Increasing Mobile Spectrum Availability
AIMS 2014

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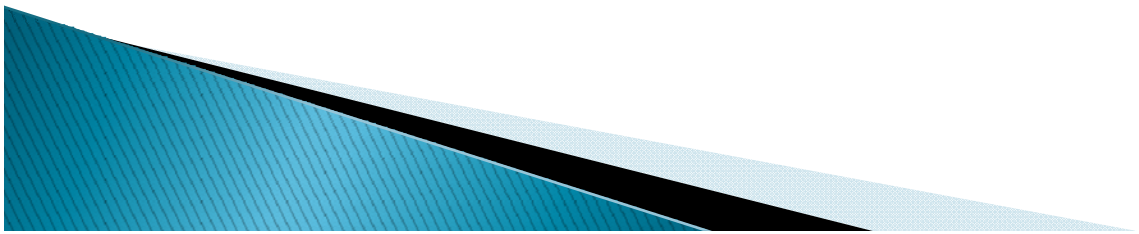
Views Expressed Herein Are Those of the Author and Do Not Necessarily Reflect Those of the FCC

Mobile Spectrum Availability

- Useable spectrum already allocated
  - Mobile Communications: from about 600 MHz to 5 GHz today
- Options:
  - Reallocate spectrum to higher value usage
    - Cost: recent estimate of $18B to reallocate 1755-1850 MHz
    - Time: typically 10 years or more
  - Share spectrum
    - However incumbents protected from interference and this imposes constraints
    - Worst case analysis often used for protection
  - Use spectrum in higher bands
    - Current technologies not capable within demands of size and power constraints



Spectrum Availability Strategies

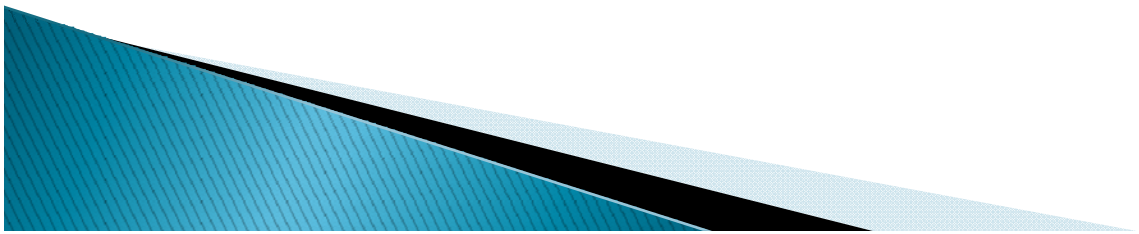
- Near term
  - Reallocate spectrum where possible
    - H Block , AWS-3, Incentive Auction 600 MHz
  - Promote spectrum sharing opportunities while protecting incumbents
  - Advance concept of small cell deployment with lower power levels*
  - Examine applicability of Interference levels on future spectrum allocations*
- Longer term:
  - Work with industry on usability of Higher Band Spectrum

*Recommendations of
FCC Technological Advisory Council

Spectrum Sharing

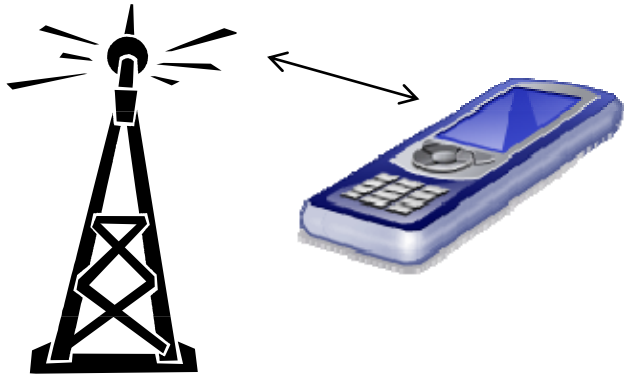
New Paradigm: White Space

- Basic Concept:
  - Identify unused spectrum – White Space
  - Device/Network adapts to use it – Dynamic Spectrum Access (DSA)
  - Technical standards protect incumbent services
- First Implementation: Provided for unlicensed operation in white space in TV bands based on database access
  - The result of 10 years of discussion with stakeholders

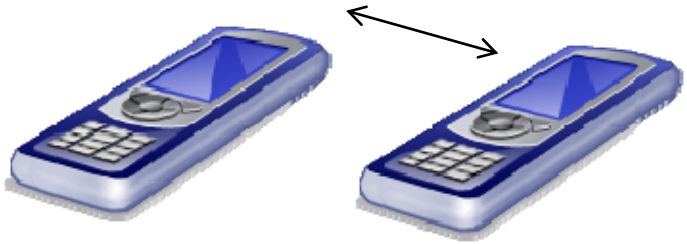


Personal/Portable Devices

- Power limit: 100 mW except 40 mW on adjacent channels
- May operate on channels 21-51, except channel 37
- Mode I device obtains channels from a fixed or Mode II device
- Mode II device obtains channels from database (may contact database thru fixed device or Mode II device)
- Mode II devices re-check database daily
- Mode I devices must contact, or receive a contact signal from, their fixed or Mode II device at least once per minute



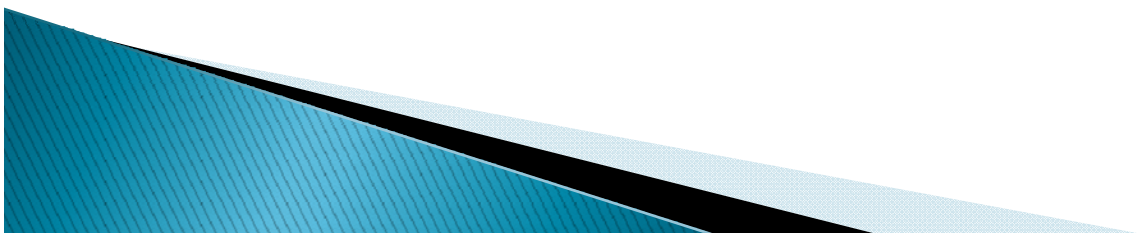
Mode 1: Portable device obtains location/channels from fixed device



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

White Space Database Administrators

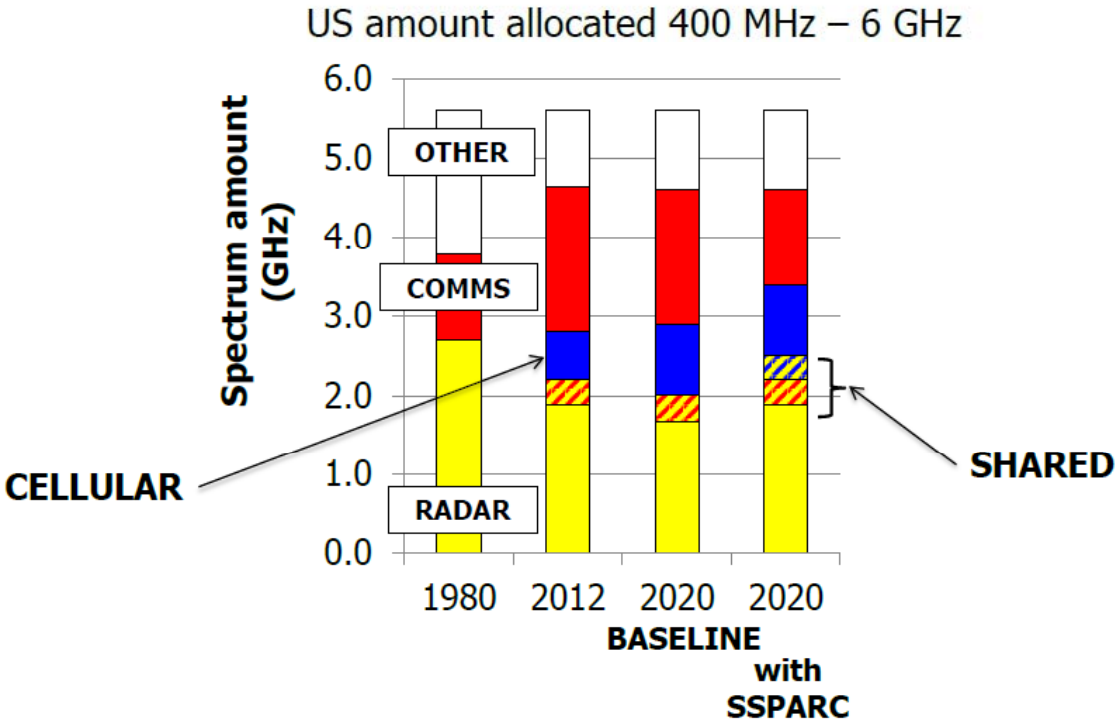
- Key innovation
  - White space channel allocation under control of database administrator
- Multiple database administrators
- Database administrators are required to work together and share registration information
- Database administrators met separately to agree on algorithms for calculating TV contours and develop a standard for information sharing



Small Cells and Spectrum Database

Spectrum Allocations

DARPA Motivation for radar/communications spectrum sharing

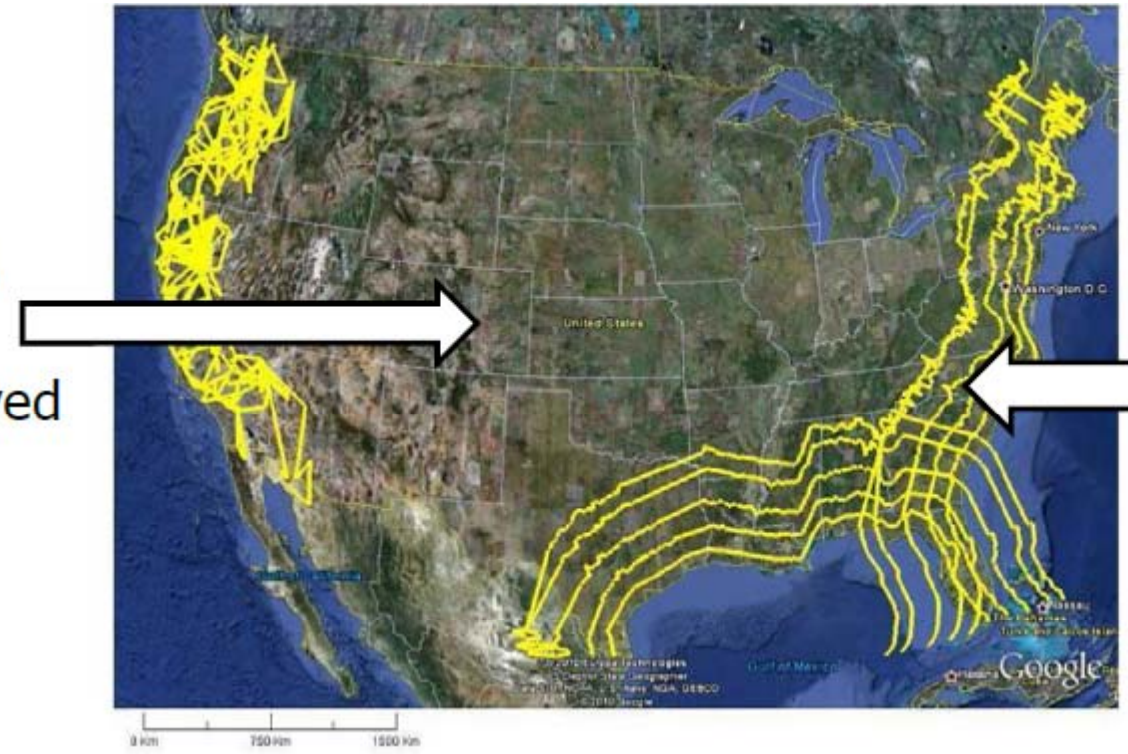


Improve BOTH radar and communications capabilities

Limitations of geographic isolation

NTIA study of WiMax sharing with 3550-3650 MHz Navy S-band radars.

WiMax networks may be deployed inland.



WiMax may not be deployed close to shore.
100-500 km standoff

55% of US population lives within 80 km of shore.

NOAA analysis of US census data.

NTIA 2010, "An Assessment of the Near-Term Viability of Accommodating Wireless Broadband Systems in the 1675-1710 MHz, 1755-1780 MHz, 3500-3650 MHz, and 4200-4220 MHz, 4380-4400 MHz Bands"

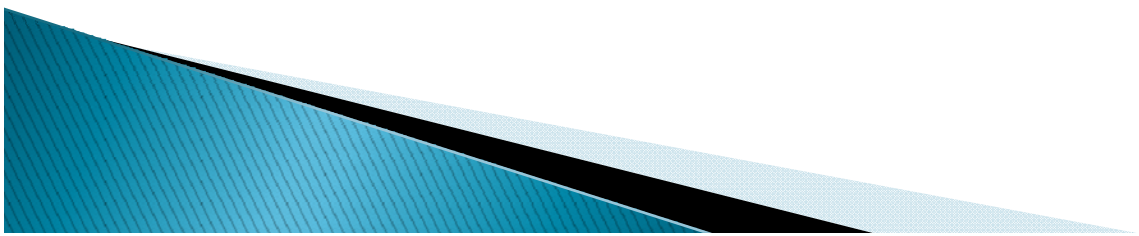
3.5 GHz

- FCC/NTIA reexamined 3.5 GHz based on small cell deployment
- Small cells
  - Limited power
  - Many in-building applications
  - Low antenna heights
- Proposed Spectrum Access System
  - Protect incumbent systems
  - Building on white spaces experience
  - Dimensionality of spectrum access system under discussion but expected to be evolved beyond white spaces
    - Many incumbents are mobile

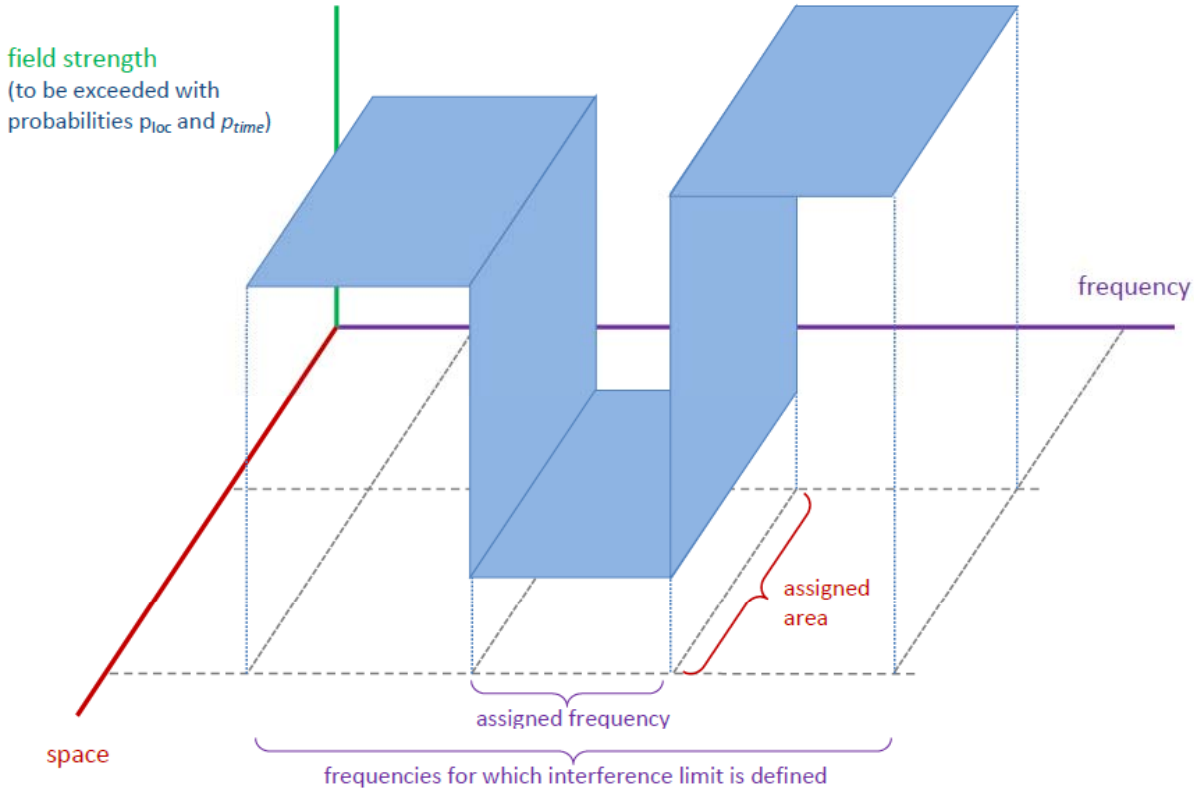
Interference Levels

Interference

- Incumbent protected from interference
- No clear definition for ‘acceptable interference’
  - Worst case often argued
- Current rules limit transmitted power but have no impact on receiver ability to reject interference
  - Limited incentive for improving receiving performance

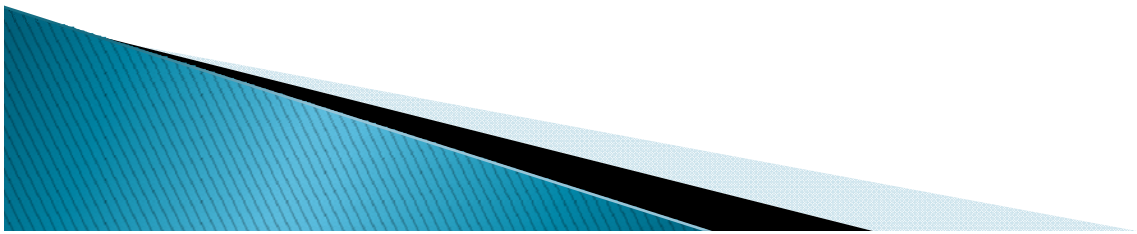


FCC TAC Recommendation on Harm Claim Thresholds



Harm Claim Threshold

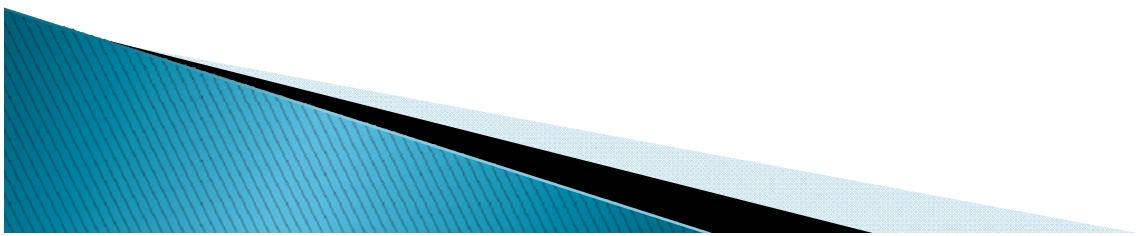
- Multi-stakeholder Groups define harm claim thresholds for specific frequency bands
- Harm claim thresholds provide a safe harbor by defining allowable interference levels
- Shifting from Worst Case situations and no interference to a probabilistic definition of allowable interference levels
- Under consideration for use in 3.5 GHz



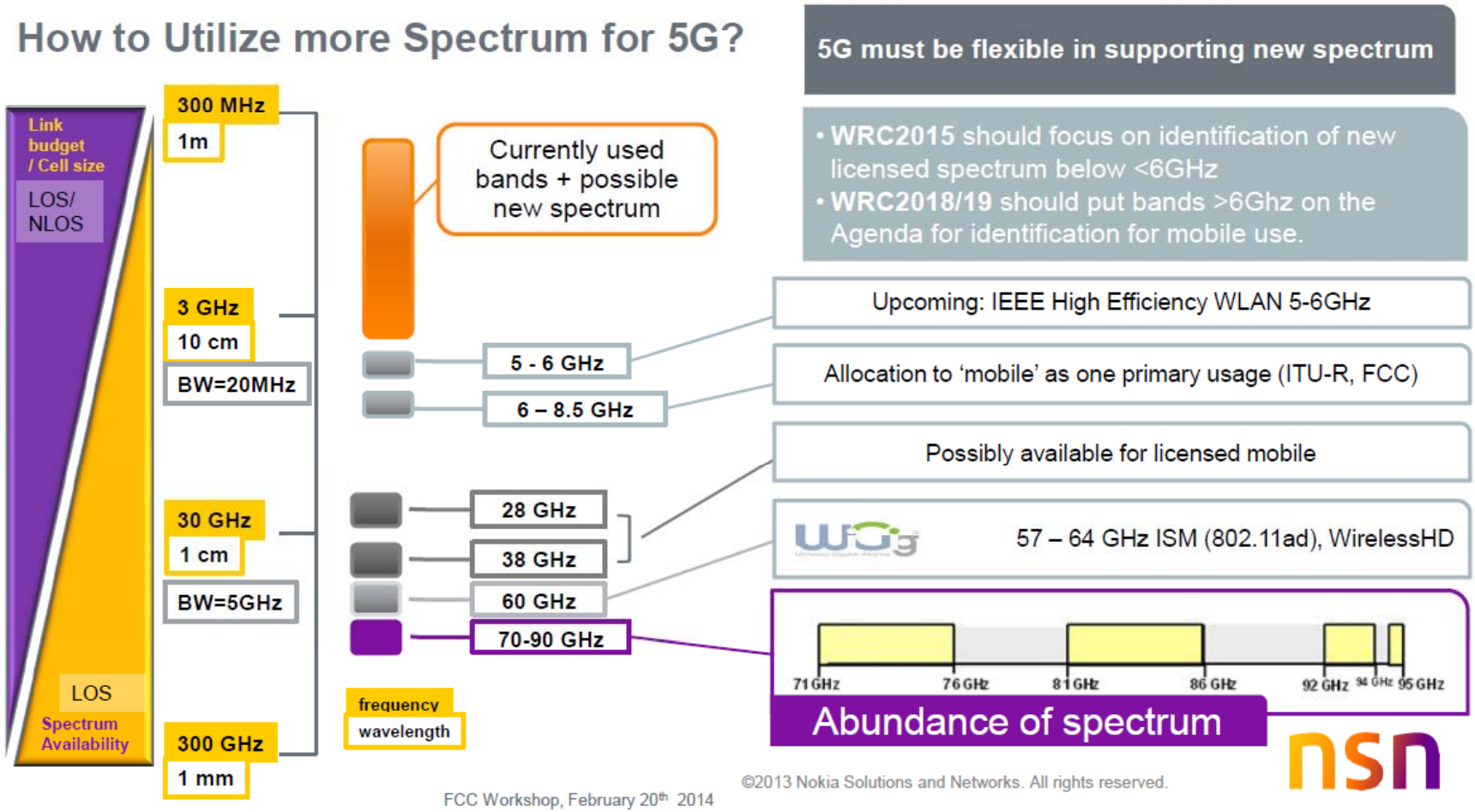
Long Term Higher Band Opportunities

Higher Band Opportunities

- Increasing research interest in higher bands for communication purpose (> 20 GHz)
- Work coalescing under 5G Banner
- Advantages
  - Large amounts of spectrum
  - Small antenna size permits complex antenna arrays allowing beam forming
  - High attenuation can be mitigated by beam forming over short distances
  - Good candidate for small cell strategies
  - Addresses needs of future Internet of Things
- Disadvantages
  - Device issues especially for mobile devices
  - Many research dimensions to address: 2020+ target dates



Opportunities at Higher Band



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Questions?

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