White Paper

Stacking xMax® Against WiMax™ IEEE 802.16e

xG Technology, Inc.

www.xgtechnology.com

March 2010

Executive Summary

To address the burgeoning market opportunity for low-cost mobile voice and broadband data services, xG® Technology, Inc. has developed an innovative wireless communication system (aka "xMax®") that is capable of delivering mobile voice over IP (VoIP) and broadband data services in the 902-928 MHz unlicensed band. From a business model perspective xG Technology is targeting this scalable radio access network (RAN) solution towards new-entrant service provider partners, such as cable companies, competitive local exchange carriers (CLECs), satellite companies, foreign incumbent local exchange carriers, etc. that may be seeking to deliver mobile VoIP/data services to the market on a nationwide or selected market basis.

In this white paper we compare xMax with IEEE 802.16e (aka "WiMax™") to determine which of the two technologies provides a better return on investment (ROI) for new entrant service providers. Using a detailed mobile service operational model, also described in this white paper, we calculate "Total Lifetime Customer Net Value ($) Per CapEx ($)" metrics for different voice/data revenue mixtures and different market types (e.g. urban, heavy suburban, etc.) and draw the following conclusions:

1. This paper shows that xMax is capable of returning roughly three times more profit to the operator than WiMax. Even under the most generous of assumptions, new entrant service providers could have the ability to derive ROI that is potentially orders of magnitude better under xMax than WiMax.
2. Scalable 902-928 MHz xMax mobile wireless networks are profitable across a much wider range of population densities than are 2.5 GHz WiMax mobile wireless networks. In fact, only in the densest of environments, which in most metropolitan areas typically contain less than 20% of the population, is a WiMax network more profitable than an xMax network.
3. The ROI advantage of xMax stems partially from the use of unlicensed spectrum and partially from its explicit support for voice services but mostly from the fact its well-designed 902-928 MHz RAN architecture better matches the voice/data capacity per coverage area requirements that the targeted service provider is likely to encounter as a new entrant in mature markets.
4. For new-entrant operators, the ability to provide mass-scale mobile voice services can result in a more profitable revenue base that provides the financial stability and cash-flow needed to support the increasing demand for broadband data.

In summary, a thorough and careful analysis, which has been purposefully liberal with its capacity and coverage assumptions for WiMax IEEE 802.16e, has demonstrated that xMax is a well-engineered, commercially compelling solution that is well-matched for today's and tomorrow's market requirements. It should be given strong consideration by any new-entrant service provider who is making a RAN technology decision.

1 Introduction

To address the burgeoning market opportunity for low-cost mobile voice and broadband data services, xG Technology, Inc. has developed an innovative wireless communication system (aka "xMax") that is capable of delivering mobile voice over IP (VoIP) and broadband data services in the 902-928 MHz unlicensed band. From a business model perspective xG Technology is targeting this scalable radio access network (RAN) solution towards new-entrant service provider partners, such as cable companies, competitive local exchange carriers (CLECs), satellite companies, foreign incumbent local exchange carriers, etc. that may be seeking to deliver mobile VoIP/data services to the market on a nationwide or selected market basis.

The inclusion of voice capability in addition to broadband data in the xMax RAN solution is a crucial differentiation that will be emphasized throughout this white paper. This is because, while mobile data services represent an important, high-growth area, mobile voice remains and will continue to remain the major revenue earner for mobile operators. Note the following market facts:

- According to telecom research firm Ovum, voice still accounts for nearly 70% of cellular industry revenues—and as late as 2014, its share of revenues won't dip below 60% in any region of the world.
- The GSM Association estimates that of the 4B mobile users worldwide, roughly 90% are voice only users
- ABI Research estimates that 2010 worldwide mobile voice revenues will be $580B
- This is contrasted with ABI Research's estimate that 2009 worldwide mobile data revenue was approximately $169B with roughly half of that being messaging related.

Currently, mobile broadband data revenues are less than 20% of those of mobile voice. Even using bullish industry assumptions for mobile broadband data growth, it is likely to take 9-10 years before mobile broadband data revenues are on parity with mobile voice revenues. Thus, networks that allow service providers to offer mass-scale mobile voice in addition to mobile broadband data as they see fit stand to significantly improve network profitability.

In this white paper we seek to compare xMax with IEEE 802.16e (aka "WiMax") to determine which of the two technologies, xMax or WiMax, provides a better return on investment (ROI) for new entrant service providers. Using a detailed mobile service operational model, also described in this white paper, we calculate for both xMax and WiMax "Total Lifetime Customer Net Value ($) Per CapEx ($)" metrics for different voice/data revenue mixtures and different markets including Manhattan, Greater Philadelphia, Miami, LA County and Kansas. In calculating the ROI metrics across a broad set of service mixtures and market assumption we are able to better understand the strengths of the respective technologies and draw conclusions that are more meaningful for the new-entrant operator.

We begin with brief technical overviews of both technologies, highlighting physical (PHY) and Media Access Control (MAC) layer differences and network architecture similarities. Following this we describe the operational model used to calculate the "Total Lifetime Customer Net Value ($) Per CapEx ($)" metric – this model is a conventional one and as will be pointed out, we have made liberal capacity and coverage assumptions for WiMax to bridge the gap between what is available in IEEE 802.16e WiMax systems today and what is being proposed for tomorrow's IEEE 802.16m WiMax systems. Finally we provide a discussion of the results and draw conclusions regarding the strengths of each technology.

2 xMax and WiMax IEEE 802.16e Overview

2.1 xMax Network Architecture

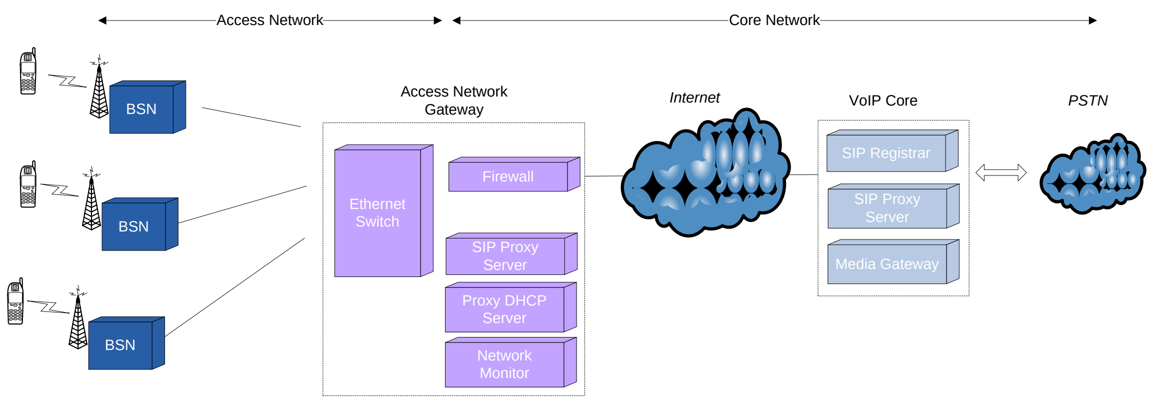


Figure 1: xMax Network Architecture Reference Model

The primary consideration in the design of the xMax system is the desire to provide robust, scalable, and full-featured voice and data services to mobile subscribers at a fraction of the cost of traditional approaches. A reference model form of the resulting Internet protocol (IP) centric network architecture is shown in Figure 1.

As the diagram indicates, the network architecture includes the following elements:

- Air-interface designed for operation in unlicensed as well as licensed bands
- Basestation (BSN), which provides radio to network access to handsets, and Access Network Gateway (ANG), which provides call process and IP packet delivery services. The xMax Basestation Node (BSN) is a three sector, 18 channel VOIP basestation transceiver device. The BSN channelizes the 902-928 MHz band into 18 discrete channels, which are only used when there is traffic to mobile devices that are registered with a particular channel. Radio

spectrum utilization is highly efficient in that the system occupies only that spectrum which is necessary for individual data streams. The bandwidth of each channel is 1.44MHz with sufficient guard band between channels.
- Technology agnostic backhaul links from BSN sites and the ANG (Fiber, Metro Ethernet, PTP Wireless, etc.)

While the BSN is conventional in both architecture and functionality, the ANG is a novel piece of wireless infrastructure equipment that consists of the following:
- Ethernet Switch which aggregates BSN links
- Firewall which provides *private* to *public* network address translation (NAT) services
- SIP Proxy Server which supports SIP call control, SIP message compression, and E911 services
- Proxy DHCP Server which is used for IP address services
- Network Monitor which is responsible for end-to-end network management and monitoring services

The architecture further supports the service deployment cost objectives by leveraging commercial off the shelf (COTS) voice over IP (VoIP) equipment, software and services, shown as VoIP core in Figure 1. The VoIP core contains the following elements:
- SIP Proxy Server which provides traditional SIP call control services
- Media Gateway – which provides media transcoding between IP and PSTN networks and is responsible for subscriber accounting/billing, PSTN call termination, “Direct Inward Dialing” (DID) phone number maintenance, voicemail services, and inter-network call signal routing, among others.

We note that for most deployments it is expected that the VoIP core will be operated and managed by a third party partner so the capex and maintenance costs associated with this equipment is considered out of scope.

2.2 xMax Physical Layer and MAC

xMax is a single-carrier system with forward error-correction (FEC), interleaver, symbol mapper, and pulse shaping filter. The baseline system supports 1.3 Mbps aggregate per channel with a single-order modulation and all 18 RF channels in use. The xMax system is capable of providing 23 Mbps aggregate. Higher rates are possible with higher-order modulation and xG is currently working on adaptive modulation extensions to the system which has the potential to substantially increase the system’s data capability.

Those familiar with wireless system physical layer design will note that the xMax is a conventional single carrier system.

The design of xMax MAC (aka xMAC) protocol was driven by the observation that existing MAC protocols (e.g. IEEE 802.11, WiMax, HSDPA) do not meet latency and scalability requirements for voice services. As an example, the downlink latency associated with the IEEE 802.11 MAC becomes unacceptable for > 12 concurrent calls.

Similarly, the downlink latency associated with the WiMax MAC with basic scheduler becomes unacceptable for > 17 calls.

In designing xMAC, the xG engineering team focused on meeting the following requirements

- Deterministic latency (30msec) independent of number of concurrent calls
- Adaptable to changes in voice codec
- Scalable to 300+ concurrent calls
- Supports several thousand registrations
- Support of IP traffic (i.e. QoS, Admission Control)

The resulting xMAC is a heterogeneous MAC protocol wherein timeslot based access (TBA) is used for voice and broadband data sessions and contention based access (CBA) is employed for signaling and short message applications (e.g. SMS).

Finally we note that in order to meet the objective of providing low-cost mobile voice and broadband data services the xMax RAN solution has been designed around commonly used and open Internet protocols (e.g. SIP, RTP, UDP, IP, etc.) and designed to operate in both unlicensed spectrum, such as the 902-928 MHz unlicensed ISM band, and licensed spectrum. As a result of these design considerations xMax includes responsive interference "detect and avoid" (DAA) techniques capable of 33 channel changes (handoffs)/sec that are suitable to combat any in-band interference encountered in the unlicensed spectrum, and extends the SIP and RTP protocols to the wireless domain.

2.3 WiMax IEEE 802.16e Network Architecture

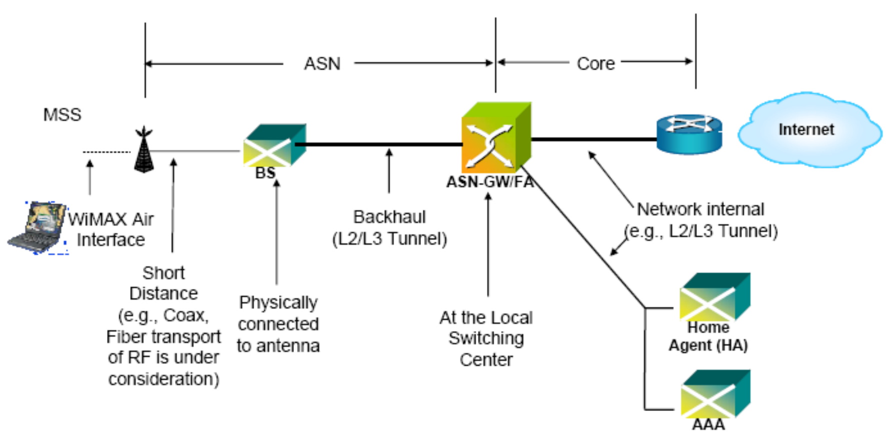


Figure 3: WiMax Network Architecture Reference Model (Source: Intel Presentation

As shown in Figure 3, WiMax IEEE 802.16e also has an open IP-based architecture. The network architecture includes the following elements:

- Air-interface designed for operation in licensed 2.5 GHz and 3.5 GHz bands as well as the 5.8 GHz unlicensed band,

- Basestation (BS), which provides radio to network access to handsets, and Access Service Network Gateway (ASN), which provides handover, authentication, radio resource management, IP address allocation, etc. The WiMax Basestation (BS) is typically a three sector unit with support for 3.5, 5, 7, 10 or 20 MHz channel widths,
- Technology agnostic backhaul links from BS sites and the ASN (Fiber, Metro Ethernet, PTP Wireless, etc.),
- Core Services Network (CSN) which contains the home agent (HA), authentication/authorization/accounting (AAA) server, and other elements such as the VoIP core used in the xMax network.

Similar to the xMax network, the BS and ASN are considered to be managed and operated by the network access provider (NAP) while the CSN is considered to be operated by a network service provider and therefore out of scope for this analysis.

2.4 WiMax IEEE 802.16e Physical Layer and MAC

Figure 4 shows a diagram of the WiMax IEEE 802.16e digital baseband processing chain.

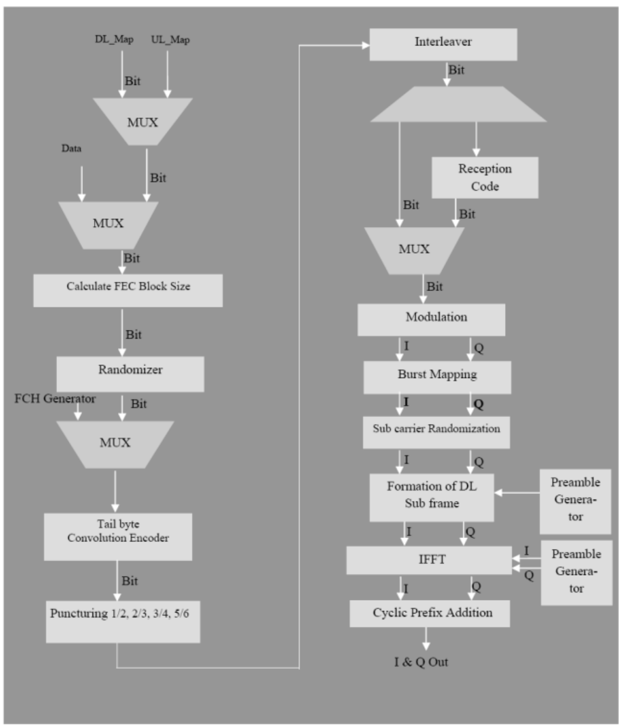


Figure 4: WiMax PHY Digital Baseband Processing Chain

From a physical layer perspective one significant difference between xMax and WiMax IEEE 802.16e is the fact that WiMax is based on orthogonal frequency division multiplexing (OFDM) which has much higher spectral efficiency and better resistance to multipath fading than does the single carrier modulation technology used by xMax. WiMax extends classic OFDM in the sense that it is scalable and allows the use of bandwidths ranging from 1.25 MHz to 20 MHz. Support for multiple input multiple output (MIMO) technology further enhances the potential spectral efficiency advantage of WiMax over xMax.

The WiMax MAC contains a scheduling algorithm that enables the BS to control quality of service (QoS) by balancing time slot assignments among the handsets and their respective application needs. In principle WiMax supports the QoS requirements for different types of services including Unsolicited Grant Services (UGS) for services such as VoIP without silence suppression, real-time Polling Services (rtPS) for services such as MPEG video or VoIP with silence suppression, non real-time Polling Services (nrtPS), and Best Effort Services (BE) for regular Internet browsing, etc.

The basic MAC scheduler for WiMax has been shown to lead to an inordinate amount of overhead. So-In, et. al. "Capacity Evaluation of IEEE 802.16e Mobile WiMax" has calculated that the overhead is such that WiMax can only support 4-7 simultaneous voice sessions per MHz of spectrum with today's scheduler. That number is shown to be improved by up to a factor of 10 in enhancements being proposed in future versions of WiMax. Since the MAC scheduler could, in theory, be improved with current IEEE 802.16e systems, in this analysis we use a voice capacity number closer to what could be theoretically achieved rather than what is being demonstrated in systems today.

2.5 Discussion

xMax is uniquely positioned for low-cost operation in the 902-928 MHz unlicensed band. Its inclusion of rapid detect and avoid technology together with its use of wireless extensions of the SIP and RTP protocols enable it to operate robustly in the presence of the types of interferers inherent to the 902-928 MHz unlicensed band. As will be made evident shortly, the 902-928 MHz band is advantageous to new-entrant operators not only because it is license free but also because RF propagation and building penetration at 900 MHz is significantly better than at 2.5 GHz – for the operator this means significantly less site acquisition and equipment cost (i.e. much lower CapEx).

WiMax is a well-designed wireless system and its multi-carrier OFDM framework gives it an inherent raw data capacity advantage at a basestation level over xMax. WiMax, unfortunately, has two issues that largely blunt this capacity advantage:

1. As pointed out earlier, the baseline WiMax MAC scheduler is not able to meet QoS requirements for voice at high load and as a result uses significantly more effective bandwidth per voice call than does xMax.
2. WiMax is designed for operation in either the 2.5 GHz band, 3.5 GHz band, or the unlicensed 5.8 GHz band. While these bands are "cleaner" from an in-band interferer perspective than the 902-928 MHz unlicensed band used by xMax, the RF propagation and penetration characteristics of these band are significantly worse and, as a result, the new-entrant operator incurs significantly more network rollout costs than is the case with xMax. One could entertain the notion of deploying WiMax in the 902-928 MHz band but it is highly unlikely that a WiMax network will be able to deliver quality voice and data services in this band as they have not been designed with this in band mind and it is not clear how they will perform in interference rich environments. Its even unclear how WiMax will perform

in the unlicensed 5.8 GHz band where wideband interferers, which can be more problematic than narrowband frequency hoppers, are prevalent.

In the following section we develop a detailed operational model for performing ROI comparisons between xMax and WiMax that accounts for WiMax's raw data capacity advantage over xMax, its voice capacity disadvantage, and its coverage area disadvantage.

3 Using An Operational Model To Calculate A Meaningful ROI Metric

In this section we describe an operational model that was developed to calculate a meaningful ROI metric that could be used to compare xMax to WiMax IEEE 802.16e.

3.1 Deployment Markets

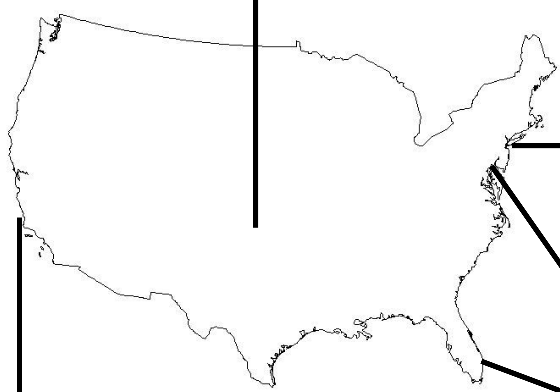
Mobile network buildout ROI metrics are invariably tied to capacity versus coverage tradeoffs which in turn are dependent upon the spatio-geographic nature of the market in which the network is being rolled out. To ensure that an accurate assessment of xMax and WiMax was made, the model includes rollouts in the following markets:

- NY City - Manhattan
- Greater Philadelphia
- Miami-Ft. Lauderdale area
- Los Angeles County
- Kansas

Figure 5 provides coverage area, population, and average population density details for each of these markets.

With respect to population density, it should be noted that population densities are rarely homogeneous within a market – typically, 20-30% of the population resides in dense "central business district" type pockets while the remainder reside outside of these pockets. Figure 6 shows population distribution as a function of population density for the NY Metro, Greater Philadelphia, Miami-Ft Lauderdale, Los Angeles County, and City of Las Vegas markets. It can be seen that in the NY Metro area roughly 42% of the population resides in areas having a population density below 2,000 people/square-km while in the Greater Philadelphia, Miami-FLL, and Las Vegas areas more than 70% of the population resides in areas having a population density below 2,000 people/square-km. The importance of this will be made clear shortly.

Deployment Assumptions	
Description	KANSAS
Type	Rural
Coverage Area (sq. km)	213096
Population	2,802,134
Density (pop/sq.km)	13



Deployment Assumptions	
Description	NYC
Type	Dense Urban
Coverage Area (sq. km)	59
Population	1,634,795
Density (pop/sq.km)	27,489

Deployment Assumptions	
Description	PHIL
Type	Urban
Coverage Area (sq. km)	350
Population	1,540,351
Density (pop/sq.km)	4,406

Deployment Assumptions	
Description	Miami/FLL
Type	Heavy Suburban
Coverage Area (sq. km)	2890
Population	3,955,969
Density (pop/sq.km)	1,369

Deployment Assumptions	
Description	LA
Type	Urban
Coverage Area (sq. km)	12308
Population	9,862,049
Density (pop/sq.km)	801

Figure 5: Deployment Markets Covered By Model

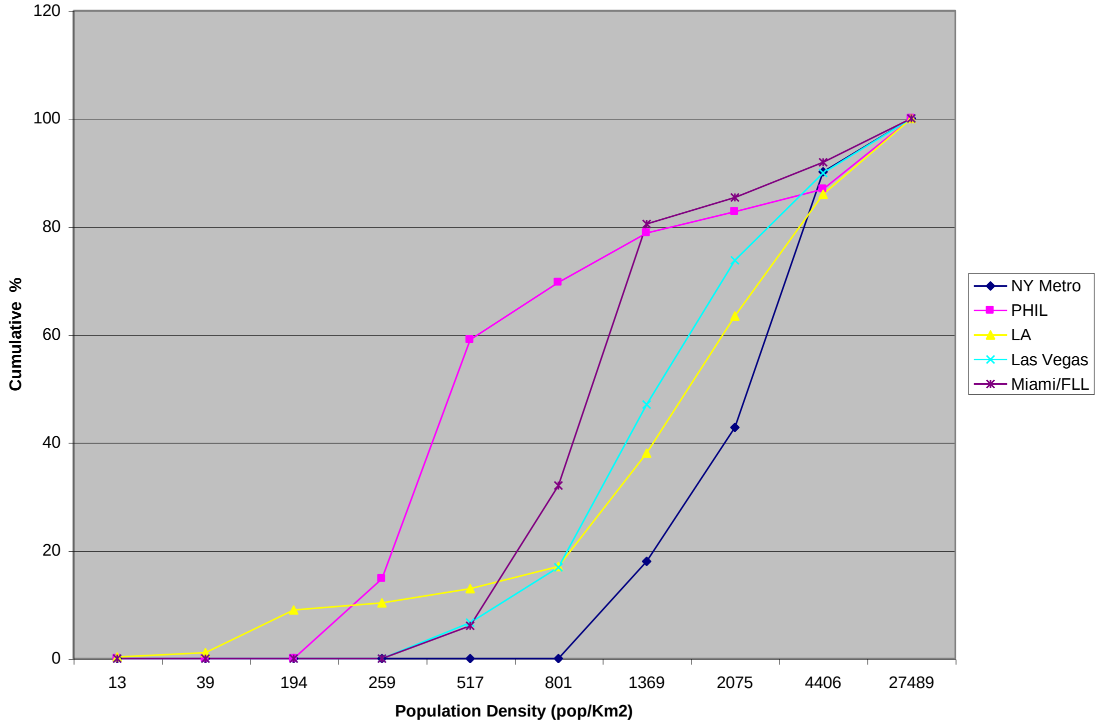


Figure 6: Population Density Distribution For Different Markets

3.2 Assumptions

The key assumptions made in the operational model are enumerated and described below. Except where indicated otherwise, all business assumptions made are assumed to be the same for both WiMax and xMax.

<u>Key WiMax IEEE 802.16e related assumptions:</u>

- Frequency Band – since the markets used in the analysis are all in the United States, we use the 2.5 GHz licensed frequency band. It should be noted that this band provides the best propagation characteristics of the frequency bands typically associated with WiMax deployments.
- Spectrum – we assume 20 MHz of spectrum as this provides a better basestation cost vs. capacity tradeoff relative to 3.5, 5, or 10 MHz.
- Cell Radius – based on the results found in Belloul, et. al., "Measurements and Comparison of WiMax Radio Coverage at 2.5 GHz and 3.5 GHz" we assume a cell radius of 953m to provide roughly 20 Mbps throughput per 20 MHz of spectrum.
- Aggregate Throughput – we assume roughly 20 Mbps throughput per 20 MHz of spectrum.
- Voice Capacity – although current WiMax systems are not close to providing this level of capacity we assume that optimal schedulers will eventually be developed

and deployed in WiMax systems so we assume 33 simultaneous voice sessions per MHz of spectrum.
- Data Service – we assume a 3:1 downlink to uplink ratio, with a 768 Kbps service rate, and a 20:1 contention ratio.
- Voice/Data Market Penetration – market penetration for voice and data services is a variable that can be varied.
- Spectrum License Cost – using results from the November 2009 FCC 2.5 GHz Broadband Radio Service Auction 86 we assume $10K per MHz of spectrum.
- Network OpEx Cost – we assume roughly $1500 per month per basestation for backhaul costs, power, etc. and assume that network operations and maintenance costs to amount to 20% of cumulative network CapEx.
- Other – the model supports inclusion of handset costs, subsidies, etc. which we ignore in this analysis. We do assume that customer churn will be roughly 4% which is slightly higher than industry norm but representative of what a new-entrant service provider is likely to encounter in a mature market. Finally, sales, general and administrative costs are assumed to be 6% of total revenue.

Key xMax related assumptions:
- Frequency Band – we assume that the xMax network will be deployed in the 902-928 MHz unlicensed band.
- Spectrum – from a cost perspective we assume that the entire 26 MHz will be used but that due to co-users of the band only 20 MHz of spectrum will be usable by the xMax system at any given point in time. This is a conservative estimate as empirical evidence and xG experience suggests that much more than 20 MHz of spectrum is usable by the xMax system at any given point in time.
- Cell Radius – xG Technology has deployed a pilot network in the Ft Lauderdale area. Based on this actual network deployment and associated field measurements we assume a cell radius of 2.3 Km.
- Aggregate Throughput – we assume roughly 18 Mbps throughput per 20 MHz of spectrum.
- Voice Capacity – we assume 33 simultaneous voice sessions per MHz of spectrum.
- Data Service – we assume a 3:1 downlink to uplink ratio, with a 768 Kbps service rate, and a 20:1 contention ratio.
- Spectrum License Cost – there is no spectrum cost associated with the 902-928 MHz unlicensed band.
- Voice/Data Market Penetration – market penetration for voice and data services is a variable that can be varied.
- Network OpEx Cost – similar to what was assumed for the WiMax network, we assume roughly $1500 per month per basestation for backhaul costs, power, etc. and assume that network operations and maintenance costs to amount to 20% of cumulative network capex.
- Other – the model supports inclusion of handset costs, subsidies, etc. which we ignore in this analysis. We do assume that customer churn will be roughly 4% which is slightly higher than industry norm but representative of what a new-entrant service provider is likely to encounter in a mature market. Finally, general and administrative costs are assumed to be 6% of total revenue.

The following shows information taken directly from the model.

Technology/Service Assumptions		
	IEEE 802.16e	**xMax**
Technology Assumptions	-	-
Frequency Band	2.5 GHz	902-928 MHz
Spectrum Used (MHz)	20	20
BTS Coverage Radius (Km)	0.953	2.3
Frequency Reuse	1x3x3	1x3x3
Duplexing Scheme	TDD	TDD
Service Assumptions (Voice)		
Target Penetration (% of Pops)	9	9
-		
Allocation To Voice Traffic (%)	7	7
Aggregate Voice Throughput Per BTS (Mbps)	1	1
***Effective* Bandwidth Per Voice Channel (Mbps)**	0.03	0.030
Number of Simultaneous VoIP Users Per BTS	47	37
***Equivalent* Erlangs @ 2% Blocking Probability**	37.5	28.3
Avg. Busy Hour Erlangs Per Subscriber	0.03	0.03
Voice Subscribers Per BTS	1249	942
% of Voice Subscribers on Unlimited Plan	50	50
Unlimited Voice Plan Pricing ($/month)	40	40
% of Voice Subscribers on Per Minute Plan	50	50
Cost Per Minute (Per Minute Plan) ($)	0.10	0.10
Voice ARPU ($/month/voice subscriber/BTS)	30.00	30.00
Service Assumptions (Broadband Data)		
Target Penetration (% of Pops)	3	3
-		
Allocation To Broadband Data (%)	93	93
Aggregate Data Throughput Per BTS (Mbps)	20	16
DL:UL Ratio (X:1)	3	3
Aggregate DL Data Throughput Per BTS (Mbps)	15	12
Target DL Service Rate (Mbps)	0.768	0.768
Contention Ratio (X:1)	20	20
Data Service Subscribers Per BTS	389	308
Busy Hours Per Day	10	10
$/MB	0.05	0.05
Data ARPU ($/month/data subscriber/BTS)	32	32
Misc.		
Weighted Average ARPU ($/month/subscriber/BTS)	31	31

Network CapEx/OpEx Assumptions		
	IEEE 802.16e	xMax
Network CapEx		
Spectrum Cost ($K/MHz)	10.0	0
BTS Cost ($K)	35	75
Network Infrastructure Equipment Cost ($K)	400	500
Site Acquisition/Installation Cost ($K)	50	50
Depreciation Period (Years)	5	5
Network OpEx		
-		
BTS Facilities ($K/BTS)	1.5	1.5
Network Operations/Maintenance (% of CapEx)	20	20

Subscriber Acquisition/Retention Assumptions		
	IEEE 802.16e	xMax
Voice/Data Handset Retail Price ($)	0	0
Voice/Data Handset Cost ($)	0	0
Voice/Data Handset Operator Subsidy (%)	0	0
Broadband USB Modem Retail Price ($)	0	0
Broadband USB Model Cost ($)	0	0
Broadband USB Modem Operator Subsidy (%)	0	0
Account Activation Fees ($)	0	0
Sales, Marketing, Tech Support (% of Gross Revenue)	20	20
Monthly Churn (%)	4	4

3.3 Operational Model and ROI Metric

As indicated earlier, in this analysis we have adopted "Total Lifetime Customer Net Value ($) Per CapEx ($)" as the ROI metric used to compare xMax with IEEE 802.16e WiMax. We calculate total lifetime customer net value as the weighted average (across the five year period being considered in this model) customer profit per month multiplied by the expected number of months the customer will be a subscriber (easily shown to be 25 months for a 4% monthly churn rate) less the cost of acquiring the customer (aka CPGA).

A snapshot of the operational model for both WiMax IEEE 802.16e and xMax is shown below for the Miami/Ft Lauderdale market with 12% overall market penetration (75% voice and 25% broadband data). The resulting "Total Lifetime Customer Net Value ($) Per CapEx ($)" metric is shown to be 1.56 for WiMax and 4.48 for xMax indicating that for every dollar of CapEx xMax returns roughly $3 more in profit to the operator than does WiMax.

The following section presents the results across different markets and different voice/data service mixtures.

WiMax IEEE 802.16e					
	Year 1	Year 2	Year 3	Year 4	Year 5
Number of Subscribers (start of period)	-	214,015	345,144	425,489	474,716
Gross Additions	214,015	214,015	214,015	214,015	214,015
Disconnected Subscribers	-	82,886	133,671	164,788	183,853
Net Additions	214,015	131,129	80,344	49,228	30,162
Average Number of Subscribers	107,008	279,580	385,317	450,102	489,797
Network CapEx					
Spectrum Cost ($K)	199				
Number of BTS	1,014	1,014	1,014	1,014	1,014
BTS CapEx ($K)	35,490	0	0	0	0
Network Infrastructure CapEx ($K)	400				
Site Acquisition Costs ($K)	50,700	-	-	-	-
Total Network CapEx ($K)	86,789	-	-	-	-
Cumulative Network CapEx ($K)	86,789	86,789	86,789	86,789	86,789
Revenues					
Service Revenue ($)	39,293,199	102,661,724	141,488,238	165,277,622	179,853,609
Equipment/Activation Revenue ($)	-	-	-	-	-
Total Revenues ($)	39,293,199	102,661,724	141,488,238	165,277,622	179,853,609
Operating Expenses					
Cost of Service ($)	35,609,842	35,609,842	35,609,842	35,609,842	35,609,842
G&A ($)	2,357,592	6,159,703	8,489,294	9,916,657	10,791,217
Sales, Marketing, Technical Support ($)	25,681,829	25,681,829	25,681,829	25,681,829	25,681,829
Customer Equipment ($)	-	-	-	-	-
Depreciation	17,357,842	17,357,842	17,357,842	17,357,842	17,357,842
Total Operating Expenses	81,007,105	84,809,217	87,138,808	88,566,171	89,440,730
Income From Operations	(41,713,907)	17,852,507	54,349,430	76,711,451	90,412,879
Performance Measures					
Unused Voice Capacity (%)	0.94	0.83	0.77	0.73	0.71
Unused Data Capacity (%)	0.93	0.82	0.76	0.71	0.69
Monthly Churn (%)	4	4	4	4	4
ARPU ($/month)	31	31	31	31	31
CPU ($/month)	43	18	13	12	11
Profit Per Customer ($/month)	(12)	13	17	19	20
Cost Per Gross Add (CPGA) ($)	120	120	120	120	120
Customer Lifetime Net Value (CNLV) ($)	277				
Total CLNV $ / CapEx $	1.56				

xG xMax					
	Year 1	Year 2	Year 3	Year 4	Year 5
Number of Subscribers (start of period)	-	214,015	345,144	425,489	474,716
Gross Additions	214,015	214,015	214,015	214,015	214,015
Disconnected Subscribers	-	82,886	133,671	164,788	183,853
Net Additions	214,015	131,129	80,344	49,228	30,162
Average Number of Subscribers	107,008	279,580	385,317	450,102	489,797
Network CapEx					
Spectrum Cost ($K)					
Number of BTS	174	227	313	366	398
BTS CapEx ($K)	13,050	3975	6450	3975	2400
Network Infrastructure CapEx ($K)	500				
Site Acquisition Costs ($K)	8,700	2,650	4,300	2,650	1,600
Total Network CapEx ($K)	22,250	6,625	10,750	6,625	4,000
Cumulative Network CapEx ($K)	22,250	28,875	39,625	46,250	50,250
Revenues					
Service Revenue ($)	39,293,199	102,661,724	141,488,238	165,277,622	179,853,609
Equipment/Activation Revenue ($)	-	-	-	-	-
Total Revenues ($)	39,293,199	102,661,724	141,488,238	165,277,622	179,853,609
Operating Expenses					
Cost of Service ($)	7,582,000	9,861,000	13,559,000	15,838,000	17,214,000
G&A ($)	2,357,592	6,159,703	8,489,294	9,916,657	10,791,217
Sales, Marketing, Technical Support ($)	25,681,829	25,681,829	25,681,829	25,681,829	25,681,829
Customer Equipment ($)	-	-	-	-	-
Depreciation	10,050,000	10,050,000	10,050,000	10,050,000	10,050,000
Total Operating Expenses	45,671,421	51,752,533	57,780,124	61,486,487	63,737,046
Income From Operations	(6,378,222)	50,909,191	83,708,114	103,791,135	116,116,563
Performance Measures					
Unused Voice Capacity (%)	0.51	0.02	0.02	0.02	0.02
Unused Data Capacity (%)	0.50	0.00	0.00	0.00	0.00
Monthly Churn (%)	4	4	4	4	4
ARPU ($/month)	31	31	31	31	31
CPU ($/month)	16	8	7	7	6
Profit Per Customer ($/month)	15	23	24	24	24
Cost Per Gross Add (CPGA) ($)	120	120	120	120	120
Customer Lifetime Net Value (CNLV) ($)	460				
Total CLNV $ / CapEx $	4.48				

4 Discussion - The Business Case for xMax

Figures 7-9 plot the "Total Lifetime Customer Net Value ($) Per CapEx ($)" ROI metric as a function of population density for 12% overall market penetration and three different voice/data revenue mixtures.

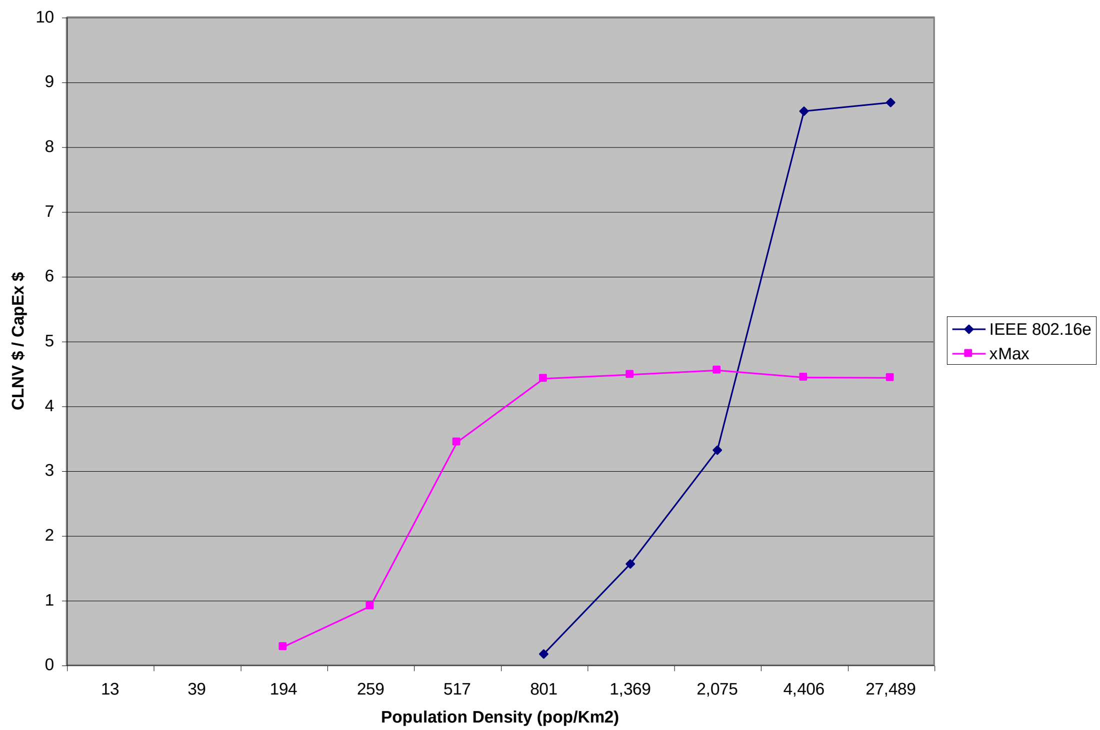


Figure 7: ROI Metric (75% Voice, 25% Data)

As can be seen from these plots, WiMax IEEE 802.16e provides the new entrant operator a better ROI only in the most densely populated areas, roughly 3000 people per square kilometer or more. The reason for this is that because of 2.5 GHz RF propagation characteristics, WiMax networks are range limited for population densities below 3000 people per square kilometre and have more capacity than needed – capacity that the service provider needs to pay for regardless of whether its used or not. In the case of the Miami/FLL market rollout, approximately 1000 basestations are needed to cover the 2890 square kilometres but this results in 75% more capacity than what is needed to support 12% market penetration. Decreasing the capacity of the basestation is an option but this has little effect on the ROI metric as the cost associated with a channel card is small compared against site acquisition and the rest of the basestation. In other words the cost of putting steel in the ground is the largest component of CapEx.

xMax on the other hand requires only 174 basestations to cover the 2890 square kilometres with additional basestations added to the network as traffic demands increase. This match of capacity to market requirements yields a much better ROI to the service provider.

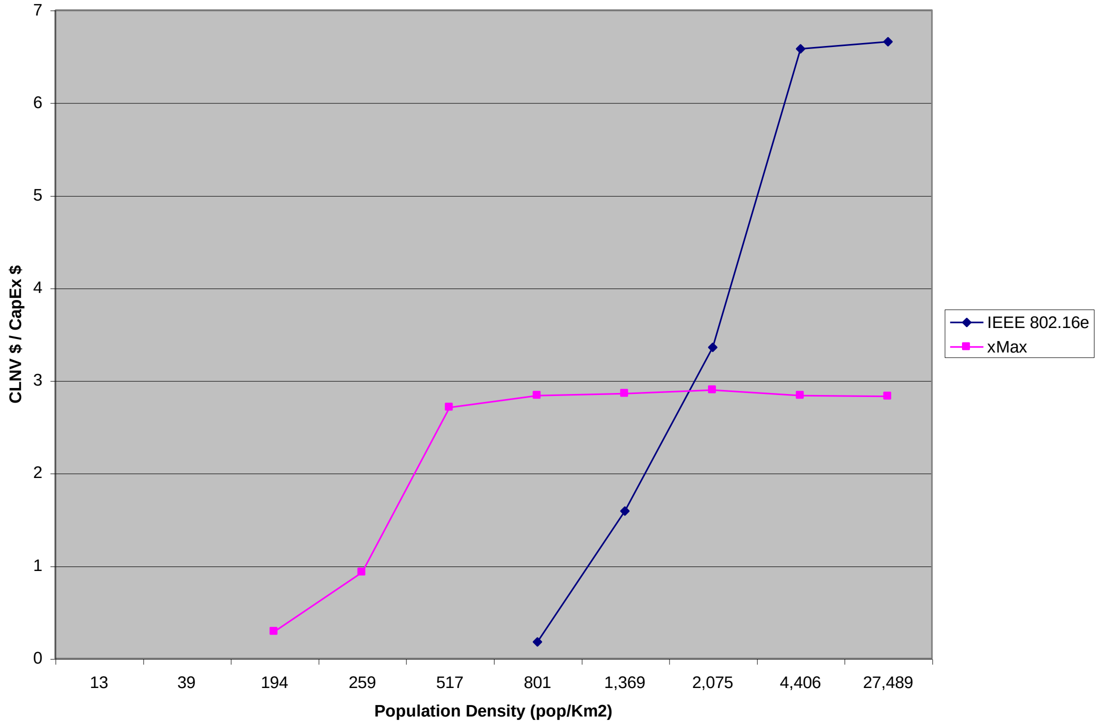


Figure 8: ROI Metric (65% Voice, 35% Data)

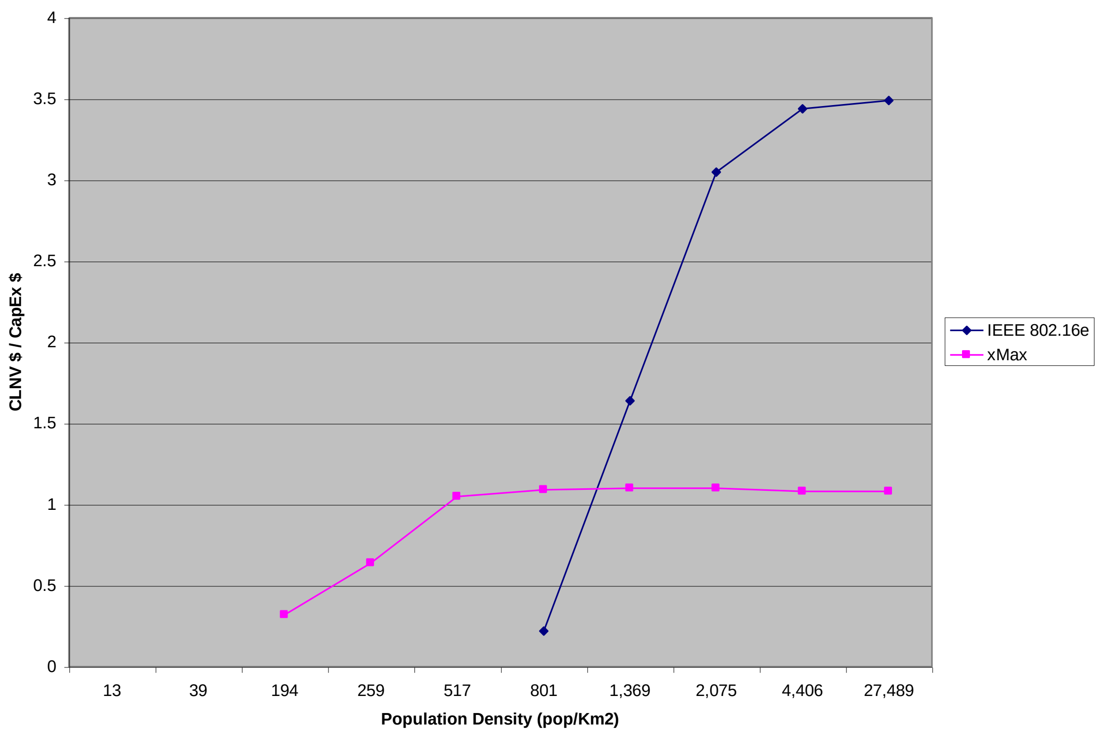


Figure 9: ROI Metric (50% Voice, 50% Data)

Figure 10 plots the average of the five population density distributions shown in Figure 6 and highlights the area where WiMax IEEE 802.16e is more profitable and where xMax is more profitable. It is clear that for a generic metro area, xMax is more profitable for 70% of the population.

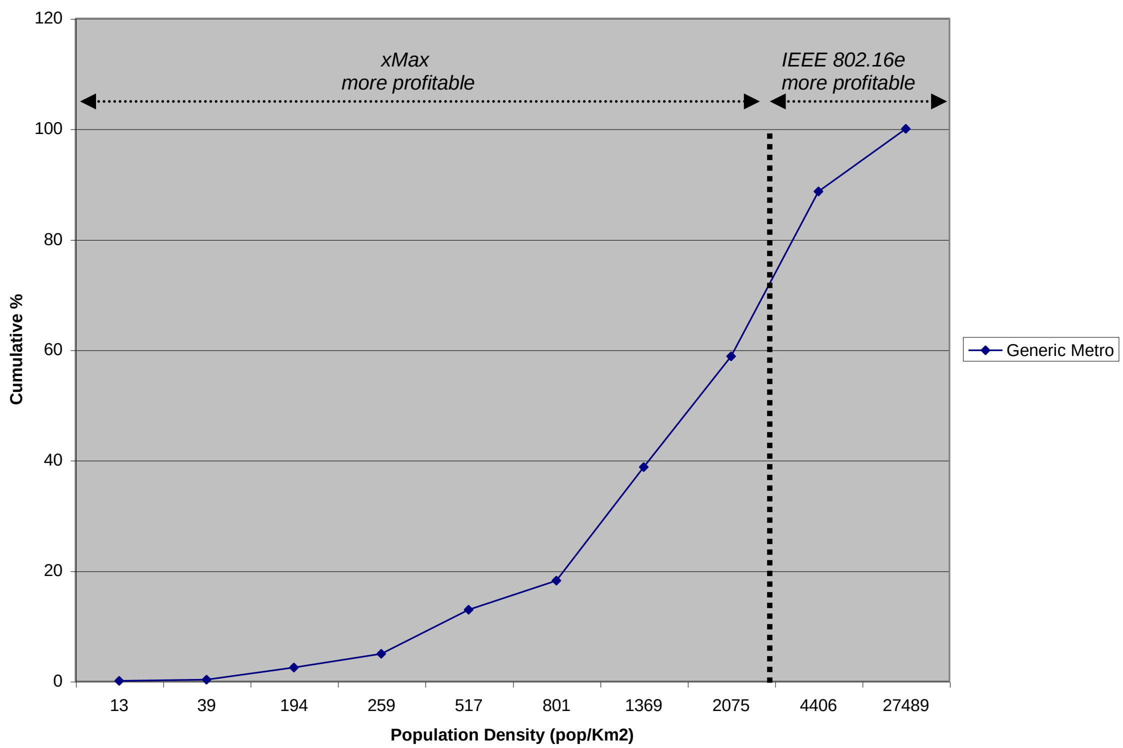


Figure 10: xMax vs. WiMax For Generic Metro Area (75% Voice, 25% Data)

To provide another perspective on the advantage of xMax, Figure 11 shows five target markets and shades in red the areas where WiMax IEEE 802.16e is more profitable than xMax. As can be seen, with the exception of the NY Metro area, in all of the other markets the regions where WiMax is more profitable than xMax is extremely low.

We note here that the ROI analysis made very generous assumptions regarding the capabilities of IEEE 802.16e from a capacity and coverage perspective so it is quite likely that WiMax may not even provide advantages over xMax in these limited areas.

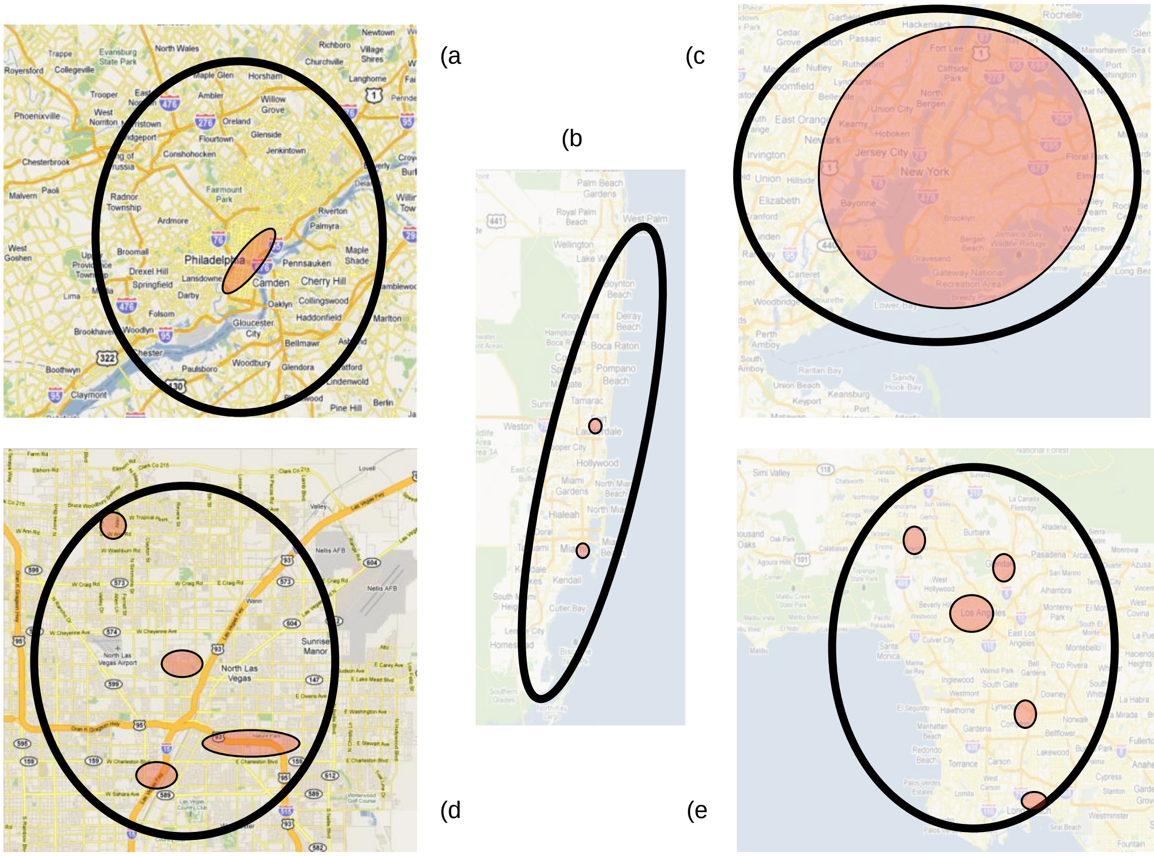


Figure 11: Areas (Shaded Red) Where WiMax is More Profitable Than xMax (a) Greater Philadelphia, (b) Miami/FLL, (c) NY Metro, (d) Las Vegas, (e) LA County

5 Summary

In this white paper we compare xMax with IEEE 802.16e (aka “WiMax”) to determine which of the two technologies, xMax or WiMax, provides a better return on investment (ROI) for new entrant service providers. Using a detailed mobile service operational model, also described in this white paper, we calculate “Total Lifetime Customer Net Value ($) Per CapEx ($)” metrics for different voice/data revenue mixtures and different market types (e.g. urban, heavy suburban, etc.) and draw the following conclusions:

1. New entrant service providers who anticipate higher revenue from voice services than broadband data services in the near-term are much better served from an ROI perspective with xMax than they are with WiMax.
2. Scalable 902-928 MHz xMax mobile wireless networks are profitable across a much wider range of population densities than are 2.5 GHz WiMax mobile wireless networks. In fact, only in the densest of environments, which in most metropolitan areas typically contain less than 20% of the population, is a WiMax network more profitable than an xMax network for a wide range of voice/data service mixtures.

3. The ROI advantage of xMax stems partially from the use of unlicensed spectrum and partially from its explicit support for voice services but mostly from the fact its well-designed 902-928 MHz RAN architecture better matches the voice/data capacity per coverage area requirements that the targeted service provider is likely to encounter as a new entrant in mature markets.
4. For new-entrant operators, mobile voice services result in a profitable revenue base that provides the financial stability and cash-flow needed to support the increasing demand for broadband data.