Future-Proofing the Network:
A Case for Flexibility in the Wireless Enterprise

What applications will you need to satisfy your workforce over the next five years? Which of those will be your constituents' killer application? Do you already have the infrastructure you need in place to support these applications? ***Is your wireless network future-proof?***

Today's wireless enterprise needs are supported with multiple wireless applications that run over many different services operating under different (and often conflicting) frequency bands. The complexity of enabling these different technologies can be astounding. Yet the wireless industry is expanding exponentially. With so many new services and emerging over the next five years, the typical Information Technology (IT) organization will be dealing with a level of complexity and a cost structure that can become unmanageable if they are unprepared.

Only networks that evolve to support emerging technologies will thrive, leaving rigid architectures obsolete. To combat this challenge, CIOs must view current network investments through a future-proof lens; this reduces the risk of having to rebuild the network in the future.

Flexible Wireless Enterprise Networks

Today's wireless enterprise service model involves managing and funding multiple wireless services. What is the Total Cost of Ownership (TCO) for all of these services? What will it be in 3 to 5 years, when the number of frequencies has increased by over 200% and the network complexity has expanded? How can you maximize the longevity of your investments in a world of ever-changing protocols and constantly evolving security risks? Managing the longevity of the enterprise wireless network will be critical to maximizing return on investment (ROI) over time.

Many IT planners have immediate wireless LAN access and coverage needs that must be addressed; choosing a versatile network that is flexible and supports emerging frequencies can actually reduce costs over time. "No one wants to have to explain the need for a forklift upgrade where large parts of the infrastructure must be overhauled." [1] It is critical to adopt a broader view of enterprise networks as strategic future assets, deployed today.

Many mobile enterprise architectures lack the scalability to adapt. Additionally, with so many spectrum bands emerging over the next five years, the typical IT department cannot afford to be caught off-guard by these shifts.

The key to responding quickly to industry changes and dynamic customer needs will be the future-proof system—an infrastructure designed to quickly and effectively respond to changes in the enterprise. Key attributes of this flexible system include:

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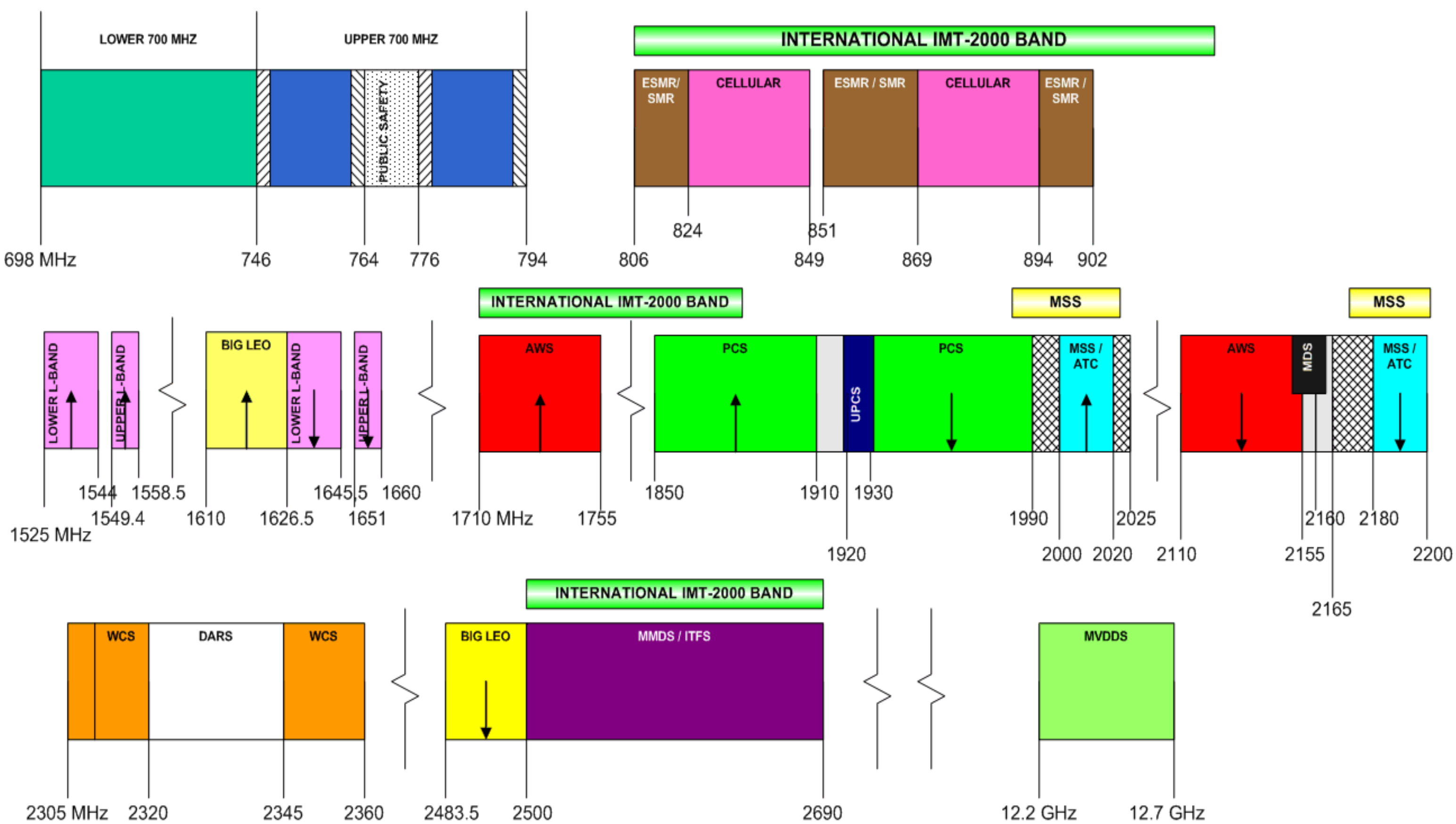
[1] McLaughlin, Laurianne, *Future-proof your network*, Network World, July 18, 2006.

- ❖ *Ability to work with multiple frequencies and channel bandwidths*
- ❖ *Optimum coverage & capacity in areas served*
- ❖ *Connectivity among different types of networks*
- ❖ *Ability to respond to unknown services*

Ability to work with Multiple Frequencies

The future-proof system will have a flexible (frequency agile) wireless infrastructure solution, one that responds not only to the multiple frequency bands in use today, but is also flexible and robust enough to support emerging frequency bands in the future.

Today, all commercially-licensed wireless communication is contained within a small amount of spectrum, about 190 MHz in total. These bands support service providers such as Sprint, Verizon, and Cingular as well as public safety communications. Today's frequencies include Cellular (A&B), ESMR 800, ESMR 900, and PCS bands. Moving forward over the next five years, spectrum policy is adjusting to make room for new, bandwidth-hungry applications. From the 190 MHz of existing spectrum, we will see the introduction of 568 MHz of new frequencies that have been or will be licensed and allocated, yielding an increase of nearly 300%, in the available spectrum. There will be as many as 8 additional bands (already licensed) emerging quickly in the industry profile for commercial and public safety uses, and several unlicensed bands including 900 MHz, 2.4 GHz, 3.6 GHz, and 5.8GHz, which are being utilized more frequently. Existing and emerging bandwidth is depicted in Figure 1 below.



What do IT directors and CIOs need to know about emerging spectrum bands?

Cellular networks today are currently optimized for voice communications. Over the next five years, networks will have to accommodate more demanding requirements driven by new and emerging applications. Performance and cost factors will have to yield higher efficiencies (higher throughput in Mbps and cost-per-Mb transfer rates) than they do today. Future applications will be enabled by moving away from circuit switch frameworks and toward IP-centered architectures, spurring the release of new access technologies that will enable new applications.

Emerging capabilities for wireless enterprise users include:

- *Data casting*, a one-to-many distribution technology enabling the cost-effective and efficient distribution of digital content to mass audiences. A typical service involves data and information transfer to multiple receivers, enabling faster, larger, and more frequent transfers to a higher volume of simultaneous users.

- *Unicasting*, a one-to-one distribution technology that allows for personalization of information, similar to how the Internet works today.

- *Trickle casting*, the ability to forward and store information that is not needed in real-time. The information is transmitted at a slower data stream (and secondary priority) and stored on a device for later use.

- *Broadband wireless*, which is provided by using wireless access to data networks with high data rates.

These architectures will allow for new applications to be enabled, and provide them to users in the cost effective ways.

To prepare for the future, IT professionals must understand emerging frequency bands and each band's potential uses, ability to impact the industry, and importance to the organization. As a resource for preparing the IT organization for this purpose, Figure 2 summarizes the emerging frequency bands and their importance to enterprise users.

	Bands	**Total In Band**	**Expected Service**	**Expected Technology**	**Starting Build Year**	**Important for the Wireless Enterprise Because…**
1	**Lower 700**	48*	Datacasting/ Mobile Media (can also be used for Broadband Services)	Media/Flo DVB-H	2006	*… this band will enable operators to broadcast real-time data out to multiple customer sites, cost-effectively. Customers will watch real-time events or store them via personal devices (trickle-cast). These services are also known as Mobile Media and the band can be used for broadband services.*
2	**Upper 700**	30	4G	3GPP/3GPP2	2008	*… with its inherent propagation characteristics, this band will stimulate increased competition by enabling new entrants to penetrate the market.*
3	**1.5 MSS**	68	4G/Fixed	3GPP2/WiMax	2007	*… will be offered via Hybrid Terrestrial/satellite system. This also provides ubiquitous enterprise coverage that is*

						required for some emerging applications.
4	**AWS-1**	90	3.5 G	3GPP/3GPP2	2007	*… new players will be able to compete today, with new spectrum, offering an array of wireless/wireline/Media Telecom converged solutions to the enterprise. Other players will start to offer all-you-can-eat and cheaper flat rate voice/ data pricing models.*
5	**AWS-2**	20	5 G	3GPP-LTE	2010	*… this will be available to enable the next generation of wireless solution because of the spectrum timing coinciding with the next evolution of technology. Improves data transfer rates using OFDM modulations and advanced antenna technologies.*
6	**2.1 MSS**	40	3.5 G	3GPP/3GPP2	2008	*… today, this band mirrors 1.6 MSS band usage because of its proximity to the new AWS spectrum. Over time, it might be used in conjunction with AWS.*
7	**WCS**	30	Fixed	Navini, other Proprietary, WiMax	2007	*…this band enables high speed DSL-like fixed wireless services, beginning to emerge and currently offered by Bell South and Nextwave.*
8	**BRS/EBS**	190	Fixed, Nomadic, Backhaul	Fixed and Mobile WiMax	2005	*… band provides a great amount spectrum to the market. Mobile WiMax announced, by Sprint, will offer higher speed services in City Zones and office complexes to complement their 3G offering. This will be notably faster than cellular networks, including 3G because of bandwidth allowing for higher peak speeds and support asymmetrical data applications. Services offered are fast and secure enough to use with a corporate WAN & VPN. Others like Clearwire are offering DSL-like fixed wireless service today in secondary markets.*
9	**3.6 GHz**	50	Fixed, Nomadic	WiMax derivative Fulfils cognitive radio requirement	2008?	*… this band holds promise in the future once Contention Based Protocols (CBP) are defined and implemented. The band will require FCC registration and has many of the positive attributes of unlicensed spectrum with power levels never seen in other unlicensed bands.*
10	**4.9 GHz**	50	Public Safety			*… this serves as a new public safety band. Implemented for data services using, in many cases, mesh networks. There is an inherent benefit of having public safety bands working in buildings when needed.*
	Total	**568**				

Figure 2

New Services Impact Architecture

With so many frequencies available, each with their own unique characteristics and offerings, application requirements will demand the ability to work over multiple bands. Parallel wireless networks offer one way to meet this demand, yet parallel networks can be laden with issues. Aside from the expense of constructing, maintaining, and managing multiple, separate networks, this architecture yields disruptions during each installation and each upgrade and repair cycle. Parallel wireless networks can also compromise service integrity, since they depend on the physical separation of antennas to mitigate interference. Lastly, parallel networks are not future-proof because the addition of new wireless technologies supported by new frequencies will continue to require the deployment of additional parallel networks.

Adopting a versatile network architecture that supports the multiple frequency bands of today and the emerging bands of the future will help to ensure the viability of the enterprise wireless network. Ultimately, an IT organization needs a system configuration that provides mobility, connectivity, and ease today, while preventing the need for a forklift system replacement in the near future.

Optimum Coverage and Capacity in Areas Served

Voice and data transmissions perform differently over an air interface; in other words, network coverage is not just network coverage. Because digital networks are primarily designed to handle voice traffic, the coverage provided is essentially binary; users either receive the call or do not. If that same network is to be leveraged for data transfer, an adaptive approach should be taken.

Most of today's digital wireless networks and access technologies are *adaptive rate* - the systems are sufficiently intelligent to trade off capacity for coverage. In other words, if an application is served by an external base station, while it has higher throughput outside of the building (and closer to the base station), it can still extend coverage (accept more attenuation) but have lower throughput (rather than none at all) inside of a building. A modulation and coding scheme is applied in order to overcome the attenuation of the walls of the building, however, this does trade off throughput for the end user.

Effective modulation schemes help a mobile enterprise system adapt with the environment, and can therefore vary the capacity of the network. The speed is then dictated by the amount of information that can be carried in the payload (a function of the modulation and coding scheme). In order to function, each modulation and coding scheme must pass a carrier-to-interference threshold. Coverage and throughput must be leveraged for optimum performance.

An example is 802.11g WLAN technology, where the data rate depends on signal interference in the environment, stepped down from 54 Mbps, 48, 36, 24, 18, 12, 9, 6 using OFDM, and reverts to CCK and then DBPSK/DQPSK + DSSS respectively for 11 Mbps to 5.5 to 2.0 and then to 1.0. Even more pronounced effects occur with 3G to 5G technologies currently in development. Well-designed architectures deliver optimum coverage in addition to optimum throughput.

Today, there are different devices and networks for each application and service in use. This silo approach does not always work efficiently or maximize the productivity of corporate assets and information workflows. As new applications with higher throughput requirements increase and more "all-in-one" converged device usage occurs, a more future-proof architecture is required.

Connectivity between Different Types of Networks

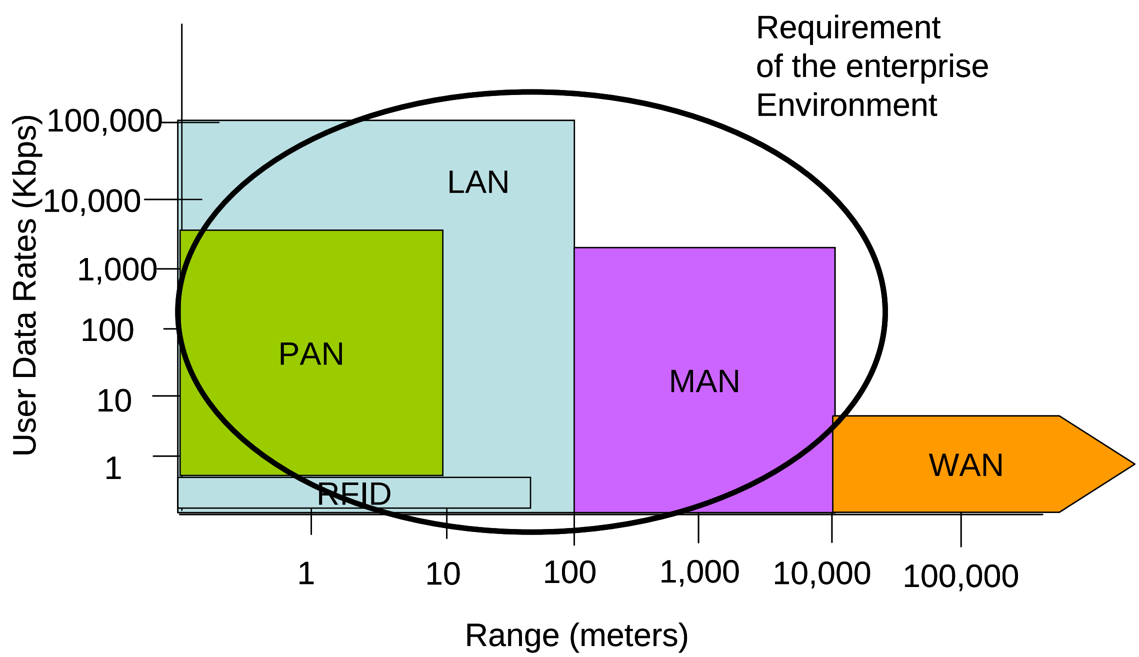
Higher connectivity between different types of networks and network devices can improve the future-proof quality of the entire network. More connectivity yields more productivity. With different networks working on multiple frequencies, the complexity of using parallel systems grows; a system that enables network access across multiple frequencies will be ideal.

The Power of the Network

Using *Metcalfe's Law,* one can explain many of the network effects of communications technologies, for example, the World Wide Web. *Metcalfe's Law* states that the value of a telecommunications network is proportional to the square of the number of users of the system (n^2). Furthermore, Reed's law stipulates that each member is not only connected to the entire network as a whole, but also to many significant subsets of the whole. These subsets add value independent of either the individual node or the network as a whole. Given these principles, the *connectivity* of a network frequently predicts whether a particular vendor's solution or architecture will dominate the marketplace. These principles have implications for whether an innovative solution can enter a marketplace that requires different technologies. [2]

Multiple Networks, Multiple Frequencies

Today's wireless networks include the Personal Area Network (PAN), such as Bluetooth, infrared, fire wire, USB cables, and ultra-wide band (UWB); the Local Area Network (LAN) typically deployed in homes, university campuses, office buildings, with a single IP subnet and one IP address; the Metropolitan Area Network (MAN) used in today's cell phone networks; and the Wide Area Network (WAN), connecting multiple MANs. Currently, these networks use the same 2.4 GHz band; however, moving forward these wireless networks will operate on multiple frequencies.



Ability to Respond to Unknown Services

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[2] Metcalfe's law – Wikipedia, http://en.wikipedia.org/wiki/Metcalfe's_law

Today's cutting edge applications integrate voice, data, applications, and device capabilities into a seamless experience for the end-user. The ability to support these emerging technologies rests entirely on the network infrastructure deployed today.

What is your killer application? The unknowns ahead require the installation of an in-building infrastructure that optimizes the wireless network coverage and will maximize your investment. "To truly future-proof your network, it's not enough to stay on top of port counts and protocols. Future-minded network planning also means understanding where your company's business is heading and what that, in turn, means to your network." [3]

The Killer Application

Users, wireless developers, planners and the industry as a whole are currently preparing for the next killer application. For enterprise users, the need for applications that support specific vertical specialties is the most pressing issue. The ability of the network to adequately support specialized applications driving efficiency and productivity is critical to enterprise planners and can be more important than a horizontal industry-wide application.

One example of an anticipated killer application is *convergence*. The convergence trend promises a future with iconic multi-functional devices with new, converged services (which may not have been contemplated today). To fully appreciate the importance of convergence, it is important to consider both device convergence and network convergence.

Device Convergence

Converged dual-mode, tri-mode and quad-mode devices that work on multiple networks will be useful for multiple applications. These devices are physically differentiated by their form-factor, which dictates their primary use. Physical form-factor is most notably driven by display, size, battery capacity and user input functionality.

Converged devices are driven by a primary product purpose. Most problematic issues relate to the tradeoffs of having multiple formats/functionalities that are combined into one device. This tradeoff may lead to many "false starts" because these compromises could cause converged devices to fall short of user expectations. As with any system, customers demand simplicity, uncompromised security and a great user experience above all else.

Network Convergence

The advantage of network convergence is that one core infrastructure can be leveraged by multiple access networks. This emerging trend could create a networked world where users decide which information and applications to receive and communicate, depending on their access level and device.

Examples of network convergence capabilities include fixed mobile convergence (FMC) where one can receive a call with all of the functionality of a PBX system through a laptop or

[3] McLaughlin, Laurianne, ibid.

converged VoIP cellular phone. Another example is the ability to instantly review a document on a PDA, then later access it for editing through a full keyboard device.

Ultimately for the enterprise, new applications will drive wireless access network requirements across four factors: power requirements; latency, data rate, and interference protection; range; and cost.

Conclusion

Emerging technologies and applications that improve workforce productivity require flexible pipelines in order to work efficiently and optimally. In an environment of uncertainty, only future-proof networks will withstand the test of time and maximize original deployment investments.

With all of the permutations that can exist, future-proofing is a critical component of an enterprise wireless network strategy. A network that is able to meet four primary criteria - *flexibility across multiple frequencies, optimum coverage and capacity, connectivity, and ability to respond to unknown requirements* - will adapt and withstand the evolution of mobility over the next five years. Is your network sufficiently flexible and future-proof?

White paper prepared by MobileAccess Networks.

About MobileAccess Networks

MobileAccess Networks is an enterprise wireless innovator that provides a universal platform for connecting the people and applications that drive business. The MobileAccess Universal Wireless Network is the key to widespread wireless connectivity in hospitals, office buildings, public venues and other large-scale facilities. The company's intelligent, in-building infrastructure delivers business-quality performance, scalability, security and signal reliability to more than 1000 customers, including Fortune 1000 companies such as Lehman Brothers and Hearst Corporation, leading healthcare facilities such as Northwestern Memorial and Clarian Health, as well as many public sector customers such as Aladdin Resort and Casino, ALLTEL Stadium, American University, and the Oakland International Airport. For more information, visit www.mobileaccess.com.