BROADCAST ENGINEERING AND THE SPECTRUM
REVOLUTION
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The Federal Communications Commission’s (FCC’s) National Broadband Plan (NBP), released to Congress in March of 2010, calls for 500 megahertz of spectrum to be made available within ten years for broadband (essentially mobile broadband). Of this 500 megahertz, 300 megahertz should be within the segment 225 MHz to 3.7 GHz and should be made available within five years.

It is the view of this author\(^1\) that the NBP and the United States policies endorsing it have already had and will continue to have a profound, and in fact revolutionary, effect on spectrum allocations and spectrum management policy in the United States. In the coming years, it will not be business as usual for broadcast licensees, and especially broadcast television licensees, and for broadcast engineers who toil in the spectrum fields. This is no secret. What may not be completely understood by broadcast engineers, however, is that a complete overhaul in the priorities for providing media to the public has already occurred. There are two assumptions that are the underpinnings for this revolution. The first is the belief that mobile broadband is the ultimate key to social and economic prosperity, in the United States and worldwide, and it will improve every aspect of life. The second is that this universal benefit cannot be realized because of the severe shortfalls of spectrum necessary to allow it to fulfill the natural progression of 4, 5 and 6G networks. This paper does not suggest a “chicken Little/sky is falling” approach to this revolution. Rather, it is offered as an informational resource, providing a wide, international perspective of where spectrum management has changed in a very short period of time, and what it portends for the broadcast licensee and for broadcast engineers in the near term.

These policy changes have had direct effects already, not only on television main channel issues, threatening very directly and profoundly the future of free, over-the-air television broadcasting, electronic news gathering for television and radio, and in trends in media availability to the public. They have also had an effect on our Broadcast Auxiliary Service (BAS) allocations. As one early example of this, the FCC has proposed to permit fixed microwave facilities used for wireless backhaul (in support of mobile broadband) to operate in the 7 and 13 GHz bands on a shared basis with broadcasters. Another is the recent decision of the FCC in the TV White Spaces docket.

I. Introduction.

The following statistics, obtained from International Telecommunications Union (ITU) sources, should surprise you. Currently, approximately 5 billion of the world’s estimated 6.8 billion people are connected to global telecommunication networks via

\(^1\) This paper does not reflect necessarily the views of the Society of Broadcast Engineers, Inc. This paper has not been adopted by or accepted by the Board of Directors of the Society. The views expressed herein are those only of the author and are not attributable to the Society.
mobile terminals. Mobile telephony and mobile broadband demand and consumption have been growing at what accepted predictions show to be an unprecedented pace. Currently, 3G technologies are providing services to more than one billion subscribers worldwide; and, by 2013, the number of 3G subscribers is projected to reach approximately 2.4 billion. Estimates of worldwide wireless data traffic indicate that it grew by 5,800 percent during the two year period from 2006 to 2008 with slightly decreased rate of 4,500 percent forecast over the next few years. Current projections indicate that by 2014 monthly worldwide mobile data traffic will exceed the total for all of 2008. One 3G carrier in the United States reported in February 2010 that its mobile broadband traffic had grown more than 5,000 percent over the past three years. This strong current and projected demand creates an ever-expanding market for 3G-based devices, including 3G feature phones, smart phones, PDAs, tablets, e-readers, gaming devices, consumer electronics devices, and laptops.

For the majority of individuals in developing countries, the first, and the only access to the Internet, is via mobile networks. Other mobile broadband consumers increasingly demand a user experience that is similar to services and applications that they currently experience in wired office and home environments. Thus, the increasing demand for higher data rate services with comparable quality of service to the global mobile broadband consumer will (as virtually every telecommunications professional who has studied this agrees) place increasing pressure on finding spectrum resources to support the growth of a variety of mobile applications.

The FCC, the U.S. Congress, the White House, and now the ITU uniformly accepts the premise that access to mobile broadband will potentially trigger the creation of innovative new businesses, provide cost-effective connections in rural areas in the United States, in developing countries and under-served areas, increase productivity, improve public safety, and allow for the development of mobile telemedicine, telework, distance learning, and other new applications that will transform lives.

Any way this is viewed, it is an overwhelming series of widely accepted and unquestioned policy assumptions. In summary, the delivery of media is believed in the future to be by means of mobile broadband mechanisms. It is no wonder, therefore, that the United States, now in Europe, and likely soon in the rest of the world, is looking everywhere for spectrum to fuel the tsunami.

It is suggested that the threat posed by the United States’ plan to allocate 500 megahertz of spectrum for mobile broadband in the next ten years (which has already started): (1) represents the largest threat to both broadcast and broadcast auxiliary spectrum at the moment domestically; and (2) has (predictably) become not merely a domestic allocation matter, but an international one as well. Because mobile broadband devices necessitate worldwide markets, the international allocation of spectrum for mobile broadband will likely become carved in stone in terms of United States domestic allocations. A probable major agenda item at the WRC-16 ITU conference is in essence the allocation of 500 megahertz of spectrum worldwide for mobile broadband, similar to the NBP in the United States. The television broadcast service is at this point a main target for broadband reallocation domestically. Broadcasters stand to suffer “collateral
damage” at 3 and 7 GHz, and those actions are easily viewed as a precursor of future actions that affect broadcasters in different bands, including 2 GHz and possibly 2.5 GHz. There is general acceptance in the telecommunications industry of the forecast of severe shortages of mobile broadband spectrum, primarily but not exclusively between about 225 MHz and about 3.7 GHz, and that is the single-minded focus of the current FCC; the United States Congress; and the White House now.

II. Background.

The National Broadband Plan (NBP) developed by FCC (largely, incidentally, by FCC contractors, rather than FCC staff) was released to Congress in March of 2010. It calls for 500 MHz to be made available within ten years for broadband, of which 300 MHz should be within the segment 225 MHz to 3.7 GHz, and made available within five years. Recommendation 5.8.5 of the NBP is that the FCC should institute a rulemaking to reallocate 120 megahertz from the broadcast television service for mobile broadband due to propagation characteristics of that spectrum.

The NBP uses a “value of spectrum” metric for determining what spectrum should be reallocated for mobile broadband. The demand for mobile broadband is escalating at a tremendous rate, says the Commission.

In mid-April, Congress was considering H.R. 3125, the Radio Spectrum Inventory Act, which provides for an inventory of spectrum between 225 MHz and 3.7 GHz within one year of passage, including assessment of the spectrum efficiency of each incumbent user in that segment. That, of course, would include the Broadcast and Broadcast Auxiliary Services. The FCC called off Congress, promising to do the same inventory called for by that Bill without a Congressional mandate. FCC reports to SBE that BAS spectrum has been carefully included in the inventory. Because mobile BAS is frequency agile and itinerant, broadcasters have very little ability to document the intensity of use of the bands in the inventory range, as opposed to frequency-specific (i.e. individual channel assignment) services, which can more easily document the number of licenses issued and the number of transmitters per license authorized and actually in use.

President Obama signed a Presidential Memorandum on June 8, 2010 entitled Unleashing the Wireless Broadband Revolution. This committed the federal government to find an available 500 MHz of federal and commercial spectrum over the next 10 years for reallocation to broadband. That document and fact sheet that accompanied it essentially endorsed the entirety of the NBP. The President said that the reallocated spectrum will foster investment, economic growth and help create hundreds of thousands of jobs by meeting the “burgeoning demand” for mobile and fixed broadband, other “high-value uses” and benefits for other industries. Currently, wireless companies have about 534 megahertz allotted to them. That number will almost double in the next ten years, apparently. The White House said the reallocation of spectrum would be voluntary, employing tools such as proceeds of spectrum auctions to compensate those who agree to relinquish their “unused or under-used” spectrum. According to the Fact Sheet distributed by the White House about the Memorandum: “The Administration has no official
estimate of the auction revenues from this plan. The actual amount will depend on effective implementation and additional design details, but based on past auctions, many analysts believe the revenue potential could reach in the tens of billions of dollars. The proceeds would be invested in public safety, additional job-creating infrastructure investments and deficit reduction.” So, the reallocation of spectrum for mobile broadband is on a roll from the White House’s perspective because of the need for mobile broadband spectrum, job creation, and deficit reduction. In the face of these justifications, allocations of more traditional incumbent services are certainly fair game. Nothing is sacred. Sources within the Federal government report to SBE that United States government spectrum in active use between 225 MHz and 3.7 GHz is also on the table for reallocation.

III. The Ubiquitous Mobile Broadband Telecommunications Network.

The United States and the ITU are of the view that the development of a ubiquitous mobile broadband network will have social effects far beyond those now in place. As just a sample, the following is an excerpt from an ITU-R (the radiocommunications segment of the ITU that deals with spectrum allocations) document that is intended for the upcoming WRC-12 next year. The document proposes that the ITU-R undertake studies to determine the amount of spectrum needed to support mobile broadband systems, and report the results of these studies to the next WRC (WRC-16) for regulatory actions as required, including new allocations and identifications. These are the plans and expectations for the expanded mobile broadband network worldwide:

*Healthcare.* Information technology plays a key role in improving health and health care delivery. Mobile broadband can improve care quality, safety, efficiency, and reduce disparities in health care. Increased access to broadband will serve to engage patients and families in managing their health and enhance care coordination. Broadband access might help ensure adequate privacy and security of health information. Increased access to broadband wireless systems can dramatically improve the collection, presentation and exchange of health care information, and provide clinicians and consumers the tools to transform care. Technology alone cannot heal, but when appropriately incorporated into care, technology can help health care professionals and consumers make better decisions, become more efficient, engage in innovation, and understand both individual and public health more effectively.

*Education.* Broadband can be an important tool to help educators, parents and students meet major challenges in education. A country’s economic welfare and long-term success depend on improving learning for all students, and broadband-enabled solutions hold tremendous promise to help reverse patterns of low achievement and lack of access. With broadband, students and teachers can expand instruction beyond the confines of the physical classroom and traditional school day. Broadband can also provide more customized learning opportunities for students to access high-quality, low-cost and personally relevant educational material. Broadband can improve the flow of educational information, allowing teachers, parents and organizations to make better decisions tied to each student’s location, needs and abilities. Improved information flow can also make
educational product and service markets more competitive by allowing school districts and other organizations to develop or purchase higher-quality educational products and services.

**Economic Growth.** Broadband and the Internet make it possible for small businesses to reach new markets and improve their business processes. They have also become a critical pathway for individuals to gain skills and access careers. It is a core infrastructure component for local communities seeking to attract new industries and skilled work forces. As a result, small businesses, workers, and communities must have the broadband infrastructure, training and tools to participate and compete in a changing economy. Broadband can help every community.

**Government Services.** Smarter use of broadband can facilitate a vast change in government. Like private companies, government can make its services available 24 hours a day, seven days a week, 365 days a year. Broadband-enabled online services can create paths across government’s bureaucratic silos so that someone wanting to access unemployment benefits can deal with the local government and the federal government at the same time. Broadband holds the potential to move all government forms online, eliminating paperwork. Broadband allows for online tutorials for simple government services, which can help free government employees to focus on the most complicated cases. And broadband can increase efficiency by increasing the speed and depth of cooperation across departments and across different levels of government.

**Civic Engagement.** Civic engagement starts with an informed public, and broadband can help by strengthening the reach and relevance of mediated and unmediated information. Broadband can enable government to share unmediated information more easily. Providing more information and data to the public about the processes and results of government can strengthen the citizenry and its government. Broadband can also empower citizens to engage their government through new broadband-enabled tools. Broadband has already increased access to information and revolutionized the way citizens interact with each other.

**Public Safety.** There are significant benefits, including cost efficiencies and improved technological advancement, if the public safety community can increasingly use applications and devices developed for commercial wireless broadband networks. Ultimately, this system must be flexible, allowing public safety entities to forge incentive-based partnerships with commercial operators and others. This system will allow the public safety community to realize the benefits of commercial technologies, which will reduce costs and ensure the network evolves.

It is envisioned that the above type of future service offerings will open up new opportunities for connectivity, allowing consumers to be situation-conscious, to multi-task, and to access a wide range of telecommunication services supported by packet-based mobile and fixed networks. The mobile broadband manufacturing industry is evolving towards next generation highly efficient radiocommunication technologies, coupled with an all-IP open Internet network architecture. Through technological innovations such as MIMO and adaptive beam forming antenna systems, the efficiency of spectrum usage has continuously improved. However, the evolution of the technologies will not provide all the necessary capacity to meet the growing demand.
The conclusion of this ITU-R input document is as follows: “As the use of mobile broadband technologies expands, existing mobile service allocations may not be adequate to meet the growing demand. Furthermore, the benefits of global or regional harmonization of frequency bands may not be realized unless adequate spectrum is identified for this purpose. One administration has estimated that a total of 500 MHz of additional spectrum may need to be available for mobile broadband use within the coming 10 years.” The document notes that the adversely affected radio services include broadcasting:

**Indication of possible difficulties:** Any spectrum likely to be considered as candidates to support mobile broadband systems is equally likely to be encumbered by other mobile, fixed, broadcast, radiolocation and satellite services.

**IV. Specific Concerns.**

There are numerous handicaps that broadcasters have in dealing with this tsunami of mobile broadband allocation fever. One is that, as a practical matter, broadcasters don’t have much frequency loading data relative to what is available to broadcasters above 450 MHz -- arguably, therefore, broadcasters are using the BAS spectrum above 450 MHz inefficiently. That has been acceptable in the past but not longer. Even the Federal Government is having a very hard time keeping what is allocated to them. One might assume that if the Federal Government is forced to give up large blocks of UHF or low microwave spectrum, broadcasters have no sacred cows. NTIA has already identified 115 megahertz of spectrum held by the government for reallocation: 100 megahertz is currently used by DoD for radar systems and naval vessels, and 15 megahertz is used by NOAA for weather balloons and satellites. If spectrum used for those purposes is subject to reallocation, you can be sure that broadcasters’ uses of spectrum will not be given much weight when deciding whether or not to reallocate it, given the assumed universal applications of mobile broadband.

**V. Conclusions.**

This is a revolutionary period in domestic spectrum allocations. The White House’s National Economic Council stated recently that freeing up 500 megahertz of spectrum for wireless broadband connectivity over the next ten years is a “national imperative.” CTIA, representing wireless carriers, has estimated that it is more like 800 megahertz of spectrum needed in order to keep pace with consumer demand for smartphones and tablet computers. It is difficult to conceptualize a strategy for the retention of broadcast main channels and the spectrum defense of BAS allocations in their present configurations in the face of (1) the anticipated social and economic value of mobile broadband expansion in the near future; and (2) the assumed voracious demand for available bandwidth and the assumed shortfalls in spectrum in view of this demand in the next ten years. If the allocations envisioned for mobile broadband are implemented on the timetables proposed domestically and internationally, the demand for and the work of
television broadcast engineers, radio broadcast engineers and the profession of broadcast engineering will inevitably change substantially. Broadcast engineers stand to be directly and adversely affected by the NBP, and by the worldwide effects that have been triggered by it. It would be useful for SBE, NAB and MSTV to work together to assess threats to UHF and microwave main channel and BAS allocations below 5 GHz. Under the circumstances, success may be measured differently than broadcasters have measured success in allocations proceedings against specific competitors for spectrum access in the past.

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