CSMAC 5G Subcommittee Recommendations

June 8th, 2016

Membership

Co-chairs:

- Mariam Sorond (Mariam.Sorond@dish.com)
- Robert Kubik (robert.kubik@samsung.com)

NTIA Liaison:

- Rangam Subramanian (domestic and technical)
- Bob Denny (international)

Members:

- Michael Calabrese
- Mike Chartier
- Marty Cooper
- Tom Dombrowsky
- Harold Furchtgott-Roth
- Dale Hatfield
- Paul Kolodzy
- Janice Obuchowski
- Carl Povelites
- Charla Rath
- Jeff Reed
- Steve Sharkey
- Bryan Tramont

Work Plan

NTIA Question: What are the technology and standardization challenges unique to 5G that are associated with federal/non-federal spectrum sharing, and what specific roles/actions should NTIA take to address these challenges?

- The subcommittee has also prepared an extensive report. The report shall be provided in July.

- The subcommittee also recognizes that some of the recommendations don't have an immediate action involved, but would have an action as 5G is further developed and/or if a specific band is referenced. As part of the future work, the subcommittee will provide recommended next steps.

Recommendation - 1

1. Deployment specific evaluation

5G networks could use different portions of the same spectrum or different spectrum for different types of deployments. The deployment characteristics could vary widely with the supported use case and application. The different deployment scenarios will impact sharing in multiple ways:

- Initial 5G technologies are likely to be deployed first in urban, high-density environments where building penetration and clutter may greatly impact propagation, and so should be considered in determining coordination zones and other sharing parameters.
- A band that is sparsely used by incumbents for critical communications may be shared to support non-critical, delay insensitive IoT type applications such as smart meters and atmospheric sensors.
- One of the design objectives of 5G is the capability to provide flexibility in multiplexing multiple vertical services within a carrier bandwidth. It is possible that a 5G base station would transmit physical channels with different numerologies, meaning that depending on supported use cases, a base station can divide entire carrier bandwidth into smaller sub-bands and transmit physical channels on each sub-band with different numerologies. Further, these sub-bands could have different waveforms, access schemes, channel coding and even large power deltas between them. As these unique features get developed, they could have a role in sharing.

Recommendation: *NTIA should evaluate bands under consideration for coexistence using 5G specific deployment scenarios and use models, as referenced in the bullets above.*

Recommendation - 2

2. Large frequency range and bandwidths

Based on the wide range of frequencies and bandwidths being considered for 5G, it is essential to conduct sharing and co-existence studies for each band independently, especially because the technical and operational characteristics including protection criteria and deployment scenarios would vary widely. 3GPP is considering utilizing different waveforms depending on the frequency bands, i.e. a waveform X can be supported between Frequencies A and B, a waveform Y between frequency B and C and henceforth. Further, in many cases due to the large envisioned channel bandwidths, it is possible that the spectrum overlap is only partial either within the channel or at the edges only, and as consequence the impact and mitigation techniques could vary significantly. Likewise the large bandwidths will also impact OOBE and adjacent bands.

Recommendation: *Due to the sometimes large bandwidth allocations in 5G (100 MHz and above), the chance of overlaps with different types of federal systems will increase and NTIA should study coexistence on a case-by-case basis.*

Recommendation - 3

3. New duplexing schemes

Currently 2G, 3G, and 4G technologies either operate on an FDD, TDD or downlink only mode. For 5G it is envisioned that new duplexing schemes will be introduced, such as dynamic duplexing, simultaneous transmission and reception on same frequency. This may provide more flexibility in coexistence with adjacent or co-channel networks.

Recommendation: *The duplexing and spectrum usage schemes of 5G will provide a unique opportunity to customize co-existence solutions and NTIA should investigate the possibility of leveraging these schemes for coexistence in federal and non-federal systems.*

Recommendation - 4

4. Probability aspects

Traffic characteristics are going to vary widely depending on what kind of services the spectrum is utilized for. For example, spectrum utilized for low powered IoT type use cases with sparse but delay tolerant traffic may require a different coordination approach than mobile broadband use cases. The sharing studies in general should consider the traffic characteristics of the services deployed in a spectrum band and the probability of interference, specifically when one calculates cumulative interference, and the impact of that interference from the perspective of what harm it could cause. This becomes more relevant to 5G due to advanced techniques such as MU-BF and 3D-MIMO that steer signal only in the wanted region instead of wide area coverage. Also in practice many system deployments are over-designed to support high reliability metrics and should be able to able to handle both short term and long term interference at different thresholds.

In the past, the sharing analysis was mostly based on a "worst-case" scenario. A more probabilistic approach that can still provide a strong level of protection to incumbent systems should be investigated (e.g., exceeding an interference level of X for less than Y% of the time at Z locations where X, Y and Z could vary from system to system).

Recommendations:

- *NTIA should consider a more transparent and consistent process that clearly outlines the methods and parameters used to determine the interference criteria which could be beneficial for ensuring effective sharing of the spectrum between federal and non-federal systems.*
- *NTIA should also investigate new and innovative approaches to coordination and sharing of spectrum on a temporal basis.*

Recommendation - 5

5. Phased approach with upgrades

As has been the case with 4G (LTE) and how it progressed from LTE to LTE-A to LTE-A Pro, it is expected that 5G will also be developed and be deployed in phases. Newer technologies will be incorporated into the initial 5G standards over several evolutions of the specifications and some of the technologies that may not be currently available for effective sharing could become available during the latter part of the evolutionary cycle of 5G. Similarly it may be reasonable to assume that the other incumbent technologies would also migrate to advanced versions. With each upgrade cycle, it would be very helpful if it is encouraged to incorporate sharing technologies within new versions. Another consideration could be to use similar physical layer characteristics to improve compatibility and sharing.

Recommendations:

NTIA should:

- *Investigate and encourage a continual iterative sharing process to evaluate, re-assess risk and sharing techniques/mechanisms as 5G systems evolve to support advanced techniques.*
- *Investigate and encourage commercial and federal participation in the standardization of sharing mechanisms as part of technology evolution.*
- *Encourage that the federal systems as part of their upgrade cycle to incorporate more robust techniques of interference mitigation.*
- *Investigate participation in an existing standards organizations where technology evolutions to facilitate sharing are discussed*

Recommendation - 6

6. Propagation Modeling for sharing/co-existence studies

Historically, models like ITM and TIREM have been the main stay during the coordination analysis and determination of protection zones. However, these models may not have the same level of predictability at higher frequencies (20 GHz and above) to estimate the interference from 5G systems. In absence of such models very conservative assumptions may be used which may lead to unnecessary constraints when evaluating capability between systems.

Recommendation: *NTIA should allocate the resources necessary to investigate revision of propagation models, and if needed undertake measurements, for the higher frequencies so that accurate/appropriate models can be utilized for estimating interference from 5G systems in a varied set of environments and distances. New models should be promoted in ITU-R Study Group 3 for global harmonization at WRC-19.*

Future Work

The subcommittee recommends that the 5G work should continue and will provide an outline of recommended future work in the report