

FCC Actions to Increase Spectrum Access Through Advanced Sharing Techniques



Julius Knapp, Chief
Office of Engineering and Technology
Federal Communications Commission

ISART
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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

Spectrum Strategy

- Driver: Continued growth of mobile & other services

- Key Milestones:

- National Broadband Plan
- Middle Class Tax Relief & Jobs Creation Act of 2012
- Presidential Memos
- NTIA ten year plan
- PCAST Report
- Department of Defense Spectrum Strategy

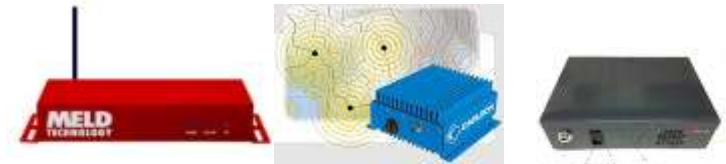


- Strategy:

- Consider potential reallocations, but becoming more difficult
- Develop advanced spectrum sharing techniques
- Continue to advance efficient use of the spectrum (flexibility)

Progress on White Space in the TV Bands (Unlicensed)

- Adopted final rules in 2012
- Nine devices approved:
 - Adaptrum, Koos Technical Services, Meld, Carlson, Redline and 6harmonix
 - All fixed devices, designed for professional installation - location entered manually
 - All are generic boxes with an input for a digital signal (voice, video, data).
- Data bases approved:
 - Spectrum Bridge, iconectiv (formerly Telcordia), Google, Key Bridge Global and KB/LS Telcom
- IEEE adopted "af" standard
- Strong international interest



Meld

Carlson

Adaptrum



Spectrum
Bridge



iconectiv



Wireless Cameras Cover Park
in Wilmington NC

Data Base Administrator Approval Process

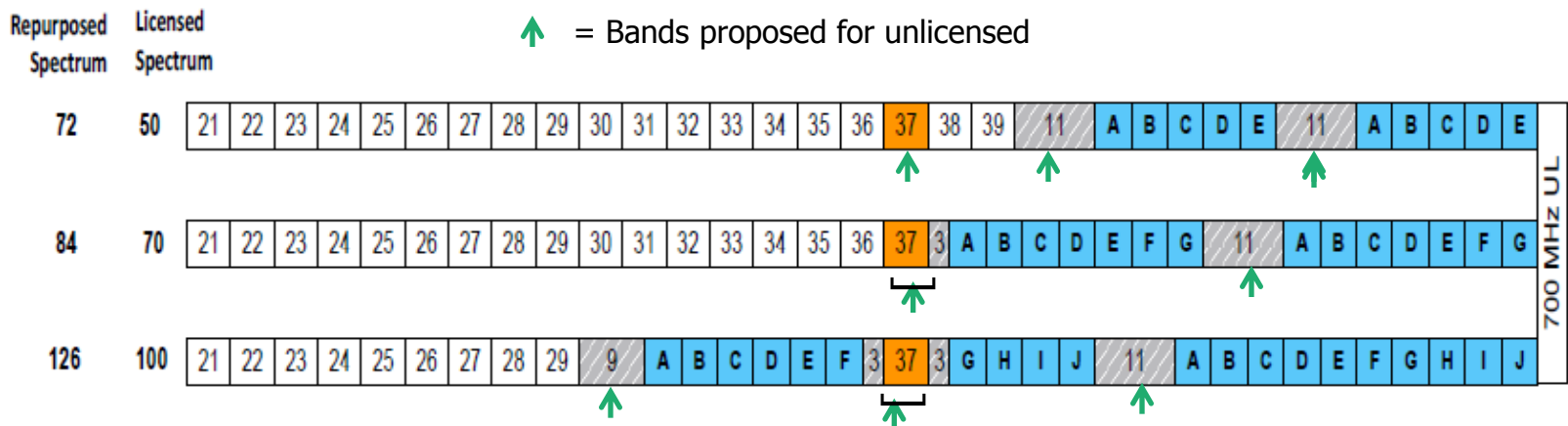
- File application
- Workshops
- Submit data base
- FCC Review
- Public beta test
- Final report
- Public comment
- Final approval
- Maintenance: Q&A's

White Space Database Administrators

Administrator Name	Contact Information	Approval Status
Airity, Inc. (formerly WSdb LLC)		Pending
Comsearch	H. Mark Gibson, 19700 Janelia Farm Boulevard, Ashburn, VA 20147 mgibson@comsearch.com	Pending
Frequency Finder, Inc.	Peter Moncure, 8910 Dick's Hill Parkway, Toccoa, GA 30557 pmoncure@radiosoft.com	Pending
Google Inc.	Alan.Norman, 1600 Amphitheatre Parkway, Mountain View, CA 94043 alannorman@google.com	Approved
KB Enterprises LLC and LS Telcom	Dr. Georg Schöne, Im Gewerbegebiet 31-33, D-77839 Lichtenau, Deutschland GSchoene@LStelcom.com	Approved
Key Bridge Global LLC	Jesse Caulfield, 1600 Tysons Blvd., Suite 1100, McLean, VA 22102 jesse.caulfield@keybridgeglobal.com	Approved
NeuStar, Inc.	Brian Rosen, 1775 Pennsylvania Ave., NW, Washington, DC 20006 brian.rosen@neustar.biz	Pending
Spectrum Bridge, Inc.	Peter Stanforth, 1064 Greenwood Blvd, Lake Mary, FL 32746 peter@spectrumbridge.com	Approved
iconectiv	John P. Malyar, 1 Telcordia Dr., Piscataway, NJ 08854 jmalyar@iconectiv.com	Approved
Microsoft Corporation	Ian Ferrell, One Microsoft Way, Redmond, WA 98052, ianf@microsoft.com	Pending

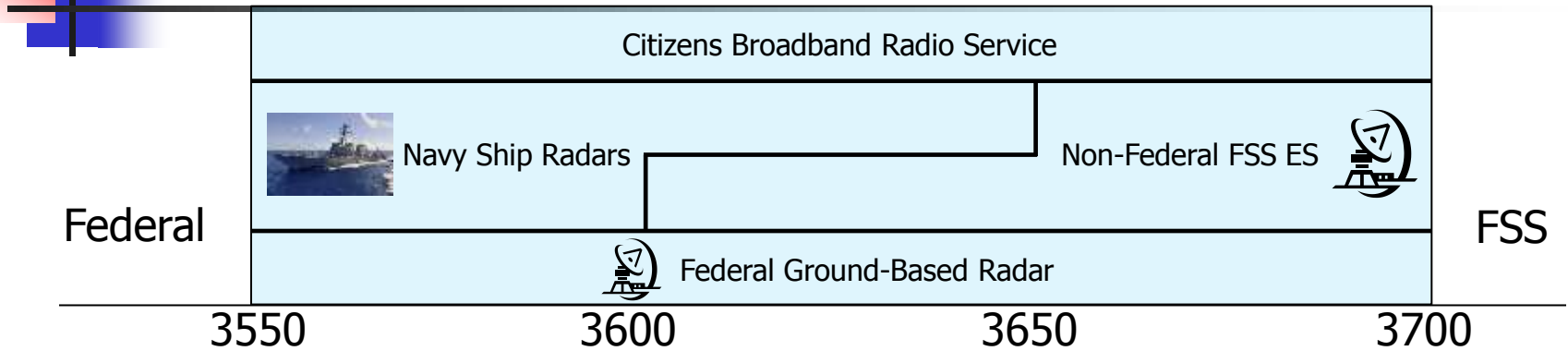
Proposed Rule Changes

- NPRM adopted Sept. 30, 2104
- Proposed unlicensed operation in:
 - Remaining white space
 - Duplex gap
 - Guard bands
 - Channel 37 – Shared non-Ix to medical telemetry and astronomy
 - Recovered spectrum until wireless operation commences

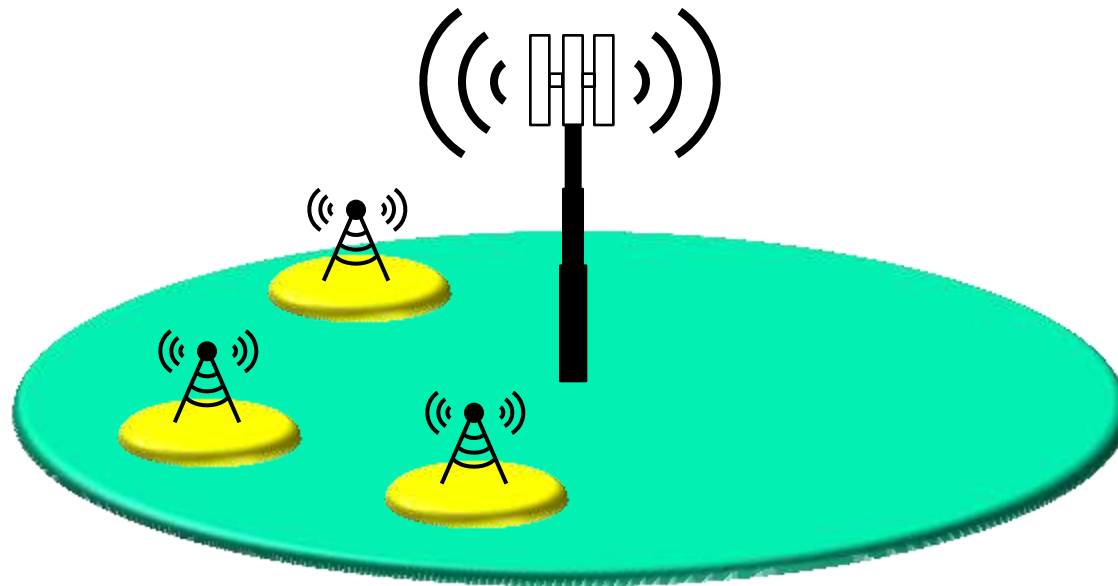


Citizens Broadband Radio Service

Report & Order Adopted April 17, 2015

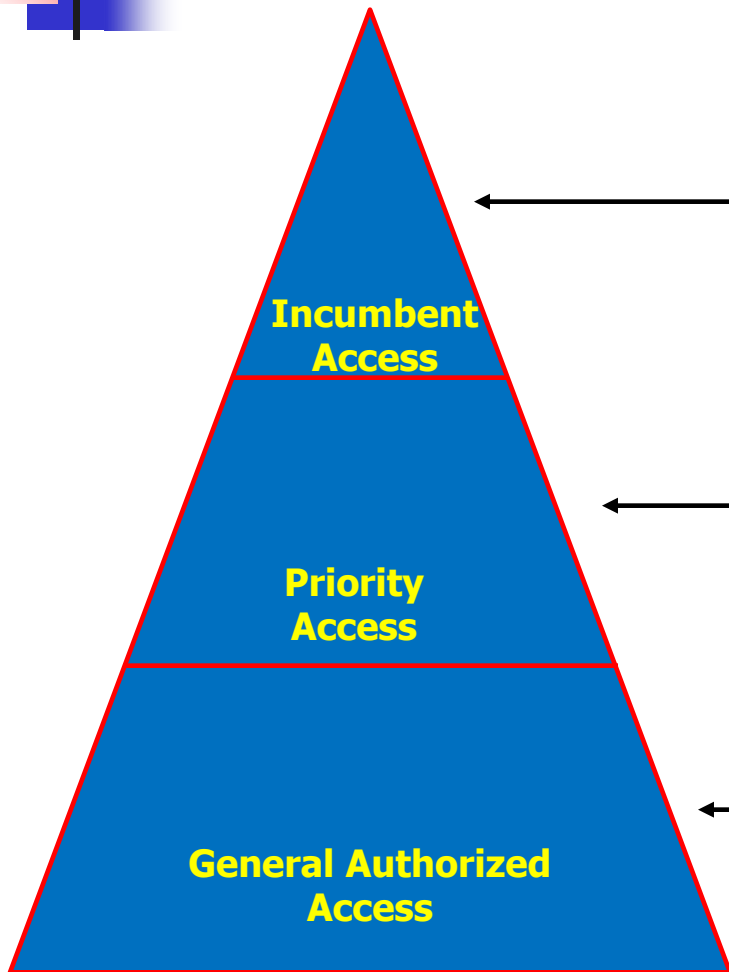


150 MHz
of
contiguous
spectrum



Dynamic
spectrum
access
for small
cells

Three Tier Access



Incumbent Access: Includes authorized federal and grandfathered 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

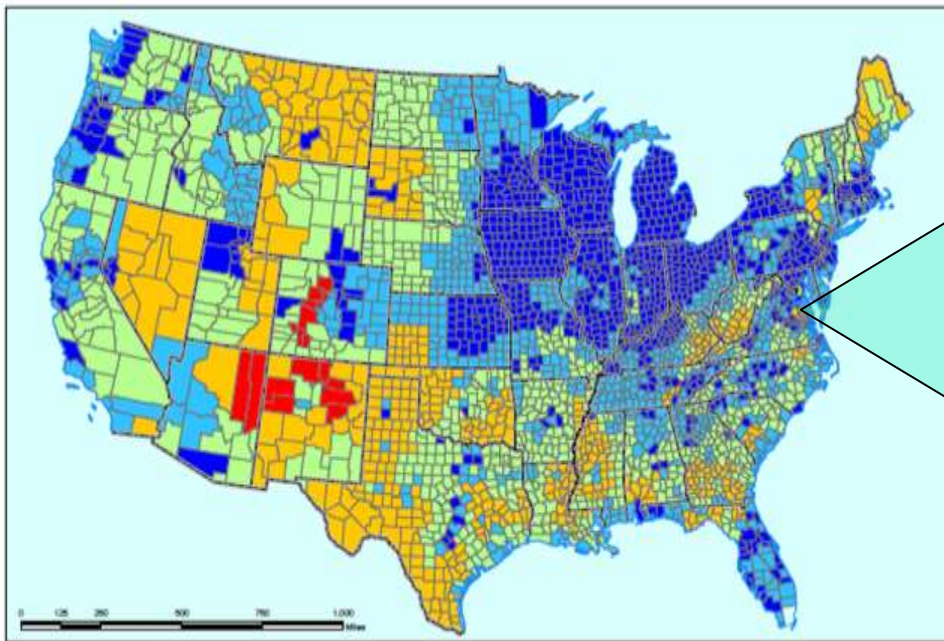
General Authorized Access (GAA): Users authorized to use the 3.5 GHz Band opportunistically. GAA users required to accept interference from Incumbent and Priority Access tier users.

License Areas

PALs licensed by census tract

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

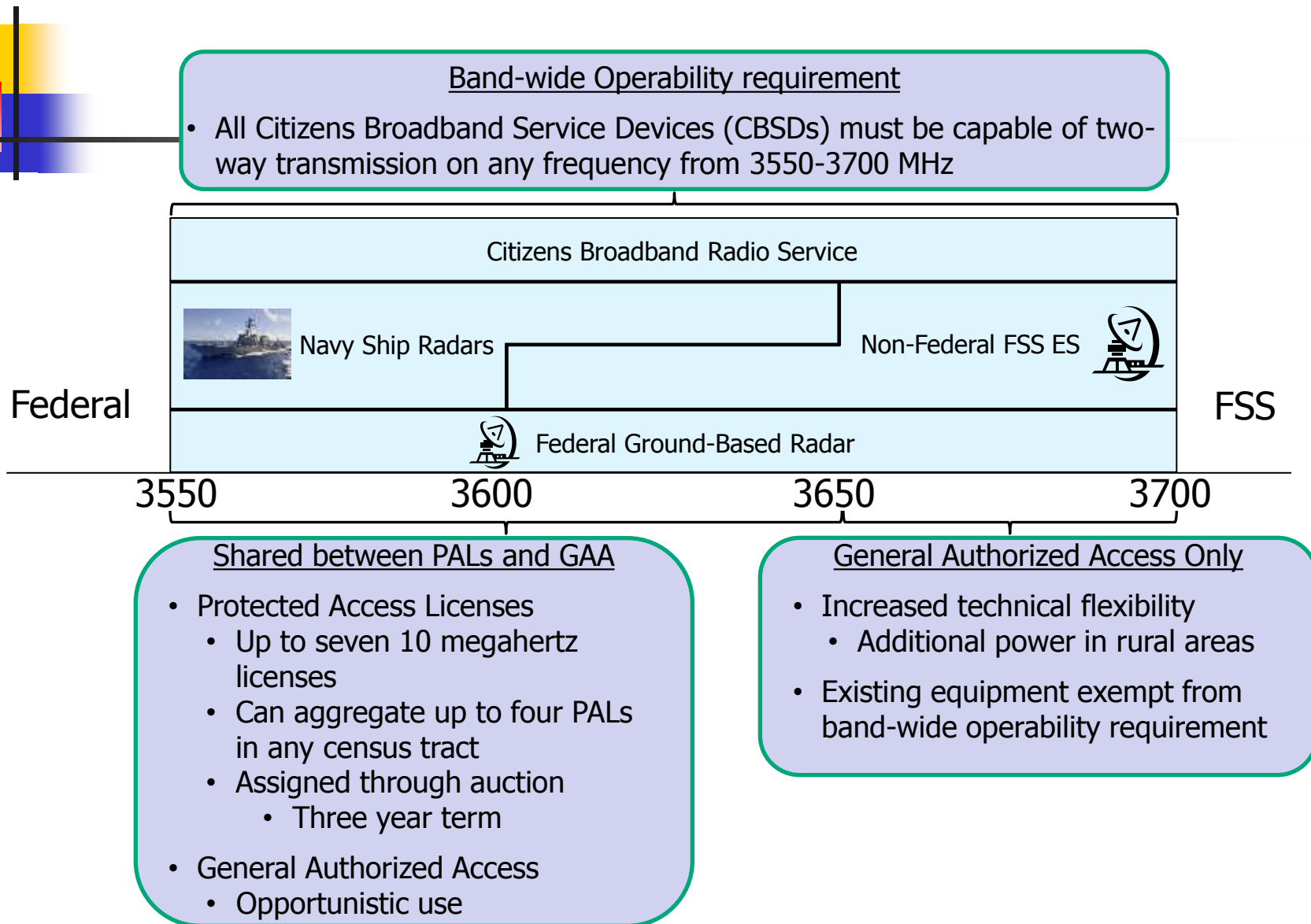
U.S. Census Tracts



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 3650-3700 MHz

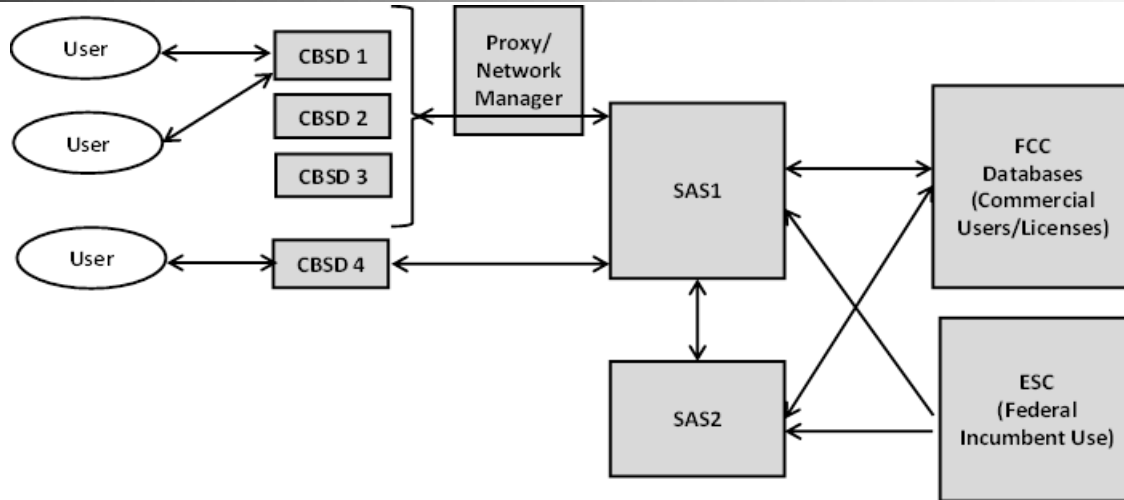
- Incumbent terrestrial broadband licensees grandfathered for five+ years
- Grandfathered FSS (3600-3700 MHz) register with FCC yearly
 - Protection based on operating parameters
 - Further Notice explores additional protection criteria



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



More Work To Do

Further Notice of Proposed Rulemaking

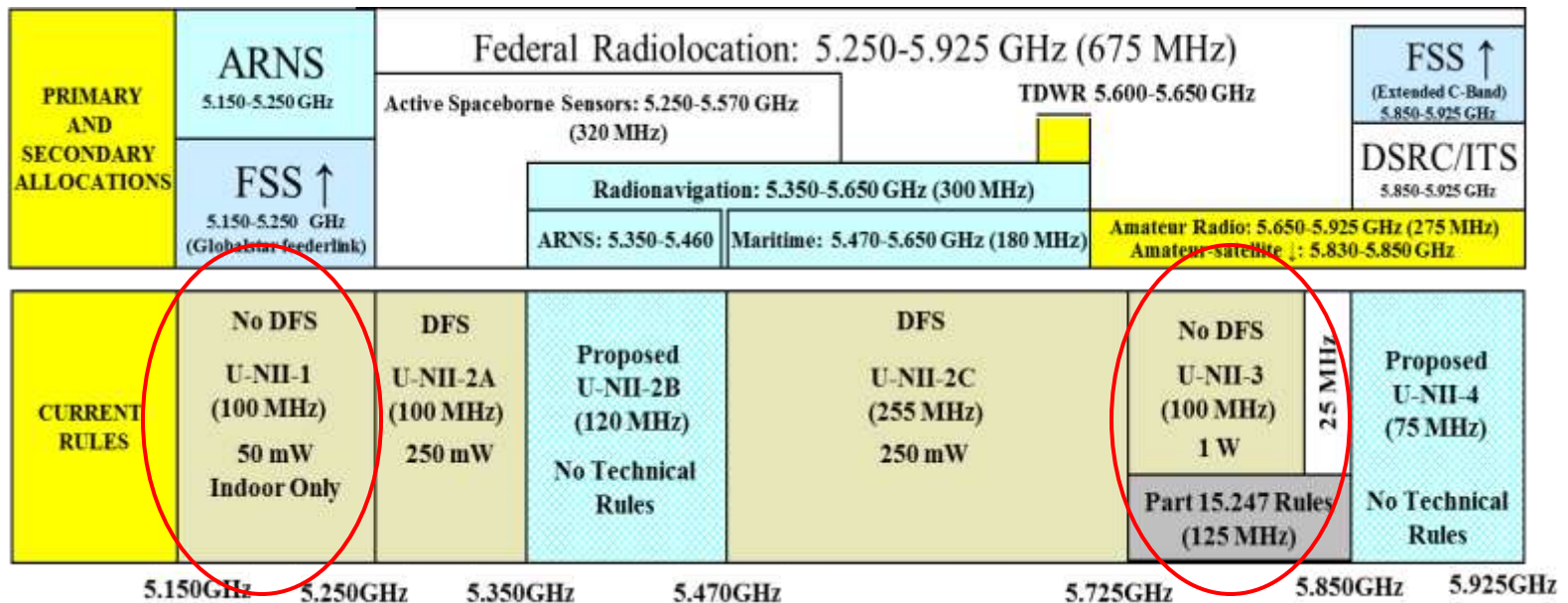
- Defining “Use” of PAL frequencies
- Implementing secondary markets in Priority Access Licenses
- Optimizing Protection for FSS
 - In-band protection of FSS in 3600-3700 MHz
 - Out-of-band protection of C band FSS earth stations

- 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

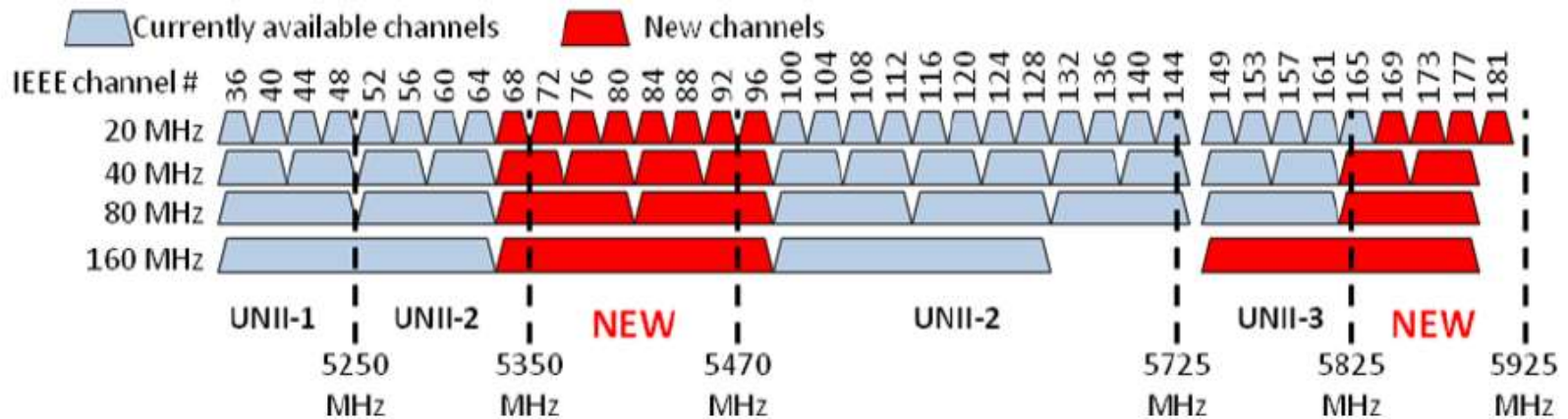
Expanding Spectrum for Unlicensed at 5 GHz

Previous Rules



- NPRM proposed to expand access to spectrum for unlicensed at 5 GHz
- First R&O 3/31/14 - Removed indoor-only restriction & increased permitted power for U-NII 1
- Continuing to work on sharing in proposed U-NII-2B and U-NII-4

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



Ongoing Work

U-NII-2B (120 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 MHz)

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

Expanding Use of the Millimeter Wave Spectrum

- FCC Notice of Inquiry (NoI) adopted 10/17/14
- Examines new developments in technology that could dramatically expand the horizon for spectrum that could be used for mobile wireless service, faster broadband speeds
- Recommended by Technological Advisory Council
- NoI is beginning of Process

Federal Communications Commission		FCC 14-154
Before the Federal Communications Commission Washington, D.C. 20554		
In the Matter of)	
Use of Spectrum Bands Above 24 GHz For Mobile Radio Services)	GN Docket No. 14-177
Amendment of the Commission's Rules Regarding the 37.0-38.6 GHz and 38.6-40.0 GHz Bands)	ET Docket No. 95-183 (Terminated)
Implementation of Section 309(j) of the Communications Act – Competitive Bidding, 37.0-38.6 GHz and 38.6-40.0 GHz Bands)	PP Docket No. 93-233 (Terminated)
Petition for Rulemaking of the Fixed Wireless Communications Coalition to Create Service Rules for the 42-43.5 GHz Band)	RM-11664
NOTICE OF INQUIRY		
Adopted: October 17, 2014		Released: October 17, 2014
Comment Date: December 16, 2014		
Reply Comment Date: January 15, 2015		
By the Commission: Chairman Wheeler and Commissioners Clyburn, Rosenworcel, Pai, and O'Rielly (using separate statements)		
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<http://www.fcc.gov/document/noi-examine-use-bands-above-24-ghz-mobile-broadband>



NoI: Technology

Smart Antennas	<ul style="list-style-type: none">• Base Station Antenna (32, 64 elements, patch antennas)• Handset Antenna (modular arrays of 4 elements or more)• Digital/Analog/hybrid beamforming/MIMO processing of array(s)• Modules comprising of a RFIC chip and beamforming unit
Bandwidth	<ul style="list-style-type: none">• Throughput is a function of available bandwidth• Large contiguous blocks of spectrum present certain advantages over multiband spectrum aggregation, particularly with respect to handsets• contiguous blocks of 500 MHz- 2GHz
Performance	<ul style="list-style-type: none">• Maximum throughput up to 10 Gbit/s and at least 100 Mbit/s at cell edge• end-to-end latency of < 5 milliseconds and air latency of < 1 millisecond• channel bandwidths in excess of 1-2 GHz
Backhaul	<ul style="list-style-type: none">• Integrated backhaul/access (multi-hop communication)• Inband/Outband options in the mmW bands; Fiber and other options
Deployment Scenarios	<ul style="list-style-type: none">• Initial deployment will be complementary as hotspot offloading• Eventually a standalone network, but one that is like a WiFi network rather than a ubiquitous nationwide system of mmW access points



NoI Frequency Bands

LMDS	<ul style="list-style-type: none"> • Co-primary for fixed and mobile • Large contiguous bands 27.5-28.35 GHz, 29.1-29.25 GHz, 31-31.3 GHz, • Licensed on geographical basis, FSS sharing possible
39 GHz	<ul style="list-style-type: none"> • Co-primary for fixed and mobile; Large contiguous bands (1.4 GHz), • Licensed by Economic Area; May require exclusion zones
37/42 GHz	<ul style="list-style-type: none"> • Co-primary for fixed and mobile (but not authorized for mobile) • Large contiguous bands 37-38.6 (1.6 GHz) and 42-42.5 (0.5 GHz) • Larger contiguous block possible by combining with LMDS band • Federal use
60 GHz	<ul style="list-style-type: none"> • Co-primary for fixed and mobile • Large contiguous bands 57-64 (7 GHz) and 64-71 (7 GHz) • Unlicensed operation in the 57-64 GHz band (IEEE 802.11ad) • Potentially three 2.3 GHz block licensed operation in the 64-71 GHz band
70/80 GHz	<ul style="list-style-type: none"> • Co-primary for fixed and mobile • Large contiguous bands 71-76 (5 GHz) and 81-86 (5 GHz) • Non-exclusive licensed operation, Database aided spectrum coordination, • Does not support the concept of CMRS (service area-based)
24 GHz	<ul style="list-style-type: none"> • No Mobile allocation; licensed in geographic areas to fixed services



Next Steps

- Staff considering next steps in domestic proceeding
- WRC 15 is expected to frame future WRC agenda item to identify spectrum for advanced mobile services
- U.S. is developing its position
- We are working with other nations in multiple fora

Model City Program

- NTIA/FCC Model City Program for Demonstrating and Evaluating Advanced Wireless Spectrum Sharing Technologies
- Outgrowth of PCAST
- Comment invited last summer
- Workshop held April 15-16 to explore concept, scope, governance, process, technical considerations and funding alternatives.

Some trade-offs to Consider

Urban Area:
A "Real Test"
but high risk

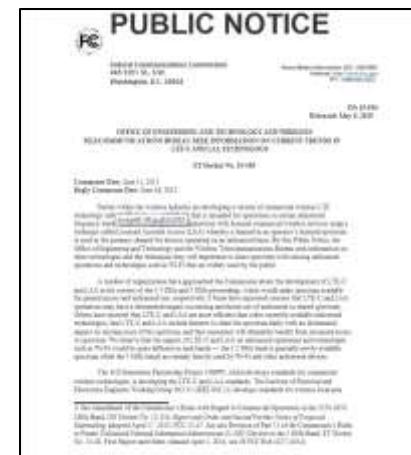
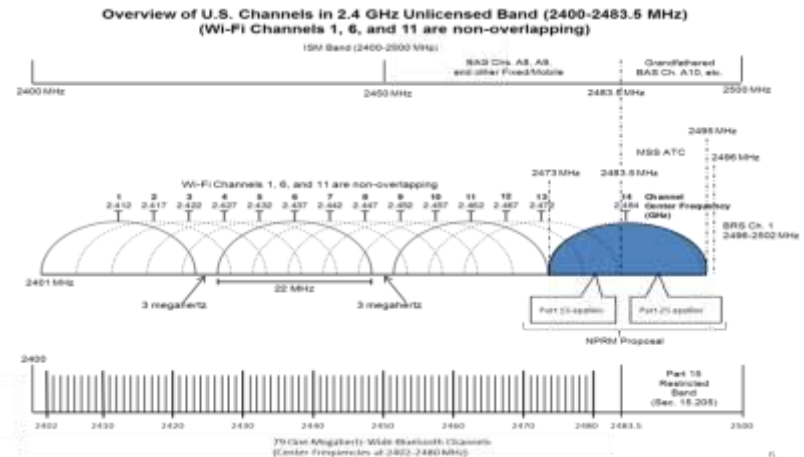


Remote Area:
More limited
demonstration
but low risk

Other "Sharing" Matters

- Proceeding on Globalstar's proposed Terrestrial Low Power Service (TLPS)

- FCC Public Notice issued on May 5, 2015 solicits information on LTE-U and LAA: standards development & how they will share spectrum





Spectrum Sharing: Research and Development

- NTIA: Center for Advanced Communications
- National Information Technology R&D (NITRD)/
Wireless Spectrum R&D (WSRD)
- National Science Foundation
- Defense Applied Research and Development Program: Radars
- The Department of Defense (DOD) Section 845 Other Transaction
(OTA) agreement to develop and mature technologies and support
policy development to enable advanced approaches to electromagnetic
spectrum use
- Academic Work
- Conferences: ISART, DySpan and others



Conclusion

Questions?