Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)
	) GN Docket No. 09-47
Comments – NBP Public Notice # 26	) GN Docket No. 09-51
	) GN Docket No. 09-137
	)

COMMENTS OF
ADAPTRUM, INC.

Introduction

The Commission's Public Notice of December 2, 2009[1] sought comment on the "on the use of spectrum currently licensed to broadcast television stations" in connection with the possibility that "these bands could be repurposed for wireless broadband services." Adaptrum applauds the Commission for asking bold questions, but also urges the Commission to further examine the facts and not to rush into conclusions as the contemplated policy decisions will have long term impact on American economy and society. With sound evidence and forward thinking, the Commission will be able to put forth the right spectrum policies that will encourage innovation and create a vibrant and competitive wireless broadband market for our Nation's broadband future.

Adaptrum is a Silicon Valley startup developing cognitive radio and network technology to increase spectrum utilization especially in the VHF/UHF band. The cognitive radio technology developed by Adaptrum can opportunistically reuse vacant spectrum without causing harmful interference to incumbent users. Adaptrum has been an active participant in the TV whitespace proceeding, Docket 04-186, and submitted a TV whitespace prototype for the FCC laboratory testing that provided key evidence on the feasibility of the TV whitespace operation.

Spectrum problem or infrastructure problem?

We fully agree as the Commission' assessment that there is a growing demand for wireless broadband services and we are facing capacity shortage in wireless networks especially

[1] DATA SOUGHT ON USES OF SPECTRUM, NBP Public Notice # 26, DA 09-2518 December 2, 2009 (http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-09-2518A1.pdf)

cellular networks. We believe however, as far as the carriers are concerned, this is more of an infrastructure and technology problem than a spectrum problem.

Modern cellular networks are built upon a fundamental principle called frequency reuse. As illustrated in **Figure 1**, cellular networks are organized as cells where one radio frequency/channel may be reused in separated cells throughout the coverage area. The cells using the same radio frequency/channel are called co-channels cells. The minimum spacing between the co-channel cells and average signal power within these cells are designed in such a way that certain communications capacity can be maintained in a cell, withstanding the interference from all other co-channel cells.

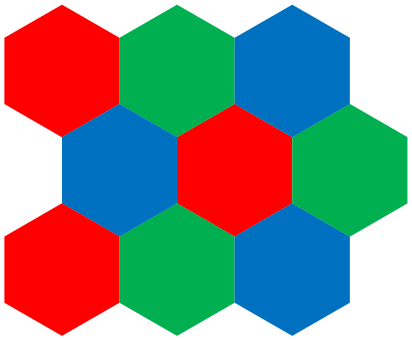

Figure 1: Illustration of 3-channel frequency reuse. Each color – red, green, or blue – represents one radio frequency.

Given individual cell communications capacity C, and the number of cells N within certain service area, the combined network capacity in the service area is $N \times C$. When smaller cells are deployed, there are more cells within the service area and thus increased network capacity. For example, by reducing the cell radius from 10 km macro cells to 1 km micro cells, cellular networks increased their capacity by a factor of 100.

Some simple math can be done to see the impact of additional spectrum to the carriers. Today AT&T and Verizon each holds about 90 MHz in top 50 markets in the United States. Sprint and T-Mobile each holds more than 50 MHz. Combined, the top 4 carriers have 280 MHz spectrum in any market. Even if a nationwide reallocation of UHF spectrum can yield an additional 100 MHz spectrum to the carriers, it will only increase overall carrier network capacity by 36 percent (100/280). However, by conservative estimates, a 10x or 1000% increase in network capacity will be needed to accommodate the growth of wireless data fueled by rapid adoption of smart phones in the next 5 years. Adding spectrum to carrier networks can do little to deflect this looming crisis of wireless data capacity shortage.

Alternatively, referring to the above figure, if a typical cell in today's cellular network is split into 3 smaller cells (or 1.7x reduction in radius), the overall cellular network capacity will be increased by a factor of 3 or 300%. One more iteration (splitting each smaller cell again into 3 cells) will increase the capacity 900%. *It is clear that increased frequency reuse through cell*

splitting or using smaller cells is the key to accommodating growing wireless data demand in carrier networks in the future. In fact, pico cells and femto cells are increasingly being deployed in carrier networks today especially in urban areas. While smaller cell size does present problems in terms of site acquisition, backhaul, and network planning, it is an infrastructure and technology issue that the carriers have faced since day one and will continue to address using new deployment model and innovative wireless networking technology.

Nationwide reallocation of UHF TV spectrum may further increase market power of a handful of carriers

The US cellular industry is dominated by the top 4 carriers[2] which combined own more than 90 percent of US cellular subcarriers. The industry is a classic oligopoly where the carriers dictate subscriber services, devices and applications. Leveraging their massive spectrum holdings, vast network infrastructure and subscriber base, the carriers close out competition in the US cellular market and make it impossible for a new entrant to enter the cellular market and be a meaningful player.

It is our concern that a nationwide reallocation and auction of UHF TV spectrum will result in further concentration of spectrum only accessible to these carriers. While various policies (*e.g.* spectrum cap) have been designed to diversify the spectrum licensees in the past, the outcome proves otherwise. Smaller spectrum license winners are often speculators or otherwise don't have the financial resource to build a viable cellular business. Their spectrum winds up in the hands of major carriers through merger or acquisition[3].

While acquiring additional spectrum does little to improve a major carrier's network capacity as discussed, the carrier can use the acquired spectrum to its strategic advantage – lock out potential competitors who otherwise may use the spectrum to roll out competitive services. In fact, without policy repercussion against such anti-competitive spectrum warehousing, there is no reason why a carrier in a dominant market position and with financial means will not do that. Spectrum warehousing can also be speculative in nature by smaller spectrum licensees as discussed above. Spectrum warehousing not only wastes spectrum resources but also prevents such resources from being used in an otherwise more competitive and efficient market – a double detriment to the public good.

A sound spectrum policy requires better understanding of current spectrum utilization

Spectrum utilization measurements by various entities[4] showed that more than 80 percent of the spectrum below 3 GHz is not used in any part of the country especially in suburban and

[2] AT&T, Verizon, Sprint, and T-Mobile.
[3] For example, AT&T bought UHF channel 54 and 59 licenses (700 MHz band) for $2.5 billion in 2007 from Aloha Partners, who paid $29 million for the same licenses in 2002.
[4] See for example studies from New America Foundation and Shared Spectrum.

rural areas. While one may argue with the accuracy of such measurement[5], the importance of knowing how much spectrum we are really using – whether it is 10 percent, 20 percent, or 50 percent – is undisputable especially from a spectrum policy perspective. If there is indeed a gross underutilization of the spectrum, it is important to establish a complete inventory of federal and non-federal spectrum licensees, their licensed areas, and how they are using their licensed spectrum bands today. We strongly support the timely introduction of the Radio Spectrum Inventory Act H.R. 3125 by the House and the corresponding Senate bill S. 649. We believe the Commission should use these bills as the first step towards a major spectrum policy reform to meet the Nation's future spectrum needs.

The Commission in conjunction with NTIA should consider conducting a comprehensive spectrum utilization study in *all* licensed bands including the broadcast TV bands, federal bands including military and public safety bands, as well as various cellular bands (PCS, AWS, WCS, 700 MHz, BRS/EBS, etc.) We recommend that the Commission requires *all spectrum license holders to periodically sample their actual spectrum usage in their licensed areas and make such data available to the Commission upon request*. Transparency will lead to accountability. Comprehensive data on current spectrum usage will assist the Commission in making strategic policy decisions to free up the underutilized or undervalued spectrum bands to meet the growing demand of wireless broadband.

Pending the comprehensive spectrum utilization study, it is probably premature to discuss proposals to repurpose any specific spectrum bands. Specifically, the proposal to conduct a nationwide reallocation and auction of UHF TV spectrum has shortcomings as discussed: the repurposed spectrum will do little to improve carrier network capacity but inadvertently increase the market power of the bigger carriers; because of spectrum warehousing, the spectrum may not be put into efficient use for years to come. Nationwide reallocation of UHF TV spectrum also faces significant practical difficulties: lengthy and contentious FCC and congressional process where societal value and public interest will be weighted again economic value, lots of TV programming cancelled and TV stations going off air, consumer going through a second "digital transition".

A market driven approach for licensed broadband in TV spectrum

Instead of a mandatory nationwide reallocation of TV spectrum, we recommend a softer and market driven approach:

- Permit broadcaster licensees to deploy broadband services within their coverage contours
- Allow channel sharing so that contents from multiple broadcasters *in the same service area* can be aggregated into a single 6 MHz air channel

[5] Spectrum analyzer based measurement detects incumbent signal power and may not be as sensitive as a native incumbent receiver operating close to noise floor. Noise figure and desensitization (upon overloading) of the spectrum analyzer may also affect the result.

- Allow broadcast licensees to lease their spectrum for broadband services
- Specify technical rules governing licensed broadband operation in a TV channel (e.g. transmission power and adjacent channel protection)[6]

Individual broadcast station will have maximum flexibility moving forward: 1) it can continue broadcast HD programming on its licensed channel and stay unchanged; 2) it can pay to have its content broadcasted on another broadcaster's channel in the same service area and empty out its own physical channel for broadband services; 3) in this case, it can also lease the channel to a secondary broadband licensee – note however the leasing agreement must contain pro-competition and efficient use clauses to discourage spectrum warehousing and 4) it may choose switch back to 1 from 2 or 3. In Case 2 and 3, part of the proceeds from the broadband service deployment or channel leasing should go to the Treasury.

This will be a complete voluntary and market driven process where almost all the Commission needs to do is to relax the broadcast rules and the market will do the rest. The broadcaster fulfills its public interest obligations by continuing broadcasting its programming either on its own channel or a channel shared with another broadcaster in the same service area. The broadcaster will have nothing to lose and everything to gain. If deploying broadband services or channel leasing does bring significantly higher revenue, the broadcaster will have incentive to use its spectrum for broadband. We can envision an equilibrium to be achieved over time and the market will ultimately decide how much spectrum will stay in broadcast and how much goes to broadband.

Cognitive radio is key to spectrum efficiency and future wireless broadband networks

Cognitive radio technology and opportunistic spectrum access enables a type of real-time spectrum sharing that is otherwise impossible and opens a new realm for policies governing spectrum licensing and allocation. Cognitive radio technology can greatly improve spectrum utilization in various bands without requiring spectrum reallocation and thus holds the key promise to solve the Nation's spectrum problem. The Commission's Rule Making on TV Whitespace is a critical first step to unleash the potential of this technology. Policy consistency and timely closure of the proceeding is important to allow this promising technology to come to fruition in the marketplace.

If underutilized spectrum bands are identified in the Spectrum Inventory Act, cognitive radio can put these "dark" spectrum back into efficient use through either short-term secondary licensing or opportunistic sharing. Short-term secondary licensing applies to bands where the license holders are unable or unwilling to build out. Opportunistic sharing is especially applicable to military and public safety spectrum bands where the usage is sporadic temporally

[6] The Commission's TV White Space rules can be used as reference.

and geographically and where significant communications capacity exists but cannot be transferred through exclusive licensing.

With greater access to spectrum resource through secondary and opportunistic sharing, cognitive radio enabled wireless networks could be a key component in the National Broadband Plan by providing a low cost and high speed alternative access for consumers where carrier networks are either unavailable or too expensive. This is especially true in rural and underserved areas where bigger carriers have little or no incentive to roll-out their infrastructure and where local WISPs, utilities, and governments are setting up their own wireless network to serve the communities. This could also be true in urban areas – hotels, airports and shops – where WiFi networks today are already off-loading a significant amount of wireless data traffic[7].

For more than 20 years the watchword of FCC spectrum policy has been deregulation, giving licensees and manufacturers more flexibility to bring new technology rapidly to the marketplace.[8] These policies have served the US well. It is no accident that Wi-Fi and CDMA cellular have their regulatory roots in the US with FCC deregulation in the 1980s. The rulemakings that resulted in enabling – but not requiring – both technologies were opposed by the mainstream industry players at the time. Similarly, the Commission should not let opposition by mainstream large firms blind it of its traditional vision that has served the public well in recent decades.

The spectrum policies for the VHF/UHF TV bands have been overly rigid and do not permit the natural evolution of the spectrum to better uses. A "command and control" reallocation of TV spectrum to broadband is an unnecessary break from the successful deregulatory policy of the current era. We urge the Commission to give broadcast licensees the option to make their spectrum use more efficient with the concomitant economic benefits while maintaining their public interest obligations. As we end the golden jubilee year of Nobel laureate Ronald Coase's pioneering paper on spectrum economics[9] let us use our faith in market place forces to decide if and when a transition of VHF/UHF spectrum from broadcasting to other

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[7] AT&T Mobility CEO Ralph de la Vega was quoted last week as saying "AT&T was actively looking for ways to move more traffic off its cellular network, such as providing free WiFi hotspots and promoting femtocells."

[8] For example, the 1986 decision not to adopt a regulatory standard for the air interface of 2nd generation cellular service at a time when consensus standards organizations worldwide and foreign regulators operating in a "command and control" mode were unwilling to consider innovative CDMA technology, resulted in the commercialization of CDMA technology by Qualcomm and its adoption by several US carriers. CDMA, the core technology of all 3G systems, may never have been commercialized without this type of bold FCC deregulation. Consensus standards groups and command and control regulators generally avoid disruptive technologies due to the decision making framework used. Yet it is disruptive technologies that often give the greatest benefits for the whole economy.

[9] R. H. Coase, The Federal Communications Commission., *Journal of Law and Economics*, Vol. 2. (Oct., 1959), pp. 1-40. http://www.ccer.edu.cn/download/7874-1.pdf

uses is justified. The Commission's public interest obligations with respect to broadcasting can be satisfied with viable alternatives to traditional command and control spectrum management.

/S/

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