

**Before the  
FEDERAL COMMUNICATIONS COMMISSION  
Washington, DC 20554**

**In the Matter of** )  
 )  
Wireless Telecommunications Bureau ) WT Docket No. 13-135  
Seeks Comment on the State of )  
Mobile Wireless Competition )

**To:** Chief, Wireless Telecommunications Bureau

**COMMENTS OF xG TECHNOLOGY, INC.**

xG Technology, Inc. (“xG” or “the Company”), by its representatives, hereby submits its response to the Public Notice (*PN*) issued by the Wireless Telecommunications Bureau (Bureau) on May 17, 2013, which seeks input for the Commission’s annual report on the state of mobile wireless competition.<sup>1</sup> xG herein describes its recently developed xMax™ technology and the role it can play in bringing low-cost voice and broadband data to rural America and elsewhere and in deploying wireless broadband communications to the First Responder community for rapidly restoring communications capabilities in the immediate aftermath of a catastrophic event.

In the *PN*, the Bureau asked for comments on how advanced network technologies affect spectrum access. The Bureau appears also to be concerned with whether the looming spectrum shortage will constrain the deployment of faster and more advanced mobile broadband networks.<sup>2</sup> xG welcomes this opportunity to describe its recently developed cognitive radio technology and how its use of unlicensed spectrum may mitigate the anticipated concerns.

**The Company and the background of its technology** -- xG is a leading developer of innovative communications technologies for wireless networks. Its extensive patented intellectual property portfolio covers a broad range of applications including cognitive radio networks. The Company has commercialized its technologies to create xMax™, the world’s first carrier-class cognitive radio network using licensed or unlicensed spectrum. The Company has

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<sup>1</sup> *Wireless Telecommunications Bureau Seeks Comment on the State of Mobile Wireless Competition*, WT Docket No. 13-135, Public Notice (*PN*), DA 13-1139, rel. May 17, 2013.

<sup>2</sup> *PN*, at page 6.

successfully deployed and operated cognitive cellular mobile radio test networks in Fort Lauderdale, Florida and rural Arkansas using the unlicensed 900 MHz band (902-928 MHz) under Part 15 of the Commission's Rules.

Recently, the U.S. Army awarded xG a contract to conduct laboratory and field tests of its xMax cognitive cellular network for potential use by military forces. Under the terms of the contract, the Company delivered xMax equipment to the Fort Monmouth, New Jersey laboratory facility for the Army's Communications-Electronics Research, Development, and Engineering Center (CERDEC). In addition, xG installed and provided training for the Army to operate a multisite xMax system over a large part of the Army's Fort Bliss Desert Training areas. It is important to note that the Army tried to, but could not, jam the xMax devices, even over a two-week period and using numerous advanced methodologies. And, because of xMax's advanced technology, virtually any level of encryption can be utilized. These are factors that must be considered in any national security situation and is another benefit of the cognitive radio system developed by xG.

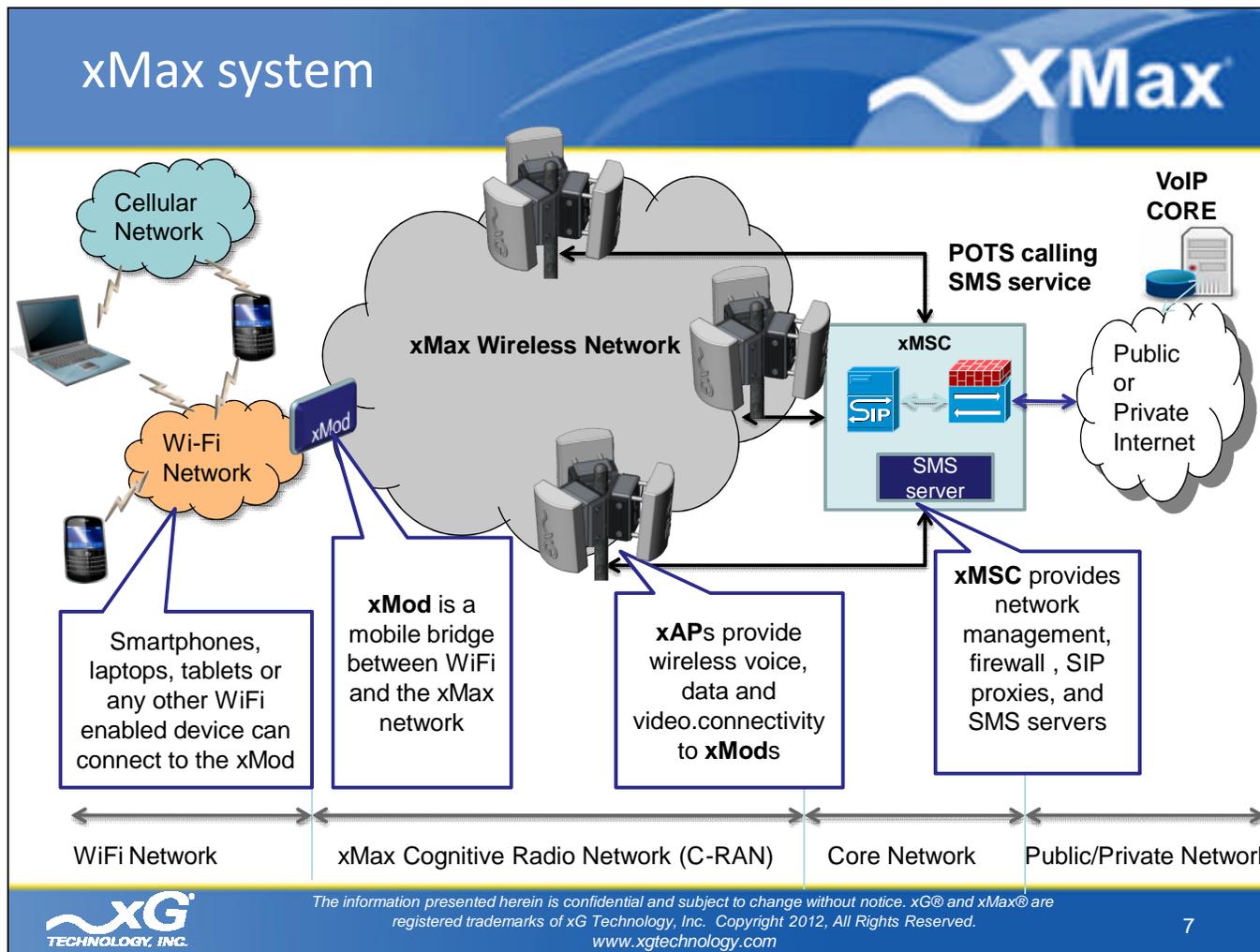
xG has commercialized its technology through a range of spectrum-agnostic, cognitive radio solutions that enable commercial service providers and public safety entities to deliver a wide range of fixed and mobile wireless services using licensed and/or unlicensed spectrum.<sup>3</sup>

A graphic description of the network is shown below:

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<sup>3</sup> Further information about the Company can be found at [www.xgtechnology.com](http://www.xgtechnology.com).



The RF equipment shown in the graphics are the xAP (base station) and xMod (subscriber or other end-user units). As indicated, the xMod is a bridge between Wi-Fi, USB and Ethernet enabled devices and the xMax network. The xMod unit contains a Wi-Fi access point (FCC certified) that currently operates in the 2.4 GHz band. It also contains an xMax subscriber radio that currently operates in the unlicensed 900 MHz band (although it can be manufactured for use in any other band). The xMax Mobile Switching Center (xMSC) is the backbone network element in the xMax regional network. The xMSC controls the delivery of voice and data services and manages all elements in the xMax network (xAPs and xMod personal hotspots).<sup>4</sup> Devices that have Wi-Fi capability, such as computers, laptops, smartphones (Apple

<sup>4</sup> xMax, xAP, xMod and xMSC are all registered trademarks of xG Technology, Inc. Wi-Fi is a registered trademark of the Wi-Fi Alliance.

or Android) and tablets can attach to the Wi-Fi access point in the xMod. Devices can also be tethered to the xMod directly via USB and Ethernet cables. The versatility of the network and the fact that it is capable of operating in either licensed or unlicensed spectrum are factors of considerable value in structuring a system to be capable of providing emergency communications. In addition, xG already has demonstrated applications (apps) that perform secure voice calls, PTT, texting, file transfer, pictures and video over the end user device although any app can be used.

## **INTRODUCTION**

The quantum leap in chip technology and the abilities created by xG's xMax carrier class cognitive radio network solution are factors that can play a useful role for any form of wireless communications for normal, unusual, or emergency situations. The xMax system will allow the use of any present telecommunications or computer device, provided it has the ability to connect to the xMod. These include any smartphone, laptop or desktop computer, tablet, or any other device that has a Wi-Fi, USB, or Ethernet connection. The xMax system permits voice calling to and from landline phones, mobile-to-mobile calling, text messaging, web browsing and receiving/sending data.

When operating in the unlicensed 900 MHz band, the raw data rate is approximately six (6) Mbps per channel. Re-banding in the future affords the opportunity to design for other channel bandwidths, power levels and bit rates. One xMod can support up to five (5) wireless devices at the same time since it also functions as a hub. The xMax system can be set up and made operational within minutes of arrival at an emergency situation.

While the xMax technology is capable of operating on any frequency, the current hardware design limits operation from approximately 300 MHz to 3 GHz. Antenna selection dictates the actual operating frequencies which can be controlled by software. Current devices are configured for operation in the unlicensed 900 MHz band. A web-accessible controller can

create a set of rules that either permit or exclude any portion of the network's frequency range, thereby allowing instant changes to the allowable frequency bands as conditions change.

The proprietary cognitive radio technology incorporates orthogonal frequency division multiplexing (OFDM) and four-by-two multiple input-multiple output (MIMO) features.<sup>5</sup> The technology is used in the xMod as well as in the xAP (the xMax base station). This permits interference-free operation on any of the selected frequency ranges. A key feature of the cognitive aspect of the system is the ability to detect and avoid potentially interfering radio signals seamlessly. This is part of the cognitive radio strategy pioneered by xG and is, to our knowledge, the only such cognitive radio technology that has been proven successful in actual field operating conditions. This feature, known commonly as Dynamic Spectrum Access or DSA, actively spots interferers and causes the equipment to change frequencies before communications are adversely affected. In addition, xMax radios utilize a multi-tier interference mitigation technology to actually factor out interference at the receiver. Both short burst interference and long burst interference are removed by parallel digital signal processing (DSP) engines in real time. Even interferers many times stronger than the xG signal are removed in real time. Problematic interferers are then dealt with by the previously mentioned DSA. Thus, xG equipment can operate without interference in high density and shared radio spectrum with near impunity for a virtual dedicated spectrum experience.

Components of the xMax system, including the xAP and xMod, are compact and light weight. The xMod can fit in one's pocket, or on a vehicle's dashboard. One can carry it anywhere and power it from a built-in battery or car charger, thereby providing a WiFi bubble of up to 28,000 square feet, for up to five end-user devices.

The access point (xAP) essentially replaces big and bulky base stations and can be

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<sup>5</sup> xG incorporates 4X2 MIMO, which uses two antennas for transmit / receive and two more for receive only. A powerful Digital Signal Processing (DSP) system receives four independent signals and mathematically negates interference.

mounted on utility poles, cellular towers, or buildings; and xG has demonstrated mobile access points with satellite back-haul on trailers and vehicles. An xMax mobile access point on a trailer is much less expensive than a traditional Cell on Wheels (COW) or fixed cell because the equipment is small and power efficient. Given this size advantage, it will also fit in drones, aerostats and aircraft, including both helicopter and fixed-wing. Thus, rapid and mobile service areas can be established anywhere at any time. It also fits in vehicles such as Humvees, trucks, SUVs, cars, ships, boats and other vehicles.

Since every component of the network utilizes the xMax cognitive radio technology, no frequency planning or use pattern analysis is necessary prior to system deployment due to its ability to create its own RF plan in real time. This is called Self Organizing Networking (SON). SON eliminates the need for complex, error prone and expensive frequency planning. An on-going complication of fixed cellular networks is self interference. This is especially true of LTE. The patented SON attributes of xMax fully eliminate this problem, manpower and expense, reducing the system engineering and buildout costs dramatically and eliminating self interference.

xMax systems are scalable. In many instances, massive capacity is not required. There is no need to install a full capacity system where only less capacity is needed. Because all xAPs self organize, there is no need for frequency planning and the proposition becomes essentially “plug and play” when expansion is needed. The more xAPs one installs the more users that can be accommodated; growth is thus limited only by the total number of channels available for operation. By way of example, in an extreme case, the unlicensed 900 MHz band provides 18 discrete channels, so up to 18 xAPs could be installed at one location without self interference or planning. Each xAP would provide up to 6 Mbps of bandwidth to multiple users.

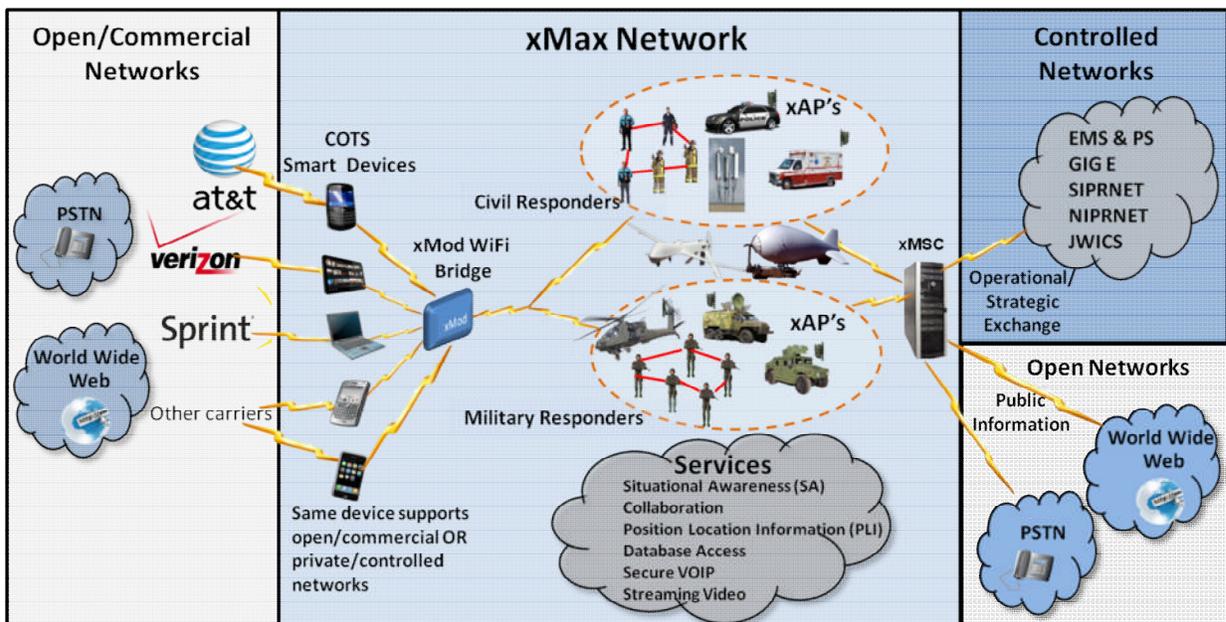
As previously noted, in tests of the xMax system recently conducted by the U.S. Army, the Army was unable to jam the xMax devices, despite repeated attempts to do so using sophisticated methodologies. And, because of xMax’s advanced technology, virtually any level

of encryption can be utilized. These are factors that must be considered in any national security situation and is another benefit of the cognitive radio system developed by xG. Traditional cellular wireless technologies have no such capability. The xMax system with inference mitigation and avoidance and self-organizing capability make this system smaller, faster, less expensive and easier to put into service.

**xMax as a primary network** -- As discussed, xMax can work in any spectrum. xG's current products are designed for use in the unlicensed 900 MHz band. However, the equipment can be designed and built for use on licensed spectrum as well. Thus, xMax makes for an inexpensive, rapidly deployable, interference resistant, secure and efficient network. With the low cost and scalable design, the xMax network is an excellent choice for the first responder community.

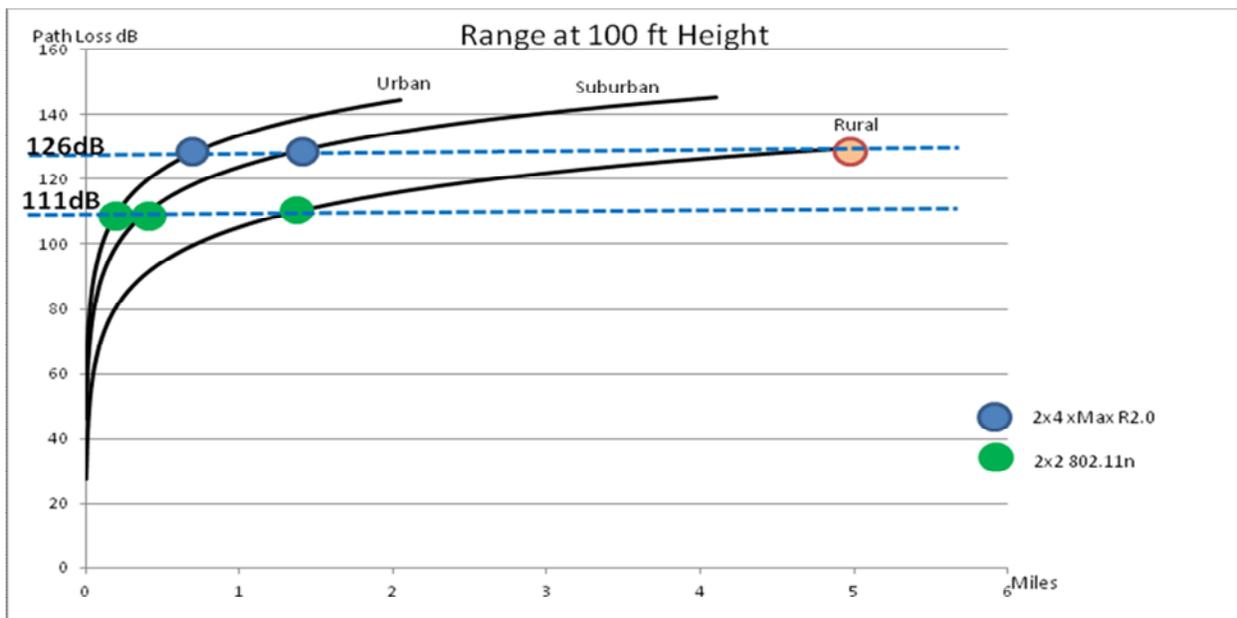
**xMax as a disaster recovery network** -- Because xMax is cognitive, it can serve as an always ready backup system should a primary system fail. Mobile cells can very quickly roll out to any area, and then self organize onto the licensed spectrum and begin providing services. As the primary system is repaired and cells become active again, the xMax network will change frequency automatically. Interference with the primary system is avoided. In addition, xMax access points can be pre-positioned on utility poles, buildings and other structures, always on and ready to activate should the primary cell signal go down. This forms a de-centralized system, which by definition is more reliable. Because the xAP is small and efficient, it can be battery powered and the battery can be solar charged, making it a very durable backup or even primary wireless network.

**Vast interoperability** -- When one considers that xMax works as a bridge to bring together disparate communications systems in a secure and jammer-proof network, it is easy to see how the technology can easily incorporate communications from many civil, military and commercial services. See the following graphic.



### Technical Considerations

**Coverage** -- When operating in the unlicensed 900 MHz band, depending on the height of the deployed xAP antenna, the range from a single xAP is anywhere from a half-mile radius at 40 feet above ground level, up to and beyond a 12-mile radius depending on antenna height and the topography of the area in which deployed. This assumes 4 watts EIRP, as prescribed by the FCC's Part 15 rules. Range can be increased substantially if xG is allowed to operate with increased power during emergencies. The range chart below assumes a modest 100-foot tower under the FCC's Part 15 rules.



**Bandwidth** -- Each xAP is capable of delivering one channel of 1.44 MHz bandwidth.

Each channel can support up to 6 Mbps bandwidth when operated under the FCC’s Part 15 rules. Higher power will allow higher data rates and longer range. Multiple xAPs can be co-located to stack capacity as needed. Each xAP can use omnidirectional or directional antennas. Using directional antennas will increase range and allow three xAPs to be used to form an omnidirectional cell.

### Comparing xMax to other technologies

	xMax	LTE	3G	WiMax	Comment
High data rate	Y	Y	N	Y	
Interference resistance	Y	N	N	N	Only xMax is designed for interference mitigation
All IP	Y	Y	N	Y	
Self configuring	Y	N	N	N	Only xMax is cognitive
Designed for voice and data	Y	N	Y	Y	xMax has special voice QOS attributes
Dynamically selects spectrum	Y	N	N	N	xMax can use licensed and shared spectrum
Operates in free unlicensed spectrum	Y	N	N	N	Designed from the beginning to share
Cognitive	Y	N	N	N	DSA + deep interference mitigation
Simplified engineering	Y	N	N	N	No frequency planning
MIMO	Y	Y/N	N	Y	LTE only uses MIMO on the downlink
Inexpensive	Y	N	N	N	Less cost, less planning, less engineering
De-centralized	Y	N	N	N	A de-centralized network is more durable
Jammer proof	Y	N	N	N	Making it cognitive makes it jammer proof

### CONCLUSION

xMax is a rapidly deployable system that can operate on unlicensed spectrum without interfering with licensed commercial or public safety operations. xMax can communicate with any existing or new device that has a Wi-Fi, USB or Ethernet interface. This capability means that virtually all existing smartphones, laptops and tablets can be used as instant xMax terminals through the portable xMod wireless bridge. The use of cognitive radio techniques, by

themselves, is a huge step forward in resolving the question of how much additional spectrum will be required to support next generation technologies and mobile broadband applications. Cognitive radio coupled with operating in unlicensed spectrum, as exemplified by xG's xMax technology, is what truly distinguishes xMax as one of the leading new technologies of the 21<sup>st</sup> Century.

Respectfully submitted,

**xG TECHNOLOGY, INC.**

*/s/ Harold Mordkofsky*

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