Unit 4: Wireless Networks Types and PAN Technologies

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Objectives

After studying this unit, you will be able to:

- Discuss the various types of wireless networks
- Explain wireless PAN Technologies (WPAN)

Introduction

Wireless LAN (WLAN) is very popular nowadays. Maybe you have ever used some wireless applications on your laptop or cellphone. Wireless LANs enable users to communicate without the need of cable. Each WLAN network needs a wireless Access Point (AP) to transmit and receive data from users. Unlike a wired network which operates at full-duplex (send and receive at the same time), a wireless network operates at half-duplex so sometimes an AP is referred as a Wireless Hub.

The major difference between wired LAN and WLAN is WLAN transmits data by radiating energy waves, called radio waves, instead of transmitting electrical signals over a cable.WLAN uses CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance) instead of CSMA/CD for media access. WLAN can't use CSMA/CD as a sending device can't transmit and receive data at the same time.

Nowadays there are three organizations influencing WLAN standards. They are: ITU-R: which is responsible for allocation of the RF bands , IEEE which specifies how RF is modulated to transfer data and Wi-Fi Alliance that improves the interoperability of wireless products among vendors.

But the most popular type of wireless LAN today is based on the IEEE 802.11 standard, which is known informally as Wi-Fi. The 802.11a operates in the 5.7 GHz ISM band. Maximum transmission speed is 54Mbps and approximate wireless range is 25-75 feet indoors. 802.11b operates in the

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2.4 GHz ISM band. Maximum transmission speed is 11Mbps and approximate wireless range is 100-200 feet indoors and 802/11g: operates in the 2.4 GHz ISM band. Maximum transmission speed is 54Mbps and approximate wireless range is 100-200 feet indoors.

The ISM (Industrial, Scientific and Medical) band, which is controlled by the FCC in the US, generally requires licensing for various spectrum use. To accommodate wireless LAN's, the FCC has set aside bandwidth for unlicensed use including the 2.4Ghz spectrum where many WLAN products operate.

Wi-Fi stands for Wireless Fidelity and is used to define any of the IEEE 802.11 wireless standards. The term Wi-Fi was created by the Wireless Ethernet Compatibility Alliance (WECA). Products certified as Wi-Fi compliant are interoperable with each other even if they are made by different manufacturers. Access points can support several or all of the three most popular IEEE WLAN standards including 802.11a, 802.11b and 802.11g.

4.1 Types of Wireless Networks

There are three primary usage scenarios for wireless connectivity :

1. Wireless Personal Area Networking (WPAN)
2. Wireless Local Area Networking (WLAN)
3. Wireless Wide Area Networking (WWAN)

4.1.1 WPAN (Wireless Personal Area Network)

WPAN describes an application of wireless technology that is intended to address usage scenarios that are inherently personal in nature. The emphasis is on instant connectivity between devices that manage personal data or which facilitate data sharing between small groups of individuals. An example might be synchronizing data between a PDA and a desktop computer. Or another example might be spontaneous sharing of a document between two or more individuals. The nature of these types of data sharing scenarios is that they are ad hoc and often spontaneous. Wireless communication adds value for these types of usage models by reducing complexity (i.e. eliminates the need for cables).

A wireless personal area network (WPAN) is a personal area network — a network for interconnecting devices centered around an individual person's workspace — in which the connections are wireless. Wireless PAN is based on the standard IEEE 802.15. The two kinds of wireless technologies used for WPAN are Bluetooth and Infrared Data Association.

A WPAN could serve to interconnect all the ordinary computing and communicating devices that many people have on their desk or carry with them today; or it could serve a more specialized purpose such as allowing the surgeon and other team members to communicate during an operation.

A key concept in WPAN technology is known as "plugging in". In the ideal scenario, when any two WPAN-equipped devices come into close proximity (within several meters of each other) or within a few kilometers of a central server, they can communicate as if connected by a cable. Another important feature is the ability of each device to lock out other devices selectively, preventing needless interference or unauthorized access to information.

The technology for WPANs is in its infancy and is undergoing rapid development. Proposed operating frequencies are around 2.4 GHz in digital modes. The objective is to facilitate seamless operation among home or business devices and systems. Every device in a WPAN will be able to plug into any other device in the same WPAN, provided they are within physical range of one another. In addition, WPANs worldwide will be interconnected.

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Example: An archeologist on site in Greece might use a PDA to directly access databases at the University of Minnesota in Minneapolis, and to transmit findings to that database.

- ***Bluetooth:*** Bluetooth uses short-range radio waves over distances up to approximately 10 metres. For example, Bluetooth devices such as a keyboards, pointing devices, audio head sets, printers may connect to personal digital assistants (PDAs), cell phones, or computers wirelessly.

  A Bluetooth PAN is also called a piconet (combination of the prefix "pico," meaning very small or one trillionth, and network), and is composed of up to 8 active devices in a master-slave relationship (a very large number of devices can be connected in "parked" mode). The first Bluetooth device in the piconet is the master, and all other devices are slaves that communicate with the master. A piconet typically has a range of 10 metres (33 ft), although ranges of up to 100 metres (330 ft) can be reached under ideal circumstances.

- ***Infrared Data Association:*** Infrared Data Association (IrDA) uses infrared light, which has a frequency below the human eye's sensitivity. Infrared in general is used, for instance, in TV remotes. Typical WPAN devices that use IrDA include printers, keyboards, and other serial data interfaces.

- ***WiFi:*** WiFi uses radio waves for connection over distances up to around 91 metres, usually in a local area network (LAN) environment. Wifi can be used to connect local area networks, to connect cellphones to the Internet to download music and other multimedia, to allow PC multimedia content to be stream to the TV (Wireless Multimedia Adapter), and to connect video game consoles to their networks (Nintendo WiFi Connection).

- ***Body area network:*** A body area networks is based on the IEEE 802.15.6 standard for transmission via the capacitive near field of human skin allowing near field communication of devices worn by and near the wearer. The Skinplex implementation can detect and communicate up to 1 metre (3 ft 3 in) from a human body. It is used for access control to door locks and jamming protection in convertible car roofs.

4.1.2 WLAN (Wireless Local Area Network)

WLAN on the other is more focused on organizational connectivity not unlike wire based LAN connections. The intent of WLAN technologies is to provide members of workgroups access to corporate network resources be it shared data, shared applications or e-mail but do so in way that does not inhibit a user's mobility. The emphasis is on a permanence of the wireless connection within a defined region like an office building or campus. This implies that there are wireless access points that define a finite region of coverage.

Wireless local area networks (WLANs) are the same as the traditional LAN but they have a wireless interface. With the introduction of small portable devices such as PDAs (personal digital assistants), the WLAN technology is becoming very popular. WLANs provide high speed data communication in small areas such as a building or an office. It allows users to move around in a confined area while they are still connected to the network.

Example: of wireless LAN that are available today are NCR's waveLAN and Motorola's ALTAIR.

Transmission Technology

There are three main ways by which WLANs transmit information : microwave, spread spectrum and infrared.

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1. ***Microwave Transmission:*** Motorola's WLAN product (ALTAIR) transmits data by using low powered microwave radio signals. It operates at the 18GHz frequency band.

2. ***Spread Spectrum Transmission:*** With this transmission technology, there are two methods used by wireless LAN products : frequency hopping and direct sequence modulation.

   (a) *Frequency Hopping:* The signal jumps from one frequency to another within a given frequency range. The transmitter device "listens" to a channel, if it detects an idle time (i.e. no signal is transmitted), it transmits the data using the full channel bandwidth. If the channel is full, it "hops" to another channel and repeats the process. The transmitter and the receiver "jump" in the same manner.

   (b) *Direct Sequence Modulation:* This method uses a wide frequency band together with Code Division Multiple Access (CDMA). Signals from different units are transmitted at a given frequency range. The power levels of these signals are very low (just above background noise). A code is transmitted with each signal so that the receiver can identify the appropriate signal transmitted by the sender unit. The frequency at which such signals are transmitted is called the ISM (industrial, scientific and medical) band. This frequency band is reserved for ISM devices. The ISM band has three frequency ranges : 902-928, 2400-2483.5 and 5725-5850 MHz. An exception to this is Motorola's ALTAIR which operates at 18GHz. Spread spectrum transmission technology is used by many wireless LAN manufacturers such as NCR for waveLAN product and SpectraLink for the 2000 PCS.

3. ***Infrared Transmission:*** This method uses infrared light to carry information. There are three types of infrared transmission : diffused, directed and directed point-to-point.

   (a) *Diffused:* The infrared light transmitted by the sender unit fills the area (e.g. office). Therefore the receiver unit located anywhere in that area can receive the signal.

   (b) *Directed:* The infrared light is focused before transmitting the signal. This method increases the transmission speed.

   (c) *Directed point-to-point:* Directed point-to-point infrared transmission provides the highest transmission speed. Here the receiver is aligned with the sender unit. The infrared light is then transmitted directly to the receiver.

The light source used in infrared transmission depends on the environmemt. Light emitting diode (LED) is used in indoor areas, while lasers are used in outdoor areas.

Caution Infrared radiation (IR) has major biological effects. It greatly affects the eyes and skin. Microwave signals are also dangerous to health. But with proper design of systems, these effects are reduced considerably.

Technical Standards

Technical standards are one of the main concerns of users of wireless LAN products. Users would like to be able to buy wireless products from different manufacturers and be able to use them on one network. The IEEE Project 802.11 has set up universal standards for wireless LAN. In this section we will consider some of these standards.

Requirements

In March 1992 the IEEE Project 802.11 established a set of requirements for wireless LAN. The minimum bandwidth needed for operations such as file transfer and program loading is 1Mbps. Operations which need real-time data transmission such as digital voice and process control, need support from time bounded services.

Types of Wireless LAN

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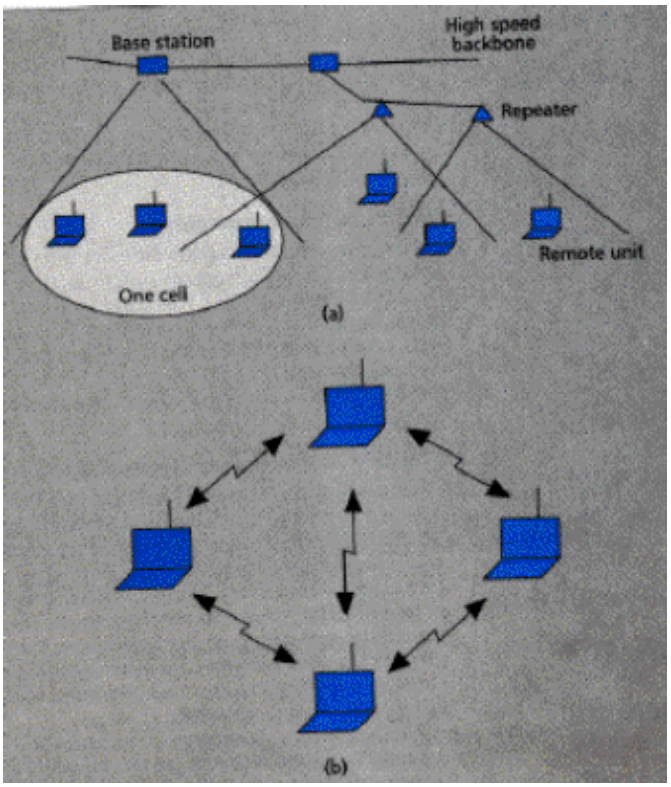
The Project 802.11 committee distinguished between two types of wireless LAN : "ad-hoc" and "infrastructred" networks.

Figure 4.1: Infrastructred Wireless LAN; (b) Ad-hoc Wireless LAN



Source: http://www.doc.ic.ac.uk/~nd/surprise_95/journal/vol2/mjf/article2.html

- ***Ad-hoc Networks:*** Figure 2b shows an ad-hoc network. This network can be set up by a number mobile users meeting in a small room. It does not need any support from a wired/ wireless backbone. There are two ways to implement this network.
- ***Broadcasting/Flooding:*** Suppose that a mobile user A wants to send data to another user B in the same area. When the packets containing the data are ready, user A broadcasts the packets. On receiving the packets, the receiver checks the identification on the packet. If that receiver was not the correct destination, then it rebroadcasts the packets. This process is repeated until user B gets the data.
- ***Temporary Infrastructure:*** In this method, the mobile users set up a temporary infrastructure. But this method is complicated and it introduces overheads. It is useful only when there is a small number of mobile users.
- ***Infrastructure Networks:*** Figure 2a shows an infrastructure-based network. This type of network allows users to move in a building while they are connected to computer resources. The IEEE Project 802.11 specified the components in a wireless LAN architecture. In an infrastructure network, a cell is also known as a Basic Service Area (BSA). It contains a number of wireless stations. The size of a BSA depends on the power of the transmitter and receiver units, it also depends on the environment. A number of BSAs are connected to each other and to a distribution system by Access Points (APs). A group of stations belonging to an AP is called a Basic Service Set (BSS). Figure 4.2 shows the basic architecture for wireless LANs.

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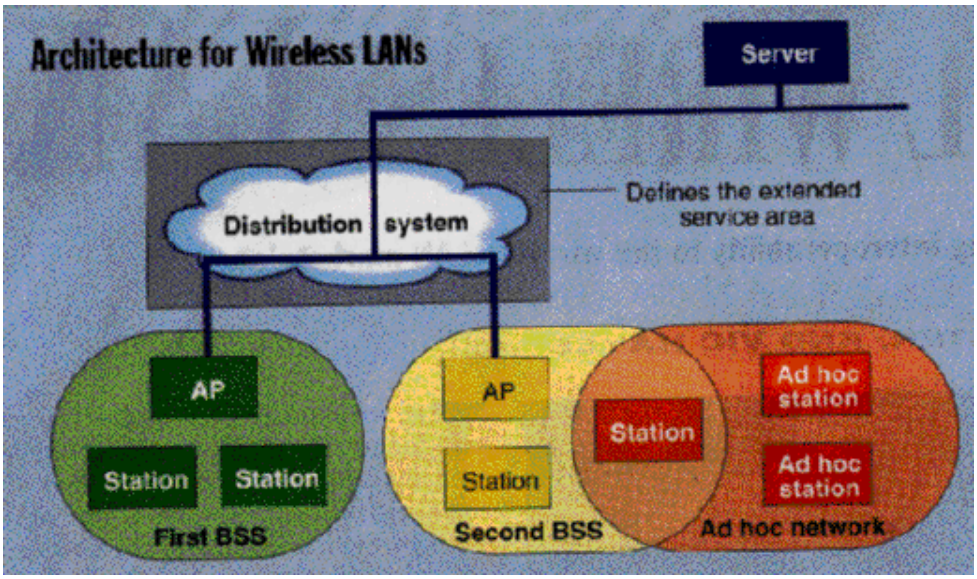
Figure 4.2 : Architecture for Wireless LANs



Source: http://www.doc.ic.ac.uk/~nd/surprise_95/journal/vol2/mjf/article2.html

Conclusion

Wireless LAN provide high speed data communication. The minimum data rate specified by the IEEE Project 802.11 is 1Mbps. NCR's waveLAN operates at 2Mbps, while Motorola's ALTAIR operates at 15Mbps.

Because of their limited mobility and short transmission range, wireless LANs can be used in confined areas such as a conference room.

Did u know? In the U.S, almost all WLANs products use spread spectrum transmission. Therefore they transmit information on the ISM band. But with this frequency band, users can experience interference from other sources using this band.

4.1.3 Wireless Metropolitan Area Network (WMAN)

Whereas WLAN addresses connectivity within a defined region, WWAN addresses the need to stay connected while traveling outside this boundary. Today, cellular technologies enable wireless computer connectivity either via a cable to a cellular telephone or through PC Card cellular modems. The need being addressed by WWAN is the need to stay in touch with business critical communications while traveling.

Input and Output, Information Processes

WiMAX works with radio wave for transmission and microwaves for reception in frequencies between 2,3 and 3,5 GHz. This allows reaching speeds of 70 Mbps within distances up to 50 km from the access point. Thus, a radial area of 100 Km could be cover with only one access point. Thus, a radial area of 100 Km could be cover with only one access point.

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Applications Fields

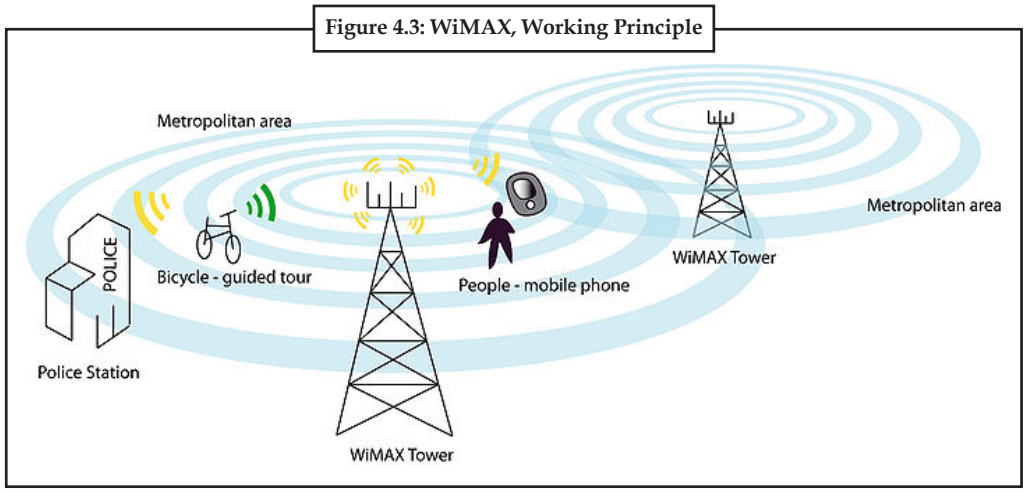
The technology is commonly used to provide internet to rural areas in which installing other types of technology becomes too expensive. Installed in the cities, WiMAX will allow people to connect to the internet whenever they want without looking for 'hotspots'. This will transform the user internet mobile lifestyle.

Working Principal

The first WiMAX standard IEEE 802.16, was created to administrate the interoperability of all devices working between 10 and 66 GHz.It will allow,as WiFI does, recieve and transmit encryted information among devices that have the technology. Within this standard, we should make some remarks to the IEEE 802.16a, IEEE 802.16e-2005 and IEEE802.16m which will allow to work with frequencies from 2 to 11 GHz, mobility and speed up to 1GB, respectively.

In order to clarify this, an example will be given. Imagine you have a bike which you pick up in a renting point. This point allows you to create your own touristic routes around the city and this is automatically uploaded to your bicycle. Using WiMAX working technology the bicycle (mobile device) will be capable to guide you according to the uploaded touristic tour. In case that you follow the wrong direction or get lost, the wireless connection will allow you to put you again on track. Furthermore, if your bike is stolen, it can send a message to the closest police station or to your smart phone and keep track of it. All this, will be possible just using one access point with high connection reliability.

Figure 4.3: WiMAX, Working Principle



Source: http://wikid.eu/index.php/Wireless_Metropolitan_Area_Networking_%28WMAN%29

Future Development

Wimax forum is planning to release in 2012 WiMAX Release 2 (standard IEEE802.16m) which will enable more efficient, faster, and more converged data communications. WiMAX Release 2 will provide,as well, compatibility with Release 1 solutions by upgrading channel cards or software of the old system.

Self-Assessment

Fill in the blanks:

1. The two kinds of wireless technologies used for WPAN are Bluetooth and .....

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2. ..... uses short-range radio waves over distances up to approximately 10 metres
3. A Bluetooth PAN is also called a .....
4. The intent of ..... technologies is to provide members of workgroups access to corporate network resources be it shared data, shared applications or e-mail but do so in way that does not inhibit a user's mobility.
5. ..... method uses a wide frequency band together with Code Division Multiple Access (CDMA).
6. There are three types of infrared transmission: ....., directed and directed point-to-point.
7. A group of stations belonging to an AP is called .....

4.2 Wireless PAN Technologies (WPAN)

The communication network established for the purpose of connecting computer devices of personal use is known as the personal area network PAN (Personal Area Network).when a network is established by connecting phone lines to personal digital devices or PDAs (personal digital assistants), this communication is known as PAN (Personal Area Network). Thomas Zimmerman was the first research scientist to introduce the idea of Personal Area Network (PAN).

The basic purport of establishing PAN (Personal Area Network) is provide a communication channel to the individuals, who want to carry their own digital devices .however at the same they want to stay in contact with the network. PAN (Personal Area Network) networks often cover an area of 30 feet. Personal computer devices may include palm tops mobile phones, potable media players, play stations and net books. These devices help a person to browse internet while traveling, to write notes and to send instant messages. These personal digital devices assist a person to develop networks and communicate via intranet, internet or even extranet. There are many wireless technologies which are helpful in developing wireless personal area network. Personal area networks (PAN) are developed either using cables or wireless technologies. Wireless PAN (Personal Area Network) is connected to the wired PAN (Personal Area Network) system either using firewire or USB.

PANs (Personal Area Network)s are dependent on the Bluetooth or infrared technologies for the transmission of wireless signals. Piconets are ad hoc networks. In this piconets network number of devices are connected by using Bluetooth technology. One key master device is further attached to seven or more than dynamic slave seven devices. Master device has a control and option to activate these devices at any time. Piconets work over a range of 200metres and transmit data of about 2100 kbit/ sec. the main focus point of wireless PAN (Personal Area Network) is to facilitate individual workspace. The Bluetooth technology used in wireless PAN (Personal Area Network) connection is based on IEEE 802.15 standard.

Wireless Personal Area Network (WPAN) can perform really efficient operations if we connect them with specialized devices. For examples it can help surgeons to seek guidance from other surgeons or team members during a surgical operation. Wireless Personal Area Network (WPAN) is based on plug –in technology. When wireless equipments come into contact with each other within the range of few kilometers, give an illusion if they are connected with a cable. Rapid development and improvement in this technology is needed in this area. This further development would help develop a seamless network between office and home devices. This development would help scientists, archeologists and people associated to other departments to transfer their findings to any database around them.

The wearable and portable computer devices communicate with each other. These devices while communicating transfer digital signals and information, these signals are transferred using the

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electrical conductivity coming out of human body. This linkup information exchange can take place even between two people who are carrying digital assistance devices while they are shaking hands. In this process of hand shake, an electric field is generated around people, and they emit Pico amps. These emissions complete the circuit and hence an exchange of information takes place. This information exchange includes the transfer of personal data such as email address, phone numbers etc.

The purpose of PDAs is to make the use of electric field around human beings. Mobile phones (smart phones only), palmtops and even pagers serve this purpose. Wireless digital devices work twenty four hours a day and seven days a week. This enables you to stay in communication circle always.

Notes PAN (Personal Area Network) network has enabled the transfer of data within the small geographical areas with the help of many small and portable carrying devices.

4.2.1 IEEE 802.15

Wireless PAN technologies utilize both radio frequencies and infrared light, depending on the application. The IEEE 802.15 standards working group focuses on the development of standards for wireless PANs and coordinates with other standards, such as 802.11 wireless LANs.

The 802.15 standards working group contains the following elements:

- 802.15.1? This working group, Task Group 1, defines a wireless PAN standard based on Bluetooth v1.1 specifications, which uses frequency hopping spread spectrum (FHSS) and operates at up to 1 Mbps. The 802.15 group published 802.11.1 in June of 2002, and it is meant to serve as a resource for developers of Bluetooth devices.
- 802.15.2? The group responsible for this standard, Task Group 2, is defining recommended practices to facilitate the coexistence of 802.15 and 802.11 networks. An issue is that both networks operate in the same 2.4 GHz frequency band, making coordination between operations necessary. The group is quantifying the interference and proposing methods to counter the interference.
- 802.15.3? This is Task Group 3, which is drafting a new standard for higher-rate wireless PANs. Data rates include 11, 22, 33, 44, and 55 Mbps. Combined with these higher data rates, quality of service (QoS) mechanisms make this standard good for satisfying needs for multimedia applications. This group is also focusing on lower cost and power requirements. A draft of the 802.15.3 standard is now available for purchase.
- 802.15.4? This group, Task Group 4, is investigating the definition of a standard with low data rates that leads to extremely low-power consumption for small devices where it's not practical to change batteries within months or years. For example, sensors, smart badges, and home automation systems are candidates for this technology. Data rates include 20, 40, and 250 kbps. A draft of the 802.15.4 standard is now available for purchase.

4.2.2 Bluetooth

The introduction of Bluetooth in 1998 was the result of several companies, including Ericsson, IBM, Intel, Nokia, and Toshiba, working together to create a solution for wireless access among computing devices. Bluetooth, which is a specification and not a standard, is ideal for small devices with short-range, low-power, and inexpensive radio links. This makes Bluetooth a good solution for connecting small devices within range of a person in a small working area. That's why the 802.15 chose Bluetooth as the basis of the 802.15.1 standard.

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Basic Features

The Bluetooth Special Interest Group (SIG) published the initial version of the specification in mid-1999. There have been updates since then, but the technical attributes are essentially the same. Bluetooth transceivers operate at up to 1 Mbps data rate in the 2.4GHz band, using FHSS technology. It constantly hops over the entire spectrum at a rate of 1,600 hops per second, which is much faster than the 802.11 version of frequency hopping.

Low-power Bluetooth devices have a range of 30 feet. High-power Bluetooth devices, however, can reach distances of around 300 feet. The high-power mode, though, is rare.

Bluetooth modules have relatively small form factors. Typical measurements are 10.2 x 14 x 1.6 millimeters, which is small enough to fit in a variety of user devices.

Bluetooth enables automatic connection among Bluetooth devices that fall within range of each other, but a user has the ability to accept and disallow connections with specific users. Users, however, should always be aware of whether their Bluetooth connection is enabled. To ensure security, disable the Bluetooth connection. Encryption is also part of the specification.

Could Bluetooth Replace Wireless LANs?

Bluetooth has characteristics similar to wireless LANs. Through the use of the high-power version of Bluetooth, manufacturers can develop Bluetooth access points and routers with a similar range as 802.11 networks. The current Bluetooth products, however, are mostly low power and focus on wireless PAN functions. In addition, it would be difficult for any Bluetooth wireless LAN products to gain a strong foothold in the market because 802.11 products already have widespread adoption.

The place where Bluetooth falls behind 802.11 is performance and range. 802.11 components can reach data rates of up to 54 Mbps, while Bluetooth lags way behind at around 1 Mbps. This might be good enough for most cable replacement applications? such as an interface between headphones and a PDA? but higher performance is necessary when surfing the web through a broadband connection or participating on a corporate network. Also, the range of 802.11 is typically 300 feet inside offices, which is much greater than Bluetooth. Bluetooth would require many access points to fully cover larger areas.

As a result, it's highly unlikely that Bluetooth products will win over 802.11. This is certainly apparent because electronics stores primarily sell 802.11 (Wi-Fi) solutions for wireless LAN applications, not Bluetooth.

Could Wireless LANs Replace Bluetooth?

It's possible that 802.11 wireless LANs could have a big impact on the sale of Bluetooth devices, mostly because 802.11 meets or exceeds nearly all of the characteristics of Bluetooth. Because widespread adoption of Bluetooth is still lacking, there's time for 802.11 vendors to get their foot in the door with manufacturers needing support for wireless PANs.

Some modifications would need to be made, however. The size of 802.11 components needs to be smaller, but that is becoming more of a reality as semiconductor companies strive for miniaturization of their 802.11 chipsets. These smaller components require less power, making them more competitive for devices, such as mobile phones, that have smaller batteries. With the 802.15 group defining standards for wireless PANs based on Bluetooth? and the 802.11 group focusing on wireless LANs? it's likely that both Bluetooth and 802.11 will continue to coexist and complement each other.

Minimizing Bluetooth Interference

As more wireless products become available, you need to carefully manage potential frequency interference. Tests have shown significant interference between Bluetooth and other systems

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operating in the 2.4 GHz band, such as 802.11 wireless LANs. A critical problem is that Bluetooth and 802.11b neither understand each other nor follow the same rules. A Bluetooth radio might haphazardly begin transmitting data while an 802.11 station is sending a frame. This results in a collision, which forces the 802.11 station to retransmit the frame. This lack of coordination is the basis for radio frequency (RF) interference between Bluetooth and 802.11.

Because of the potential for collisions, 802.11 and Bluetooth networks suffer from lower performance. An 802.11 station automatically lowers its data rate and retransmits a frame when collisions occur. Consequently, the 802.11 protocol introduces delays in the presence of Bluetooth interference.

The full impact of RF interference depends on the utilization and proximity of Bluetooth devices. Interference occurs only when both Bluetooth and 802.11b devices transmit at the same time. Users might have Bluetooth devices in their PDAs or laptops, but no interference will exist if their applications are not using the Bluetooth radio to send data.

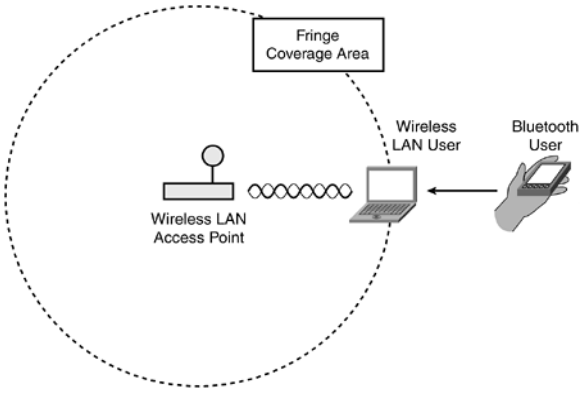
Some Bluetooth applications, such as printing from a laptop or synchronizing a PDA to a desktop, utilize the radio for a short period of time. In this case, the Bluetooth devices are not active long enough to noticeably degrade the performance of an 802.11 network. For example, a user might synchronize her PDA to her desktop when arriving at work in the morning. Other than that, their Bluetooth radio might be inactive and not cause interference the rest of the day.

The biggest impact is when a company implements a large-scale Bluetooth network, such as one that enables mobility for doctors and nurses using PDAs throughout a hospital. If the Bluetooth network is widespread and under moderate-to-high levels of utilization, the Bluetooth system will probably offer a substantial number of collisions with an 802.11 network residing in the same area. In this case, Bluetooth and 802.11 would have difficulties coexisting, and performance would likely suffer.

In addition to utilization, the proximity of the Bluetooth devices to 802.11 radio NICs and access points has a tremendous affect on the degree of interference. The transmit power of Bluetooth devices is generally lower than 802.11 wireless LANs. Therefore, an 802.11 station must be relatively close (within 10 feet or so) of a transmitting Bluetooth device before significant interference can occur.

A typical application fitting this scenario is a laptop user utilizing Bluetooth to support connections to a PDA and printer and 802.11 to access the Internet and corporate servers. The potential for interference in this situation is enormous, especially when the user is operating within outer limits of the coverage area of the 802.11 network. Figure 4.4 illustrates this situation. The signal from the Bluetooth device will likely drown out the weaker 802.11 signal because of the distance of the access point.

Figure 4.4: RF Interference Can Occur Between Bluetooth and 802.11 Wireless LAN Devices



Source: http://etutorials.org/Networking/wn/Chapter+4.+Wireless+PANs+Networks+for+Small+Places/Wireless+PAN+Technologies/

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Here are some tips on how to avoid interference from Bluetooth devices:

- ***Manage the use of RF devices?*** One way to reduce the potential for interference is to regulate the types of RF devices within your home or office. In other words, establish your own private regulatory body for managing unlicensed RF devices. The extreme measure would be to completely ban the use of Bluetooth; however, that is not practical or even possible in all cases. For example, you can't feasibly prohibit the use of Bluetooth in public areas of large offices. For private applications, you could set company policies to limit the use of Bluetooth to specific applications, such as synchronizing PDAs to desktops.
- ***Ensure adequate 802.11 coverage?*** Strong, healthy 802.11 signals throughout the coverage areas reduce the impact of the Bluetooth signals. If wireless LAN transmissions become too weak, the interfering Bluetooth signals will be more troublesome. Perform a thorough RF site survey, and determine the appropriate location for access points.
- ***Move to the 5 GHz band?*** If none of the preceding steps solve the problem, consider using a 5 GHz wireless LAN such as 802.11a. You can completely avoid RF interference in this band? at least for the foreseeable future.

Self-Assessment

Fill in the blanks:

1. The basic purport of establishing ..... is provide a communication channel to the individuals, who want to carry their own digital devices .
2. Wireless Personal Area Network (WPAN) is based on ..... technology.
3. The purpose of ..... is to make the use of electric field around human beings.
4. The full impact of ..... interference depends on the utilization and proximity of Bluetooth devices.
5. ..... was the first research scientist to introduce the idea of Personal Area Network (PAN).
6. Wireless PAN (Personal Area Network) is connected to the wired PAN (Personal Area Network) system either using .....

Case Study **Wireless LAN**

The Situation

Prior to their implementation of a Meru wireless LAN, Greene County Public Schools (GCPS) had a wireless network system that wasn't "making the grade." Their legacy system consisted of mobile carts within each of the schools which were equipped with low-end Linksys® wireless routers. Because of this system configuration, wireless access was only active within the rooms where the carts were connected.

Difficulty of Use and Technology Adoption. Operating under the old system, teachers found the process of connecting a class to the wireless carts difficult and disruptive. At times, they were unable to connect to the devices correctly. The cumbersome nature of the process led to dampened enthusiasm for the system which adversely affected GCPS' efforts to use the technology for instructional purposes.

System Management As GCPS' legacy wireless network grew over time, it became increasingly more disparate. Consequently, the IT team found themselves lacking an

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efficient way to implement system management and controls—including preventing the infiltration of unauthorized devices. At the same time, with the number of users steadily growing, finding an effective way to segregate student and public access from the private faculty/staff wireless network was also becoming a priority. With no single point of management, the IT staff was spending increasing amounts of time performing hands-on maintenance and troubleshooting of individual components throughout all the different school buildings. They also had to find a way to abate the growing number of students and faculty using their own personal wireless devices on the school network (laptops, mobile phones and other hand held devices). These critical issues related to system management and security became a drain on IT department resources which translated into an unacceptable level of cost for the school system.

Performance. The legacy wireless network lacked the required throughput capability and, in turn, the predictability needed for running critical school applications. The old network would often exhibit "shaky" performance when used for state required Standards of Learning (SOL) testing. As a result, ensuring Quality of Service (QoS) during SOL testing and other on-line assessments became a high priority concern for the IT staff. With a plan for growth in the number of wireless devices in classrooms, GCPS needed a scalable system that provided all the required capacity without compromise in performance.

Scalability. Like most public school systems, GCPS is subject to the push to devote more space to learning and less to other areas of school operations. With physical space at a premium, the IT department was running out of viable options for housing their expanding LAN equipment. This dilemma made the idea of expanding the wireless network under a centralized system an even more attractive option.

The Meru Solution

With its list of technology priorities in hand, a short window of opportunity to deploy a new solution, and a fixed budget, GCPS turned to their technology service partner, Advanced Network Systems, to find a wireless system that met all of their requirements. During the summer of 2008, GCPS replaced its legacy system with a Meru solution consisting of an MC3100 controller and 74 AP311 dual radio access points. The solution was deployed at the County's high school, middle school and two elementary schools.

Reaping the Benefits of Meru

According to Dale Herring, the benefits realized as a result of the Meru solution deployment were numerous. "We've been extremely pleased with Meru. We now have a really powerful system that has all the capabilities that we need," said Herring. He added, "From an IT perspective, the Meru system's centralized configuration and management features have cut down on a lot of time we used to spend maintaining all the different systems we had." Herring noted that another benefit of the Meru system is its high level of flexibility. "Because we now have a consistent wireless solution, device compatibility issues have been eliminated; this allows GCPS' IT team to easily share laptops and other devices between schools when demands shift. Since there are no configuration changes to perform, devices move seamlessly from school to school. Having this kind of flexibility means we spend less of our time on management and a smaller budget needed because we don't have to have as many devices at every school." Herring noted, "One of the big reasons we chose a Meru solution is its compatibility and technology investment protection. No matter what type of device is connected to the network, a/b/g or n, Meru's access points can accommodate all the least common denominator in terms of performance as we go forward."

Expanding on the idea of better system performance Herring added, "Because Standards of Learning testing is considered a mission-critical application for the school district, we need to have guaranteed quality of service when it comes to its implementation. 'Hiccups'

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in the system are incredibly disruptive and are not an option. With Meru's built in QoS, the on-line SOL testing process has gone very smoothly; the system has reliably supported this and all the other bandwidth-intensive applications we use it for."

According to Dale Herring, "We've had a lot of positive feedback and increased use of the wireless system because connectivity is now a more seamless, transparent process. Disruptions to the teaching process in our classrooms are minimal; plus we were able to easily segregate access for students and the public from the private portion of the network. Everyone in the IT department loves the flexibility and we don't worry the way we used to about adding more devices or new applications. We are all definitely benefiting rom having a pervasive system that provides access wherever and whenever it's needed; both inside and outside of the school buildings."

New Opportunities with a Meru Solution

The 2008/2009 school year brought forth new opportunities for GCPS to improve the learning environment using their state-of-the-art Meru wireless network. Students and school personnel alike are reaping the benefits of being able to successfully run applications over the air including web-based assessments, instructional videos and presentations, along with Internet-based learning and staff training.

Opportunities on the horizon are all about learning and teaching processes. The technology and cost/benefit analysis of implementing an e-reader program is now under consideration. The GCPS' IT department is currently piloting e-reader technology to support the County's reading program in the Middle School. If successful, the program will be expanded to all schools. According to Dale Herring, "We considered the option of e-readers before the Meru installation. But now since we have the technology to effectively support this kind of program, the concept has gained a lot of traction and taken on a new meaning. Students are now able to access the most up to date material throughout the facility, not just in certain designated locations." With the number of electronic formats consolidating and significant improvements in device battery life, the use of hand-held devices containing e-books has grown significantly within the educational market. Herring added, "The concept of e-readers appeals to students and school administrators alike. Students already lug around enough laptops and heavy books. On the other side, books are expensive and quickly fall out of date which makes it challenging for schools to stay current."

As part of the teacher development and evaluation process, GCPS administrators are using iPod's to wirelessly connect to a web portal to run their classroom observation software. So far this year, over 1000 informal classroom observations have been conducted and recorded. That data collected is used to insure that best instructional practice is being followed, to provided specific feedback to teachers, and to help administrators stay in touch with what is going on in the classrooms. According to Herring, "Using a secure wireless/web-based system, we've made big strides in recording evaluation info in real time and keeping it secure. We essentially eliminated the need to keep data on a device which could get lost or stolen and need for any further data transfer." Purchased with private enterprise grant funds, the implementation of these mobile devices has had a significant, positive impact on the collection, storage and utilization of this vital information.

Plans for the Future

GCPS has plans to expand the implementation of Meru products in its primary school and school board office in the near future. Further out on the horizon are plans for a VoIP telephony solution which could ultimately also be run over their Meru wireless network.

About Greene County Public Schools Greene County is located in central Virginia at the foot of the Blue Ridge Mountains, with the Shenandoah National Park and the Skyline Drive forming its western boundary. Although rural in nature, this picturesque County is part of the Charlottesville metropolitan region which includes the University of Virginia.

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As a result, the County has become a community that has experienced significant growth in its residential population as well as business investment and economic development. The Greene County Public School System has a student enrollment of approximately 2,800 and is comprised of seven schools including one primary, two elementary, one middle, one high school, an alternative education center, and a technical educational center. The school system's popular tag phrase, "Every child, every chance, every day," echoes its formal commitment to build a positive, responsible and effective learning community where students, teachers and staff are encouraged to believe, achieve and succeed.

About Advanced Network Systems, Inc. Advanced Network Systems specializes in the design, installation and support of information technology solutions. The company's expertise covers a wide variety of IT applications, including network security, virtualization, managed IT services, core infrastructure, networked storage, and wireless, as well as IP-based telephone and conferencing systems. With multiple locations, serving Virginia and West Virginia, Advanced Network Systems supports a diverse base of clients, including small and medium-sized businesses, government agencies, and educational institutions.

Questions:

1. Study and analyse the case.
2. Write down the case facts.
3. What do you infer from it?

Source: http://www.getadvanced.net/wlancasestudy

4.3 Summary

Wireless LAN (WLAN) is very popular nowadays

Wireless LANs enable users to communicate without the need of cable. Each WLAN network needs a wireless Access Point (AP) to transmit and receive data from users.

The major difference between wired LAN and WLAN is WLAN transmits data by radiating energy waves, called radio waves, instead of transmitting electrical signals over a cable.

WPAN describes an application of wireless technology that is intended to address usage scenarios that are inherently personal in nature.

WLAN on the other is more focused on organizational connectivity not unlike wire based LAN connections.

WLAN addresses connectivity within a defined region, WWAN addresses the need to stay connected while traveling outside this boundary. Today, cellular technologies enable wireless computer connectivity either via a cable to a cellular telephone or through PC Card cellular modems.

The basic purport of establishing PAN (Personal Area Network) is provide a communication channel to the individuals, who want to carry their own digital devices .

Wireless PAN technologies utilize both radio frequencies and infrared light, depending on the application.

4.4 Keywords

Wireless personal area network (WPAN): is a personal area network , a network for interconnecting devices centered around an individual person's workspace

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Body Area Networks: is based on the IEEE 802.15.6 standard for transmission via the capacitive near field of human skin allowing near field communication of devices worn by and near the wearer.

Piconet: and is composed of up to 8 active devices in a master-slave relationship (a very large number of devices can be connected in "parked" mode).

WLAN: is more focused on organizational connectivity not unlike wire based LAN connections.

Personal area network (PAN): The communication network established for the purpose of connecting computer devices of personal use

4.5 Review Questions

1. What are the various types of wireless networks?
2. Define the following:
3. transmission technology
4. microwave transmission
5. spread spectrum transmission
6. Describe the various types of wireless LAN
7. Explain the working principal of WiMAX
8. Could Bluetooth replace wireless LANs?
9. Could wireless LANs replace Bluetooth?
10. Discuss the steps used to avoid the interference from Bluetooth devices

Answers: Self-Assessment

1. Infrared Data Association
2. Bluetooth
3. Piconet
4. WLAN
5. Direct Sequence Modulation
6. Diffused
7. Basic Service Set (BSS)
8. PAN (Personal Area Network)
9. Plug –in
10. PDAs
11. RF
12. Thomas Zimmerman
13. Firewire or USB

4.6 Further Readings

Books

802.11 Wireless Networks: The Definitive Guide, Second Edition, Matthew Gast

Introduction to wireless networks, John Ross

Wireless Communications & Networking, Vijay Garg

Wireless Communications: Principles and Practice, Theodore S. Rappaport

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Online links

http://wikid.eu/index.php/Wireless_Metropolitan_Area_Networking_%28WMAN%29

http://www.tutorial-reports.com/wireless/wlanwifi/wifi_architecture.php

http://en.wikipedia.org/wiki/Personal_area_network

http://www.doc.ic.ac.uk/~nd/surprise_95/journal/vol2/mjf/article2.html