 dBm / 10 megahertz
 - Enforced by SAS
 - May agree to different limits
- End user equipment
 - Maximum 23 dBm EIRP / 10 megahertz
 - Only operate if receive and decode CBSD signal
 - Security features to modification of firmware or hardware that changes RF characteristics



More Work To Do

Further Notice of Proposed Rulemaking

- Defining “Use” of PAL frequencies
 - Implementing secondary markets in Priority Access Licenses
 - Optimizing Protection for FSS
 - In-band protection of FSS in 3600-3700 MHz
 - Out-of-band protection of C band FSS earth stations
-
- SAS Provider selection and authorization
 - Will use process similar to TV White Spaces
-
- Multi-stakeholder process
 - FCC appreciates industry establishing a multi-stakeholder process
 - Regulations set framework
 - Industry collaboration will be key to successful implementation



Unlicensed at 5 GHz



Ongoing Work

U-NII-2B (120 Megahertz) 5350-5470 MHz

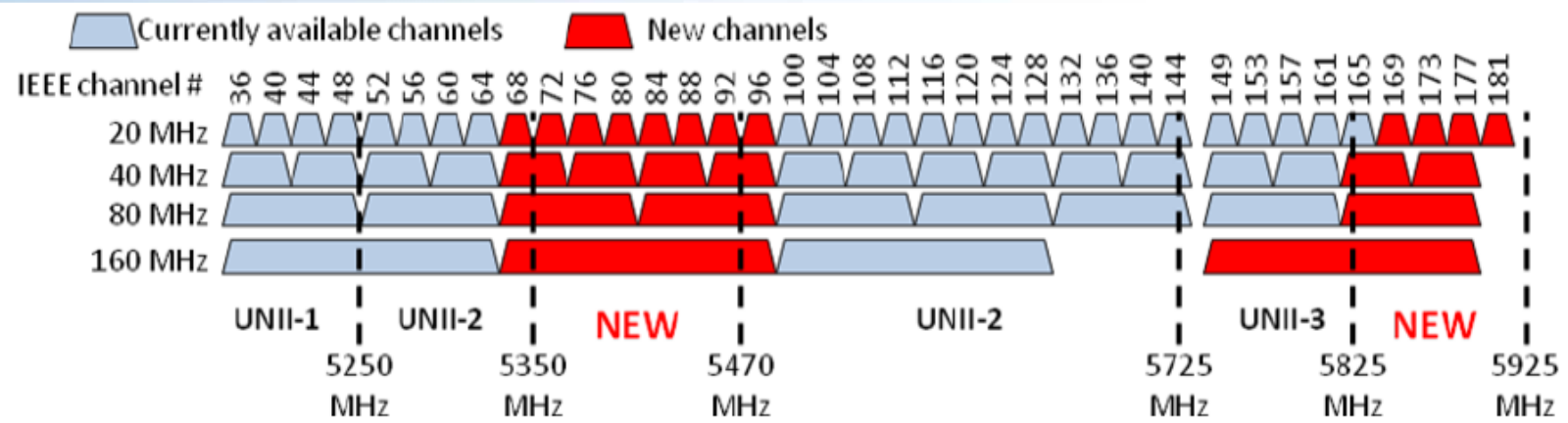
- Sharing with federal plane/ship/terrestrial radars & earth exploration satellite
- US proposing to continue international work for WRC-19
- Moving forward domestically
- Work group established:
 - FCC/NTIA/DoD/NASA
 - Considering IX protection studies & developing ways to share
 - Evaluating sharing with indoor low power/then outdoor high power

U-NII – 4 (75 Megahertz) 5850-5925 MHz

- Sharing with Dedicated Short Range Communications
 - Vehicle to Vehicle
 - Vehicle to Infrastructure
- IEEE Tiger Team had been working on industry proposals
 - Detect and avoid
 - Split the band
- FCC/NTIA/DoT collaborating
- Considerations:
 - Protect safety of life
 - Roads are everywhere
 - Wi-Fi & DSRC are similar



Implications for Wi-Fi



UNII-1: 5150-5250 MHz band

UNII-2: 5250-5350 MHz and 5470-5725 MHz band

UNII-3: 5725-5825 MHz band

Current 802.11ac and Potential New Usable Channels



Issues on Reconsideration

- Manufacturers of backhaul equipment and WISPA argue that the U-NII-3 OOB limit is too stringent
 - Reduces usable bandwidth
 - Requires expensive filtering
 - Joint petitioners filed consensus proposal, March 23, 2015
 - Relax OOB between 5.091 GHz and 5.15 GHz by 1 dB for every dB antenna gain exceeds 6 dBi provided that antenna is oriented at 30° or less above horizon
 - Three new OOB certification options
 - Mixture of installation locations; conducted OOB emission limits, OOB EIRP limits, and DFS
 - 5 km exclusion zone around each TDWR
 - Two methods for operators of point-to-point devices to verify that emissions in 5.725-5.85 GHz are below TDWR receiver threshold
 - FCC waived compliance deadline until December 2, 2015
 - FCC 15-61, June 1, 2015



Additional Issues on Reconsideration

- Clarify that set-top boxes in U-NII-1 band can operate at the maximum power
- Reconsider two-year from effective date cut-off of U-NII-3 certified devices under 15.247



Questions?