

Mobile Wireless Communications-Introduction

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Hello. Welcome to this module on wireless communications. I am professor Aditya Jagannatham from the electrical engineering department at the Indian Institute of Technology at Kanpur. So what we are going to do is we are going to look at some of the basic aspects of wireless communication. Some of the recent developments and wireless communication. The legacy and history and what is the current state of wireless communications and the latest wireless communication technologies.

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2G Wireless Systems			
<i>Genera tion</i>	<i>Standard</i>	<i>Rate</i>	<i>Services</i>
2G	GSM (<i>Global System for Mobile Communications</i>)	10 Kbps	Voice calls
2G	CDMA (<i>Code Division for Multiple Access</i>)	10 Kbps	Voice calls
2.5G	GPRS (<i>General Packet Radio Service</i>)	50 Kbps	Internet/e-mail access
2.5G	EDGE (<i>Enhanced Data Rates for GSM Evolution</i>)	200 Kbps	Internet/e-mail access

To start with let's just have a brief overview of the various generations of wireless communication standards right and some of you might be familiar with this already to some extent so the basic wireless communications the modern revolution in cellular communications as we know began with the 2G or the second generation of cellular communications and notably the most prominent standard of 2G or the second generation is GSM which is the global system for mobile communication and another standard for 2G is also a CDMA. These are some acronyms you might have already heard. CDMA which stands for code division for multiple access and both these 2G standards support about 10 kilobits of rate which is enough for basic voice that is to make your voice a telephone call. So these support voice calls and of course as you all probably must already be familiar the higher the data rate I mean the larger the data rate the richer the services that you can support on any given standard or in a wireless communication system. For instance the later generations that is what are known as 2.5G or the 2.5 generation GPRS that is general packet radio service and edge which is the enhanced data rates for GSM evolution and these support about 50 kilobits per second to 200 kilobits per second and they allow not only voice calls but access to Internet, email and other features.

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3G Wireless Systems

<i>Generation</i>	<i>Standard</i>	<i>Rate</i>	<i>Services</i>
3G	WCDMA (Wideband CDMA)/UMTS (Universal Mobile Telecommunication System)	384 Kbps	Video Telephony, video streaming
3G	CDMA 2000	384 Kbps	Video Telephony, video streaming
3.5G	HSDPA (High Speed Downlink Packet Access)/HSUPA (High Speed Uplink Packet Access)	5-30 Mbps	Online Gaming, HD Streaming

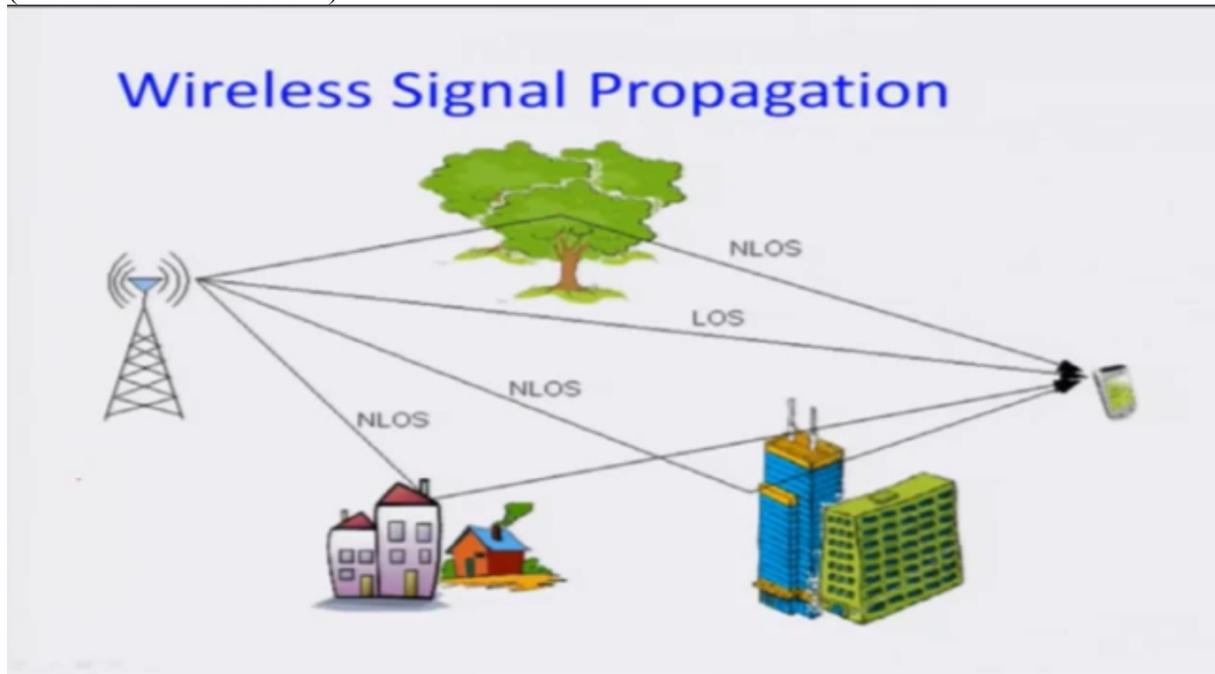
And this was followed by the 3G revolution that is 3G wireless communication systems and there are two competing standards again. One is the W CDMA which is the wideband CDMA also known as UMTS or the universal mobile telecommunication system which have data rates around 300 to 400 kilobits per second as you can see that is a massive increase compared to the previous standards and CDMA 2000 which has again a similar data rate about 400 kilobits per second and both these support along with voice calling they support video calling that is when you transfer along with your voice when you transmit a video to the other end and 3.5G further improves the data rate this is known as HSDPA high-speed downlink packet access and HSUPA high-speed uplink packet access which support data rates up to 30 megabit per second and they allow a richer set of services such as online gaming, high-definition video, video streaming, streaming on-demand etcetera. (Refer Slide Time: 02:38)

4G Wireless Systems

<i>Generation</i>	<i>Standard</i>	<i>Rate</i>	<i>Services</i>
4G	LTE (Long Term Evolution)	100-200 Mbps	Mobile TV, Multiplayer Gaming
4G	WiMAX (Worldwide Interoperability for Microwave Access)	100 Mbps	Mobile TV, Multiplayer Gaming

And the latest wireless standards are known as 4G or the fourth generation. They are the most prominent one is LTE which is long term evolution a huge data rate of around 100 to 200 megabits per second supports mobile TV, high-definition TV, multiplayer gaming, fast gaming and also 4G. Another 4G standard is WiMAX which stands for worldwide interoperability for microwave access again has a data rate around 100 megabits per second supports mobile TV and multiplayer again. So this is a brief overview and we are going to look at some more some of facets and some of the salient aspects of these standards as we go along.

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So just to give you an idea of the basics of wireless communication that the physics of wireless communications because it's important although you don't need to know about this in great detail it's important to keep this at the back of your mind to have a better perspective of wireless communication as you know a wireless communication is fundamentally defined by the channel. The moment we say a wireless communication system is defined by the wireless channel. The channel where there is no wire between the transmitter and receiver and as you can see in this picture over here that means there is no fixed path for which the signal propagates from the transmitter to the receiver but the signal propagate in fact propagates by a multiple paths to reach the receiver to reach yourself cell phone. There's a direct path. There's a signal which comes to the reflection from trees, neighborhood, homes, buildings etc.

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Wireless Channel Fading

- The wireless signal can reach the receiver via direct and **multiple** scattered paths.
 - Multipath Propagation
 - As a result, the receiver sees the **superposition** of multiple copies of the transmitted signal.

And when these multi paths and this is known as multipath propagation because of this multipath propagation what you have is a superposition of these different signals at the receiver and from a basic knowledge of physics you know that when these different signals superpose at the receiver they interfere with each other. They can end up killing or attenuating each other.

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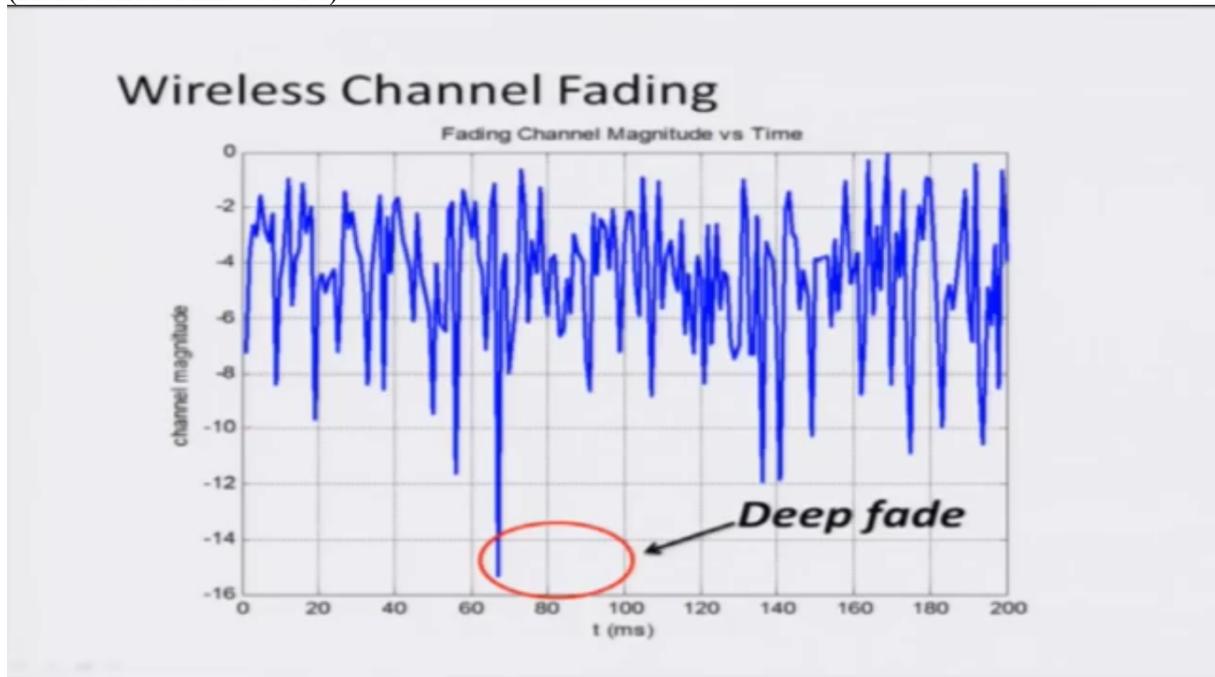
Wireless Channel Fading

- Results in **interference**, amplifying or attenuating the signal power seen at the Rx.
 - This phenomenon is termed as **fading**.

They can also end up constructively adding to each other. As a result what you see is you see a varying of the received signal strength. This process is known as fading and that's also the reason you have a varying number of bars on your mobile phone which shows at any point of time what is the signal strength that is received by your mobile Phone. Also the strength of the signal decreases as the distance of propagation increases that is the farther you're from the base station or an access point, the strength of the received signal is progressively decreases. So all these factors contribute to the challenges one faces in designing and implementing

wireless communication systems because the signal strength is no longer a fixed quantity and as the signal strength varies and importantly as signal strength decreases the performance decreases. So how do you keep up or how do you improve the services or how do you ensure reliability of and maintenance of services with this in this varying signal regime is one of the fundamental challenges in a wireless communication system which makes it a very challenging and an interesting aspect.

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And of course what this picture shows you is sort of the magnitude. The fading channel magnitude as a function of time and you can see there are at some instances it's you have a really good signal strength but some instances the signal strength dips far below the acceptable threshold and that is known as a Deep fade. All right so it's important to keep this sort of this important physical aspect of the wireless communication system in your mind as you think about these wireless communication systems. So we'll stop this basic module which gives you an overview of the wireless communication systems at this point and we'll take up a systematic a brief introduction or a systematic study of some of these other aspects in other modules. Thank you very much.