WIRELESS TECHNOLOGIES, WIRE LESS FIDELITY (WI-FI) & WORLD WIDE INTEROPERABILITY FOR MICROWAVE ACCESS (WIMAX)

Abstract:
One of the technological advances that are having a major impact on the way we do business isthe increase in wireless networks. This paper references how Wi-Fi technology is deployed andsome of its advantages over traditional means. It also explores how Wi-Fi technologies communicate in the spread spectrum and how they differ from one another.

Keywords: *Wireless Technologies, Wireless Fidelity, Wi-Fi, WiMax, 802.16a*

Conclusion: Although there are concerns about how long it can continue, or at least when it will slow down, new technology continues to enter the market on a regular basis. One of the technological advances that are having a major impact on the way we do business is the increase in wireless networks. "Since the turn of the millennium, wireless networks have proliferated. Wi-Fi...has freed us to move around our office and many public places with our laptops and handhelds, yet still have instant, unencumbered access to our companies' intranets and the internet" [5].Since Wi-Fi technology is being deployed in homes, offices, and public places one can naturally wonder what the future holds for wireless communications. This paper references how Wi-Fitechnology is deployed and some of its advantages over traditional means. It also explores howWi-Fi technologies communicate in the spread spectrum and how they differ from one another.

ORIGIN AND MEANING OF THE TERM "WI-FI":

Despite the similarity between the terms "Wi-Fi" and "Hi-Fi", statements reportedly made by Phil Belanger of the Wi-Fi Alliance contradict the conclusion that "Wi-Fi" stands for "Wireless Fidelity". According to Belanger, the Interbrand Corporation developed the brand "Wi-Fi" for the Wi-Fi Alliance to use to describe WLAN products that are based on the IEEE 802.11 standards.

HISTORY:

Wi-Fi uses both single carrier direct-sequence spread spectrum radio technology (part of the larger family of spread spectrum systems) and multi-carrier OFDM (Orthogonal Frequency Division Multiplexing) radio technology. These regulations then enabled the development of Wi-Fi, its onetime competitor HomeRF, and Bluetooth.

The precursor to Wi-Fi was invented in 1991 by NCR Corporation/AT&T (later Lucent & Agere Systems) in Nieuwegein, the Netherlands. It was initially intended for cashier systems; the first wireless products were brought on the market under the name WaveLAN with speeds of 1 Mbit/s to 2 Mbit/s. Vic Hayes, who held the chair of IEEE 802.11 for 10 years and has been named the 'father of Wi-Fi,' was involved in designing standards such as IEEE 802.11b, and 802.11a.http://en.wikipedia.org/wiki/Image:Wi-Fi_logo.png

OFFICIAL WI-FI LOGO:

Wi-Fi is a wireless technology brand owned by the Wi-Fi Alliance intended to improve the interoperability of wireless local area network products based on the IEEE 802.11 standards. Common applications for Wi-Fi include Internet and VoIP phone access, gaming, and network connectivity for consumer electronics such as televisions, DVD players, and digital cameras. Wi-Fi technologies have gone through several generations since their inception in 1997. Wi-Fi is supported to different extents under Microsoft Windows, Apple Mac OS X and open source Unix and Linux operating systems.

USES:

- A Wi-Fi enabled device such as a PC, game console, cell phone, MP3 player or PDA can connect to the Internet when within range of a wireless network connected to the Internet. The area covered by one or more interconnected access points is called a hotspot. Hotspots can cover as little as a single room with wireless-opaque walls or as much as many square miles covered by overlapping access points. Wi-Fi has been used to create mesh networks, for example, in London.Both architectures are used in community networks.
- Wi-Fi also allows connectivity in peer-to-peer (wireless ad-hoc network) mode, which enables devices to connect directly with each other. This connectivity mode is useful in consumer electronics and gaming applications.When the technology was first commercialized there were many problems because consumers could not be sure that products from different vendors would work together. The Wi-Fi Alliance began as a community to solve this issue so as to address the needs of the end user and allow the technology to mature. The Alliance created the branding Wi-Fi CERTIFIED to show consumers that products are interoperable with other products displaying the same branding.
- Many consumer devices use Wi-Fi. Amongst others, personal computers can network to each other and connect to the Internet, mobile computers can connect to the Internet from any Wi-Fi hotspot, and digital cameras can transfer images wirelessly.

- Routers which incorporate a DSL or cable modem and a Wi-Fi access point are often used in homes and other premises, and provide Internet access and internetworking to all devices connected wirelessly or by cable into them. Devices supporting Wi-Fi can also be connected in for client-to-client connections without a router.
- In business environments, increasing the number of Wi-Fi access points provides redundancy, support for fast roaming and increased overall network capacity by using more channels or creating smaller cells. Wi-Fi enables wireless voice applications (VoWLAN or WVOIP). Over the years, Wi-Fi implementations have moved toward 'thin' access points, with more of the network intelligence housed in a centralized network appliance, relegating individual Access Points to be simply 'dumb' radios. Outdoor applications may utilize true mesh topologies. As of 2007 Wi-Fi installations can provide a secure computer networking gateway, firewall, DHCP server, intrusion detection system, and other functions.

ADVANTAGES:

Wi-Fi allows LANs to be deployed without cabling for client devices, typically reducing the costs of network deployment and expansion. Spaces where cables cannot be run, such as outdoor areas and historical buildings, can host wireless LANs.

As of 2007 wireless network adapters are built into most modern laptops. The price of chipsets for Wi-Fi continues to drop, making it an economical networking option included in even more devices. Wi-Fi has become widespread in corporate infrastructures, which also helps with the deployment of RFID technology that can piggyback on Wi-Fi.

Different competitive brands of access points and client network interfaces are inter-operable at a basic level of service. Products designated as "Wi-Fi Certified" by the Wi-Fi Alliance are backwards inter-operable. Wi-Fi is a global set of standards. Unlike mobile telephones, any standard Wi-Fi device will work anywhere in the world.

DISADVANTAGES:

- Power consumption is fairly high compared to some other low-bandwidth standards, such as Zigbee and Bluetooth, making battery life a concern.
- The most common wireless encryption standard, Wired Equivalent Privacy or WEP, has been shown to be easily breakable even when correctly configured. Wi-Fi Protected Access (WPA and WPA2), which began shipping in 2003, aims to solve this problem and is now available on most products. Wi-Fi Access Points typically default to an "open" (encryption-free) mode. Novice users benefit from a zero-configuration device that works out of the box, but this default is without any wireless security enabled, providing open wireless access to their LAN. To turn security on requires the user to configure the device, usually via a software graphical user interface (GUI). Wi-Fi networks that are open (unencrypted) can be monitored and used to read and copy data (including personal information) transmitted over the network, unless another security method is used to secure the data, such as a VPN or a secure web page. (See HTTPS/Secure Socket Layer.)
- Many 2.4 GHz 802.11b and 802.11g Access points default to the same channel on initial startup, contributing to congestion on certain channels. To change the channel of operation for an access point requires the user to configure the device.
- Wi-Fi networks have limited range. A typical Wi-Fi home router using 802.11b or 802.11g with a stock antenna might have a range of 32 m (120 ft) indoors and 95 m (300 ft) outdoors. Range also varies with frequency band. Wi-Fi in the 2.4 GHz frequency block

has slightly better range than Wi-Fi in the 5 GHz frequency block. Outdoor range with improved (directional) antennas can be several kilometres or more with line-of-sight.

- Wi-Fi performance also decreases exponentially as the range increases.

- Wi-Fi pollution or an excessive number of access points in the area, especially on the same or neighboring channel, can prevent access and interfere with the use of other access points by others, caused by overlapping channels in the 802.11g/b spectrum, as well as with decreased signal-to-noise ratio (SNR) between access points. This can be a problem in high-density areas, such as large apartment complexes or office buildings with many Wi-Fi access points. Additionally, other devices use the 2.4 GHz band: microwave ovens, security cameras, Bluetooth devices and (in some countries) Amateur radio, video senders, cordless phones and baby monitors can cause significant additional interference. General guidance to those who suffer these forms of interference or network crowding is to migrate to a WiFi 5 GHz product, (802.11a or the newer 802.11n IF it has 5GHz/11a support) as the 5 GHz band is relatively unused and there are many more channels available. This also requires users to set up the 5 GHz band to be the preferred network in the client and to configure each network band to a different name (SSID).
- It is also an issue when municipalities,[6] or other large entities such as universities, seek to provide large area coverage. This openness is also important to the success and widespread use of 2.4 GHz Wi-Fi.
- Interoperability issues between non WiFi brands or proprietary deviations from the standard can disrupt connections or lower throughput speeds on all user's devices that are within range, to include the non-WiFi or proprietary product.

STANDARD DEVICES:

- Wireless access points connects a group of wireless devices to an adjacent wired LAN. An access point is similar to a network hub, relaying data between connected wireless devices in addition to a (usually) single connected wired device, most often an ethernet hub or switch, allowing wireless devices to communicate with other wired devices.
- Wireless adapters allow devices to connect to a wireless network. These adapters connect to devices using various external or internal interconnects such as PCI, miniPCI, USB, ExpressCard, Cardbus and PC card. Most newer laptop computers are equipped with internal adapters. Internal cards are generally more difficult to install.
- Wireless routers integrate a WAP, ethernet switch, and internal Router firmware application that provides IP Routing, NAT, and DNS forwarding through an integrated WAN interface. A wireless router allows wired and wireless ethernet LAN devices to connect to a (usually) single WAN device such as cable modem or DSL modem. A wireless router allows all three devices (mainly the access point and router) to be configured through one central utility. This utility is most usually an integrated web server which serves web pages to wired and wireless LAN clients and often optionally to WAN clients. This utility may also be an application that is run on a desktop computer such as Apple's AirPort.
- Wireless network bridges connect a wired network to a wireless network. This is different from an access point in the sense that an access point connects wireless devices to a wired network at the data-link layer. Two wireless bridges may be used to connect two wired networks over a wireless link, useful in situations where a wired connection may be unavailable, such as between two separate homes.

NON-STANDARD DEVICES:

Distance records include:
June 2007: 382 km is held by Ermanno Pietrosemoli and EsLaRed of Venezuela, transferring about 3 MB of data between mountain tops of El Aguila and Platillon Swedish space agency:310 km, but using 6 watt amplifiers to reach an overhead stratospheric balloon.

WIMAX

WiMAX, the Worldwide Interoperability for Microwave Access, is a telecommunications technology aimed at providing wireless data over long distances in a variety of ways, from point-to-point links to full mobile cellular type access. It is based on the IEEE 802.16 standard, which is also called WirelessMAN. The name WiMAX was created by the WiMAX Forum, which was formed in June 2001 to promote conformance and interoperability of the standard. The forum describes WiMAX as "a standards-based technology enabling the delivery of last mile wireless broadband access as an alternative to cable and DSL

USES:

The bandwidth and reach of WiMAX make it suitable for the following potential applications:
- Connecting Wi-Fi hotspots with each other and to other parts of the Internet.
- Providing a wireless alternative to cable and DSL for last mile broadband access.
- Providing high-speed data and telecommunications services.
- Providing a diverse source of Internet connectivity as part of a business continuity plan. That is, if a business has a fixed and a wireless Internet connection, especially from unrelated providers, they are unlikely to be affected by the same service outage.
- Providing nomadic connectivity.

BROADBAND ACCESS

Many companies are closely examining WiMAX for "last mile" connectivity at high data rates. The resulting competition may bring lower pricing for both home and business customers or bring broadband access to places where it has been economically unavailable. Prior to WiMAX, many operators have been using proprietary fixed wireless technologies for broadband services.

WiMAX access was used to assist with communications in Aceh, Indonesia, after the tsunami in December 2004. All communication infrastructure in the area, other than Ham Radio, was destroyed, making the survivors unable to communicate with people outside the disaster area and vice versa. WiMAX provided broadband access that helped regenerate communication to and from Aceh.

WiMAX was used by Intel to assist the FCC and FEMA in their communications efforts in the areas affected by Hurricane Katrina.[2]

SUBSCRIBER UNITS:

WiMAX subscriber units are available in both indoor and outdoor versions from several manufacturers. Self-install indoor units are convenient, but radio losses mean that the subscriber must be significantly closer to the WiMAX base station than with professionally-installed external units. As such, indoor-installed units require a much higher infrastructure investment as well as operational cost (site lease, backhaul, maintenance) due to the high number of base stations required to cover a given area. Indoor units are comparable in

size to a cable modem or DSL modem. Outdoor units are roughly the size of a laptop PC, and their installation is comparable to a residential satellite dish.

With the advent of mobile WiMAX, there is an increasing focus on portable units. This includes handsets (similar to cellular smartphones) and PC peripherals (PC Cards or USB dongles). In addition, there is much emphasis from operators on consumer electronics devices (game terminals, MP3 players and the like); it is notable this is more similar to Wi-Fi than 3G cellular technologies.

MOBILE HANDSET APPLICATIONS

Some cellular companies are evaluating WiMAX as a means of increasing bandwidth for a variety of data-intensive applications.

Sprint Nextel announced in mid-2006 that it would invest about US$ 5 billion in a WiMAX technology buildout over the next few years.[3] As of Friday, November 9, 2007, this project in partnership with Clearwire has been shelved, but the project could be revived with or without Clearwire once Sprint hires a new CEO. On December 5, 2007, Bin Shen, Sprint's VP of Product Management and Partnership Development, announced that Sprint's WiMAX network will go live in a soft launch in Chicago, Baltimore, and Washington DC. Full commercial launch is still expected to be approximately spring of 2008.[4] NYT reports[1] that Sprint's soft launch in the three test markets went live as of January 11, 2008. Sprint hopes to use WiMAX as a springboard past its competitors and past concerns about its shrinking user base and concerns about the financial wisdom of the large WiMAX deployment.

TECHNICAL INFORMATION:

WiMAX is a term coined to describe standard, interoperable implementations of IEEE 802.16 wireless networks, similar to the way the term Wi-Fi is used for interoperable implementations of the IEEE 802.11 Wireless LAN standard. However, WiMAX is very different from Wi-Fi in the way it work

PHYSICAL LAYER:

The original WiMAX standard (IEEE 802.16) specified WiMAX for the 10 to 66 GHz range. 802.16a, updated in 2004 to 802.16-2004, added specifications for the 2 to 11 GHz range. 802.16-2004 was updated to 802.16e in 2005 and uses scalable orthogonal frequency-division multiple access (SOFDMA) as opposed to the OFDM version with 256 sub-carriers (of which 200 are used) in 802.16d. More advanced versions, including 802.16e, also bring Multiple Antenna Support through Multiple-input multiple-output communications (MIMO) See WiMAX MIMO. This brings potential benefits in terms of coverage, self installation, power consumption, frequency re-use and bandwidth efficiency. 802.16e also adds a capability for full mobility support. The WiMAX certification allows vendors with 802.16d products to sell their equipment as WiMAX certified, thus ensuring a level of interoperability with other certified products, as long as they fit the same profile.

Most commercial interest is in the 802.16d and .16e standards, since the lower frequencies used in these variants suffer less from inherent signal attenuation and therefore give improved range and in-building penetration. Already today, a number of networks throughout the world are in commercial operation using certified WiMAX equipment compliant with the 802.16d standard.

ARCHITECTURE:

http://en.wikipedia.org/wiki/Image:WiMAXArchitecture.png
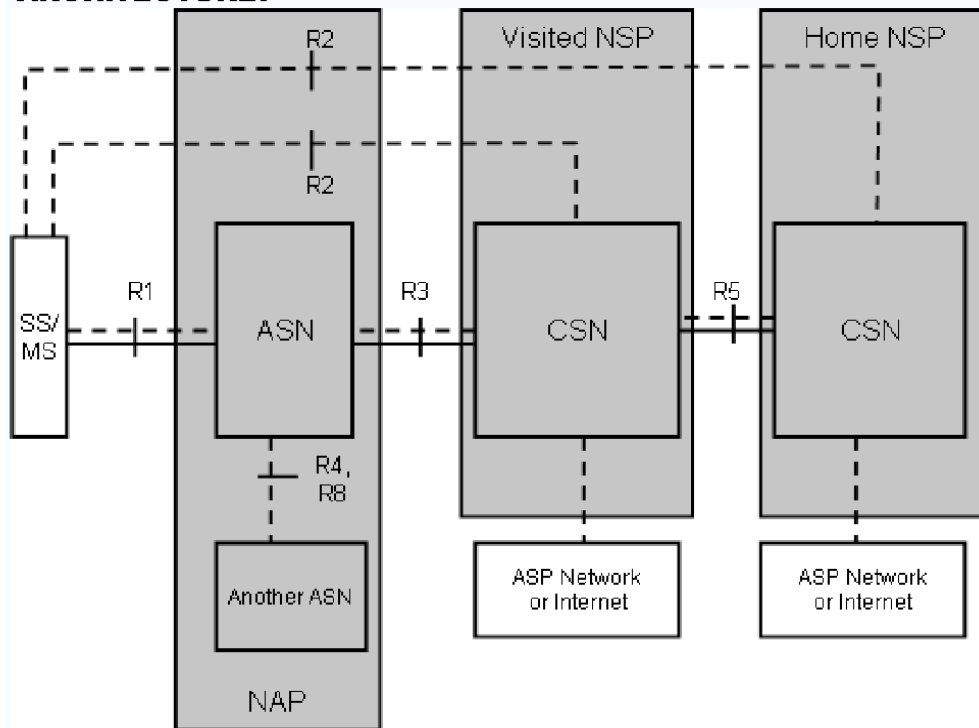
The WiMAX Forum has defined an architecture that defines how a WiMAX network connects with other networks, and a variety of other aspects of operating such a network, including address allocation, authentication, etc. An overview of the architecture is given in the illustration. This defines the following components:

- SS/MS: the Subscriber Station/Mobile Station
- ASN: the Access Service Network
- BS: Base station, belongs to ASN
- ASN-GW: belongs to ASN
- CSN: the Connectivity Service Network
- HA: Home Agent, belongs to CSN
- AAA: AAA Server, belongs to CSN
- NAP: a Network Access Provider
- NSP: a Network Service Provider

plus a number of interconnections (or reference points) between these, labeled R1 to R5 and R8.It's important to note that the functional architecture can be designed into various hardware configurations rather than fixed configurations. For example, the architectureflexible to allow various scale and functionality of remote/mobile stations and collaborative aggregations of femto, pico, and mini RS/MS.

COMPARISON WITH WI-FI:

- Possibly due to the fact both WiMAX and Wi-Fi begin with the same two letters, are based upon IEEE standards beginning with "802.", and both have a connection to wireless connectivity and the Internet, comparisons and confusion between the two are frequent. Despite this, the two standards are aimed at different applications.
- WiMAX is a long-range system, covering many kilometers that typically uses licensed spectrum (although it is also possible to use unlicensed spectrum) to deliver a point-to-

point connection to the Internet from an ISP to an end user. Different 802.16 standards provide different types of access, from mobile (analogous to access via a cellphone) to fixed (an alternative to wired access, where the end user's wireless termination point is fixed in location.)

- Wi-Fi is a shorter range system, typically hundreds of meters, that uses unlicensed spectrum to provide access to a network, typically covering only the network operator's own property. Typically Wi-Fi is used by an end user to access their own network, which may or may not be connected to the Internet. If WiMAX provides services analogous to a cellphone, Wi-Fi is more analogous to a cordless phone.
- WiMAX and Wi-Fi have quite different Quality of Service (QoS) mechanisms. WiMAX uses a mechanism based on setting up connections between the Base Station and the user device. Each connection is based on specific scheduling algorithms, which means that QoS parameters can be guaranteed for each flow. Wi-Fi has introduced a QoS mechanism similar to fixed Ethernet, where packets can receive different priorities based on their tags. This means that QoS is relative between packets/flows, as opposed to guaranteed.
- WiMAX is highly scalable from what are called "femto"-scale remote stations to multi-sector 'maxi' scale base that handle complex tasks of management and mobile handoff functions and include MIMO-AAS smart antenna subsystems.

SPECTRAL EFFICIENCY:

One of the significant advantages of advanced wireless systems such as WiMAX is spectral efficiency. For example, 802.16-2004 (fixed) has a spectral efficiency of 3.7 bit/s/Hertz, and other 3.5–4G wireless systems offer spectral efficiencies that are similar to within a few tenths of a percent. The notable advantage of WiMAX comes from combining SOFDMA with smart antenna technologies. This multiplies the effective spectral efficiency through multiple reuse and smart network deployment topologies. The direct use of frequency domain organization simplifies designs using MIMO-AAS compared to CDMA/WCDMA methods, resulting in more-effective systems.

COMPETING TECHNOLOGIES:-
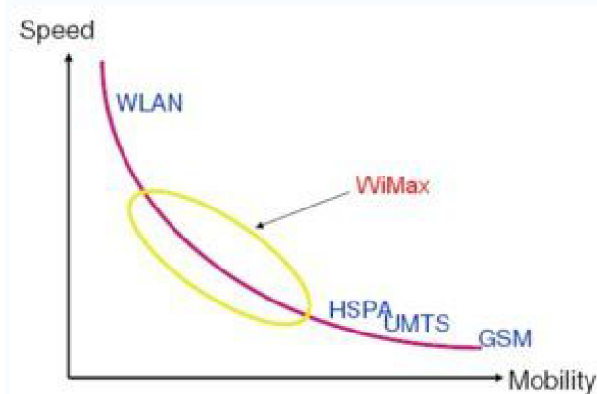
Within the marketplace, WiMAX's main competition comes from existing widely deployed wireless systems such as UMTS and CDMA2000, as well as a number of Internet oriented systems such as HIPERMAN and WiBro.

MOBILE BROADBAND WIRELESS ACCESS:-

Mobile Broadband Wireless Access (MBWA) is a technology being developed by IEEE 802.20 and is aimed at wireless mobile broadband for operations from 120 to 350 km/h. The 802.20 standard committee was first to define many of the methods which were later funneled into Mobile WiMAX, including high speed dynamic modulation and similar

scalable OFDMA capabilities. It apparently retains fast hand-off, Forward Error Correction (FEC) and cell edge enhancements.

The Working Group was temporarily suspended in mid 2006 by the IEEE-SA Standards Board since it had been the subject of a number of appeals, and a preliminary investigation of one of these "revealed a lack of transparency, possible 'dominance,' and other irregularities in the Working Group".

FUTURE DEVELOPMENT:

The goal for the long term evolution of both WiMAX and LTE is to achieve 100 Mbit/s mobile and 1 Gbit/s fixed-nomadic bandwidth as set by ITU for 4G NGMN (Next Generation Mobile Network) systems through the adaptive use of MIMO-AAS and smart, granular network topologies. 3GPP LTE and WiMAX-m are concentrating much effort on MIMO-AAS, mobile multi-hop relay networking and related developments needed to deliver 10X and higher Co-Channel reuse multiples.

Since the evolution of core air-link technologies has approached the practical limits imposed by Shannon's Theorem, the evolution of wireless has embarked on pursuit of the 3X to 10X+ greater bandwidth and network efficiency gains that are expected by advances in the spatial and smart wireless broadband networking technologies. What will clearly define 4G more than either WCDMA or OFDMA wireless link methods will be wireless networks that more effectively adapt to and take advantage of available spectrum