CSMAC
Spectrum Efficiency Subcommittee

August 15, 2017

Subcommittee Members

- Co-Chairs:
  - Bryan Tramont
  - Jennifer Warren
- NTIA Liaison:
  - Giulia McHenry
  - Ed Drocella

- Members:
  - Audrey Allison
  - Laurie Buckhout
  - Michael Calabrese
  - Mark Crosby
  - Tom Dombrowsky
  - Carolyn Kahn
  - Paul Kolodzy
  - Mark McHenry
  - Janice Obuchowski
  - Charla Rath
  - Rick Reaser
  - Steve Sharkey

Improving Spectrum Efficiency: 2 Questions

1. What additional regulatory, procedural, legislative, or policy actions could be implemented to improve spectrum efficiency without harming effectiveness, including enhanced funding options for the federal agencies? Carolyn Kahn - Lead
2. What practices (technical and otherwise) has industry adopted to optimize its efficiency across disparate networks that might provide useful lessons for NTIA and federal agencies? Bryan Tramont - Lead

Task Group 1 Schedule

Regulatory, Procedural, Legislative, or Policy Actions

- Subcommittee kickoff: 4/27/17
- Task meetings:
  - Outreach discussion: 5/22/17
  - Outreach plan: 6/7/17
  - Brainstorming and preliminary recommendations: 8/8/17
- Report
  - Draft report
  - Review & finalize draft report
  - Final Report for 11/17
- Outreach
  - Survey questions development: 6/20/17
    - 6 questions developed for OMB
    - 14 questions developed for federal agencies
  - Conducted targeted outreach (management/regulatory focus) to-date; use inputs to inform questions and dialogue with federal agencies
    - NTIA – ITS metrics effort: 7/17/17*
    - OMB interview: 7/19/17
  - CSMAC member input
  - Conduct additional outreach
    - Federal agencies (implementation focus): DoD, FAA, NASA, NOAA, DHS
    - Follow-on: NTIA (ITS), OMB (OFPP)

*"Spectrum Efficiency Study Description," Institute for Telecommunication Sciences for Office of Spectrum Management," NTIA, July 2017.

Considerations Include:

- Further expansion of the Spectrum Relocation Fund (SRF)
- Spectrum efficiency metrics
- Agency accountability & resourcing
- Federal incentives
- Macro-level (federal and non-federal) options
  - Sharing
  - Property rights
- Combinations

Task Group 2 Schedule

Industry Practices Supporting Government Network Optimization

- Kickoff on 4/27/17
- Survey questions development 5/16/17
  - 14 questions total were developed and shared with all of CSMAC
- Question finalization 5/22/17
  - Solicitation of industry respondents
- Response review 7/12/17
- Draft of August Report
  - Solicitation of additional industry respondents
- Finalize Inputs
- Final Report for 11/17

Responses Received

- Surveys were sent to all CSMAC members
- Total of 6 responses were received
- Responses came from:
  - Manufacturers
  - Service providers
  - Broadcasters

1) What practices (technical and otherwise) has industry adopted to optimize its efficiency across disparate networks that might provide useful lessons for NTIA and federal agencies?

- Traffic management techniques
- Self Optimizing Networks
- Dynamic Load Balancing
- Software Defined Networking
- Traffic Offloading
- Up to date propagation models and emission data
- Licensing models that allow for updating without specific regulatory permission
- Market based incentives

2) What future practices has industry planned or considered?

- Network slicing for optimization
- Integrated access and backhaul (IAB)
- Cooperative cells
- More efficient beamforming
- Higher order MIMO
- Database mechanisms
- Politeness etiquettes or techniques to ensure fair sharing
- Newer standards, incentives to customers to get them to adopt latest technology
- Regularly upgrade technology
- More efficient frequency reuse, including small cell deployment
- Broadcast radio moving toward all-digital transmission scheme

3) Industry has emphasized the need for access to low, mid, and high-band spectrum in order to be able to meet customer expectations. How does spectrum efficiency play into the need for access to spectrum across a broad range of frequencies like this, and which bands are used to provide which services? How should these types of frequency requirements apply to government users?

- Allows serving customers at various distances from the cell site
- Less likely that any particular band will develop as “silo” for a particular use
- Indoor uses will primarily be served by mid-band and high-band spectrum
- Low latency is best accomplished using wider bandwidths available at higher frequency
- Determine whether federal agencies with compatible missions could be considered for sharing and consolidation
- Deployment designed to meet user requirement for coverage and capacity

4) How is spectrum efficiency improved when new standards are introduced into broadband networks – e.g. 3G to 4G to 5G?

- More efficient waveform
- Shorter time slots
- Flexible frame structure
- Dynamic duplexing
- Advanced multiple antenna techniques
- Higher order modulation
- Technology advances allow disparate networks sharing the spectrum with little or no coordination

5) What other methods have you used to improve network efficiency?

- Cellular network densification using small cells
- Opportunistic use of unlicensed spectrum where available
- Standards bodies that include handset manufacturers, chipset manufacturers, wireless providers
- Network operators have forced manufacturers to become more efficient at space and power requirements, and environmental hardening of equipment.

6) What difficulties, technically and economically, do you encounter when such transitions occur?

- Spectrum re-farming results in inefficient spectrum use during transition
- Difficulty and expense are incurred when you upgrade a network
- The need to continue to provide service (backward compatibility) often limits the ability to make improvements in efficiency

7) How do you go about phasing out less efficient technologies?

- We are interested in evolving networks so that transitions are less disruptive
- Minimizing hardware upgrades, focus on software ready platforms
- Rely on standards organization and industry or trade organizations
- As customers acquire devices operating on the new technology, the demand for the older less efficient technology is reduced and an increasing portion of the spectrum can be refarmed to new technology with the older technology eventually phased out completely.

8) As a manufacturer or commercial service provider, what incentives do you typically need to offer customers to incent them to switch to more efficient technologies, and do you think such incentives can translate from commercial customers to government users?

- Device upgrades and better service plans
- Improved functionality
- Opportunities to make use of multi-purpose networks should be encouraged over single purpose networks
- Free phones, subsidized phones, or subsidized data packages
- A significant portion of a switch occurs through the natural turnover of devices
- Reduced price equipment encourage customers to shift technology
- In some cases customers may need to be required to buy, or be given a new device to continue service

9) Are there differences in the efficiency advantages that can be gained based on the size (in terms of contiguous bandwidth available) and the frequency of blocks of spectrum? (i.e. can larger blocks of spectrum be used more efficiently than smaller blocks?) If so, how significant/great of a difference?

- Spectrum use efficiency is a function of guard band requirements – larger guard band requirements result in wasted spectrum
- Larger blocks result in reduction in guard band requirements
- New technology reflects increasing demand of individual users
- Larger blocks of spectrum give more technical operations for higher speed and lower latency – meaning any single user is actively using the channel for smaller periods of time
- Contiguous blocks of spectrum drive economies of scale in the radio and filter design
- Larger contiguous blocks of spectrum help to make the more bandwidth-intensive applications possible, and encourage the development of more commercial applications that help spur demand for the latest generation of equipment
- Larger blocks require less overhead (relative to the amount of data carried in wider channels) to support the messaging

10) Some recent allocations and spectrum decisions are based on the use of database technology (e.g. TVWS, 3.5 GHz SAS). How is industry anticipating this type of controlled spectrum access to impact overall spectrum efficiency, and are these technologies something the government should be developing in their exclusive bands as well?

- Investment certainty and interference protection will be of utmost importance
- A database to automate frequency coordination is for the most part frequency agnostic
- Wireless industry still prefers the certainty that licensed, dedicated spectrum supports
- Ideally the sharing architecture should be as simple as possible to minimize cost and complexity
- Inaccuracies are often introduced into databases due to lack of requirements to use geolocation technologies or to verify user information
- Implementation is very situation specific with no one-size fits all approach
- Any approach to sharing should provide the lightest touch possible

11) How important will unlicensed off-loading continue to be for meeting future spectrum use requirements?

- Unlicensed spectrum is an important part of strategy for achieving future data rate and capacity requirements
- Licensed spectrum is still much preferred over unlicensed spectrum
- Unlicensed off-loading will continue to be critical for meeting spectrum use requirements
- Off-load unlicensed data represents more than twice the amount of mobile data
- Want to be able to use both Wi-Fi and unlicensed LTE to continue off-loading
- Off-loading may be less necessary as carriers begin offering unlimited data for a fixed fee

12) What have been the biggest obstacles to optimizing efficiency, and how is industry overcoming them?

- Obstacles
  - Loss of efficiency during spectrum re-farming
  - Tradeoff between cost and power
  - Regulatory restrictions
- Overcome obstacles by driving operational efficiency
  - Focus on virtualization of network functions on common COTS platforms and Software Defined Networks

13) Are there other lessons learned on the commercial side that has application for government users?

- Planning for sharing is critical to ensure bands can be used to their fullest extent
- There are sometimes operational changes that can enhance the availability of spectrum in shared environments
- Agencies should be given visibility of what COTS systems/technologies are in the pipeline for development and how they could be procured in a more streamlined way
- NTIA should facilitate dialogue about opportunities today that could address new and rapidly changing missions of each agency
- Accurate information about actual operations is critical
- Economic incentives for government users

14) Are there efficiency gains that government users could readily achieve that you are aware of?

- Public safety network is a good example of commercial/government collaboration. This model may be effective for other government spectrum uses
- Look at COTS, recent standards, and the use of software defined radios
- Federal systems are operating with out-of-date technologies
- Providing incentive and funding to upgrade these networks would provide significant efficiency gains.

15) Input: More is Better!