802.16, Next Generation Wireless

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1. Abstract

In recent years, plenty of interest has been shown in wireless technology. The idea of wireless local area networks (WLAN) started with the 802.11 standards, referred to as Wi-Fi. The importance of Wi-Fi is currently very evident, almost all laptops and PDAs have Wi-Fi as a standard feature. There are a number of standards that constitute 802.11. There are three main flavors of the 802.11 standard: 802.11b, 802.11g and 802.11a. Two of the standards, 802.11b and 802.11g, have interoperable characteristics. 802.11 operates on a completely different frequency and does not interoperate with 802.11b and 802.11g. The main motivation behind this paper is to discuss the next generation standard, namely the 802.16 standards. What makes the 802.16 standard significant is the fact it can be successfully deployed anywhere. The 802.16 standard is currently still under development. Some of the main motivations for the next generation wireless standard are:
1. Users are dissatisfied with network interference.
2. Network service provides need to reach customers more cost effectively.

Some of the main benefits of using 802.16 are listed below:
1. Bandwidth on demand
2. High quality throughput
3. Good coverage
4. Quality
5. Cost

2. Future of the Wireless World

As mentioned earlier, there have been new developments in wireless standards and almost every electronic device has some kind of wireless capability. IEEE discovered the next generation standard 802.16, which is more concerned about the broadband access' last mile applications of wireless technology. The IEEE 802.16 standard defines wireless service as connection between the subscriber and the core network the core network being a telephony network or the Internet. 802.16 is referred to as wireless MAN (Metropolitan Area Network) and the sub component of the standard is called WiMAX,

which is under 802.16a. See the illustration in figure 1. Therefore 802.16 is set of IEEE standards that are applicable to a group of spectrum ranging from 2ghz to 66ghz.

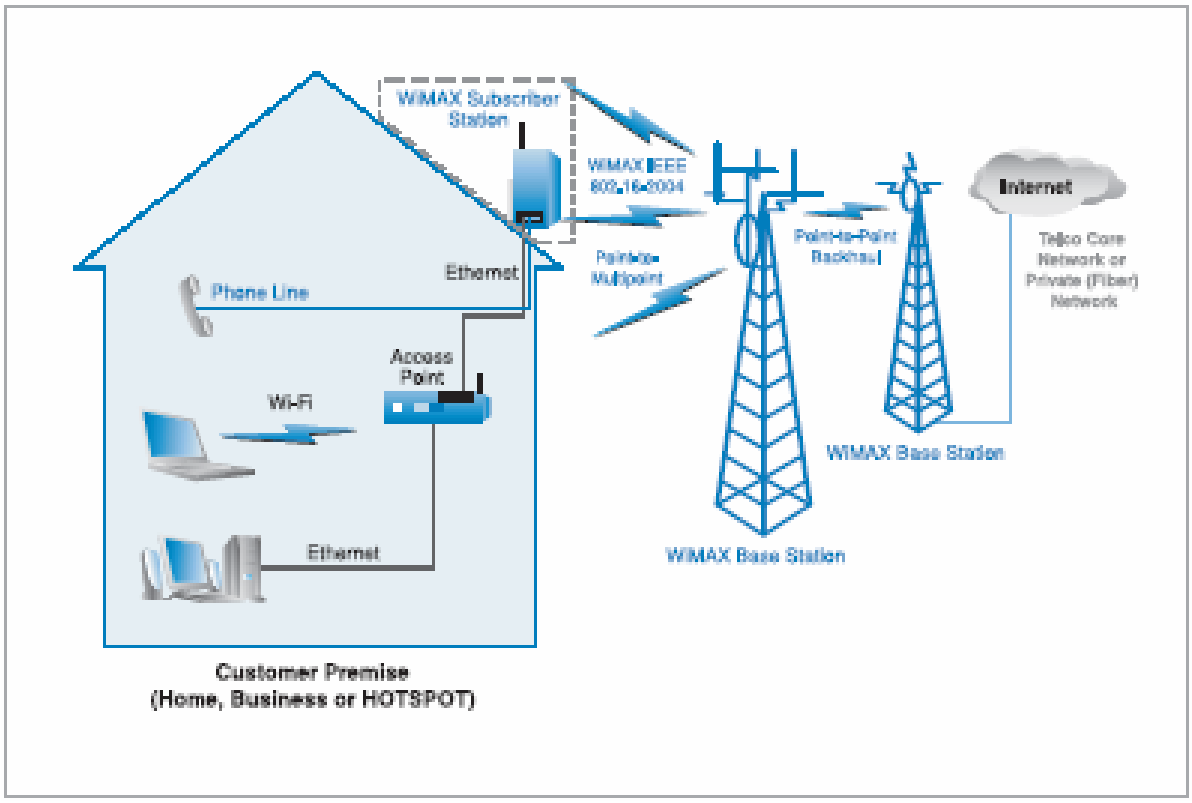

Figure 1: General Network Illustration

The 802.16 standards are concerned with the air interface between a user's trans receiver station and the base receiver station. The 802.16 standard was approved in June 2004. 802.16 is a Point –to-Multipoint Protocol, which means multiple subscribers can access the same radio platform using the multiplexing method or queuing method. The Point-to-Multipoint protocol is a connection oriented system that can operate on a star or a mesh network using both FDD and TDD. The 802.16 compliant devices are mean to work in multiple spectrums. Some of the fundamental properties of 802.16 are listed below.

1. Supports multiple services at the same time.
2. Bandwidth on demand.
3. Link adaptation – which is matching of signal, coding, protocol and modulation parameters to the condition on radio link.
4. Point to point topology with mesh technology.

The 802.16 and WiMAX are designed as a new addition to Wi-Fi and bluetooth.The protocol structure for WI-Max is shown below:

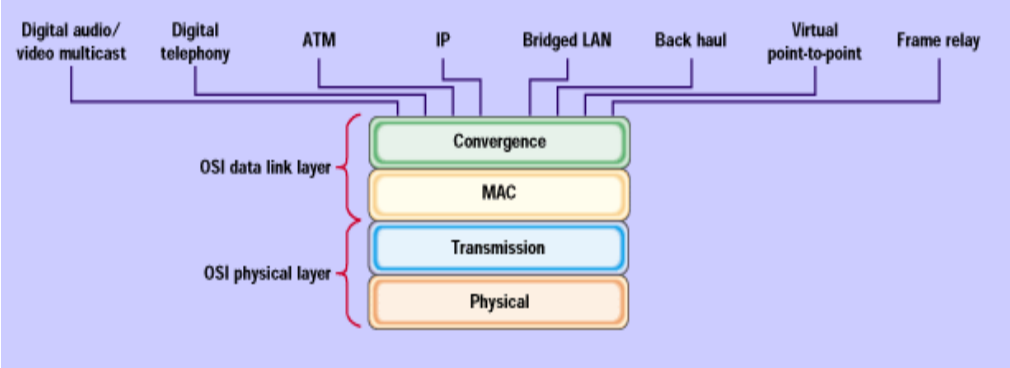

Figure 2: Protocol Structure for WiMax

The above diagram shows the four layers which are 1. convergence, 2. MAC, 3. transmission and 4. physical. All four layers map to the two layers of the OSI model which are the physical and data link layer. The 802.16 standards support three physical layer modes, namely the 256 point FFT and OFDM(Orthogonal frequency division multiplexing). The other modes are single carrier and OFDMA (orthogonal frequency division multiplexing access). The MAC uses protocol data unit (PDU) of variable length which helps in increasing the efficiency. Multiple PDU can be sent as one physical stream to save over load and at the same time multiple service data units (SDU) can be sent to save the MAC layer overhead. When fragmenting is done, in that case multiple SDU, can be sent across frame boundaries and thereby quality of service is guaranteed. The MAC layer performs two primary functions periodically like scheduling, packing and fragmenting. The MAC layer performs slow activities which include executing activities that are based on pre set timers, though there are not time limits and fixed deadlines.

3. WiMAX at Work

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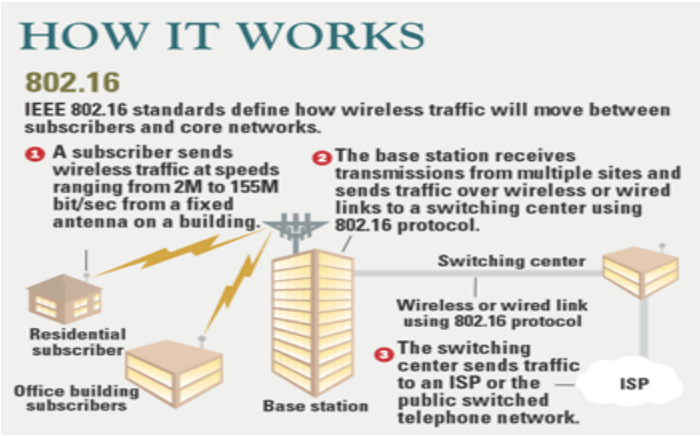

Figure 3: WiMAX at Work

As shown earlier the protocol architecture for the 802.16 standard, the physical layer is responsible for the error correction scheme, synchronization techniques, modulation, and time division multiplexing. For the transmission section from the subscribers to the base station, the 802.16 uses Demand Assignment Multiple Access with time division multiple access (DAMA TDMA). DAMA is a capacity assignment technique that changes with the capacity demand from multiple stations. TDMA is the process of dividing time on a channel into a sequence of frames each with a specific number of slots thereby forming a logical channel. With DAMA and TDMA, the assignment of the slots are dynamic because they have to support two operations, one being the continuous transmission speed like audio and video and other being the IP based traffic.

The layers above physical layer are involved in providing services to subscribers like transmitting in frames and grouping them in the Media Access Control layer (MAC). The MAC protocol specifies when a transmitter can begin to function. In the other direction from base station to subscriber there is only one transmitter and the job of MAC is quite easy.

4. Wimax Under the Hood

The MAC layer supports many network services including services that are used by corporate and residential users. 802.16 accomplishes these functions by dividing the layer into sub layers so that each layer can handle a specific function and can give good wireless privacy. The convergence sub layer maps the services to the core MAC sub layer and the convergence sub layers are responsible for bandwidth allocation and quality of service (QOS). The MAC common part sub layer is connection oriented and can include connectionless service like Ethernet and IP. The common sub layer handles functions like requesting bandwidth and including bandwidth on demand which is a new feature. In the recent years there has been a lot of research going on in wireless security. 802.16 has good security features. In 802.16, authentications is based on PKI technology which is based on X.509 certification. It is almost the same as the Ethernet interface which has a MAC address. The 802.16 trans receiver will have one built-in certificate for itself and one for the manufacturer. These certificates help the user trans receiver to uniquely authenticate back to the base station. The base station validates and checks if that trans receiver can be offered service. If the validation succeeds then the base station sends the trans receiver an authorization key using the user trans receiver's public key. As mentioned earlier, 802.16 have mechanisms for QoS. Bandwidth can be allocated to trans receivers or can be allocated to individual connections and managed. User trans receivers are given the option of stealing bandwidth from other connection or they can negotiate with the base station for increased bandwidth. Scheduling services are used to allocate bandwidth. 802.16 operates in the frequency range of 2 – 11 Ghz range, 802.16a has the capability to go beyond the limit of communication between a base station and trans receiver. This is achieved by making the base station to support mesh networks, where the user's trans receiver acts in between the another user receiver trans receiver and base station which is almost like a switch. It is observed that 802.16 should support continuous and bursty traffic therefore is designed as a set of interfaces that are predicted on a common media access control.

Features	WLAN – 802.11	Wi –Max 802.16
Bandwidth	Fixed – 20Mhz /52	Variable – 1 to 28Mhz/256
Spectrum efficiency	2.7 Mbits/s/Hz	3.1 -3.8 Mbits/s/Hz
Error vector requirement	-25 db – to achieve 10% packet error rate	-31db – for 1% packet error rate
Rx Noise figure	10db	7db
Duplexing	TDD	TDD, FDD, HDD
TX Dynamic Range	Tx Power Fixed	50 db range
Guard interval	Fixed ¼ symbol time	Variable from 1/32 to ¼ symbol time.

Figure 4: A radar view of 802.11 and 802.16:

5. Conclusion

In the next few years it will be very clearly seen that Wi –Fi and Wi – Max are complementary technologies. The widely available Wi- Fi in hotspots like hotels, airports will continue to grow for next few years. However by the way wireless standards are developing, all units will almost be dual mode like Wi- Fi / WiMAX, basically which means WiMAX users will not only have Wi –Fi hot spot access but at the same time will have mobile city wide WiMAX access.

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