4G MOBILE WIRELESS WiMAX

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Hello. Welcome to another module in wireless communications in this MOOC massive open online course. So far we have looked at our brief introduction to wireless communications, the 2G standard, a 3G standard that is WCDMA. Let's talk briefly a little bit about another 4G or the Fourth Generation Mobile Wireless standard that is WiMAX.

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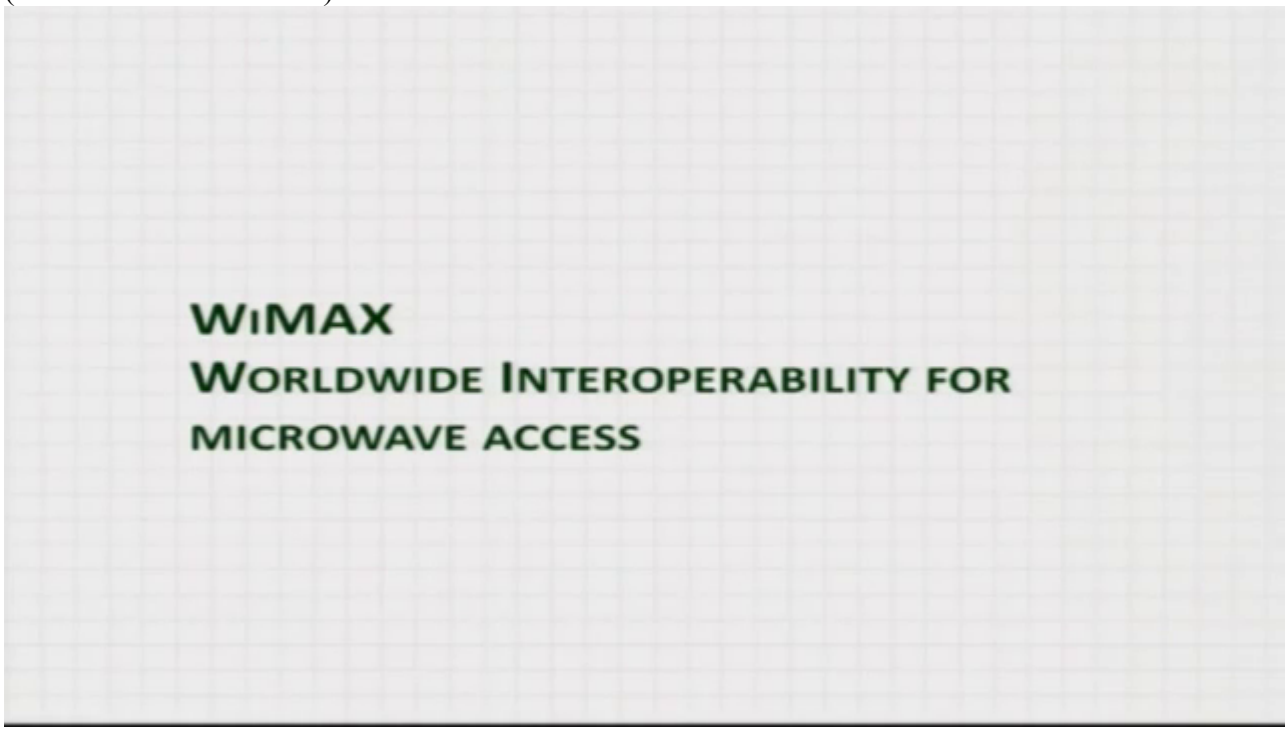

And WiMAX stands for Worldwide Interoperability for Microwave Access.

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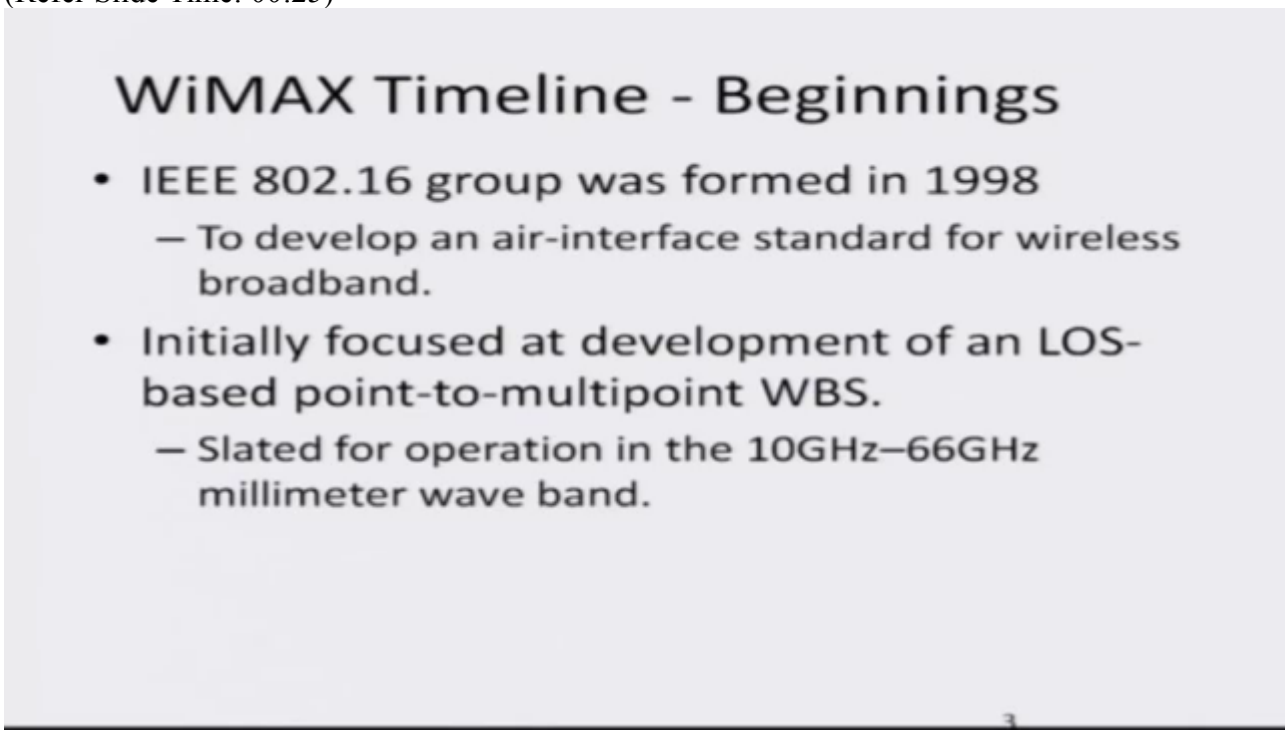

The technical name for it is 802.16 and this group was formed in 1988 to develop an air interface for broadband wireless applications that is really increase the wireless data rates to what you have on the Ethernet kind of broadband networks. And it was initially demented and only for a line of sites such as for instance where you have a very good signal strength between devices.

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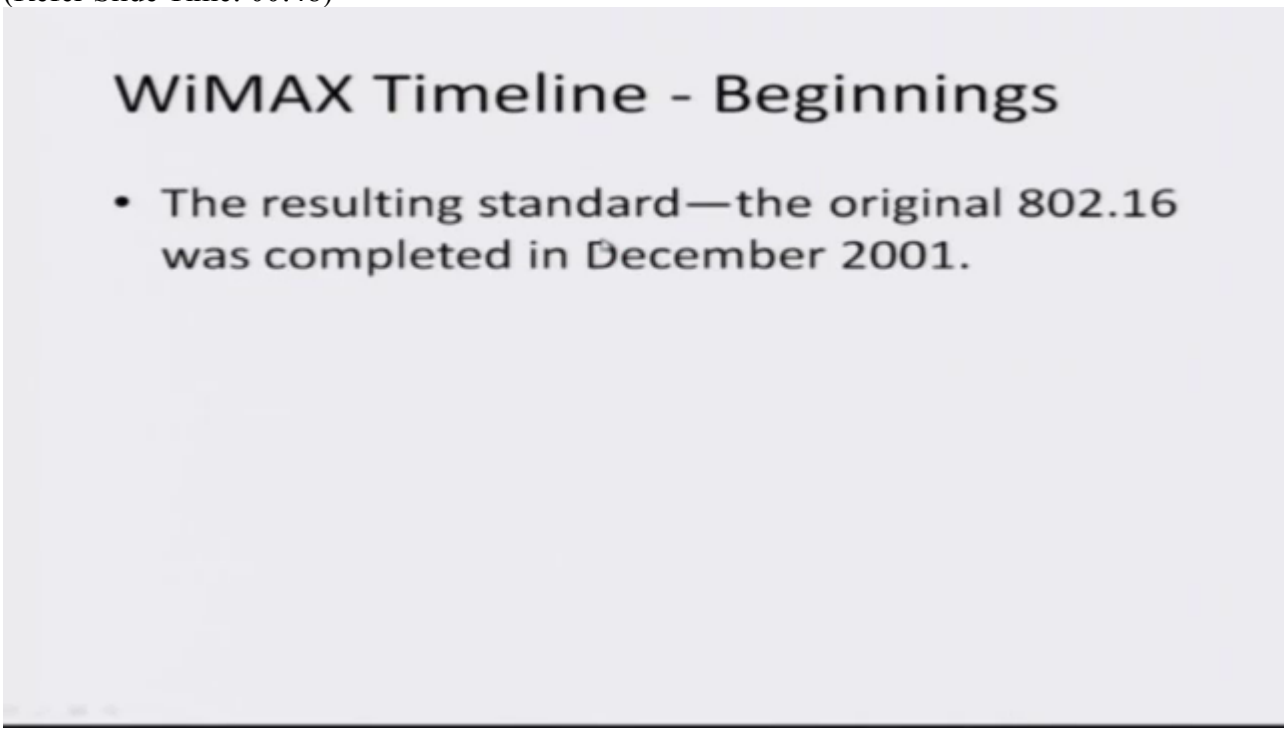

And this original standardization was completed in 2001.

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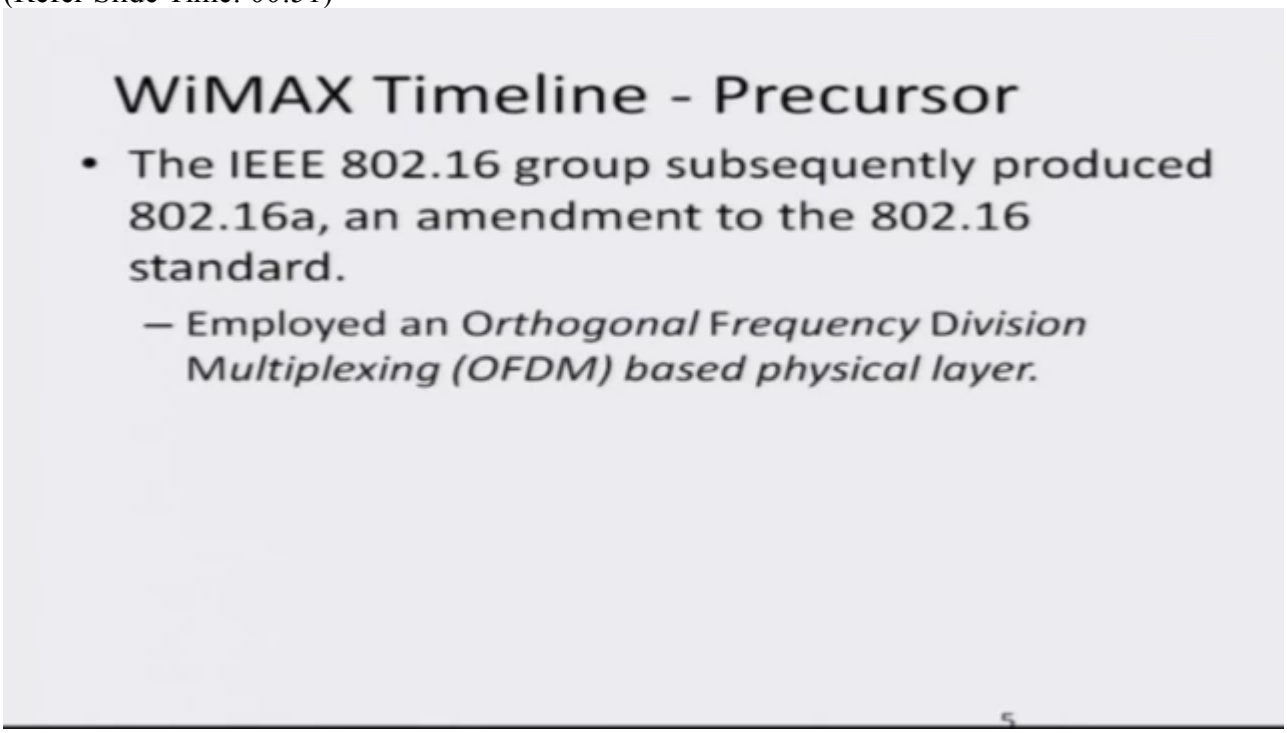

And this was again evolved subsequently for instance the 802.16 group subsequently produced 802.16a which is based on a novel technology known as OFDM or Orthogonal

Frequency Division Multiplexing. This is an interesting standard, a very robust standard which we were going to see its forms the basis for a large number of 4G wireless standards because it supports a very high data rate so that was extended to OFDM.
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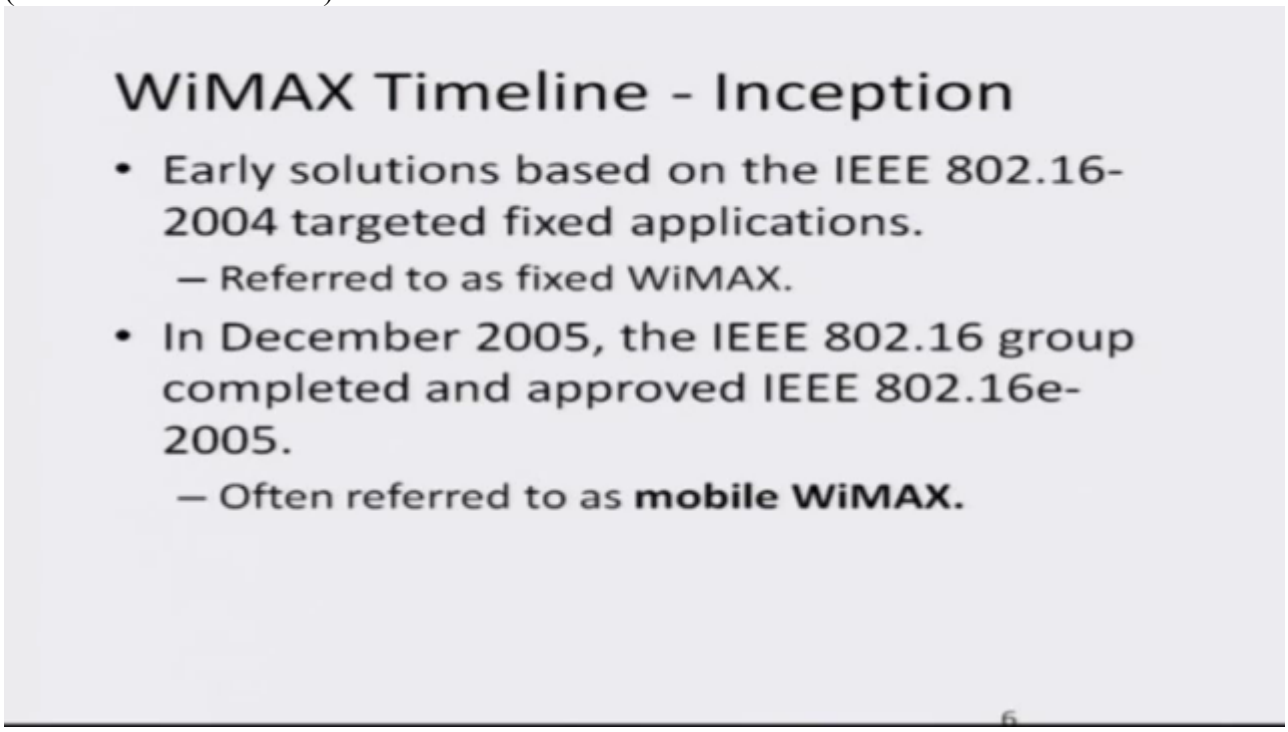

And the initial solutions in WiMAX 802.16 were fixed that there was no mobility and they were known as fixed WiMAX and later around mid 2000s, 2005 the standard was extended to 802.16e and this was known as mobile WiMAX where mobility was added as another component of WiMAX.
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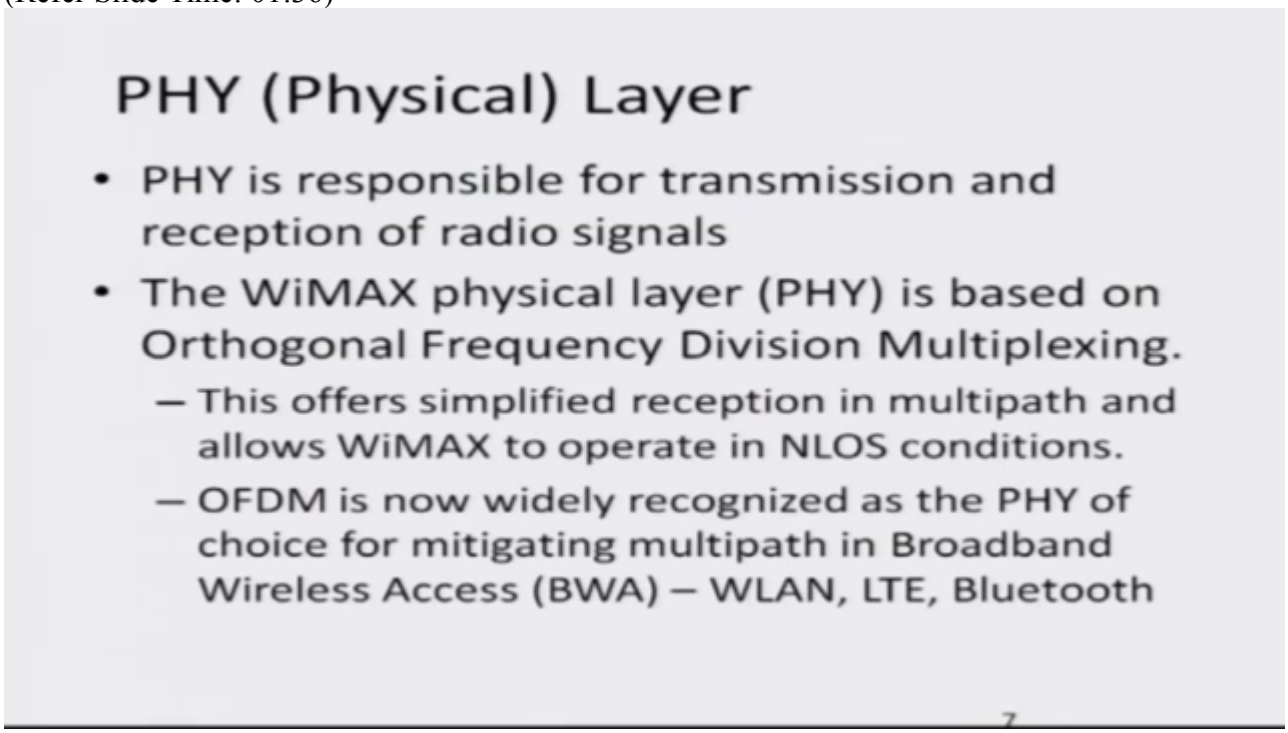

And as I've already pointed out the WiMAX basically is based on OFDM or Orthogonal Frequency Division Multiplexing which is sort of an advanced signal transmission technique and significantly enhances the signal strength and the data rate to achieve broadband communication capabilities and therefore it's widely recognized as the choicest strategy for transmission of signals in broadband wireless access for instance be it Wireless LAN or LTE which is another 4G wireless standard or Bluetooth and so on.
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WiMAX OFDM Parameters

Parameter	Fixed WiMAX	Mobile WiMAX			
Number of Subcarriers	256	128	**512**	1024	2048
Used data subcarriers	192	72	**360**	720	1440
Pilot subcarriers	8	12	**60**	120	240
Number of null/guardband subcarriers	56	44	**92**	184	368
Cyclic Prefix	1/32, 1/16, 1/8, 1/4				
Oversampling Rate (Fs/BW)	Depends on BW. 7/6 for 256 OFDM, 8/7 for multiples of 1.75 MHz and 28/25 for multiples of 1.25 MHz, 1.5 MHz, 2 MHz or 2.75 MHz.				
Channel BW (MHz)	3.5	1.25	**5**	10	20
Subcarrier spacing	15.625	**10.94**			

And this is a table which shows some of the specs or the key aspects of WiMAX, most of them are fairly advanced but what you can look at is basically the overall bandwidth. If you the bandwidth there's channel bandwidth, it can support bandwidths all the way from 5, 10 to 20 megahertz will supports a huge bandwidth which means simultaneously can support a huge data rate corresponding to these huge bandwidths. If you remember WCDMA has a bandwidth of about 5 megahertz WiMAX can support a bandwidth of about 20 megahertz which means the data rate proportionately increases significantly.
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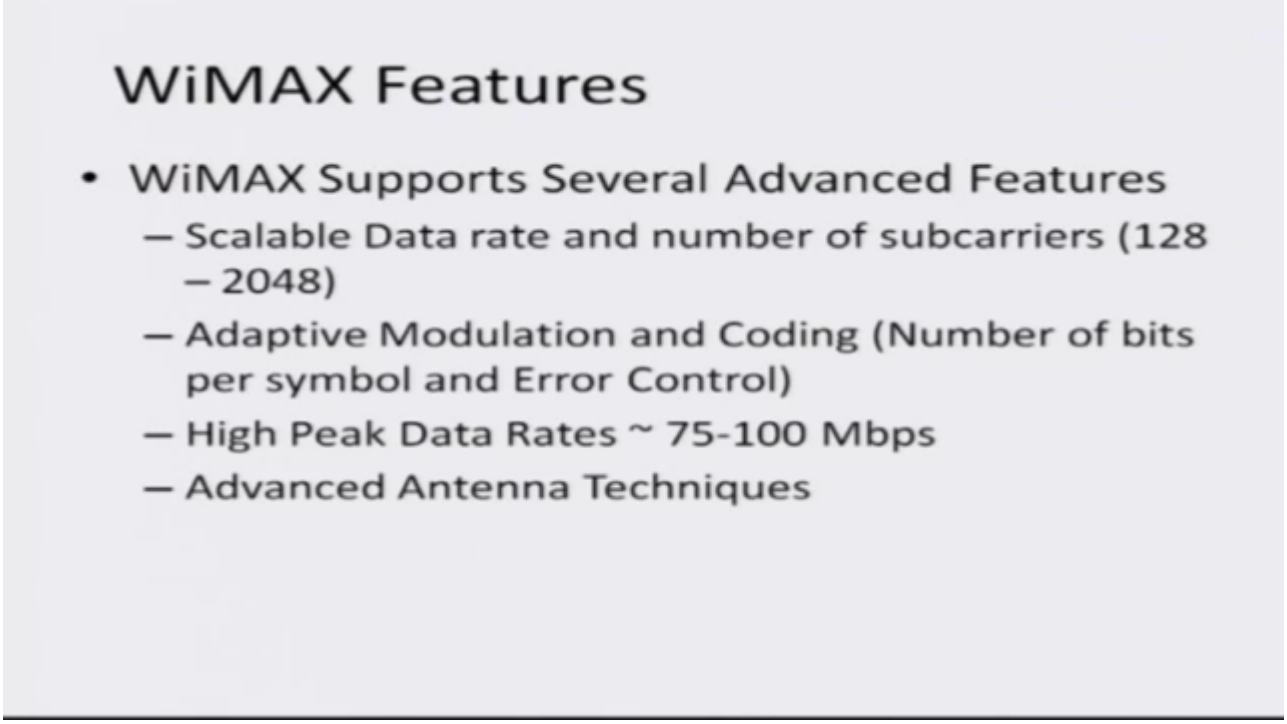

And WiMAX again supports several advanced features such as adaptive modulation and coding that is adaptively changing the number of bits transmitted according to the strength of the link and other aspects of the links so as to improve the efficiency, very high peak data rates around 75 to 100 megabits per second an advanced, antenna techniques that is not just a single antenna but multiple antennas to significantly improve the received signal strength.

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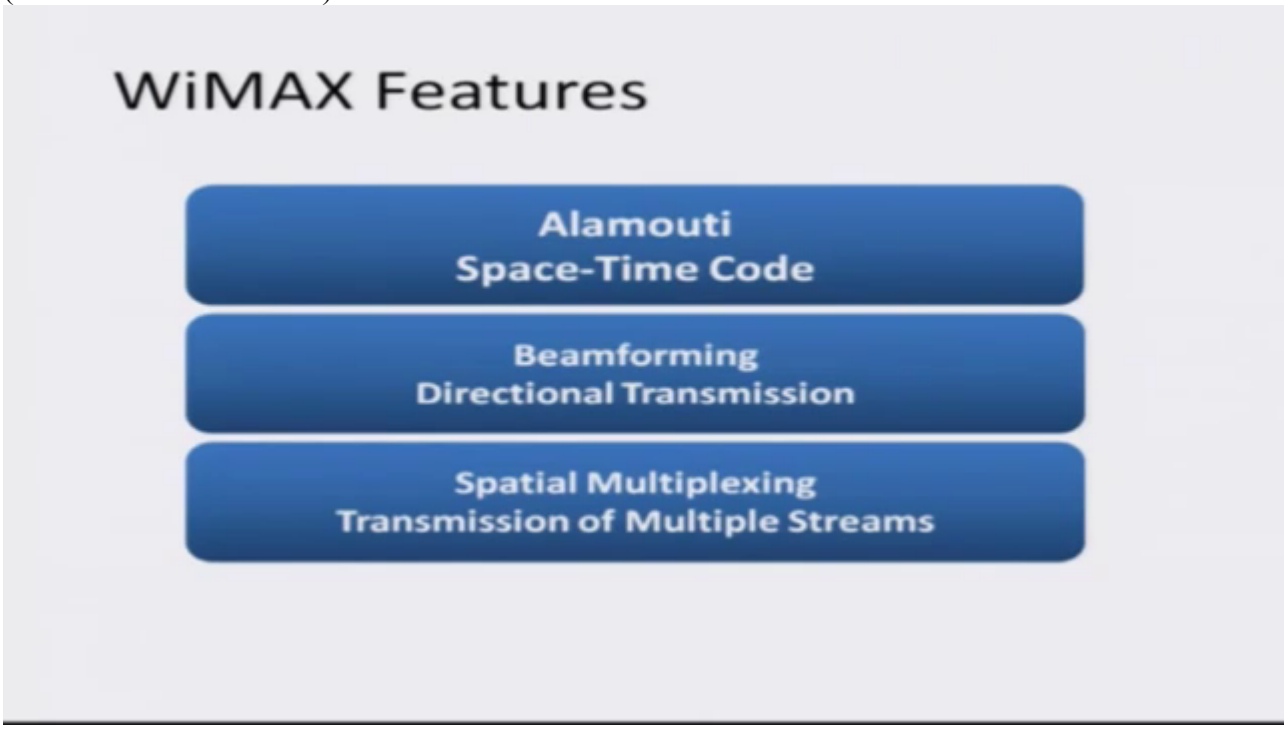

These are different features which are summarized here. There's a the space time codes which again increase the reliability through coding. Beamforming which basically focus the energy transmitted from the antennas in a particular direction to improve the energy efficiency of the antennas and therefore to increase the data rate or the signal strength to particular users and

thereby improving the service. Spatial multiplexing which is transmitting which multiplexing more than one streams or more than one uses therefore in space there by transmitting either additional data to a single user or transmitting additional data to various users and this is an important feature which is made possible by multiple antennas and this is something that we are also going to see

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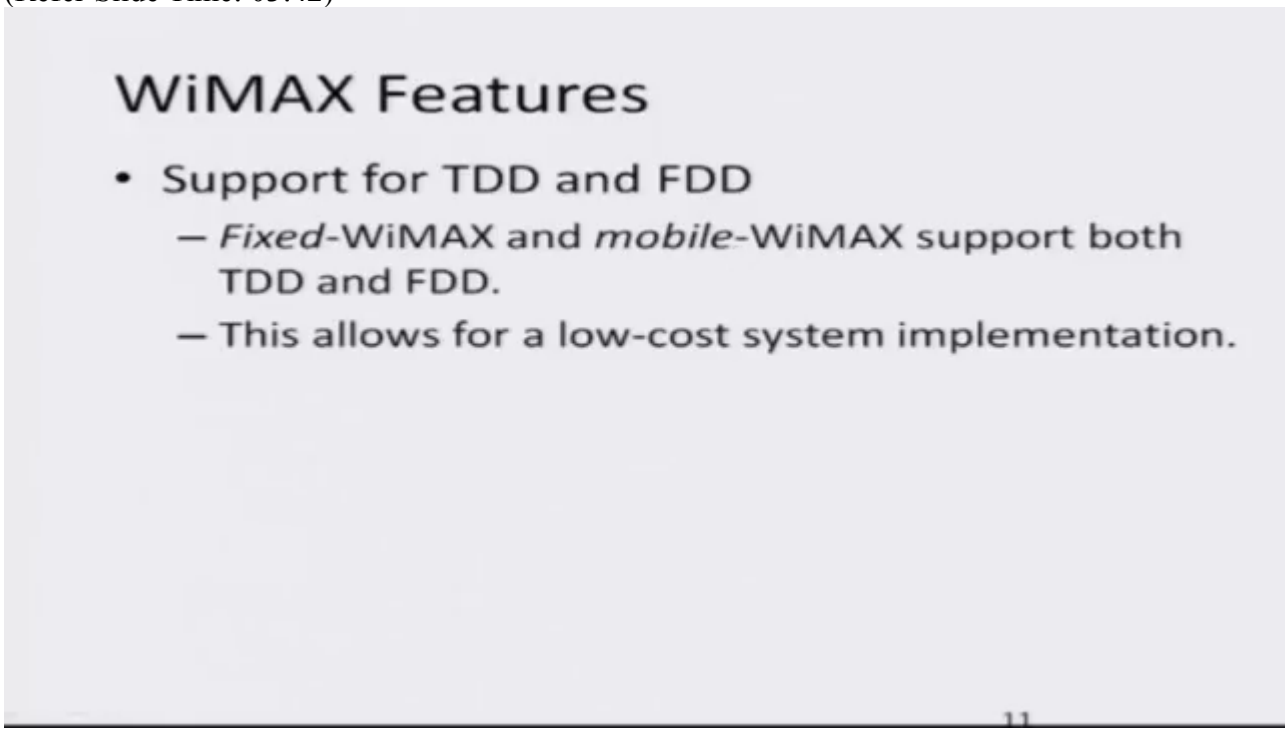

slightly supports also TDD and FDD that is Time Division Duplex and Frequency Division Duplex that is where uplink and downlink are either divided in different time slots or divided in frequent different frequency band that gives additional flexibility for operation.

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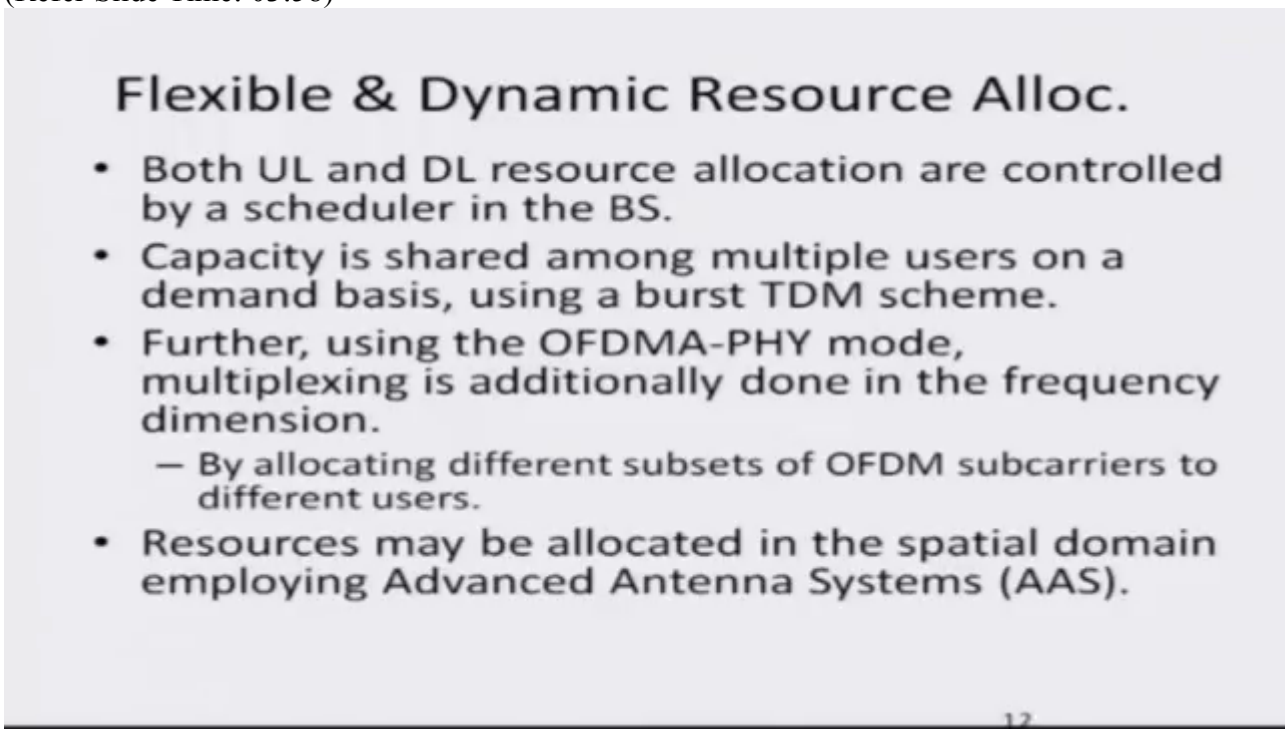

And also it enables what is known as dynamic resource allocation that is sharing the resources rather than GSM which has a fixed time slot for each user allows the resources to be shared dynamically thereby allocating more resources to data hungry users such as users who are on video calls or users on video streaming while allocating or less users to users who are on applications or services that are not so data hungry such as voice calls which require less data rates. So this flexible scheduling is what helps or what enables efficiently handling several users or several types of users in this wireless network or on different services such as video streaming, internet browsing, email browsing, file transfer, voice calling and so on, that helps really address the challenge of handling this wide gamoo of services very efficiently in this wireless mobile network. And additionally resources can also be allocated using advanced antenna systems in the spatial domain that is because they are not limited to a single antenna, but they can since they can support multiple antennas these users can be efficiently allocated or multiple users can be if multiple users and multiple data streams can be efficiently multiplexed using these advanced antenna systems.
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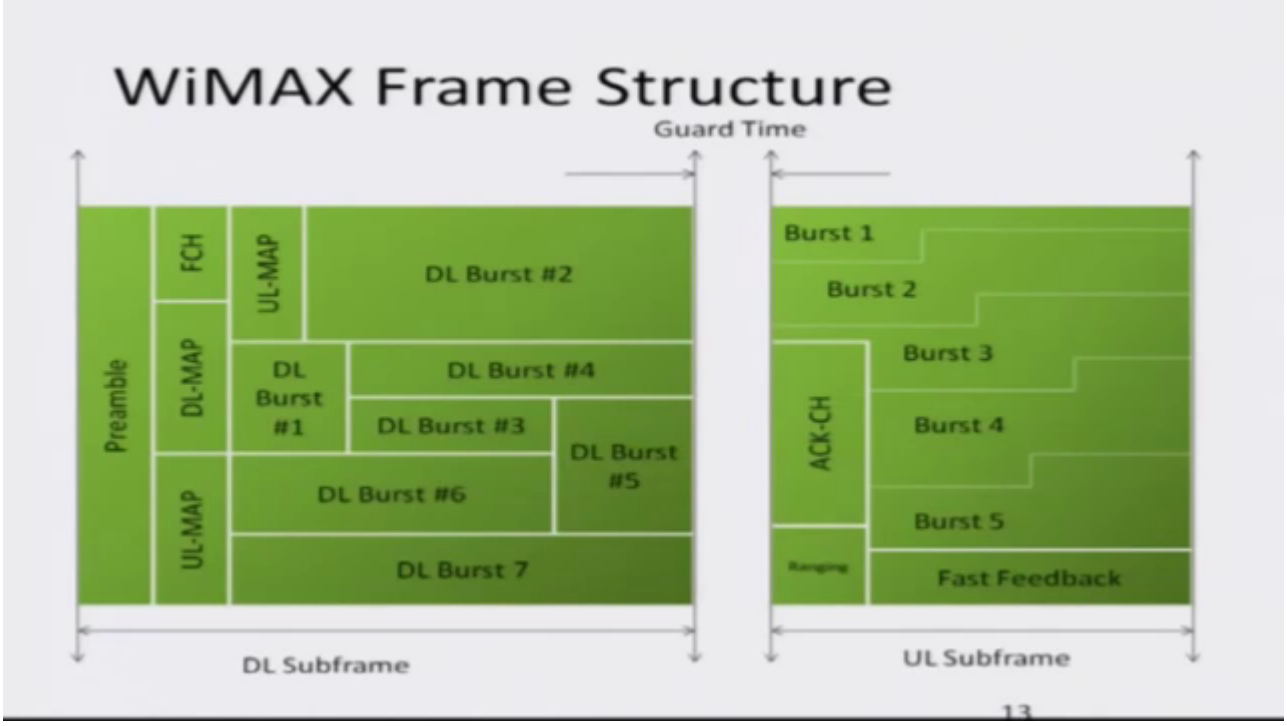

And what I have here is a basic WiMAX frame structure which shows how the users can be – the different users can be scheduled efficiently. As you guys you can see these different blocks that are allocated for different applications or different users are asymmetric as you can see some of the blocks are very large, some of the blocks are very small, which means different users depending on the kind of application, depending on the nature or the intensity of the data rate required by these different applications can be appropriately allocated resources, thereby improving the overall efficiency.
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WiMAX Scheduling Services

Scheduler type	Services
Unsolicited grant services (UGS):	Support for fixed-size data packets at a constant bit rate (CBR). - Voice
Real-time polling services (rtPS):	Designed to support real-time service flows, such as MPEG video, that generate variable-size data packets on a periodic basis. - Video
Non-real-time polling service (nrtPS):	Designed to support delay-tolerant data streams, such as an FTP, that require variable-size data grants at a minimum guaranteed rate.
Best-effort (BE) service:	Supports data streams, such as Web browsing, that do not require a minimum service-level guarantee. – Internet, e-mail
Extended real-time variable rate (ERT-VR) service	For real-time applications, such as VoIP with silence suppression, that have variable data rates but require guaranteed data rate and delay.

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And there are various services that are supported by WiMAX such as voice which is known as the unsolicited grant service, real-time polling service which is supported for applications such as video, the non real-time polling service for other applications such as FTP that is a basic file transfer best-effort service for applications such as web browsing email internet etcetera and the extended real-time variable rate service on the ERT-VR service.

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Mobility Support

- WiMAX supports the following types of mobility

Type	Features
Nomadic.	The user is allowed to take a fixed subscriber station and reconnect from a different point of attachment.
Portable.	Nomadic access is provided to a portable device, such as a PC card, with expectation of a best-effort handover.
Simple mobility.	The subscriber may move at speeds up to 60 kmph with brief interruptions (less than 1 sec) during handoff.
Full mobility:	Up to 120 kmph mobility and seamless handoff (less than 50 ms latency and <1% packet loss) is supported.

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Also WiMAX supports a variety of device mobility aspects; for instance, the device can be nomadic that is basically it's practically speaking not mobile except over -- except after an extended period of operation these can be devices such as for instance your desktop which is more or less installed at a particular place or a base station which is more or less fixed at a

particular place after installation. Portable for instance devices which are mobile but devices which they are not moving at a very high speed for instance a laptop which a user uses at a fixed position for duration such as a couple of hours before moving to another location et cetera. Simple mobility like mobile phones et cetera which users are in such as cars who are moving in speeds up to 60 km/h or less and full mobility for instance with devices such as laptops or mobile phones with users in high-speed mobile scenarios such as fast speed trains and can support mobility of up to about 120 kilometers per hours.

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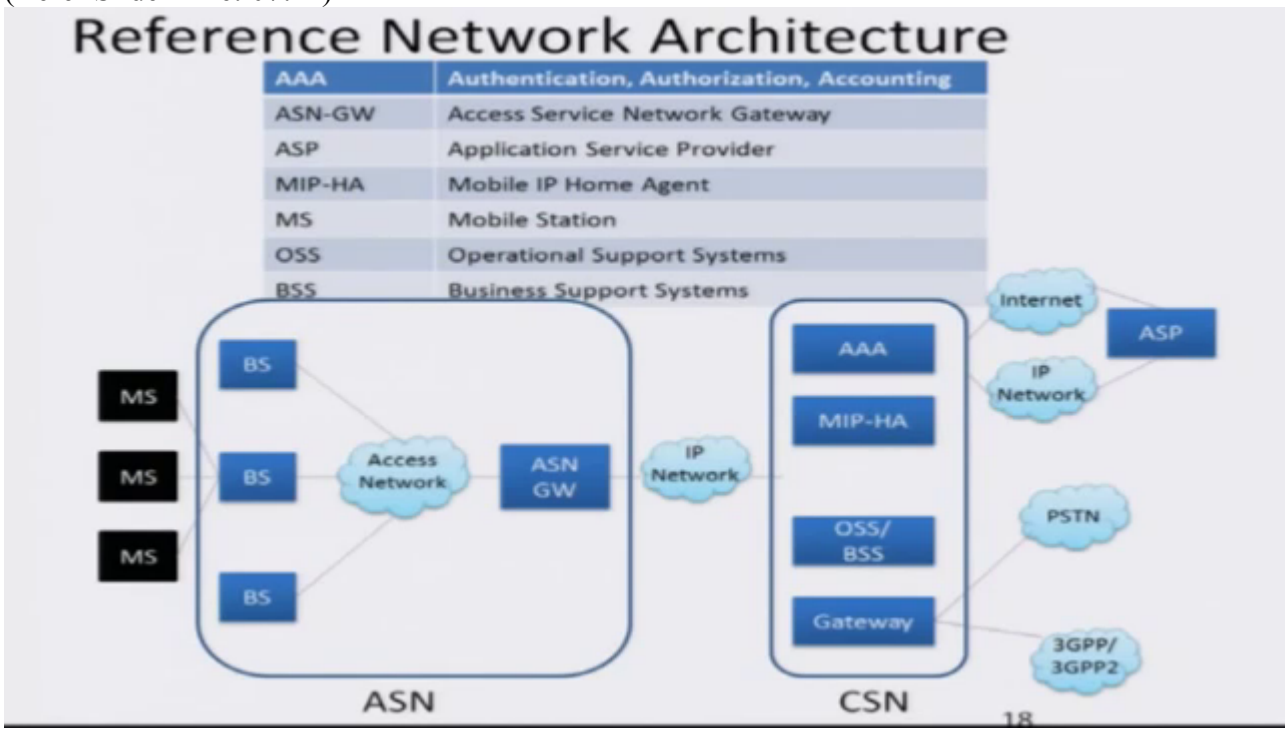

And the network architecture of WiMAX is slightly different although it has a mobile station it has a base station. These base stations are no longer connected on your conventional telephone lines to the other parts of the network, the backhaul or what connects these base stations amongst themselves and to the other aspects are entirely based on an Internet kind of type of network which is based on the transmission of data packets rather than which is known as a packet switched network. So these are connected to the access service network gateways and these are connected through again an Internet like network to a core service network which has several components such as gateways which connect to the other landline telephone network, the 3G networks, the 2G networks, the internet and other IP networks and they also have modules for authentication, mobile IP agents, operational support systems, business support systems such BS such as billing, insuring or billing for the services et cetera and so on. So the core network enables a vast set of rich set of services in this WiMAX architecture or in this WiMAX cellular network. So let's stop this introduction to the WiMAX module here. Thank you very much.