

Wireless Technologies

Present to
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September 8, 2010

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ZigBee

ZigBee is the second short range communication technology for the second. Communication is designed for communication in wireless sensor networks (Wireless Sensor Network), starting from setting standards for - send data to by focus on the IEEE 802.15.4 with highlight on low-power communications for low-speed data transfer and inexpensive communication of this kind are used for communication about the detector or sensor and reduce the complicated to install.

Protocol Architectures.

ZigBee is based on the IEEE 802.15.4 Standard that is created by ZigBee Alliance. In term of architecture, it is divided into Zigbee stack created is called a block layer (layer), each layer is divided into categories and based on the use of layers.

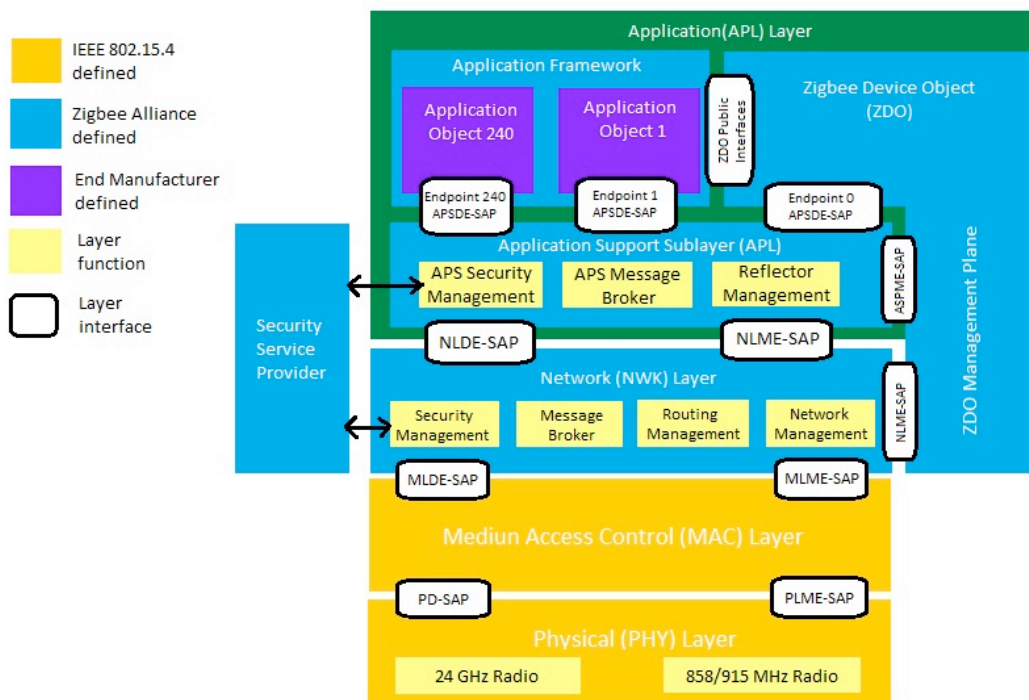


Figure A.1 ZigBee Protocol Architecture

From Figure A.1 architecture of Zigbee is followed the standard OSI: Open System Interconnection 7 models, which in this definition only model main Physical (PHY) Layer, Medium Access Control (MAC) Layer, Network (NWK) Layer, Application Support Sub. -layer (APS), Zigbee Device Object (ZDO).

ZigBee uses the Physical Layer and MAC Layer of IEEE 802.15.4, a wireless set standards for WPAN (Wireless Personal Area Network) to work in a Layer on a

lower level, such as signal power, Link Quality, Access control, Security, etc. The request Device that can send a request for information to be stored. And then transfer data to and receive information to complete.

Data Transmission

ZigBee defines the frequency district into 3 districts ;

- Radio frequency 2.4 Ghz has 16-channel and data transfer rate is 250 Kbps.
- Radio frequency 915 Ghz has 10-channel and data transfer rate is 40 Kbps.
- Radio frequency 868 Ghz has 1 channel and data transfer rate is 20 Kbps.

Since ZigBee frequency operates in unlicensed bands; For global band in the industrial, scientific and medical (ISM) uses 2.4 GHz at 250kbps , European Band use 868 MHz at 20kbps and North American Band 915 MHz at 40kbps.

Transmission Medias

Range of Transmission distance in open space communications for approximately 200 meters in a building about 30 meters communication distance can be extended by adding communication intermediate node or router.

Signal Encoding Techniques

Using mixed signal (modulation) as an Offset Quadrature Phase Shift Keying (Offset- QPSK) and noise problems for Direct Sequence Spread Spectrum (DSSS) at the rate of vertical spread (spreading) 2 million chip / sec.

Errors

ZigBee uses frames, ACK to confirm the receipt and send more data to be transmitted. In fact an error when sending data If not, the ACK frame back to sent without Send all information to be sent to. An error will not occur between the sending and receiving.

Application

Since advantages of Zigbee is a wireless communication system that low-cost, low

power consumption makes work longer even if the battery is small, the communication two-way (Two way) also Zigbee network of communications Mesh. The reliability is higher and more remote. Therefore be applied widely. In the industry and household systems, such as home and building automation that is standard offering control for home appliances, lighting, environment, energy use, and security, industrial control systems, sensors detect medical, telecommunications systems. Or even a computer peripheral toys or games.

Usage

ZigBee become is becoming widely uses in Thailand but not as much as the Europe and North America because in Europe and North America have the team project for develop this technology. In addition, they expected to hit the market full force since 2006 and then companies have already invested millions of this technology device. However, in Thailand, organization that manufactures Electric appliance has a relationship with the ZigBee Alliance and has more development to the typical user in many ways of usage such as the LG ,Sumsung and etc. In example, produce the sensor in the electronic appliance to comfortable to home .

Cost

The cost starts at \$1.5 – \$2.5.

Bluetooth

Bluetooth refers to an open specification for a technology to enable short-range wireless. This technology allows the devices communicate without wires over an air-interface by radio wave to transmit and receive data.

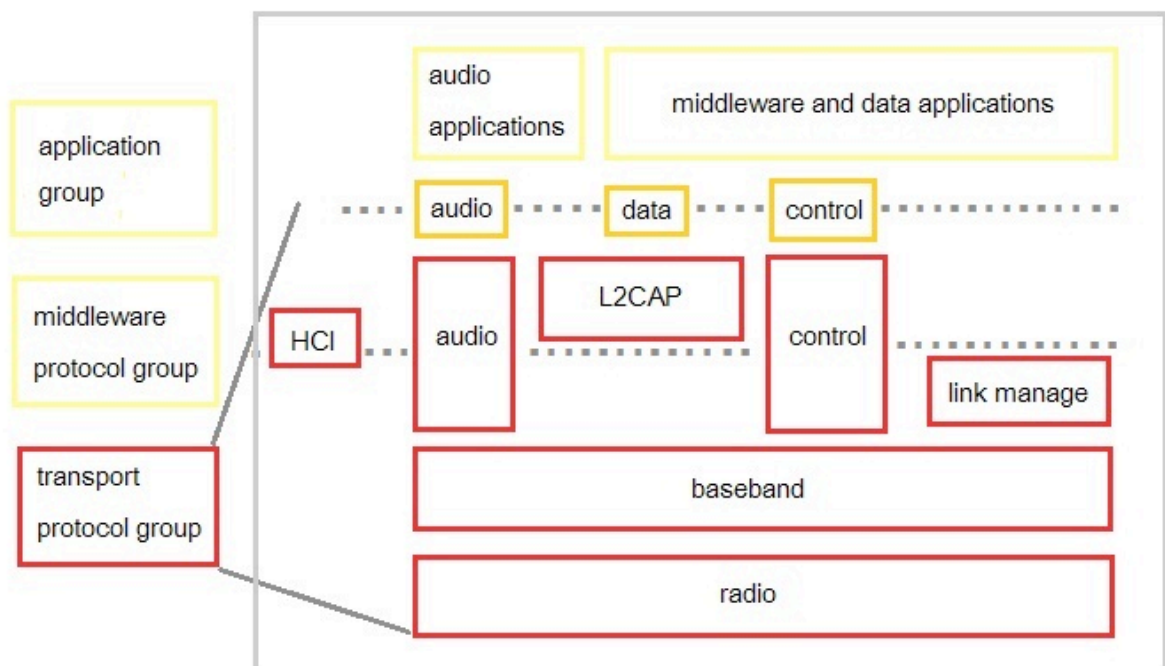
Protocol Architectures

Bluetooth communication is like the Master and Slave roles. At baseband level when 2 devices is established a Bluetooth link, one will act like a Master and another one will act like a slave. With this situation, the ad hoc network devices are called the piconets. Within piconet, there are the units to share the same channel. Each piconet has only one master and slaves (up to 7 slaves). The master determines the frequency hopping pattern and the phrase for the hopping sequence and the master is assumed by the device that initiates the communication. Slaves within a piconet must also synchronize their internal clocks and frequency hops with that of the master.

The Bluetooth protocol stack has divides into three groups:

- **The transport protocol group**

This group is composed of the protocols that allow Bluetooth device to locate each other and to crate configure and manage both physical and logical links. These protocols developed to carry audio and data traffic between devices. Figure illustrates the protocols in this group.



The transport protocols support asynchronous transmissions for data communicate and synchronous transmissions for telephony-grade voice communication. To make the high quality of audio application, the audio is arranged in high priority. So audio traffic passes all of the intermediary protocol layers and goes directly from audio application to baseband layer then baseband layer transmits it in small packets directly over the Bluetooth air-interface.

- **The middleware protocol group**

The middleware protocols makes use of the underlying transport protocols and present to the application layers standard interfaces that may be used for communicating across the transports. Each of the middleware layers defines a standard protocol that allows application to use a higher level of abstraction than would direct communications with the lower-layer transport protocols

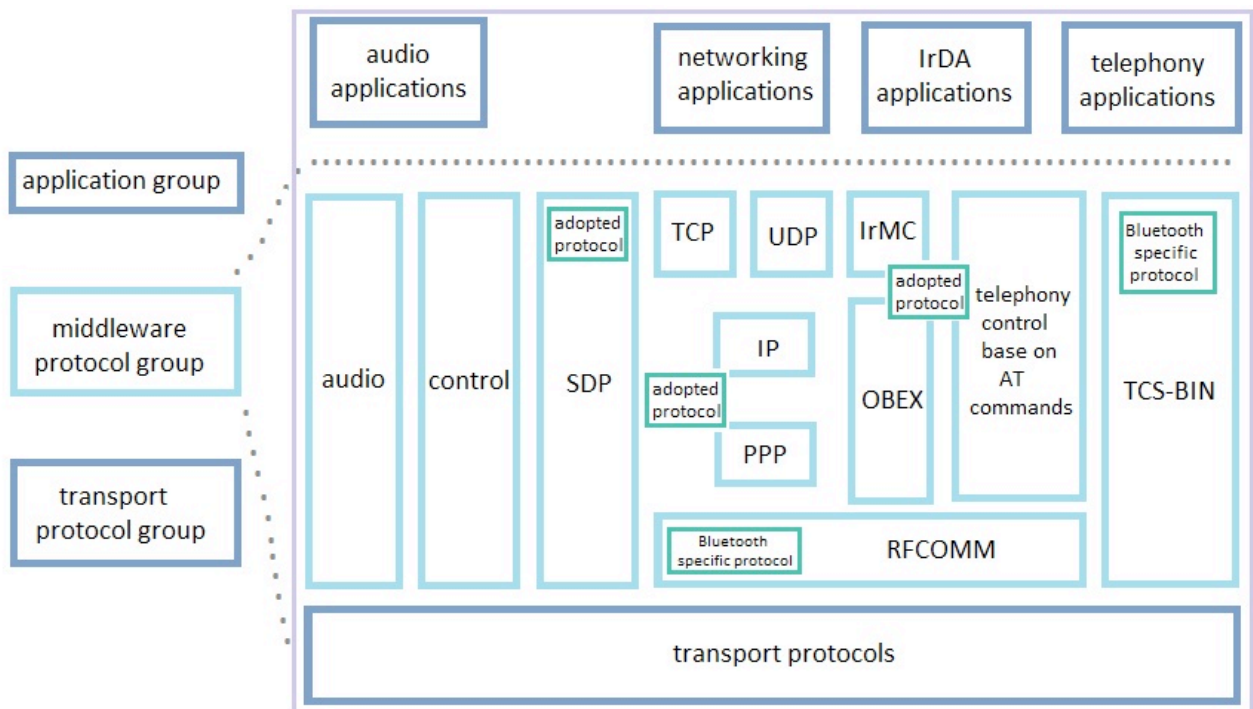
The middleware protocols consist of:

- RFCOMM , a serial port abstraction;

- service discovery protocol(SDP) ,used to describe available services and to locate needed services;

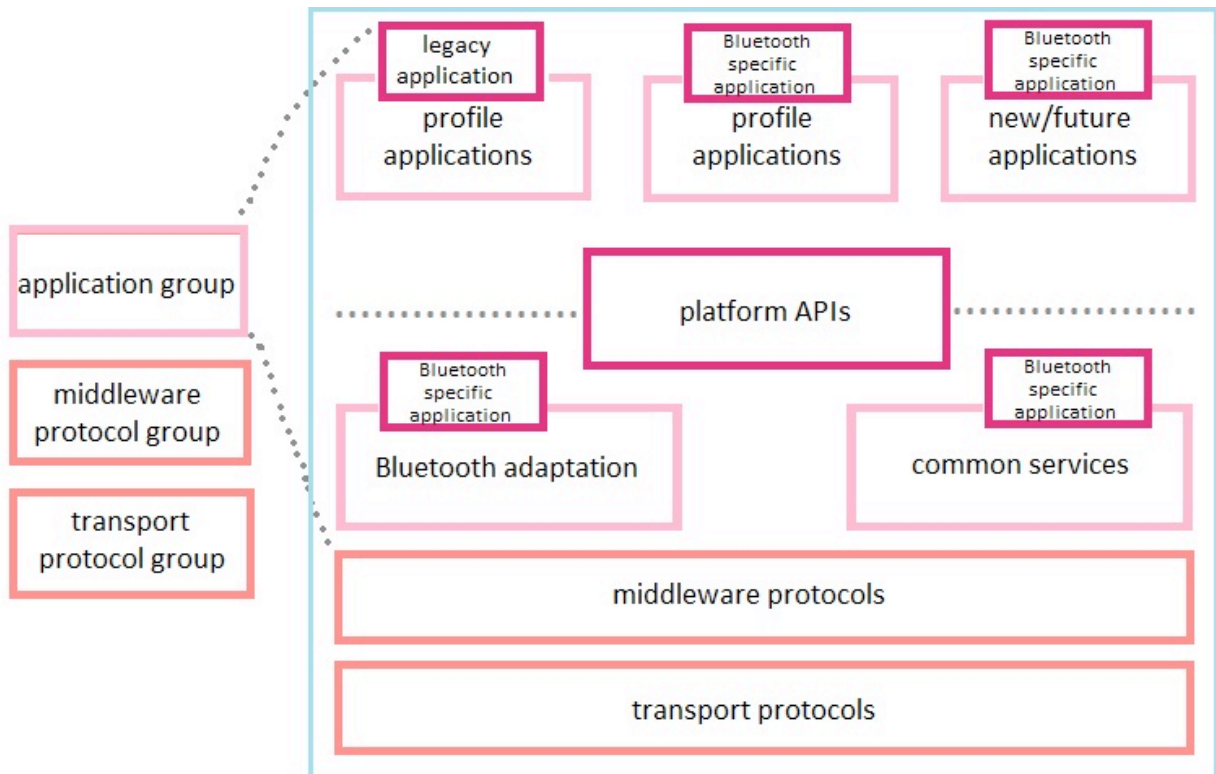
- A set of IrDA interoperability protocols adopted from the IrDA standard that enables interoperable use of IrDA-enabled applications; and

- a telephony control protocol(TCS), used for controlling telephone calls that might be used either for audio of data.



- **The application protocol group**

The application group here refers to software that resides above the protocol stack as defined by SIG. this is software that is supplied by device manufacturers, independent software vendor or other which exercises the protocol stack to accomplish some function that benefits the user of a Bluetooth device.



Standards

The Bluetooth protocol is being considered by the 802.15 WPAN standards task group.

Data transmission

- The spectrum is divided into 79 channels.
- Bandwidth is limited to 1 MHz/channel.
- Frequency hopping spread spectrum communications must be employed.

Bluetooth communication method is frequency division spread spectrum (or frequency hopping). The method is that divides the spectrum into different frequencies, or channel.

Single message packet is transmit on selected channel, then radio selected a new channel (hopping to new frequency) to transmit next packet and so on.

PSHSS provide some benefit

- 1.) Reduce RF interference that disturb the device
- 2.) Provide degree of security since only a receiver who knows the frequency hopping pattern can receive all the packet of message.

For Bluetooth communication the spread spectrum is required in 2.4 GHz range, largely to minimize interference problem the spectrum is unlicensed

Transmission Media

Range;

Range in Bluetooth is divided into 3 categories that may vary depending on class of radio used in an implementation:

- Class 3 radios – have a range of up to 1 meter or 3 feet
- Class 2 radios – most commonly found in mobile devices – have a range of 10 meters or 33 feet
- Class 1 radios – used primarily in industrial use cases – have a range of 100 meters or 300 feet

POWER;

The most commonly used radio is Class 2 and uses 2.5 mW of power. *Bluetooth* technology is designed to have very low power consumption so it required maximum battery life instead of a high data transfer rate, consumes between 1/2 and 1/100 the power of classic Bluetooth technology.

Signal Encoding Techniques

Two types of encoding schemes are specified for Bluetooth audio. The first is pulse coded modulation (PCM) with either of two types of logarithmic compression (call A-law and u-law) applied. PCM audio with these compression type is well know and widely used foe general audio, including things like short sound clips. The second audio encoding scheme is continuous variable slope delta (CVSD) modulation. The characteristics of typical voice conversations, which have a more predictable continuity than general audio (music, for example), make a delta-slope prediction more efficient. CVSD generally is also more tolerant of communicate errors. Thus CVSD, in general, is a more effective and efficient (and thus generally preferred) method to use for Bluetooth audio communication; we observe once again that this is an optimization for voice versus other forms of audio.

Errors

The Bluetooth technology error detecting is to detect and correct the error that can happen by

1. 1/3 rate Forward error correction
2. 2/3 rate Forward error correction
3. ARQ – Automatic Repeat request ; Transmitter (transmitter) data and check code (check code) which the receiver (receiver) is in error. If the receiver can not find any errors. It will send a testimonial (ACK, acknowledgment) back to the transmitter If the transmitter does not receive a certification (not ACK) will attempt to send the data again.

Application

Bluetooth appears in many products that have to shares or transfer data between the devices such as telephones, the [Wii](#), [PlayStation 3](#), [PSP Go](#), [Lego Mindstorms NXT](#), [iPod Touch](#) and in some high definition watches, modems and headsets.

Bluetooth protocols simplify the discovery and setup of services between devices.

This makes using services easier because more of the security, network address and permission configuration can be automated than with many other network types.

Here is some example scenario that always use with the Bluetooth technology;

- Stereo headset and Speaker
- Audio players and Portable Media Players (PMP).
- Printers, scanners and multifunctional devices.
- Keyboards, mice and videogame controllers.
- Mobile phones, desktops, laptops and ultra-portables.

Usage

Bluetooth has been used widely in Thailand and overseas have some time now, because Bluetooth is technologies brand that is cheaper and actually works in various. Especially regarding the connection between mobile phones and accessories. For overseas development performance and the speed of Bluetooth increase .The rate of use is very high and has spread worldwide.

Cost

Start at \$3.The devices for this technology is very cheap.

Wireless LAN

Wireless LAN is one of the wireless communications technology that uses magnetic waves in the air as radio waves (Radio Frequency) or infrared waves. (Infrared) for communication information from one point to another point without having to rely on Hot line signal (cable) are respectively notch or complicated to use. For technology Wireless LAN feature device called an access point (access point), a device for and receive signals and connect to the infrastructure network in an organization that already exists

Protocol Architectures

Standards; IEEE 802.11 standard in early that the performance is relatively low. There is also no guarantee of quality of service, called QoS (Quality of Service), which is important in an environment with a variety of applications available for use. In addition, mechanism on the security that is used is vulnerable to many IEEE has established several working groups set up together to develop and improve standards for potential increases.

- IEEE 802.11a

To improve the ability of devices to transfer data at speeds up to 54 Mbps, but uses radio frequency is 5 GHz band for public use in the United States with noise From other devices. Less than the 2.4 GHz band, however, disadvantages of the IEEE 802.11a standard that uses radio waves at a frequency of 5 GHz is the frequency in some countries can not be used in public works for example, Thailand does not allow the use devices IEEE 802.11a 5 GHz because the frequency area has been allocated for other activities already. In addition, another disadvantage of the IEEE 802.11a WLAN equipment Radius is the size of the signal is relatively short (about 30 meters shorter than the radius of the signs of IEEE 802.11b WLAN equipment that is approximately 100 meters for indoor use). Also IEEE 802.11a WLAN devices are priced higher than the IEEE 802.11b WLAN with IEEE 802.11a WLAN equipment is so popular more than IEEE 802.11b WLAN.

- IEEE 802.11b

Use a technology called CCK (Complimentary Code Keying) combined with DSSS (Direct Sequence Spread Spectrum) to enhance the ability of the device to transfer data at speeds up to 11 Mbps via wave radio frequency, 2.4 GHz (a frequency called. ISM (Industrial Scientific and Medical) has been allocated internationally for use in public science industry and medical devices that often this area is for example IEEE 802.11, Bluetooth, cordless phones and microwave) majority. IEEE 802.11 WLAN equipment used in the current IEEE 802.11b standard equipment and the well-known trademark in the name Wi-Fi.

- IEEE 802.11g

OFDM technology in the applied radio frequency is 2.4 GHz IEEE 802.11g WLAN device has the ability to send and receive data at speeds of 54 Mbps signal radius of IEEE 802.11g WLAN device is the radius of the device signal IEEE. Because 802.11a and IEEE 802.11b 2.4 GHz frequency band is shared internationally. IEEE 802.11g

WLAN device also is compatible with the IEEE 802.11b WLAN devices (backward-compatible), so it is likely that the high IEEE 802.11g WLAN device is widely popular if the price is not too expensive and would IEEE 802.11b eventually replace.

- IEEE 802.11e

Improvement of the IEEE 802.11 MAC Layer in order to support the work principle Quality of Service for application on multimedia (Multimedia) because the IEEE 802.11e MAC Layer is updated, so additional standards can be used with all IEEE 802.11 WLAN devices version

- IEEE 802.11i

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IEEE 802.11 technology standard for WLAN. Popular most widely used definition is (Specification) for WLAN devices in the Physical (PHY) Layer and Media Access Control (MAC) Layer.

In the PHY Layer of IEEE 802.11 standards has made the device capable of data transfer speeds 1, 2, 5.5, 11 and 54 Mbps with three media types that is public radio frequencies 2.4 and 5 GHz, and infrared (Infrared) (1 and 2 Mbps only).

In parts of the MAC Layer, the standard IEEE 802.11 was assigned to a mechanism called CSMA / CA (Carrier Sense Multiple Access / Collision Avoidance), which is similar to the principle of CSMA / CD (Collision Detection) of the standard IEEE 802.3 Ethernet which are used widely in the network. LAN wired the signal.

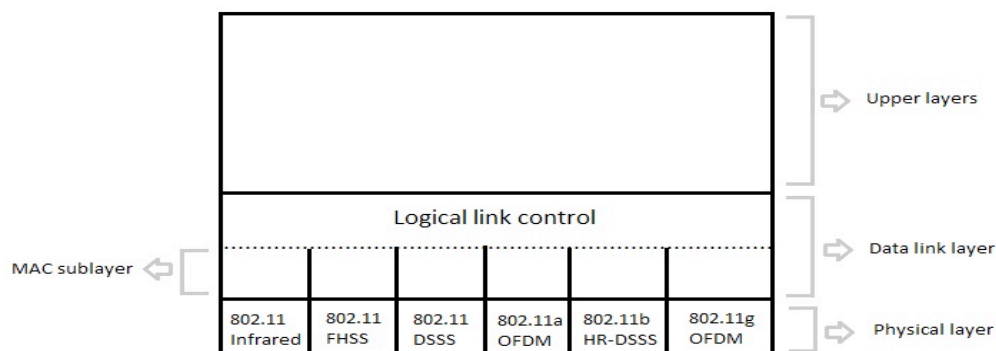


Figure C.1 Layered Stack of WLAN.

Also in the IEEE802.11 standard is set to have the option to create security for IEEE 802.11 WLAN network by using encryption mechanisms (Encryption) and user authentication. (Authentication) is called WEP (Wired Equivalent Privacy)

Data Transmission

Standards	Frequency	Maximum data transmit rate	Distance
IEEE 802.11b	2.45 GHz	11 Mbps	100m (300ft)
IEEE 802.11a	5.8 GHz	54 Mbps	50m (150ft)
IEEE 802.11g	2.4 GHz	54 Mbps	100m (300ft)

Transmission Media

Transmit power; transmit power will not exceed 100mW or 20dBm. The transmit power that much it means to be broadcast in the wide distance but can be adjust for sending the lower to fit your needs. Especially for use within the organization must submit the appropriate use of force to the region. Since sending high, may be to interfere with nearby office and may be illegally using wireless networks.

Antennas; For the type of antennas that are available are two major types is an Omni-Direction Antenna, a pillar of any manufacturer provided with the product then. The properties of this type of antenna is to receive and send signals in all directions in a circle that causes the signal is distributed around a radius of coverage. Another major type is Direction Antenna which fits for transmit signals in a straight line, used with products Wireless Bridge for the communication(Point-to-Point.)

Signal Encoding Techniques

Standards	modulation scheme
IEEE 802.11b	DSSS
IEEE 802.11a	OFDM
IEEE 802.11g	OFDM / Security

Direct Sequence Spread Spectrum (DSSS);

Direct Sequence Spread Spectrum is a technique that is used to specify the carrier wave frequency used. It can send the data over a Narrow Band method is suitable for environments with noise interference from other radio severe.

Orthogonal Frequency Division Multiplex (OFDM);

This technique is used to speed up data transmission by new standards of wireless networking is IEEE 802.11a and 802.11g. This radio transmission signal by a Multiplex channel frequencies are divided into sub-carrier frequency (subcarrier), each multi-frequency sub-carrier frequencies are mutually perpendicular that causes it is independent of each other. Frequency carrier wave that is perpendicular to each other so no problem of overlapping of adjacent signals.

Applications

Wireless network can be used with ease and much higher security. In addition, it offers speed of communication increases as the response and can be used in areas with good whether using high-speed Internet. The use of multiple video streaming and use of female entertainment. Applications for wireless networks has seen a wide range.

- User residential accommodation to bring wireless network to use the shared usage with family members to listen and watch entertainment on the Internet via various wireless products from anywhere within the home without wiring to the signal difficult.
- Users within an organization can be used to increase the productivity of your staff. Reduce the cost of placing the cable signal. Expand the network to have the flexibility. Network administrators can detect system and modify the problems that may occur on the network from anywhere. Allows quick and easy to manage more.
- Users within the school. Schools can use the wireless network for students to attend online. You can search on the Internet from any point of the school allows students to work more easily and quickly.

Usage

This technology is popular and widespread in Thailand and internationally. Because the technology that reduces the complexity in terms of technical and cost is not high. The development in Thailand has many things to see for example the hot spot by various public places. To provide users access anytime, anywhere concept meets the modern world wireless networks. Even in the developed world will see that all areas will have to support the WiFi service in various areas of living and users can access more easily.

Cost

A simple WLAN (Wireless Local Area Network) for a coffee shop or similar establishment needs a broadband high speed internet connection and a router/access point/gateway broadcast device. This will enable multiple users within 100-300 feet or so of the broadcast device to share the broadband connection.

- A business class cable or DSL broadband connection costs approximately \$60-150 a month.
- Broadcast devices (802.11g are the most popular) cost anywhere from \$40 - \$100.

In summation, basic set-up hardware costs can be as little as \$40 and monthly broadband connection costs will be around \$80-150.

WiMAX

WiMAX stands for Worldwide Interoperability for Microwave Access that is a wireless technology capable of greater than Wi-Fi technology for both speed and distance. The ability to distribute the signal to a single point to multiple points. (Point-to-Multipoint) also supported the Non-Line of Sign is able to connect or work. Despite obstacles such as trees, walls and buildings, etc.

Protocol Architectures

WiMAX is initially being developed from the wireless short range with standard IEEE 802.11 standard was developed technologies, Wi-Fi later the standard new and the others. IEEE 802.15 standard has been used to develop the technology into wireless connection of electronic devices. The communication in the near term. Well known in the name of the current Bluetooth and IEEE 802.16 standards has come to develop wireless technology with standard WiMAX.

The standards for WiMAX as following;

- IEEE 802.16.

A standard that between the provider within the 1.6 to 4.8 km transmission in high frequency range 10-66 GHZ frequency standard, which is a prototype or a first signal in the development of another model.

- IEEE 802.16a.

Develop from the original IEEE 802.16 is able to increase work support Non-Line of Sign efficiently through obstacles. 2-11 GHZ frequency range that shabby either expanded network systems connect high-speed wireless Internet is a perfect cross to connect with DSL connection for residential use several different connections simultaneously or network systems between or within its own company.

- IEEE 802.16e.

Is designed to support mobile and portable devices such as PDA and Notebook etc.

Both IEEE 802.16 and IEEE 802.16a standard as the equipment used in infrastructure In the main part of the device is an IEEE 802.16e version is used on the infrastructure equipment in the receiver.

The main protocol specified in IEEE 802.16 still remains a second layer is the Physical Layer, or popular short called the PHY and Media Access Control Layer or MAC Layer only. The two layers will be responsible for different things . PHY layer is a floor on the

detailed physical characteristics of the signal different whether it is controlling power transmission, the modulation of making multiple CF for many users, encoding various characteristics of the antenna and so on. While, the MAC will be on stage about access. Treatment and control of various security checks, a link to the various protocols over etc.

Data Transmission

Standard	Network	Speed	Distance	Frequency
IEEE 802.16a	WMAN	Maximum 75 Mbps (20 MHz BW)	Normal 6.4-5 km.	2-11 GHz
IEEE 802.16d	WMAN	Maximum 75 Mbps (20 MHz BW)	Normal 6.4-5 km.	Sub 11GHz
IEEE 802.16e	Mobile WMAN	Maximum 30 Mbps (10 MHz BW)	Normal 1.6-5 km.	2-6 GHz

Transmission Media

Transmit Power;

In general, WiMAX basestation transmits power levels about +43 dBm (20 W), and the mobile station transmits at +23 dBm (200 mW).

Antennas;

There are three types of Antena

- **Omni directional antenna;** use for the small area that the subscribers are located near the basestation
- **Sector antennas;** this antenna focus on the beam more than the area. The subscribers is covered within the beam degree of the antenna.
- **Panel antennas;** can also be a configuration where potentially the WiMAX radio is contained in the square antenna enclosure. Such configurations are powered via the Ethernet cable that connects the ra-dio/antenna combination to the wider network.

Distance;

- Basestation WiMAX coverages large area around 30 miles
- WiMAX Router is around 1-3 miles

Signal Encoding Techniques

In WiMAX will have to make that adjustment Adaptive Modulation modulation and encoding suitable signal interference occurs that causes the maximum speed possible in the environment automatically. Therefore, the length of different with the signal to noise (S / N ratio) difference would result in the modulation and encoding vary according to the signal to noise and cause. speed data transfer down. Due to the deployment of modulation of the distance between different base stations with more clients.

WiMAX has Convolutional Coding for Binary non-recursive Code Rate that rates vary according to the data such that only any good. If there is less interference to protect little less ,the protection is depended on the interference. In addition, it also has the option Convolutional Turbo Code, Block Turbo Code and Low Density Parity Check (LDPC) for using. But likely to happen is that most manufacturers choose to use only Convolutional Turbo Code with Convolutional Coding Standard pairs only. Because the advantages of Convolutional Turbo Code is superior to many other encoding that is not a matter of flexibility in the encoding and superior performance in preventing errors etc.

Errors

WiMAX uses FEC (Forward Error Coding) in order to increase reliability and efficiency of data transfer. It must be added the ability to detect problems or correct errors in data transmission in 802.16e and is also used to support encryption in this section. This section will consist of the Channel Coding encoding many of the objectives and use different. Because WiMAX can make Adaptive Modulation for maximum effectiveness in environments transfer to the frequency difference, and this is one thing that is adapted to the environment.

The process of doing two types of Hybrid ARQ type I and type II or Chase Combining or Incremental Redundancy, which is the first in that if information is received the error. Archive will be out before the error. After the new information will be sent together. Before FEC decoding to remove the following information. The information obtained is more accurate in the second part will change the encoding of information that will repeat with The accuracy and performance than the first.

Applications

WiMAX has the ability to send signals from one distribution to multiple locations. (Point-to-Multipoint) and can work in. (Non-Line-of-Sight) that can function despite any obstructions such as buildings, trees WiMAX can connect wirelessly with a fast and consistent. And support for large data transfers. (Such as voice, video, data, image streaming) to mobile devices. It also allows users to use Application at home or at work even during travel to access to the services continuously and smoothly.

Usage

Technology WiMAX would start to get recognition and increase its popularity and use since 2005 and should be successful and become a standard wireless communication the latest another is monitoring that might share. marketing wireless technology of the future within the current maximum.

And also as expected. Networking and WiMAX client began the production and distribution in more business and have been installed in a regional network of international technology leaders around the world, more and more. Therefore, it is possible that WiMAX is a step into the global wireless standards within a very long, according to the forecast and analysis is expected to take the same market.

In Thailand , now has the infrastructure start to service of the WiMAX study, aimed to bring the actual service.

WiMAX technology is so interesting and would be focus on that actually works or not, and how much popular. Because of benefit of the system, whether in the distance, speed ,limitations of the connection , can reduce the weakness of other systems.

Cost

For the equipments for the WiMAX is not too expensive

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