WiMAX

Introduction

- WiMAX stands for Worldwide Interoperability for Microwave Access.
- WiMAX is a standardized wireless version of Ethernet intended primarily as an alternative to wire technologies to provide broadband access to customer premises.
- WiMAX would operate similarly to Wi-Fi but at higher speeds over greater distances and for more users.
- WiMAX can provide service even in areas that are difficult for wired infrastructure to reach and the ability to overcome the physical limitations of traditional wired infrastructure.
- WiMAX was formed in April 2001, anticipating the publication of the original 10-66 GHz IEEE 802.16 specifications.
- WiMAX is to 802.16, as the Wi-Fi Alliance is to 802.11.

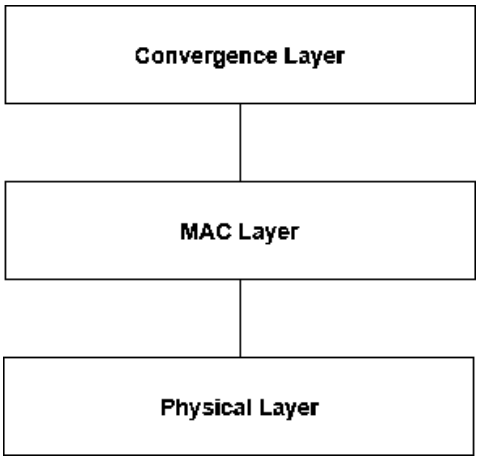
How is WiMAX different from other wireless technologies, such as Wi-Fi and cellular?

- WiMAX provides much higher data rates than Wi-Fi.
- WiMAX is used for outdoor networks, while Wi-Fi is used for indoor networks.
- WiMAX uses IEEE 802.16 standards, while Wi-Fi uses IEEE 802.11 standards.
- WiMAX operates in the frequency band of 2 GHz to 11 GHz, while Wi-Fi operates in the frequency band of 2.4 GHz and 5 GHz.
- WiMAX is used to provide Internet services such as Mobile Data and hotspots, while Wi-Fi is used to connect devices to the Internet.

Features

- It's a worldwide interoperability for wireless access. Interoperability for wireless access in WiMAX means that different WiMAX devices from different vendors can work together seamlessly. This is important because it allows users to choose the best WiMAX device for their needs without worrying about whether or not it will work with their existing WiMAX network.
- Interoperability is achieved through the use of standards. WiMAX is based on the IEEE 802.16 standard.
- It is used to provide higher data rates with increased coverage.
- WiMAX would operate similarly to Wi-Fi but at higher speeds over greater distances and for more users.
- **Speed:** 46mbps Downlink and 4 Mbps uplink
- **Bandwidth:** 3.5Mhz to 10 MHz
- **Range**: up to 50km
- **Data transfer**: 120 kmph
- **Cell capacity**: 100-200 users
- **Duplexing mode (Duplexing mode in wireless communication refers to the direction of data transmission between two devices):** used TDD or FDD technique to implement this duplexing mode, but mainly TDD is focused.
- It uses hard handover and MAN technique.
- Can operate non-LOS.
- Mobile WiMAX uses Orthogonal frequency division multiple access (OFDM) as a multiple-access technique.

Architecture



- **Physical Layer:**
    a) Specifies frequency band, synchronization between transmitter and receiver data rate, and multiplexing scheme.
    b) Encodes and decodes signals and manages bit transmission and reception.
    c) Converts MAC layer frames into signals to be transmitted.
- **MAC Layer:**
    a) Provides an interface between the WiMAX protocol stack's convergence and physical layers.
    b) Provides point-to-multipoint communication based on CSMA/CA.
    c) Transmits data in frames and controls access to shared wireless medium.
    d) Defines how and when a subscriber may initiate a transmission on the channel.

In other words, the MAC layer is responsible for managing the flow of data between the different layers of the WiMAX protocol stack and the physical layer. It also ensures that all subscribers on the network have fair access to the shared wireless medium.

The MAC layer uses a variety of techniques to achieve this, including:

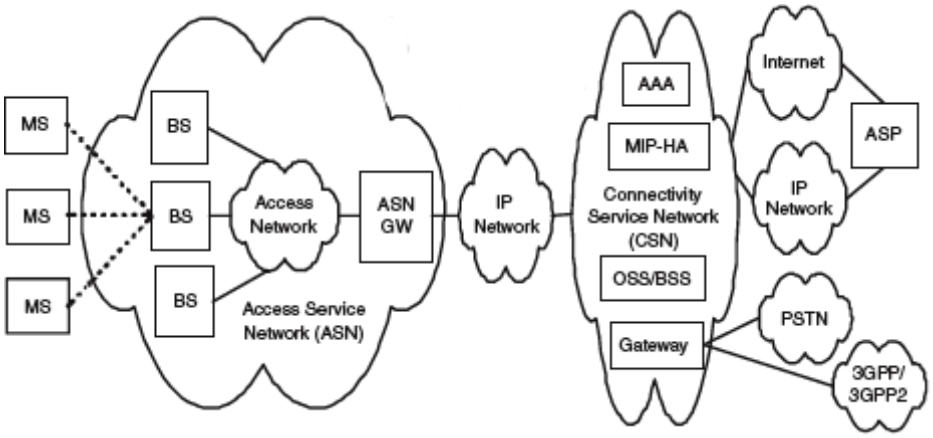
a) **CSMA/CA**: CSMA/CA is a medium access control protocol that ensures that only one subscriber transmits at a time.
b) **Framing**: The MAC layer frames the data before transmitting it to the physical layer. This helps to ensure that the data is received correctly.
c) **Scheduling**: The MAC layer can schedule transmissions to ensure all subscribers have fair access to the network.

The MAC layer is an important part of the WiMAX system, and it is responsible for the performance and reliability of the network.

- **Convergence Layer:**
    a) Provides the information of the external network.
    b) Accepts higher layer protocol data unit (PDU) and converts it to lower layer PDU.
    c) Provides functions depending upon the service being used.

Network Architecture

- **Mobile Stations** (MS) the end user uses to access the network.
- The **access service network** (ASN) comprises one or more base stations and one or more ASN gateways that form the radio access network at the edge.
- **Connectivity service network** (CSN), which provides IP connectivity and all the IP core network functions.



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 micro-mobility 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 point 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, 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 and corporate networks. The NSP owns the CSN 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.

Protocols used

- **IEEE 802.16**: IEEE 802.16 is the WiMAX's physical and medium access control (MAC) layer standard. It defines the WiMAX signal's physical characteristics and the rules for how subscribers access the shared wireless medium.
- **IP**: IP is the Internet Protocol used to route packets over the Internet. WiMAX uses IP to carry traffic between subscribers and the Internet.
- **TCP**: TCP is the Transmission Control Protocol, which provides reliable end-to-end communication over IP. WiMAX uses TCP for many applications, such as web browsing and file transfer.
- **UDP**: UDP is the User Datagram Protocol, providing unreliable but fast IP communication. WiMAX uses UDP for applications like streaming video and online gaming.
- **DHCP**: DHCP is the Dynamic Host Configuration Protocol, which automatically assigns IP addresses to devices. WiMAX uses DHCP to assign IP addresses to subscribers.
- **DNS**: DNS is the Domain Name System used to resolve domain names to IP addresses. WiMAX uses DNS to resolve the domain names of website subscribers want to visit.
- **PPP**: PPP is the Point-to-Point Protocol, which establishes a point-to-point connection between two devices. WiMAX uses PPP to connect the subscriber's device and the base station.
- **ARP**: ARP is the Address Resolution Protocol, which maps IP addresses to MAC addresses. WiMAX uses ARP to map the IP addresses of other subscribers on the network to their MAC addresses.
- **ICMP**: ICMP is the Internet Control Message Protocol used to send error and control messages between devices. WiMAX uses ICMP to send error messages to subscribers and control the data flow on the network.

Applications

WiMAX technology is used in a variety of real-life applications, including:

- **Broadband Internet Access**: WiMAX provides high-speed internet access in rural and underserved areas where traditional wired broadband is unavailable.

- **Wireless Backhaul**: WiMAX provides a wireless link between a cellular base station and the core network, eliminating the need for a wired connection.
- **Mobile Broadband**: WiMAX provides mobile broadband services, allowing users to access high-speed internet on the go.
- **Public Safety**: WiMAX provides wireless connectivity for public safety networks, allowing emergency responders to communicate and share information in real time.
- **Smart Grid**: WiMAX provides wireless connectivity for smart grid systems, allowing utilities to monitor and control the power grid remotely.
- **Telemedicine**: WiMAX provides wireless connectivity for telemedicine systems, allowing healthcare professionals to diagnose and treat patients remotely.
- **VoIP** (Voice over Internet Protocol): WiMAX is also used to provide a wireless link for Voice over IP (VoIP) phone services, allowing users to make phone calls over the internet.
- **Video Surveillance**: WiMAX provides wireless connectivity for video surveillance systems, allowing security personnel to monitor and record video footage remotely.

Advantages of WiMAX

- **Wide Coverage Area**: WiMAX can cover an area of up to 50 kilometers, making it suitable for providing broadband access in rural and underserved areas.
- **High Data Rates**: WiMAX can provide data rates of up to 75 Mbps, higher than many other wireless technologies.
- **Scalability**: WiMAX can be easily scaled to support many users and devices.
- **Interoperability**: WiMAX is based on an international standard, which allows for interoperability between different vendors' equipment.
- **Cost-effective**: WiMAX is a cost-effective solution for providing broadband access in areas where it is not economically feasible to deploy wired infrastructure.

Disadvantages of WiMAX

- **Limited Mobility**: WiMAX is designed for fixed or nomadic (semi-fixed) use, not for mobile use.
- **Interference**: WiMAX operates in the same frequency range as other wireless technologies, which can lead to interference.
- **Security Concerns**: WiMAX uses a shared spectrum, making it vulnerable to security threats such as eavesdropping and jamming.
- **Limited device availability**: WiMAX devices are not as widely available as devices for other wireless technologies, such as Wi-Fi.
- **Limited penetration**: WiMAX signals may have trouble penetrating through walls, buildings and other obstacles.

Bibliography

https://www.geeksforgeeks.org/wimax-in-computer-network/

https://www.tutorialspoint.com/wimax/what_is_wimax.htm

https://en.wikipedia.org/wiki/WiMAX

https://bard.google.com/