LTE, WLAN BLUETOOTH AND FUTURE

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Hello. Welcome to another module in wireless communications in this MOOC Massive Open Online Course. And this concluding module we are going to look at some of the roadmap for the future in wireless communication system. We're going to look at some of the state-of-the-art wireless communication technologies and what is upcoming in these wireless communication technologies.

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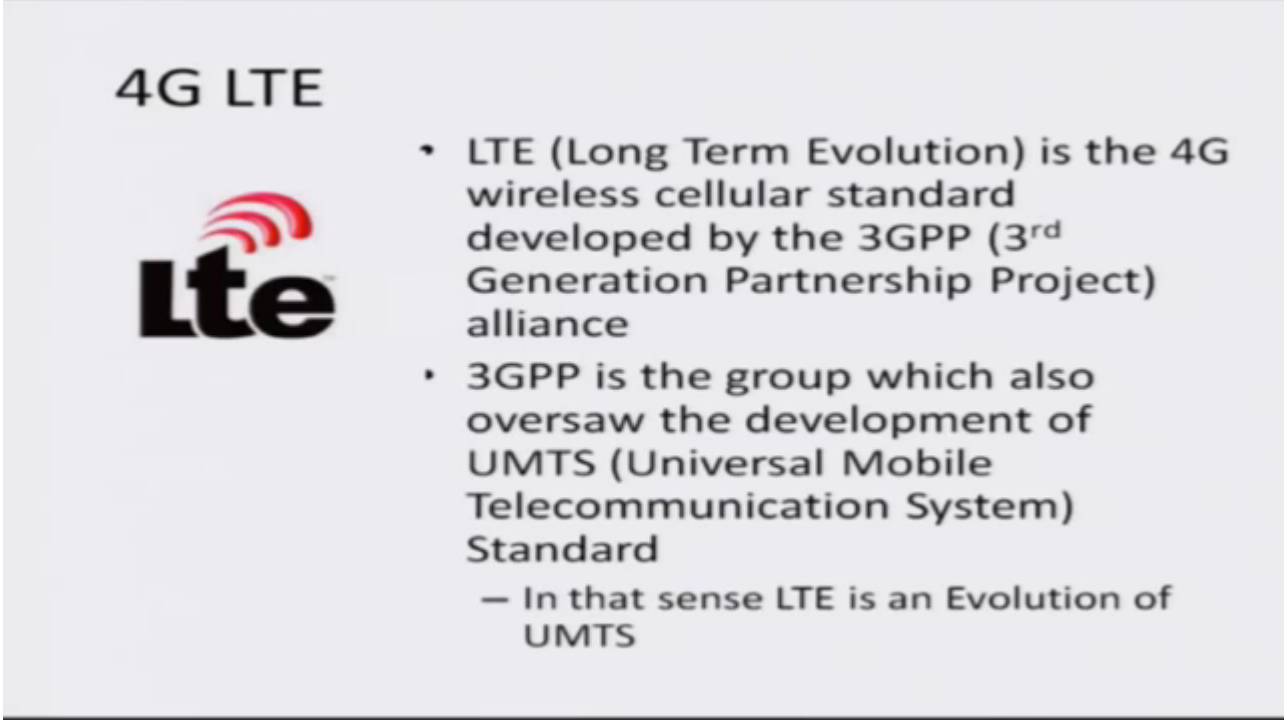

Let's start by looking the Dominant Wireless Communication Technology that is the 4G standard LTE which is long term evolution. It's again developed by the 3GPP, that is a third generation partnership project which is the same umbrella body that overlooks the development of WCDMA.

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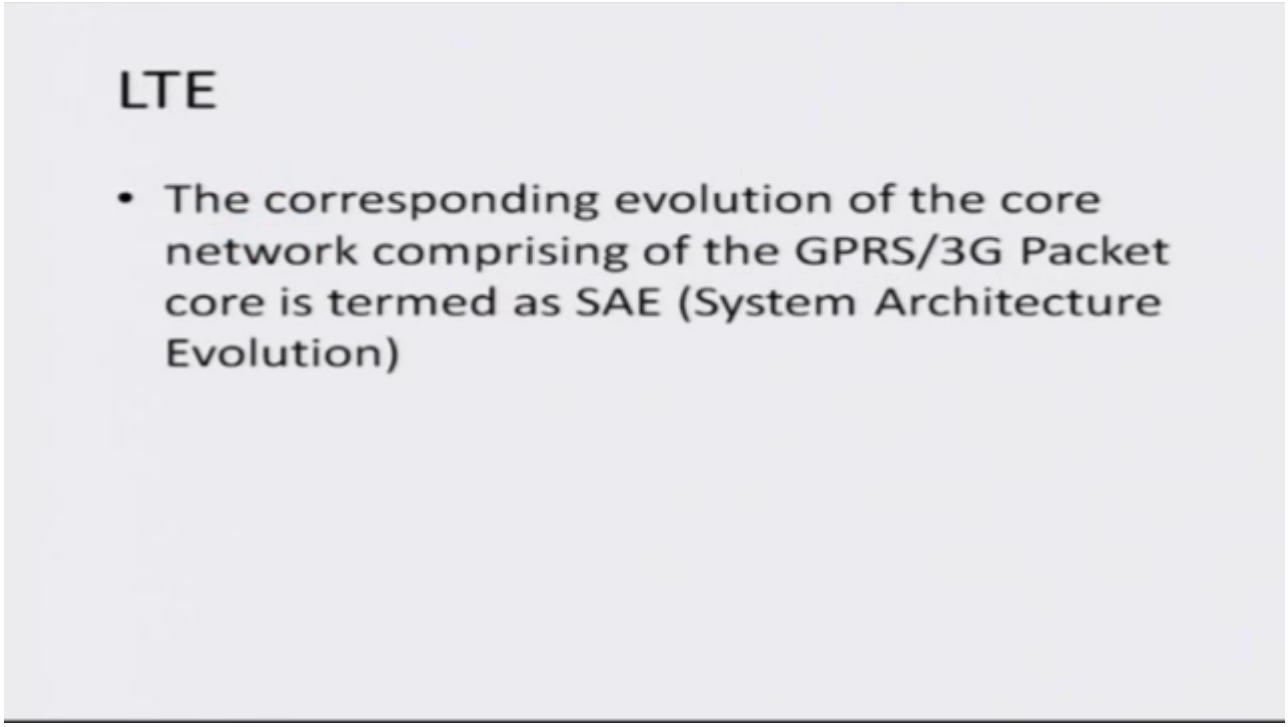

And LTE in a sense is an evolution of WCDMA.
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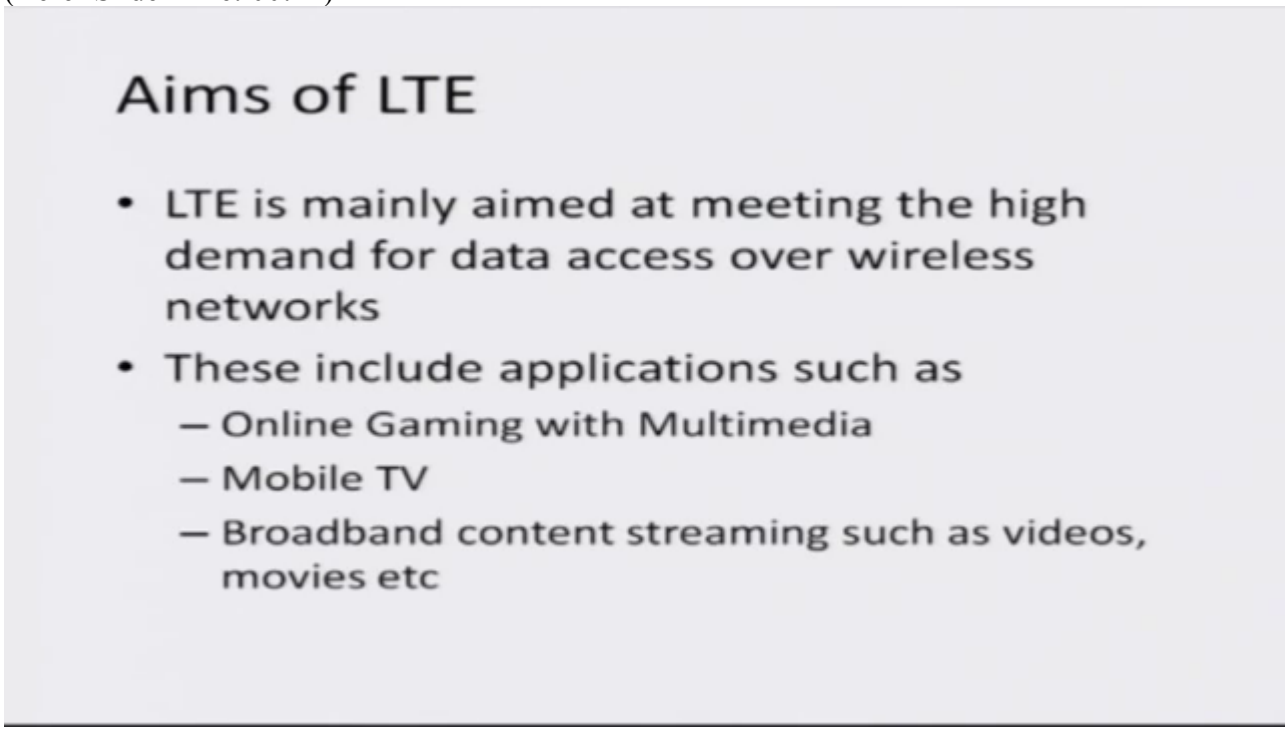

And LTE is aimed at meeting basically by enabling broadband data rates over wireless networks and this is to enable vast array of applications such as online gaming, mobile TV, high-definition mobile TV, broadband content streaming such as broadband movie streaming, broadband video calling et cetera.
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LTE Timeline

2000	3GPP Release 99 Air Interface
2001	3GPP Release 4/ Deployed in Japan
2002	3GPP Release 5, IMS, HSDPA, Commercial Deployment in Europe
2004	3GPP Release 6, HSDPA, MBMS, Work started on LTE
2007	3GPP Release 7, HSPA+, VOIP
2008	Preliminary version with Release 8
2010	Targeted first deployment

And LTE again is tied to the development of the other 3GPP standards as WCDMA. We're in the early 2000's the different standards or different releases in WCDMA were developed followed by the preliminary version of LTE in 2008 and with early deployments of LTE in 2010.

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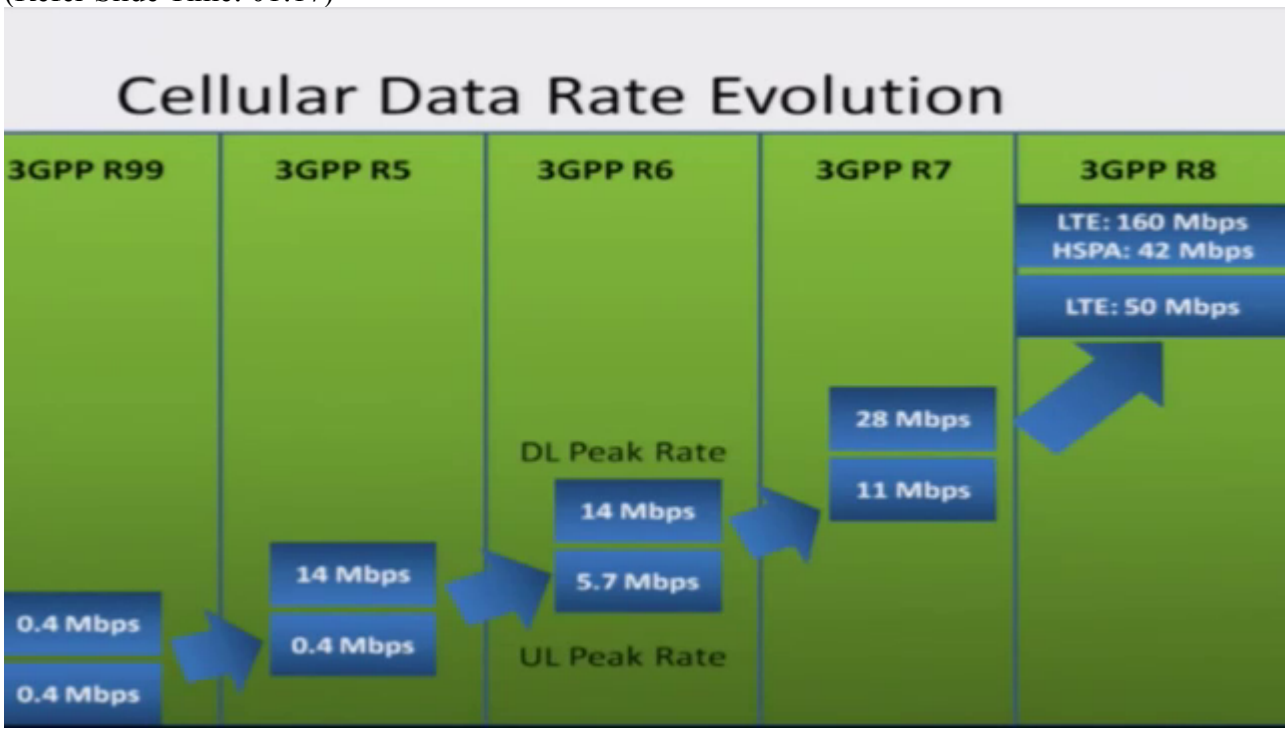

And this is again something that we have already seen which shows a systematic evolution of the data rate from our own 400 kilobits per second in the first release of WCDMA to about 14 megabits per second 28 megabits per second in HSDPA and HSUPA plus releases followed by LTE which is a true broadband standard which can enable data rates about 160 megabits per second in the downlink and 50 megabits per second in the uplink.

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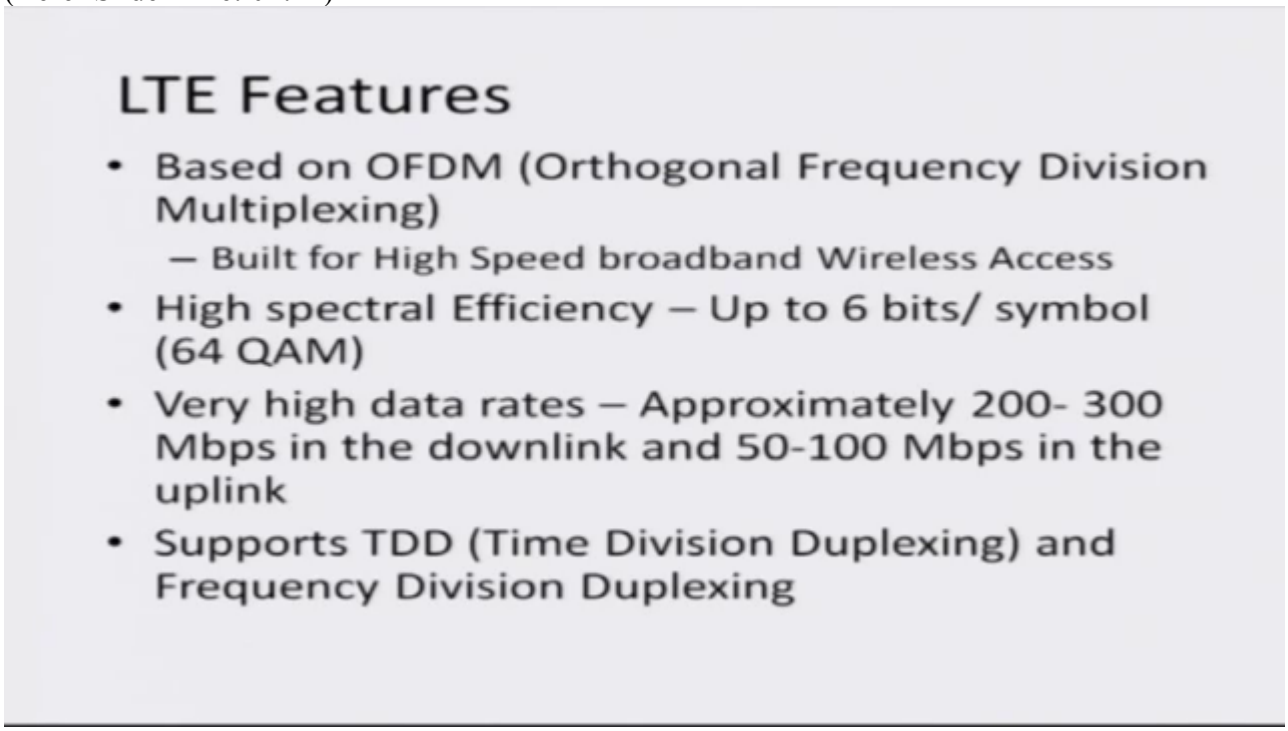

LTE again similar to WiMAX is based on the powerful OFDM radio signal transmission technology that is Orthogonal Frequency Division Multiplexing and it's built for high-speed broadband wireless access. It has a very high spectral efficiency that is in the same bandwidth or in the same spectrum can support it a very support a very high data rate by transmitting a large number of information bits for every symbol that is up to 6 bits per symbol transmits data rates of about 200 to 300 megabits per second in the downlink and about 50 to 100 megabits per second in the uplink and also supports both time division duplexing and frenzy division duplexing mechanisms.

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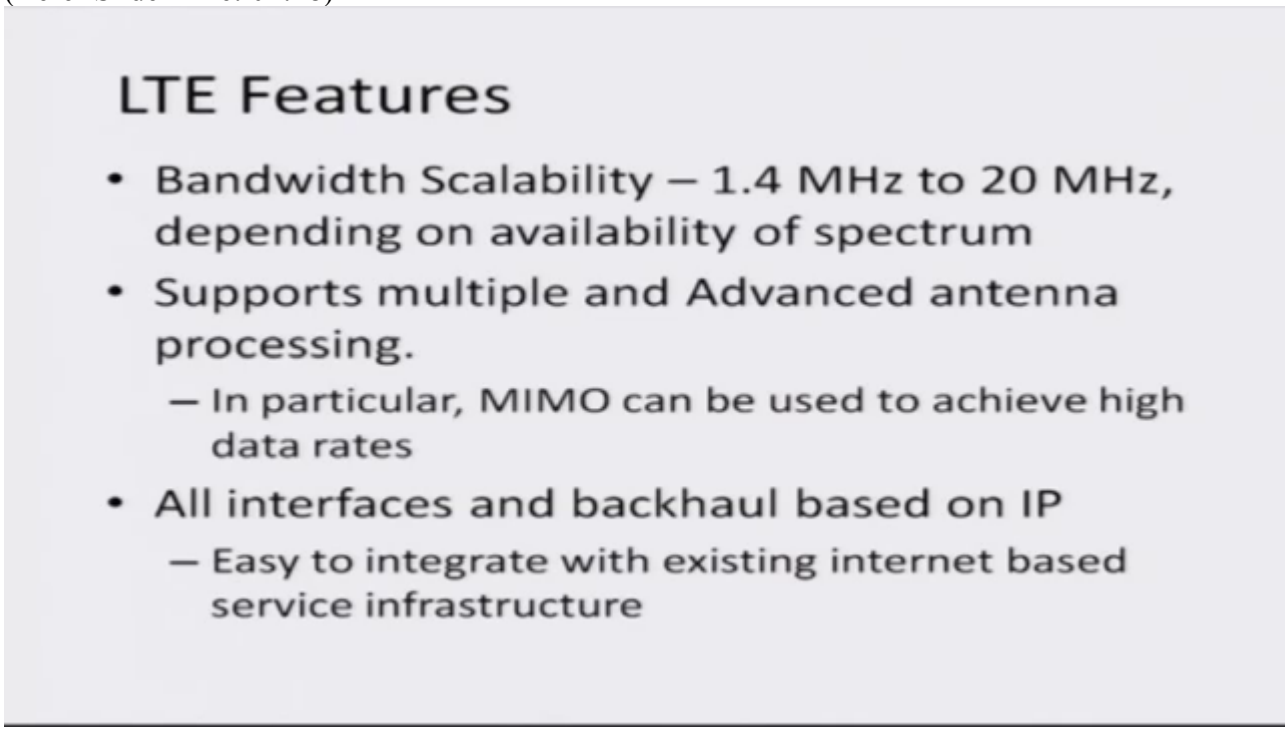

And it supports a huge bandwidth of about 20 megahertz and as we already seen larger bandwidth implies, higher data rate and also supports advanced antenna techniques where you have multiple antennas which to improve the diversity, also MIMO that is multiple antennas at the transmitter and receiver to achieve a very high data rate and all the interfaces and backhaul are based on the internet protocol or an IP kind of a network to enable seamless connection to the Internet to enable the rich set of services that the Internet has to offer.
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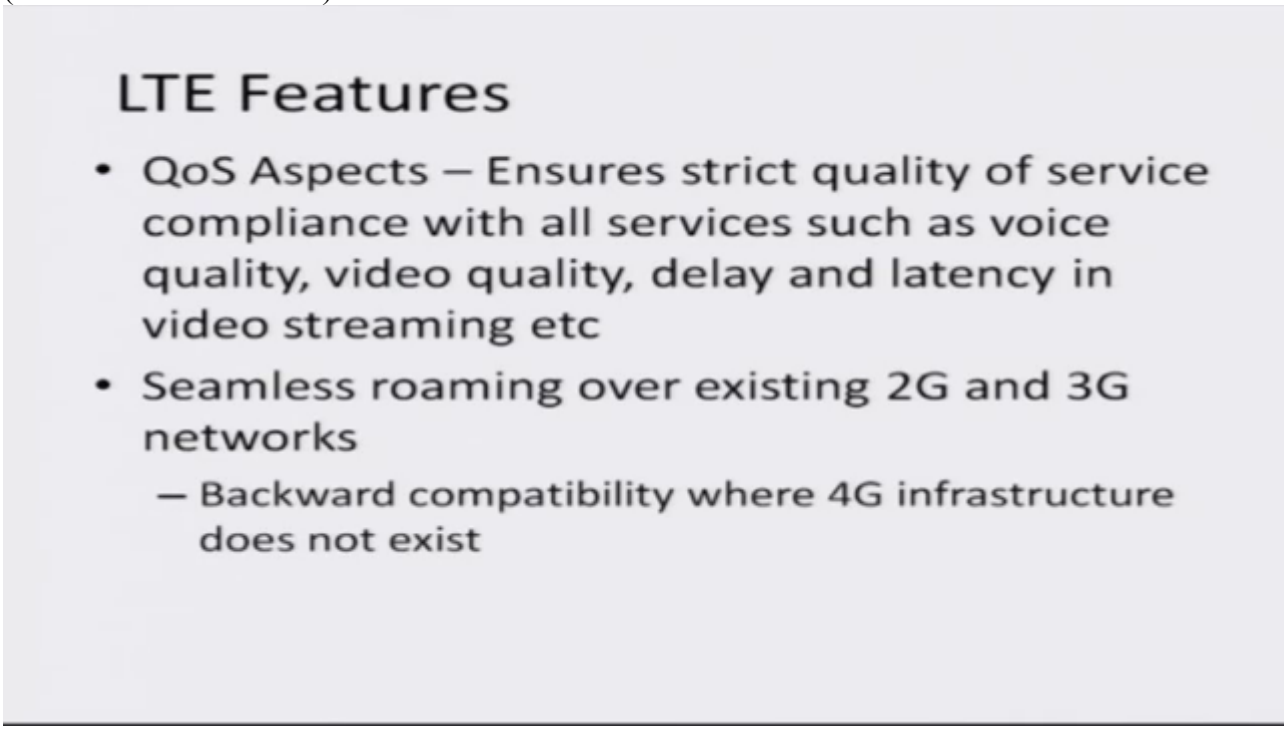

And also has a high quality of service reliability. It ensures not just services such as video, video calling, video streaming, but also has a strict set of guidelines to meet the quality of each service, and therefore that makes the experience of fee that's intended to make the experience of each of the users a much more pleasurable experience, a much more convenient experience rather than experiencing for instance jitter in video or stalling of video et cetera, so it has higher grade of quality of service or higher quality of service reliability and also enables roaming backward compatibility with other 2G and 3G wireless networks where 4G is not readily available.
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The other Wireless standard, not Wireless silver standard but the other popular wireless data transmission mechanism is the wireless LAN or Wi-Fi which has become equally popular in the past decade.

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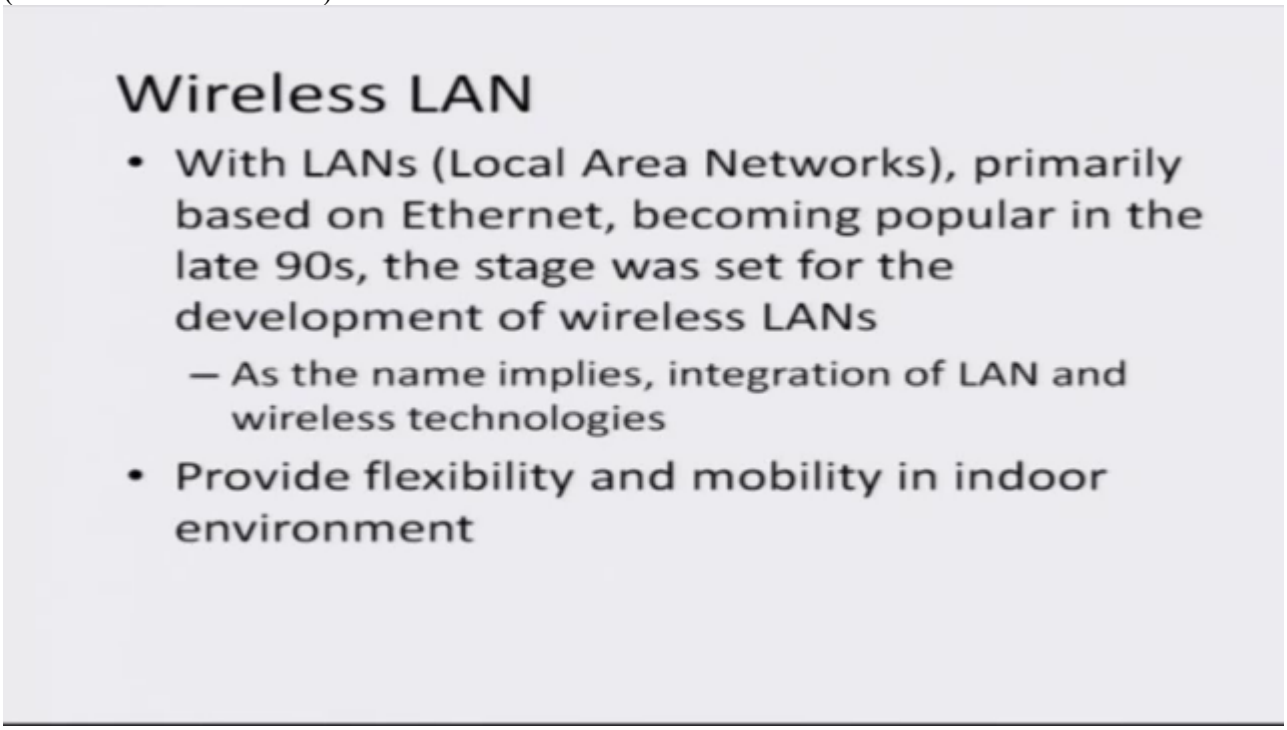

Wireless LAN stands for Wireless local area network. It's the wireless component of a wired local area network such as Ethernet which supports high data rates going up to currently on the gigabit per second in a local area network. And that provides a flexibility and mobility for indoor equipment rather than being tethered on Ethernet to provide a flexibility to connect various devices in a local area network.

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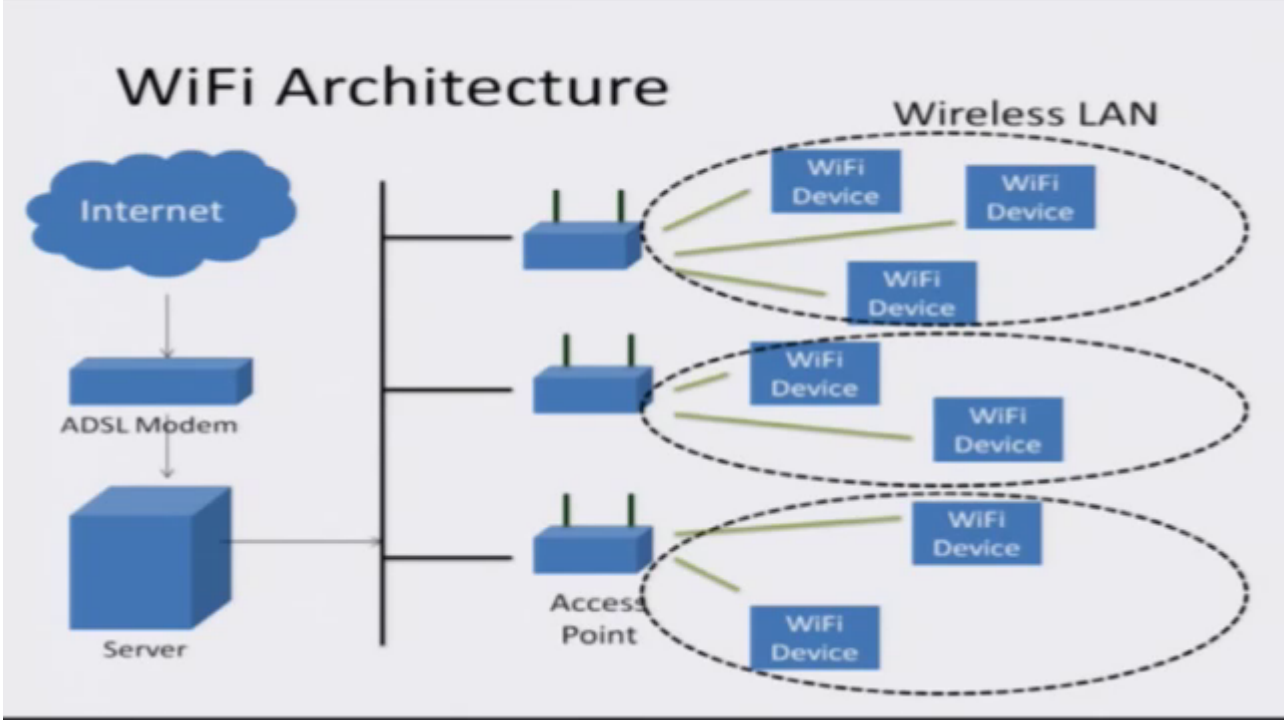

For instance here you have a basic schematic of a Wi-Fi architecture where you have the internet connected to a server and the various access points to which the various Wi-Fi devices are connected such as laptops smartphones et cetera.

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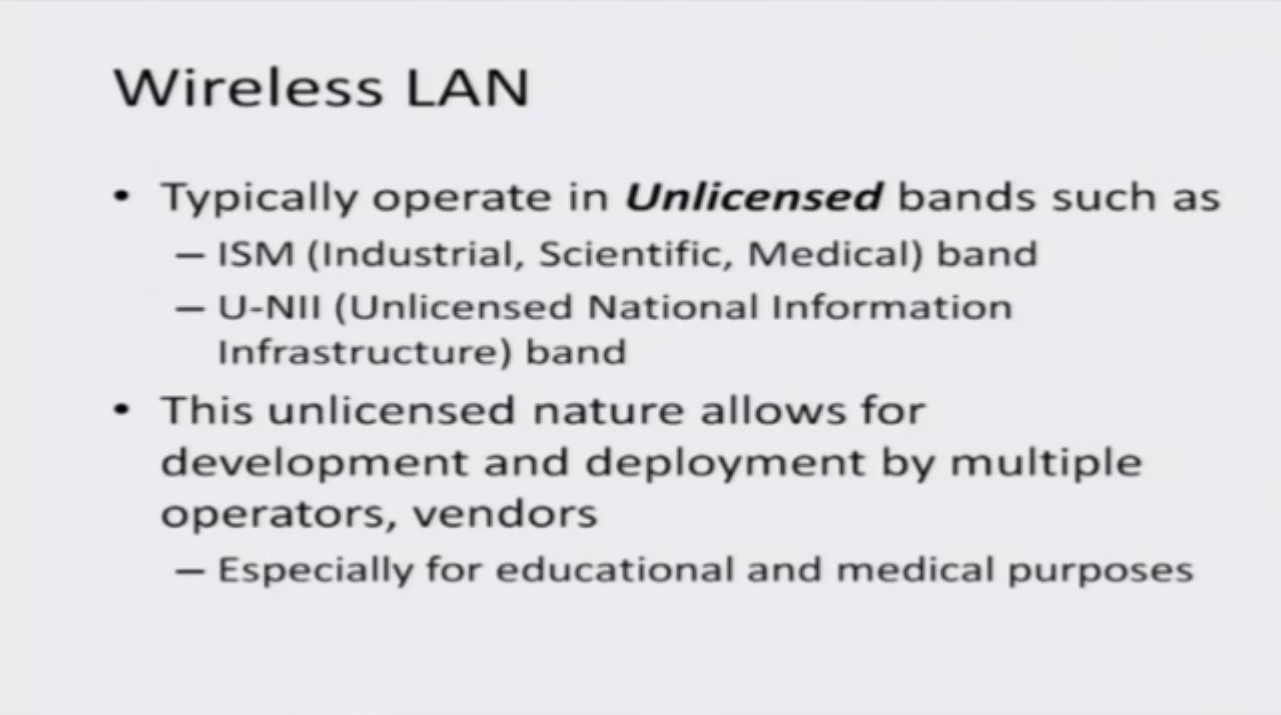

And the other advantage of Wi-Fi is this it operates in the unlicensed man such as ISM which is the industrial scientific medical band and U-NII band, the Unlicensed National Information Infrastructure band and this allows for fast deploy development by multiple operators and vendors making the Wi-Fi ecosystem a very rich one rather than restricted to a few carriers and develop a vast set of applications or employed for a vast set of purposes such as not just commercial purposes but for educational and medical purposes.

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And the Wi-Fi or wireless LAN have the advantage that they can provide connectivity in hotspot areas such as homes, offices, coffee shops, airports, hubs, universities, schools, educational institutes, offices, government institutes, community centers et cetera thereby enabling the connection of a rich set of devices and internet and data access for a rich set of devices.

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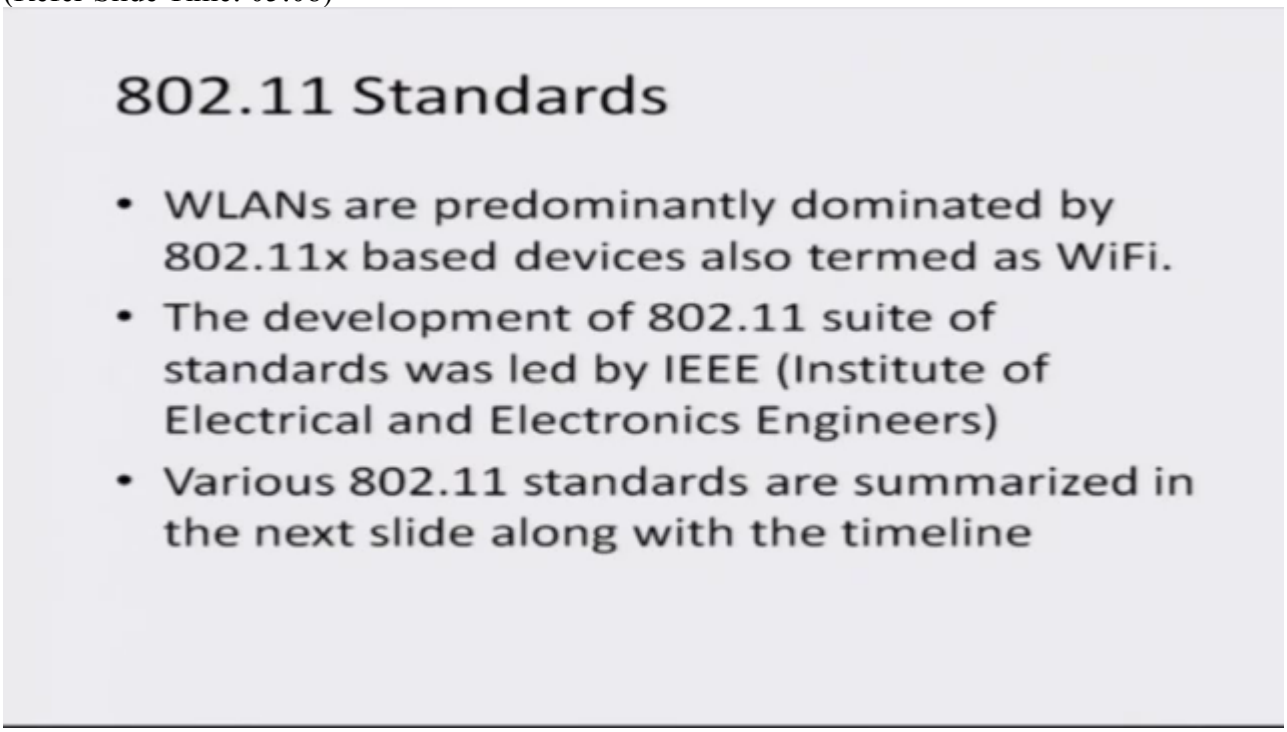

And the wireless LAN standard is predominate dominated by the 802.11x based services also known as Wi-Fi. Wi-Fi is the colloquial term or the used or the trade term used for the 802.11x or 802.11 suite of services developed by IEE.

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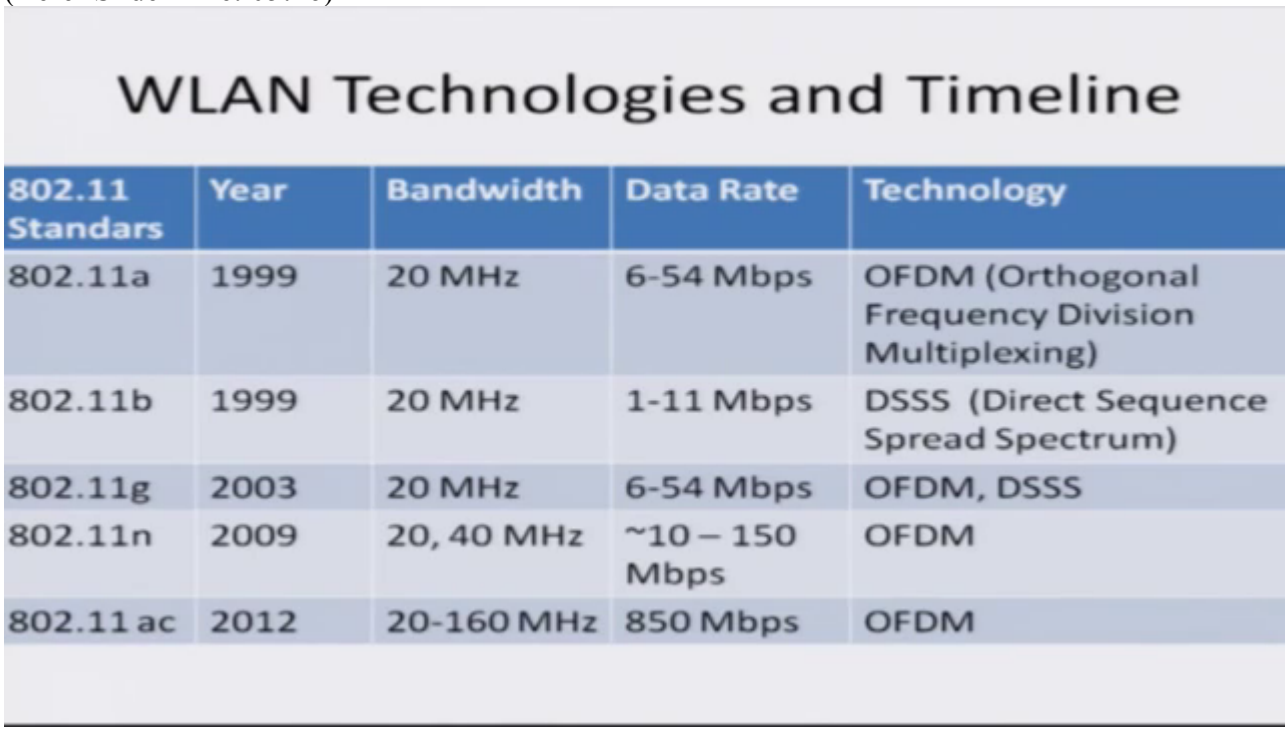

And the various IEEE standard, 802.11 standards are such as 802.11a the more popular 802.11b which was formulated in 1999 and can support up to 11 megabits per second. And they latest ones such as 802.11g and the more recent ones such as 802.11n which can support about – to about 150 megabits per second is based on OFDM and 802.11ac which is the most recent one can support up to a gigabit per second and is again based on OFDM.

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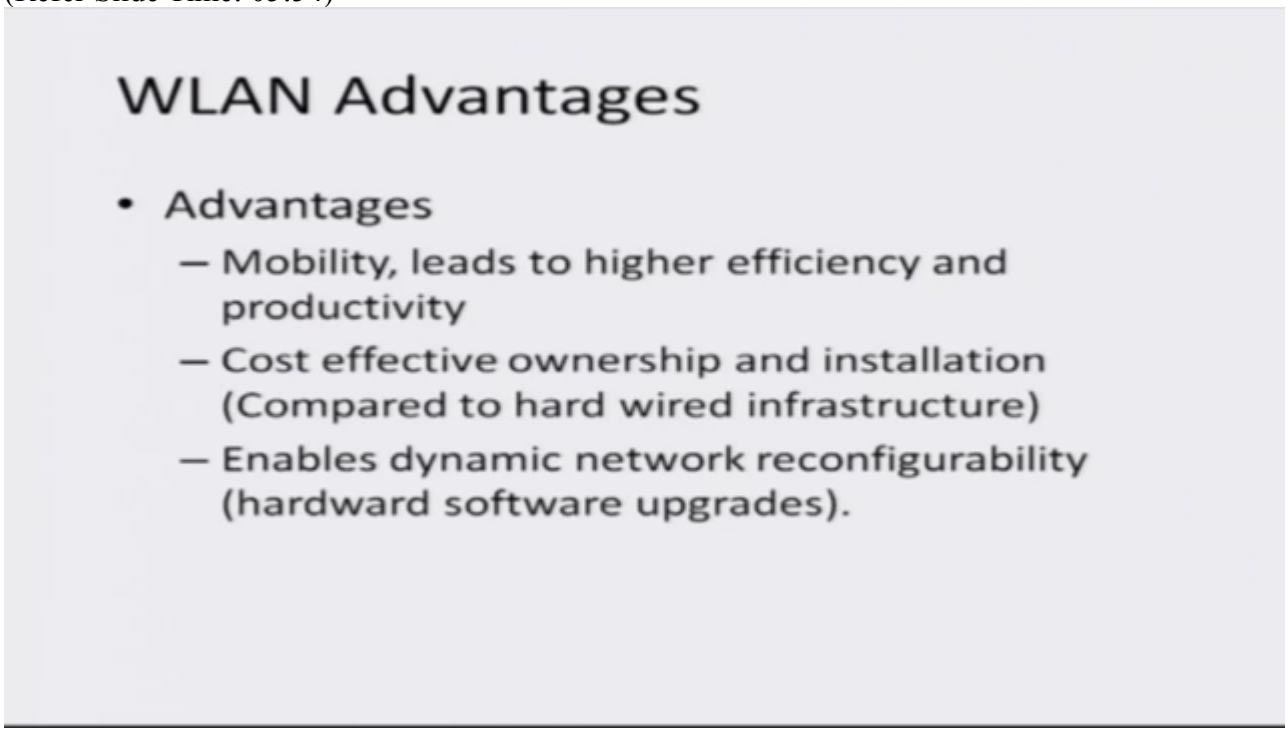

And that advantages of Wi-Fi or WLAN is that it supports mobility which leads to a higher efficiency, cost effective ownership and cost-effective installation compared to installation of

a wired infrastructure such as Ethernet and enables dynamic reconfiguration of the entire network.
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And as you are all, most of you must be familiar WLAN the connection to WLAN is for WLAN adapter. Most of these WLAN adapters now come standard with either laptops or smartphones that enable ready connection to Wi-Fi network whenever one is available.
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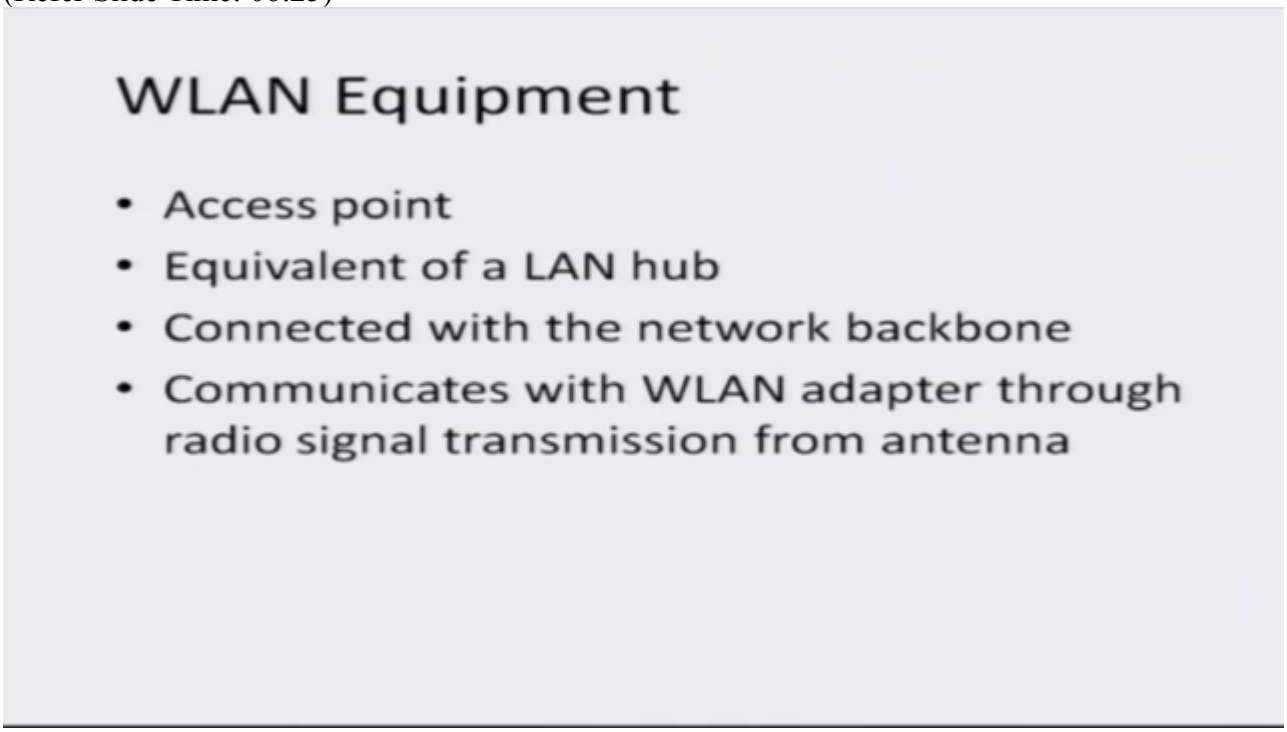

And the WLAN typically connects consists of access points which are equivalent of LAN hubs and these access points communicate with the WLAN adapters through antennas on the devices such as on your smartphones or on your laptops.

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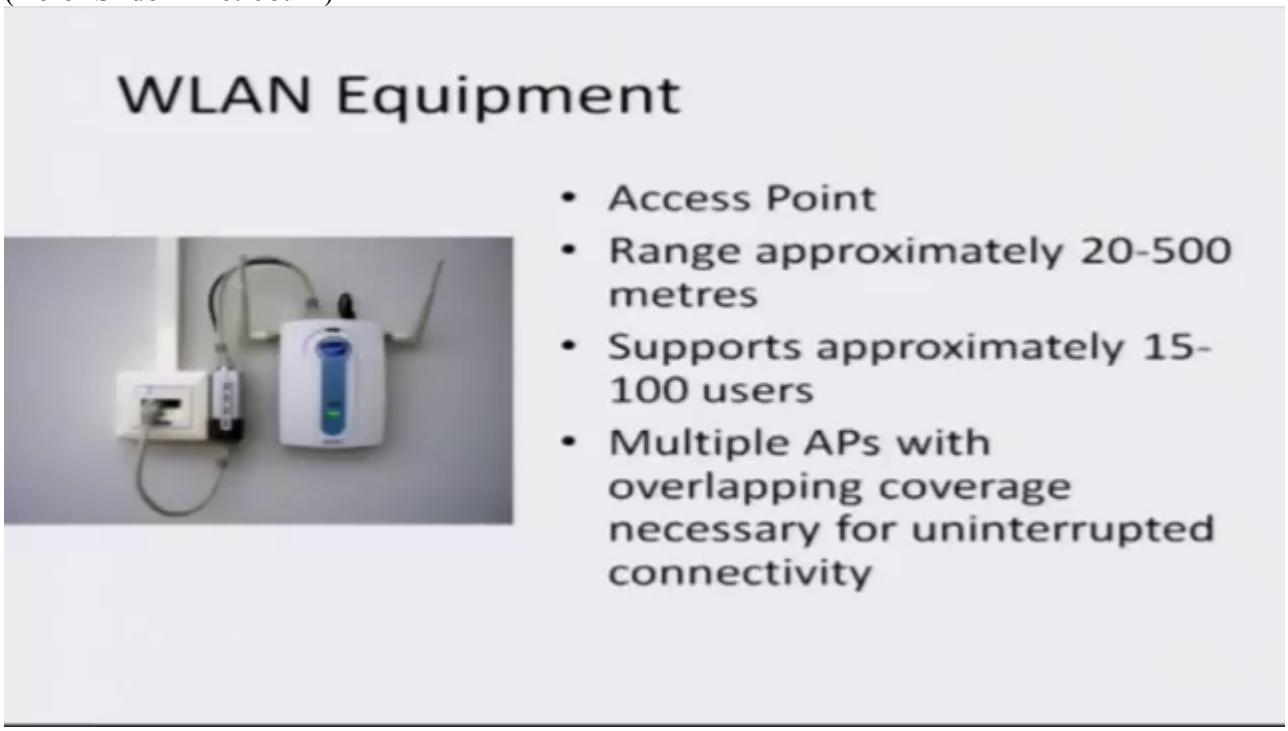

And the wireless the WLAN access typically has a range of about 20 to 500 meters, so therefore it's much shorter range than a cellular network which is range of several kilometers supports about 15 to 100 users and therefore if you have a large HARQ spot with a large number of users you need a large number of access points to cover provide service to a large number of users.

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The other interesting Wireless standard which is also very popular is Bluetooth which is formally known as WPAN or a Wireless Personal Area Network and the technical number for Bluetooth is IEE 802.15.1.

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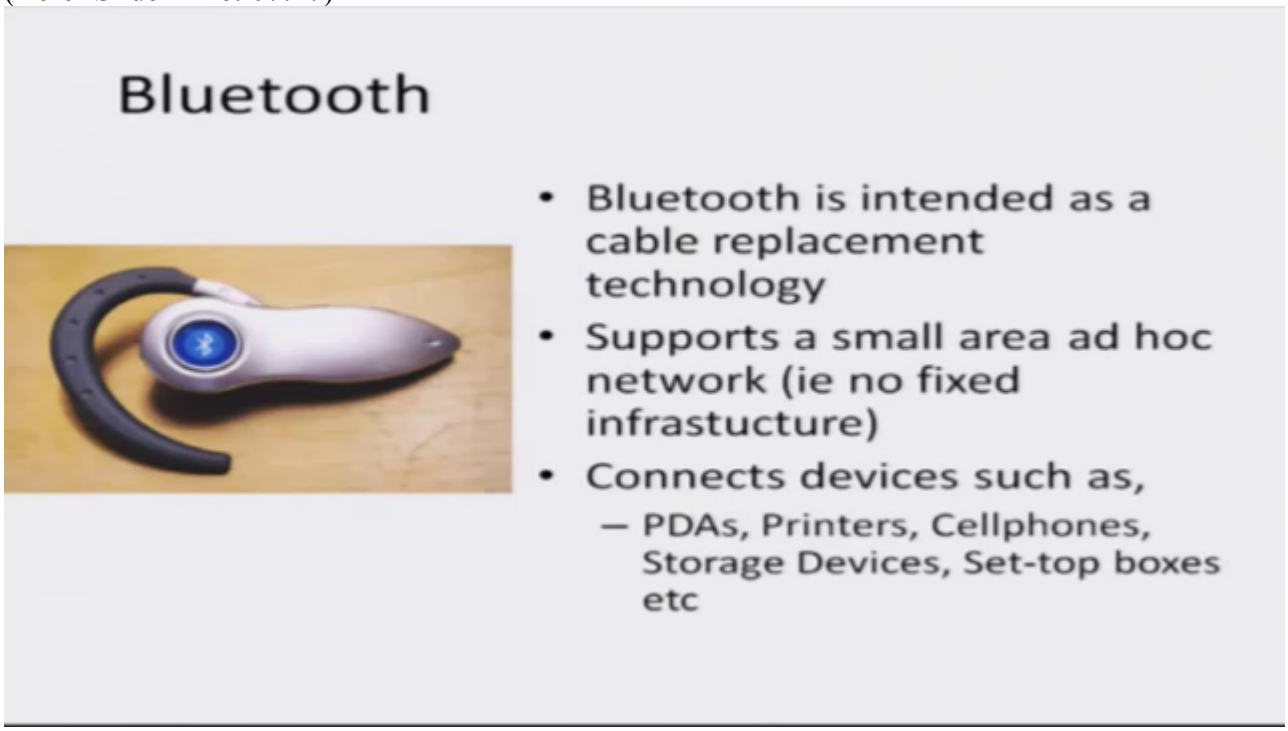

Bluetooth is primarily intended as a cable replacement technology that is for instance let's say you have a headset or a pair of headphones and you want to connect it to your smartphone or laptop instead of having a cable and instead of having a large -- these large number of devices, having a large number of cables one can conveniently use Bluetooth to connect in this low range these small devices rather than using cables, one can use Bluetooth and connect a variety of devices such as PDS, printers, cell phones, storage devices, set-top boxes et cetera.

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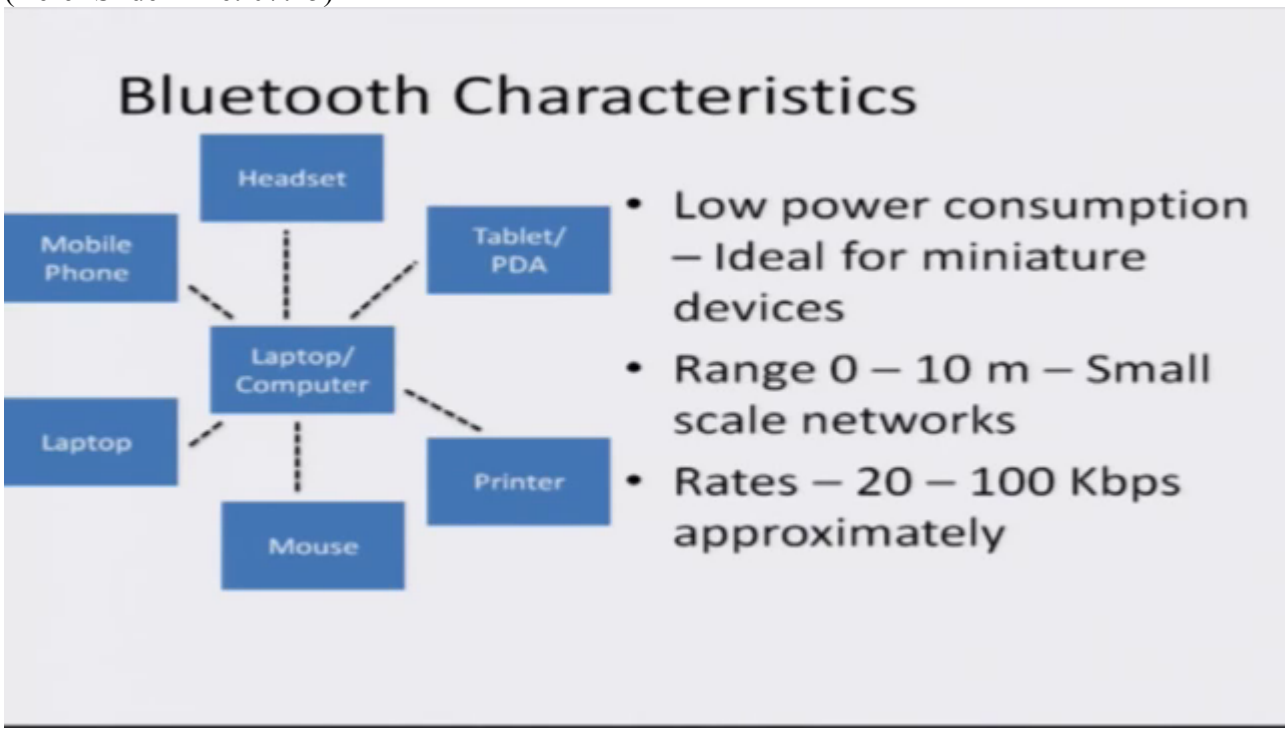

for instance here you have a typical Bluetooth ecosystem which has a laptop, along with the tablet, PDA, a printer, a mouse, another laptop, mobile phone, a headset and various such devices and the range of Bluetooth is typically small, it's about 0 to 10 meters much smaller of course even then Wi-Fi and rates are also around 2o to 100 kilobits per second which is suitable for connecting headsets, connecting printers et cetera.
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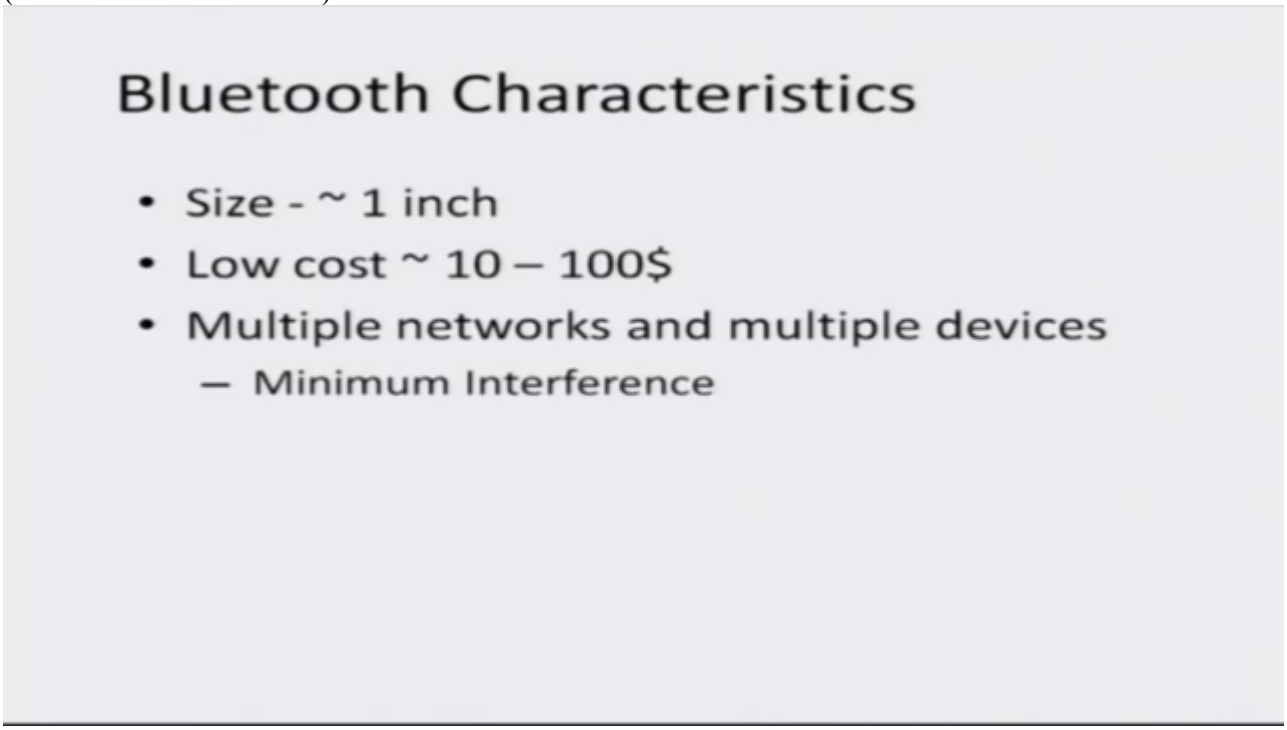

And typical Bluetooth devices cost supposed to be inexpensive at about $10 to $100 and also the transmit power is supposed to be low so that they cause minimum interference to other Bluetooth devices making a large number of making it possible to support a large number of Bluetooth devices in a given area.
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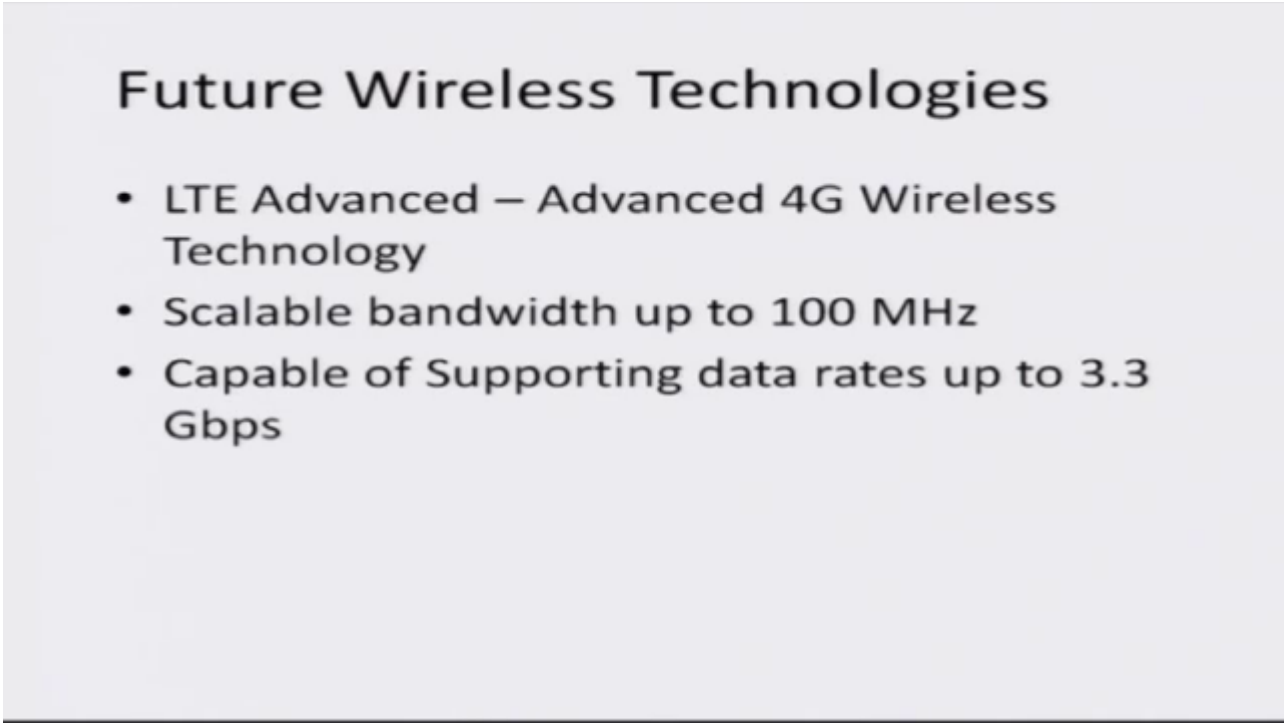

There are other future wireless technologies such as LTE Advanced which is an advanced version of LTE which is support -- supposed to support bandwidth of several, about 100 megahertz and support data rates of up to a gigabit per second if not more.

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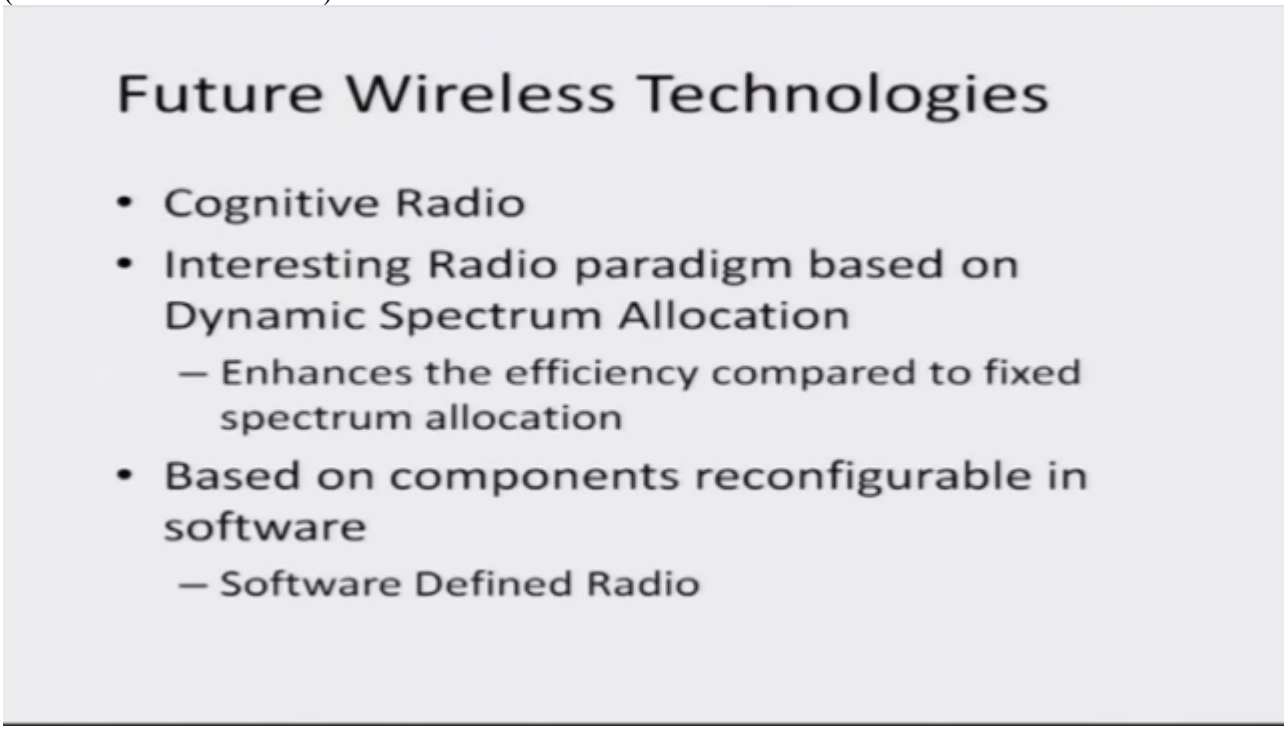

And another interesting future wireless technology is Cognitive Radio which is very interesting within and is based on what is known as dynamic spectrum allocation. Currently most devices wireless communications are based on static spectrum allocation that is a certain portion of the spectrum is allocated to the device for a fixed amount of duration rather than make that spectrum allocation static this spectrum can be dynamically allocated or shared by several users or secondary users and that is the foundation for the Cognitive Radio

Paradigm and this is a very promising wireless paradigm which is expected to be developed and implemented in the near future.

And it's based on a key aspect, technology aspect known as Software Defined Radio which is basically based on the large number of different radio technologies which can be implemented in rather cheap software and can be deployed at relatively conveniently or various such radio technologies can be deployed in quick succession relatively conveniently over the same device thus making it possible to dynamically allocate different spectral regions to different devices. So these are the -- so this module has exposed. This module basically looks as some of the other wireless technologies such as WLAN, Bluetooth and also some of the interesting upcoming wireless technologies. So that concludes the wireless communication module in this book. Thank you. Thank you very much.