

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554**

In the Matter of)	
)	
Implementing Public Safety Broadband Provisions Of the Middle Class Tax Relief and Job Creation Act of 2012)	PS Docket No. 12-94
)	
Implementing a Nationwide Broadband Interoperable Public Safety Network in the 700 MHz Band)	PS Docket No. 06-229
)	
Service Rules for the 698-746, 747-762 and 777-792 MHz Bands)	WT Docket No. 06-150
)	

To: The Commission

**RESPONSE OF xG TECHNOLOGY, INC.
TO NOTICE OF PROPOSED RULEMAKING**

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SUMMARY

xG Technology, Inc. (“xG” or “the Company”) is a leading developer of innovative communications technologies for wireless networks. The Company has commercialized its technologies to create xMax, TM the world’s first carrier-class cognitive radio network which has proven successful in actual field operating conditions. Herein, xG submits its comments which examine the role of its cognitive radio technology in deploying a nationwide public safety broadband network in the 700 MHz band, to facilitate ubiquitous, immediately deployable wireless broadband communications to the First Responder community, both as a primary communications system and as emergency response, by rapidly restoring communications capabilities in the immediate aftermath of a catastrophic event.

The xMax cognitive radio system is a breakthrough technological advancement in the radio art that has been proven to work as designed and developed by xG in Fort Lauderdale, Florida. Test systems have been successfully deployed in both urban and rural settings, as well as in tests conducted by the U.S. Army. The xMax system has been proven to have a fast and easy setup when deployed. It eliminates frequency planning issues that arise in other traditional (non-cognitive) wireless networks that cause delays and consume valuable manpower in the early hours of a response. It is the only carrier-class wireless network capable of immediately using the unlicensed bands along with whatever licensed bands have been programmed into the system. Nothing else gives this flexibility to use any available frequencies to get first responders communicating and coordinating.

Because of its interference avoidance capabilities and the fact that it can operate on such a wide band of frequencies (including unlicensed spectrum), it is uniquely suited for use in providing prompt and interoperable communications in the event of emergencies and national

disasters.

Another of its most important and unique advantages is that it is the only system to our knowledge that can use commercial off-the-shelf (COTS) devices from any cellular network that have either Wi-Fi, USB, or Ethernet connections, and still allow these devices to work on their original networks when either returned to service or when otherwise required.

Experience has shown that conventional technologies typically require extensive frequency planning, allow only the use of devices specifically designed to be used with the particular system and do nothing to mitigate electrical interference issues. In short, they are not flexible or adaptable enough as the circumstances change to adequately perform in immediate disaster situations.

xMax is an all IP and VoIP system that has the advantages of light weight, portability, low power consumption, frequency versatility and interference avoidance and mitigation. It can also be used in conventional telecommunications systems to maximize frequency utilization. xG believes that xMax holds great promise for public safety and homeland security.

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TO NOTICE OF PROPOSED RULEMAKING**

xG Technology, Inc. (“xG” or “the Company”), by its representatives, hereby submits its response to the Commission’s *Notice of Proposed Rulemaking (NPRM)* in these proceedings, which seeks comment on the development of a unified set of technical parameters for the D Block spectrum and existing public safety broadband spectrum to protect against harmful RF interference. xG’s comments examine the role of its cognitive radio technology in deploying a nationwide public safety broadband network in the 700 MHz band to facilitate ubiquitous, immediately deployable wireless broadband communications to the First Responder community both as a primary communications system and as emergency response, by rapidly restoring communications capabilities in the immediate aftermath of a catastrophic event.

STATEMENT OF INTEREST

xG welcomes this opportunity to describe its recently developed technologies and how it is well positioned to assist in providing emergency communications following a local or national

disaster as well as its ability to fill in critical capability gaps for the proposed and anticipated FirstNet network.

It is anticipated that FirstNet will oversee the construction, deployment, operation and management of the designated 700 MHz band spectrum to form a nationwide wireless network for use by public safety entities. Further, it is likely that such a network will be comprised of base stations installed at primarily commercial cellular towers and infrastructure. At such time as this system becomes operable, it will also become vulnerable to the same unforeseen circumstances and natural disasters to which commercial wireless networks are currently subject. In other words, the same natural or manmade disasters that disrupt communications networks today will likely disrupt the FirstNet network in the future.

In addition, it is anticipated that the timeline for deployment of the FirstNet wireless network may extend for years as funding is identified, construction begins and the network begins to take shape.

xG proposes a solution both for eventual disaster recovery as well as an interim solution that makes radio spectrum available immediately, along with the technology to use the spectrum now.

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

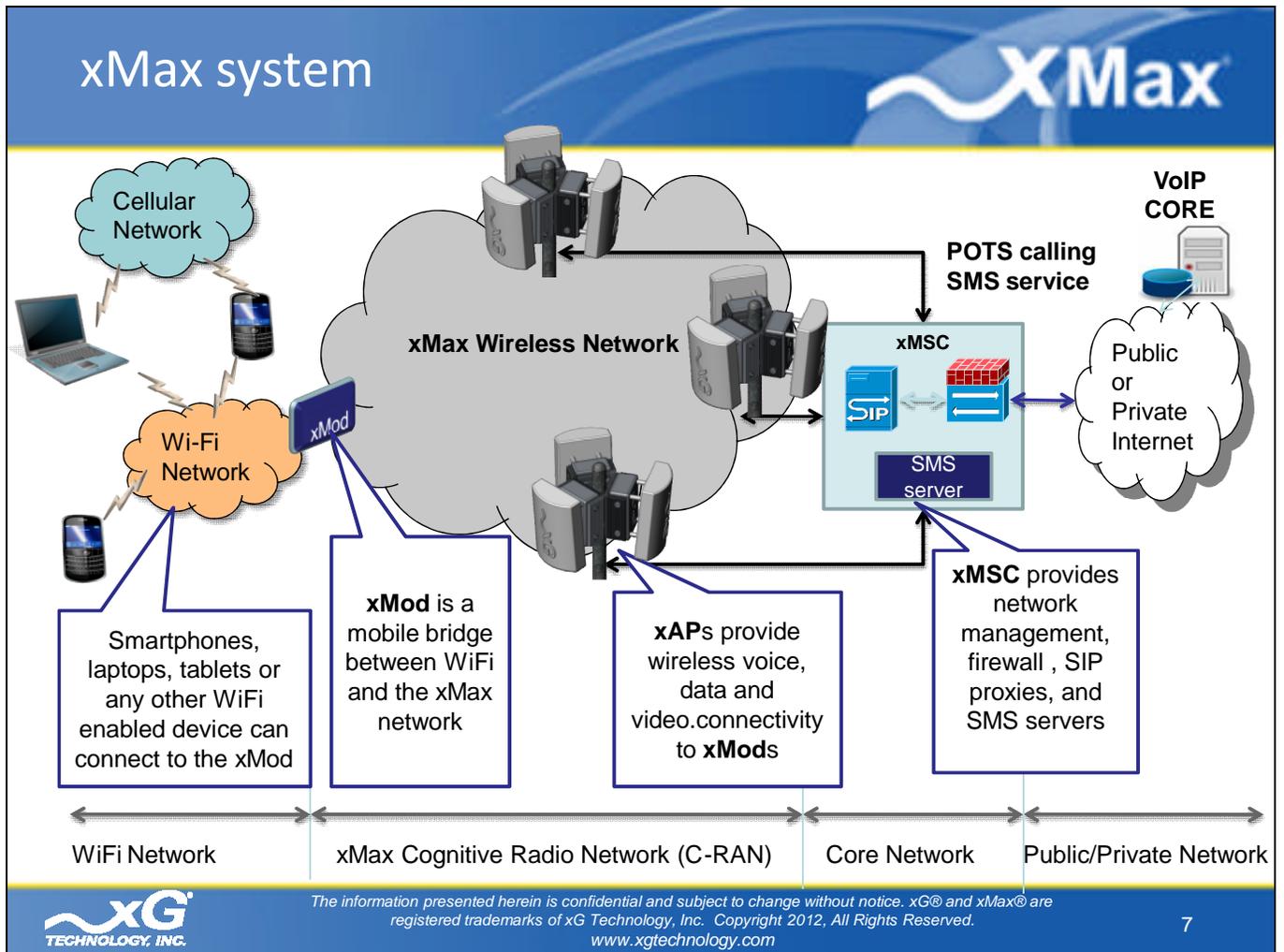
licensed or unlicensed spectrum. The Company has successfully deployed and operated cognitive cellular mobile radio test networks in Fort Lauderdale, Florida and rural Arkansas using the unlicensed 900 MHz band (902-928 MHz) under Part 15 of the Commission's Rules.

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. In addition, xG recently conducted demonstrations for the FCC's Office of Engineering and Technology and its Public Safety and Homeland Security Bureau. 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.¹

(The remainder of this page is intentionally left blank.)

¹ Further information about the Company can be found at www.xgtechnology.com.

A graphic description of the network is shown below:



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 the 700 MHz band or 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).²

Devices that have Wi-Fi capability, such as computers, laptops, smartphones (Apple 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 not only FirstNet but also any form of wireless communications for normal, unusual, or emergency situations. Using the xMax system will provide the control of command in any situation, in any environment, using any present telecommunications or computer device, provided it has the ability to connect to the xMod using secure Wi-Fi, USB, or Ethernet. 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 to the 700 MHz band, for example, affords the

² xMax, xAP, xMod and xMSC are all registered trademarks of xG Technology, Inc. Wi-Fi is a registered trademark of the Wi-Fi Alliance.

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.³ The technology is used in the xMod as well as in the xAP (the xG 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 impacted. In addition, xMax radios utilize a multi-tier interference mitigation technology to actually factor out interference at the receiver. Both short burst

³ 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.

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 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 ongoing complication of fixed cellular networks, including the 700 MHz network contemplated for FirstNet, is self interference. This is especially true of LTE. Indeed, this is one of the

Commission's primary concerns in these proceedings.⁴ 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 in certain geographic areas. There is no need to install a full capacity system where only less capacity is needed. In many, if not most coverage areas, a single xAP is all that is needed to support many first responders with full capability. This dramatically lowers the cost of deployment. In areas where more capacity might be needed, one can simply install more xAPs. 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 personnel.

It should be noted that in tests of the xMax system recently conducted by the U.S. Army, 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. 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.

⁴ *NPRM*, at ¶¶ 27 and 28.

Primary and secondary use of xMax

xG proposes that the Commission should establish rules that allow the use of xMax initially as a secondary system to augment the eventual permanently installed 700 MHz nationwide radio network. There will be areas where the costs will not justify investing in massive infrastructure to build out a traditional cellular system. xMax will be much more cost effective, given that xAPs can be utility pole mounted and backhauled with DSL or other wireline network. Stronger wireless coverage can be had by installing several inexpensive access points along a rural road than with a single tower installation, especially when terrain is a factor. Furthermore, when the LTE base station must be augmented with Pico cells due to terrain or obstructions, self interference becomes a problem that normally would be solved through expensive infrastructure. xMax cells are fully self organizing and never self interfere.

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 operation in the 700 MHz FirstNet spectrum just as easily. Because xMax is cognitive and able to operate in shared spectrum, both the dedicated FirstNet spectrum and the unlicensed 900 MHz band can be used together seamlessly, effectively granting FirstNet an *additional* 26 MHz of spectrum at no additional cost. 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.

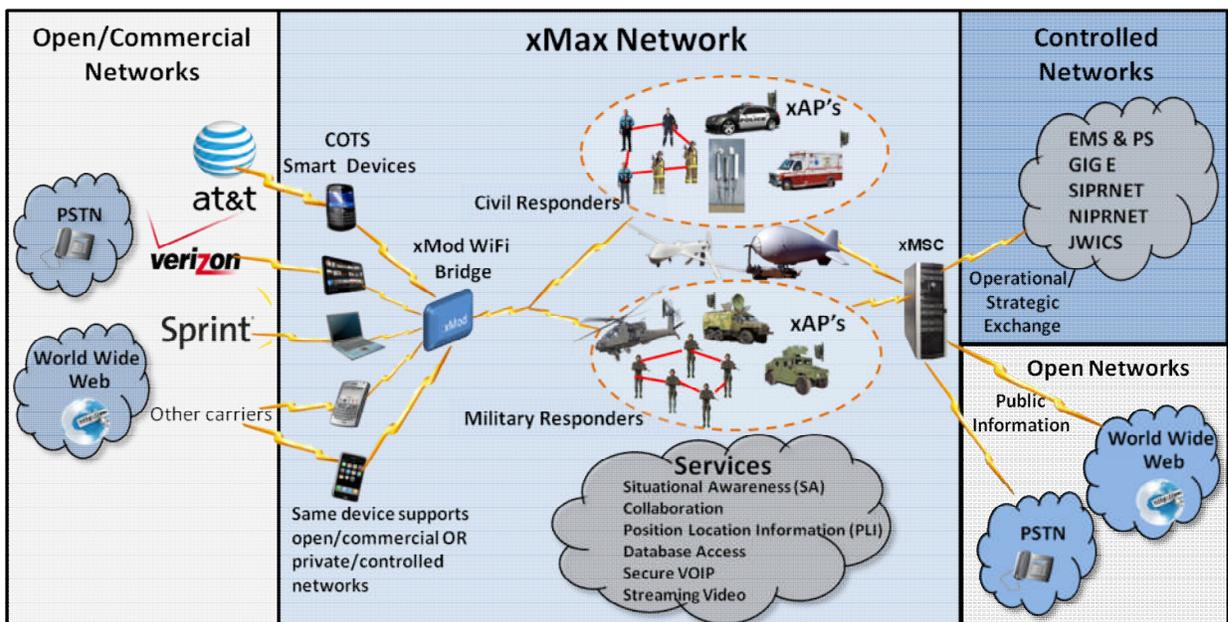
xMax as a disaster recovery network

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; self organize onto the

FirstNet 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.



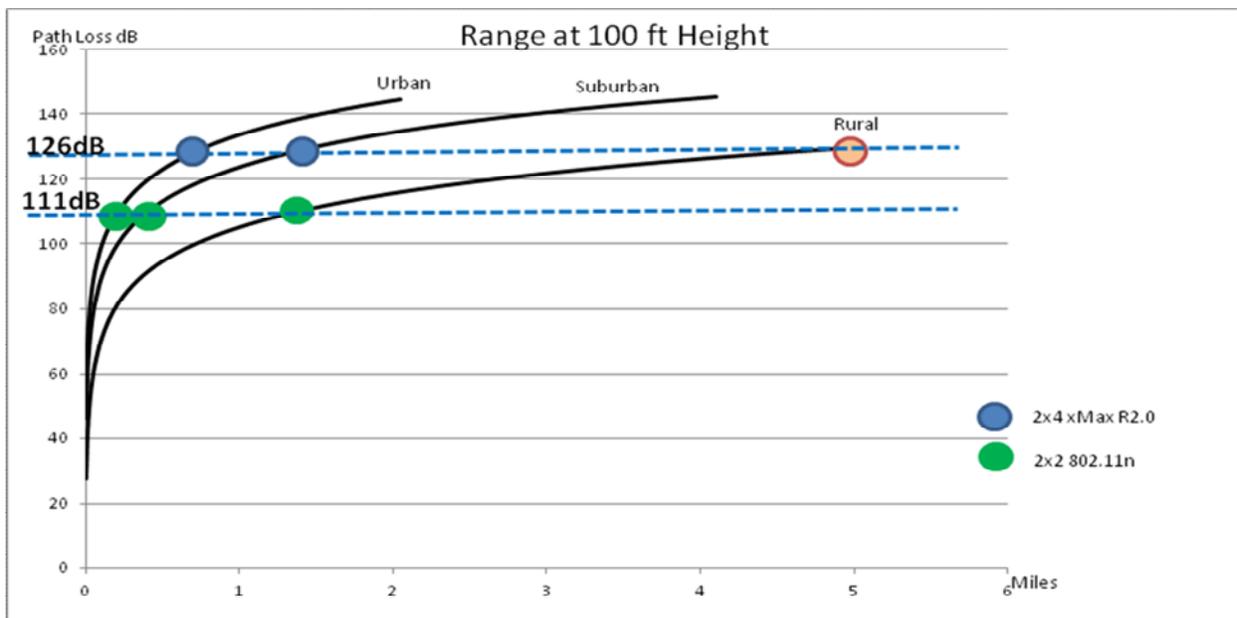
RESPONSES TO NPRM

Having described the xMax system, its capabilities and its advantages in emergency circumstances, we will seek to provide other useful information to the Commission.

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. If the system is operating on FirstNet 700 MHz spectrum, power would not be limited to the Part 15 rules and range and data rate would be much greater. 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. See the following images of xMax components.

Photo of an xMod



Inside the xMod

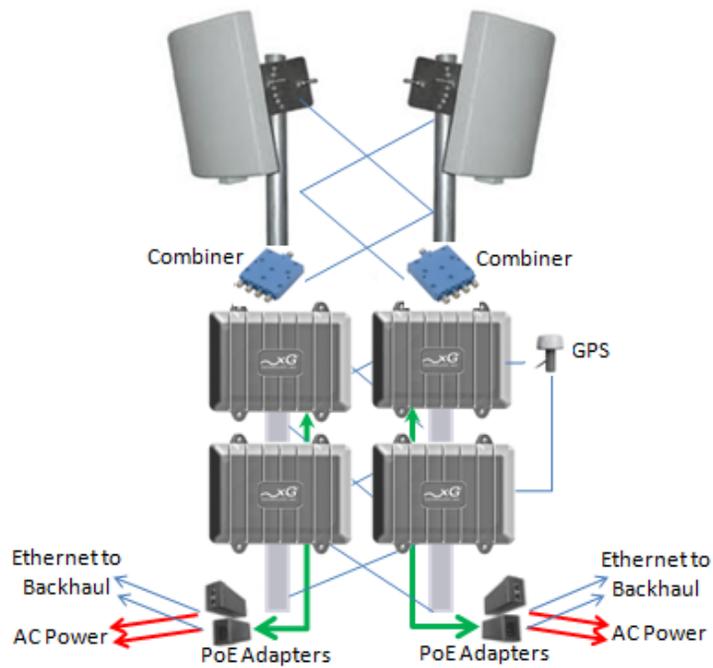


xAP configurations



Single Channel
Omni Coverage

Multiple stacked xAP's for more capacity



Directional xAPs stacked three ways (omnidirectional)



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

xG urges the Commission to consider the merits of a shared spectrum system like xMax. Current xMax products operate virtually interference free in the unlicensed 900 MHz band and can be produced to operate in FirstNet's 700 MHz band. Optimally, FirstNet would incorporate

xMax both for the 700 MHz band and the unlicensed 900 MHz band, thus affording an additional 26 MHz of RF spectrum for emergency communications.

xG is focused on delivering an *affordable, interoperable, immediately deployable, scalable and fully expeditionary network* which FirstNet users can exploit at any time, under any circumstance, and with any mini-USB or Wi-Fi equipped Smart device, no matter what LTE equipment eventually gets adopted and procured as the FirstNet end-user device. xMax is available now and will be compatible with whatever technology FirstNet deploys. Moreover, xMax is capable of delivering services that FirstNet will not initially provide, *e.g.*, voice. Finally, xMax's expeditionary design-basis and ability to instantaneously deploy *independent of fixed networks and infrastructure* means that xG can guarantee a level of resilience and continuity of operations beyond what FirstNet will provide as currently envisioned. xG is prepared to provide the Commission with additional information upon request.

Respectfully submitted,

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