Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
Unlicensed Operation in the TV Broadcast Bands	)	ET Docket No. 04-186
	)	
	)	
Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band	)	ET Docket No. 02-380

COMMENTS OF TROPOS NETWORKS

Tropos Networks ("Tropos") submits these comments in response to the Federal Communications Commission's ("Commission") Further Notice of Proposed Rulemaking ("FNPRM") in the above proceedings.[1] The Commission asks for comments on a variety of proposals with regard to the provisions necessary to implement final rules for devices operating in the broadcast television spectrum ("TV bands").[2]

Tropos urges the Commission to restrict TV band operations to unlicensed users, that contention based spectrum sensing technology be the means to ensure coexistence with licensed operations, and that the current technical rules associated with unlicensed use be adhered to as much as possible. Combining unlicensed technology with the propagation quality of the TV bands will bring competition and expanded choice to the broadband market, where it is

---

[1] *Unlicensed Operation in the TV Broadcast Bands,* First Report and Order and Further Notice of Proposed Rule Making, 21 FCC Rcd 12266 (2006) ("FNPRM").

[2] The television broadcast bands at issue in this proceeding include TV channels 2 to 51.

desperately needed. Contention based technology in an unlicensed environment, a proven and mature technology, will protect TV band incumbents while expeditiously providing affordable broadband access to all Americans.

I. INTRODUCTION

Tropos Networks, headquartered in Sunnyvale, California, provides wireless Wi-Fi technology that delivers broadband access using unlicensed spectrum. In more than 450 deployments, Tropos technology is providing wireless broadband over large geographic areas. Its MetroMesh architecture allows a network to be installed at substantial savings over legacy systems by eliminating costly backhaul and proprietary client devices. No large towers need to be constructed; no streets need to be excavated. The system's capacity is designed for advanced applications delivering voice and video. Portable wireless devices, now mass produced to operate in a Wi-Fi environment, also reduce cost and expand consumer choice.

With its partners, Tropos has emerged as a facilities-based broadband provider in a market that lacks connectivity and competition. Tropos is the technology provider to EarthLink in its Philadelphia and Anaheim projects, and in the Google/EarthLink San Francisco project. Tropos equipment in New Orleans, in place prior to Hurricane Katrina to support video surveillance, is being expanded in coverage and use. The fully deployed Corpus Christi, Texas network covers more than 100 square miles and reaches 90% of the city's 277,000 residents; it is the world's largest multipurpose mesh network. In Philadelphia, 15 square miles of what will be a 135 square miles system is now deployed. Deployment in Longmont, Colorado, covering 22 square miles, was completed in less than 90 days. The Alexandria, Virginia network will encompass 16 square miles of the city and provide affordable, high-speed Internet access for residents and visitors.

The Federal Trade Commission, in a recent staff report, profiles the expanding number of municipal Wi-Fi deployments delivering broadband.[3] The innovation permeating Wi-Fi technology, the growing investment committed, and the expanding number of deployments is demonstrating how technology can lower cost and bring broadband to all Americans, including those without access to broadband services in rural America.

Tropos believes that the efficiencies and cost saving attributes of mesh networks operating in unlicensed spectrum, when combined with the spectrum character of the television bands, particularly at 507 to 600 MHz, will deliver broadband at much reduced prices throughout the country. Investment will build on the successes already demonstrated but with greater efficiencies. The opportunity the Commission now has to make a tangible difference in affording broadband to rural, urban and suburban areas should be pursued expeditiously.

II. THE COMMISSION SHOULD ALLOW ONLY UNLICENSED OPERATION IN THE TV BANDS

In the FNPRM, the Commission seeks comment on whether it should allow unlicensed, licensed, or hybrid operations in the TV bands.[4] The Commission should reject licensed and hybrid advocacy and return to its original intent to establish an unlicensed regime. A licensed or hybrid regime will add enormous costs to broadband access, which will be borne by the consumer. Further equivocation will deter the development and investment currently being directed to the unlicensed operations envisioned for the TV bands.

---

[3] *Municipal Provision of Wireless Internet*, FTC Staff Report (September 2006) (http://www.ftc.gov/ftc/news.htm).

[4] FNPRM at ¶¶26-32.

The Unlicensed Environment Provides a Clear Path to Expanded Broadband Access

Tropos believes that the Commission should only allow unlicensed operations in the TV bands. To fragment the band between licensed and unlicensed uses would make the spectrum far less useful and desirable for either. The quality and importance of the TV bands is well established. The frequencies are lower, the wave lengths longer. Longer length waves hold their energy over longer distances and also bounce around physical objects such as buildings. These are ideal wave lengths for wireless broadband just as they are for broadcast television. Additionally, these waves can carry tremendous amounts of information, allowing wireless broadband to deliver very high bit rates at lower cost and greater spectrum efficiency. In contrast, broadband and other services delivered at higher frequencies require more infrastructure costs because more base stations are needed to retransmit signals. These costs reduce the return on capital and embed additional costs on consumers.

The importance of access to the TV band for expanding broadband access cannot be overstated. Higher costs means higher prices to consumers. This is particularly true in rural America and in the Tribal Lands, where costs are higher due to reduced population density. The more frequencies assigned to wireless broadband, the more millions of people throughout America, including rural areas and Tribal Lands will be able to afford broadband access. The benefits flowing from the propagation characteristics of the TV bands translate directly to lower deployment costs to all areas. The enormous entry costs associated with a licensed regime, such as purchasing spectrum, will choke broadband deployment. The propagation character of the TV

bands, when combined with unlicensed technology's ability to lower costs, presents unparalleled opportunity.[5]

The impetus for this proceeding was the "significant growth of and consumer demand for unlicensed wireless broadband applications and services" and the corresponding need to "provide additional spectrum for the operation of unlicensed devices that support such applications and services."[6] Since the issuance of the Commission's 2004 TV Band Notice of Proposed Rulemaking,[7] the development and growth of personal wireless broadband IP-based services has exploded. The unlicensed environment has been part of this expansion, demonstrating not only the demand for affordable broadband access, but its ability to deliver a meaningful competitive alternative to legacy wireline and wireless broadband providers.

The Commission's own Consumer Advisory Committee believes that expanding broadband access and lowering the costs of universal service is inextricably tied to providing more unlicensed spectrum.[8] The Commission's Spectrum Policy Task Force pointed out four years ago, that "most prime spectrum has already been assigned to one or more parties, and it is becoming increasingly difficult to find spectrum that can be made available either for new

---

[5] As Commissioner Copps stated: I have long supported freeing up additional unlicensed spectrum. In many contexts – as with the enormously successful bands that support today's Wi-Fi networks – unlicensed uses most closely approach the ideal of the people's airwaves, to be used in direct service of the public interest. With our recent AWS auction and the upcoming 700 MHz auction, we are opening up a huge swath of prime spectrum to licensed use – and it seems to me, on the present record, that the appropriate balance is to open up the TV white spaces to *unlicensed* use *See,* FNPRM (Concurring Statement of Commissioner Michael J. Copps).

[6] *Unlicensed Operation in the TV Broadcast Bands; Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band,* Notice of Proposed Rulemaking, 19 FCC Rcd 10018 at ¶7 (2004).

[7] *Id.*

[8] Consumer Advisory Committee, *Recommendation Regarding General Principles of Implementation for Universal Service Reform,* CC Docket 96-45 (November 14, 2006)

services or to expand existing ones."[9] It recommended that the Commission consider alternative methods for creating additional spectrum access for unlicensed devices, such as "[o]pportunistic or dynamic use of existing bands – through either cognitive radio techniques to find "white space" in existing bands or use protocols to get out of the way of primary users."[10] Notably, in the current and 109th Congress, significant legislative attention has been directed toward making the TV bands available for unlicensed use as expeditiously as possible.[11]

Wi-Fi's use of unlicensed spectrum and its explosive proliferation has provided consumers, businesses and governments with a tangible and affordable broadband alternative. It has fueled the vast and ever-growing demand for a variety of Wi-Fi-enabled devices and anytime, anywhere broadband data access.[12] To abandon the goal of expanding broadband access by way of unlicensed spectrum in the TV bands would be grievous error. There is near universal embrace for new unlicensed spectrum to meet the challenge of broadband deployment."[13] The Commission should emphatically embrace unlicensed operations in the TV bands.

---

[9] Spectrum Policy Task Force, Report to the Commission, ET Docket No. 02-135 (November 2002) ("*SPTF Report*") at 14.

[10] *SPTF Report* at 63.

[11] S. 234, Wireless Innovation Act of 2007, H.R. 5252, Title VI (S.Rept. 109-355)(109th Congress).

[12] Wi-Fi is more than laptops. It's also for phones, PDAs, gaming devices, video cameras, parking meters, utility meters and sensors that detect biological, chemical and radioactive hazards and other applications. There are millions of unlicensed Part 15 devices using spectrum for a variety of purposes - including remote meter reading, utility load management, cordless telephones, wireless local area networks, and other diverse applications. *See, Amendment of the Commission's Part 90 Rules in the 904-909.75 and 919.75-928 MHz Bands*, Notice of Proposed Rulemaking, 21 FCC Rcd 2809; 2812 (2006).

[13] Remarks of Commissioner Michael J. Copps, Practicing Law Institute/FCBA, Washington, DC, 2006 FCC LEXIS 6563 (December 15, 2006).

Contention Based Sensing Technology Ensures A Robust Spectrum Environment Promoting Innovation and New Entrants

Use of contention based protocols for the operation of unlicensed devices will allow effective and efficient use of the TV bands by several interests rather than one or a few, in contrast to the licensed or hybrid proposals. In a shared spectrum environment, no exclusive usage right and no interference protections impose on unlicensed technology the responsibility to ensure adequate interference management. As a condition of operation, unlicensed devices may not cause harmful interference to authorized radio services, including broadcast and other unlicensed devices. Unlicensed devices accept interference that they receive and are subject to strict emission limits.[14] Instead of having the freedom from interference that pervades the licensed spectrum model, shared spectrum technology must directly confront it. Investment is directed toward compatibility with other users and interference management. The Commission's initial vision with regard to the innovation and benefits of the unlicensed environment should be carried forward to the TV bands.

The benefits of a contention based unlicensed environment include the relatively low cost of service through expeditious deployment, low infrastructure and capital costs, avoidance of paying for spectrum via the auction process, and lack of proprietary devices to access the unlicensed network. Tropos experience shows that infrastructure can quickly be deployed and become operational, oftentimes only requiring minutes for a technician to install a router to a street lamp or light pole.[15]

---

[14] 47 C.F.R. §§15.5, 209, 215-257.

[15] Tropos MetroMesh networks, for example, can deliver 5x or more bandwidth than 3G solutions at 1/4 the cost to deploy and operate.

The Commission observed in adopting proposals for exclusive unlicensed operations in the TV bands, "[b]ecause of the favorable propagation characteristics of the TV spectrum, these new devices could provide more effective service at greater ranges than unlicensed devices that operate at higher frequency bands."[16] A recent Commission Staff Report noted the benefits to both broadcasters and unlicensed operations:

> new unlicensed broadband operations may provide synergy with traditional broadcast operations and offer broadcasters the opportunity to provide new services. In addition, because transmissions in the TV band are subject to less propagation attenuation than transmissions in the spectrum where existing broadband unlicensed operations are permitted, allowing unlicensed operation in the TV bands could benefit wireless internet service providers (WISPs) by improving their service range, thereby allowing WISPs to reach new customers.[17]

Unlicensed wireless technologies provide a more flexible and readily deployable infrastructure than licensed or hybrid services and present not only coexistence but opportunity for broadcasters. The Commission should only allow unlicensed devices to operate in the TV bands.

II. SPECTRUM SENSING WILL ADEQUATELY PROTECT INCUMBENT TV BAND OPERATORS

To ensure that no harmful interference to TV stations and other authorized users of the TV bands will occur, the Commission has proposed to require unlicensed devices to incorporate spectrum sensing and other technical requirements to identify the unused TV channels in the area where the unlicensed devices operate.[18] Spectrum sensing effectiveness depends on appropriate detection thresholds, channel availability check time, and other technical requirements that are capable of accurately assessing the environment and neither understate nor overstate the presence

---

[16] *TV White Space Order* at ¶13.

[17] Federal Communications Commission 2004 Biennial Regulatory Review; Office of Engineering and Technology, ET Docket No. 04-178, 20 FCC Rcd 60, 66-67 (2005) ("Staff Report").

[18] FNPRM at ¶¶33-48.

of licensed operations. Otherwise, the unlicensed devices will "bounce" around or detect false positives making unsustainable commercial use of the TV bands. The Commission's TV band rules should recognize the primary goal to protect broadcast operations while providing adequate spectrum for innovative broadband services.

Tropos embraces employment of dynamic frequency selection ("DFS") to detect if a TV Band signal is present before the spectrum can be accessed. A DFS mechanism can be integrated into a system so both fixed and mobile/personal unlicensed devices avoid interference if an incumbent signal is present.[19] In this context, the Commission relates the continued concern of broadcasts interests,[20] regarding the hidden node, where there is an obstruction between the sensing receiver and the signal to be detected.

Spectrum sensing protocols are now embraced in the Commission's rules addressing 5 GHz U-NII. Discerning a TV signal is significantly easier that the military radar signals at 5 GHz. The TV signal, whether analog or digital, can be readily detected even when the signal is below its normal threshold. While Tropos agrees that multiple sensing capabilities should be distributed throughout a network, it questions the effectiveness of the Commission's suggestion that every device on the network must contain sensing capability. The requirement will accrue additional costs but not additional benefit. Nor, as discussed below, will mandating geo-location capability as an additional element of the gating criteria provide additional protection.

Tropos believes that the strength and reliability of current contention based sensing protocols, which have expanded enormously since the commencement of these proceedings, will

---

[19] Systems using a contention based protocol are common for both licensed and unlicensed systems. For example, unlicensed Wi-Fi devices under the IEEE 802.11 standard the contention based protocol Carrier Sense Multiple Access with Collision Avoidance ("CSMA/CA") uses a listen before talk scheme.

[20] FNPRM at para. 39.

provide adequate protection to broadcast operations while avoid costs that provide no additional protection. The detection capability of a device can be enormously more sensitive than a DTV receiver, a reality that should be recognized in examining the ability of contention based technology to protect broadcast operations. Unlicensed devices with channel detection and avoidance mechanisms are the most efficient and effective means to protect broadcasters.

Similarly, while specifying a period of time over which sensing must occur before a channel may be addressed, the FNPRM proposes a 30 second period of time for the initial channel availability check and that the channel be rechecked at least every 10 seconds. These are reasonable formats and within current technology capability.[21] However, the Commission should temper the inclination to establish specific requirements in favor of describing the objective- ensuring that unlicensed devices do not encroach upon broadcast operations. Technological innovation continues to create new and varied unlicensed applications and devices. Market forces, which served as the underpinning of how the unlicensed environment is now delivering broadband, serve as a better guide for determining the time periods and if they are necessary for spectrum sensing. The Commission's rules should be directed not toward particular operating parameters but the criteria to evaluate whether a device adequately protects broadcast operations.

Spectrum sensing is fully capable of protecting wireless microphones and other broadcast auxiliary services from harmful interference. Part 74 wireless microphones are heavily used at sports and entertainment arenas, conference centers, and other similar locations and tend to be shielded from potentially harmful interference by physical infrastructure. If portable unlicensed devices are also operating, spectrum sensing technology can detect the presence of a wireless

[21] FNPRM at ¶41.

microphone. The likelihood of interference from unlicensed device signals is low; specific interference mitigation is unnecessary. Therefore, the Commission should not require TV band unlicensed devices to operate at reduced power or to incorporate "smart beacon" sensing capabilities particular to these services.

The Commission expresses its intention to rely on industry developed protocols to promote and ensure spectrum sharing among unlicensed users while minimizing constraints on product designs. It then suggests that it establish minimal technical requirements to facilitate sharing, out of fear that a single device or network will monopolize channel use. Tropos believes that Commission-promulgated standards will ill serve innovation in the unlicensed environment and may undermine the Commission's objective to promote competition. Industry driven efforts have been successful in the unlicensed space. The Commission's proposal echoes of establishing spectrum "etiquette" rules and the inflexibility and delay that accompanies such regimes. The result will only stifle innovation and competition.

III. THE COMMISSION SHOULD NOT REQUIRE USE OF A GEO-LOCATION/ DATABASE OR THE CONTROL SIGNAL APPROACH

In seeking to protect broadcast operations, the Commission inquires whether to adopt a geo-location/database or a control signal approach to identify vacant channels at the unlicensed device's location.[22] The expanding use of contention based sensing protocols affirms its use as the most efficient and effective means to ensure coexistence. The costs and lack of practicality of these alternatives outweigh their perceived benefits.

Adding geo-location/database capability to unlicensed devices and/or requiring installers be certified unnecessarily raises installation costs of unlicensed broadband networks without an accompanying benefit. The Commission indicates it own wariness regarding the accuracy of

[22] *Id.* at ¶¶49-51.

current databases and the cost and effectiveness of establishing and maintaining accurate information. There exists no complete and real time database reflecting broadcast operations. If anything, the record indicates a that GPS/database incorporated into an unlicensed device would not be a reliable means to determine whether use of an unlicensed device will cause harmful interference to an incumbent TV band operator.[23]

Parallels to other circumstances where the geo-location/database approach has been used conflict with the objective here. Neither the broadband over power systems database nor that of wireless telemetery are used to select the channels the devices are to operate on. The Commission itself notes that the database would need constant updating to contain accurate and useful information. Also, appropriate computational software would need to be developed to identify vacant channels at the unlicensed device's location.[24]

The Commission also examines whether personal/portable devices should operate only when they receive a control signal from a fixed radio transmitter.[25] Tropos reiterates[26] its concern that there is an inherent conflict in having TV incumbent licensees responsible for a database that controls access to the band. That there are also areas where control channels do not exist because of the lack of broadcast stations further undermines the concept. The control channel, whether operated by broadcasters, a database manager or frequency coordinator ultimately suffers the inherent infirmities of all geo-location/database alternatives of too much information to be constantly updated and resulting in a costly and bureaucratic endeavor that

---

[23] *Id.* at ¶50.

[24] The software would also have to account for varying terrain as well as device-specific power and emission configurations.

[25] FNPRM at ¶¶52-54.

[26] Tropos comments at 5 (filed Nov. 30, 2004).

falls short of the accuracy and reliability presented by contention based technology. It also moves the unlicensed environment, where coexistence has prospered, away from its minimal logistic and procedural structure that has been the foundation of its success.

Tropos urges the Commission to focus on requiring use of a contention based technology as a far better alternative to avoid harmful interference to TV band incumbents than a database requirement. Contention based technology provides the most effective and immediate harmful interference mitigation methodology.

IV. THE COMMISSION'S OUT-OF-BAND LIMITS AND RESTRICTIONS ON ADJACENT CHANNEL OPERATIONS SHOULD AFFORD ADEQUATE BANDWIDTH WHILE PROTECTING INCUMBENT OPERATIONS

The Commission further examines the degree out-of-band ("OOB") emissions emanating from a TV band device.[27] In examining the appropriate level, the Commission's rules must acknowledge the reality that TV viewers already operate a range of Part 15 devices that reflect the OOB of current rules and that not all devices operating in the TV band will transmit at maximum power across all frequencies.

Tropos agrees with Microsoft's concern regarding emissions outside the operating channels of the device yet still within the TV bands.[28] Broadband service offerings will likely require aggregation of 6 MHz channels. Too strict OOB limits are likely to reduce drastically the amount of spectrum available for use by unlicensed TV band devices[29]. The signal roll off emanating from the rule cannot be so steep that too little of the 6 MHz active channel would be available for service. Tropos believes that the parameters established by Section 15.247 of the

---

[27] FNPRM at ¶¶59-61; 47 C.F.R. 15.209.

[28] See Comments of Microsoft at 25-27.

[29] FNPRM at ¶59.

Commission's rules addressing emissions outside of the operating channel, referenced in the Microsoft comments, can be structured to provide adequate capacity for the operating channel while presenting benign emission characteristics fully protecting adjacent channel broadcast operations. The Section 15.209 limits should apply only in restricted bands of operation. In instances where no incumbent TV band operators are using frequencies corresponding to OOB emissions, the Commission should exempt unlicensed devices from the Section 15.209 OOB limits, using instead the Section 15.247 limits.

The Commission also seeks comment on whether to prohibit fixed devices from operating on a channel adjacent to a TV station within that station's service area but to allow the lower power personal/portable devices to operate without adjacent channel restrictions.[30] The Commission should permit fixed devices to operate on a channel adjacent to a channel used by an incumbent TV band operator. Use of a spectral mask will be effective at filtering harmful interference to adjacent channels, just as such masks have been successfully used to enable simultaneous use of millions of cell phones that operate on adjacent frequencies

CONCLUSION

Tropos equipment, operating in the unlicensed environment, is delivering broadband to individuals and businesses that would not otherwise have access. In the over two years since the Commission issued its Notice of Proposed Rulemaking, broadband provided through unlicensed technology has grown exponentially. The Commission should now move this innovation to the TV bands where costs will be furthered lowered, services increased and access broadened.

---

[30] FNPRM at ¶42.

The Commission should allow only contention based unlicensed operations in the TV bands to capture this ability of the unlicensed environment to provide affordable broadband networks. The best method to ensure that TV band incumbents are adequately protected from harmful interference is to require unlicensed devices to incorporate spectrum sensing to identify unused TV band spectrum.

Respectfully submitted,

Bert Williams
Acting Vice President, Marketing
Tropos Networks
555 Del Rey Avenue
Sunnyvale, California 94585
408.331.6800

John E. Logan
Attorney for Tropos Networks
1050 Connecticut Avenue, NW
Tenth Floor
Washington, D.C. 20036
202.772.1981

January 31, 2007