

The TCO Advantages of a WLAN & WWAN Combination

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Abstract:

Over the last several years there has been a continuous growth in the number of mobile workers in the US and abroad. A variety of enterprise applications including email, customer relationship management (CRM), enterprise resource planning (ERP), and others are being deployed among mobile workers by businesses large and small to maximize competitiveness, increase customer responsiveness, reduce costs, and increase personal flexibility. Increasingly these applications, and their associated business processes, are dependent on the Internet, driving the demand for wireless Internet access to a frenzied level among mobile workers. Wireless Internet access via Wireless LAN (WLAN or Wi-Fi) hot spots has reached the mainstream market, largely in part to highly visible global campaigns by Intel and a multitude of public establishments embracing the technology. After a period of missed expectations, a choice of wide area cellular networks (WWAN) has recently reached center stage and now presents itself as a viable option for commercial wireless Internet access, while looming in the future is the promise of metropolitan wireless networking in the form of WiMax. In developing the most effective wireless Internet deployment strategy among a given mobile workforce, IntelliClear offers this white paper to: present the case for wireless Internet access; review the various wireless technologies to be considered; evaluate a total cost of ownership (TCO) analysis for WLAN and/or WWAN; outline the current strategies of the industry's top PC OEMs for wireless Internet access; and present a key set of considerations to those thinking about a wireless Internet deployment. IntelliClear was commissioned by Sony Electronics Inc. to develop and publish this whitepaper. This whitepaper represents the views and opinions of IntelliClear without influence or bias to the views and opinions of any vendor or client.

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The Proliferation of Wireless Internet Access

Growing mobile professional population

In the competitive global market place of today there is one dynamic that continues to grow and impact the way business is conducted on an evolutionary basis, in a revolutionary way: the growth of the mobile worker population. IDC projects that from 2002 the US mobile worker population will grow by a staggering 14.1% to an estimated 104.5 million mobile workers in 2006.¹ Market research firm In-Stat places the current number of remote and mobile workers at 95.8 million with nearly 50% of those workers coming from companies smaller than 1,000 employees.² The Yankee group estimates that the mobile worker population is split between field sales personnel (34%), field service (28%), and mobile executives and others accounting for the remaining 38%.³ Such figures suggest the mobile worker phenomena is not just reserved to executives of large enterprises, but rather a broad mix of commercial businesses and job titles from the field worker to the corner office titan. It is easy to envision this trend continuing without discrimination across vertical industries, job disciplines, business sizes, and demographics.

The driving forces of the growth of mobile and remote workers revolve around four distinct business objectives:

- 1) **Maximizing Competitiveness:** Companies are increasingly sending its employees on the road to conduct business at the point of execution. 40% of US workers traveled for business in 2004, which is expected to rise by another two-thirds by 2006.⁴
- 2) **Increasing Customer Responsiveness:** Nearly 50% of experienced email users today feel that ASAP or within one day is the proper email response time.⁵
- 3) **Reducing Costs:** Taking employees out of the office and allowing them to work from home and other remote sites can facilitate lower overhead for buildings and a decrease in the cost of services to keep them running. Nortel Networks reportedly

saves \$40 million annually in real estate costs, while reporting consistently higher employee satisfaction and company loyalty through the use of home workers.⁶

4) **Improving Personal Flexibility:** Allowing employees, and in the case of smaller businesses the owners themselves, to leave the office to attend personal activities, while still allowing the flexibility to respond to urgent or important matters, has produced a new level of worker flexibility. 56.7% of US employees spend 90 minutes or more a day on email, with 10% spending more than 4 hours per day on email.⁷ Responding to email doesn't require an employee to be in the office and is increasingly being executed remotely on mobile devices.

Internet Access is the Key to Productivity

Businesses have methodically built processes and operations around the Internet in order to capture greater efficiencies leading to the achievement of the aforementioned four objectives that are driving the growth of mobile workers. In order to accomplish such an achievement remote workers must have access to company information assets. 33% of US Senior Executives said that incomplete access to all network applications was a primary obstacle to implementing a solid remote worker program.⁸ The importance of away-from-the-office Internet access cannot be over-estimated and typically divides itself into those who require constant broadband access in an office setting, and those that require constant broadband access in a mobile setting.

Employees using a fixed broadband connection at home to telecommute once a week reported an average 33% increase in productivity. When one adds this to the potential real estate savings that employers can realize by reallocating office space, the benefits of having a telecommuting policy translate to an estimated average cost savings to the enterprise of \$5,000 per tele-worker.⁹ The days of giving the mobile worker a laptop PC, cell phone, and company credit card to execute business effectively on the road are over. Access to the Internet has become the primary requirement of the mobile

¹ International Data Corporation (IDC) - *US Mobile Worker Population Forecast and Analysis, 2002-2006*

² In-Stat/MDR, May 2004

³ Yankee Group, 2004

⁴ International Data Corporation (IDC), date and publication unknown

⁵ USC Annenberg School Center for the Digital Future

⁶ Nortel Networks Case Study: Nortel Networks Home Workers

⁷ American Management Association (AMA), July 2004

⁸ AT&T, Economist Intelligence Unit, November 2004

⁹ 2003 Telework America Survey

worker. More specifically, access to the Internet throughout the day and not just after the late night check-in to the broadband equipped hotel. In his book *Business @ the Speed of Thought* Bill Gates explains "...like a living organism, an organization functions best if it can rely on a nervous system that will instantaneously deliver information to the parts that need it." As such, access to the Internet anytime, anywhere, has gone from being a vision to being a necessity.

Wireless Internet Access is the Key to Mobile Worker Success

In a study conducted by Ipsos Reid in 2004 with *Blackberry* users, it was found that the average mobile worker spent 39% of their time away from the office and could convert as much as 196 hours of downtime per year into productive time using a mobile computing device (in this case a *Blackberry* handheld device). The same study found that the average number of emails per day per mobile worker was 48, with 39% being time sensitive.¹⁰ Such statistics suggest that enabling mobile workers with wireless internet access, and in particular wireless email, could have a profound impact on productivity and customer responsiveness, not to mention employee satisfaction and retention. 29% of small businesses said that wireless Internet access help them compete with larger businesses, signaling additional perceived business benefits of wireless Internet access.¹¹

According to Gartner only 8% of US workers are enabled for mobile email today, a number that is expected to rise to 21% by 2007.¹² In 2005 one-quarter of businesses across the globe expect to make wireless/mobile computing a top IT spending priority.¹³ There is significant emphasis being placed on wireless Internet access, with the dividends likely to make a major impact on company bottom lines by providing access to email and applications to mobile workers.

Wireless Internet Access Technologies

The word "wireless" has become ubiquitous among users and practitioners of information technology (IT). However, the word wireless can be ambiguous because as it relates

only to the movement of data. Wireless comes in several different forms and can be broken into four main categories: Wireless Personal Area Networks (WPAN), Wireless Local Area Networks (WLAN or Wi-Fi), Wireless Metropolitan Area Networks (WMAN or WiMax), and Wireless Wide Area Networks (WWAN).

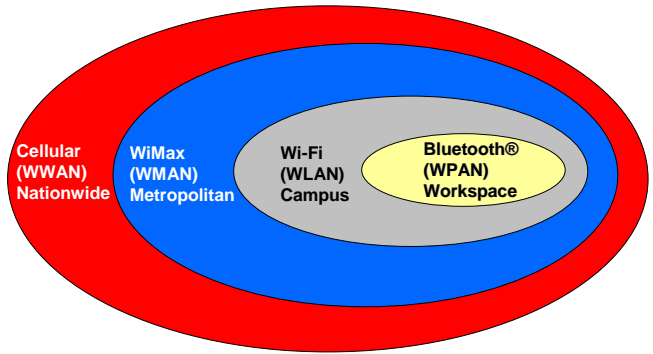


Figure 1: Wireless Technologies and Ranges

Each wireless method can be easily distinguished by its distance of operation (reach) and data transfer rate. As will be discussed in subsequent sections of this white paper, there are multiple versions of WWAN, WLAN, and WMAN according to various specifications and technology protocols. Gartner predicts that half of all enterprises with more than 1,000 employees will use at least five wireless network technologies by 2007.¹⁴

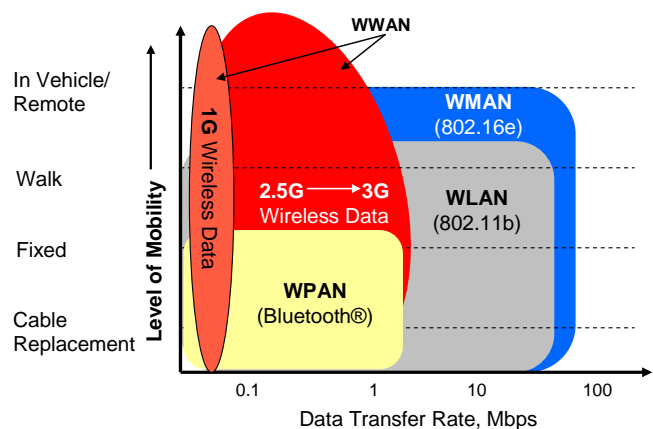


Figure 2: Mobility vs. Wireless Network Technologies¹⁵

¹⁰ Ipsos Reid Blackberry ROI Study, 2004

¹¹ Harris Interactive for HP, April 2005

¹² Gartner Group (date unknown)

¹³ KnowledgeStorm, January 2005

¹⁴ Intermec Whitepaper 2004, *Defining a Successful Wireless Solution*

¹⁵ Intermec 2003 – *Taking it to the Streets: A Guide to Wide Area Wireless for the Non-Technical Business Professional*, modified by IntelliClear to add WMAN.

The Applications Driving Wireless Internet Access

Gartner estimates that the number of mobile workers using a mobile device, and the number of applications provisioned per mobile worker, increased significantly in 2004 and that the average enterprise had 80% more mobile applications in the field by the end of 2004.¹⁶ A large portion of those applications rely on, or are made far more effective with, wireless Internet access. Fundamental uses of remote or wireless access functionality are becoming ever-present and essential, even as next-generation mobile applications become more fully incorporated into company workflow and are more closely coupled to critical company resources. Usage patterns include Internet access, email, corporate intranet connectivity, availability of personal information, and access to personal computer resources.

Key Mobile Applications

The mobile applications driving wireless Internet access include both horizontal and vertical selections and are in most cases device independent. Those applications include, but are not limited to the following:

Sales and Marketing Related Apps:

- Sales Force Automation (SFA)
- Customer Relationship Management (CRM)

Manufacturing & Transportation Related Apps:

- Dispatch (i.e. track and trace)
- Field service (i.e. work order management)
- Inspection and regulatory compliance
- Warehouse (i.e. pick and pack operations)

Consumer Services Related Apps:

- Hospitality (i.e. event processing, check-in, etc.)
- Retail (i.e. POS and roaming sales execution)
- Healthcare (i.e. point of care)

Enterprise Operations Related Apps:

- Corporate intranet (campus roaming)
- Insurance claim processing
- Defense (i.e. personnel and equipment processing)

Following email, CRM and SFA are seen as “beachheads” to be deployed within the enterprise according to IDC.¹⁷ Another application that is emerging for wireless Internet is voice over IP (VoIP), which has been deployed by 23% of US corporations, with 30% planning to deploy in 2005.¹⁸ VoIP in a mobile environment is part of an on-going evolution of convergence that is bringing about the reality of unified messaging, an ideal scenario for the mobile worker. Unified messaging seeks to drive integrated access and simplicity to telephone calls, voice messages across multiple phone numbers, email, fax, CRM messages, and instant messaging. Such capabilities will drive new levels of productivity and motivation to provide anytime, anywhere wireless Internet access.

Many of the mobile applications being deployed incorporate application service provider (ASP), or Services Oriented Architecture (SOA) models. Both ASP and SOA are able to distribute software-based services and solutions to customers across a wide area network from a central data center. Examples of an ASP model would be currently red hot Salesforce.com and its CRM solution. An SOA can achieve the same result through loose coupling among interacting software agents in a mobile environment. Additional architectural considerations should be given to the applicable regulations within the given industry (Sarbanes Oxley, HIPPA, etc), as well as efficiency and bandwidth required for the applications to function properly in a wireless environment.

Handhelds vs. laptops vs. Tablets

Gartner projects in 2006 that 64.4 million mobile computing devices will be shipped worldwide, representing growth of 60% from 2003.¹⁹ These units include handheld and laptop computing devices. For many organizations the question will be what type of device will work best for their mobile application needs? The answer to the question comes in a series of questions such as the required battery life, acceptable weight, optimal screen size to accommodate the application, and the mix between information access and document creation.

¹⁷ International Data Corporation (IDC), date and publication unknown

¹⁸ In-Stat/MDR, February 2005

¹⁹ Gartner Dataquest, June 2004

¹⁶ Gartner Group 2003

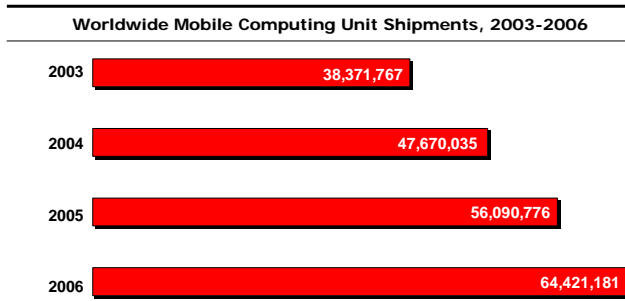


Figure 3: Worldwide Mobile Computing Device Shipments²⁰

In a variety of instances a handheld may do the trick; however, increasingly consideration is being given to the integration of mobile devices into the mobile worker's full spectrum of work activities. Where a handheld device (smartphone, PDA, etc.) may be more of an augmentation to the workers routine, full fledged mobile computing devices (laptops and tablets) can act as both a desktop replacement and a mobile computing device. Other advantages of laptops include larger screens to allow workers to navigate enterprise applications, a more robust development environment, additional layers of security, reduced need for training, and the ability to use the device to access information and/or create presentations, documents, and other typical deliverables. The laptop PC continues to be the staple mobile device of choice for most mobile workers, especially in light of continued technology advances that are delivering more powerful and versatile mobile PCs that are lighter and easier to carry. Intel® Centrino™ is the most prevalent example of such technology that continues to deliver incremental value to the laptop PC.

Bluetooth® Technology – The Convenience Enabler

The first entry in the wireless arena is WPAN, commonly referred to as Bluetooth. When considering wireless Internet access, Bluetooth is not generally a consideration as most devices will accomplish Internet access via a network connection. Bluetooth is usually a key consideration for connecting one hardware device to another. There are Internet Access Points (such as

PicoBlue) that provide a means for a Bluetooth computing device to wirelessly connect to IP networks over Ethernet via Point-to-Point Protocol (PPP); however, this paper will not consider Bluetooth as a key wireless Internet access method for mobile workers.

Bluetooth primarily provides a low-power, short-range frequency-hopping radio link between devices. Operating in the unlicensed industrial, scientific, and medical (ISM) band at 2.4 GHz, the vision of a WPAN is that a user with Bluetooth could wirelessly connect to Bluetooth-enabled devices such as a personal digital assistant (PDA), a portable printer, digital camera, headphones, keyboard, or other devices on a network. The focus of a WPAN is centered on an individual's workspace (in their office), or existence space (in their car, kitchen, etc.).



Figure 4: WPAN Personal Area Network Device Possibilities

The Economist Intelligence Unit reported in January of 2004 that one in four global businesses that had deployed mobile computing solutions had also deployed some form of Bluetooth.²¹ Security concerns by IT professionals, lack of compelling and affordable peripheral devices and application incompatibilities (not taking advantage of Bluetooth technology), have inhibited the widespread growth of Bluetooth (and consequently WPAN) in the mainstream *commercial* market. For those professionals who use Bluetooth everyday, the technology provides outstanding reliability and convenience in a close-range wireless environment.

²⁰ Gartner Dataquest, June 2004

²¹ Economist Intelligence Unit, January 2004; n=309 executives worldwide

Wireless LAN (Wi-Fi) – The Mainstream Enabler

The Meteoric Rise of Wi-Fi

When it comes to wireless internet access the most common implementation is that of wireless local area networks (WLAN) – as known as Wi-Fi. Launched in 1997 through the unlicensed spectrum of up to 5.8GHz via the IEEE 802.11 specification (mainly b and g), WLAN implementations have exploded over the last 24 months. Although consumers are leading the way in adoption and implementation of Wi-Fi, businesses large and small are increasingly jumping into the Wi-Fi arena.

The Wi-Fi explosion has been facilitated in large part by the introduction of Intel® Centrino™ mobile technology in January of 2003, which was accompanied by one of the largest advertising campaigns in the history of the high technology industry. Dana Houghton, a senior marketing manager at Intel, put the total Centrino™ campaign cost at close to \$300 million according to *Technology Marketing Magazine* in September of 2003.²² Intel plastered the Centrino™ blue and maroon butterfly-like logo on billboards, hotel lobbies, airports, store windows, buses, magazines, and newspapers for months following its introduction. The campaign by Intel had the effect of moving wireless data into the mainstream of technology consideration, while helping propel the multi-billion-dollar industry of wireless data. In the US, Wireless home networking (WHN) recently achieved a staggering awareness level of 72%, according to Ipsos-Insight.²³

Wi-Fi and Mobile Internet Access

For Wi-Fi to be useful to the mobile worker it has to be available outside of an office building. A campus to campus short-range solution (across the street or a few blocks) for mobile workers may include some form of wireless bridging. Companies such as Adtran, Canon, LightPointe, Orthogon make products based upon RF, microwave (a close RF relative), and optical technologies that provide reasonably “easy to configure” wireless bridging solutions that are secure and are able to effectively deal with the physical elements.

For Wi-Fi access on the road mobile workers will require one or more hotspots. A hotspot is a public location (airport, hotel, coffee shop, eating establishment, etc.) where Wi-Fi access is available, generally with a paid subscription or daily fee. Gartner estimates there are 30 million global hotspot users²⁴, across an estimated 132,000 hotspot locations worldwide.²⁵ The number of hotspots in North America was estimated to be 22,700 in 2004, growing to 95,500 by 2009.²⁶ Hotspots in larger public locations or chains are often managed by large providers such as Boingo (6,400 hotspots in the US), T-Mobile (5,500 in the US), and Cingular Wireless (over 3,000 in the US).

Number of Wi-Fi Hotspots Worldwide by Region, 2004 and 2009 (in thousands)

	2004	2009
Asia-Pacific	29.4	71.0
North America	22.7	95.5
Western Europe	26.0	114.0
Other	5.9	27.7
Total	84.4	308.0

Figure 5: Worldwide Hotspot Forecast²⁷

Fees generally range from \$9.95 per day for ad-hoc use, to \$29.99 per month as a subscription. Free Wi-Fi hotspots are becoming fewer in number as establishments move to services that charge a nominal fee and provide revenue sharing opportunities. Wi-Fi hotspot finders, which can easily fit onto a key chain, can make it easier for mobile workers to find available hotspots and generally cost around \$30. Despite what appears to be a large number of hotspots across the globe, the gaps between hotspots can often be sizeable and create a formidable limitation for mobile workers relying on Wi-Fi for wireless Internet access.

²² Technology Marketing Magazine in September of 2003

²³ Ipsos-Insight in February of 2004

²⁴ Gartner Dataquest, February 2004

²⁵ Gartner Dataquest, January 2004

²⁶ Pyramid Research, March 2005

²⁷ Pyramid Research, March 2005

Security Considerations for Wi-Fi

As an unlicensed frequency, public Wi-Fi offers little security and can potentially attract hackers who can take advantage of the unprepared and naïve user. Hotspots can be susceptible to unintentional associations with surrounding networks and corresponding associations with wireless hackers. The final section of this whitepaper provides a number of simple suggestions that organizations can do to prepare their mobile workers to minimize security risks at public Wi-Fi locations.

From a technology standpoint, security can be increased by using shared key authentication and wired equivalency protocol (WEP – the original security mechanism for 802.11 WLANs). There are potential issues with both that will not be explored as a part of this whitepaper. With respect to hotspots, the use of the 802.1x security standard is enabling IT managers and business professionals to use selected hotspots as a more secure virtual extension of their corporate networks and offices. 802.1x provides an authentication and encryption framework used in the advanced Wi-Fi security specifications 802.11i and WPA (Wi-Fi Protected Access), which were developed to address vulnerabilities identified in WEP.²⁸

WiMax – The Questionable Enabler

The simplicity and growth of Wi-Fi has been impressive — even astonishing — by any measurement. Wi-Fi has helped create demand for “wireless networking anywhere.” Hotspots are ideal for mobile Internet access, but the dead spaces between the home, office, and the next hotspot are often too large for the most serious of mobile workers. This is commonly known as the “broadband gap,” or the “digital divide.” A technology solution for the digital divide - one that has the support of such industry leaders as Intel - is Wireless Metropolitan Area Networking (WMAN - also known as WiMax). There are differing opinions on the viability and availability of WiMax in the near future. The lack of infrastructure, products, and competing technologies make for a long road to realizing the vision of WiMax. One thing that all analysts agree on is the fact that WiMax will not help the

average mobile worker for another two to three years and therefore is considered a questionable enabler at this point. Nonetheless, a brief education on WiMax will be valuable so when WiMax stories come about the reader is ready to understand its place in the wireless Internet access spectrum.

Based upon the IEEE 802.16 and ETSI HiperMAN wireless MAN specifications, WiMax will work with WLAN by connecting 802.11 hotspots to the Internet, and creating opportunities for continuous wireless connectivity and “last-mile” broadband connectivity to businesses and homes worldwide. As a licensed spectrum (meaning service providers will have to pay the Federal Communications Commission for bandwidth), WiMAX provides metropolitan area network connectivity at speeds of up to 75 Mb per second, transmitting signals as far as 30 miles. However, a firm understanding is required in order to set the appropriate expectations of functionality and availability from a timing perspective. There are two versions of WiMax: 802.16d and 802.16e. They differ in terms of expected benefits and the time frame for deployment.

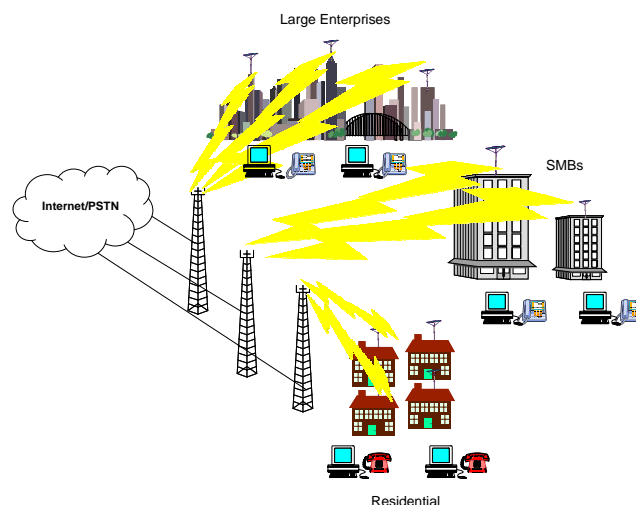


Figure 6: Broadband Wireless Access in the Last Mile²⁹

802.16d is referred to as fixed WiMax and is targeted at providing wireless broadband to “large parts of the world that are too expensive to serve with wired technologies,” according to Sean Maloney, Executive Vice President and General Manager of the Intel Communications Group.

²⁸ T-Mobile® Website

²⁹ Alvarion, 2004

According to Jake Smith, Mobility Marketing Manager at Intel, 802.16d (fixed WiMax) will begin pilot installations in 2005, but will not become a scalable standards based technology until 2006 as the price and cost of 802.16 implementations reaches critical mass. The range of fixed WiMax is expected to be 30 miles, and it can be deployed both indoors and outdoors. Intel is so confident of the technology that Maloney goes on to say "WiMAX-certified systems will provide the building blocks to connect the next five billion users to the Internet and truly usher in the broadband wireless revolution."

To the mobile worker who desires wireless Internet access anytime, anywhere, 802.11d is not going to be a solution of interest. Instead, 802.16e will be the answer to "anywhere" wireless data prayers (when it is made available). While 802.16d is delivering broadband to villages in India and China in 2008, 802.16e will just be starting its own pilot installations. 802.11e is referred to as "portable WiMax," and although not sporting the same impressive frequency, range, and throughput as 802.16d, portable WiMax is expected to fill the wireless gaps for die-hard wireless data users who want to be connected everywhere, all of the time. In fact, portable WiMax is expected to compete with Wi-Fi hotspots once widespread implementation takes place.

When portable WiMax (yes when, not if) becomes available it will be a viable wireless Internet access option for mobile workers to augment their existing WLAN and WWAN wireless Internet access methods. In the "here and now", there is nothing that IT managers and mobile workers need to consider as it relates to WiMax. Simply keep your eyes on the future.

Wireless Wide Area Network (WWAN) – The Burgeoning Enabler

The Ultimate Vision of Wireless Internet Access

Rounding out the family of wireless Internet access solutions is wireless wide area network (WWAN). A WWAN covers a much broader area than Wi-Fi or WiMax, with coverage usually measured on a nationwide, or even global basis. The WWAN network infrastructure (there is

more than one network in the US and abroad) is provided by cellular carriers such as Cingular Wireless, Verizon, and Sprint. WWAN is offered to users for a monthly usage fee (much like a cell phone subscription, or even part of a cell phone subscription). Because WWAN uses the existing cellular infrastructure with a multitude of towers as coverage (and to a lesser degree satellites), WWAN provides wireless data access over the Internet across a coverage area that would generally be measured in hundreds, or even thousands of miles.

In earlier years WWAN, including 3G, was hyped to the point of setting expectations that never seemed to materialize – that is until now. WWAN as a wireless Internet access method is ready to go into the mainstream as four key vectors have aligned into place:

- Powerful networks (2.5 & 3G) offer unprecedented speed with ubiquitous global coverage
- Many device choices have emerged to provide greater awareness and capability
- Robust mobile platforms and applications are either available or being developed
- Widespread adoption of WWAN is driving greater economies of scale

Besides being used as a data transport, WWAN networks have the advantage of allowing voice traffic over the same network. Both cellular telephones and WWAN PC Cards have the ability to make voice calls as well as pass data traffic on WWAN networks. WWAN networks, with the advent of CDMA2000 1x EV-DO, can now enable voice over the internet (VoIP), thus making phone services a possibility for WWAN data users.

WWAN Technologies – Choose Wisely

Swiftly changing WWAN standards, differing carrier implementations, and international influences all combine to create a confusing set of circumstances to mobile workers wanting to fully understand the WWAN space. At a high level, mobile workers have a choice of four different WWAN networks for data transmission: **CDMA** (Code Division Multiple Access), **GSM** (Global System for Mobile Telecommunication), **GPRS** (General Packet Radio Service), and **CDPD** (Cellular Digital Packet Data).

However, it is not enough to know these key technologies; one must drill down deeper into the three key implementations of the current day for US broadband WWAN data:

- **GPRS/EDGE:** 2.5G/2.75G standard, providing up to 384 Kbps throughput, at an average coverage of 1 to 5 miles, with a frequency range of up to 1,900 MHz. GPRS provides both national and global coverage, while EDGE provides national and some global coverage.
- **CDMA2000/1x EV-DO** (Evolution Data Optimized): 3G standard, providing up to 2.4 Mbps throughput, at an average coverage of 1 to 5 miles, with a broad range of frequencies from 400 to 2,100 MHz. EV-DO despite its superior bandwidth, provides only limited regional coverage today.
- **WCDMA/UMTS:** 3G standard, providing up to 10 Mbps (with HSDPA technology), at an average coverage of 1 to 5 miles, with a broad range of frequencies from 1,800 to 2,100 MHz. Like EV-DO, UMTS despite its superior bandwidth, provides only limited regional coverage today.

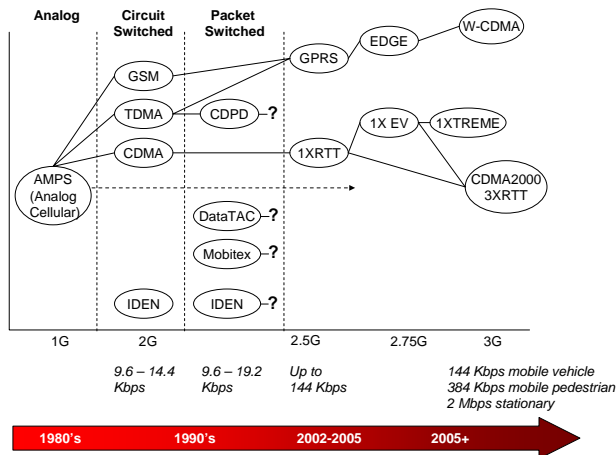


Figure 7: Evolution of WWAN Networks³⁰

Although GPRS today has the broadest coverage, EDGE has the best combination of speed and coverage. EVDO and UMTS have speed advantages, but limited coverage.

³⁰ Intermec 2003 – *Taking it to the Streets: A Guide to Wide Area Wireless for the Non-Technical Business Professional*

Broadband Wireless Technologies

Commercial Name	Usage	Standard	Through-put	Range	Frequency
UWB (ultra wideband)	WPAN	802.15.3a	110-480 Mbps	Up to 30 feet	7.5GHz
Bluetooth®	WPAN	802.15.1	Up to 720Kbps	Up to 30 feet	2.4GHz
Wi-Fi	WLAN	802.11a	Up to 54Mbps	Up to 300 feet	5GHz
Wi-Fi	WLAN	802.11b	Up to 11Mbps	Up to 300 feet	2.4GHz
WiMAX	WMAN fixed	802.16d	Up to 75Mbps (20MHz BW)	Typical 4-6 miles	Sub 11GHz
WiMAX	WMAN Portable	802.16e	Up to 30Mbps (10MHz BW)	Typical 1-3 miles	2-6 GHz
EDGE/GPRS (TDMA - GSM)	WWAN	2.5G	Up to 384Kbps	Typical 1-5 miles	1,900 MHz
CDMA2000/1x EV-DO	WWAN	3G	Up to 2.4 Mbps (typical 300-600 Kbps)	Typical 1-5 miles	400, 800, 900, 1,700, 1,800, 1,900, 2,100 MHz
WCDMA/UM TS	WWAN	3G	Up to 2Mbps (up to 10Mbps with HSDPA technology)	Typical 1-5 miles	1,800, 1,900, 2,100 MHz

Figure 8: Broadband Wireless Technologies³¹

The Powerful Advantages of WWAN

The obvious advantage of WWAN is the ability for mobile workers to realize wireless Internet access nearly anytime, anywhere (provided bandwidth and coverage exists for the carrier network selected) at acceptable prices. This is accomplished through increased range, bandwidth, and improving economies of scale for WWAN solutions. The realization of broadband over cellular networks is providing the ultimate solution for mobile workers who want to maximize productivity, accessibility, and responsiveness, without having to search for hotspots while on the road.

Security Considerations for WWAN

As a licensed frequency, WWAN is considered a more secure wireless technology than Wi-Fi, despite the potential “layers of security” present in a WLAN. Cellular networks incorporate the latest military technology, along with sophisticated encryption and authentication technology, providing a higher degree of security than public Wi-Fi networks (hotspots).

³¹ Intel, January 2004

PC Card or Embedded WWAN Solution?

One key question that will emerge in the IT community when considering a WWAN deployment is whether to enable a new or existing mobile device with a WWAN PC card, or to invest in mobile devices that have embedded WWAN technology (via a SIM card). There are differing opinions in the market on which path to follow with concerns over flexibility and costs. In-Stat/MDR forecasts that embedded WWAN cards as a percentage of the total WWAN mobile solutions in the US (22.5 million) will reach over 50% by 2009.

	CPC and Embedded WAN	CPC Modems	% of Total Units Shipped	CPC and Embedded WAN	% of Total Units Shipped
2003	550	550	100%	-	0%
2004 Fcst.	1,417	1,389	98%	28	2%
2005 Fcst.	2,300	2,185	90%	115	10%
2006 Fcst.	4,803	4,371	91%	432	9%
2007 Fcst.	8,658	6,926	80%	1,732	20%
2008 Fcst.	13,770	9,183	67%	4,523	33%
2009 Fcst.	22,532	10,590	47%	11,942	53%
CAGR 03-07	44%	38%	-	128%	-

Figure 9: US Cellular PC Card (CPC) and Embedded Modem Forecast (Units in Thousands)³²

There are some industry experts that are critical of integrated cellular solutions (Gartner), citing high costs and the thought that most mobile workers don't mind the gaps from hotspot to hotspot. Such talk is reminiscent of the early 2000's period where the debate was over integrated Wi-Fi. Consider the following excerpt and quote from industry leading research group Aberdeen in September of 2002 on the subject of embedded Wi-Fi:

"Is the trend to embedded Wi-Fi a bed of roses for the networking standard, or are there some hidden thorns? Isaac Ro, a wireless analyst for the Aberdeen Group, believes that the future is mixed. Ro believes that, at first, consumers may find embedded Wi-Fi products a Pandora's Box of incompatible brands and components. Consumers will also find embedded Wi-Fi bringing inexpensive wireless networking. As heavyweight chipmakers move into the Wi-Fi market and the trend toward embedded

*802.11 continues, the competitive landscape will be altered, putting smaller vendors such as LinkSys at a disadvantage, says Ro. With Wi-Fi expected to become part of everything from phones to home entertainment centers, how far will the move to embed 802.11 extend? "You are not going to have a Wi-Fi fridge," Ro confidently predicts."*³³

When one considers the immense popularity of integrated Wi-Fi deployments today, the growth and success of LinkSys, and the fact that there are indeed internet enabled refrigerators and other household appliances³⁴, one cannot help but believe the embedded WWAN discussion will head in the same direction with a similar outcome.

IntelliClear believes that embedded WWAN solutions for notebooks and other mobile devices provide a strong value add to the wireless Internet access story for mobile workers. As such, IntelliClear believes the refresh cycle of notebooks and other devices is such that the utility harnessed from an integrated WWAN solution today will pay for itself in cost savings relating to configuration and set-up, ease of use, and technical support over a short period of time. If in the future there comes a superior WWAN solution, embedded or otherwise, the timing is likely to closely coincide with the refresh cycle of the device, allowing for migration if necessary. In other words, *"don't let best be the enemy of better."*

Wireless Internet Access Total Cost of Ownership

Wireless LAN TCO Shatters that of a Wired LAN

The Farpoint Group, in a whitepaper published in January 2004 (Document FPQ 2004-013.1), found that for a 50 node network that the cost savings from a wireless LAN deployment amounted to \$27,600 in year one, growing to \$61,200 by the end of year three. The wireless LAN implementation generated a per node savings over the wired solution of \$552 and \$1,224 respectively over the one and three year periods. A majority of the savings

³³ MobileInfo.com, September 2002

³⁴

http://searchsmb.techtarget.com/sDefinition/0,,sid44_gci914545_00.html (whatism.com)

³² In-Stat/MDR, 06/2004

were in the costs to add and move wired ports (assuming 42% of ports move annually – which is considered typical).³⁵ Although the savings is somewhat reduced upon introducing additional costs relating to security (encryption, authentication, intrusion detection, rogue access point detection and neutralization, and fault-tolerance provisions), the TCO under WLAN is still expected to be far less in the short and long term as compared to a wired network. Often times it is not a matter of a wireless LAN versus a wired LAN, but rather does wireless make sense as part of the overall network. In many cases WLAN infrastructures are best deployed using the existing wired infrastructure as the “backbone” for the wireless LAN.

WLAN and WWAN Factors Compared

Before diving into a total cost of ownership (TCO) analysis between Wi-Fi and WWAN, a comparison of WLAN and WWAN across a number of key factors of interest to mobile workers should be reviewed. Consider the comparison outlined in figure 10.

	Wireless LAN	Wireless WAN	Conclusion
Bandwidth	Up to 54 Mbps	Up to 2.4 Mbps	Advantage Wi-Fi
Range/Coverage	Up to 300 feet from an access point (AP). This can be extended with wireless bridges for local use, and hotspots for national/global coverage. Still, gaps will exist.	Depends on the carrier selected, but likely can be nationwide, even global. From a technology standpoint, users can be 1-5 miles from a cellular tower.	Advantage WWAN
Convenience	Once a mobile worker leaves their base Wi-Fi network, they must find a hotspot to reconnect to the Internet.	A mobile worker, as long as they are in their coverage area, can roam freely without losing their Internet connection. Quality of service issues may exist in some areas, but are likely to be minimal.	Advantage WWAN
Security	Unlicensed frequency with layers of security. Vulnerabilities exist in public areas, but can be somewhat minimized by the use of VPNs, 802.1x, strict policies, and other assorted security methods.	Licensed frequency that includes sophisticated technology for encryption and authentication. Security can be enhanced via VPNs and strict policies.	Advantage WWAN
Upfront Costs	Integrated Centrino may add as much as \$200 to the price of a notebook, not taking into account the feature upgrades required by OEMs for Centrino notebooks. A Wi-Fi PC card averages about \$79.00.	Integrated WWAN SIM card may add as much as \$150 to \$200. A WWAN PC card will typically run about \$100 from a selected carrier with the commitment to a service period of one year or more.	Wash - no particular cost advantage for either solution

Figure 10: WLAN and WWAN Compared

Although IntelliClear awards a number of advantages to the WWAN solution, an organization must decide what factors are the most important to their mobile workers and drive the comparison objectively from there. Regardless of the wireless solution being selected, there is a need for companies to move away from the model of the individual who purchases the mobile device, selects a carrier for the wireless service, bills the company for one or both of the expenses, and then asks the IT guy to help integrate the solution to the corporate network as a favor or as an executive privilege. Over time, such an inefficient process will generate skyrocketing costs, security and manageability issues, and integration nightmares.

Wireless TCO Components to Consider

For the purposes of this paper IntelliClear will focus on the solution being a notebook PC (laptop) to be used for wireless Internet access in the continental US. As with any TCO analysis there are direct expenses and indirect expenses to be considered:

Direct expenses associated with acquiring and deploying a mobile wireless solution may include the following:

- Hardware and accessories – mobile devices, PC cards, SIM cards, extra batteries, etc.
- Software – hosted apps., middleware, security, etc.
- Services – design, integration, configuration, deployment, training, etc.
- Operations – airtime fees, technical support, user help desk, consumables, etc.
- Maintenance – SW and HW maintenance, repair, extended warranties, spares, etc.
- Building costs for wireless infrastructure as appropriate

Indirect expenses for sustaining operations may include the following:

- Downtime: back-up, restore, failures, lost work due to non-working conditions (no coverage, looking for a hotspot, etc.)
- IT support: troubleshooting, technical help desk, testing, logistics, change management, etc

³⁵ Farpoint Group, January 2004 (Document FPQ 2004-013.1)

Other indirect expenses, or savings, that may be more difficult to quantify include productivity losses/gains, impact of a faster/slower response rate, employee retention rates, ease of configuration, ease of updates (software and firmware), ease of migration, and end to end quality of service rates.

The above expenses, from an accounting standpoint, can also be categorized as the cost of equipment (CAPEX or capital expense), the cost of equipment installation (OPEX – operational expense), and the cost of maintenance (also OPEX). As such, the typical TCO calculation then becomes the following:

$$\text{TCO} = \text{CAPEX} + \text{OPEX}$$

CAPEX: Capital expense

OPEX: Operational expenses

TCO Analysis for WLAN versus WWAN

IntelliClear has conducted a high-level TCO analysis for three wireless Internet access solutions: WLAN alone, WWAN alone, and WLAN and WWAN together. The analysis also includes considerations for the solutions being either integrated (embedded Wi-Fi and/or WWAN), or PC card related. The analysis is for *one mobile worker*, with the assumption being that greater numbers will bring lower prices for airtime charges and hardware – the largest cost components. The key assumptions for the analysis are the following:

- One year period
- Strictly mobile solution, with no building costs considered as part of the solution
- A notebook PC as a mobile device at a starting price of \$2,000
- The mobile worker travels for business five days per month, or 60 days per year
- Average mobile worker hourly labor rate = \$50 (\$75,000 per year with 40% benefits)
- Average internal IT hourly labor Rate = \$50 (\$75,000 per year with 40% benefits)

See Figure 11 on the next page for the results of the TCO analysis, which shows that the integrated WLAN and WWAN combo solution generates a minimum annual TCO savings of \$247.50 as compared to the integrated WWAN

only solution. The TCO savings are substantially higher when comparing the integrated WLAN/WWAN combo against the PC card (non-integrated) solutions. Keep in mind that these savings are for a quantity of one, as *IntelliClear believes that many of these solutions will be purchased and used by small businesses or individuals*, as opposed to large enterprises. One must keep in mind that the savings could be substantially higher as additional downtime caused by end users fumbling with PC cards, activation, drivers, and other technical issues were not taken into consideration in the TCO analysis.

Integrated WLAN and WWAN – The Right Answer For Mobile Workers

The TCO analysis, although at a high level, reveals a compelling case for a combined integrated WLAN and WWAN solution to the notebook PC. The TCO does not comprehend a number of other expected benefits of the integrated WLAN/WWAN combo solution that are likely to be realized by the mobile worker including:

- Additional productivity gains via greater access to the Internet in more places.
- A stronger end to end quality of service agreement that is likely to be realized with cellular carriers that offer an integrated hotspot and WWAN plan.
- The impact of a more favorable response rate to customers, suppliers, and other business stakeholders.
- An increase in employee retention as mobile workers is given a more robust set of tools to do their job.
- Greater availability of the mobile device on the Internet to perform updates such as security patches, software revisions, etc.

IntelliClear believes that as more commercial enterprises, large and small, realize the direct and indirect benefits associated with mobile devices for mobile workers equipped with integrated WLAN and WWAN capabilities, that more consideration and purchases will take place. There is an inherent lack of awareness that must be overcome first, mainly breaking through the noise barrier with IT managers and executives who often do not take the time to consider such mobile solutions from a broad business perspective. In the competitive global marketplace of today, such lack of attention can no longer be afforded.

	WLAN Only	WWAN Only	WLAN & WWAN	
Direct Costs				
<i>Hardware and Accessories</i>				
Notebook PC	\$2,000.00	\$2,000.00	\$2,000.00	
Integrated solution	\$2,025.00	\$2,125.00	\$2,150.00	*1
PC card solution	\$2,070.00	\$2,100.00	\$2,170.00	*2
Extra battery	NA	NA	NA	
<i>Software</i>				
	NA	NA	NA	
<i>Services</i>				
Design	NA	NA	NA	
Configuration savings with an integrated solution	\$12.50	\$25.00	\$37.50	*3
Integration	NA	NA	NA	
Deployment	NA	NA	NA	
Project Management	NA	NA	NA	
Training	NA	NA	NA	
<i>Operations</i>				
Airtime fees	\$359.40	\$959.40	\$1,199.40	*4
Technical support	Included	Included	Included	
User help desk	NA	NA	NA	
<i>Maintenance</i>				
Hardware	NA	NA	NA	
Software	NA	NA	NA	
Repair	NA	NA	NA	*5
Indirect Costs:				
<i>Downtime</i>				
Lost work due to no coverage (looking for hotspots, etc.)	\$1,500.00	\$250.00	\$0.00	*6
Back-up	NA	NA	NA	
Restore	NA	NA	NA	
Failures	NA	NA	NA	
<i>IT Support</i>				
Troubleshooting on PC Card Solution	\$12.50	\$25.00	\$37.50	*7
Troubleshooting on Integrated Solution	\$0.00	\$0.00	\$0.00	
Technical help desk	NA	NA	NA	
Testing	NA	NA	NA	
Logistics	NA	NA	NA	
Change management	NA	NA	NA	
<i>Productivity Gains</i>				
End to end quality of service rate	Likely to be higher with both WLAN and WWAN, but not quantified			
Impact of a faster response rate	QoS may be more easily obtained via cellular carriers			
Employee retention	Likely to be higher with both WLAN and WWAN, but not quantified			
Ease of updates	Likely to be higher with greater connectivity, but not quantified			
Ease of migration	Updates are more easily deployed with greater connectivity, but not quan			
Time savings with an integrated WLAN/WWAN easy to use solution	\$0.00	\$0.00	\$250.00	*8
Total TCO for One Year (non-integrated)	\$3,941.90	\$3,334.40	\$3,406.90	
Total TCO for One Year (integrated)	\$3,871.90	\$3,309.40	\$3,061.90	
TCO Savings for One Year with the Integrated Solution	\$70.00	\$25.00	\$345.00	
Minimum TCO Savings for One Year with the WLAN/WWAN Combo	\$0.00	\$0.00	\$247.50	

NA - indicates that the amount will likely be the same for each solution, or not applicable to the solution but considered

*1 - Estimate \$25 for WLAN and \$125 for WWAN; however, for some SIM cards the price to the user can be upwards of \$400

*2 - The WWAN PC card for \$100 assumes a carrier subsidy in return for a commitment of typically one year or more of WWAN service

*3 - Estimate 15 minutes of extra configuration for an IT professional for WLAN, and 30 minutes for WWAN. If an end user attempts to configure the time (and costs) could be substantially higher (activation, drivers

*4 - Estimate for one year subscription; WLAN & WWAN together estimated; savings likely with integrated voice on the plan

*5 - There may be some repair due to PC card insertion and re-insertion and possible lost PC cards

*6 - Per travel day estimate of 30 minutes for WLAN, 5 minutes for WWAN, and 0 for WLAN & WWAN

*7 - PC cards often have issues with standby, hibernation, and other issues that cause lock-ups. These lock ups will create a service call to the IT department of 15 minutes for WLAN and 30 minutes for WWAN.

*8 - Estimate 5 minutes per travel day of savings in seamless switching between WLAN and WWAN due to software and ease of use associated with well implemented WLAN/WWAN combos.

Figure 11: WLAN and WWAN TCO Analysis

Available Wi-Fi and WWAN Laptop Solutions

The TCO analysis conducted by IntelliClear reveals a clear direction for mobile workers of small and large businesses in favor of an integrated WLAN/WWAN combination. It is important to note that notebook PC purchases in retail are now rivaling that of desktop PCs, largely in part due to the volume of small business and individual purchases. Such a dynamic indicates the desire of smaller entities towards mobile solutions, and thus the impact a wireless Internet solution such as the WLAN/WWAN combo can have. The challenge is finding the right solution to evaluate and purchase. At the time of this paper's publication the following was identified as a high level view of each of the major mobile PC vendors' strategies with respect to wireless Internet data solutions:

PC OEM Approaches to Wireless Offerings

- **Dell:** Dell is taking a modestly aggressive approach in selling products such as the Dell TrueMobile 5100 Tri-band GPRS PC Card with the T-Mobile Wireless Service, and the Dell TrueMobile 5100 Tri-band GPRS PC Card with the AT&T Wireless Service, along with subscriptions to the respective providers. Dell offers optional integrated Wi-Fi and/or Bluetooth® Technology, but does not have any announced plans for integrated WWAN.³⁶
- **HP:** HP is extremely aggressive on the WWAN relationship side supporting CDMA, GPRS, and EDGE. HP has developed relationships with US wireless operators AT&T/Cingular, Sprint, T-Mobile, and Verizon. HP supplies activated CPC modems with the computing products it sells, allowing customers to select the service they desire. HP offers integrated WLAN on nearly all models, with optional integrated Bluetooth, but no announced plans for integrated WWAN.³⁷
- **Toshiba:** Toshiba is taking a passive approach to wireless, with no announced WWAN relationships. Toshiba offers optional integrated Wi-Fi and/or Bluetooth on many of its notebook offerings, but has no announced plans for integrated WWAN.³⁸
- **Sony:** Sony is taking an extremely aggressive approach on the WWAN product side. Sony's VAIO® T-Series notebook, announced in May 2005, includes SmartWi™ technology that seamlessly integrates wireless Wide Area Network (WAN – GSM/GPRS/EDGE), 802.11 b/g wireless LAN1, and Bluetooth® technologies (all standard), allowing for quick and easy toggling among wireless connectivity options depending on the surroundings. Sony's supported WWAN service is EDGE with Cingular in the US.³⁹
- **IBM:** IBM is taking a passive approach to wireless, stating company experience with WWAN carriers, but no publicly advertised offerings for a WWAN service. Optional integrated Wi-Fi and/or Bluetooth is available on ThinkPad models, but no announced plans for integrated WWAN.⁴⁰
- **Panasonic:** Panasonic, like Sony, is taking an extremely aggressive approach to wireless, providing Toughbook models with optional integrated WWAN and/or WLAN with a dual pass-through antenna that allows seamless integration between the two. Panasonic allows users to select the carrier of choice, including those offering Edge/GSM/GPRS and CDMA 1XEVD0/1XRTT technologies.⁴¹

Managing the Pitfalls of Wireless Internet Access

While wireless Internet mobile solutions provide compelling benefits to mobile workers, there are a number of issues to consider during the planning stages of a mobile worker deployment:

³⁶ Dell website, June 6, 2005

³⁷ HP website, June 6, 2005

³⁸ Toshiba website, June 6, 2005

³⁹ Sony website, June 6, 2005

⁴⁰ IBM website, June 6, 2005

⁴¹ Panasonic website, June 13, 2005

- **Cost:** The price of an unlimited WWAN service can be upwards of \$80.00 per month, making WWAN a serious financial commitment for mobile workers, especially if they are footing the bill. Look for plans that integrate hotspots, WWAN, and voice into one plan, with flexible billing options. Such plans can help drive costs down, especially in a large enterprise environment.
- **Network Dependence:** WWAN services are network dependent, meaning that a firm must commit to a particular service (carrier), which in turn ties them to the carrier's coverage area and plan for some specified period of time. Selecting the right network for the mobile worker's usage patterns, and/or selecting a network with broad coverage, is critical to the success of a WWAN deployment. Try to balance coverage area with bandwidth – both are important.
- **Security:** There are a number of security risks with WLAN that must be considered; and although WWAN operates over licensed frequencies, there are still some moderate security risks there as well. Physical borders between private and public networks are hazy, and wirelessly connected devices can easily infringe two of the most fundamental network security policies - confidentiality and authentication. Where there are hackers who want to hack, there are risks when mobile workers broadcast packets into cyberspace. There are a number of measures that can be taken by mobile workers to minimize security risks including the following:
 - Identify specific applications that are approved to run across public networks.
 - Define the Wi-Fi locations that mobile workers are allowed to connect to.
 - Establish VPN capabilities for remotely connecting to the enterprise network.
 - Install a PC based firewall.
 - Disable Wi-Fi ad-hoc mode as appropriate.
 - Turn off wireless cards/capabilities when not in use.
 - Don't "brag" about having Wi-Fi access in public locations.
 - Make folders private.

- Password protect files.
- Have detailed written policies.

The more prepared mobile workers are for safe wireless access, the less risk there will be of intrusion.

- **Performance:** Environmental factors such as coverage, user movement, and other physical factors can affect throughput and performance. Anyone who has ever used a cellular phone will understand the possible limitations of coverage and how coverage can be affected in a dynamic mobile environment. At the same time, cell phone users have all learned to cope with and manage such limitations. Concerns over the reliability and performance of wireless networks can be further minimized through the use of Service Level Agreements (SLA's) that credit businesses when the network operations do not perform to specified metrics.
- **Application Perseverance:** Mobile workers wirelessly connected can unknowingly move out of their coverage area creating issues with existing transport protocol implementations and cause user applications to terminate or become suspended. Efficient application development can mitigate these issues and create safeguards against data loss and application degradation.

About IntelliClear (www.intelliclear.com)

IntelliClear is a market research and business consulting firm committed to the delivery of actionable market intelligence to the global IT community. IntelliClear's mission is to bring clarity to IT market intelligence by delivering results-oriented research, responsive industry experience, and effective data synthesis - leading to confident go-to-market plans. IntelliClear leverages the experiences of seasoned IT and market research professionals, while utilizing its global network of industry consultants and research partners to execute projects across a broad spectrum of disciplines and geographies. This paper was written by the CEO of IntelliClear, Eric Shuster, with editorial contributions provided by IntelliClear Managing Director and General Partner, Alex Kalamarides Ph.D.