Mobile Wireless Communication

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Hello. Welcome to another module on wireless communications in this massive open online course. And so in the last module we looked at some of the basic aspects, the introductory aspects of wireless communication systems, basically an introduction to the terminology of various standards and also some of the aspects salient aspects of the physics of the wireless communication system.

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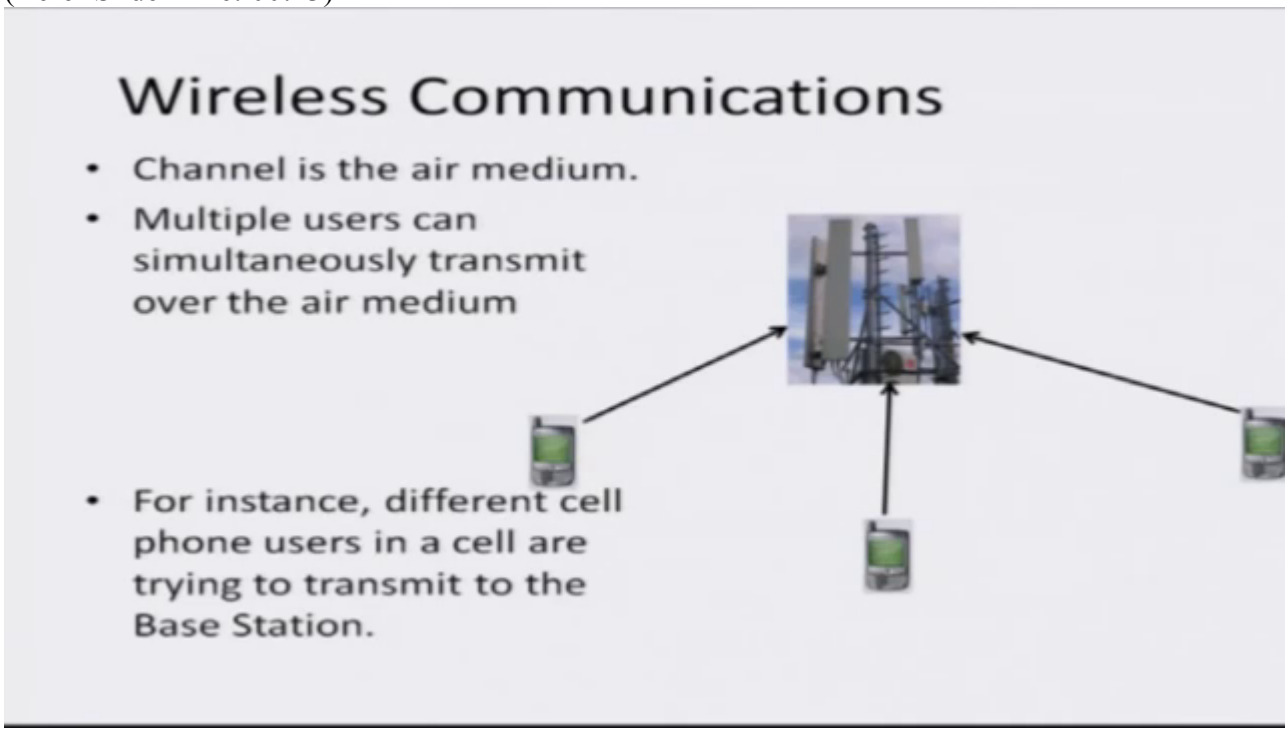

What we are going to do now is start looking at progressively the evolution of wireless communication system through the various generations. And one of the key aspects of a wireless communication system as you can see is there are several users or several devices that are trying to simultaneously access the wireless medium as you know the wireless medium is the radio propagation medium which is common for all the users to access the base station. And naturally when these different users are trying to access the base station or trying to connect to the base station from your handset or your whatever your wireless devices simultaneously you need some protocol or you need some sort of discipline by which these different users can access the base stations because if all the users transmit simultaneously then their signals are going to end up interfering at the base stations. So the channel is the air medium or the radio propagation medium and these multiple users would like to simultaneously transmit over the medium. And for instance different cell phone users are trying to transmit simultaneously to a base station or different laptops or trying to simultaneously access a wireless access point, right?

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And therefore how do you decide who gets priority or who accesses this channel at a certain given point. And the answer through which you can enable these multiple people or these multiple devices to use this common medium is known as a multiple access technology, the name itself means that these different users can access the medium with following some rules or some protocols and that is determined by that particular multiple access technology.

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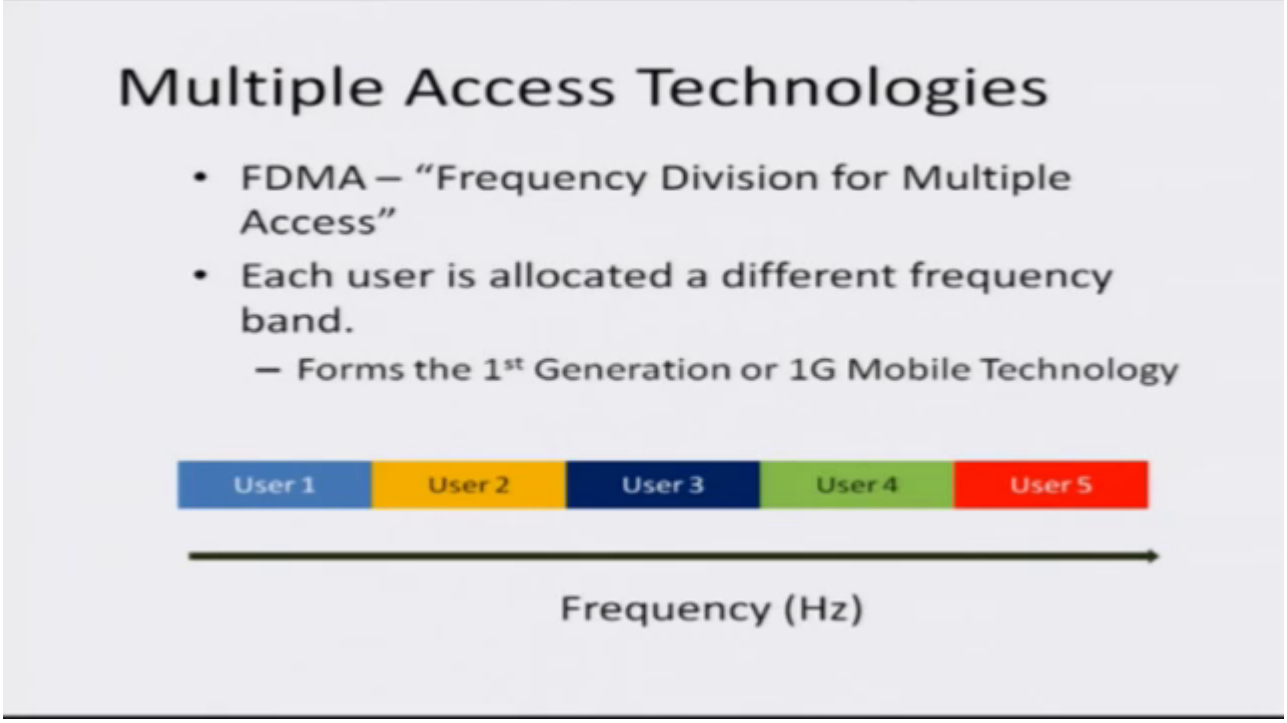

For instance one of the earliest multiple access technologies and also one of the simplest is what is known as FDMA or frequency division for multiple access in which each user is allocated a different frequency band. So User 1 is allocated in this picture you can see User 1 is allocated a certain portion of the frequencies, User 2 is allocated a certain set of

frequencies and so on. And all these users then use their appropriate frequency band for transmission thus not interfering with each other and this forms the first generation, now this is known as 1G Mobile Technology which was there in the early 80s.
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Some of you might remember seeing this bulky cellphones that are shown in this picture which correspond to the – which basically belong to the first generation Wireless technology.
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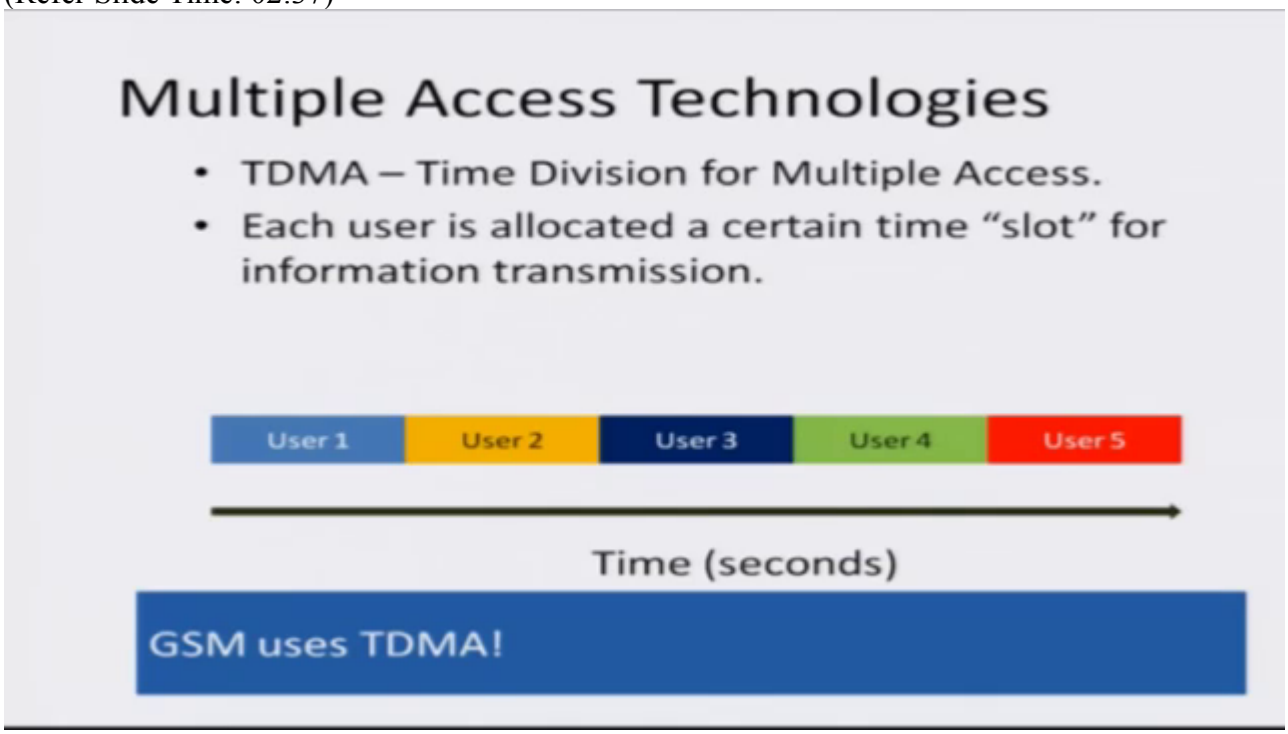

And GSM and the dominant standards, other dominant standards of its or belong to what is known as TDMA or the second generation of wireless communication technologies which are based on TDMA or Time Division for Multiple Access in which there are no different

frequencies or the users are on the same frequency band but they have different time slots that is each user is allocated a different portion of the time during which you can transmit thus all the other users are silent during this particular time slot and therefore this avoids interference between these different users, for instance, as I already said GSM is an example of a TDMA a technology.

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And I just want to give you a brief introduction to GSM, the rest of this module we'll talk about various aspects of GSM. GSM is one of the most dominant mobile communication standards. It stands for the Global System for Mobile Communication and it's an ETSI a European Telecommunications Standards Institute approved initiative. The original intention of it was to develop a second generation wireless communication system for Europe basically to unite all the fragmented or the various fragmented standards across different countries. This standard or the group to monitor this standard was initially formed in 1982 by allocating the bands -- certain bands in a certain frequency range.

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And the main idea as I've already pointed out was to develop a second generation, a unified standard that can be followed across countries that will help develop devices that can uniform form or follow a uniform set of rules or a uniform set of protocols to communicate over the wireless channel.

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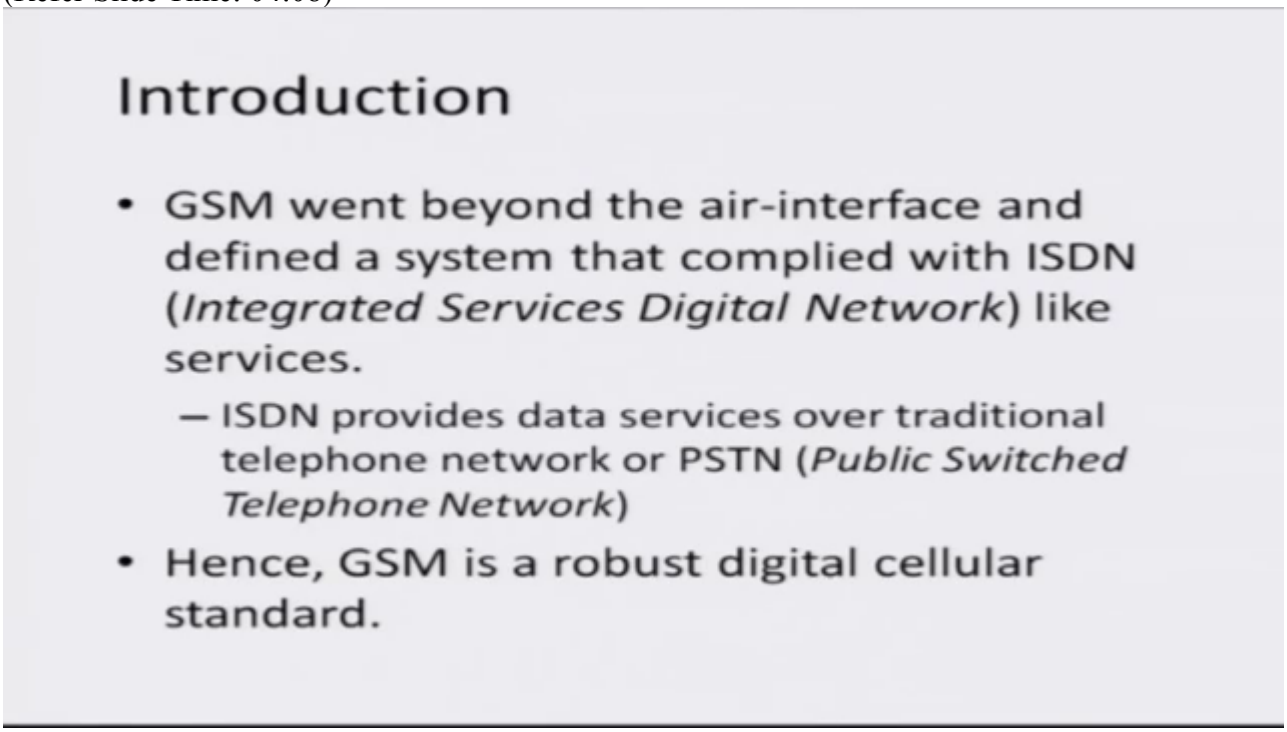

And in fact GSM was meant beyond was a much more advanced standard in the sense that it was not meant not only for voice calls that is to enable the conventional telephone calls between person to person, but also avail a variety of services such as basic news services, message services, etcetera over the telephone network. So GSM in that sense is was – and we say it has a robust digital cellular standard.

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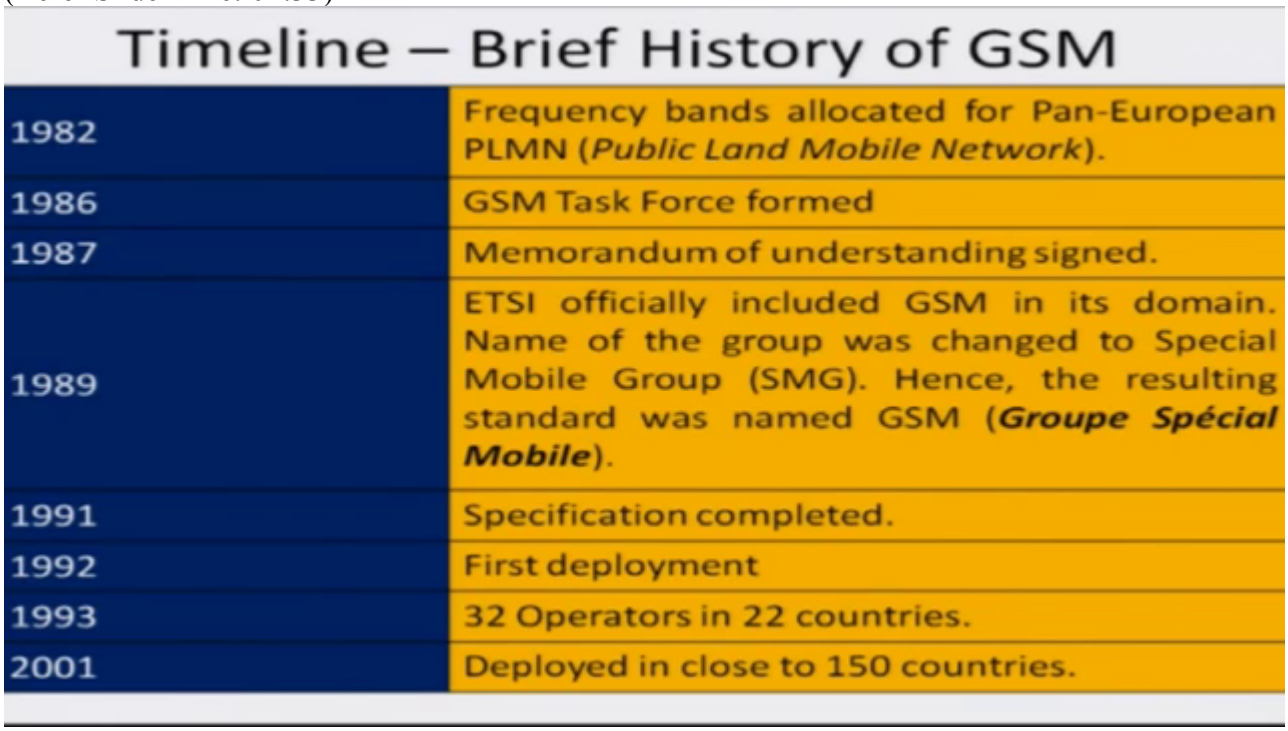

And this is a brief history of the timeline of GSM, the standard, the group was formed in 1982. The task force was formed in about 1986 and various developments took place through the 1980s and it was complete -- the specification was completed in 1991 that initial deployments were in the early 90s that is 1992-93 and by 2001 it was overwhelmingly popular and with deployment in close to about 150 countries across the globe.

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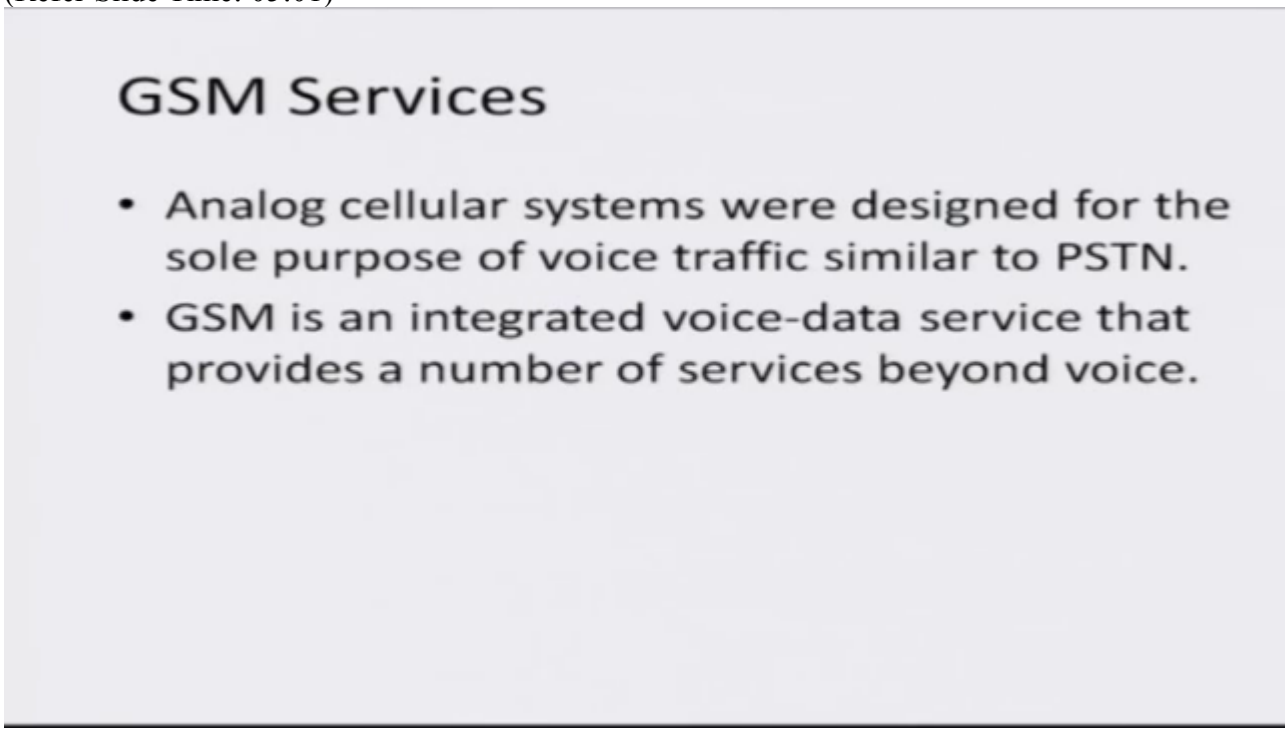

And the GSM is as I've already pointed out is not just meant for voice but also meant for an integrated voice data service that is provide number of services that go beyond simple voice calling from telephone to telephone.

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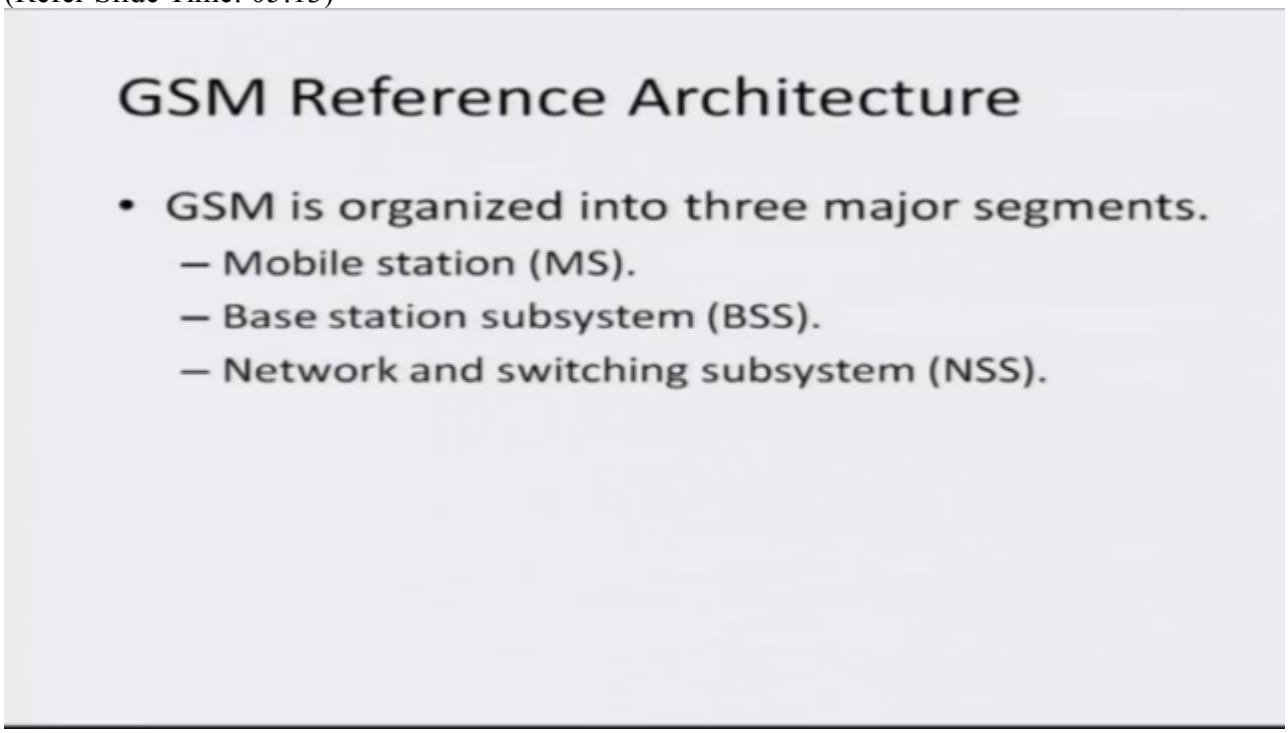

And to give you a basic introduction to the organization of the GSM reference architecture which divided into three major components. One is what most of you're familiar with which is the mobile phone or the mobile station which the user acquires. The other is the base station through which the user connects to communicate with the rest of the network. And then there's the heart of the network which is basically known as the network and switching subsystems.

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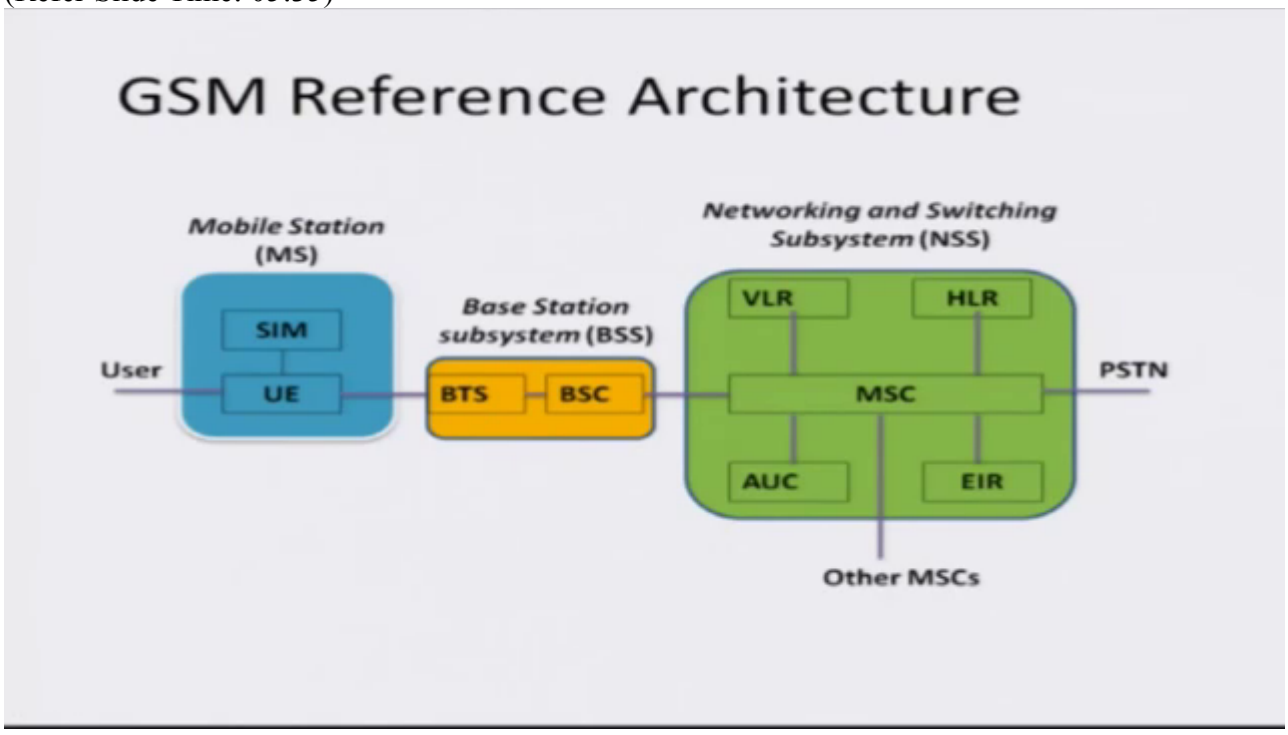

And let's look briefly at the features or the principles, working principles of each of these components. As I've already pointed out we have the mobile station, the base station subsystem and the network and switching subsystem.
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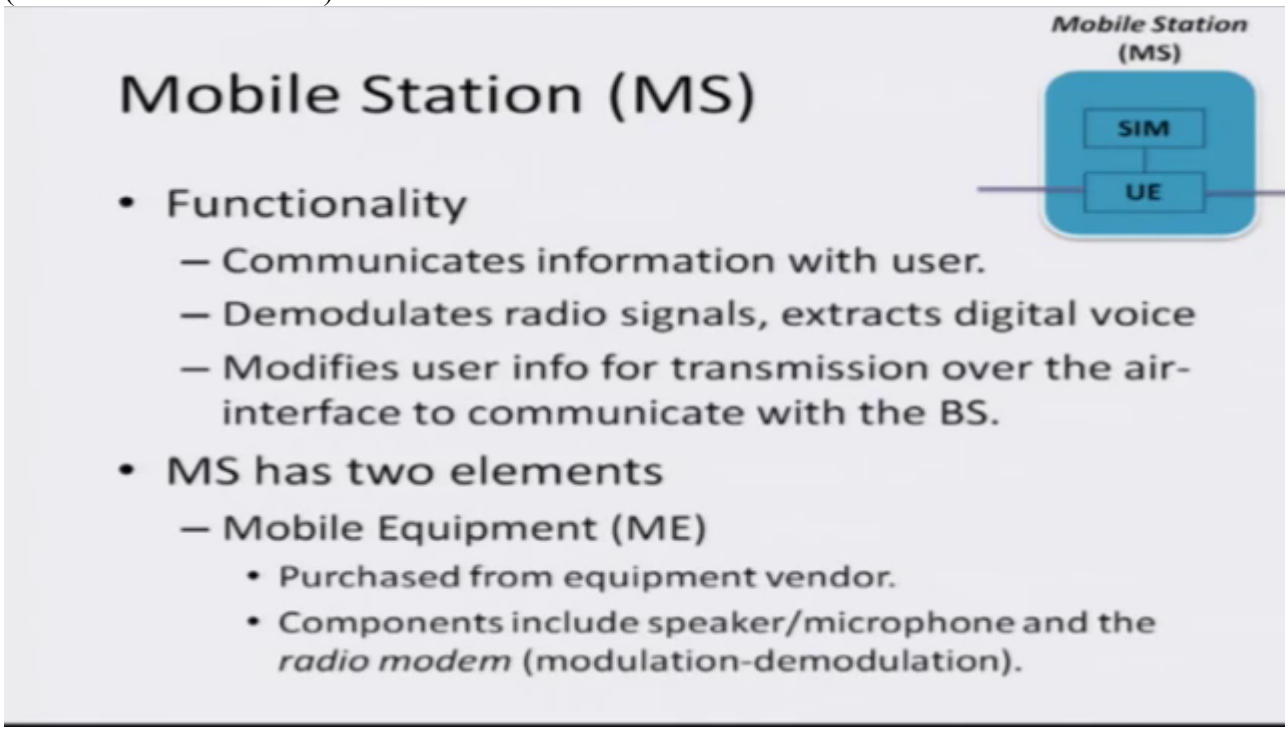

The mobile station is basically your mobile phone that consists of two components; it's one is your mobile device which basically receives the signal, demodulates the signal, converts the physical signals into the voice signals, takes the bits and converts them into a voice signal that you hear over the phone. And this mobile equipment is purchased from an equipment vendor, it typically includes the speaker, microphone and also the radio modem which is key to receiving the radio signals and converting them and doing the processing that is required on these radio signals.
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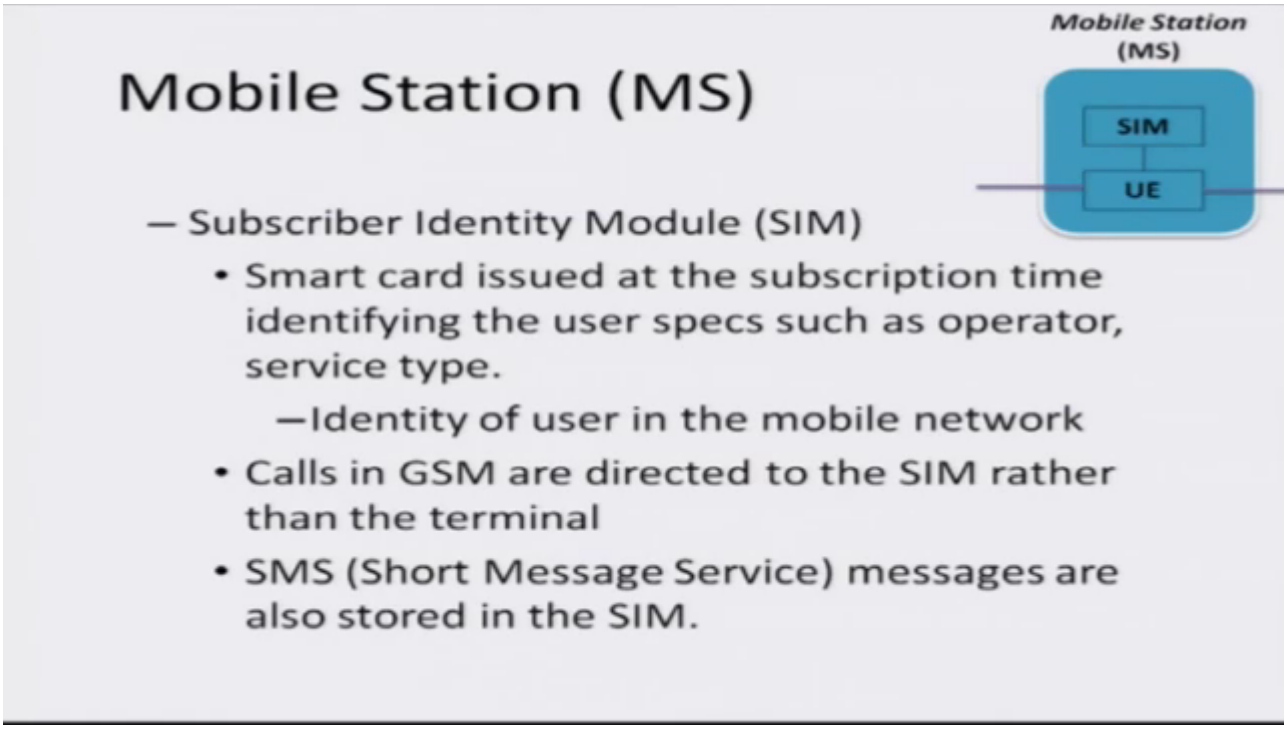

Other important aspect of the mobile phone as most of you already know is what is known as the SIM or also it is an acronym for the subscriber identity module. And this is a smart card which is issued at the time of subscription to a service by a particular operator and this serves as your identity, the SIM serves as the identity in the network, right? And the calls in GSM are directed to a SIM. And for instance your short message service feature all the short messages are stored et cetera, are stored on the SIM.

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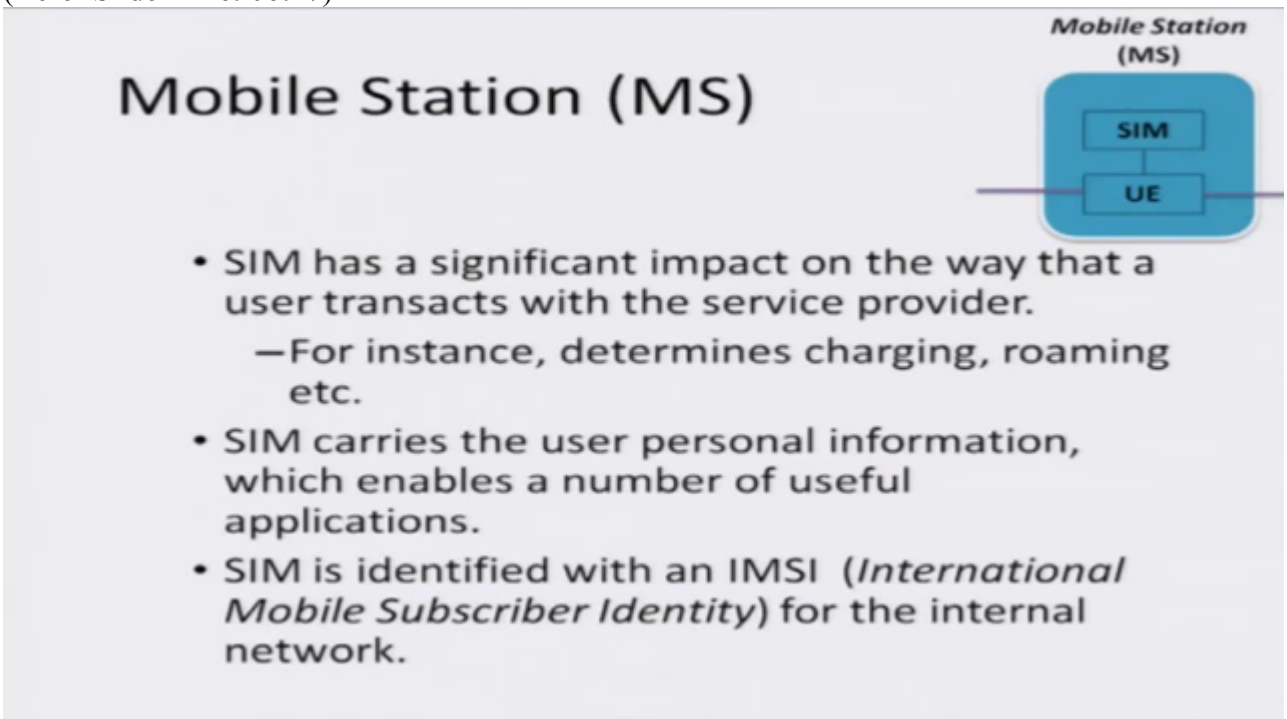

And the SIM has a significant impact. For instance, it determines how much you're charged for your calls, the roaming aspects of your phone, and also stores your personal information, your subscription information and also a number of useful applications. And the SIM is of

identified with what is known as an IMSI that is an International Mobile Subscriber Identity. This is your identity on the network. So the SIM is identified by this IMSI number which is basically your identity or carries your subscription information on this network.
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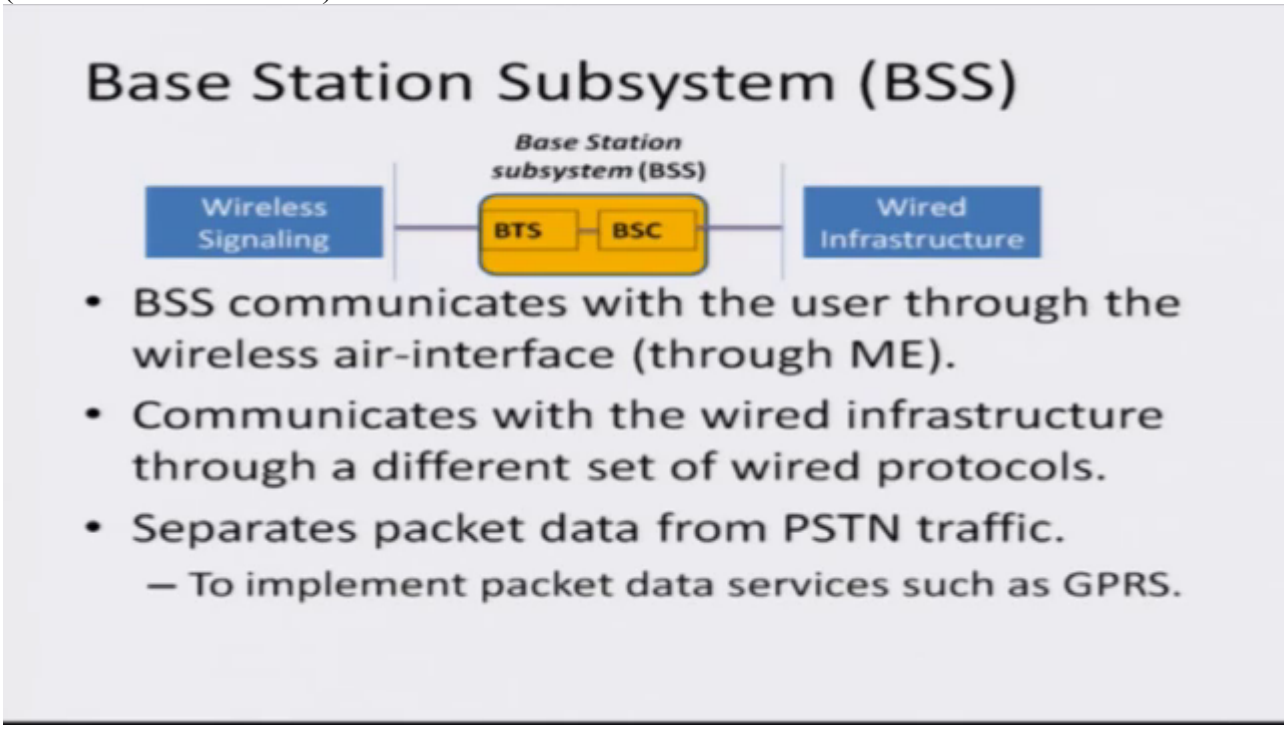

And the other component in mobile network is of course the base station through which is at the other end of the wireless channel that is the device connects to the base station, so the base station receives the signals from the mobile station and transmits the signals and on the other end the base station connects with other base stations and also it connects with the wired infrastructure such as the telephone network and so on and separate and has various features. The main feature is to basically receive the signals from the mobile station and transmit it through other base stations or transmitted to the other parts of the network. So this basically comprises the first component of the tethered or the static component of the mobile wireless network which is responsible for receiving the signals and transmitting it, converting it and appropriately transmitting it to other parts of the network.
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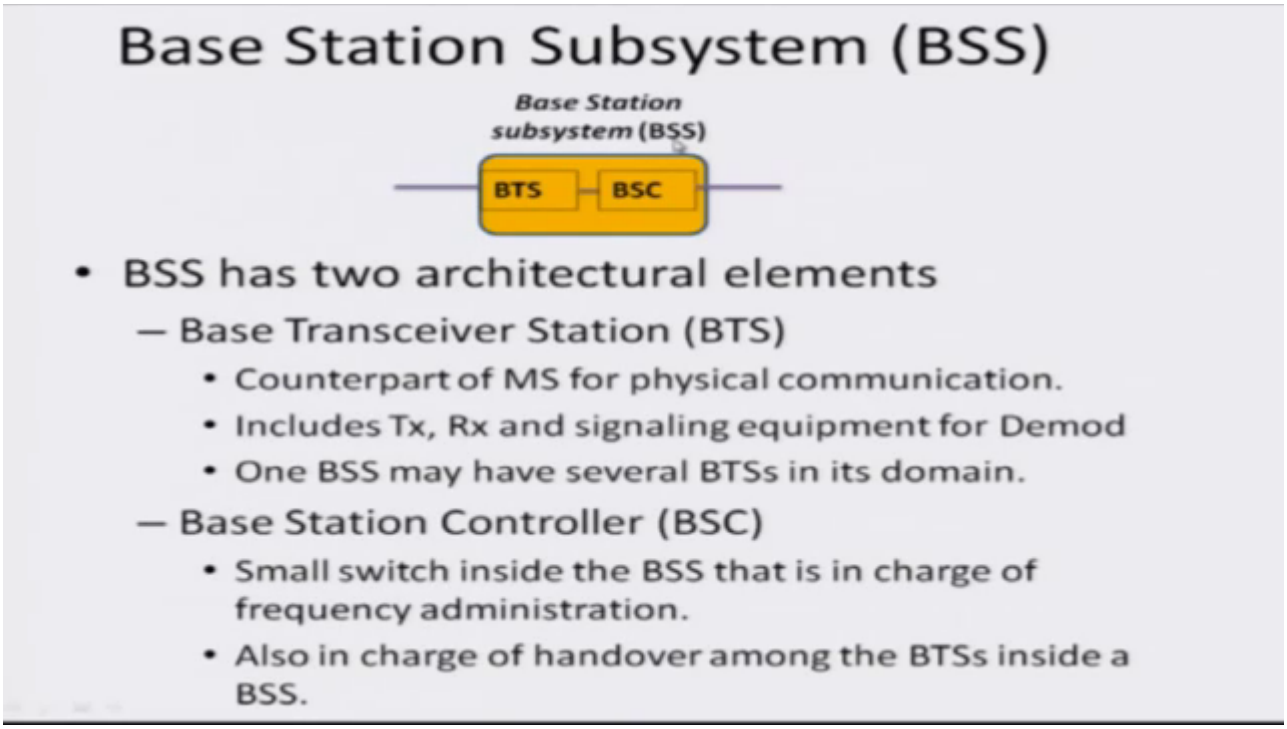

It consists of two components; one is the BTS the Base Station – the actually base station, and also a Base Station Controller which either controls a single base station or a group of base stations, domain use of a base station controller it is it manages the various resources amongst the various base stations such as the different frequencies that are allocated to these different base stations or for instance the handover, the way the call is handed over from one base station to the other base station and so on.

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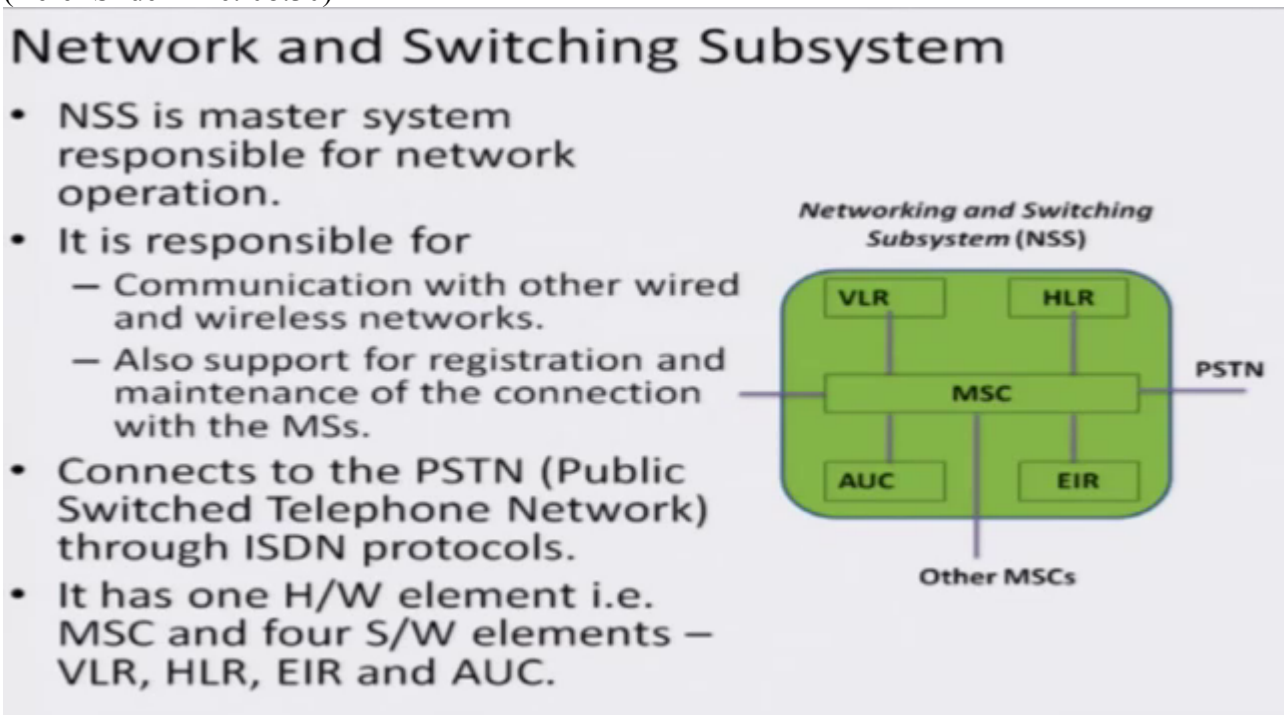

And the heart of the mobile network is the network and the switching subsystem which is responsible for a variety of operations and it's responsible for communication with other networks, other operators, it's responsible for registering, validating, authenticating a

particular user, registering the whereabouts of a particular user, registering if a user is roaming in another cell etcetera and basically connecting to other networks such as the Internet or the Landline Network and so on, okay.
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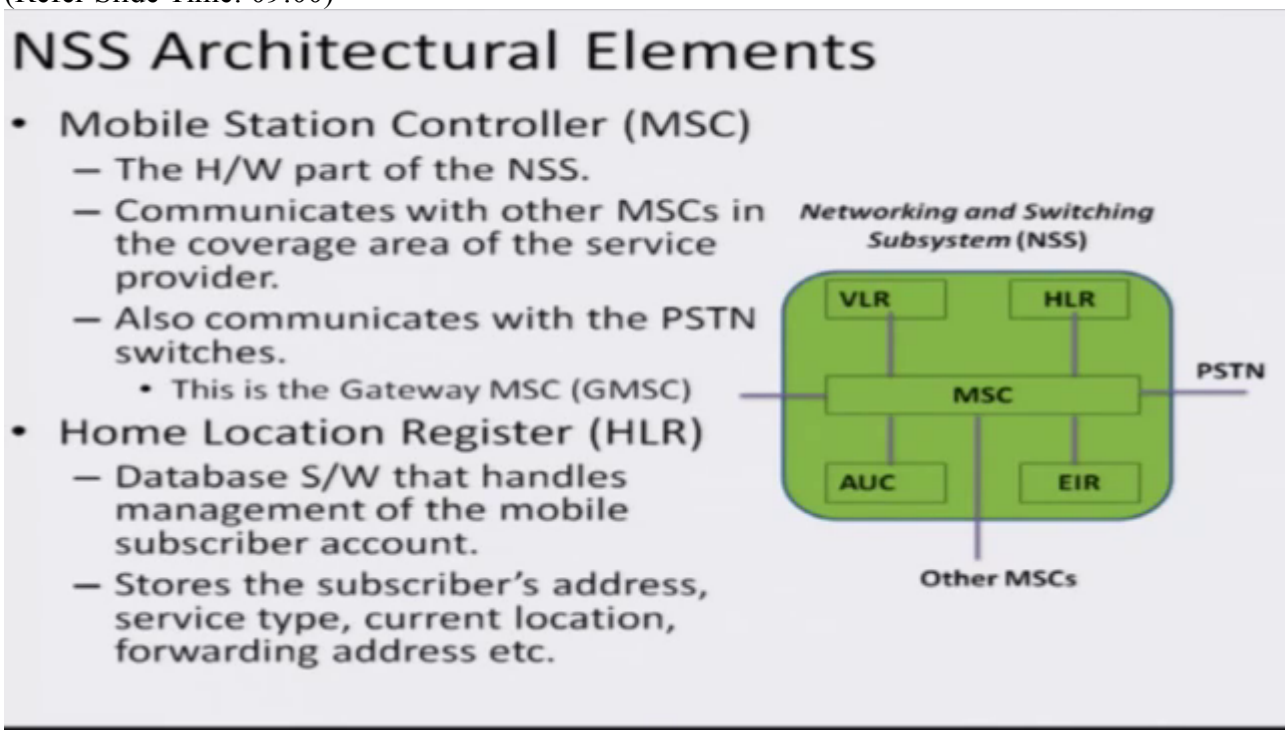

And it has various companies, the mobile station controller which controls the MSC, which controls all the different modules in this network switching subsystem. There's a home location register which is a software database that basically stores information that is related to the subscriber account, stores the subscribers address, the type of service the current location, the forwarding address if the user is not in his home cell but it's in a different cell or he's roaming in a different cell it stores information about the cell he's roaming in et cetera so that calls can be appropriately forwarded to the appropriate cell.
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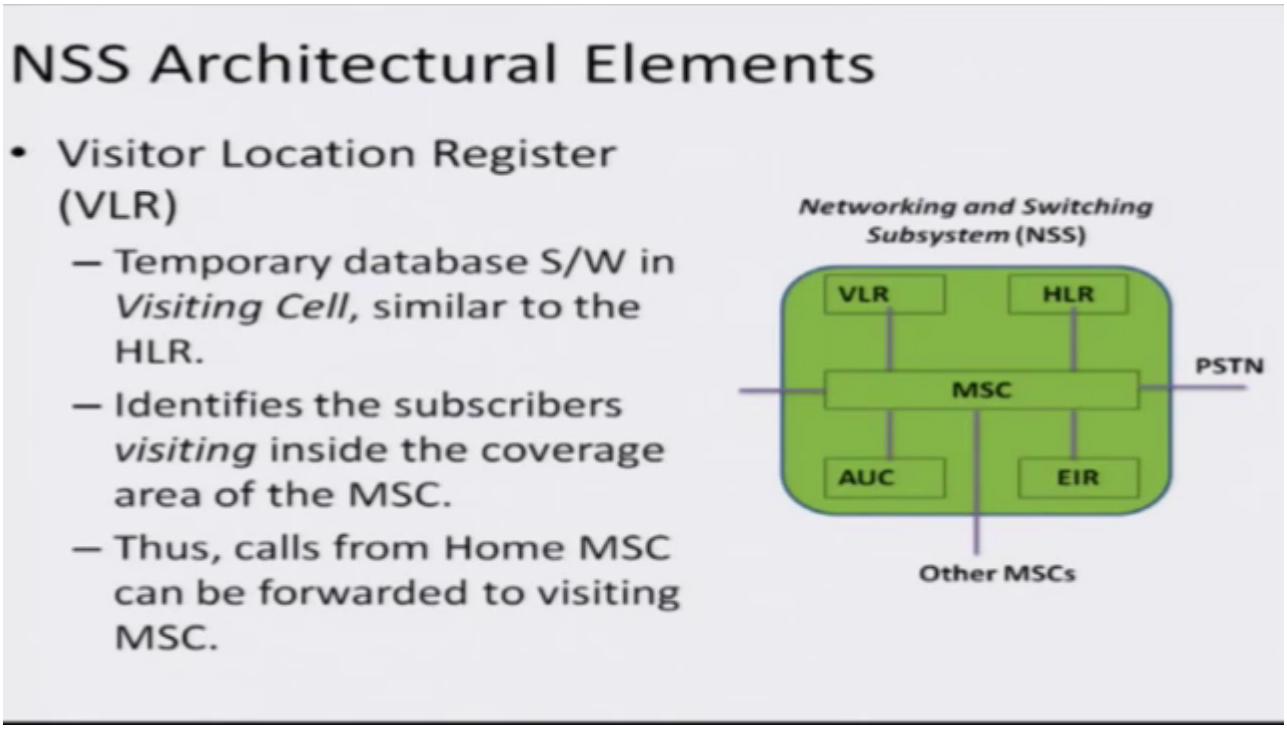

There is a visitor location register which shows if information of the subscriber or the user if it's not in his home cell but it's roaming in a different cell so that the calls can be appropriately routed to the user in the cell he's visiting in or when he is away from his home cell.

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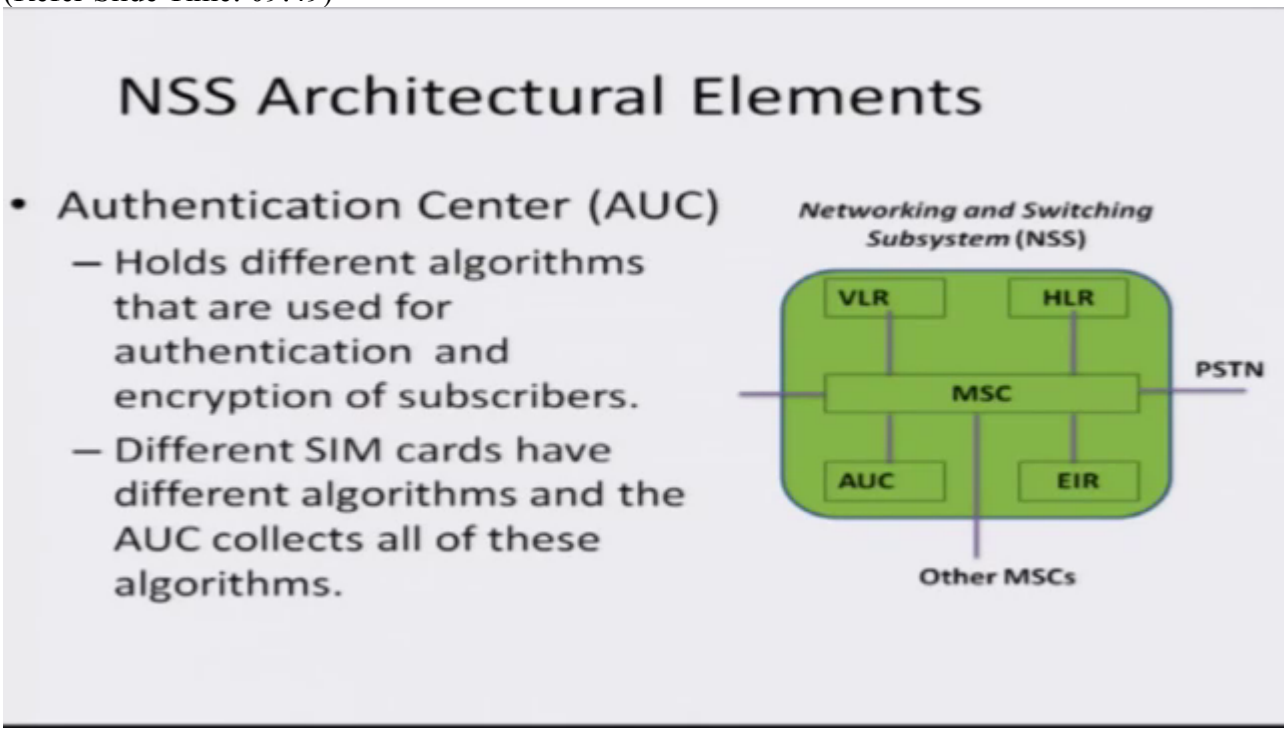

And then there is also an authentication center which holds all the key algorithms because the information that you transmit over the air has to be secured so that it cannot be eavesdrop by other devices and other malicious users. So there is a bunch of encryption and authentication algorithms that are associated with each service. These are comprehensively stored in the

authentication center. And these are several algorithms which are different for different SIM cards and all these comprehensively stored in the AUC or the Authentication Center module.
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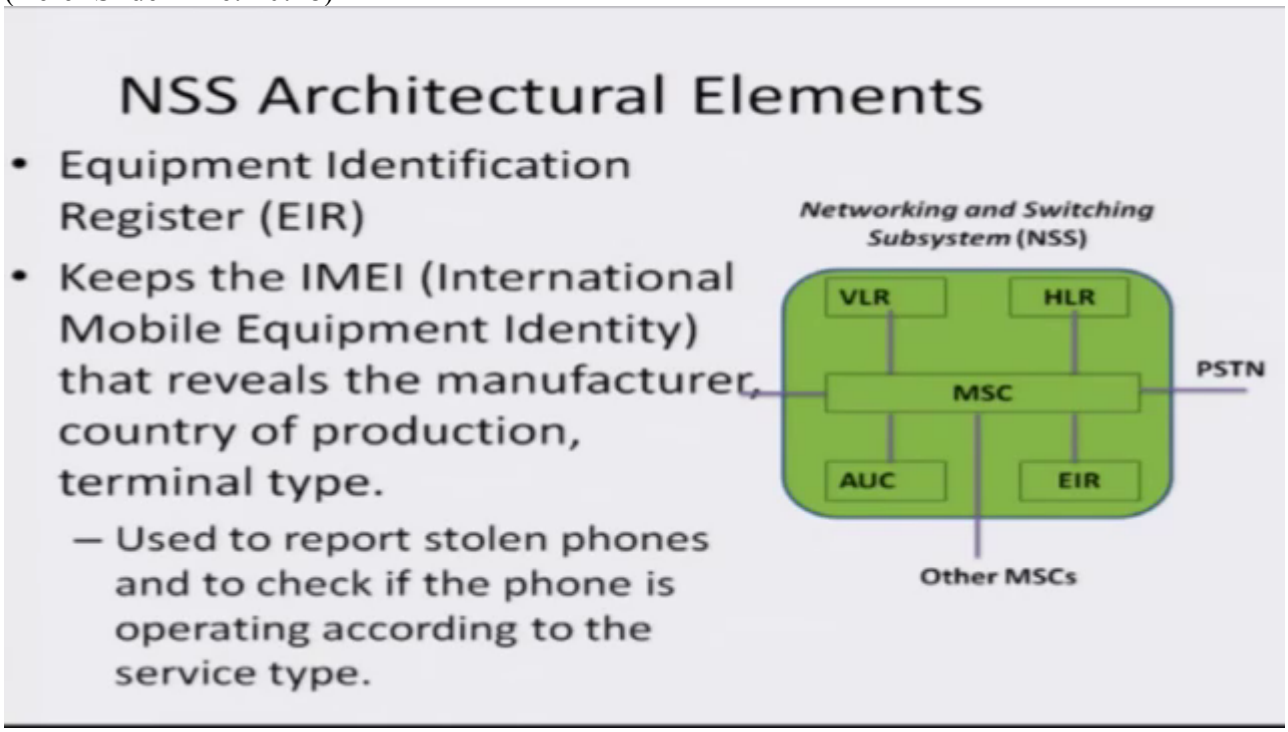

And the last one is the EIR which is the equipment identification register. Its stores the IMEI or the International Mobile Equipment Identity for a particular device that carries information about the type of the device, the type of services that are supported by the device and also in case the device is stolen that can be appropriately reported and flagged in the Equipment Identification Register.
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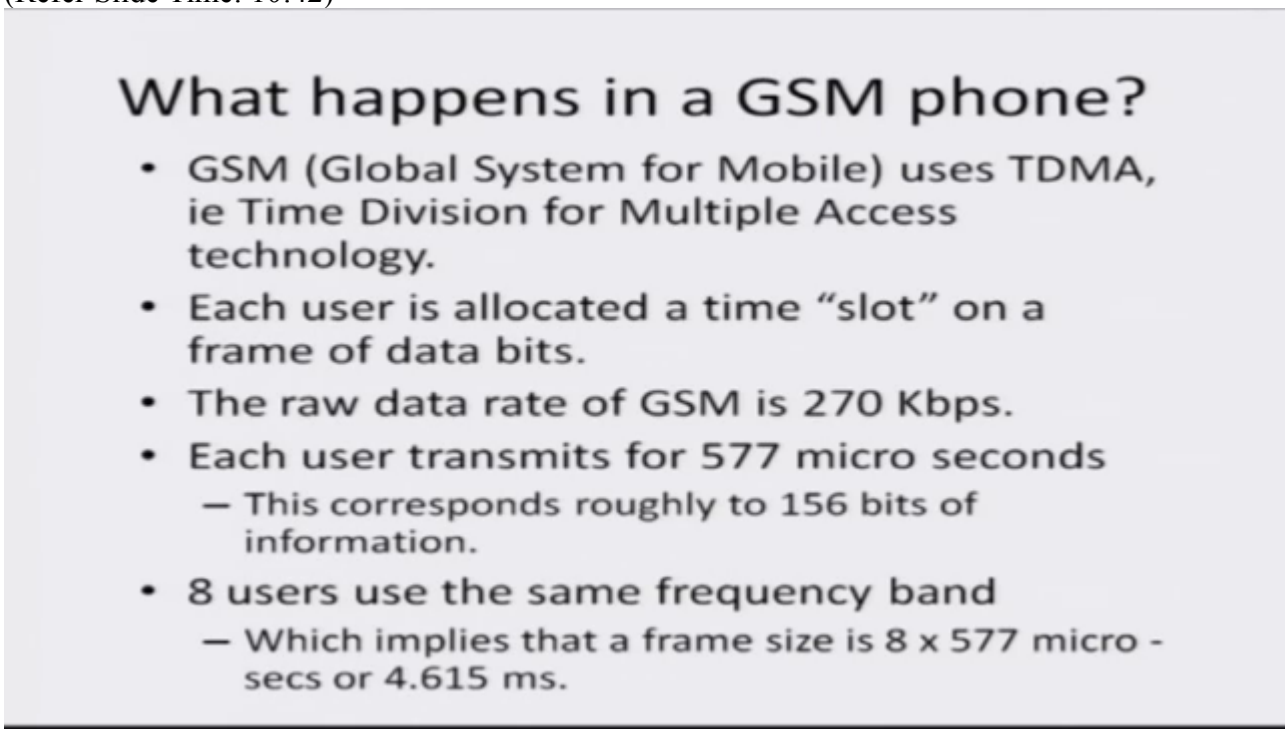

And the basic operation of GSM is that GSM is a system which has a data rate about 270 kilobits per second that is aggregate and each user transmits as I said in a TDMA fashion that is in this particular time slot. Each time slot is a burst that is spread at around 577 microseconds and transmits about 156 bits of information.
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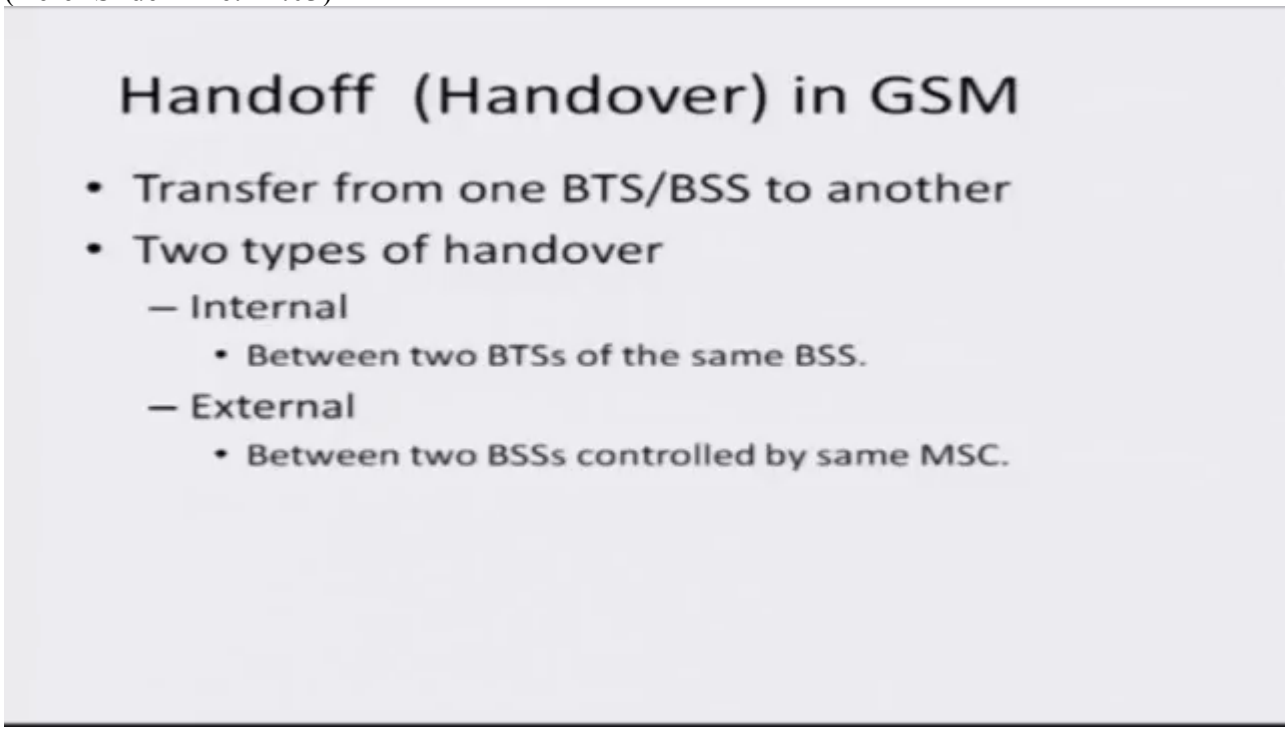

And other aspect of GSM is the handover and the handover is an important aspect of mobile communications which makes mobile communications possible. The hand over means that when you're travelling across cells and when you when your call has to be handed over from one base station to the other this process is known as a handover. This is typically done for a variety of reasons. As you're travelling across cells, as your signal from one base station fades because of the distance or decreases in power because of it decreases in strength, because of the distance and you move closer to another base station then your call has to be handed over to the base station to which you're closer to and this process, this is one of the aspects of handover.

The other aspect is if you are in the boundary roughly at the boundary of two cells and one of the ells is very highly loaded while the other cell is lightly loaded then some of the calls from one cell might be shifted to the other cell to balance the loads across these different cells that is known as load balancing in the mobile wireless network.
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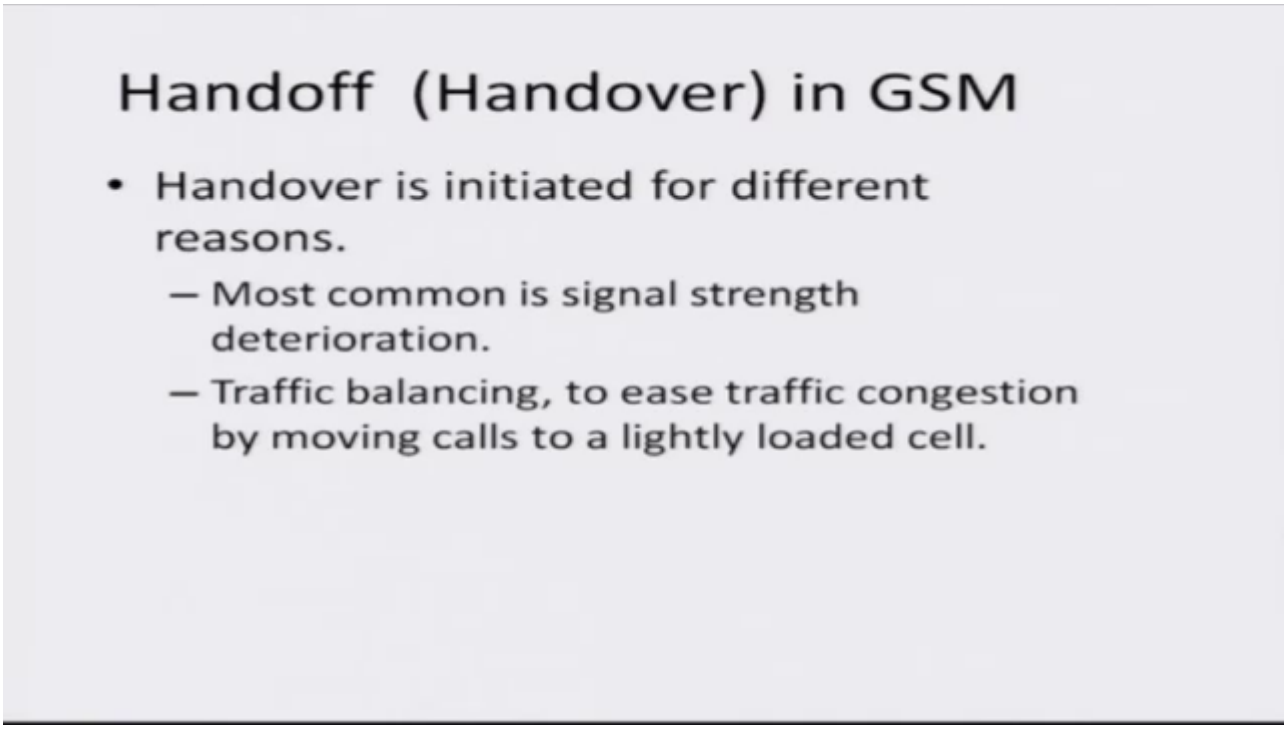

So handover is one of the most important aspects of GSM and in fact any mobile network. And the most common fashion to do handover is to measure the signal strength from various base stations and once the signal strength and from one base station dips below a certain threshold and the signal strength from another base station is above a certain threshold the call is switched from one of the base stations to the other by mechanism which is controlled or supervised by the base station controller. So these are the various fundamental mechanisms which make GSM which basically characterize GSM and not only GSM but at a certain level which are key for any mobile wireless communication system or mobile wireless cellular system. So this module is intended to give you a brief overview of the different aspects and different facets of GSM which is the 2G standard and stands for the global system for mobile communication. Thank you.