A Study of Wireless Networks: WLANs, WPANs, WMANs, and WWANs with Comparison

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Abstract- Wireless networks transfer data, such as e-mail messages and files, in advancements with video and voice communications as well. As with networks based on wire, or optical fiber, wireless networks convey information between computer devices. Wireless networking **is the new technology of networking. People can enjoy the benefits of wireless network where they live and work. This paper describes the wireless networks, evaluating their main standards and behavior, including the transmission methods, device types.**

Keywords- Wireless networks- WLANs, WPANs, WMANs, and WWANs.

I. INTRODUCTION

Wireless network is a network through which data signals flow through the air. It's useful for people to communicate and access applications and information without wires. It allows people to interact with e-mail or browse the Internet from a location that they prefer. Wireless networks are not bound to a channel to follow like wired networks.

Wireless networking is less expensive and much easier to install than more traditional wired networking. Wireless networking is used at the airport, or in hotel lobbies, and a small office or home network etc. The transmitted distance can be anywhere between a few meters as a television's remote control and thousands of kilometers as radio communication.

II. BASIC FACTORS OF WIRELESS NETWORKS

Wireless media uses the antennas for sending and receiving the electromagnetic waves without using any physical conductors. Radio frequencies (RF) are generated by antennas that propagate the waves into the air. Antennas for wireless transmission can be fall under two different categories:
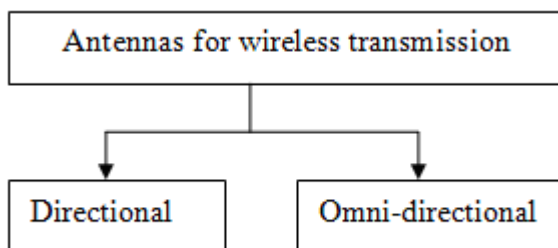
A. Directional antennas

Directional antennas are commonly used in point-to-point configurations connecting two distant buildings LANs, and sometimes point-to-multipoint (connecting two WLANs). In this, sending and receiving antenna must be properly aligned for proper transmission. An example of a directional antenna is a Yagi antenna: this antenna allows you to adjust the direction and focus of the signal to strengthen the range/reach.
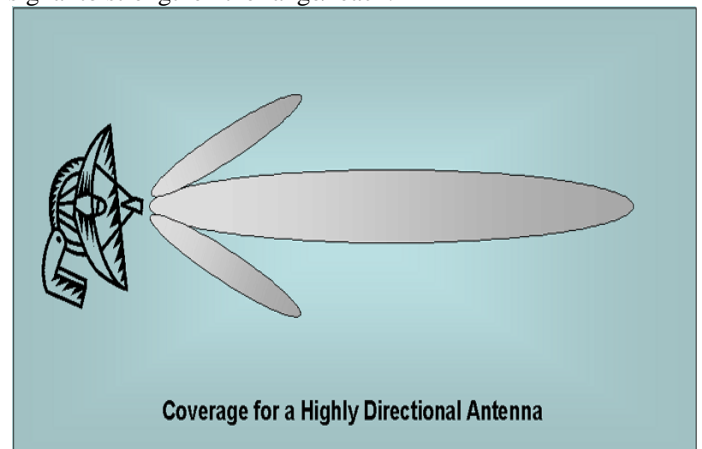

Fig. 1 Directional antennas

B. Omni-directional antennas

Omni-directional antennas are used in point-to-multipoint configurations, where they distribute the wireless signal to other computers or devices in WLAN. An access point would use an Omni-directional antenna. These antennas can also be used for point-to-point connections. In this, signal is spread in all directions and can be received by any antenna which is compatible to receive the signals.

Fig. 2 Omni-directional antennas

Three main factors influence signal distortion (changing forms of signals):

1) *Absorption Objects*
   that absorb the RF waves, such as walls, ceilings, and floors.
2) *Scattering Objects*
   that scatter the RF waves, such as rough plaster on a wall, carpet on the floor, or drop-down ceiling tiles.
3) *Reflection Objects*
   that reflect the RF waves, such as metal and glass.
4) *Responsible factors for manage the RF*

The International Telecommunication Union-Radio Communication Sector (ITU-R) is responsible for managing the radio frequency (RF) spectrum and satellite orbits for wireless communications: its main purpose is to provide for cooperation and coexistence of standards and implementations across country boundaries.

III. TYPES OF WIRELESS NETWORKS

There are different types of wireless networks available.
A. WLANS: Wireless Local Area Networks

It allows users in a local area, such as a university campus or library, to form a network or gain access to the internet. A temporary network can be formed by a limited number of users without the need of an access point; given that they do not need access to network resources.
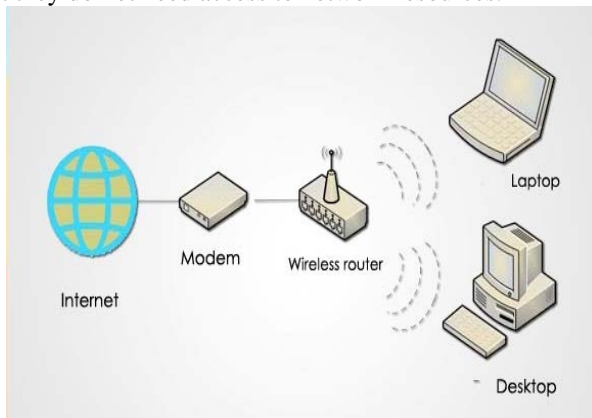

Fig. 3 Wireless Local Area Network

Two standards bodies are primarily responsible for implementing WLANs:
1)IEEE 802.11

It's a non-profit organization that provides actions to co-ordinate produce and promote data networking standards. It defines the mechanical process of how WLANs are implemented in the 802.11 standards so that vendors can create compatible products. It specifies security association management and key management as well as access control, data confidentiality and data integrity.
2)The Wi-Fi Alliance

It's basically certifies companies by ensuring that their products follow the 802.11 standards, thus allowing customers to buy WLAN products from different vendors without having to be concerned about any compatibility issues.
- *Transmission Method used in WLAN*
1) *Direct Sequence Spread Spectrum:* DSSS uses one channel to send data across all frequencies within that channel. Complementary Code Keying (CCK) is a method for encoding transmissions for higher data rates, such as 5.5 and 11 Mbps, but it still allows backward compatibility with the original 802.11 standard, which supports only 1 and 2 Mbps speeds.
2) *Orthogonal Frequency Division Multiplexing:* OFDM increases data rates by using a spread spectrum modulation.
3) *Multiple Input Multiple Output:* MIMO *transmission*, which uses DSSS and/or OFDM by spreading its signal across 14 overlapping channels at 5 MHz intervals. It requires multiple antennas.

B. WPANS: Wireless Personal Area Networks

The two current technologies for wireless personal area networks are Infra Red (IR) and Bluetooth. However, IR requires a direct line of site and the range is less. WPANs are used to convey information over short distances (about 30 feet) among a private, intimate group of participant devices. Unlike a wireless local area network (WLAN), a connection made through a WPAN involves little or no infrastructure or direct connectivity to the world outside the link. This allows small, power-efficient, inexpensive solutions to be implemented for a wide range of devices.

Fig. 4 Wireless Personal Area Network

Three standards bodies are primarily responsible for implementing WPANs:
1) *Bluetooth:* A widely used WPAN technology is known as Bluetooth (version 1.2 or version 2.0) The IEEE 802.15.1 standard specifies the architecture and operation of Bluetooth devices, but only as far as physical layer and medium access control (MAC) layer operation is concerned (the core system architecture).Higher protocol layers and applications defined in usage profiles are standardized by the Bluetooth SIG (Special Interests Group).
2) *ZigBee Alliance:* ZigBee technology is simpler (and less expensive) than Bluetooth. The main objectives of LR-WPANs (Low-Rate Wireless Personal Area Networks) like ZigBee are ease of installation, reliable data transfer, short-range operation, extremely low cost, and a reasonable battery life, while maintaining a simple and flexible protocol. The raw data rate will be high enough

(maximum of 250 Kbit/s) to satisfy a set of simple needs such as interactive toys, but is also scalable down to the needs of sensor and automation needs (20 Kbit/s or below) using wireless communication.

- *LR-WPAN device types*
  Two different device types can participate in an LR-WPAN network:
 I. *Full-function devices:* FFD can operate in three modes serving as a personal area network (PAN) Coordinator, a coordinator, or a device.
II. *Reduced-function devices:* RFD is intended for applications that are extremely simple.

3) UWB (Ultra Wideband) over IEEE 802.15.3: UWB has recently attracted much attention as an indoor short-range high-speed wireless communication. [7]. One of the most exciting characteristics of UWB is that its bandwidth is over 110 Mbps (up to 480 Mbps) which can satisfy most of the multimedia applications such as audio and video delivery in home networking and it can also act as a wireless cable replacement of high speed serial bus such as USB 2.0.

C. WMANS: Wireless Metropolitan Area Network

This technology allows the connection of multiple networks in a metropolitan area such as different buildings in a city, which can be an alternative or backup to laying copper or fiber cabling.
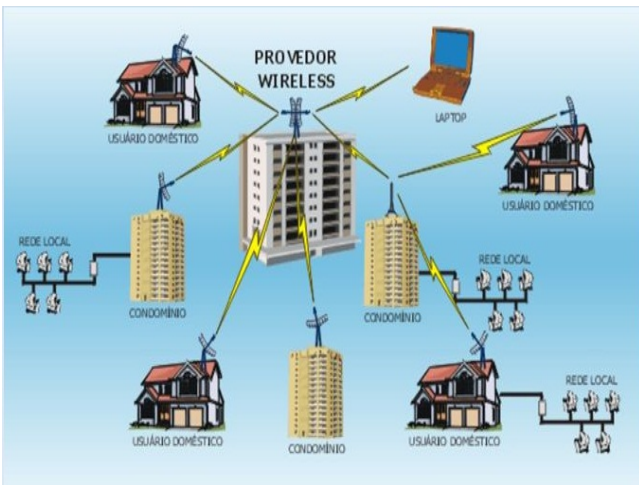

Fig. 5 Wireless Metropolitan Area Networks

One standard body is primarily responsible for implementing WMANs:
1) IEEE 802.16 WiMAX: Worldwide Interoperability for Microwave Access (WiMAX) is a recent wireless broadband standard that has promised high bandwidth over long-range transmission. It is a radio frequency technology that uses licenses and unlicensed bands to provide wireless connections for non line-of-sight real implementations with speed up to 40 mbps per channel and a cell radius up to 10 kilometers for fixed and portable access situations. In the Line-Of-Sight, WiMAX can provide link distance up to 50 kilometers.

The standard specifies the air interface, including the medium access control (MAC) and physical (PHY) layers, of BWA. The key development in the PHY layer includes orthogonal frequency-division multiplexing (OFDM), in which multiple access is achieved by assigning a subset of sub carriers to each individual user [1]. In an OFDM system, the data is divided into multiple parallel sub streams at a reduced data rate, and each is modulated and transmitted on a separate orthogonal sub carrier. This increases symbol duration and improves system robustness.

D. WWANS: Wireless Wide Area Networks

These types of networks can be maintained over large areas, such as cities or countries, via multiple satellite systems or antenna sites looked after by an ISP. These types of systems are referred to as 2nd Generation systems.
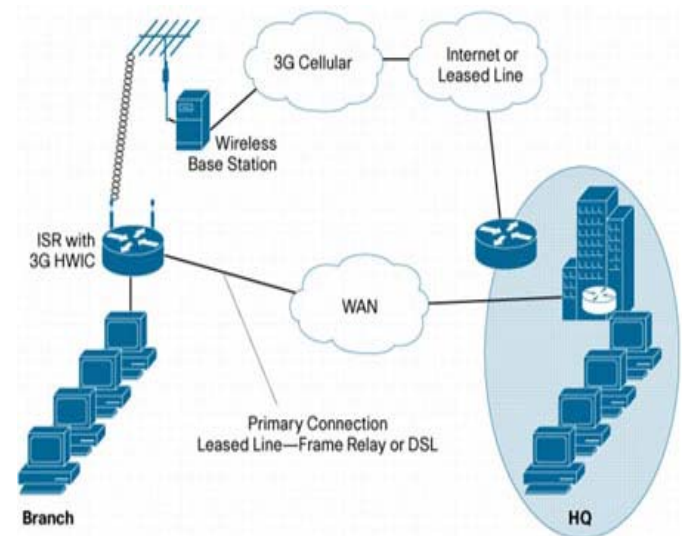

Fig. 6 Wireless Wide Area Networks

1) CDPD: Cellular Digital Packet Data is a technique used for transmitting small units of data, commonly referred to as packets, over the cellular network in a reliable manner. It allows to send and receive data from anywhere in the cellular coverage area at any time, quickly and efficiently. CDPD technology provides extensive, high speed, high capacity, cost effective data services to mobile users. With this technology, both voice and data can be transmitted over existing cellular channels.
To effectively integrate voice and data traffic on the cellular system without degrading the level of service provided to the voice customer, the CDPD network implements a technique called channel hopping.
2)3G: Third-generation (3G) is the term for the latest generation of mobile services, which provide advanced voice communications and high-speed data connectivity, including access to the Internet, mobile data applications, and multimedia content. The International Telecommunications Union (ITU), working with industry-standards groups from around the world, has defined the technical requirements and standards as well as the spectrum for 3G systems under the International Mobile Telecommunications-2000 (IMT-2000) program.

Type	Coverage	Performance	Standards	Applications
Wireless PAN	Within reach of a person	Moderate	Wireless PAN Within reach of a person Moderate Bluetooth, IEEE 802.15, and IrDa Cable replacement for peripherals	Cable replacement for peripherals
Wireless LAN	Within a building or campus	High	IEEE 802.11, Wi-Fi, and HiperLAN	Mobile extension of wired networks
Wireless MAN	Within a city	High	Proprietary, IEEE 802.16, and WIMAX	Fixed wireless between homes and businesses and the Internet
Wireless WAN	Worldwide	Low	CDPD and Cellular 2G, 2.5G, and 3G	Mobile access to the Internet from outdoor areas

Fig. 5 Comparison of Wireless Network Types

IV. COMPARISON

Here in fig 5. we compare four types of wireless networks: WLANs, WPANs, WMANs and WWANs based on IEEE standards. The coverage area of the WLAN and WPAN is very limited as compare to WWAN and WMAN. But the performances of the limited coverage area networks are better than the WWANs.

V. LIMITATIONS

1) Wireless network is bit more difficult to set up properly.
2) The speed of wireless network is significantly slower than wired network (2-50 times slower).
3) Wireless network is less stable.
4) There are security issues in wireless networks.

VI. CONCLUSIONS

This paper describes the types of wireless networks, finally ends with comparing these networks to each other with their coverage areas, performance, standards, and applications. this paper covers the general introduction about the wireless technologies with their standards bodies. In near future, the new systems such as 4G networks, SDRs (Software defined radios), M2M (Machine to Machine) communications and Open source radios have to be designed. The download speed of these systems is above 1000 mbps which is more than LTE bands (these bands were used only in U.S). The rise of new technology means
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that the manufacturers of wireless communication have to designed and launch the products into an increasingly uncertain environment, and it must be more flexible than older technology.

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