Dynamic Spectrum Access (DSA) for Economical Rural Broadband Internet

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Dynamic Spectrum Access (DSA) wireless technology enables rural broadband Internet service providers to access lower-frequency RF spectrum, reducing the cost of network deployment and operation. This will allow service providers, for the first time, to implement profitable business models and will provide consumers and businesses in rural areas with affordable and sustainable service.

1.0 Introduction

Access to broadband Internet services for rural households and businesses in the U.S. is truly lacking. According to a study by the Pew Internet & American Life Project, 46 percent of rural American households have access to high-speed Internet connections compared with 67 percent for non-rural dwellers.[1] The situation is such a concern that the U.S. Congress recently enacted a $7.2B plan to fund the rollout of broadband networks in un-served and underserved areas. This noble, taxpayer-supported effort must take into account the fundamental problem that current wireless and wireline technologies do not provide long-term, cost-effective solutions for many rural and high-cost areas. An emerging technology called Dynamic Spectrum Access (DSA) addresses this problem, allowing for affordable and sustainable broadband service.

2.0 Business Economics

If it was cost effective to reach rural households and businesses with current network technologies it would have been done already. The business economics of existing technologies simply don't work.

On the wireline side, the cost of reaching remote users with fiber or cable is prohibitively high. The $7.2B appropriated for new broadband grants and loans, when spread across the 31M un-served rural U.S. residents,[2] translates to less than $235 per person in available funds to connect them to broadband. If Congress raised the amount of available funding to $50B, that still leaves only $1,612 available per person to get the job done. Considering it costs Verizon $4,000 per customer to wire homes in *suburban* areas with FiOS,[3] wireline solutions clearly won't do the job in rural areas.

While wireless technologies are generally far more cost effective for serving remote and rural areas, the core challenges are (a) the scarcity and cost of spectrum licenses, and (b) base station infrastructure deployment and operational expenses. Most of the licensed spectrum has already been divided up among a vast array of licensees, many of whom dramatically underutilize their

[1] See John B. Horrigan, *Home Broadband Adoption 2009*, Pew Internet & American Life Project, available online at http://www.pewinternet.org/~/media//Files/Reports/2009/Home-Broadband-Adoption-2009.pdf.

[2] See USDA of Agriculture, Economic Research Service, *State Fact Sheets: United States*, available online at http://www.ers.usda.gov/StateFacts/US.htm. There are over 50M rural residents in the U.S., 62% of them without access to broadband. See also Peter Stenberg and Sarah Low, *Rural Broadband at a Glance, 2009 Edition*, USDA Economic Research Service Economic Information Bulletin Number 47, February 2009, available online at http://www.ers.usda.gov/publications/eib47/.

[3] See Daniel Roth, *The Dark Lord of Broadband*, February, 2009, available online at http://www.wired.com/techbiz/people/magazine/17-02/mf_brianroberts?currentPage=2

bandwidth.[4] With only a handful of spectrum licenses remaining for unscheduled future FCC auctions, acquiring spectrum licenses (even in rural areas) is difficult and expensive. Most of the spectrum that has been auctioned is in frequency bands above 1 GHz (where propagation over long distances and through trees is more difficult) and was sold to large, nationwide service providers whose prime interest is serving metropolitan areas. Moreover, the cost to deploy a new base station can average around $350k and require 6-to-12 months to build,[5] depending on location, the amount of new equipment needed (e.g., tower, shelter, etc.), radio equipment costs, land acquisition costs, and numerous other factors. Backhaul also adds substantial costs to network deployments, which rise in proportion to the number of base stations.

The solution to these challenges is enabled by a combination of positive developments in the regulatory environment, emerging technology, and the use of existing infrastructure. On the regulatory side, the FCC has taken action to open up spectrum to shared access, starting with its 2003 Secondary Markets Initiative[6] and most recently with its decision to permit operation in the TV white spaces.[7] In parallel with this, DSA technology has been developed to enable network operators to safely and effectively share spectrum with legacy users and services. The combination of these changes allows broadband service providers to access preferred spectrum far more cheaply than in the past (in some cases at no cost), which translates directly to the bottom line of wireless broadband access business models.

3.0 Dynamic Spectrum Access Technology

DSA enables wireless devices and networks to continually assess the RF spectrum environment to automatically and swiftly adjust frequencies to changing RF conditions and bandwidth needs. The technology enables multiple networks to utilize a given spectrum band without causing harmful interference to primary, licensed and other users. DSA-enabled broadband wireless devices can use low-cost components to find the best set of frequencies and operating parameters, improving battery life and performance.

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[4] See Scott Woolley, *Dead Air*, in *Forbes*, November 25, 2002, available online at http://www.forbes.com/forbes/2002/1125/138_print.html and Gregory Staple and Kevin Werbach, *The End of Spectrum Scarcity*, in *IEEE Spectrum*, March, 2004, available online at http://www.spectrum.ieee.org/mar04/3811.

[5] See Paul Bedell, *Wireless Crash Cours, 2nd Ed.* (McGraw Hill Professional), 2005, at 38.

[6] See *Promoting Efficient Use of Spectrum Through Elimination of Barriers to the Development of Secondary Markets*, First Report and Order and Further Notice of Proposed Rulemaking, 18 FCC Rcd 20604 (2003), available online at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-03-113A1.pdf; Second Report and Order, Order on Reconsideration, and Second Further Notice of Proposed Rulemaking,19 FCC Rcd 17503 (2004), available online at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-04-167A1.pdf.

[7] See *Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band*, Second Report and Order, 23 FCC Rcd 16807 (2008), available online at http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-08-260A1.pdf. The current device output power restrictions may need to be relaxed in order for TV white spaces to be effectively utilized in very remote areas. See, e.g., *Petition for Reconsideration* of FiberTower et al., available online at http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520201857, and *Petition for Reconsideration* of The Wireless Internet Service Providers Assoc., available online at http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6520201825.

One of the many benefits of DSA is that it enables cost-effective access to preferred (i.e., lower) frequencies. For example, DSA-enabled unlicensed devices can access the TV white spaces (54-608 MHz) for free. Service providers could also strike deals with 700 MHz licensees to use their spectrum on a cost-effective, leased basis rather than securing spectrum via auction or outright purchase.

Access to these lower frequencies allows a service provider to dramatically decrease site deployment costs because RF signals propagate over greater distances at these frequencies, which enables a given area to be covered with fewer base stations and less infrastructure. Analysis by a former 700 MHz licensee (who sold its spectrum to AT&T) suggests that a given area that could be covered by a single 700 MHz base station would require four sites in the 1.9 GHz band and ten sites in the 2.4 GHz band.[8] Assuming a base station costs $350k to deploy, an operator deploying a single 700 MHz site will spend $350k versus an operator deploying in bands above 1 GHz, who would spend between $1.4 and $3.5 million.

4.0 Dynamic Spectrum Access Rural Broadband Solution

The economical, long-term solution for implementing sustainable rural broadband Internet access networks is to deploy DSA technology, which is the only technology that can use both free and leased spectrum below 1 GHz and, to the greatest extent possible, existing radio towers and infrastructure. To illustrate the benefits of this approach, consider rural southwest Virginia which has challenging hilly terrain, but a good base of existing infrastructure. According to analysis of the FCC's Antenna Structure Registration database,[9] 97 percent of this area is within 15 km of a registered antenna structure that could likely accommodate a broadband wireless base station, and nearly 100 percent of the area is within 20 km of a registered tower. These distances are excessive using existing wireless technologies operating above 1 GHz, requiring new infrastructure to be sited, approved and constructed. Coverage would be assured, though, with DSA by using the best frequencies available for customers furthest from their serving tower, and higher frequencies for customers closer to the tower. An analysis of achievable link range shows that coverage up to 20 km can easily be achieved with frequencies in the lower portion of the TV band so long as adequate powers are permitted. Furthermore, by utilizing existing towers, service providers can significantly lower deployment costs by avoiding the need to construct towers, build access roads, and bring in utilities, among other things. DSA serves as the most economical backhaul solution as well.

The DSA solution represents an elegant, sustainable way to solve the rural broadband access challenge versus simply trying to temporarily spend our way out of the problem. The key to success is the combination of new DSA technology, the new pro-DSA regulatory environment, and the ability to leverage existing infrastructure.

[8] See Om Malik, *700 MHz Explained In 10 Steps*, available online at http://gigaom.com/2007/03/14/700mhz-explained/.

[9] The FCC's antenna database is available online at http://wireless.fcc.gov/antenna/. The analysis was performed using a geographic plotting application.

5.0 Shared Spectrum Company

Shared Spectrum Company (SSC) is the pioneer developer of innovative Dynamic Spectrum Access (DSA) technology. The company developed DSA over the past 9 years on several military projects, building prototype devices and software, conducting field tests, and commercializing the technology. SSC's DSA technology enables fundamental improvements to wireless network performance (e.g., improved link range and reliability) and reduces deployment and hardware costs.