CSMAC
Search for 500 MHz Working Group

UPDATED Interim Report
Boulder, Colorado
August __, 2011

Initial Recommendations

I. NTIA should utilize the LTE Technical Characteristics attached as an Appendix hereto for its initial interference and other analyses, and should work closely with industry to fully understand system impacts and refine analysis and sharing solutions.

II. NTIA should implement an informal process, consistent with all applicable laws, to directly exchange data and have a dialogue between government and industry in order to facilitate and implement the spectrum recommendations in this Report.

III. NTIA should stage the availability of the 1755-1850 MHz band for commercial use, with a priority on the early availability of 1755-1780 MHz, and extending in contiguous stages as necessary to accommodate the relocation and retuning of government users.

IV. NTIA should make spectrum available such that commercial users have exclusive use of the spectrum; however, given existing government uses, industry supports making spectrum available subject to pre-defined sharing zones where the commercial users accept reasonable and defined levels of interference.

Introduction

I. Need for Additional Wireless Broadband Spectrum

II. NTIA's Response

- NTIA's Primary Role re Government Spectrum
- October 2010 Ten-Year Plan and Timetable and Fast Track Evaluation
- September 30, 2011 NTIA Commitment re 1755-1850 MHz Band

III. CSMAC Role and Timetable

- Input to the September 2011 Report
- Search for 500 MHz Subcommittee
  - Technical and Valuation Subgroups
- Reply to Specific NTIA Questions
- Focus on 1755-1780 MHz

1755-1850 MHz

- **Strong Industry Support for Reallocation of 1755-1850 MHz**
  - Globally harmonized
  - Builds on AWS and PCS spectrum
  - License through auction for commercial use
- **Two-stage Approach**
  - 1755 - 1780 MHz – Highest Priority
    - FCC has 2155-2180 MHz available for paired spectrum
    - Near term availability for auction likely possible by limiting some government operations to 1780-1850 MHz pending longer term transition
    - Global harmonization and building onto AWS spectrum provides economies of scale and facilitates equipment deployment
  - 1780 – 1850 MHz – Longer Term Focus – Additional time provides:
    - Opportunity to further develop government relocation and sharing options
    - Development of pairing options as other frequency bands are studied

Principles for Spectrum Availability

- **Clearing Spectrum Should be Goal**
  - Provides greatest utility and opportunity for commercial broadband
  - Provides highest spectrum value
- **1755 -1780 MHz - SubBand**
  - Relocate government operations outside of 1755-1850 MHz band as preferred option
  - If not feasible, limit government operations to 1780-1850 MHz to the extent possible, using existing equipment
    - Avoid replacing equipment for short-term migration from 1755-1780 MHz to 1780-1850 MHz
      - Replacement increases costs of making spectrum available
      - Pursue short-term sharing options instead
- **1755-1850 MHz - Entire Band**
  - Relocate government operations to other frequency bands or technologies
  - Short to medium term sharing where necessary
  - Long-term sharing limited to cases where relocation is not possible and where sharing provides substantial access for commercial operations
    - Exclusion zones should avoided in favor of time-based/geographically limited sharing

Technology Subgroup

1(d) What Commercial wireless technical characteristics should be used in sharing analysis?

- Technical System Characteristics Attached as Appendix

1(e) - What percentage of time can Industry live with interference? Is there a way to estimate the impact of increasing interference on spectrum value?

- **No Simple Answer to What Percentage of Time for Interference is Acceptable**
  - It will depend on the area and intensity of interference
    - Interference in highly populated areas will generally have greater impact and be less acceptable than more rural areas.
  - Some operations and operators may be able to accept more interference than others
    - Impact can be technology dependent
    - Acceptable impact influenced by a variety of factors, including: overall system configuration, other spectrum holdings and exact nature of interference
  - Limited Interference and sharing will generally be preferable over exclusion zones
    - Interference potential is limited in time and/or intensity
    - As much information regarding the nature and timing of interference should be provided in order to allow planning and certainty
    - Access to population centers should be prioritized

- **NTIA Should Work with Industry to Understand Impact of Interference on a Government System-by-System Basis**

1(f) - How does industry define the impact of interference to the systems, particularly with the availability of multi-band phones?

- **Direct Impact of Interference is Degradation in Signal Quality**
  - Signal to Interference-plus-Noise Ratio (SINR) – impacts spectral efficiency & mobile network capacity
  - The stronger the interference , the worse the SINR of the received signals
  - Impairment relationship applies regardless of the technology in question (HSPA, LTE or others)

- **Impact on user experience differs depending on services provided**
  - Impact to circuit-switched (CS) real-time services, such as voice, may be greater than to packet-switched (PS) data services such as email and web-browsing
    - CS voice - degradation in voice call quality, or, a dropped call
    - PS data service - lower data rates resulting in a longer downloading time for an email or a web page
  - Trend is away from CS to PS services

- **Multi-Band Phones can help mitigate impact of interference**
  - Network can command the multi-band phone to move to another frequency band through inter-frequency handover (IFHO) when severe interference is encountered in the serving frequency band.
  - Current multi-band phones operate in one frequency band – some delay (hundreds of milliseconds) to retune to new frequency during an IFHO
  - Multi-band carrier aggregation will allow future multi-band phones to operate in multiple frequency bands simultaneously, avoiding the delays associated with an IFHO and allow the system to more effectively deal with interference in a band
    - 3GPP Release 10
    - Supported in both HSPA and LTE
  - Provides mitigation against interference, <u>but at expense of network capacity</u>

1(g) - If there will be interference to industry at some locations or time within an agreed sharing approach, what is needed in terms of service rules to incorporate the interference into the terms of the license and licensee expectations?

- **Rules Will Vary Based on Level and Structure of Interference and Sharing**
  - Exclusion zones are worst case and have greatest negative impact on use of spectrum
    - May be acceptable if limited or in geographically remote areas
  - Creation of "Sharing Zones" based on cooperative sharing mechanism providing coordination between sharing entities will help maximize spectrum use by both parties and minimize disruption to operations
    - Database information or prior signaling of intent
    - Use of streamlined information sharing methods should be investigated (e.g., DoD portal)
  - Uncoordinated sharing feasible in some cases
    - 5 GHz unlicensed example
  - Numerous lessons learned and experience with 1710 – 1755 MHz band

- **More Information From Involved Parties (both Interfering and Interferee) is Necessary**
  - Information regarding the expected level, rate of occurrence and location of interference
  - Power, antenna characteristics and height, bandwidth, anticipated timing , etc.

- **Rules Should Define Expected Interference Level and the Relative Responsibilities of the Sharing Parties as Closely as Possible**
  - 800 MHz rebanding example
    - Rules (90.672) define conditions, including signal strength and receiver performance requirements, under which unacceptable interference should not be received
    - Provides coordination requirements (90.675), assigns responsibly for resolving interference (90.673) and mitigation procedures (90.674)

- **Rules should provide flexibility for resolving interference**
  - Overly prescriptive rules will not yield optimum solutions or allow for new approaches as technology changes
  - 2GHz BAS example where industry provided filters to ENG operations

1(i) - Band pairing of 1780-1850/separation requirements – What will industry do in terms of band pairing with 1780-1850 MHz if NTIA can free that portion of the spectrum, or will it implement TDD?

- **The Entire 1755-1850 MHz Band Meets Principles for Spectrum Identification and Use**
  - **Paired Spectrum**
    - CMRS traditionally uses FDD technology - requires paired spectrum
    - FDD technology remains preferred over TDD for mobile broadband and should be a priority
      - TDD may have advantages to support asymmetric traffic, but can create uplink/downlink interference issues with adjacent operations and ultimate mix of traffic is not clear.
    - Optimal pairing - downlink/uplink bands close enough to enable efficient device and antenna design, but not so close that interference problems within the device are created
  - **Interference Issues**
    - Minimize the risk of harmful interference
    - Services with similar attributes make good neighbors, while services with very different characteristics can lead to interference
      - For example – Mobile broadband adjacent to high power broadcast
  - **Equipment Design Issues**
    - Allocating spectrum adjacent to current mobile broadband frequency bands facilitates leveraging R&D and investment
    - Allocations consistent with current uses, (e.g. duplex spacing) simplifies equipment design and promotes compatibility with existing systems
  - **Spectrum Harmonization**
    - International harmonization helps drive greater economies of scale
      - Reduces costs of equipment and services
      - promotes global roaming
      - eases frequency management efforts near international borders
    - US efforts should be promoted within the ITU

1(i) Response Cont. - 1755-1780 MHz

- **1755-1780 MHz Should be Uplink Paired with 2155-2180 MHz**
  - Meets Principles
    - Paired Spectrum - Builds on AWS - Paired spectrum readily available (AWS 2/3)
    - Interference issues – Aligns uplink/downlink with adjacent operations
    - Equipment design – Consistent with existing AWS equipment
    - Harmonization - 3GPP Band Class 10
- **Near-term auction availability following a reallocation decision this year**
- **Should remain highest priority**

1(i) Response Cont. - 1780-1850 MHz – Allocate Consistent with Principles

- **Paired Spectrum**
  - Preference for mobile uplink paired with suitable downlink band
  - Priority on extending spectrum in contiguous blocks from 1780 MHz
  - Potential downlinks paired bands identified for study or migration to terrestrial use
    - 2 GHz MSS bands (2000-2020/2180-2200 MHz), 2200-2290 MHz
      - Potential exists to build mobile broadband spectrum consistent with AWS and PCS use
      - Should be a priority for consideration
    - Other options possible as search for 500 MHz continues
- **Interference Issues**
  - TDD use would create interference problems with AWS and PCS uplinks
    - Require large guardbands
- **Equipment Design**
  - Within range of existing AWS and PCS bands
  - Similar duplex spacing if paired properly
- **Harmonization**
  - Identified globally for mobile broadband
- **Include as Part of a long-term spectrum plan**

Overview of Government Systems

Fixed Pt-to-Pt

- **Operate throughout the 1755-1850 MHz band**
- **Relocation of similar systems has been done both in non-government and in the 1710-1755 MHz government band Operate throughout the 1755-1850 MHz band**
- **Process and cost of relocation is well understood**
- **Relocation options include**
  - 4, 6, 7, 8, 11 and 15 GHz bands
  - Alternative solutions, such as fiber optics
- **Relocation should be feasible**
- **Transitional sharing should also be feasible**

Tactical Radio Relay

- **Portable Microwave system providing backhaul connection for voice, video and data communications**
  - Navy/Marine Corps equipment is capable of operating in the 1350-1850 MHz band
  - Army equipment is capable of operating in the 1350-2690 MHz band
  - Paired frequencies (1350-1390 paired with spectrum in the 1755-1850 MHz band)
    - 25 kHz bandwidth with minimum 50 MHz separation between transmit/receive
- **Oct. 2010 NTIA report (pg 3-27) states that a minimum of 95 megahertz of contiguous spectrum is required**
  - March 2001 NTIA report states that the channels in the 1350-1390 MHz band are paired with the 1755-1850 MHz band
  - If only 40 MHz is available in 1350-1390 MHz band, it would appear that the full 95 MHz in the 1755-1850 MHz band is not necessary and that it may be possible to limit operation to above 1780 MHz pending longer term relocation
- **TRR trunks support 16, 32, or 64 channels per trunk with each channel capable of 16 kbps (March 2001 NTIA report)**
  - Equates to 0.64 bps/Hz
  - Section 101.141(a)(1) of the FCC rules requires a minimum bit rate of 1 bps/Hz for fixed systems
  - TRR equipment is operating at only 64% of the efficiency required for FCC authorized operations
  - Would appear to indicate that transition to more efficient operations is appropriate
- **Areas for consideration**
  - May be able to operate on a secondary, coordinated basis in other portions of the spectrum or bands (see relocation chart)
  - Short term restrict operations to above 1780 MHz
  - Long term relocation (2020-2110 MHz, 2200-2290 MHz within range of existing equipment)
  - Transition to more spectrally efficient equipment
  - If sharing is necessary, additional information on expected operations is necessary to determine feasibility of dynamic sharing.
    - Timing and duration of use
    - Number of channels used for small scale operations versus large scale

Satellite TT&C

- **DoD conducts TT&C uplink (Earth-to-space) operations in the 1761-1842 MHz band**
  - Not primary communications links, but are used for Tracking, Telemetry & Control of satellites
  - Critical for satellite operation, but use not as intense as primary communications

- **NASA and NOAA conduct similar operations in the 2025-2110 MHz band (March 2001 NTIA report)**
  - 2025-2110 MHz is globally harmonized

- **Co-primary allocation added for DoD operations and locations in 2004 (US footnote 346)**
  - Decision recognized that in-orbit satellites could not be modified
  - Expectation was that the DOD would begin to use the 2025-2110 MHz band for future satellite operations.

- **Areas for Consideration**
  - Identify and resolve any barriers to DoD operating in the 2025-2110 MHz band
  - Comparison of DoD operations against NASA and NOAA operations
  - Evaluate sharing impact given necessary long-term transition
    - How many satellites currently operate in the 1761-1842 MHz band?
    - How many operate in the 1761-1780 MHz portion of the band?
    - How many of the satellites are capable of operating on multiple channels in the 1761-1842 MHz band?
    - How many of the satellites include TT&C operations on channels outside of the 1761-1842 MHz band?
    - What would be the normal or average frequency and duration of communications for TT&C operations?
    - What are the typical power and other operating parameters for normal TT&C communications with those satellites?
    - Based on past experience, how often does an anomaly occur that would require the uplink facility to operate at maximum power, and what would be the expected duration of such communications?

Precision Guided Munitions

- **Airborne platforms**
  - NTIA has identified a number of PGM training areas, including line of site contours (October 2010 report)
  - PGM training exercises require access to these frequencies for two hours at a time (pg 3-23, March 2001 NTIA report).
  - Given long line-of-sight for airborne platforms, they impact large areas

- **Areas for Consideration**
  - Are transceivers in PGMs frequency agile with the 1755-1850 MHz band? If so, can operations be restricted to above 1780 MHz in the near term?
  - Is a long-term migration to alternative spectrum (for example 2200-2290 MHz) feasible?
  - Do PGMs already operate in other frequency bands?
  - What would be the expected time frame for exhausting the current stock pile for weapons once a relocation band is identified?
  - If sharing is considered
    - What is the frequency and duration of training on these areas?
    - How much spectrum is used during those periods and is it possible to coordinate those times and frequencies?

Air Combat Training (ACTS)

- **Navy and Air Force System to Transmit Data Between Aircraft and Ground Stations**
  - Current ACMI/TACTS - Ground-to-air channels of 1830 or 1840 MHz/air-to-ground transmissions on either 1778 or 1788 MHz with 4 MHz bandwidth (March 2001 report)
  - Report notes (4-7), that these systems will be either replaced or complemented by JTCTS
    - Flexibility to tune across the entire 1710-1850 MHz band in 5 MHz increments.
    - 2001 DoD report (6-10) notes that JTCTS would begin replacing ACMI/TACTS in the 2006 time frame with completion around 2010

- **Areas for Consideration**
  - What is the status of the JTCTS and is the ACMI/TACTS still operational?
  - If JTCTS tunes across the entire band, is it possible to limit use to above 1780 MHz?
  - What analysis has been done to look at a long-term migration to 2200-2290 MHz?

Video Surveillance

- **US&P Assignments for Law Enforcement Agencies**
  - Unlikely that co-channel sharing is possible with commercial mobile operations

- **Current analog equipment using bandwidths of up to 18 MHz is being replaced with digital equipment using 6-8 MHz bandwidths.**
  - Result of clearing activities in the 1710-1755 MHz band
  - Should dramatically reduce that amount of spectrum necessary
    - Allowing use to be restricted to above 1780 MHz in the short term
    - Relocation band necessary long term to facilitate reallocation of the entire 1755-1850 MHz band

- **Areas for Consideration**
  - Restrict use to above 1780 MHz in the short-term
  - Study potential relocation bands – See relocation table
  - May be configurable to operate in the following spectrum: 2290 – 2500 MHz, 3100 – 3500 MHz, 4400 – 5000 MHz, 6200 – 6400 MHz and 8200 – 8600 MHz

Aeronautical Mobile Telemetry (AMT)

- **Downlinks operate from manned aircraft, unmanned aerial vehicles (UAV), and missiles or other ordnance devices**
  - Flight characteristic data and video are transmitted to the ground for analysis
  - Telemetry signals are designed to be robust to completely capture the downlink data
  - Because of the operating altitude of some of the aircraft, a wide area may be illuminated by telemetry signals

- **383 AMT assignments identified in the band**
  - It would be helpful to have more information on these assignments:
    - Do they occupy the entire band
    - Are they are constrained to specific areas of operation

- **Possible sharing scenario based upon framework developed for Medical Body Area Networks to coexist with AMT in the 2360 – 2390 MHz band**
  - Viability depends on exclusion zones and details of use
  - May be feasible on transitional basis

UAVs and Other Airborne Platforms

- **The October 2010 NTIA report lists a number of airborne uses that do not appear to be covered in previous reports**
  - May 25 NTIA presentation to CSMAC notes the expansion of these uses from training to domestic operations
- **Airborne platforms have long line of sight and present a significant sharing challenge**
- **More information is required about these uses**
- **Alternative Frequency bands should be considered**
  - See Relocation Chart

Possible Relocation Bands for 1755-1850 MHz identified by NTIA*

Type of Operation	Possible Relocation Bands	Factors Considered
Fixed point-to-point microwave	4400-4950, 7125-8500 MHz, and 14.5-14.7145/15.1365-15.35 GHz, possibly higher such as 25-27.5 GHz or wireline or commercial	Availability of equipment and adequate spectrum resources
Military tactical radio relay	1435-1525, 2025-2110, 2110-2165, 2200-2310 MHz	Minimize modifications to equipment. Existing equipment such as MSE/HCLOS have tuning range up to 2690 MHz, so no equipment modifications are necessary
Air combat training systems	1350-1390, 1435-1525, 2025-2110, 2200-2300, 2360-2395 MHz	Bands where airborne operations can be accommodated or are already being performed. Similar or better propagation characteristics. Coordination with aeronautical telemetry is possible
Precision guided munitions	1350-1390, 1435-1525, 2025-2110, 2200-2300, 2360-2395 MHz	Bands where airborne operations can be accommodated or are already being performed. Similar or better propagation characteristics. Coordination with aeronautical telemetry is possible
Law enforcement mobile video surveillance applications	225-328.6/335.4-380, 420-450, 902-928, 1350-1390, 1435-1525, 1675-1695, 2025-2110, 2200-2300, 2360-2395 MHz	Availability of equipment, similar or better propagation characteristics, and radio services similar to those in the 1755-1850 MHz band where successful sharing was possible
High- resolution (fixed or transportable) video data links for surveillance	225-328.6/335.4-380, 420-450, 902-928, 1350-1390, 1435-1525, 1675-1695, 2025-2110, 2200-2300, 2360-2395 MHz	Availability of equipment, similar or better propagation characteristics, and radio services similar to those in the 1755-1850 MHz band where successful sharing was possible
Tracking, telemetry, and commanding for Federal Government space systems	2025-2110 MHz, 8/7 or 30/20 GHz	Availability of equipment and adequate spectrum resources
Air to Ground Telemetry	1350-1390, 1435-1525, 2025-2110, 2200-2300, 2360-2395 MHz	Bands where airborne operations can be accommodated or are already being performed. Similar or better propagation characteristics. Coordination with aeronautical telemetry is possible
Land mobile robotic video functions (e.g., explosive ordnance and hazardous material investigations and disposals, etc.).	225-328.6/335.4-380, 420-450, 1350-1390, 1435-1525, 1675-1695, 2025-2110, 2200-2310, 2360-2395 MHz	Similar or better propagation characteristics. Radio services similar to those in the 1755-1850 MHz band where successful sharing was possible
UAS, UAV, RPV	225-328.6/335.4-380, 2025-2110, 2200-2300, 4400-4950, and 14.5-14.7145/15.1365-15.35 GHz	Many of these bands are used today; key is to replace the band 1755-1850 MHz

*A number of potential relocation bands are also identified as potential candidate bands for broadband use, including 1300-1390, 1675-1710, 2200-2290, 2700-2900, 3500-3650 and 4200-4400 MHz and any changes considered should be consistent with a long-term spectrum plan.

Valuation and Implementation Subgroup

July 2011

1b - How should the impact of exclusion areas on the value of spectrum for commercial services be measured?

- **Defining an exclusion area**
  - Absolute exclusion
  - Partial exclusion
    - Temporal
    - Power limits
    - Altitudinal
    - Other conditions

- **Examples of exclusion areas**
  - Auction 66
    - 2110-2150 MHz – 5700 commercial point to point links (2-3 year negotiation periods)
    - 2150-2155: 149 BRS PSAs
    - 1710-1755 MHz 925 federal government links
      - Relocation timing from 3 – 72 months
      - 64 permanent protection in all 6 blocks in Yuma, AZ and eastern NC
  - Auction 73
    - 700 MHz Lower A block – Channel 51 interference protection zones

1b - How should the impact of exclusion areas on the value of spectrum for commercial services be measured? – cont'd

- **Value of spectrum excluded**
  - Relative MHz/Pops and density of excluded area are key factors
  - Many other factors can impact value including highway miles, universities, vacation areas, etc.
  - Brattle report notes a 41% value difference between a MHz/Pop relative value versus relative values in Auction 66*
- **Value of remaining spectrum**
  - Value impacted by roaming costs or incremental capacity required for excluded area
  - Value could be impacted if systems inside the exclusion area cause interference outside the exclusion area
    - Devices (Brattle Group calculates a 3% increase in device costs implies 2.2% decrease in value**)
    - Higher network equipment costs near the exclusion zones
  - Impact to value could be greater for new entrant, regional or small carriers
- **For partial exclusion value decrease impacted by duration of exclusion**
  - For A Block in Auction, RSAs with > 48 months duration on average 50% less than RSAs with 12 months (but small sample size)

*See page 13, Brattle Group Report, Inc., "The Economic Basis of spectrum Value: Pairing AWS-3 with the 1755 MHz Band is More Valuable than Pairing it with the Frequencies from the 1690 MHz Band, " April 2011

** Id. at page 17

1b - How should the impact of exclusion areas on the value of spectrum for commercial services be measured? – cont'd

- **CSMAC attempted to look at the difference in values of licenses impacted as well as surrounding licenses**
- **In looking at the results of FCC Auctions 66 and 73, correlation between encumbrances and auction results were reviewed and analyzed**
- **Due to sometimes small sample sizes the results probably do not meet strict academic standards of extracting results. Additionally, other numerous auction bidding factors that could affect the final pricing on a license, besides encumbrances, were not significantly factored**
- **Cellular Market Areas (CMAs) are the smallest licensed areas which should, due to their size, reflect a greater impact from the exclusions than necessarily would the larger populated licenses auctioned as Economic Areas (EAs) or Regional Economic Area groupings (REAGS)**
- **Results should be further analyzed if NTIA believes this analysis is useful**

1b - How should the impact of exclusion areas on the value of spectrum for commercial services be measured? – cont'd

- **Examples of value impacted – permanent protection areas**
  - Auction 66
    - 3 Cellular market (A block) areas impacted
      - Yuma, AZ – CMA #321 – 225k Pops
      - Cherry Point in NC-13 – CMA #577 – 262k Pops
      - Jacksonville, NC (Camp Lejeune, Bogue Field, New River)– CMA #258 – 169k Pops
    - Two EAs (B & C Blocks)
      - LA - EA #160 - <1% of 20.2M Pops impacted
      - Greenville, NC EA – EA# 21, > 50% of 886K Pops impacted
    - Two REAGs (D-F)
      - Both REAGs impacted < .5% (each REAG has approximately 57M Pops)
  - Auction 73
    - Many A block EA licenses were impacted by broadcasters on channel 51
    - A block licensees cannot impact channel 51 receivers – effectively limiting the use of A block licenses in the affected areas
      - Estimated 45% of nationwide Pops impacted
        - Chicago – 90%+ pops
      - 10% of square miles nationwide
        - Dayton - 90%+ square miles

1b - How should the impact of exclusion areas on the value of spectrum for commercial services be measured? – cont'd

- **Calculated value lost (difference in difference to average auction value)**
  - **Auction 66**
    - Permanent protection areas:
      - Neither NC 13 nor Jacksonville received any bids; Yuma received 1 bid for $199K ($.03 per MHz Pop)
        - CMA value lost based on average RSA and MSA per MHz pop pricing ~ $2.3M (75-100% discount)
        - Implied loss due to below market pricing in Greenville, NC EA license ~$10M (which represents a discount of 70-90% to average EA pricing on similar size)
    - Value lost in adjacent areas
      - Two RSAs surrounding Cherry Point/Camp Lejeune: NC-12: No bids, NC-14: 25% of RSA average
      - If adjacency to exclusion areas resulted in the bids/lack of bids, the implied loss in value is approximately $900k
    - Note: all three of the above CMA licenses did receive a bid in the re-auction of certain AWS licenses in FCC Auction 71
      - Auctioned August 2008, two years after Auction 66
      - NC-13 (Cherry Point) was never granted by the FCC and remains under FCC control
      - The three still sold at an average discount (53%) to the average for comparable CMAs in Auction 66
  - **Auction 73**
    - A block was $5B less than B Block (57% discount) despite both being 6 x 6 paired 12 MHz licenses

If spectrum is not available nationwide, NTIA should limit exclusion zones to less dense population areas, limit the depth of spectrum affected and plan for the exclusion zone to only be necessary for a limited period of time. Any exclusion that affects a licensee's use of spectrum will have a relative impact on the value of the spectrum.

1c - Given the need for spectrum in high density areas, what is the value of spectrum in specific, limited geographic areas?

- **Urban, more dense areas, drive the greatest need for additional spectrum capacity**
- **Various factors will affect value**
  - Lack of economies of scale will affect desirability of spectrum
  - The better the economies of scale, the less negative impact on value, the more interest in use
    - # of Pops included
    - MHz depth available
    - Adjacency to current bands in use
    - International harmonization
  - Other considerations
    - Adjacency to future planned bands
    - Timing of limitation
    - Regulatory certainty around future access if expanded
- **Likely to be more valuable to incumbents versus new entrants**

If spectrum is not available nationwide, NTIA and FCC should maximize the number of licensed pops to drive economies of scale to make such spectrum of use and value to operators

1h - How does the staged release of portions of the spectrum impact spectrum valuation?

- **Staged release could mean**
  - Auction now but not available until a future date
  - Auctioned at a future date
- **Staged release could be by frequency or geography**
- **Auction staged and non-staged spectrum now**
  - Value of staged spectrum is impacted by the PV impact of the deferral (assuming no risk to access at later point in time)
  - Pushes incumbent to relocate by a defined point in time
- **Auction non-staged spectrum now, auction staged spectrum later**
  - Subsequent auction of staged spectrum may increase due to speculators (but may not be put to use as quickly)

NTIA and FCC should auction staged and non-staged spectrum bands at the same point in time. Although auctioning both at the same point in time may affect value, auctioning staged spectrum may have greater effect on pushing incumbents to relocate by a defined point in time

1j - What is the impact of moving Federal operations to other bands?

- **Cost to move operations**
- **Timeline to move operation**
- **Technical/Technology considerations**
- **Maintaining comparable capabilities in the new band**
- **Consideration of the Impact to Incumbents**
- **Introducing New Service Rules**
- **Regulatory Considerations**
  - National/International
    - Modify Existing and/or Introduce New Regulations/Allocations

1k - How can the mechanism or process of new entrants coordinating with remaining Federal operations during a relocation transition be better defined? How can the transition steps be defined to avoid day by day, location by location compatibility analysis and coordination?

- **Future spectrum reallocations or sharing should only be mandated in response to identifiable needs/demands taking into account impact to both commercial and government operations**

- **The timeline of the relocation process should be clearly defined and consistently applied**

- **Improve information dissemination prior to reallocation/auction/sharing process so that potential applicants for spectrum will have a clear understanding of the technical requirements and needs of incumbents. This would also allow parties interested in sharing to have a better understanding of Federal Government needs. For example, commercial entities must have sufficient information to fully understand whether commercial deployments will be possible before the Federal operations are fully relocated**

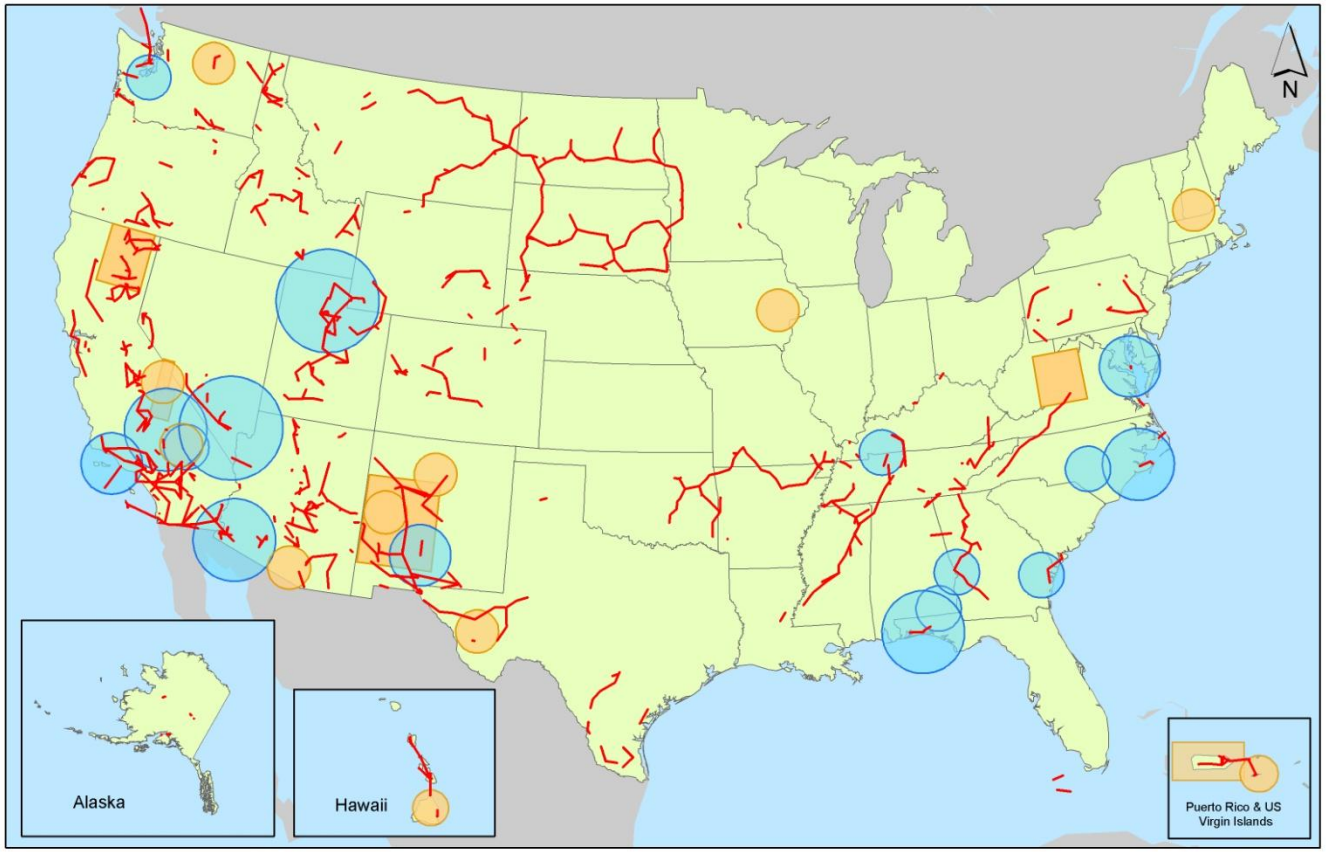
- **Use the portal established by the Department of Defense ("DoD") as the baseline model for exchanging information between Federal Government and commercial entities regarding relocation issues**

Cont'd 1k - How can the mechanism or process of new entrants coordinating with remaining Federal operations during a relocation transition be better defined? How can the transition steps be defined to avoid day by day, location by location compatibility analysis and coordination?

- **Develop secure on-line capabilities that will allow, where feasible, for virtually instantaneous coordination between Federal and non-Federal systems operating on frequencies identified for relocation or sharing**
- **Oversight responsibility for the relocation of Federal Government systems should be centralized**
- **Funds should be allocated for agencies to hire temporary personnel solely to address a relocation process**
- **To facilitate the process, interim spectrum clearing benchmarks (measured by spectrum, geography, or a similar metric) should be evaluated as a vehicle for facilitating the deployment of commercial systems during the relocation process**
- **Incentives should be created to spur agencies to promptly clear spectrum bands identified for reallocation to other uses**

Appendix

1.7 GHz Incumbents – Government Holdings



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1.7 GHz Incumbents

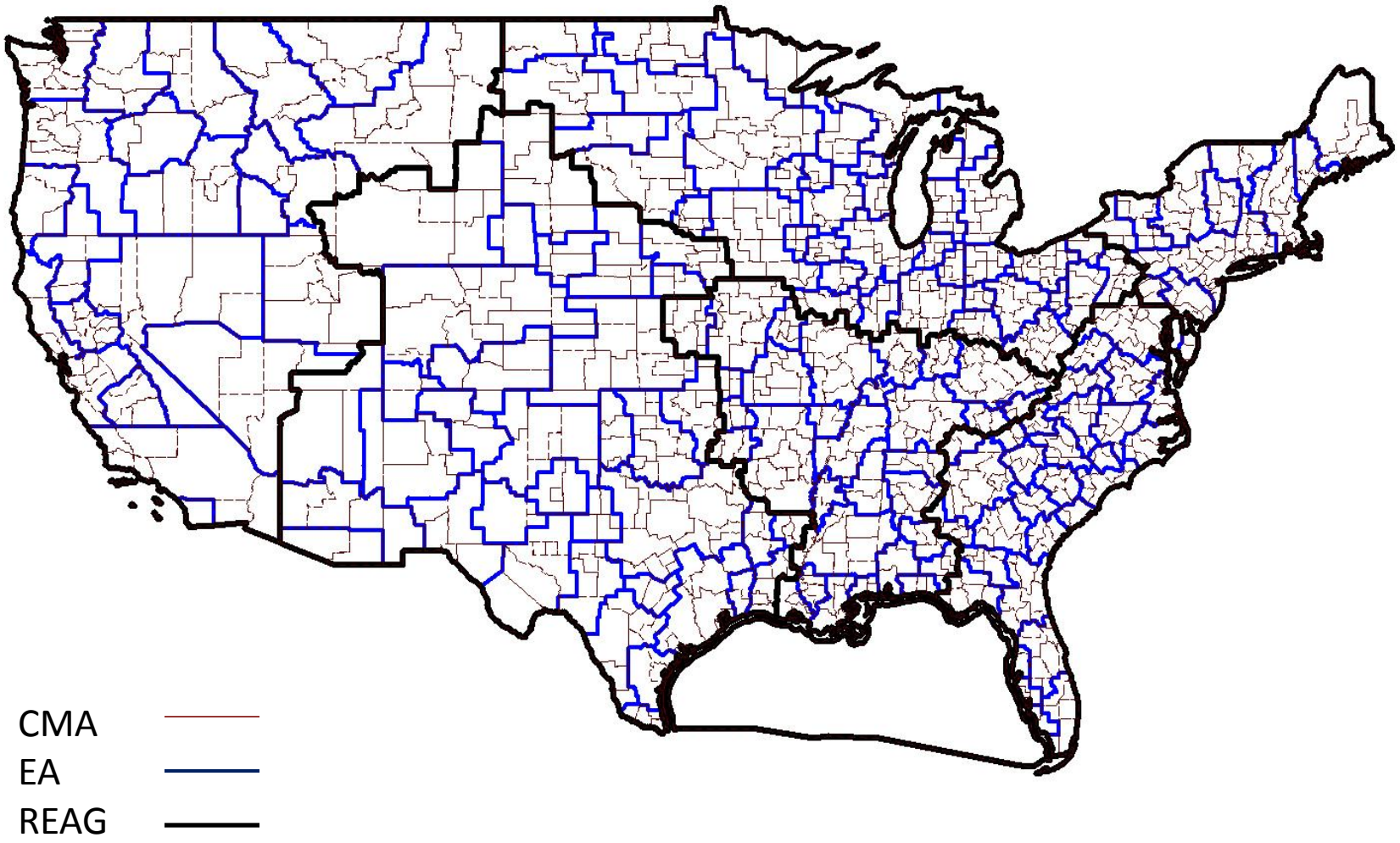
1.7 GHz Microwave Paths
RA Sites
DoD Protected Sites

Impacted 5.3M Pops

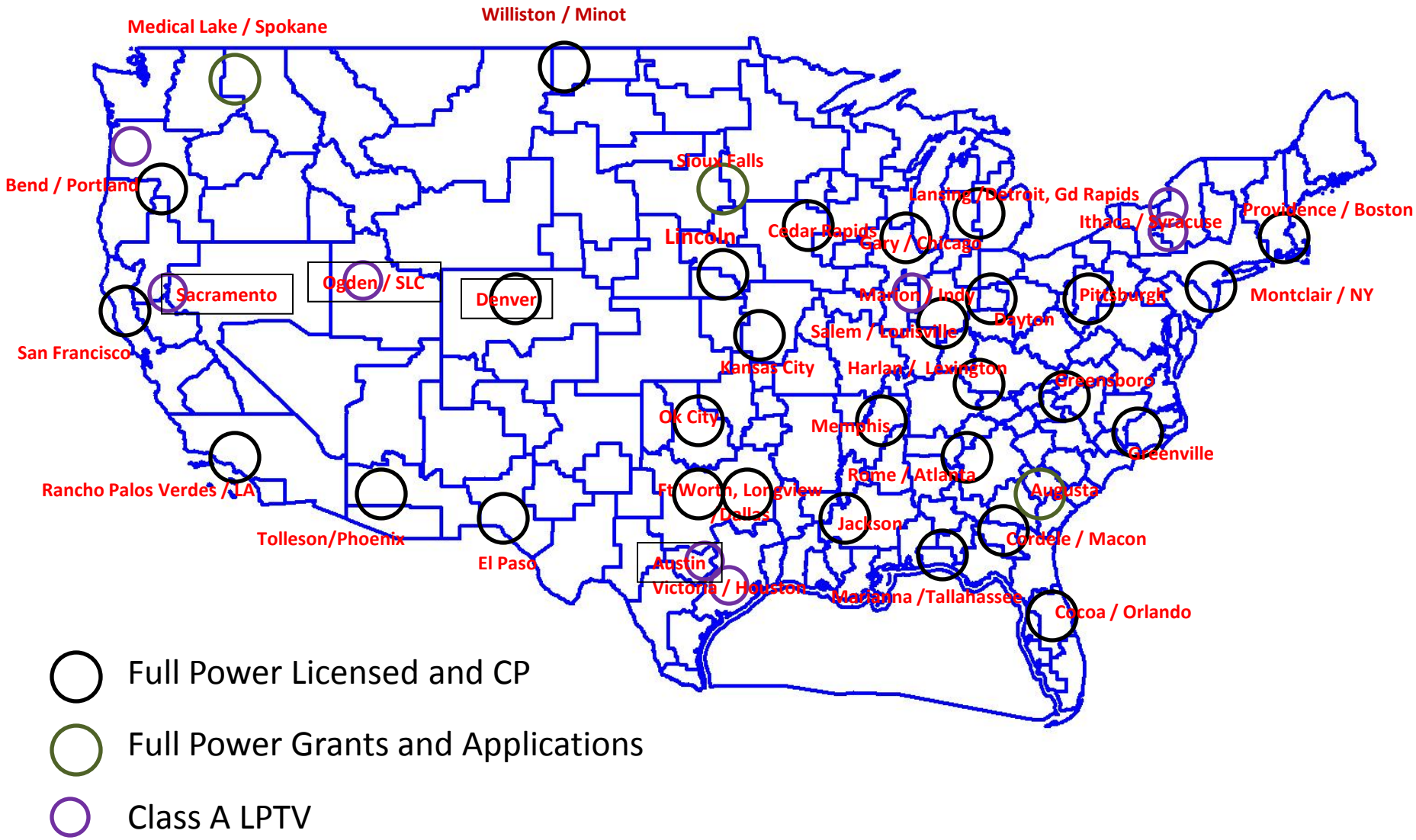
Impacted 4.4M Pops

Impacted 27.6M Pops

Continental USA – CMAs, EAs and REAGs



Channel 51 Interference



Full Power Licensed and CP

Full Power Grants and Applications

Class A LPTV