

August 12, 2015

James Woodyatt
xG Technology, Inc
Suite 701
240 Pineapple Avenue
Sarasota, FL 34236

Dear Mr Woodyatt:

Thank you for the time to work with your team to understand the xMax product and its associated technologies. The work enabled me to understand the core technologies, the current capabilities, and potential extensions. I have given thought to the applicability of the current product and its extensions to a few markets. So attached is my "Initial Assessment of xMax Product Capabilities and Marketplace Impact".

It is my belief that if desired, then this initial assessment should be expanded to provide a more comprehensive comparative analysis with currently available competitive products to provide the needed data to have fruitful discussion with potential clients and/or partners.

Please contact me if there are any questions.

Sincerely,

A handwritten signature in black ink, appearing to read "Paul J. Kolodzy". The signature is fluid and cursive, with the first name "Paul" being the most prominent.

Paul J. Kolodzy, PhD

Initial Assessment of xMax Product Capabilities and Marketplace Impact

The consumer communications market (cellular and “WiFi”) have focused primarily on producing the greatest link speeds possible. Introduction of new spectrum and advanced signal processing techniques such as MIMO and OFDMA have been optimized to enable service providers (such as Verizon, AT&T) and equipment manufacturers (such as CISCO/Linksys, ASUS, D-Link) to claim the highest data rates that are reaching close to 500 Mbps¹.

Users of commercial wireless systems (such as wireless bridges between buildings or fixed infrastructure; WISPS, wireless telemetry systems) are keenly aware of spectrum congestion and the impact of interference but the equipment vendors focus on cost and maximizing data rate.

Military communications are struggling to keep up with the rapidly advancing technologies for consumer communications while providing capabilities that are robust to enemy jamming and are free from installed infrastructure (without base stations – aka peer-to-peer). The military has been able to develop highly capable transceivers (radars, GPS and radios) that are resistant to jamming/interference² but at the cost of expensive platforms, very limited data rates, and long refresh cycles that require soldiers to use antiquated equipment³.

The past 20 years of advancement in communications has been focused on getting higher link speeds. The proliferation of wireless systems has enabled a very high density of wireless users (wireless devices are everywhere) and thus our communications systems are no longer limited by speed of the links but the capacity to cope with the interference between devices. This is especially true to unlicensed devices (aka WiFi) and in commercial wireless systems. It will become acute in consumer cellular with the onset of low cost, highly proliferated Internet of Things (IoT).

A quick assessment of the xMax technology⁴ indicates that it provides superior interference tolerance capabilities to currently available consumer and commercial communications systems^{5,6}. It provides a superior data rate capability to available military systems. That is, it

¹ MIMO technology has the capacity for both of exploiting multiple spatial streams as well as eliminating interference sources. The primary uses of MIMO technology for communications has been exclusive in providing additional link capacity.

² Antenna array signal processing has been demonstrated over the past 20+ years the capacity to “steer” up to N-1 nulls of 30 dB attenuation (or more) with N being the number of elements. The applications of this technology has been radar and GPS receivers.

³ The technology integrated into the XMax wireless bridge has demonstrated in interference suppression technology that is in line with that developed from for radar and GPS systems and that has yet to be integrated into communications systems. This technology can provide significant advantages particularly in environments associated with highly utilized unlicensed spectrum and adjacent channel TDD/FDD interference.

⁴ Core technologies developed by XG Technology attempt to exploit both MIMO processing, DSA or dynamic channel selection, and temporal coherence to provide a greater number of degrees of freedom to address interferers

⁵ Assessment of the xMax was performed to provide a baseline performance with respect to interference suppression and a comparison to alternative commercial off-the-shelf technologies. Capacity assessment was not performed.

fills a niche within the communications marketplace that is now becoming increasingly important and will be growing over the next 15 years. Comparisons between current market-leading technology solutions (Ubiquity and ASUS) and the xMax product show a significant advantage to the xMax system in terms of interference tolerance⁷⁸.

The xMax technology that provides interference tolerance via spatial diversity also enables enhanced capacity for a homogeneous (e.g. all xMax) wireless network. Current wireless networks enable multiple users through dividing access in time but xMax, if properly configured, can provide up to an increase of capacity of three times over conventional wireless networks such as 802.11 (WiFi) using both time and spatial access.

Three market segments present opportunities for xMax⁹ and its potential variants: commercial, consumer, and the military.

The commercial marketplace is not as limited by standards and thus the current product potential to provide unique capabilities. The potential clients or partners for xMax span the entire ecosystem from the chipset manufacturers, to the equipment vendors, to the service providers.

The consumer marketplace, however, is very different. It is based upon strict standards that are developed by equipment vendors. The xMax technology should be capable of being modified to work with those standards to provide a substantial interference tolerance capabilities. The potential clients or partners span the most of ecosystem from the chipset manufacturers to the equipment vendors (most likely second tier vendors that need a market discriminator).

The military marketplace has two potential applications areas: low cost/moderate capacity point-to-point which is well aligned to the xMax's bridge architecture; and military-on-military spectral sharing. The spectral sharing application needs interference tolerance to enable robust performance. Spectral sharing for the DoD will continue to be an important growth area due to the desire to make more DoD spectrum available for commercial/consumer use. The military marketplace is in general governed by Programs of Record and their specific funding sources. Potential clients may be the integrators for Programs of Record that envision a P3I (Preplanned Product Improvement).

As mentioned above, the current xMax product line has two near-term potential customers: the commercial space can use the bridge product in the current implementation for public safety,

⁶ Preliminary assessment (simulation and measurement) indicated that the XMax system could operate with up to three co-channel interference sources of source power (100% duty cycle) within a few dB of the desired XMax system. Duty cycles less than 100% with periodicity longer than the X max frame size could be tolerated at higher powers.

⁷ Interference assessment with the Ubiquity 915 MHz 2 x 2 MIMO bridge indicated that co-channel signal levels (100% duty cycle) of 20 dB below the desired signal were sufficient to cause serious interference.

⁸ Interference assessment with the Asus 4 x 4 MIMO access point and associated clients indicated that co-channel signal levels (100% duty cycle) of 20 dB below the desired signal were sufficient to cause serious interference.

⁹ The XMax communication system operates as a bridge.

urban-core network infrastructure, and other point-to-point applications; and the military space for fixed infrastructure (or hub-n-spoke mobile) applications.

Next steps should include:

1. Assessment of the customer needs to match the specific capabilities of the xMax technology to the deficit or desired market advantage
2. Comparative testing between market-leading (per segment) systems. This directly influences the value proposition to the potential customer/partner. This should include enterprise level equipment provided by Ruckus and CISCO.
3. Determine the effort necessary to integrate XMax technology into current standards-based waveforms such as 802.11n and 802.11af.
4. Determine the impact of IoT efforts and the relevance of XMax technology to this burgeoning marketplace.