Introduction to Data Communications

Wireless Technology

Present to

Asst. Prof. Dr.Steven Gordon

by

Vanansanan Wongwian 5122791387
Wiminwan Thipdararat 5122791916
Vibhu Nilayon 4922770708

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Bluetooth

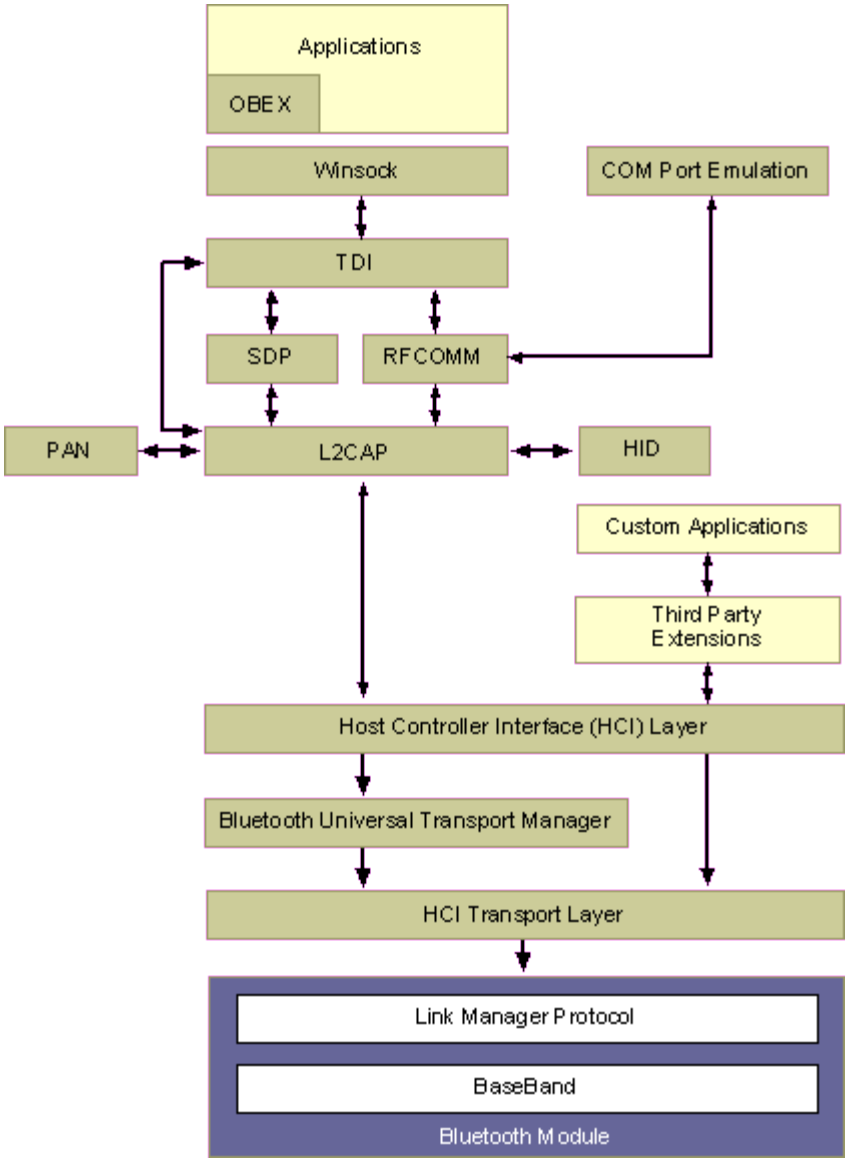
Bluetooth is an open wireless technology standard for exchanging data over short distances (using short wavelength radio transmissions) from fixed and mobile devices, creating personal area networks (PANs) with high levels of security. Created by telecoms vendor Ericsson in 1994, it was originally conceived as a wireless alternative to RS-232 data cables. It can connect several devices, overcoming problems of synchronization. Today Bluetooth is managed by the Bluetooth Special Interest Group.

To use Bluetooth wireless technology, a device must be able to understand certain Bluetooth profiles, which are definitions of possible applications and specify general behaviors that bluetooth enabled devices use to communicate with other bluetooth devices. There are a wide range of bluetooth profiles that describe many different types of applications or use cases for devices.

Protocol Architecture

layered stacks

The protocol stack makes up the core portion of the Bluetooth implementation. This stack enables devices to locate each other and establish a connection. Through this connection, devices can exchange data and interact with one another through various applications. The following image map shows the supported layers within the Bluetooth stack. To link to topics that provide information about the elements in the image map, move your pointer over the element, and then choose the element.



OBEX (Object Exchange) is an object exchange protocol that is implemented on top of Winsock over Bluetooth and IRDA transports.

Obex client module: Obexapi.dll

Obex server module: Obexsvr.dll

TDI (Transport Driver Interface) is an interface that serves as an adaptation layer to Winsock-based user APIs.

COM Port Emulation can implicit COM ports to be created over RFCOMM channels. It hosts dial-up and LAN access profiles. The port emulation facility is included in Btd.dll.

SDP (Service Discovery Protocol) is a Bluetooth service discovery protocol that handles publishing and discovery of services running on top of the Bluetooth stack. The port emulation is included in Btd.dll.

SDP client module: Btdrt.dll

SDP server module: Btd.dll

RFCOMM (Serial Cable Emulation Protocol) is Bluetooth's adaptation of the TS07.10 protocol. It serves as a base for COM port emulation facilities and derived point-to-point protocols. Multiplexing and flow control between devices and applications are also implemented here. The RFCOMM layer is included in Btd.dll.

PAN (Personal Area Network) profile defines procedures to support standard IP-based network services deployed over the Bluetooth transport layer.

HID (Human Interface Device) profile defines procedures to support human interface devices such as keyboard and mouse.

L2CAP (Logical Link Control and Adaptation Protocol) is a lower connection-based Bluetooth communication protocol that implements multiplexing. L2CAP does not implement flow control. It relies on a reliable device-to-device baseband link provided by Bluetooth hardware. The L2CAP layer is included in Btd.dll.

HCI (Host Controller Interface) is a basic interface to Bluetooth hardware, responsible for controller management, link establishment, and maintenance. The HCI layer is included in Btd.dll.

Bluetooth Universal Transport Manager (BthUniv) is an intermediate transport driver between the HCI layer and the transport layer. It detects the Plug and Play (PnP) device and loads the appropriate transport driver. The Bluetooth Universal Transport Manager is in Bthuniv.dll.

HCI Transport Layer is a transport layer that delivers HCI commands to the Bluetooth hardware.

LMP (Link Manager Protocol) is the protocol that handles link establishment between Bluetooth devices, which include authentication and encryption.

BB (Baseband) enables the physical radio frequency (RF) link between Bluetooth units that form a piconet.

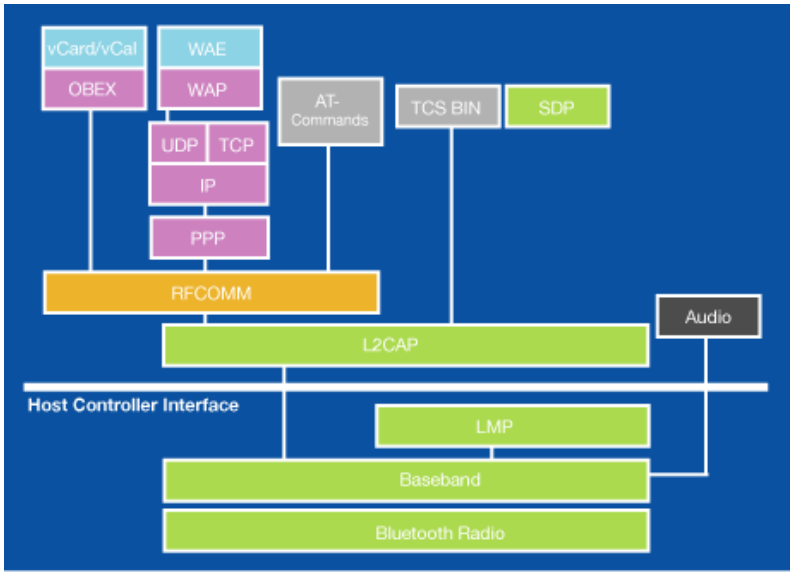
Each layer, with the exception of the HCI transport, is implemented as a separate entity that exposes its interfaces up and down through tables of callbacks. Each interface is well defined. There are no other interrelationships between parts of the stack; every layer is replaceable.

Protocol

The Bluetooth standard requires a basic level of communication between devices, so that they can connect to each other over the airwaves, at the correct frequencies, using the correct channels, and finding the correct destination(s). In order to create this basic level of communication, a specific protocol was created. The Bluetooth protocol establishes the set of rules by which all Bluetooth devices must abide in order to establish a connection to communicate with one another.

Standards

Most protocols, Bluetooth's included, are usually layered together into "protocol stacks", and the various tasks are split up and assigned to the different layers of protocols in the stack. Think of it like an organization or company that is located in an office building with multiple floors. The building is organized so that each floor is a different department within the company. Each department has separte duties and responsibilites, but each department is necessary for the entire organization to function as a whole.



Prolocol Stack

Data Transmission

Spectrum and Frequency

Frequency hopping spread spectrum - FHSS is a radio transmission process where a message or voice communications is sent on a radio channel that regularly changes frequency (hops) according to a predetermined code. The receiver of the message or voice information must also receive on the same frequencies using the same frequency hopping sequence. Frequency hopping was first used for military electronic countermeasures. Because radio communication occurs only for brief periods on a radio channel and the frequency hop channel numbers are only known to authorized receivers of the information, transmitted signals that use frequency hopping are difficult to detect and monitor.

Data rates

The basic (gross) radio channel data transmission rate for a single Bluetooth radio channel is 1 Mbps with over 723.2 kbps available to a single user. Later versions of the Bluetooth system have been enhanced to provide for higher speed data transmission services through the use of more advanced modulation technologies. This increases the gross data transmission rate to 2 Mbps or 3 Mbps dependent on which modulation technology is used.

The data rate available to each user is less than the gross radio channel data transmission rate because some of the data transmission is used for control and channel management purposes. Each of the users in a Piconet must also split the total available data transmission rate.The Bluetooth system allows for different rates in different directions or for equal data rate transmission. For example, a Bluetooth Piconet that provides for headset operation, which uses 64 kbps channels in both directions, uses a total data transmission rate of 128 kbps.

Transmission Media
Transmit Power

The transmitter powers for Bluetooth are quite low, although there are three different classes of output dependent upon the anticipated use and the range required. Power Class 1 is designed for long range communications up to about 100m devices, and this has a maximum output power of 20 dBm, Next is Power Class 2 which is used for what are termed for ordinary range devices with a range up to about 10m, with a maximum output power of 4 dBm. Finally there is Power Class 3 for short range devices. This support communication only to about 10cm and it has a maximum output power of 0 dBm.

There are also some frequency accuracy requirements for Bluetooth transmissions. The transmitted initial centre frequency must be within ±75 kHz from the receiver centre frequency. The initial frequency accuracy is defined as being the frequency accuracy before any information is transmitted and as such any frequency drift requirement is not included.

In order to enable effective communications to take place in an environment where a number of devices may receive the signal, each device has its own identifier. This is provided by having a 48 bit hard wired address identity giving a total of 2.815 x 10^14 unique identifiers.

Antennas

Feature

1.LTCC chip type –Low cost
2.Dielectric chip type –Space saving
3.New chip type –Less sensitive to ground effect
4.FPCB type –Space saving
5.Frequency : 2400~2485 MHz

Technology

1.Accumulated in-house production technology involving ceramic process
2.Optimization of antenna performance and customization based on various application experiences
3.Strong R&D design capability

Distance

Among different bluetooth specifications, there are 2 most popular classes (types) of devices:

Class 1: range up to 100 meters (in most cases 20-30 meters)

Class 2: range up to 30 meters (in most cases 5-10 meters)

Additional facts:

-The range depends not only on the transmitter, but also on the mobile phone which is receiving files.

-The range depends on atmospheric, geographic, urban conditions

-The bigger range, the slower transmission speed.

Class 1 devices might be boosted to work on a better range (like 200 meters), however you should not believe it is possible to broadcast files (in a bluetooth marketing sense) to mobile phones over 1000 meters range, as some vendors suggest

Signal Encoding Technique

Analog and Digital Data

Bluetooth is a digital communication interface. It tends to be used for audio signals more than other applications so it is often perceived as carrying analog audio. Despite the appearance, it is definitely digital and not analog.

Signals

Two other systems have been designed to convert the Bluetooth signal from a cell phone into analog format and relay it to the hearing aid. These systems both have a remote module for Bluetooth reception and digital-to-analog conversion, but they differ in the means by which they pass the converted audio signal to the hearing aid. In both cases the remote module is roughly the size of a television remote control, too large to be mounted at ear level.

Errors

Error Detection

Bluetooth can detect the error so it can retry or inform higher layer. It can transmit extra information and the reciever can recalculate the error received code from received data.

Error Correction

Three data error-correction schemes defined for the baseband controllers are: 1/3, 2/3 rate forward error correction code (FEC), and automatic repeat request (ARQ) scheme. FEC is implemented on the data payload to reduce the number of retransmissions. In a reasonable error-free environment, FEC adds unnecessary

overhead, which reduces the throughput. 1/3 FEC uses a simple repetition code that repeats the bit three times. The 2/3 FEC scheme encodes data using a (15,10) shortened hamming code. Each block of 10 information bits is encoded into a 15-bit code word that can correct all single errors and detect all double errors in each codeword.

In the ARQ scheme packets are transmitted and retransmitted until the transmitting device receives an acknowledgement of a successful reception.

ARQ

The use of error detection, timers, acknowledgements, and retransmissions is referred to as Automatic.Repeat Request (ARQ) [3]. ARQ involves the detection of a packet drop and then efficiently transmitting a copy. A number of methods for implementing ARQ exist. In TCP/Reno, Go-Back-N ARQ is used. In this method, once a packet is dropped, a REJ acknowledgement is sent from the receiver to indicate to the sender to transmit that packet again. All packets with sequence number greater than the dropped packet are not cached. Once retransmission occurs, these packets are retransmitted.

In Bluetooth, a simple ARQ mechanism is implemented. Once a packet is transmitted and determined to be dropped, up to *n* retransmissions are done before Bluetooth drops the packet. Currently Bluetooth buffers only two packets one which is transmitted and waiting for acknowledgement and the other which is about to be transmitted.

Applications

1.PDA

2.Mobile phone

3.DMB phone

4.Laptop

5.Headset

6.Car entertainment

7.MP3

8.USB dongles

Cost

Bluetooth devices use low-cost transceiver microchips, so the cost of manufacturing Bluetooth enabled devices is relatively low. Bluetooth chips are estimated to cost around 500-1,000 to manufacture. As a result, the prices of consumer Bluetooth devices are low.

Furthermore, since Bluetooth technology operates on an unlicensed radio spectrum, there is no charge for communicating between two Bluetooth devices. That's right, it's FREE.

The only cost the consumer receives is the cost of the actual product that is enabled with Bluetooth technology. However, any use of Bluetooth technology, data, or voice, using your cell phone is part of your regular cell phone bill. There is no account or service registry associated with using Bluetooth technology.

Wireless LAN

Wireless Local Area Network is a communications network that can has connectivity to wireless devices with a limited area. This make people can move around the area that can connect into Wireless. A wireless LAN is a flexible data communication implemented as an alternative for, using electromagnetic wave within a building. Wireless LAN do not required the sight line between sender and receiver but it has a base station that called "access points" to transmit and receive data with a radio frequency.

Radio waves are often referred to as radio carriers because they simply perform the function of delivering energy to a remote receiver. The data being transmitted is superimposed on the radio carrier so that it can be accurately extracted at the receiving end. This is generally referred to as modulation of the carrier by the information being transmitted. Once data is superimposed (modulated) onto the radio carrier, the radio signal occupies more than a single frequency, since the frequency or bit rate of the modulating information adds to the carrier.

Multiple radio carriers can exist in the same space at the same time without interfering with each other if the radio waves are transmitted on different radio frequencies. To extract data, a radio receiver tunes in (or selects) one radio frequency while rejecting all other radio signals on different frequencies.

End users access the WLAN through wireless LAN adapters, which are implemented as PC cards in notebook computers, or use ISA or PCI adapters in desktop computers, or fully integrated devices within hand-held computers. WLAN adapters provide an interface between the client network operating system (NOS) and the airwaves

(via an antenna). The nature of the wireless connection is transparent to the NOS.

Network security remains an important issue for WLAN Random wireless clients must usually be prohibited from joining the WLAN. Technologies like WEP raise the level of security on wireless networks to rival that of traditional wired networks.

Protocol architectures and Data transmission

The IEEE 802 standard contains a family of networking standards that cover the physical layer limitation of technologies from Ethernet to wireless. The number 802 is related to the date the first meeting was held. The IEEE 802 is divided into 22 parts that include data-Link and Physical. For the wireless LAN 802.11 were developed for include 802.11a, 802.11b, and 802.11g four subsets of Ethernet-based protocol standards as the following details. We will show all about data rate, bandwidth support and frequency:

IEEE 802.11 is specification delivered 1 to 2 Mbps only, included forward error correction code. It can supported bandwidth 2Mbps and it frequency is 2.4GHz.It specified three physical layer technologies as diffuse infrared, frequency hopping spread spectrum and direct-sequence spread spectrum but now this specification is not used anymore.

IEEE 802.11a is use the same data like and layer protocol as IEEE 802.11 the original standard, but the physical layer is based air interface, but data transfer rates can be maximum as 54 Mbps and it frequency is 5-6GHz. OFDM (orthogonal frequency division) breaks up fast serial information signals into several sub-signals that are transferred at the same time via different frequencies. It specification delivered 6 Mbps, 12 Mbps, or 24 Mbps range and also know as Wi-Fi5.

IEEE 802.11b is use the same media access method and direct extension of the modulation technique defined as IEEE 802.11 standard, and uses a technology CCK (complementary code keying) that duplicate signals bouncing off walls. It specification data rate up to 11 Mbps and supported bandwidth 22Mbps, it frequency is 2.4GHz and also known as Wi-Fi. The ranges include microwave ovens, Bluetooth devices too.

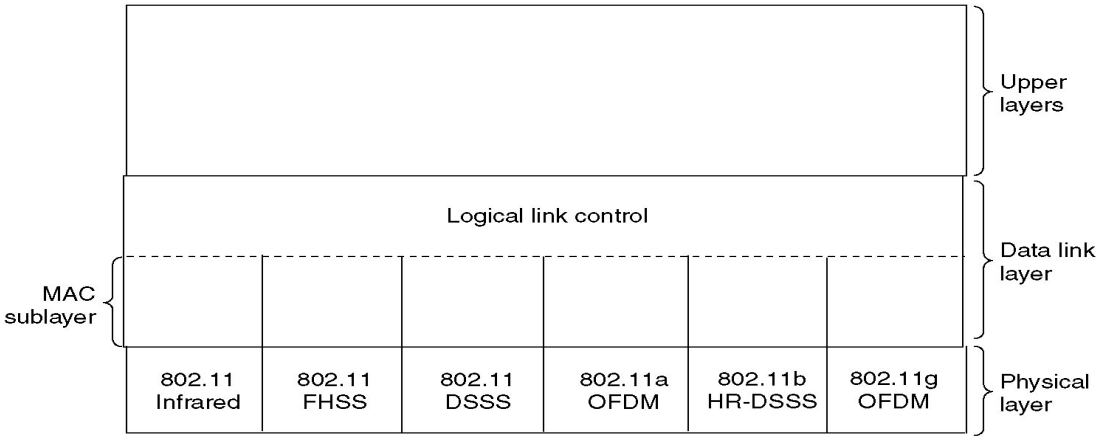
IEEE 802.11g is uses the same OFDM based transmission design as 802.11a and has the maximum physical layer rate of 54 Mbps included forward error correction codes. . It supported bandwidth 54Mbps and it frequency is 2.4GHz. It reduce throughput when compared to 802.11a as 21%. The maximum data rates is 54 Mbps over a limited distance as a wireless keyboards. This standard is unavailable because has not yet been certified.

IEEE 802.11n is a recently improvement from the 802.11 standard by adding multiple-input multiple-output antennas (MIMO). The rage is as high as 200 Mbps and it will support all major platforms. This 802.11n will provide for a lowest-common capability to ensure high-throughput networks function efficiently.

The table compared the different of the transfer rates.

IEEE WLAN Standard	Over-the-Air	Media Access Control Layer, Service Access Point
802.11a	54 Mbps	25 Mbps
802.11b	11 Mbps	5 Mbps
802.11g	54 Mbps	25 Mbps
802.11n	200+ Mbps	100 Mbps

Now we will look into the protocol stack layer of 802.11 in



details

The protocols stack layers is the implementation of particular software on a computer networking protocol suit. Nowadays offer a varied number of software to interface with a number of microprocessors. For each mobile, portable or computer, is referred as a station in 802.11 standard organizations. The difference of the station between portable and mobile is, portable can move only point to point but for mobile it access the LAN during movement.

Transmission media

The transmission media refer to the technical device that employs the material substance to transmit the waves. The transmission media are physical path that connect computer to other devices and people on a network.

Transmit Power is the amount of power used by a radio transceiver to send the signal out. Transmit power is generally measured in milliwatts, which you can convert to dBi. Most countries deem 802.11 WLAN as license free but the radio devices must limit power levels to relatively low values. The high transmit power is prefer in most user to increase rang of access points but the problem are occur often so we need to control the amount of power that we use.

The gain of antenna represents how it can increase the signal power in a particular direction with dBi. The manufactures purpose the antenna's dBi so if we have the antenna in milliwatts we do need to covert it into dBi. Most 802.11 allow the user to customize the power modes in the software drivers for suitable WLAN performance versus battery life for a notebook system.

Receiver sensitivity is defined as the minimum signal power level (in dBm or mW) that is necessary for the receiver to accurately decode a given signal. Because dBm is compared to 0 mW, 0 dBm is a relative point, much like 0 degrees is in temperature measurement. Another way of adding range uses a power amplifier. Commonly known as "range extender amplifiers" these small devices supply usually around ½ watt of power to the antenna. Such amplifiers may give more than five times the range to an existing network. Every 6 dB gain doubles range. The alternative techniques of selecting a more sensitive WLAN adapter (some are quite "deaf") and more directive antenna should also be considered.

Transmit frequency

Wi-Fi / WLAN / 802.11b, 802.11g channels, their channel frequencies and bandwidth allocations around the globe, spectral mask and summary of which channels can be used together for WLAN solutions, however it is up to individual countries to decide if all channels are allowed based on their current frequency spectrum use, and what maximum transmit power is allowed.

The table shows the channels number and their frequency.

Channel Number	Frequency (GHz)
1*	2.412
2	2.417
3	2.422
4	2.427
5	2.432
6*	2.437
7	2.442
8	2.447
9	2.452
10	2.457
11*	2.462
12	2.467
13	2.472
14	2.484

*Indicated non-overlapping channels.

Signal Encoding Techniques

The type of signal encoding techniques can divide into two parts as:

Analog Modulation

- AM (Amplitude Modulation)
- FM (Frequency Modulation)
- PM (Phase Modulation)

Digital Modulation

- ASK (Amplitude Shift Keying)
- FSK (Frequency Shift Keying)
- PSK (Phase Shift Keying)
- QAM (Quadrature Amplitude Modulation)

The modulation used in 802.11 has historically been phase-shift keying (PSK). The modulation method selected for 802.11b is known as complementary code keying (CCK), which allows higher data speeds and is less susceptible to multipath-propagation interference. 802.11a uses a modulation scheme known as orthogonal frequency-division multiplexing (OFDM) that makes possible data speeds as high as 54 Mbps, but most commonly, communications takes place at 6 Mbps, 12 Mbps, or 24 Mbps.

For short range and low power wireless (less than 10 meters) communications among personal devices such as PDA, Bluetooth and subsequent IEEE standards (802.15) are taking effects. For long range wireless communications in the metropolitan areas, WiMax as defined in the IEEE 802.16 is the standard.

The receive thresholds is defines the amount of energy needed to receive then signal and ability to read the information that it contains. If the signal strength is lower the information cannot be properly decoded and is useless. To maintain the certain level of signal strength above the receiver threshold is desirable. When deciding on a WLAN product, it is good to review the receiver performance as well as the transmitter. A good receiver can improve range by a significant amount.

Error detection in a wireless LAN environment

A device for detecting errors in a wireless communication channel comprises a receiver that receives a data stream from the wireless communication channel, In addition, the data stream will include data packets having error detection codes imbedded within the data packets. Processing resources coupled with the receiver are responsive to the error detection codes to detect errors in the data packets. Thus, an error detection system based on monitoring the amplitude, and the phase of a received signal, combined with digital CRC detection techniques provides an efficient error detection system, capable of detecting interference early in transmission, allowing more rapid recovery in retries.

Error Correction in Wireless LAN

The current error correction layer of IEEE 802.11a WLAN is designed for worst-case scenarios, a new opportunistic error correction layer based on Fountain codes and a resolution adaptive ADC. The key part in the new proposed system is that only packets are processed by the receiver chain that have encountered "good" channel conditions. Others are discarded.

Automatic Repeat Request (ARQ)

ARQ is a protocol for error control in data transmission. There are several commonly used ARQ techniques, such as “Stop & Wait”, “Go back n”, and “Selective repeat”. Each has its own advantages and disadvantages. In 802.11b, ARQ is implemented at the link layer .The link-layerARQ employs the Stop & Wait ARQ scheme. With Stop & Wait ARQ, each transmitted packet must be acknowledged before the next packet can be sent. If either the packet or its acknowledgement is lost, the sender of the packet will not receive any acknowledgement, and the sender will retransmit the packet after a certain time -out period. The 802.11b ARQ is not 100% reliable because each packet will be retransmitted at most a certain number of times.

Application

What scenarios/application are they intended for?

The WLAN is intended to make user easy to communicate by creating an area network that user can access into the Internet anywhere that have the wireless network. But this technology has advantage and disadvantage also. The advantage of WLAN is easy to access, easy to setup and user mobility and the disadvantage is the WLAN is transmit the data over air transmission so anyone can access and look into the transmitted data. For example, Doctors and nurses in hospitals are easy to communicate because hand-held or notebook computers with wireless LAN capability deliver patient information instantly.

How would the technology be used by a typical user?

As you known that WLAN is easy to install, user can install in by plug in the cable from the modem to the computer and its work then. Anyone can use this technology and then they can create the area network.

What types of devices are required?

For this case we need a transmitted device and a received device such as a router or Wi-Fi card. Because if the user wants to create the network they need to have both transmitted and received device to compose the connection.

Usage

Are they being used extensively in Thailand? Other countries? Why not?

In Thailand the WLAN is being use widely, as u know in Thailand there are many company that give user a service to connect to the Internet via Wi-Fi example, TrueWifi network around Bangkok, KSC Internet and 3BB hotsport, to make you more clearly to understand about this technology.

Example, in the university they allows student to connect to the Internet via university wifi and in the restaurant as McDonalds they also allow the costumer to connect the Internet via wifi too.

For other country the WLAN is also being use widely, in the same case that in the restaurant and in the university they allow the user to connect to the Internet via wifi too example, in USA the AT&T Company allow people to connect to the internet everywhere that have an area network.

Cost

What is the approximate cost of the equipment? What other costs are associated with using the technology?

The cost of the WLAN network is not so expensive. To setup the WLAN you need 1 wireless access point which is about 2,000-3,00 bath and if you want to connect to the PC computer that does not support the wifi networks you have to use the additional wireless USB that cost about 700-1,000 bath. The cost is not fixed if you need to create a large area network you need to buy the router that support the large area and use extra access point too.

ZigBee

Protocol Architectures

The ZigBee standard specifies a full protocol stack for enabling wireless control applications. The lower layers (physical and medium access) comply with IEEE 802.15.4. On top ZigBee specifies a network layer and an application layer. Standardized device activation and configuration procedures are provided by a commissioning framework. Functionality and interoperability of the protocol stack are governed by a set of rules called stack profile. A stack profile specifies, for instance, which addressing mechanism is use and which level of security the application shall implement. At the application layer, interoperability is ensured through public application profiles.

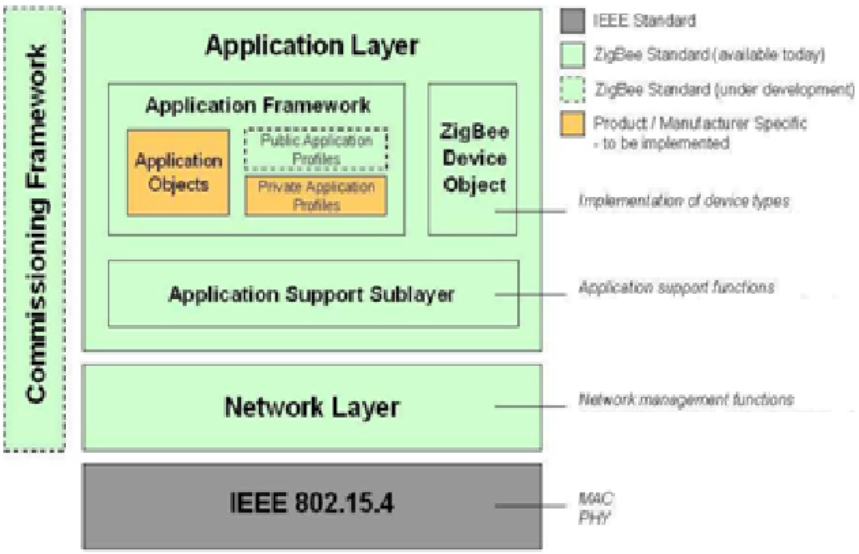
ZigBee will include two stack profiles:

- ZigBee simpler, smaller networks that typically operate in a residential environment.

Addressing is performed in a tree fashion, security implementation is fairly simple, and application bindings take place in the coordinator in a centralized manner.

- ZigBee Pro targets larger and more sophisticated networks. Addressing and routing are more scalable, security is more robust, and advanced features such as multicast are included.

Also, 'ZigBee Pro' aims at providing minimal reliance on the coordinator through distributed application bindings.



ZigBee protocol

Data Transmission

ZigBee allow devices to communicate with one another. The network coordinator is a device that sets up the network, is aware of all the nodes within its network, and manages both the information about each node as well as the information that is being transmitted/received within the network. Every ZigBee network must contain a network coordinator. Other Full Function Devices (FFD's) may be found in the network, and these devices support all of the 802.15.4 functions.

Transmission Media
The data rate:

Data rate (kbps)	Frequency	Country
250	2.4 GHZ	Global
40	915 MHz	Americas
20	868 MHz	Europe

ZigBee Alliance has been working closely to specify the entire protocol stack. IEEE 802.15.4 focuses on the specification of the lower two layers of the physical and data link layer.

ZigBee Antennas In this world there are three different styles of antenna.

- Chip Antennas: these use a chip with the actual antenna structure embedded in the chip somehow. They can be good or bad but at least have the virtue that usually the board maker doesn’t need to know very much.
- Planar Antennas: a planar antenna is built on a circuit board (a plane). They can’t be great but can be good, and they are very dependent on available board real estate and substrate.

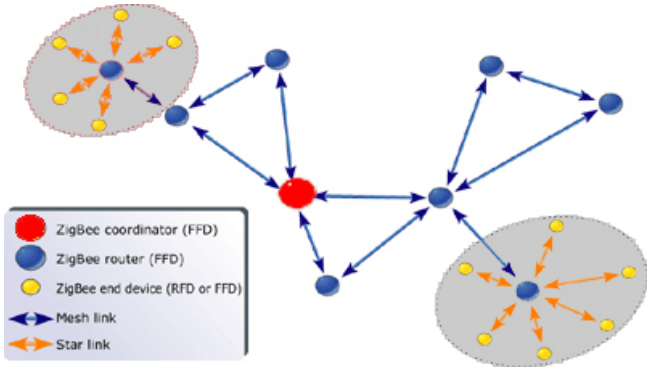
- Whip or external antennas: many of these devices have the ability to have or an external antenna via connector. With an external antenna, of course, you have all sorts of variety and generally these are optimal (but large). A whip is often a coiled piece of wire matched to the circuit. Note that a whip requires a ground plane to be.

Distance of ZigBee

ZigBee compliant wireless devices are expected to transmit 10-75 meters, depending on the RF environment and the power output consumption required for a given application, and will operate in the unlicensed RF worldwide.

Signal Encoding Techniques

ZigBee basically use digital radios

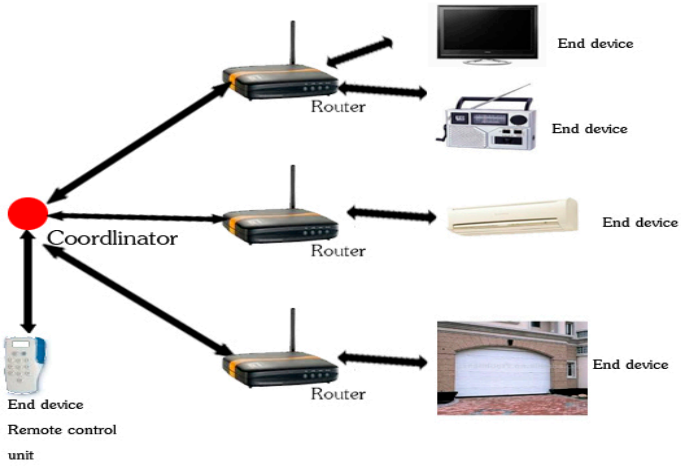


ZigBee Network

As it shown the ZigBee network picture up there. It introduces the concept of the ZigBee network topology. Several topologies are supported by ZigBee, including star, mesh, and cluster tree. As can be seen, star topology is most useful when several end devices are located close together so that they can communicate with a single router node. That node can then be a part of a larger mesh network that ultimately communicates with the network coordinator. Mesh networking allows for redundancy in node links, so that if one node goes down, devices can find an alternative path to communicate with one another.

Applications

ZigBee technology has been designed as a general-purpose low-data rate, low-power wireless solution. Contrary to competing technologies (such as Z-Wave,which focuses on home control), ZigBee has a very wide application scope. Typical examples include home automation (lighting, heating, closures, security, access to set-top boxes), building automation (lighting, HVAC, smoke detection, access control), industrial monitoring, automatic meter reading, environmental data collection, and medical sensing. The figure above introduces the concept of the ZigBee network topology. Several topologies are supported by ZigBee, including star, mesh, and cluster tree. As can be seen, star topology is most useful when several end devices are located close together so that they can communicate with a single router node.That node can then be a part of a larger mesh network that ultimately communicates with the network coordinator. Networking allows for redundancy in node links, so that if one node goes down, devices can find an alternative path to communicate with one another. Figures 4 below will provide an example of how ZigBee networking allows for multiple paths between devices.



ZigBee network

ZigBee operates in two main modes

- Non-beacon mode and beacon mode. Beacon mode is a fully coordinated mode in that the entire device knows when to coordinate with one another. In this mode, the network coordinator will periodically "wake-up" and send out a beacon to the devices within its network. This beacon subsequently wakes up each device, which must determine if it has any message to receive. If not, the device returns to sleep, as will the network coordinator, once its job is complete.
- Non-beacon mode, on the other hand, is less coordinated, as any device can communicate with the coordinator at will. However, this operation can cause different devices within the network to interfere with one another, and the coordinator must always be awake to listen for signals, thus requiring more power.

WiMax 

Protocol Architectures

WIMAX is different about the other Technologies in the Data link layer and physical layer.The IEEE 802.16 suite of standards (IEEE 802.16-2004/IEEE 802-16e-2005) [defines within its scope four PHY layers, any of which can be used with the media access control (MAC)
layer to develop a broadband wireless system. The PHY layers defined in IEEE 802.16.

Data Transmission

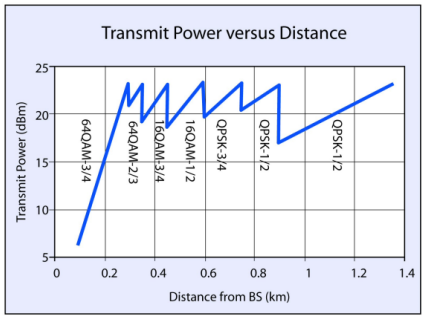
WiMAX standards in 802.16 cover spectrum ranges from at least the 2 GHz range through the 66 GHz range. This is an enormous spectrum range. However, the practical market considerations of the Forum members dictated that the first product profiles focus on spectrum ranges that offered Forum vendors the most utility and sales potential. The International standard of 3.5 GHz spectrums was the first to enjoy WiMAX products. The US license free spectrum at 5.8 GHz has a few WiMAX vendors building products. Licensed spectrum at 2.5 GHz used both domestically in the US and fairly widely abroad is the largest block in the US. Also, in the US and in Korea products are shipping for the 2.3 GHz spectrum range. Also in the US the 3.65 GHz band of frequencies now has WiMAX gear shipping to carriers.

WiMAX has a theoretical maximum bandwidth of 75Mbps. This bandwidth can be achieved using 64QAM 3/4 modulation. 64QAM can only be utilized under optimal transmission conditions. WiMAX supports the use of a wide range of modulation algorithms to enable the most bandwidth to be realized under all conditions.

The Wimax technology at theoretical maximums could support approximately 75 Mbps per channel (in a 20 MHz channe). Real world performance will be considerably lower perhaps maxing out around 45 Mbps/channel in some fixed broadband applications.

Transmission Media

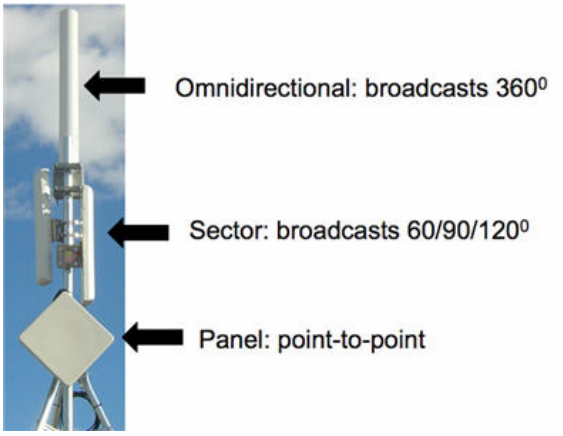
Transmit power versus distance from base station. If the maximum modulation order was instead 16QAM-3/4, then the transmit power would be monotonically reduced once the 16QAM-3/4 rate was achieved. It should be noted that the presence of fading would result in significant changes to this curve. In a real-life fading environment, additional margin may be required to counteract fading effects, and one would expect that transmitting at maximum power would occur less frequently. However, the overall trend shown in Figure 1 is correct, and shows that mobile stations will be required to transmit at high powers not only at the cell edges, but also at much closer distances in order to achieve higher-order modulation. The benefits of higher power transmission from the mobile WiMAX terminal are significant. Consider the effect of increasing the transmit power by 40%, from +23 dBm (200mW) to +24.5 dBm (281 mW). First, it would require a larger power amplifier (PA). Assuming that losses after the PA are 1 dB, the output power from the PA must increase from 250 mW (+24 dBm) to 355mW (+25.5 dBm).



WiMax transmission power

WiMAX Antennas come in various designs in order to most appropriately enhance the performance of a network according its geographical advantages or drawbacks, and its intended functional use. The different types of antennas can be classified into three main categories: omni directional, sector, and panel antennas.

- Omni directional antennas have the ability to send and receive transmissions to and from any direction and are used for point-to-multipoint or multipoint-to-multipoint configurations. These antennas use a great deal of energy in order to broadcast in 360 degrees, which ultimately causes it to have limited range and signal strength. However, they are ideal for networks where there are a high number of users within a short range.
- Sector antennas are used to target specific areas in a more concentrated manner. They can broadcast frequencies in ranges of 60, 90, or 120 degrees from their respective base stations and can be used for point-to-multipoint or multipoint-to-multipoint configurations. These antennas are more energy efficient than omni directional antennas since their beams are more concentrated in one area, which enables them to have greater range and signal strength. Many Internet Service Providers even prefer to use multiple sector antennas to cover a larger scope than to use omni directional antennas because of the sector antenna is exceptional performance.
- Panel antennas, also occasionally referred to as directional antennas, are most commonly implemented for point-to-point networks. They are often designed as a flat panel of about one square foot in size. They are aimed towards specific areas, can home a WiMAX radio in their casing, and are incredibly useful for relays. Other types of WiMAX antennas include dome, yagi, grid, and rubber antennas.



WiMax antenna

WiMAX is a relatively new technology that enables communication over a maximum distance of 30 miles; the longer the distance, the slower the speed, but it’s still faster and has a longer range than Wi-Fi, which has a maximum distance of 300 feet.

Signal Encoding Techniques

WiMAX is a wireless digital communications system, also known as IEEE 802.16, which is intended for wireless. WiMAX can be used to provide a wireless alternative to cable and DSL for broadband access, and to provide high-speed data and telecommunications services. WiMAX can also be used to connect many Wi-Fi hotspots with each other and also to other parts of the Internet

WiMAX signal is best accomplished with a vector signal analyzer capable of measuring the traditional RF parameters and the modulation quality of the digitally modulated signal. These DSP-based signal analyzers provide fast Fourier transform based spectrum analysis, wideband flexible vector demodulation and scope measurements on RF signals. The number of measurement types and analysis configurations available within the VSA is large. Properly selecting measurement configurations specific to WiMAX signal analysis will improve the process to successful and reliable testing.

Errors

WiMAX technology has built in error detection techniques to reduce the system Signal to Noise Ratio (SNR) obligations. Convolutional Encoding, Strong Reed Solomon FEC, and interleaving algorithms are used to identify and correct errors to enhance throughput. These strong error correction techniques assist to recover corrupted frames that may have been missing due to frequency selective fading or burst errors. To remove the errors, Automatic Repeat Request (ARQ) is used that cannot be corrected by the Forward Error Detection (FEC) by resending the error-ed information again. This notably improves the Bit Error Rate (BER) performance.

Applications

WiMAX could potentially erase the suburban and rural blackout areas that currently have no broadband Internet access because phone and cable companies have not yet run the necessary on wires to those remote locations.

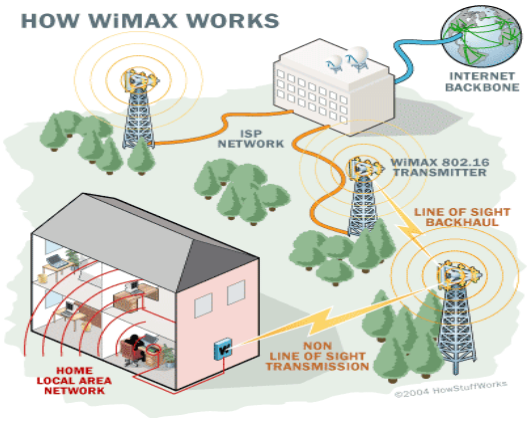
A WiMax system consist of two parts:

- A WiMAX tower, similar in concept to a cell-phone tower - A single WiMAX tower can provide coverage to a very large area as big as 3,000 square miles.
- A WiMAX receiver - The receiver and antenna could be a small box or PCMCIA card, or they could be built into a laptop the way WiFi access is today.

Figure 3. WiMax towe

Figure 4. WiMax receiver

A WiMAX tower station can connect directly to the Internet using a high-bandwidth, wired connection.It can also connect to another WiMAX tower using a line-of-sight, microwave link. This connection to a second tower, along with the ability of a single tower to cover up to 3,000 square miles, is what allows WiMAX to provide coverage to remote rural areas.



Usage

In Thailand, the National Telecommunication Commission has to allocate the existing frequency available for the WiMax services and the NTC should consider issue national Licences to attract service operators.Moreover, it is suggested that the licences should last for to 10-15 years, enough time to allow operators to gain a return on investment. And the licence should mandate deployment service obligation in order to protect licensees from wasting national frequency resources due to inactivity.In the Thai context, WiMax can support fixed wireless broadband services in rural areas, while mobile operators can invest in this technology at a lower cost by using its existing infrastructure.

"WiMax is competing with Long Term Evolution, which I see taking two years to full commercial implementation in some countries," said Collier.

Currently, Intel supports WiMax as it sees value in its price performance for wireless broadband connectivity, but it could support other wireless technology that supports user mobility.To date, lots of mobile devices support WiMax and Collier believes that with increasing volume and greater economies of scale of the WiMax module, the pricing of a WiMax module compared to Wi-Fi only could come down to less than $10 (324 baht) in a few ye

Table of participation

Section	Vanassanan	Wimonwan	Vibhu
Bluetooth	100		-
WiMax	-	-	100
Zigbee	-	-	100
WLAN	100	-	-

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