Testimony of

Michael Calabrese
Vice President & Director, Wireless Future Program
New America Foundation

Before the

Committee on Energy and Commerce
Subcommittee on Communications, Technology and the Internet
United States House of Representatives
Washington, D.C.

December 15, 2009

Legislative Hearing on H.R. 3125, the Radio Spectrum Inventory Act and H.R. 3019, the Spectrum Relocation Improvement Act of 2009

Testimony of

Michael Calabrese
Vice President & Director, Wireless Future Program
New America Foundation
December 15, 2009

Thank you, Chairman Boucher, Ranking Member Stearns and members of the Committee, for this opportunity to testify today on these two important pieces of proposed legislation.

My name is Michael Calabrese, Vice President and Director of the Wireless Future Program at the New America Foundation, a nonpartisan public policy institute here in Washington, DC. On issues concerning spectrum and wireless broadband policy, New America is part of the Public Interest Spectrum Coalition (PISC), which represents national consumer and advocacy groups including Consumers Union, Consumer Federation of America, Free Press, Public Knowledge and others. Most of my remarks reflect comments that we filed on behalf of PISC last month in response to the FCC's Wireless Innovation Notice of Inquiry (Docket 09-157) and in response to the National Broadband Plan more generally (Docket 09-51).

In addition to explaining why we support these two very complementary bills, I will make the following main points:

- The increasing capability and popularity of smartphones and other wireless computing devices will drive an explosion in mobile data demand.
- Contrary to conventional wisdom, there is an abundance of unused spectrum capacity that can be reallocated band-by-band for exclusive or for shared use.
- The spectrum inventory proposed in H.R. 3125 is critical to identifying underutilized bands and determining how best to expand access and improve spectrum efficiency.
- Actual spectrum use measurements and, ideally, spectrum monitoring, would add an important layer of useful data to the inventory; this and other NTIA/FCC costs for a robust implementation should be funded from unused appropriations for the national broadband mapping data under the Broadband Data Improvement Act.

- Many federal bands are particularly well-suited for increased sharing with private sector uses, but this will require not just streamlining the CSEA's Spectrum Relocation Fund process, but also broadening eligibility so that agencies have the means to upgrade systems to share capacity on a far greater number of bands.
- Together the inventory and the CSEA process can facilitate shared access to a far larger amount of spectrum capacity not being used at particular locations or times.
- A comprehensive spectrum inventory and CSEA reforms are also critical because it is neither practical nor desirable to rely entirely on new auctions of exclusively-licensed spectrum to meet the projected future demand for mobile data.
- Increasing opportunistic access to shared spectrum will enable hybrid networks, giving consumers the choice to transmit mobile data flows where feasible over unlicensed airwaves and local wired networks, rather than transporting most data over scarce licensed spectrum and relatively distant carrier infrastructure.

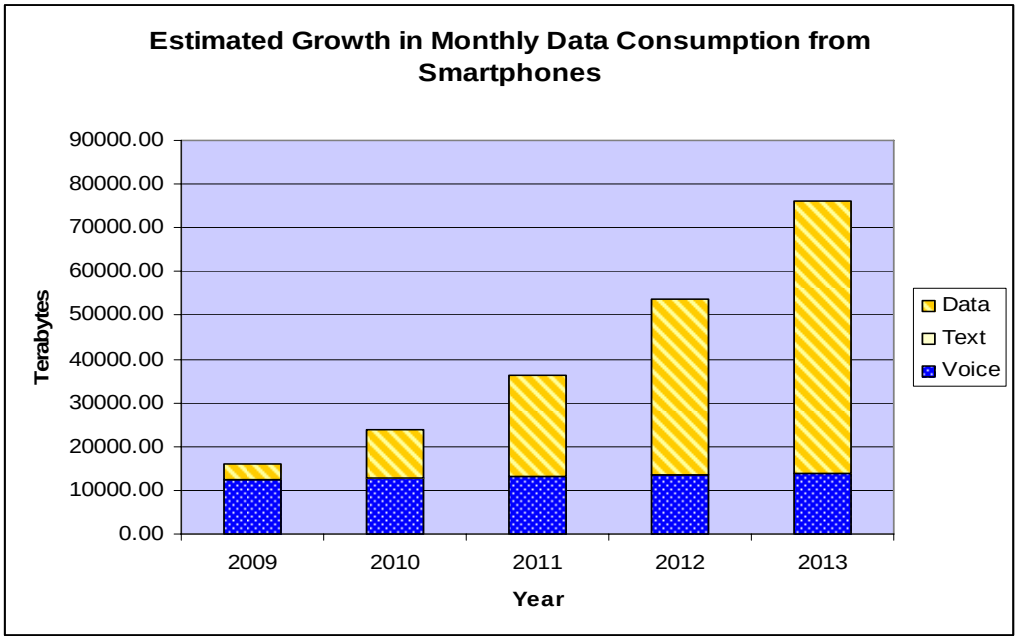
Mobile Data Demand and the Myth of Spectrum 'Scarcity'

Unleashing an abundance of spectrum and driving down its cost as an input for all things mobile is the single best means by which Congress, the Administration and the FCC can promote innovation and consumer welfare in wireless. There is no doubt that consumer demand for mobile data applications is exploding worldwide. The iPhone has proven to be the canary in the proverbial spectrum coal mine: with the equivalent of a mobile computer and thousands applications to choose among, iPhone users consume between five and ten times the bandwidth as other smartphone users – and hundreds of times the bandwidth of ordinary cell phones. The increasing market penetration and use of smartphones with capabilities similar to today's iPhone and Android is likely by itself to increase mobile data demand by a factor of 16 or more within five years (conservatively growing from approximately 3,700 to 62,000 terabytes – see Figure 1 below).

In addition, pervasive connectivity will rapidly become integrated in applications for sensing networks, health care (e.g., remote monitoring), energy conservation (e.g., smartgrid, home appliance networks), education, public safety and e-government – much as devices like the Kindle are already embedding wireless connectivity. Cisco's annual

projection of global Internet traffic predicts a 130% annual growth rate for mobile data over the next five years – with mobile Internet video driving overall consumption to 366,000 terabytes (see chart below).

***Figure 1*: Estimated Growth in Monthly Data Consumption from Smartphones**[1]



A national goal of not merely affordable broadband access, but of truly pervasive connectivity – seamless mobile connectivity anywhere and anytime – will require an enormous increase in available spectrum capacity. Despite the FCC's acknowledgment that traditional "command and control" spectrum management is outdated and inefficient, the government's continued focus on exclusive licensing by auction reinforces the conventional wisdom that spectrum is scarce. In reality, the only scarcity is government permission to use spectrum (licenses). Spectrum capacity itself is abundant. Indeed, while actual spectrum measurement studies are difficult to find, those in the public

[1] This smartphone data projection conservatively assumes the penetration of devices with capabilities similar to today's iPhone will increase from 17% to 50% in five years and that the average user will consume as much data (400 megabits/month) as today's iPhone user. Total mobile subscribership is assumed to grow at a rate of 3% per year. Growth rates for voice and text messages are assumed to be 3% per year and based upon monthly voice minutes and text messages reported from CTIA's 2009 Semi-Annual Wireless Industry Survey Results. Although 123 billion text messages were sent per month during the first half of 2009, each message is just 160 bytes (total of 19 terabytes/month) and therefore is not visible on the chart.

domain have demonstrated that even in the most valuable "beachfront" frequencies below 3 GHz, the vast majority of frequency bands are not being used in most locations and at most times. Spectrum measurement studies by the New America Foundation, by Shared Spectrum and others show that even in Manhattan and here in Washington near the White House, less than 20 percent of the frequency bands below 3 GHz are in use over the course of a business day. Spectrum usage rates are, of course, far lower in suburban and rural areas.

US Mobile Data Traffic

(Terabytes per month)

	2008	2009	2010	2011	2012	2013
Handsets						
Audio (Handsets)	638	1,444	2,946	5,696	10,630	19,331
Data and Messaging (Handsets)	320	734	1,552	3,160	7,630	16,670
Video (Handsets)	231	768	2,288	6,063	18,056	52,520
Video Calling (Handsets)	87	347	1,358	4,082	10,577	26,427
Laptops and Other						
Internet Gaming	101	241	508	1,008	1,993	3,610
Internet Video Communications	23	58	133	288	593	1,074
Internet Video to PC	1,723	5,591	15,138	36,127	82,091	153,745
Internet Voice	41	96	185	332	599	1,085
P2P	1,321	3,072	6,055	10,934	18,609	27,846
Web/Email	1,353	3,419	7,671	16,414	35,291	63,936
TOTAL	**5,837**	**15,770**	**37,835**	**84,103**	**186,068**	**366,245**

Source: Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, January 29, 2009 (U.S. data breakout)

The gross underutilization of the nation's spectrum resource should be an urgent concern for national broadband policy. Spectrum is not only an immensely valuable and publicly-owned resource, but one that is infinitely renewable: every millisecond that a frequency band is not used for communication, that capacity is wasted forever. In that respect, when former FCC Chairman Newt Minow famously called television a "vast wasteland," he could have been describing more literally the nation's spectrum resource under the prevailing exclusive zoning (licensing) system. One of the biggest obstacles to putting fallow spectrum to work, particularly in the grossly underutilized bands held by

the federal government, is the lack of transparency with respect to actual use and the types of systems and technologies that need to be accommodated to facilitate greater private sector access.

H.R. 3125: The Radio Spectrum Inventory Act

A critical step toward making substantially more spectrum capacity available for wireless broadband services and innovation is to determine and disclose how, where and when this publicly-owned resource is currently being used – or not used – by current public agency and private sector licensees. That is why New America and the broader Public Interest Spectrum Coalition strongly support enactment of H.R. 3125, the Radio Spectrum Inventory Act, as well as its Senate companion (S. 649). We agree with the bipartisan House co-sponsors that it is important to extend the inventory up to 10 GHz and not limit it to the range of frequencies most intensively used today, as the Senate bill does by restricting the inventory to spectrum below 3.5 GHz. Even if frequencies below 3.5 GHz are prioritized during the inventory process, policy should encourage continued innovation and access to the higher-frequency bands by making their use equally transparent. We also appreciate the more comprehensive scope of the inventory described in the House bill, since a more granular and comprehensive description of the actual spectrum use in each local market will assist policymakers, business entrepreneurs and technologists to propose new ways to enhance spectrum access and efficiency.

Spectrum mapping would help facilitate expanded access to broadband providers in at least three ways:

- First, more complete and transparent frequency-by-location data online will improve the functioning of secondary markets for spectrum license transfers and leasing.
- Second, it will provide information on what will be required to clear some heavily underutilized bands, so that they can be reassigned for commercial use.
- Third, it will reveal the far greater number of frequency bands that could be made available for shared access in discrete geographic areas, at certain times of day or year, or at certain altitudes or directions of arrival (azimuth, elevation).

Rural areas would be the most likely and immediate beneficiaries of a mapping of the U.S. spectrum capabilities. Wireless remains the most cost-effective and rapid means by which to bring broadband access to rural residents. It will quickly become clear that particular frequency bands are either completely unused or grossly underutilized in many rural markets. An online map of spectrum utilization on a localized basis (such as by Rural Service Area and Metropolitan Statistical Area) would provide the Commission or Congress with the information it needs to reallocate or to at least open underutilized frequencies for non-interfering use by rural broadband providers, as well as for wireless innovation more broadly. Already, thousands of locally-grown Wireless Internet Service Providers (WISPs), Rural LECs, public utilities, NGOs and local governments are utilizing wireless technology in conjunction with unlicensed spectrum to bring wireless broadband to unserved and underserved rural areas across the country. A substantial obstacle these small and local providers face in attempting to expand and scale-up their networks is access to additional spectrum.

It is also important that any federal spectrum mapping include actual and ongoing spectrum use measurements at a large and diverse sample of rural, urban and suburban locations around the nation. The major shortcoming of H.R. 3125, in our view, is that an inventory of spectrum assignments should be augmented by actual spectrum use measurements – and, eventually, a system of spectrum use monitoring – that can provide a more nuanced window into how, when, where and to what extent bands are *actually* in use. The Commission and the public need to have a more complete, comprehensive inventory of what frequencies are *actually* in use, for what purpose, with what technology, at what locations, frequencies and times. Both government and private sector assignments and uses should be included in the map. Actual spectrum use measurements in a large and regionally diverse sampling of markets should be part of the Commission's broadband mapping exercise.[2]

---

[2] *See* "Ex Parte Comments of New America Foundation," GN Docket No. 09-29, Federal Communications Commission, March 25, 2009, http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520203629, *see also* "Comments of the New America Foundation, Public Knowledge and Media Access Project, GN. Docket No. 09-51, Federal Communication Commission, June 8, 2009, http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520220266 .

The NTIA conducted spectrum measurement studies in the mid-1990s, but virtually none in recent years. Indeed, one of the recommendations of the Presidential Task Force on spectrum policy in 2004 called for "spot compliance checks" and "signal measurement surveys" to check the accuracy of NTIA's records and provide data needed to "evaluate the utility of underutilized spectrum."[3] The Task Force recommended that:

> NTIA should evaluate all spectrum use by the federal government over a five-year period to determine spectrum efficiency and effectiveness. **The review should include spot compliance checks and signal measurement surveys to verify the accuracy of the records of the Government Master File (GMF), identify congestion and instances of duplicative operations that could be combined, and evaluate the utility of underutilized spectrum.** NTIA should use the results of these reviews in the development of new and improved spectrum management policies, and the Federal Strategic Spectrum Plan. [4]

There are proven methods for efficiently aggregating usage data across a wide range of frequencies and at relatively low cost. For example, early this year Ofcom, which regulates spectrum and communications in the United Kingdom, completed a nationwide study by mounting measurement equipment on the roofs of vehicles used by a UK-wide sales force. The mobile monitors aggregated data over a period of weeks on frequency bands from 10 MHz to 6 GHz.[5] In the U.S., a nationwide fleet service – such as the Postal Service – could aggregate continuous measurements, downloading the data automatically by WiFi each evening. Another method, currently being field-tested by at least one U.S. firm, involves continuous monitoring over wide areas by a meshed network of inexpensive sensors (less than $1000 per unit) that could be mounted on the roofs of public buildings.

---

[3] The Task Force was part of the Spectrum Policy Initiative initiated by President Bush in 2003 and led by NTIA. U.S. Department of Commerce, *Spectrum Policy for the 21st Century–The President's Spectrum Policy Initiative: Report 1, Recommendations of the Federal Government Spectrum Task Force* (June 2004), at http://www.ntia.doc.gov/reports/specpolini/presspecpolini_report1_06242004.htm; *see also* http://www.ntia.doc.gov/reports/specpolini/presspecpolini_report2_06242004.htm; NTIA, *Presidential Memorandum on Spectrum Policy for the 21st Century*" (May 29, 2003), available at http://www.ntia.doc.gov/ntiahome/frnotices/2004/PresMemoonSpectrumPolicy.htm.

[4] *Ibid.*

[5] Ofcom, "Capture of Spectrum Utilisation Information Using Moving Vehicles," study available at http://www.ofcom.org.uk/research/technology/research/state_use/vehicles/.

We realize that adding a layer of actual use measurements to the inventory would entail a budgetary cost. Indeed, a very robust implementation of H.R. 3125 would also entail substantial staff time and costs, particularly if NTIA and FCC intend to display an easy-to-navigate visualization interface for the inventory on the Web. Fortunately, Congress has already authorized and appropriated adequate resources to both do measurements and to offset any extra costs associated with a very robust inventory. The American Recovery and Reinvestment Act appropriated up to $350 million, under the Broadband Data Improvement Act (BDIA), to develop and maintain "a comprehensive nationwide inventory map of *existing broadband service capability* [italics added]."[6] Just as fiber is the essential conduit for advanced wired connectivity, spectrum is the publicly owned conduit for wireless broadband. Spectrum is "wireless fiber" – the fundamental pipeline for wireless broadband service capability and we believe it would be in the public interest to have a clear and transparent mapping of those capabilities. Since NTIA is in the process of awarding less than half this appropriation to the states and territories, Congress could clarify that a portion of the remainder can be used over the remaining four years of the BDIA mapping program to map the airwaves as well.

We further recommend that spectrum mapping should be adopted as a presidential initiative coordinated from the White House under the guidance of the President's Chief Technology Officer. In addition to signaling the importance of pervasive connectivity to the economy and American competitiveness, White House leadership is necessary to secure the full cooperation of departments and agencies across the government. Federal agencies hold the rights to the majority of the spectrum frequency bands best suited for broadband services and applications. These rights are spread across dozens of agencies and coordinated by an office within NTIA (the Office of Spectrum Management) that historically has been conflicted by its primary role as defender of federal agency allocations and by dependence on spectrum management fees budgeted by these agencies. The FCC, meanwhile, is an independent regulatory agency that can neither command, nor be commanded by, the NTIA or other executive branch departments.

---

[6] *See* Sec. 6001, The American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5, 123 Stat. 115 (2009).

Therefore, while the NTIA and FCC are the essential co-partners in this effort – and show promising signs of being able to work in tandem under their respective new leaderships – it will be critical for the entire executive branch to respond to this initiative as a presidential broadband imperative.

H.R. 3019: The Spectrum Relocation Improvement Act

Although spectrum mapping would greatly facilitate the identification of bands that can be reallocated for more intensive and efficient use, the process of unlocking unused spectrum capacity should begin immediately on a band-by-band basis. Nowhere is spectrum underutilization more evident than in many of the bands reserved for use by the federal government itself.[7] According to the Commerce Department's Office of Spectrum Management, federal agencies have exclusive use of 18.1% (629 MHz) of the "beachfront" frequencies between 225 and 3700 MHz, while non-federal users have exclusive licenses to 30.4% (1058 MHz). The remaining 51.5% is shared, with federal use primary and private sector use secondary.[8] Of the roughly 2400 MHz of federal spectrum allocations below 3.7 GHz, over 1700 involves radar, radionavigation and air telemetry systems, the effective operation of which are indeed critical to national security. At the same time, actual spectrum measurement studies indicate that the military and other agencies are actually using very little if any of that capacity on most days and in most geographic locations, particularly at ground level and in more densely populated metro areas where more spectral capacity is most needed.[9]

It is important to be clear that just because a frequency band is not fully or frequently utilized in a particular geographic area – which is what the New America and Shared Sectrum measurements indicate – this does not mean it is not serving its assigned

[7] For an in-depth discussion of the utilization of federal spectrum and policy recommendations for reallocation of this underutilized spectrum, *see* Victor Pickard and Sascha D. Meinrath, "Revitalizing the Public Airwaves: Opportunistic Reuse of Government Spectrum," Wireless Future Working Paper, New America Foundation (June 2009); forthcoming in *International Journal of Communications* (2009).
[8] Karl Nebbia, Director, NTIA Office of Spectrum Management, presentation to the Commerce Spectrum Management Advisory Committee (CSMAC), December 9, 2009.
[9] Mark McHenry, "NSF Spectrum Occupancy Measurements: Project Summary," Shared Spectrum Company (August 2005)), available at http://www.sharedspectrum.com/measurements/. McHenry's 2005 study collected frequency use data in six locations along the East coast in 2004 and documented an average total spectrum use of between 0 and 3% at rooftop level across hundreds of MHz of federal spectrum.

purpose, or that its incumbent users can be relocated. Many military bands in particular are assigned for mission-critical training and emergency purposes that are episodic or geographically limited in nature. While in many such cases "clearing" a band of its current licensee and reassigning it exclusively to private sector licensees cannot be justified, there is nevertheless tremendous communications capacity that could be productively used at no cost or harm to the incumbent – just as the military today shares several radar bands with unlicensed users of low-power unlicensed devices.[10] At the same time, even a band that would register as "occupied" over the course of a day or week may still have tremendous unused spectrum capacity. A band of frequencies can be "white" (underutilized) and potentially shared on a number of different dimensions, including geography, time, power level, altitude and angle of reception.

A band-by-band approach will be necessary to determine the best means by which an underutilized band can be made available for more intensive use with minimum risk of harmful interference to incumbent services. In some bands, Congress or the FCC, in consultation with NTIA, may determine that it is feasible to relocate incumbent federal users to accommodate reassignment of frequencies on an exclusively-licensed basis, as occurred with the 45 MHz of federal spectrum at 1710 to 1755 MHz that was cleared for auction under the Commercial Spectrum Enhancement Act of 2004.[11] In a far larger number of bands, where it is not practical to relocate military or other federal users, or where that would take many years, spectrum capacity can be made available more rapidly by opening the bands to "opportunistic access" on a secondary basis that requires the user to avoid causing harmful interference with the incumbent use.

While we support the improvements to the CSEA that are proposed in H.R. 3019, we believe the legislation should be broadened to address a critical opportunity to free up far greater spectrum capacity for mobile broadband services and innovation. H.R. 3019 would continue to limit eligibility for reimbursements toward the cost of radio system

---

[10] *See* Michael J. Marcus, "New Approaches to Private Sector Sharing of Federal Government Spectrum," Wireless Future Program Issue Brief #26, New America Foundation (June 2009).

[11] On December 23, 2004, President Bush signed into law the Commercial Spectrum Enhancement Act (CSEA), Title II of Pub.L. No. 108-494; 47 U.S.C. 928(d)(2). CSEA created the Spectrum Relocation Fund through which federal agencies can recover the costs associated with relocating their radio communications systems from bands designated by Congress for reallocation to exclusive commercial use.

modernization to agencies actually clearing off a set of frequencies scheduled for auction. While only a tiny fraction of federal spectrum could be cleared and auctioned in the near future – primarily because most bands serve critical national security and other functions – a far greater number of bands could be shared more intensively by taking advantage of advances in smart radio technologies. Technologies such as spectrum sensing, dynamic frequency selection, geolocation databases and priority-in-use beaconing can enable a far greater degree of band sharing with non-federal users.

Federal spectrum incumbents need the resources to take affirmative steps to enable more intensive access and band-sharing by other users. This could be a win-win for the military. Although the DoD, for example, has begun sharing military radar bands (at 5 GHz) with low-power unlicensed operations, government users are entirely passive and take no affirmative steps to facilitate private sector use of lightly-used bands. Michael Marcus, a career-long chief spectrum engineer at the FCC, has argued that with the right incentives "a third generation of sharing could be based on new technologies for federal government radio systems that are designed with sharing in mind and that can actually *facilitate* sharing."[12] New and upgraded federal systems could be designed and procured with the broader public interest in spectrum access in mind – and not only in the very limited case of a band being cleared entirely of federal use.

We therefore suggest that H.R. 3019 be amended to broaden the purpose of the Spectrum Relocation Fund – turning it into a sort of revolving fund for modernizing federal systems not only to migrate off some bands entirely, but to facilitate the shared or more efficient use of other federal bands. Enhancing agency budgets with revenue tied to the purpose of upgrading to state-of-the-art equipment, we believe, would prove to be a far stronger and more focused incentive than giving agencies the option to lease unused capacity on secondary markets (which, if it ever generated more than trivial amounts of revenue, could not be counted on to increase the agency's overall resources since OMB or Congressional appropriators could view it as an offset). Funding federal agency relocation plans could remain the priority – and retain access to a guaranteed set-aside

[12] *See* Michael J. Marcus, "New Approaches to Private Sector Sharing of Federal Government Spectrum," Issue Brief #26, New America Foundation (June 2009).

within the Fund. But in addition the residual revenue, or some portion, should be made available to applications from agencies that could be recommended to OMB for approval – on an annual, competitive basis – by the new Technical Advisory Panel that would be appointed under H.R. 3019. Moreover, if there were any legitimate concern about auction revenues being insufficient for such purposes, Congress could revise the CSEA to direct that devices certified to operate on the newly-shared bands opened due to expenditures from the Fund pay a one-time certification fee to help replenish the Fund.

Opportunistic Access to Unused Spectrum Capacity

Opportunistic access to unused federal spectrum could be particularly useful given the lumpiness of spectrum demand by geography and population density (e.g., rural vs. suburban vs. urban). The greatest needs for capacity are not nationwide, or around the clock, but primarily urban and during peak use periods. Rather than an entire network needing additional spectrum, it may be a few cells that are substantially oversubscribed and would benefit from having access to additional spectrum for short period of time.

We believe the most promising mechanism for freeing up large quantities of spectrum capacity needed for wireless broadband deployments and other innovation is to build on the TV Bands Database, which the FCC will certify as the mechanism by which consumers identify and get permission to access "white space" channels not in use in discrete geographic locations across the nation's 210 local TV markets. Under the Report & Order adopted unanimously by the Commission in November 2008,[13] both fixed and mobile broadband devices will be allowed to operate on an unlicensed basis on unused DTV channels ("white space") provided that the devices have GPS and the capability to periodically check an online database of available TV channel frequencies in that discrete geographic location. TV band white space devices (WSDs) will be required to query a national database to determine available channels at their current location before transmit capabilities are engaged.

[13] Unlicensed Operation in the TV Broadcast Bands, *Second Report and Order and Memorandum Opinion and Order*, ET Docket No. 04-186, ET Docket No. 02-380, FCC 08-260 (released November 14, 2008) ("*TVWS Order*").

There appears to be no reason to limit the functionality of the TV Bands Database to the TV band frequencies – and no reason not to add more fallow bandwidth to this "common pool." If a potentially useful frequency band is not being used at particular locations (e.g., used in New York City but not in West Virginia), or is being used only at certain times or at certain altitudes or angles of reception, then that currently wasted spectrum capacity could at a minimum be listed in the Database for opportunistic access, subject to whatever power limits or other conditions would be necessary to avoid harmful interference to sensitive incumbent operations.

Adding other bands to the TVWS Database could ultimately increase available spectrum capacity by hundreds of megahertz or more, particularly in rural areas where measured spectrum usage below 3 GHz is in the low single digits today. The FCC's access rules for TV white space anticipates the use of frequency-hopping, multi-band radios, which are increasingly common and affordable in commercial mobile systems. Device makers and service providers would simply choose the combination of frequencies most appropriate to their needs. Devices (whether fixed access points or mobile handsets) would scan and select the clearest frequency from among those that their devices can be tuned to utilize. Both federal and non-federal bands should be added to the Database, with access to each band subject to conditions that are tailored to avoid harmful interference to existing, licensed use. And to the extent that either a federal agency or private sector incumbents truly need compensation or incentive to facilitate shared access, a permission Database mechanism provides one means by which to collect "user fees." Another means would be to impose a one-time equipment certification fee on devices tuned to operate in bands governed by the Database, since the FCC must certify devices in any case.

New Exclusively-Licensed Spectrum Alone Cannot Absorb Mobile Data Demand

As this Committee takes up the Radio Spectrum Inventory Act and the Spectrum Relocation Improvement Act, it is important to bear in mind that meeting the exploding demand for mobile data access must increasingly include a focus on enabling shared, dynamic access to unused and underutilized bands. Currently, commercial wireless

providers hold licenses for just over 500 MHz of spectrum. While it may be feasible to clear incumbents from approximately 200 MHz of spectrum within three to five years, there appears to be no economically or politically feasible path to clearing the 800 MHz recently requested by CTIA, the Wireless Industry Association.

The CTIA projection appears to be based on a 2006 study by the International Telecommunications Union (ITU). The futility of meeting projected demand by clearing new bands for auction is highlighted by the fact that the ITU study estimated a considerably higher requirement for markets (such as the U.S.) that aim to sustain sufficient spectrum capacity for three or four competing ISPs in each market. The ITU's total spectrum requirement for three competing networks is 1,980 MHz by 2020 – and 2,240 MHz to support four competitive networks (see Figure 2 below). Clearing the additional 1,700 MHz of spectrum that ITU estimates is needed to sustain robust competition among multiple networks and technologies within the same local area – and with propagation characteristics that ensure quality of service – does not seem feasible within a meaningful time frame. What is more likely to result from a policy premised solely on clearing bands and auctioning exclusive licenses is a continuation of current trends: a sort of controlled scarcity that releases "just enough" spectrum, and does so at costs that deter competitive entry and innovation, while encouraging further industry consolidation and market power.

***Figure 2*: ITU Spectrum Requirements by 2020 for High-Density Markets**

	1 network	**2 networks**	**3 networks**	**4 networks**	**5 networks**
Total Spectrum (MHz)	1720	1760	1980	2240	2500

Source: *ITU, Estimated spectrum bandwidth requirements for the future development of IMT-2000 and IMT-Advanced* (2006).

While there is no question that the existing commercial wireless business model – based on exclusive licensing, tower-based hub/spoke channelization, centralized infrastructure and metered billing – will need more exclusive-use spectrum in the short-run to meet mobile data demand, it should be equally clear that this model is not

sustainable longer term. As high-capacity wireline connections and a consumer's ability to purchase hybrid mobile devices becomes more prevalent, it is neither cost-effective nor pro-consumer to encourage a model in which most mobile data would be transported over expensive licensed airwaves, and through relatively distant carrier-provisioned infrastructure. Instead this data could and should flow short distances over unlicensed airwaves and consumer-provisioned backhaul. Recent experiments with femtocells and with services such as T-Mobile's *@Home* service – in which consumers pay an extra fee to have a share of their traffic routed by WiFi over their own wired Internet connection – reflect a growing realization that it will be most efficient to re-use spectrum down to the level of the personal cell, while utilizing consumer-provisioned wired connections for backhaul. As high-capacity wired connections become prevalent in both homes and businesses of all sizes, consumers will already be paying for backhaul that could be used to offload mobile data traffic at a point far closer to the user than the carrier infrastructure can be sited.

Wise policy choices will be necessary to facilitate – and not impede – a market evolution toward these more spectrum-efficient and cost-effective hybrid networks. In addition to easy and robust access to shared spectrum with varying propagation characteristics, the Commission's pending extension of the *Carterfone* consumer protection rules to mobile Internet access services will be critical to ensuring that consumers have the choice to use devices capable of automatically switching between multiple wireless networks based on the consumer's (and not the carrier's) preferences. We would expect that freed from carrier control, wireless device innovators will be motivated to offer consumers hybrid devices that can determine on the fly what connectivity is most economical for the consumer at a given time and place.

The commercial wireless provider, relying on a necessarily limited amount of exclusively-licensed spectrum, and shouldering the capital costs for centralized infrastructure, should increasingly confine their role to being the "quality of service provider" within a heterogeneous network controlled by consumers at the edge. Consumers will happily pay for remote coverage, for needed mobility (connectivity on the move), or for the transport of latency-sensitive applications. But they should not need

to pay an incumbent carrier or intermediary to send the bulk of their mobile data over the publicly-owned airwaves when there is a far more economic and spectrum-efficient alternative using local control over shared spectrum. Consumer welfare and economic efficiency will be enhanced by cognitive and cooperative devices that default where feasible to a local, very low-power network transmitting on unlicensed or other shared spectrum. Indeed, as more shared spectrum enables more cognitive and cooperative devices, mobile consumers can more readily hop to wireline transit on a P2P basis even when away from open WiFi ports.

Conclusion

Spectrum is an infinitely renewable resource, yet studies show that only a fraction of even prime frequencies below 3 GHz are in use, even in the largest cities, at any particular place or time. Federal agencies sit on hundreds of MHz that are unused in most areas; and many private licensees are warehousing spectrum, particularly in rural areas. Underutilized bands not in use in discrete geographic areas, or at particular times, altitudes or angles of reception, can be listed as available for opportunistic sharing (or delisted if a licensee builds out in a manner that makes shared access infeasible due to interference) – providing the necessary capacity to fuel pervasive wireless connectivity in a manner that promotes innovation and optimizes consumer choice and welfare.

Both H.R. 3125 and H.R. 3019 represent essential first steps toward freeing up access to the spectrum needed to achieve this vision. While more exclusively-licensed spectrum must be reassigned to expand on current carrier business models, it is both impractical and undesirable to fuel the nation's wireless future with the limited number of bands that can be cleared and auctioned. Pro-active policy choices that build on the concepts in these two bills will be necessary to facilitate – and not impede – a market evolution toward more spectrum-efficient and cost-effective "hybrid" wireless networks that empower consumer choice and encourage spectrum efficiency. Policies that unlock spectrum abundance will enable both pervasive connectivity and world-class innovation.

Thank you for this opportunity to testify today.