

# Assignment 1

ITS323 Data Communication

## Topic

Comparing wireless Technologies

By

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*Submitted to*

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*On Wednesday 8 September 2010*

# Table of Contents

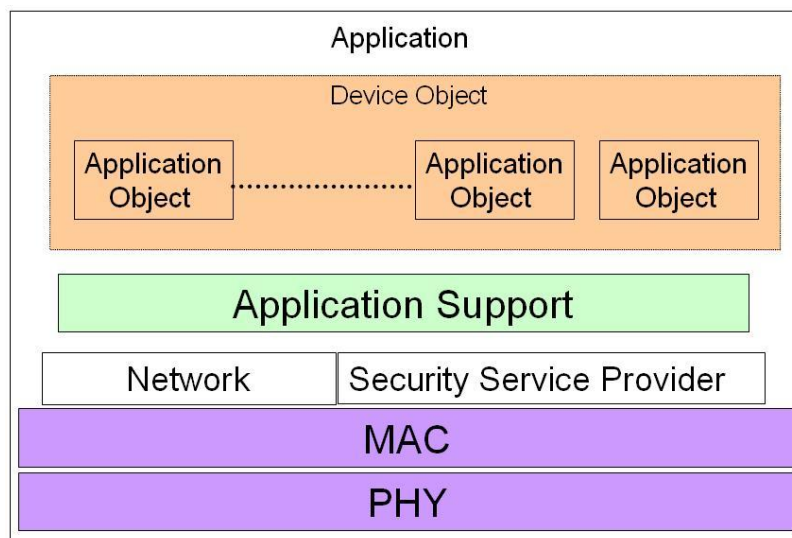
<b>Title</b>	<b>Page</b>
Title Page	1
Table of Contents	2
Table of Participation	3
Zigbee	4–5
Bluetooth	6–7
Wireless LAN	8–9
WiMax	10–11
Comparison	12–13
References	13

## Table of Participation

Section	Watanee	Chatchapol	Rojjana
Zigbee	33	33	33
Bluetooth	33	33	33
Wireless	33	33	33
WilMax	33	33	33

# Zigbee

Zigbee is a wireless communication system that accept low information, and consume low power. The price of Zigbee is also cheap. The main use of Zigbee is for create the system that call “Wireless Sensor Network”. It is being use for the industrial device, sensor, data collecting, smoke detector, and also the automation device that being use in household, such as heat sensor for opening light or air conditioning. This system will be able to work in any type of weather with just battery (2 AA) for a long period of time. This is suitable for Monitoring type. The Zigbee has 3 type of frequencies, which are 2.4Ghz (Worldwide), 915Ghz (USA and Australia), and 868Ghz (Europe). The first one that has frequency at 2.4 Ghz has 16 channels and the data transfer rate is at 250 Kbps. The spectrum is at 5 MHz. The second one that has frequency at 915 Ghz has 10 channels and the data transfer rate is at 40 Kbps. The spectrum is at 2 MHz. And lastly the one that has frequency at 868 Ghz has 1 channel and the data transfer rate is at 20 Kbps. The spectrum of this one is not exist, since it is only one channel. Zigbee use the Physical Layer and MAC Layer of IEEE 802.15.4, which is the basic for the WPAN (Wireless Personal Area Network), which will be use for the lower layer, such as the level of signal, Link Quality, Access Control, security, etc.

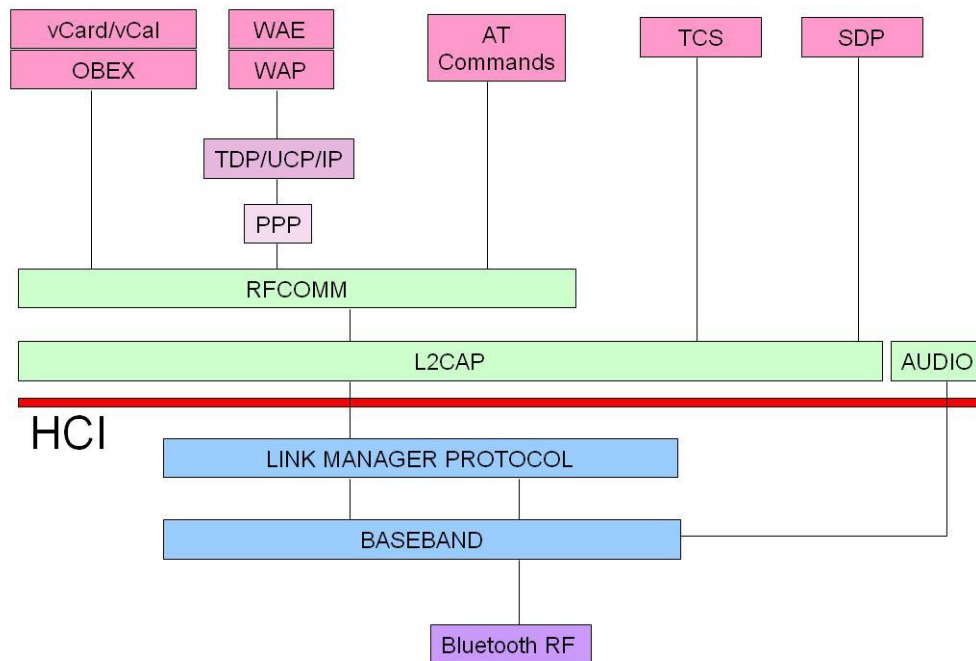


Zigbee use the guideline from the IEEE 802.15.4 to separate into 2 main categories, which are FFD (Full Function Device), the device can work anything inside the system, and the other category is the RFD (Reduce Function Device), the device which being decrease the ability to work. The distance that the Zigbee can transfer is between 10 to 75 metres and up to 1500 m for pro version, but also depends on the environment. The transmit power is 0 dBm (1

mW). The antenna that is suitable for the Zigbee to use is the Omni directional Antenna, because it has the ability to transmit equal power to every direction. The receive threshold of Zigbee is very sensitive, and also expected to decode the signal at  $-97$  dBm. The Zigbee is using 10 bit analog-to-digital converter. The Zigbee is being used all around the world, because it is already embedded inside the remote control. The cost of just only the Zigbee chip is cheap, but after combined into many devices could cost a lot of price, such as Sound detector, sensor, etc. The error correction of Zigbee is the FEC (Forward Error Correction), which is the process of finding the error-correcting code. This is used for both correcting and detecting the error. The encoder of the Zigbee is Chirp spread spectrum, which is being done by encoding the signal from the frequency of the signal that is being sent to the receiver. The receive transmission is  $-85$  dbm.

# Bluetooth

Bluetooth is the device that take the radio frequency to use as connection between mobile phone and other devices to work instead of cable line. Bluetooth use a common data link and physical layer.



Bluetooth is define to be the layer protocol, which contain core, cable replacement, telephony control and also adopted protocols. The Standard of bluetooth is the IEEE. The standard organization of bluetooth is 802.15.1. The spectrum of Bluetooth is between 2.402 and 2.480. Bluetooth connect on a frequency of 2.45GHz. The bandwidth of Bluetooth is at 721Kbps. Since bluetooth have 3 versions, so the data rate of each are different. For the version 1.2 has the data rate of 1Mb/s. For the version 2 which include the EDR has the data rate of 3Mb/s. For the last version, version 3 and including HS has the data rate of 24Mb/s. Bluetooth can send data at 64bps at a full duplex link. Bluetooth has 2 type of connections, which are Asynchronous Connectionless (ACL), and Synchronous Connection Oriented (SCO). For ACL, it is use for normal communcation, which supported the symmatic and non-symmatic Multi-slot packet. When use the ACL, the data rate to maximum is 723KbPS for one direction and the other is 57.6kbps. Master is the controller of the bandwidth, which control the slave to work. ACL supported the boardcast message too. For the second type which is SCO, it is another type of communication, which connect via voices. It supported the Symmatic connection, circuit switch, and also the connection from point-to-point. The

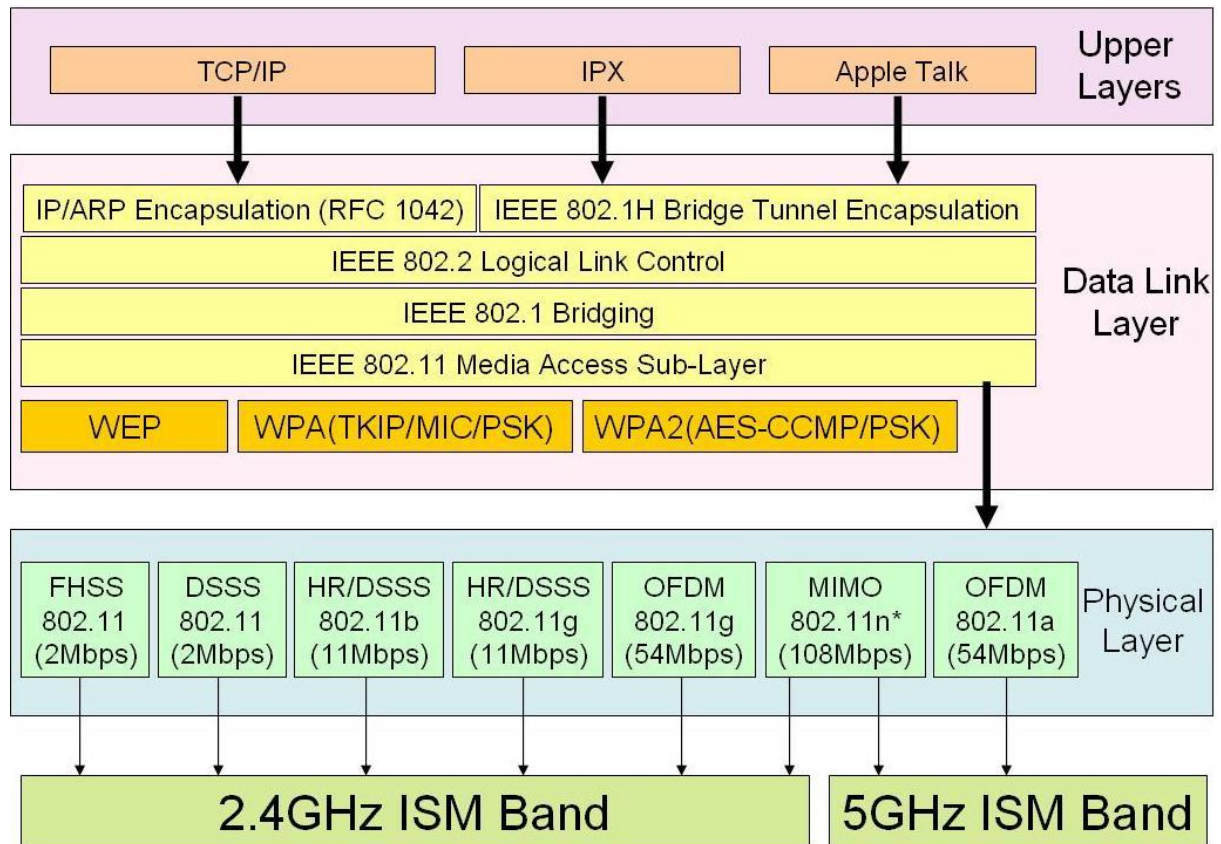
symmetric connection have the data rate of 64Kbps and can connect up to 3 channel at the same time. Bluetooth are organized into 3 power classes depend on the maximum power output. For the 1 class has the maximum of 100mW, and minimum of 1mW. For the 2 class has the maximum of 2.5mW and minimum of 0.25mW. For the last class the maximum is at 1 mW and the minimum is unknown. The receiver of bluetooth is at  $-70\text{dBm}$  or better. For the antennas of bluetooth are depend on the manufacturer. For example, the Cunturion has the internal and chio antennas, Enthertronics has various antennas for cellphone with the short range wireless bluetooth. For the distance of usage for bluetooth is 10 meters. The encoding system of bluetooth is call Gaussian Frequency-Shift keying (GFSK). It is a type of Frequency Shift Key. This method use the Gaussian filter to separate positive and negative from each other. There are three type of error correction in the bluetooth system. First is the 1/3 rate forward error correction(FEC), second is the 2/3 rate FEC, and last is the Automatic repeat request(ARQ). FEC is the system that detect and correct error without the need of additional data from the sender. ARQ consists of 3 types, which are Stop-and-wait, Go-Back-N, and Selective Repeat. There are many application for bluetooth, such as communication between mobile and hand-free headset, network for PC, for place where infrared is originally use. Usage of bluetooth are mostly for hands-free device for car and internet, also it is for receiving call without using the mobile, by linking the mobile device with the car via bluetooth. Bluetooth are used widely around the Thailand. The cost of bluetooth are various depends on the device that install it in. The receive transmission is  $-70\text{ dbm}$ .

## Wireless

Wireless Lan is the connection of computer into network. The system is linked to each other with any wire. They are using the Radio signal to connect to each other. There are 2 main types of connection, which are between computers, and also connect to the Port (Access Point), which generate larger signal and sent around. There are 5 type of connection. First is Peer-to-Peer, which is the same as connecting to the equivalent device and sharing information or using the information at the same time. Second is the Server, which is sending information via Access Point, which is working as main system that sent information to the Client. For 1 access point can have 15-50 client at the same time. Third is the Multiple access points and roaming, which is creating more Access point for connection in large group as a network. Fourth is Extension Point, which is the same as access point, but don't have to connect with the wireless network. Last is the Directional Antennas, which use the Antennas to connect between building. The Standard of wireless is the IEEE. The standard organization of wireless are various, here are some example, 802.11, 802.11a, 802.11b, 802.11g, 802.11n, and many more. For 802.11 provide 1 - 2Mbps with 2.4GHz and using either Frequency Hopping Spread Spectrum (FHSS), or Direct Sequence Spread Spectrum (DSSS). For 802.11a provide 54Mbps with 5.0GHz, the throughput is the mid-20Mb/s. It is using Orthogonal Frequency Division Multiplexing(OFDM). 802.11b provide 11Mbps with 2.4GHz. It is using DSSS. 802.11g transmit in a short distance at 20-54Mbps with 2.4GHz, and also using the OFDM. 802.11n is the same 802.11 with Multiple-Input Multiple-Output(MIMO). The throughput is at 100Mbps - 200Mbps. All of the wireless that i give example using the bandwidth of 20MHz, but the other wireless system using 40MHz. The Layer of Wireless are Data link and Physical layer. The error detection of Wireless is the Cyclic redundancy check(CRC) or Polynomial Code Checksum. This system is checking by first calculate the short binary sequence also known as CRC code for each block of data. When the data arrive, the program will calculate again and if the data in the system is different from the data that just receive then they will use the ARQ to correct the error. Sometime the system will not find the error due to the similar CRC code. Wireless are use widely inside Thailand. The cost of wireless is the same as Zigbee and Bluetooth, which will depend on the company and also the device that it is in. The length of signal also depends on place. For indoor, signal cannot travel through wall very efficiently so the travel length will be about 150 meter, but for outdoor is about 500 meters. The Decoding system of Wireless are depends on the device it is in. The application

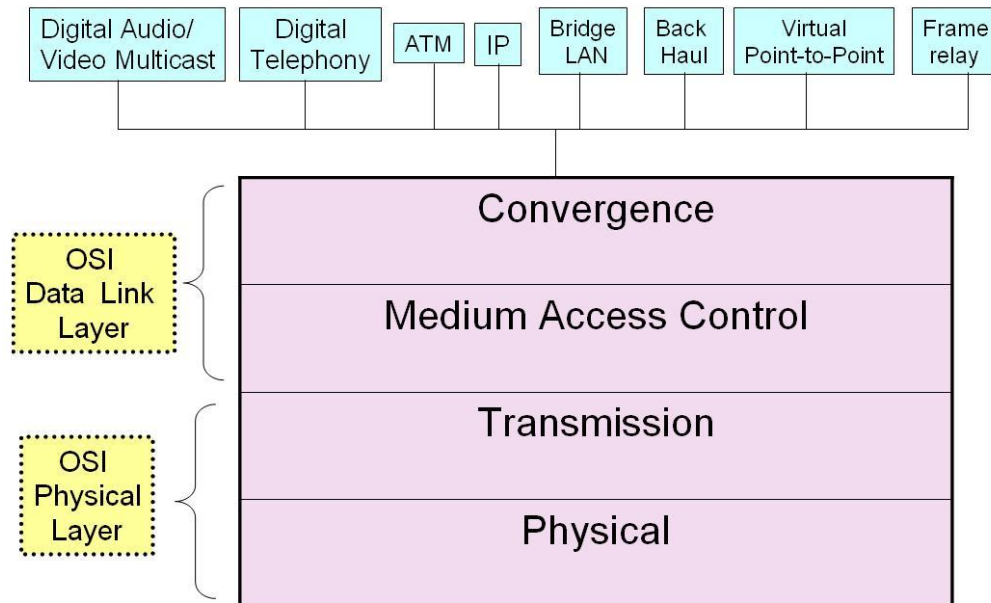


for wireless are connect between computer networking indoor and outdoor. The receive transmission is  $-70$  dbm.



## WiMAX

WiMAX is the another type of wireless broadband, with the speed of 75 Mbps with a very large length. The WiMAX work with the length of 31 Miles or about 48 Kilometer. They are 2 types of Layer in WiMAX, which are Physical Layer, and MAC Layer.



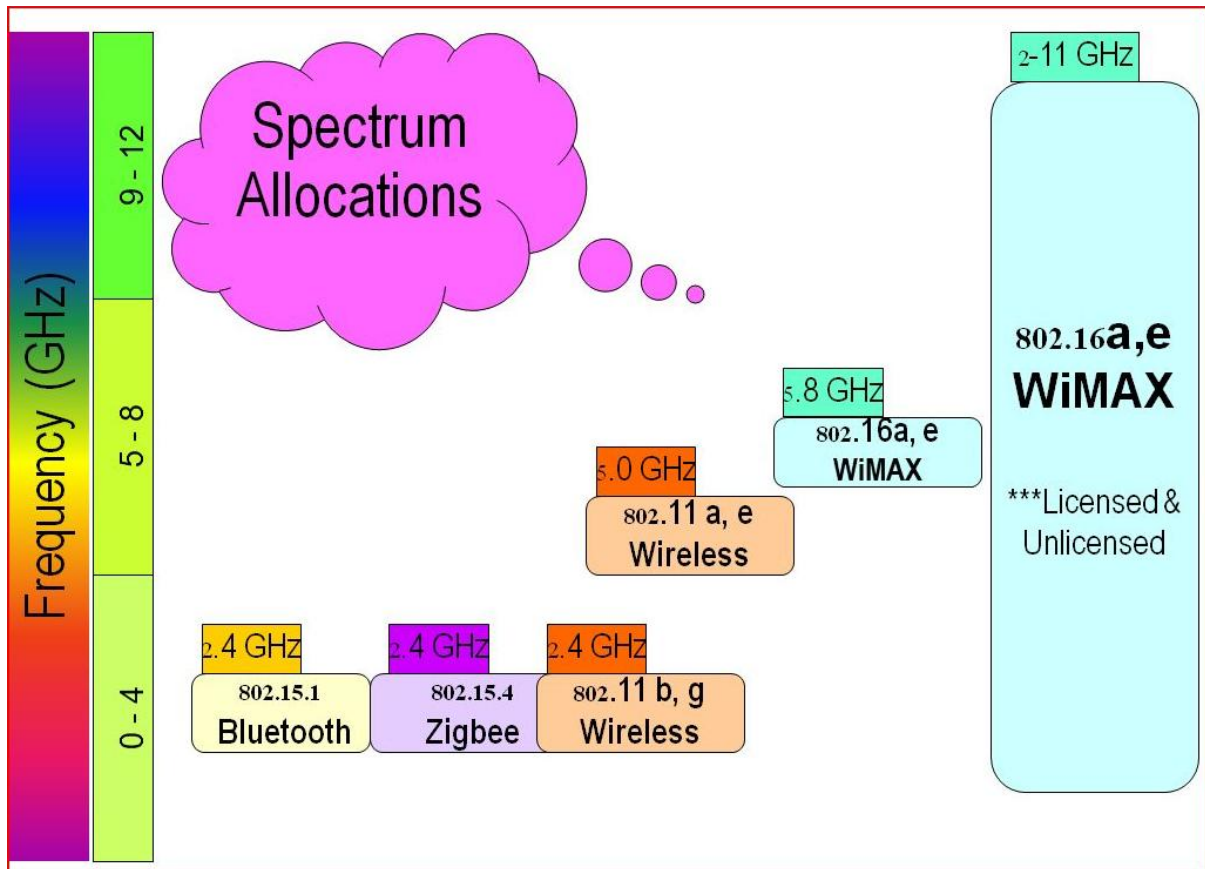
The Standard of WiMAX is the IEEE. The standard organization of wireless are various, here are some example, 802.16, 802.16a, 802.16e. For 802.16 is the basic for WiMAX, which have the connecting length of 1.6 – 4.8 Kilometer. It is the only standard that support Line of Sight(LoS), which can use the frequency of 10 – 66 GHz. The data rate is 75 Mbps. For 802.16a is the improvement of 802.16, which is able to use the frequency of 2 –11 GHz. This standard organisation use the old version and adding the special ability, which is the ability to sent signal without having the signal interfer with other object, such as tree or bulidig. It is also able to sent signal with the radius of 31 Miles or about 48 Kilometer with the maximum speed of 75 Mbps. For 802.16e is the combination of PDA, Notebook device. The system has the radius of 1.6 – 4.8 Kilometer. This system also provide better solution for communication. The signal is stable, eventhought you are on the move the entire time. The data rate is maximum of 30 Mbps. The antenna for the WiMAX is the Point-to-Point type. They use one of the port to transfer and seperate more signal to household and other small places. The signal encoding system of WiMAX is the Quaternary Phase Shift Keying (QPSK). The error detection of WiMAX is the embed system for reducing the Singal to Noise Ratio (SNR) obligations. For the error

correction, the WiMAX use the ARQ to solve the problem. There is also another type of Correcting, which is Hybrid Automatic Repeat Request (HARQ). HARQ is inside the 802.16 in the MAC Layer. It is the relate with ARQ, but the different is the retransmission system in it. It helps with the reliability of the software. The application of WiMAX are similar to Wireless, because WiMAX is a type of Wireless. WiMAX is already in Thailand, but the signal is still developing so we are not able to use it yet. The cost of WiMAX is consists of Base station and section antenna. The cost of Base station is about 40 Million Euro, and the cost of Section station is about 3 Million Euro. Into total for one antenna and base station is 43 Million Euro. And total Bandwidth is 56 GHz. The receive transmission is  $-80$  dbm.

## Comparison

For the frequency comparing, Zigbee, Bluetooth, and Wireless are about 2.4GHz. WiMAX is in a higher frequency, because WiMAX is about 10 – 66GHz. The system that has the most bandwidth is WiMAX with 56 GHz, and the lowest is Zigbee of 5 MHz. Bluetooth is more than Wireless, because Bluetooth is 721 MHz, but wireless is 20 MHz. The highest data rate of all is WiMAX, with the rate at 75 Mbps, and the lowest is still Zigbee with is 250 Kbps. Wireless and Bluetooth are nearly the same at 1–2 Mbps. The system that has the longest distance is WiMAX with 1.6 – 4.8 Km. And bluetooth is 10 meters, the shortest. Wireless is 500 meters for outdoor and 150 meters for indoor. Zigbee is at 75 meters. The antenna of Zigbee and Bluetooth are embedded inside the device, but Wireless and WiMAX need to use the antenna for separating the signal around. The advantage of Zigbee is the Mesh network that can connect with the wireless node. The Zigbee has a Longlife battery and very cheap. The advantage of Bluetooth is that it use the radio signal for sending information, so the signal able to travel anywhere. The bluetooth also have the efficient transmission and safety for the information, because they won't reuse the same frequency to prevent the slowness of signal, which is call Adaptive Frequency Hopping. The advantage of Wireless is that it is easy for connection and movement, because the operation doesn't need cable for connecting. The advantage of WiMAX is that it can able to sent information in a long distace. The information is safe. Eventhought you are moving the signal will still be strong constant. WiMAX is able to use with mobile phone, because it has a large channel. The disadvantage of Zigbee is that it can only connect in the short distance and have a low data speed. The disadvantage of Bluetooth is that it is good for connecting to small device in a small distance of 10 meters only. The signal of Bluetooth can be interfered by the sending and receiving signal of wireless. Disadvantage of Wireless is that there is a lot of standard that can cause the problem in the combine usage. Wireless can be use only in short distance, but expensive and also has a lot of interfered noise. Disadvantage of WiMAX is that WiMAX is still new to the system, so devices that WiMAX can use with is limited. And also that the channel of WiMAX is very large so that some of the country won't allow the normal people to use, because the government are using that signal. And the permission to use the system is also very hard to get.

# Overall Spectrum



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