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**Introduction**

Good morning Chairman Walden, Ranking Member Eshoo, and Members of the Communications and Technology Subcommittee. Thank you for the opportunity to join you for this important session and discussion. By way of background, I am Dennis Roberson and I currently have dual roles serving as Vice Provost for Research and Research Professor of Computer Science at Illinois Institute of Technology, and as President and Chief Executive Officer of Roberson and Associates, LLC, a technology and management consulting firm serving government and commercial customers. Prior to my current roles I served as Executive Vice President and Chief Technology Officer of Motorola and over the years have held executive positions at AT&T, Digital Equipment Corporation (now part of HP), IBM and NCR. Currently I also serve as the Chairman of the FCC's Technological Advisory Council and serve on the Department of Commerce Spectrum Management Advisory Committee. My technical focus through my various roles and areas of engagement is aligned with my personal passion to optimize the use of our nation's increasingly valuable spectrum resources through both technology enhancements and enhanced spectrum management policies and practices.

I believe that each Member of the Subcommittee already has a great appreciation for the economic importance of this natural resource has and I know that others will speak to this point, so I will focus my comments today on the opportunities and challenges that face us from a technology and policy perspective. As you know, with a few minor exceptions, all of our nation's spectral resources have been allocated for various government and commercial applications for decades. Given this reality, the only way to introduce new applications and the next generation of technology or even to expand the capacity of existing applications is to either clear and reallocate the spectrum, or to find ways to share the use of the spectrum. We cannot make more spectrum, but we can utilize it more efficiently,

First, I would like to identify key considerations of clearing and reallocating spectrum. Although it should still remain a part of overall spectrum management policy, the proposition of clearing spectrum is an increasingly daunting task involving:

1) the identification of applications in valuable spectrum that can either be re-located or terminated;

2) negotiating and finding the financial means to support the relocation costs or pay the incumbents for service termination;

3) and finally establish the plans for how and how long (often 10 years or longer) it will take to accomplish the transition.

The millimeter wave bands present an area where significant quantities of "cleared" spectrum seems feasible today. The challenge here is that it has been both expensive to support from a technology standpoint and difficult to use based on the unique propagation characteristics, such as the fact that water vapor and even oxygen absorbs the energy of these signals. None-the-less, future technological advancements could address this and exciting research is being pursued in these spectral regions. Specifically, applying Massive Multiple Input, Multiple Output (or Massive MIMO) antenna arrays to create focused transmission beams to overcome the

atmospheric challenges and even use these challenges to our advantage. This research should be encouraged and supported financially.

Next, I would like to identify the key components of spectrum sharing where things can happen at a faster pace if

1) the new user is able to share the spectrum in such a manner that the incumbent experiences little or ideally no actual harm, which is a syno9nym for perceivable impact from the presence of the new entrant;

2) or if the actual harm is outweighed by the benefit of the new shared use.

There are several emerging classes of sharing opportunity areas including:

1) satellite spectrum shared and re-applied to terrestrial needs (e.g. NOAA's 1695-1710 that was initially liberated in the AWS-3 auction),

2) radar – communications sharing (especially for services such as the lightly used Weather Radar band 2700-2900 MHz and Radar Altimeters – 4400-4600 – where aircraft have known, broadcast positions that can be used to spatially and temporally avoid interference, and of course making the 3.5 GHz band that has been re-allocated available for widely scale usage),

3) bidirectional sharing, which would among other things enable the government to employ lightly used or unused commercial spectrum when they need it for specific government activities (e.g. a DoD field test or deployment),

4) appropriate use for terrestrial purposes of the satellite allocations around the GNSS band of the spectrum around GPS, even if the use is constrained.

The key point in all this is that nearly all spectrum that isn't currently being fully utilized (spatially and / or temporally) can technically be used spectrum management policies that are driven to maximize for the efficient use and support of forward-looking technologies.

While spectrum management policies should encompass both cleared and shared use of spectrum as described above, what's most crucial to better understand the use of this scarce natural resource is understanding and assessing the current level of use across all frequencies. I have spent a considerable portion of the past eight years establishing a better mean of assessing the current level of use through the deployment of a permanent Spectrum Observatory in the City of Chicago and building a database of spectrum measurements that covers the most heavily utilized portion of the spectrum, that is the spectrum from just below the low end of the original television band (30 MHz) to just above the high band for Wi-Fi (6 GHz). Figure 1 shows an example of this spectrum usage earlier this week as observed from the top of the IIT Tower on the south side of Chicago. Figure 2 shows a related spectrum occupancy chart from a few years ago illustrating the opportunity to identity bands of interest for potential reuse or sharing.

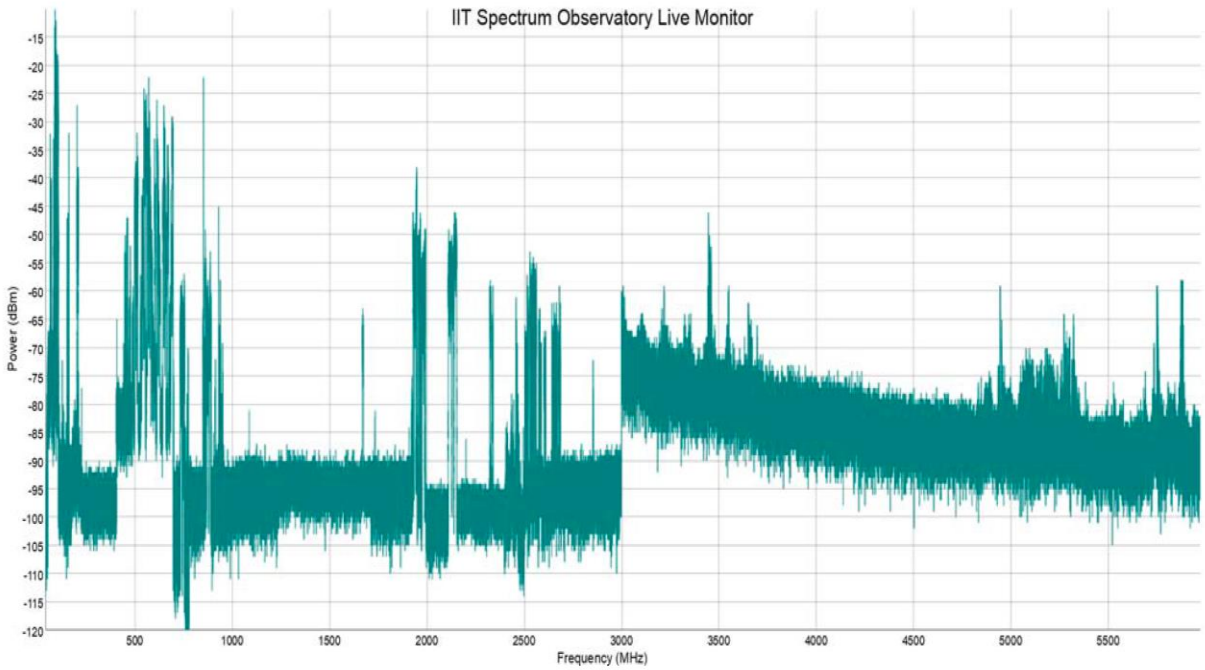


Figure 1 – Spectrum Usage in the City of Chicago – 5 October, 11:45 PM

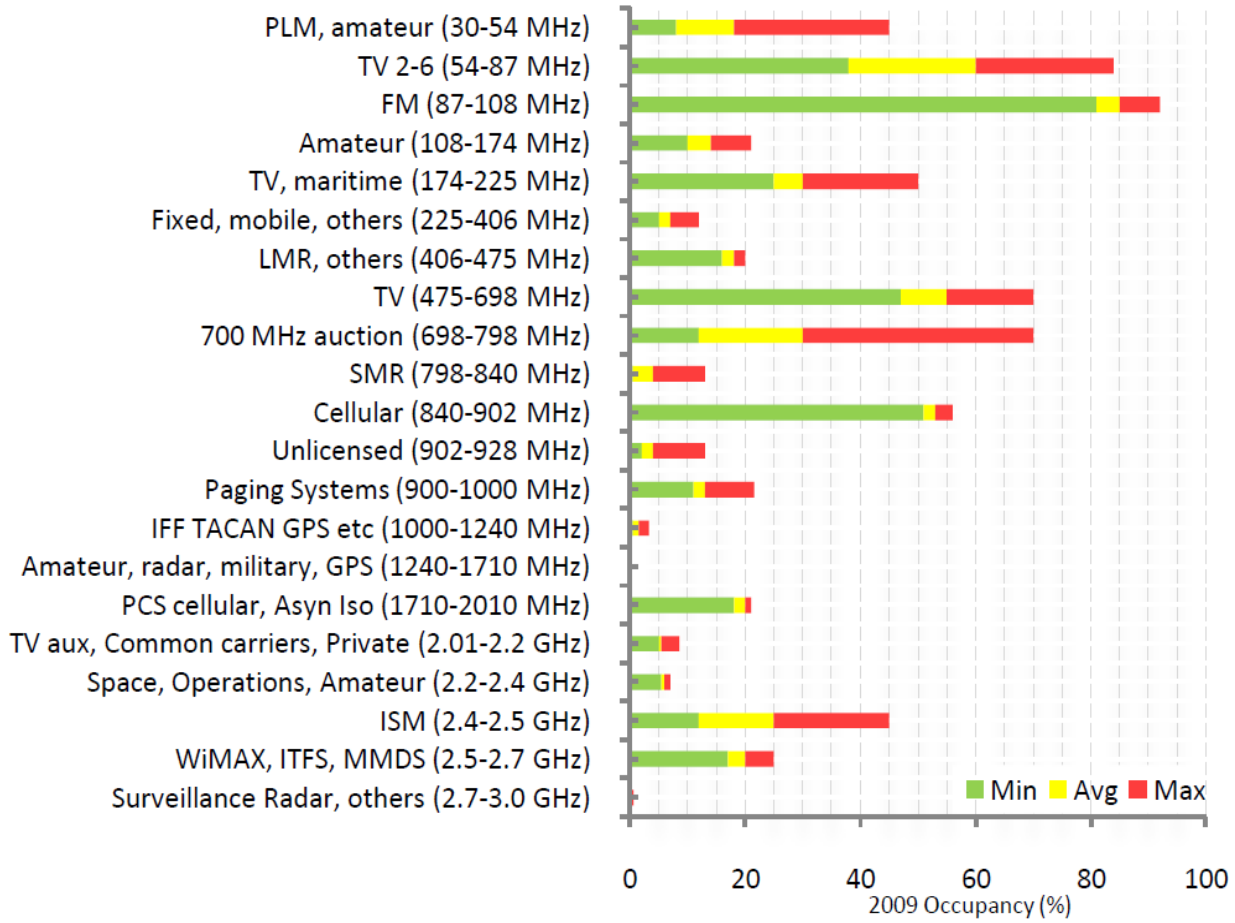


Figure 2 – Daily Average Spectrum Usage by major band for Calendar Year 2009

In simple terms, these charts show how, and how much of, the spectrum is being used over a period of time – monthly, weekly, days and hours. We can look at a particular frequency and understand down to the minute, how efficient that spectrum is being used and for what purpose it is being used. Through the wide scale deployment of similar spectrum monitoring equipment in various high spectrum usage environments (mostly urban centers and "high tech campuses"), we should be able to identify optimal spectrum bands to make available for either clearing and for sharing. In this chart the 1000 – 1240 MHz band, 1240 – 1710 MHz band and 2.7-3.0 GHz bands would be obvious bands to further investigate.

Beyond the spectrum that is observed to be readily available for enhanced usage, another major challenge to efficient spectrum usage is the "receiver standards" issue. Here poorly designed receivers for often critical functions have a huge impact on spectrum availability in adjacent bands. Since only transmitters are regulated today, and incumbents are protected relative to new entrant systems, we are effectively protecting companies that sell (or have sold) poorly designed receivers and not only continuing to allow them to sell their devices, but also impacting the ability to deploy new systems in adjacent bands. This happens based on the fear or reality that poorly designed incumbent receivers will see authorized adjacent band emissions operated within their regulatory limits as harmful interference. This is a real problem that needs to be

addressed with considerable urgency. Given the increasing value of the spectrum and its increasing impact on the U.S. economy, we need to insure that we aren't squandering valuable spectrum by allowing poorly designed receivers to limit our use of valuable areas of the spectrum. One way to address this issue is a balanced approach coming out of the FCC Technological Advisory Council called the I Interference Limits Policy. This approach uses a Harms Claims Threshold, a measured level of transmitted power to determine whether the receiver or the transmitter needs to be redesigned in the actual instance of harmful interference. The presence of such a Policy-based threshold would almost certainly lead to improved receiver designs since the cost of replacing or retrofitting receivers would likely be high relative to the cost of initial good design. This approach would also avoid the challenges of seeking to actually create a potentially innovation stifling receiver standard that the government would surely not want to pursue.

A third related area of need is for an independent testing body, a technical arbitration entity if you will, capable of adjudicating the technical differences of opinion on the suitability of new entrants to use spectrum either in a co-channel or shared band arrangement or in the adjacent band sense discussed in the previous paragraph. The organization that most closely resembles this structure that has recently been "stood up" is the National Advanced Spectrum and Communications Test Network (NASCTN) currently co-sponsored by the Department of Commerce (NIST and NTIA) and the Department of Defense with the Department of Transportation potentially sponsoring the organization in the future. This organization has a structured approach to selecting projects that are both appropriate to its independent test mission and are within its technical competence. This organization should be a significant asset to the cause of efficient spectrum allocation and management.

A fourth area to promote efficient spectrum management policies and understand technological opportunities and challenges is to create innovation zones where new wireless technologies can be tested. This concept of need is the concept of a Wireless Model City that has been spoken about in Washington for some time, but never deployed. Given the current state and urgency to meet growing demand for spectrum, it is time to implement policies that support deployment. The idea here is to create an innovation zone in one or more major cities where new wireless technologies can be tested at scale. Even though the FCC has become very responsive in making exploratory licenses or special temporary authority to use otherwise unauthorized spectrum available, often it is very difficult to obtain the local city permits to physically deploy the new technology at scale. A very modest amount of funding would be needed to provide the incentives to encourage a city to make this kind of innovation zone available to exciting and emerging companies.

The hope is that these recommendations will enable a more efficient and more certain path forward for those proposing new technology offerings. Today's consensus driven processes are often extremely long and the results very uncertain. This means that investors are often unwilling to put their money behind even promising new wireless communications technologies given the time required to navigate the regulatory processes and the unpredictability of the

ultimate results. This can place the United States at a disadvantage if other nations choose to pursue technologies in spectrum that is less encumbered than that available in the U.S.

Beyond the various technical notions as I have outlined, though this takes me outside my technical comfort zone, I would like to directly address the topic of offering incentives to federal government spectrum users. First, I completely support the idea of providing up front research funding to promote an improved understanding of various spectrum bands that have been identified as having the potential to be auctioned. Liberalizing the availability of auction funds for this purpose seems extremely appropriate and valuable. In addition, I believe expediting the development of new-shared use can be facilitated in the near term by taking steps by:

1.) Setting timeframes by which government processes should begin and end to enable decisions to be made on spectrum use at certain frequencies;
2.) Congressional support for to fund testing at one facility, like NASCTN, that will streamline the process among various federal agencies;

Requiring development of retrofit or replacement programs directly to end users or agencies that may be affected by proposed new uses of the spectrum

On the other side, while I applaud the notation of incenting good spectrum management behavior, I do not support the concept of offering various government entities incentives to either "turn in" their spectrum or offer it for shared use. In my mind, the various government entities should be budgeted in an affordable fashion to accomplish the mission that they have been assigned to perform, nothing more nothing less. Offering incentives to organizations to perform tasks that have been deemed inappropriate to be funded when we are running a budget deficit would not seem to make any logical sense. Furthermore, the government is not structured in the way that private industry operates where companies invest in various ideas and programs and are rewarded by customers and investors for their good decisions and punished for poor decisions. In turn, individual leaders in the companies and their investors reap significant personal benefits from their good decisions and find themselves seeking other employment when their decisions fail to produce marketplace results. In the government, individuals do not and really should not reap excess personal benefits for decisions that are deemed preferable by other government entities, especially on matters as critical as spectrum. Therefore we need executives with a broad perspective who can, with support from some of the structures described above, make the needed decisions on spectrum allocations.

To briefly summarize my comments, I recommend the following items:

1) Encouraging bidirectional sharing between commercial and government users.

2) Funding for research in the Millimeter Wave spectral region using Massive MIMO based communication systems should be expanded.

3) Initiating funding for selected deployments of Spectrum Observatory Systems in a few large Metropolitan areas.

4) Support be continued for the NASCTN effort housed in the Department of Commerce and supported by the Department of Defense and hopefully other Departments in the near future.

5) Provide matching funds to support a few (one or two) Wireless Model Cities.

6) Empowering senior government executives to make appropriate government decisions, supported by spectrum experts and the structures above and especially NASCTN and the Department of Commerce labs.