WiMAX

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Abstract: *This article gives an overview of WiMAX. WiMAX is not a technology, but rather a certification mark, or 'stamp of approval' given to equipment that meets certain conformity and interoperability tests for the IEEE 802.16 family .The introduction of wireless communication, definition of WiMAX and their difference with the Wi-Fi technology are illustrated. WiMAX defines a flexible all-IP-based network architecture that allows for the exploitation of all the benefits of IP. The article relates the Access, Limitations, Layers, working of WiMAX and specifications. The technology is relatively new, and several vendors are coming up with the support infrastructure. The current trends, potential applications and their future are discussed at the last.*

Keywords: *Certification Mark, IEEE, Layers, Wi-Fi.*

I. Introduction

Wireless communication is the transfer of information over a distance without the use of electrical conductors or "wires". The distances involved may be short (a few meters as in television remote control) or long (thousands or millions of kilometers for radio communications). When the context is clear, the term is often shortened to "wireless". Wireless communication is generally considered to be a branch of telecommunications.

Wireless communication can be radio frequency communication, microwave communication, for example long-range line-of-sight via highly directional antennas, or short-range communication, or infrared (IR) short-range communication, for example from remote controls or via Infrared Data Association (IrDA).

WiMAX (Worldwide Interoperability for Microwave Access) is considered today the most interesting opportunity, able to provide radio coverage distances of almost 50 kilometers for fixed receivers and 5-15 kilometers for mobile receivers and data throughput up to 70 Mbps.

WiMAX is a technology standard that enables high speed wireless internet. Mobile WiMAX allows broadband wireless connection with the convenience of mobile internet connectivity.

The IEEE 802.16 Working Group created a new standard, commonly known as WiMAX, for broadband wireless access at high speed and low cost, which is easy to deploy, and which provides a scalable solution for extension of a fiber-optic backbone. The IEEE 802.16 designed to operate in the 10-66 GHz spectrum and it specifies the physical layer (PHY) and medium access control layer (MAC) of the air interface BWA systems. At 10-66 GHz range, transmission requires Line-of-Sight (LOS).

WiMAX base stations can offer greater wireless coverage of about 5 miles, with LOS (line of sight) transmission within bandwidth of up to 70 Mbps.

WiMAX is related to the "d" release of the standard IEEE 802.16, approved during August 2004, and it supports broadband wireless "fixed" connections, while the evolution of 802.16e is in development, focused on the broadband wireless access in mobility.

II. Overview

WiMAX has the potential to replace a number of existing telecommunications infrastructures. In a fixed wireless configuration it can replace the telephone company's copper wire networks, the cable TV's coaxial cable infrastructure while offering Internet Service Provider (ISP) services. In its mobile variant, WiMAX has the potential to replace cellular networks.

Technologies providing high speed wireless internet are nothing new. However these technologies were targeted to a niche market and the specialized equipment for receiving the signals have so far been very expensive. However WiMAX has been planned in a much larger scale. Computing and communication firms over the world are working on a consensus for the WiMAX standards such as how to encrypt WiMAX signals and which frequencies to use. This in turn will help mass manufacture of WiMAX enabled chips, bringing down the costs of receivers in the $50-$100 price range.

Further, WiMAX can bring such diverse services as VoIP, video and internet under a single umbrella, resulting in better prices for the end user. The range and scope of WiMAX can eliminate captive customer bases of current telephone and cable operators and increase competition.

WiMAX is also interoperable with cellular networks. The greater bandwidth enables a wide variety of data intensive applications. In countries where wired infrastructure is not highly developed, installing a WiMAX tower will be the less expensive option to developing wired connectivity.

Fixed WiMAX: The IEEE originally formed the IEEE 802.16 working group in 1998 to provide a standard for wireless metropolitan area networks. The primary application was for high-speed fiber access solutions using high frequency line-of-sight (LOS) fixed wireless connections. The original standard was referred to as 802.16 and evolved to support fixed broadband wireless access over lower frequency non-line-of-sight (NLOS) wireless connections. The evolved standard, 802.16-2004, is often referred to as fixed WiMAX.

Mobile WiMAX: Once the 802.16-2004 standard was complete, the IEEE committee began work to further evolve the standard to support mobile applications. Mobile communication is more complex than fixed communication. The technology must be able to hand off a wireless connection from one base station to another while the user is moving, without dropping the connection. The new 802.16e-2005 standard was completed in December2005, and not only supports mobile applications but also nomadic and fixed applications. 802.16e-2005 is often referred to as mobile WiMAX.

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.

III. Features

WiMAX have lots of features to its name. Lots of limitations were found as the use of Wifi technology grew around the world, to overcome these limitations and to invent better and more efficient wireless technology was realized which turned out to be WiMAX. WiMAX have lots of features which helped in increase usability of WiMAX around the world. It is still not been used to its full potential that's why there may be more features which may not be known as yet, more and more exploration is required to get WiMAX technology to its full use, however we know some of its significant features which are important enough to mention.

A. Long Range

Connectivity from long range is much highlighted feature of WiMAX. Theoretically it is believed that WiMAX technology provides range up 30 miles (50 Km). However in practical experience it is observed that it provides range up to 10 km which is still huge breakthrough in long range connectivity. Users can connect to WiMAX base station using SUI from their homes.

B. Mobility

Another significant feature of WiMAX technology is the connectivity on move. This technology amaze the world hence increasing the use of WiMAX in some parts of the world dramatically. Especially to the urban places where cables and other network equipments are not feasible to install. Using its long range feature it provides connectivity on such area where other means of high speed Internet are not available.
The other major mobility feature of WiMAX technology is that connecting devices (Laptops, PDA etc) can move in certain area and still be connected to the network.

C. Interfacing

WiMAX radio signals are broadcasted to its subscribers from base stations. Base stations are area where all necessary hardware is installed to provide WiMAX with in its range. Since one Base station covers limited range so connecting multiple base stations to each other increase that much range for connectivity. Connecting multiple base stations to each other is not big task and can be perform in few hours.

D. Accessibility

Accessing WiMAX base station is not a difficult task, its long range capability provides connectivity at home from base stations within the range. To get high speed internet it's only required to be because subscriber to WiMAX. Service providers. They will provide you appropriate hardware to become of the subscriber. Installing the hardware is very easy; it is just plug and play. Hardware mostly connects through USB ports or Ethernet and connection can be made by clicking just a button.

E.Network Scale

The smallest-scale network is a personal area network (PAN). A PAN allows devices to communicate with each other over short distances. Bluetooth is the best example of a PAN.

The next step up is a local area network (LAN). A LAN allows devices to share information, but is limited to a fairly small central area, such as a company's headquarters, a coffee shop or house. Many LANs use WiFi to connect the network wirelessly.

WiMAX is the wireless solution for the next step up in scale, the metropolitan area network (MAN). A MAN allows areas the size of cities to be connected.

The WiMAX base station would send data to a WiMAX-enabled router, which would then send the data to the different computers on the network. We could even combine WiFi with WiMAX by having the router send the data to the computers via WiFi.

With spectrum being scarce in India, technology adoption decision would hinge on spectral efficiency. Spectral efficiency has a favorable impact on the business case as it:

Lowers deployment cost per Megabit, which would be key to rural and remote area deployments.

Offers increased network capacity to support new value-added services for increased operator revenues.

IV. Wimax Versus Wifi

WiMAX operates on the same general principles as WiFi -- it sends data from one computer to another via radio signals. A computer (either a desktop or a laptop) equipped with WiMAX would receive data from the WiMAX transmitting station, probably using encrypted data keys to prevent unauthorized users from stealing access.

The fastest WiFi connection can transmit up to 54 megabits per second under optimal conditions. WiMAX should be able to handle up to 70 megabits per second. Even once that 70 megabits is split up between several dozen businesses or a few hundred home users, it will provide at least the equivalent of cable-modem transfer rates to each user.

The biggest difference isn't speed; it's distance. WiMAX outdistances WiFi by miles. WiFi's range is about 100 feet (30 m). WiMAX will blanket a radius of 30 miles (50 km) with wireless access. The increased range is due to the

frequencies used and the power of the transmitter. Of course, at that distance, terrain, weather and large buildings will act to reduce the maximum range in some circumstances, but the potential is there to cover huge tracts of land.

WiMAX is not designed to clash with WiFi, but to coexist with it. WiMAX coverage is measured in square kilometers, while that of WiFi is measured in square meters. The original

WiMAX standard (IEEE 802.16) proposes the usage of 10-66 GHz frequency spectrum for the WiMAX transmission, which is well above the WiFi range (up to 5GHz maximum). But 802.16a added support for 2-11 GHz frequency also. One WiMAX base station can be accessed by more than 60 users. WiMAX can also provide broadcasting services also.

WiMAX specifications also provides much better facilities than WiFi, providing higher bandwidth and high data security by the use of enhanced encryption schemes. WiMAX can also provide service in both Line Of Sight (LOS) and Non-Line of Sight (NLOS) locations, but the range will vary accordingly. WiMAX will allow the interpenetration for broadband service provision of VoIP, video, and internet access – simultaneously. WiMAX can also work with existing mobile networks. WiMAX antennas can "share" a cell tower without compromising the function of cellular arrays already in place.

WiMAX uses spectrum to deliver a point-to-point connection to the Internet. Different 802.16 standards provide different types of access, from portable (similar to a cordless phone) to fixed (an alternative to wired access, where the end user's wireless termination point is fixed in location.)

Wi-Fi uses unlicensed spectrum to provide access to a network. Wi-Fi is more popular in end user devices.

WiMAX and Wi-Fi have quite different quality of service (QoS) mechanisms. WiMAX uses a mechanism based on connections between the base station and the user device. Each connection is based on specific scheduling algorithms. Wi-Fi has a QoS mechanism similar to fixed Ethernet, where packets can receive different priorities based on their tags. For example VoIP traffic may be given priority over web browsing.

Wi-Fi runs on the Media Access Control's CSMA/CA protocol, which is connectionless and contention based, whereas WiMAX runs a connection-oriented MAC.

V. Network Reference Model

The network reference model developed by the WiMAX Forum NWG defines a number of functional entities and interfaces between those entities. Fig below shows some of the more important functional entities.

Base station (BS): The BS is responsible for providing the air interface to the MS. Additional functions that may be part of the BS are micromobility management functions, such as handoff triggering and tunnel establishment, radio resource management, QoS policy enforcement, traffic classification, DHCP (Dynamic Host Control Protocol) proxy, key management, session management, and multicast group management.

Access service network gateway (ASN-GW): The ASN gateway typically acts as a layer 2 traffic aggregation points within an ASN. Additional functions that may be part of the ASN gateway include intra-ASN location management and paging, radio resource management and admission control, caching of subscriber profiles and encryption keys, AAA client functionality, establishment and management of mobility tunnel with base stations, QoS and policy enforcement, and foreign agent functionality for mobile IP, and routing to the selected CSN.

Connectivity service network (CSN): The CSN provides connectivity to the Internet, ASP, other public networks, and corporate networks. The CSN is owned by the NSP and includes AAA servers that support authentication for the devices, users, and specific services. The CSN also provides per user policy management of QoS and security. The CSN is also responsible for IP address management, support for roaming between different NSPs, location management between ASNs, and mobility and roaming between ASNs.

IP-Based WiMAX Network Architecture
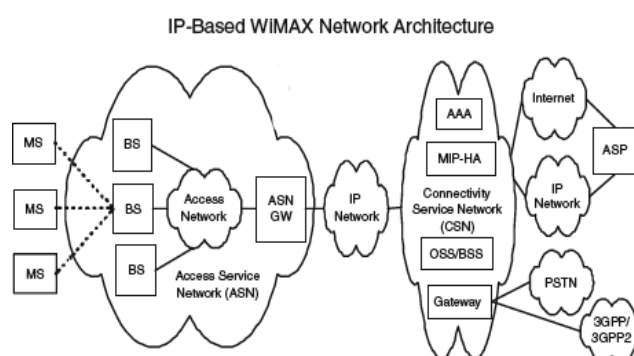
The WiMAX architecture framework allows for the flexible decomposition and/or combination of functional entities when building the physical entities.

VI. Working Of WIMAX

There are basically three different options to access internet:
• Broadband access - In your home, you have either a DSL or cable modem. At the office, your company may be using a T1 or a T3 line.
• WiFi access - In your home, you may have set up a WiFi router that lets you surf the Web while you lounge with your
• laptop. On the road, you can find WiFi hot spots in restaurants, hotels, coffee shops and libraries.
• Dial-up access - If you are still using dial-up, chances are that either broadband access is not available, or you think that broadband access is too expensive.

The main problems with broadband access are that it is pretty expensive and it doesn't reach all areas. The main problem with WiFi access is that hot spots are very small, so coverage is sparse.

WiMAX technology works little different than WiFi technology. In WiFi computers can be connected through wireless LAN card to nearby access point, wireless router or any Hotspot, it does not works this way when we talk about connectivity in WiMAX.

A WiMAX system consists of two parts:
• A WiMAX tower, similar in concept to a cell-phone tower - A single WiMAX tower can provide coverage to a very large area -- as big as 3,000 square miles (~8,000 square km).
• A WiMAX receiver - The receiver and antenna could be a small box or PCMCIA card, or they could be built into a laptop the way WiFi access is today.

A WiMAX tower station can connect directly to the Internet using a high-bandwidth, wired connection (for example, a T3 line). It can also connect to another WiMAX tower using a line-of-sight, microwave link. This connection to a second tower (often referred to as a backhaul), along with the ability of a single tower to cover up to 3,000 square miles, is what allows WiMAX to provide coverage to remote rural areas.
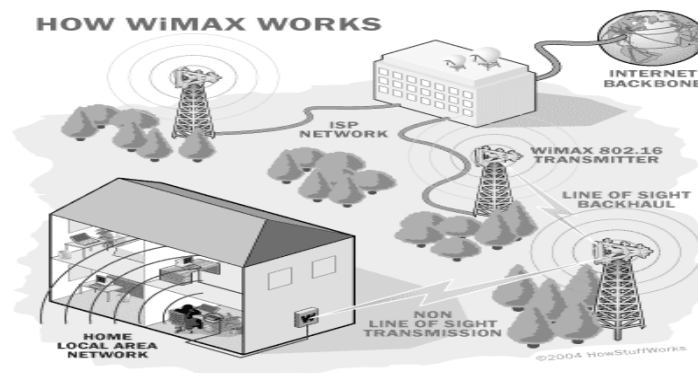
WiMAX actually can provide two forms of wireless service:

• There is the non-line-of-sight, WiFi sort of service, where a small antenna on your computer connects to the tower. In this mode, WiMAX uses a lower frequency range -- 2 GHz to 11 GHz (similar to WiFi). Lower-wavelength transmissions are not as easily disrupted by physical obstructions -- they are better able to diffract, or bend, around obstacles.

• There is line-of-sight service, where a fixed dish antenna points straight at the WiMAX tower from a rooftop or pole. The line-of-sight connection is stronger and more stable, so it's able to send a lot of data with fewer errors. Line-of-sight transmissions use higher frequencies, with ranges reaching a possible 66 GHz. At higher frequencies, there is less interference and lots more bandwidth.

WiFi-style access will be limited to a 4-to-6 mile radius (perhaps 25 square miles or 65 square km of coverage, which is similar in range to a cell-phone zone). Through the stronger line-of-sight antennas, the WiMAX transmitting station would send data to WiMAX-enabled computers or routers set up within the transmitter's 30-mile radius (2,800 square miles or 9,300 square km of coverage). This is what allows WiMAX to achieve its maximum range.

The final step in the area network scale is the global area network (GAN). The proposal for GAN is IEEE 802.20. A true GAN would work a lot like today's cell phone networks, with users able to travel across the country and still have access to the network the whole time. This network would have enough bandwidth to offer Internet access comparable to cable modem service, but it would be accessible to mobile, always-connected devices like laptops or next-generation cell phones.

VII. WiMax at Home

An Internet service provider sets up a WiMAX base station 10 miles from the home. WiMAX-enabled computer or upgraded old computer to add WiMAX capability is needed. We receive a special encryption code that would give us access to the base station. The base station would beam data from the Internet to the computer (at speeds potentially higher than today's cable modems), for which we would pay the provider a monthly fee. The cost for this service could be much lower than current high-speed Internet-subscription fees because the provider never had to run cables.

The WiMAX base station would send data to a WiMAX-enabled router, which would then send the data to the different computers on the network. We could even combine WiFi with WiMAX by having the router send the data to the computers via WiFi.

WiMAX doesn't just pose a threat to providers of DSL and cable-modem service. The WiMAX protocol is designed to accommodate several different methods of data transmission, one of which is Voice over Internet Protocol (VoIP). VoIP allows people to make local, long-distance and even international calls through a broadband Internet connection, bypassing phone companies entirely. If WiMAX-compatible computers become very common, the use of VoIP could increase dramatically. Almost anyone with a laptop could make VoIP calls.

VIII. Goals

WiMAX has stepped forward to help solve barriers to adoption, such as interoperability and cost of deployment. WiMAX will help ignite the wireless MAN industry, by defining and conducting interoperability testing and labeling vendor systems with a "WiMAX Certified™" label once testing has been completed successfully.

A. Benefits to Component Makers
• Creates a volume opportunity for silicon suppliers.

B.Benefits to Equipment Makers
• Innovate more rapidly because there exists a standards-based, stable platform upon which to rapidly add new capabilities.
• No longer need to develop every piece of the end-to-end solution.

C.Benefits to Operator
• A common platform which drives down the cost of equipment and accelerates price/performance improvements unachievable with proprietary approaches.
• Generate revenue by filling broadband access gaps.
• Quickly provision T1 / E1 level and "on demand" high margin broadband services.
• Reduce the dollar risk associated with deployment as equipment will be less expensive due to economies of scale.
• No longer be locked into a single vendor since base stations will interoperate with multiple vendors' CPEs.

D.Benefits to Consumers
More broadband access choices, especially in areas where there are gaps: worldwide urban centers where•
 building access is difficult; in suburban areas where the subscriber is too far from the central office; and in rural and low population density areas where infrastructure is poor.
• More choices for broadband access will create competition which will result in lower monthly subscription prices.

IX. Limitations

A commonly held misconception is that WiMAX will deliver 70 Mbit/s, over 70 miles (112.6 kilometers). Each of these is true individually, given ideal circumstances, but they are not simultaneously true. In practice this means that in Line of sight environments we could deliver symmetrical speeds of 10Mbps at 10Km but in Urban Environments it is more likely that 30% of installations may be Non Line of sight and therefore Users may only receive 10Mbps over 2Km. WiMAX has some similarities to DSL in this respect, where one can either have high bandwidth or long reach, but not both simultaneously.

The other feature to consider with WiMAX is that available bandwidth is shared between users in a given radio sector, so if there are many active users in a single sector, each will get reduced bandwidth. However, unlike SDSL where contention is very noticeable at a 5:1 ratio if you are sharing your connection with a large media firm for example WiMAX does not have this problem. Typically each cell has a 100Mbps backhaul so there is no contention here. On the radio side in practice many users will have a range of 2,4,6,8 or 10Mbps services and the bandwidth can be shared. If the network becomes busy the business model is more like GSM or UMTS than DSL in that it is easy to predict the capacity requirements as you sign more customers and additional radio cards can be added on the same sector to increase the capacity.

One disadvantage of WiMAX is the spectral limitation, in other words limitation of wireless bandwidth. For use in high density areas, it is possible that the bandwidth may not be sufficient to cater to the needs of a large clientele, driving the costs high.

X. Applications

The applications of WiMAX are as given below:
A.Residential and SOHO High Speed Internet Access:
The main contenders for residential and SOHO market are the DSL, and Cable Internet technologies. These technologies have already established a market presence, and have proven track record in meeting the demands of the residential and SOHO customers. WiMAX provides an alternative to existing access methods, where it is not feasible to use DSL or Cable Internet. Typical application will be in remote areas where it is not economically feasible to have a DSL or Cable Internet.

A.   Small and Medium Business:
The WiMAX WBA is well suited to provide the reliability and speed for meeting the requirements of small and medium size businesses in low density environments.

B.   WiFi Hot Spot Backhaul:
Another area where WiMAX connectivity is for WiFi hot spots connectivity. As of now, there have been several WiFi hotspots and a WiMAX backhaul provides full wireless solution to these wireless networks.

XI. Current Trends and Products

The WiMAX Forum is "the exclusive organization dedicated to certifying the interoperability of BWA products, the WiMAX Forum defines and conducts conformance and interoperability testing to ensure that different vendor systems work seamlessly with one another." Those that pass conformance and interoperability testing achieve the "WiMAX Forum Certified" designation and display this mark on their products and marketing materials. A vendor claiming their equipment is "WiMAX-ready", "WiMAX-compliant", or "pre-WiMAX" is not WiMAX Forum Certified, according to the Forum.

According to companies like Intel, Cisco, Microsoft and Siemens, the next-generation wireless technology will be based on WiMAX standards. Intel Corporation announced the availability of its first WiMAX product, providing equipment manufacturers and carriers the ability to deliver next-generation wireless broadband networks around the world.

During 2009, players like Intel anticipate there will be about 1 billion laptops with mini-PCI cards for WiMAX network access. When adding infrastructure and other equipment with WiMAX components the market potential is enormous.

Some the products available in market:
C. WiMax indoor subscriber unit (SUI)
This device is indoor wireless subscriber access product which is designed on protocol IEEE 802.61-2004 standards. This device compatible to MPM equipment PMP is point Multipoint. Device has multiple Ethernet ports interface including (VoIP). SUI have LED installed on its front side which shows the strength of the signals. This is third generation device (3G). SUI uses technology called Orthogonal Frequency Division Multiplexing (OFDM) and non-line-of-sight (NLOS) technology enables handling rural and urban obstacles like trees, building even mountains to keep the connection to the link.

D. WiMAX External antenna
This external antenna is used to improve the signal strengths of WiMax subscribers from base station. WiMax external antennas are mostly required when subscriber is located in middle of populated or dense area; it can also be used where high mountains, and tree creates obstacles within base station and subscriber location. Antenna is connected with wire to indoor subscriber unit SUI to strengthened the signals

E. Outdoor Subscriber Unit (SU-O)
This outdoor subscriber unit (SU-O) works exactly like SUI. The only different this product is its outdoor usability. It forms connection to WiMax base station to provide broadband access to WiMax subscriber. Its way of functionality is no different than SUI.

F. WiMAX Certified Base Station
The world's first WiMAX forum certified base station is Redlines' Red MAX AN-100. This device works and base station for WiMax, it is easy to install and very cost effective for deployment. Its low latency makes sure that it provides delivery of good quality and sensitive services, including voice traffic, Voice over Internet Protocol (VoIP), video and data traffic.An-100 designed architecture assures over-the-air facility with help of software. It also has dynamic ability of on-the-fly services.

Korea's electronics and telecommunication industry spearheaded by Samsung Electronics and ETRI has developed its own standard, WiBro. In late 2004, Intel and LG Electronics have agreed on interoperability between WiBro and WiMAX.

WiBro has South Korean government support with the requirement for each carrier to spend over US$1 billion for deployments. The Koreans sought to develop WiBro as a regional and potentially international alternative to 3.5G or 4G cellular systems. But given the lack of momentum as a standard, WiBro has joined WiMAX and agreed to harmonize With the similar OFDMA 802.16e version of the standard. What makes WiBro roll-outs, which will start in April 2006, a good 'test case' for the overall WiMAX effort is that it is mobile, well thought out for delivery of wireless broadband services, and the fact that the deployment is taking place in a highly sophisticated, broadband-saturated market.

WiBro will go up against 3G and very high bandwidth wire-line services rather than as gap-filler or rural under-served market deployments as is often exampled as the 'best fit' markets for WiMAX.

XII. Conclusion and Future

Although a great deal of debate continues to swirl around the WiMAX standard and its merits in comparison to incumbent cellular standards, current trends suggest that WiMAX is an ideal platform for the delivery of voice, data, and video over wireless.

WiMAX is poised to deliver high speed wireless broadband at lower costs that will aide mass adoption and thus alleviate problems faced by India's broadband market.

WiMAX complement WiFi, adding its Mobility, High power efficiency, Greater coverage, High speed and Applications such as VoIP.

WiMAX can complement existing and emerging 3G mobile and wired networks, and can play a significant role in helping service providers deliver converged services that can be accessed using a broad range of devices on a wide variety of networks.

At the technical level, 3G and WiMAX solutions fit well together by providing different capabilities while allowing for seamless integration. 3G technologies have evolved over many years to become highly spectrally efficient, allowing operators to take advantage of costly spectrum dedicated to mobile services. 3G CDMA technologies such as W-CDMA and CDMA 2000 1xEV-DO provide high through puts in low bandwidths as 5 MHz and 1.25 MHz, respectively.

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