COMMUNICATION SYSTEMS

By Lecturer Ahmed Wael
Academic Year 2017 - 2018

COURSE DETAILS

▪ Course code	LOPE3202
▪ Course Name	Communications and Wave Propagation
▪ Course Instructor	Ahmed Wael
▪ Course Weights	4 Units
▪ Lecture Time	2 Hours per Week
▪ Prerequisites	Students who attends this module have to show high mathematics, engineering analysis and MatLab skills.

COURSE OUTLINES

- Outline #1: An introduction to the basic blocks of communication systems
- Outline #2: Building the ability to mathematically analyze signal through systems
- Outline #3: Building quantitive and analytical tools for designing of communication systems

COURSE DESCRIPTION

- Apply the fundamental analytical and mathematical methods of Fourier analysis in understanding the design issues and signal transformation in any communication system.
- Apply Fourier methods to methodize of signal modulation, applications and system limitations.
- Examine the variation of different modulation schemes and their use
- Examine the noise effects in analogue and some digital communication systems

COURSE OBJECTIVES

- Objective 1: Describe the basic building blocks of communication systems.
- Objective 2: Demonstrate an ability to apply mathematical analysis to analogue, time and frequency domain signals. This include the Fourier analysis, linear system description in time and frequency domain, the convolution theorem, baseband modulation and noise analysis.
- Objective 3: Random variables and random process

REFERENCES AND LEARNING SUPPORTS

- Text Books: Communication Systems Engineering by John G. Proakis and Masoud Salehi, 2nd Edition

  Communication Systems, Simon Haykins and Michael Mohar, 5th Edition
- Recommended Text Book: Communication Systems, Simon Haykins and Michael Mohar, 5th Edition
- Teaching and Learning: Attending Communications and Wave Propagation lectures are intended to help you understand the topics in this module. It is very important to know that all information in lecture notes will not be inclusive: YOU MUST NEED TO READ CHAPTERS IN RECOMMENDED TEXTBOOKS

GRADING AND SUCCESS REQUIREMENTS

- **Grading:**

10%	Assignment based on group
15%	Mid-Term Exam
15%	Second Term Exam
60%	Final Year Exam

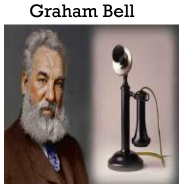
- **Success Requirement:** Students are expected to get an accumulated minimum grade of 50% to pass this module during the academic year.

TIME-LINE OF COMMUNICATIONS TECHNOLOGY

1838 - The Invention of Telegraph by Samuel Morse

1849 - Telephone had come out by Antonio Meucci

1876 - The first long distance transmission of telephone call by Alexander Graham Bell



1897 – The 1st use of radio in communications by G. Marconi

1925 – Transmitting the 1st TV signal by John L. Baird

1934 – 5000 AM mobile phones in USA

1970s – Cellular Concept born

1980 – 1G Cellular mobile system (AMPS, TACS…)

1990 – 2G cellular system (GSM, IS – 95)

2000 – 2.5G systems (GPRS, EDGE)

2003 – 3G cellular systems

Today – 4G LTE

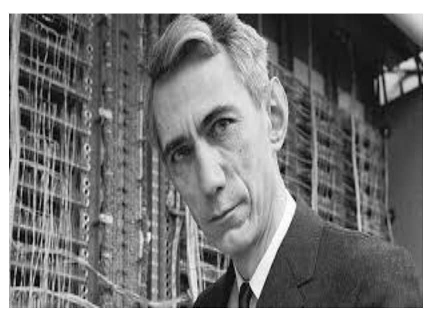
20TH CENTURY – CELLULAR DEVELOPMENT

- The 1st Portable Telephone Systems

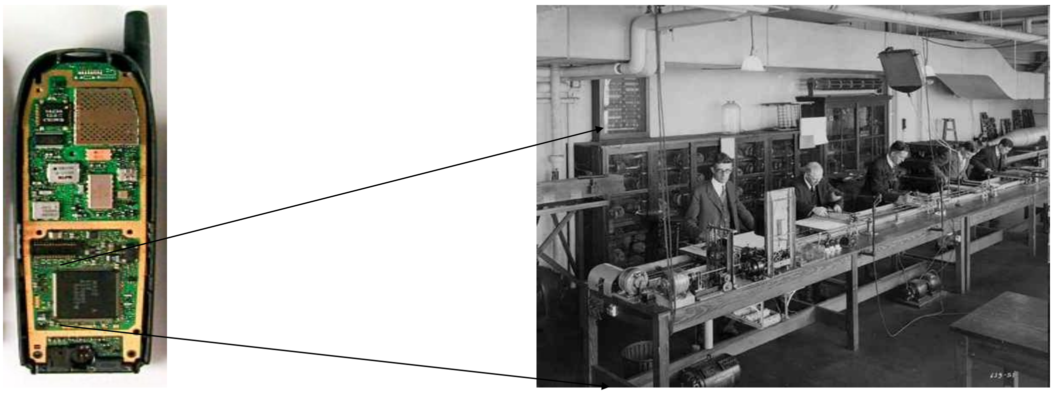
Half – Duplex (push to talk), single channel per conversation	1940's
FM with 120 KHz bandwidth channel.	
Single transmitter per city.	
Channel bandwidth reduced to 60 KHz	1950
Channel bandwidth reduced to 30 KHz	1960
Full-duplex, auto dialing based on IMTS	
Mobiles for 543 publics and more than 3500 on wait	1976

CLAUDE SHANNON

- Claude Shannon, engineer, and a mathematical genius.
- The Father of Information Theory (A triumph of mathematical theory for digital communications) and statistical basis of communications.
- The Founder of the First Sequential Decoding Circuits.
- He tells us how much information we can send in his theory and determined the capacity of communications channel.



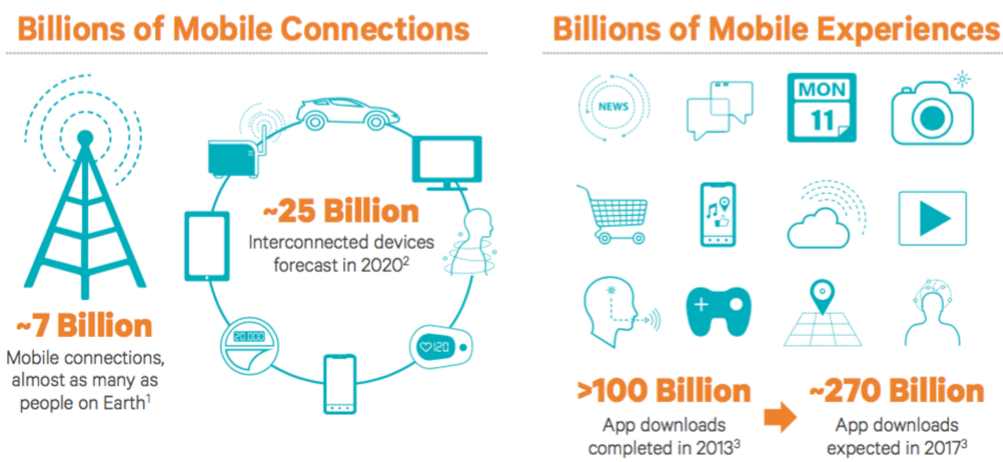
CLAUDE SHANNON



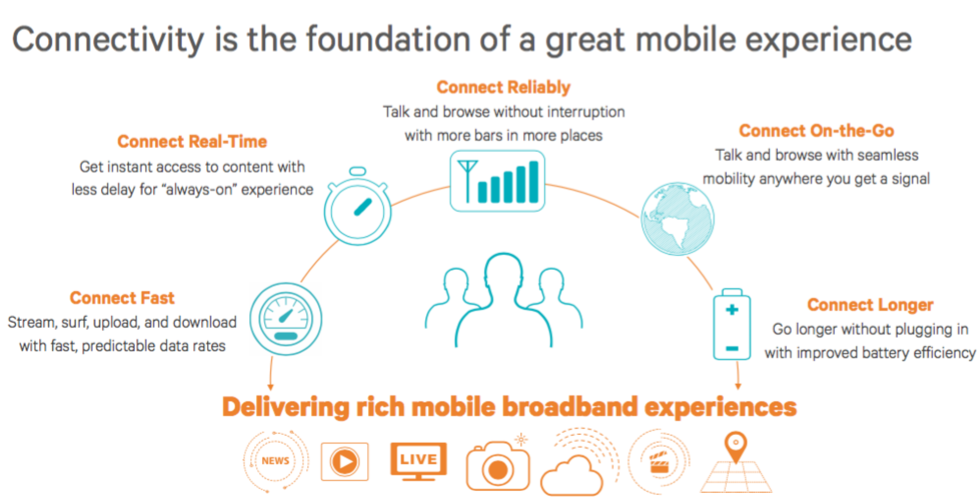
ONLY WITH MATHEMATICS IT IS ALL POSSIBLE

- Whole GSM system designed, developed and simulated with mathematical models of the communication systems.
- Algorithms for encryption, error correction, video/speech and music compression.
- 3G Codes Division Multiple Access.
- Coding for error correction.
- Design of Microwave filters.
- Digital signal processing / digital filters.
- Speech recognition / Image recognition and etc…

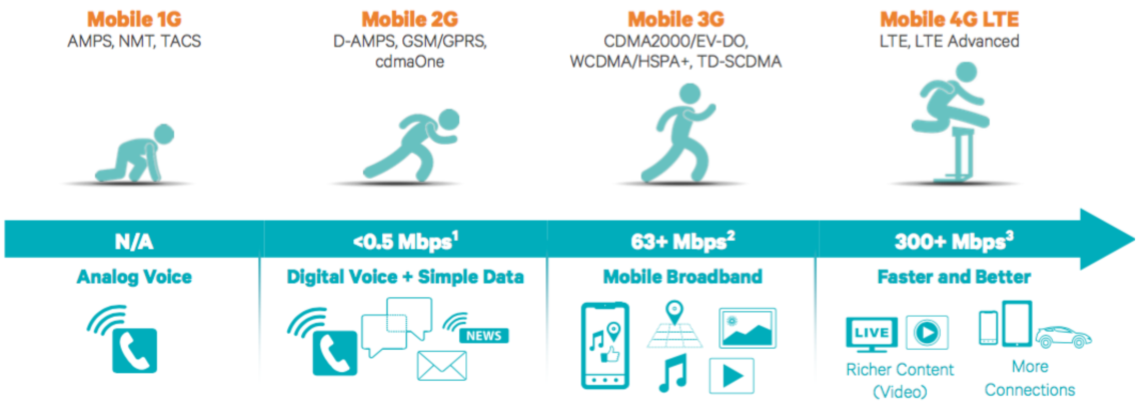
THE EVOLUTION OF MOBILE TECHNOLOGIES



THE EVOLUTION OF MOBILE TECHNOLOGIES



THE EVOLUTION OF MOBILE TECHNOLOGIES



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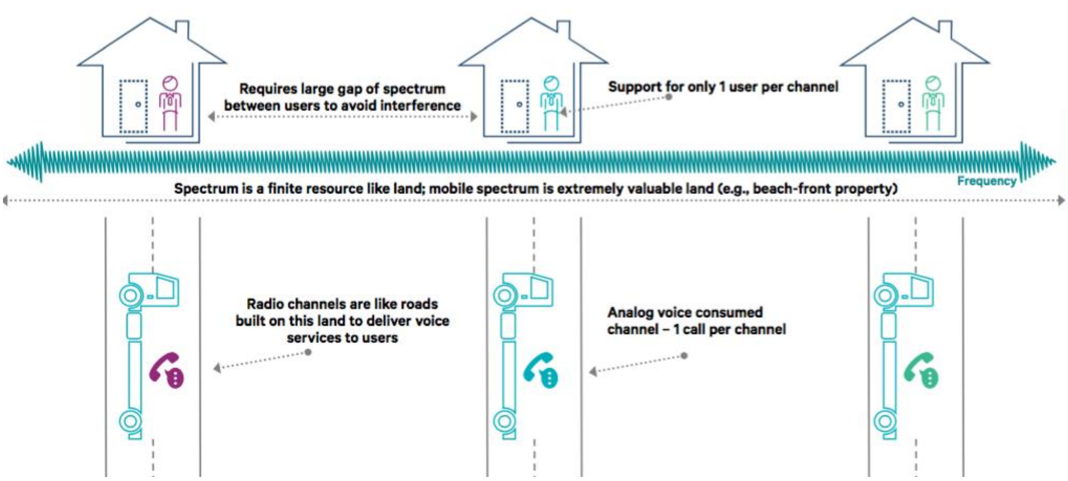
1ST GENERATION OF MOBILE COMMUNICATION



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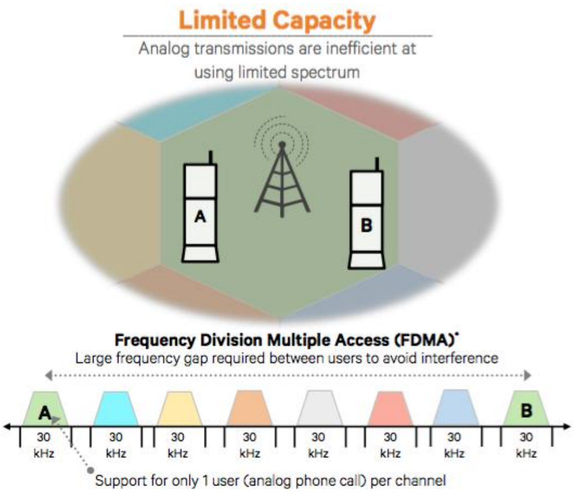
1ST GENERATION OF MOBILE COMMUNICATION



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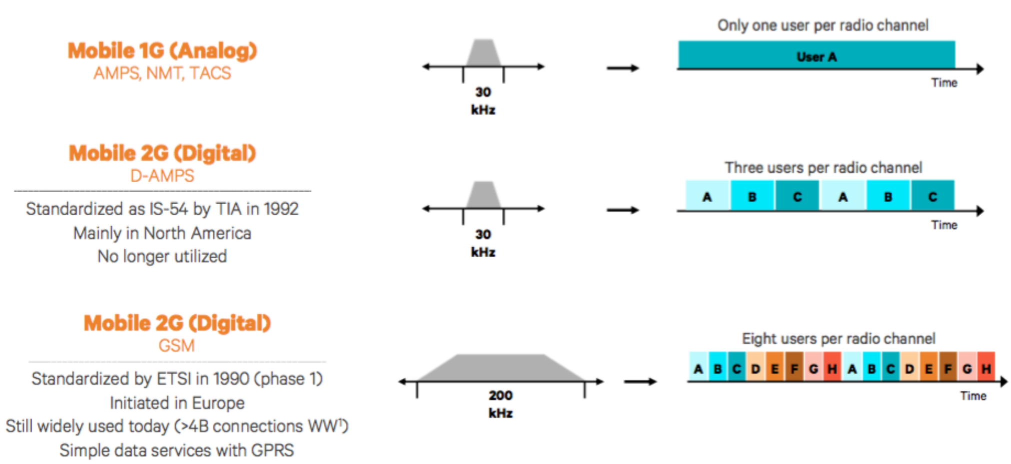
2ND GENERATION – CAPACITY IS BIGGER



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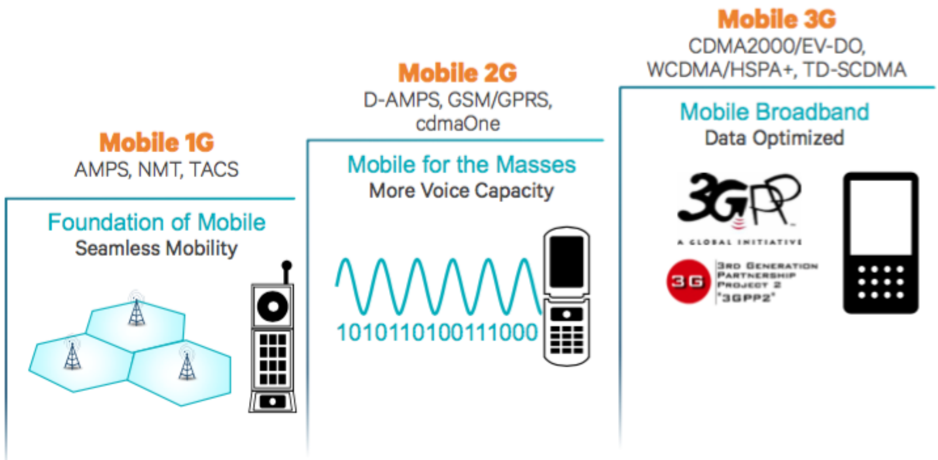
3RD GENERATION – CAPACITY IS BIGGER



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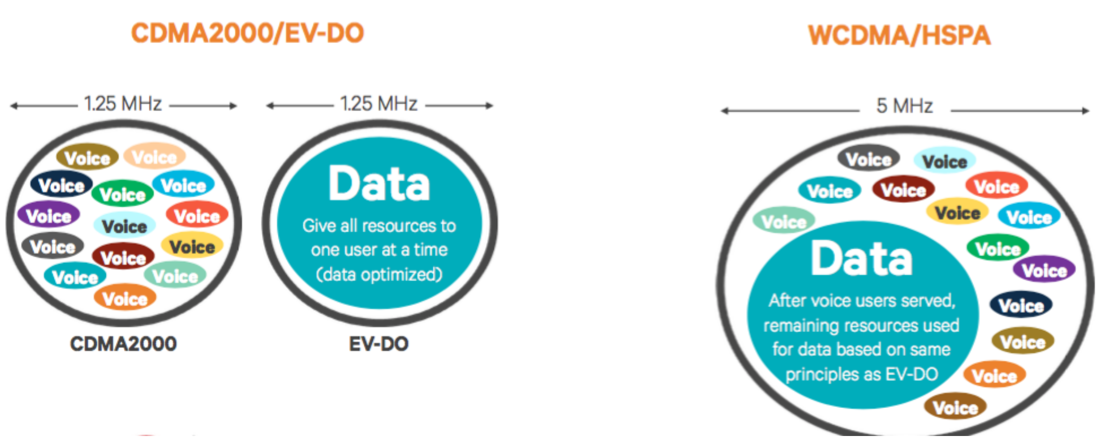
3RD GENERATION – CAPACITY IS BIGGER



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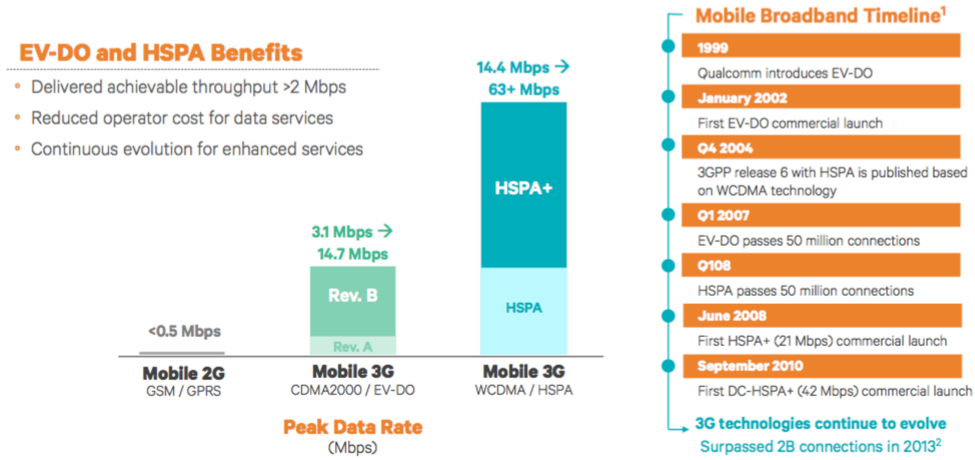
3RD GENERATION – CAPACITY IS BIGGER



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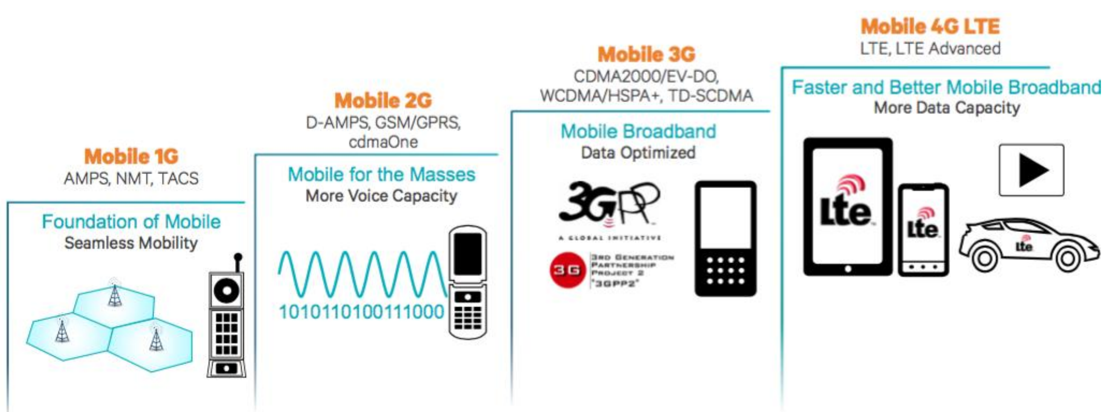
4TH GENERATION – CAPACITY IS BIGGER



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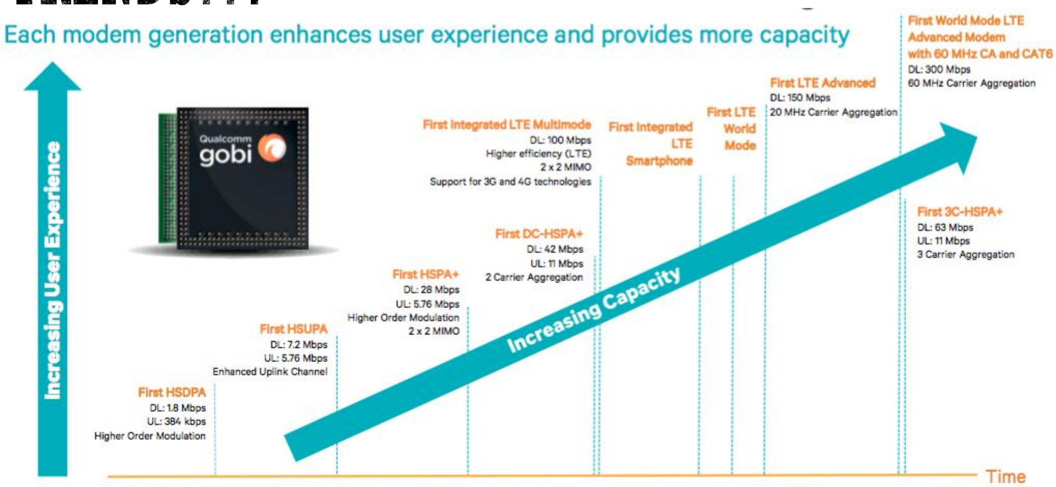
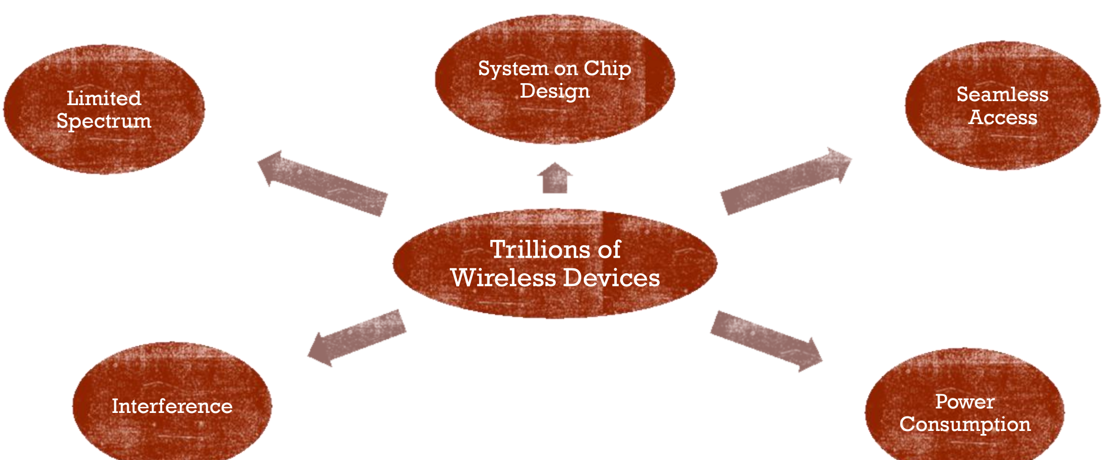
TRENDS…



FUNDAMENTAL CHALLENGES



HOW MANY DATA WE CAN TRANSMIT

- *Shannon Theory for determining channel capacity tells us how many data we can send.*

Increase power
Cooperative
System

$$C = \sum_{Channels} B\, log_2\,(1 + \frac{P}{N})$$

More Channels
MIMO Technique

Increase
Bandwidth
Cognitive Radio

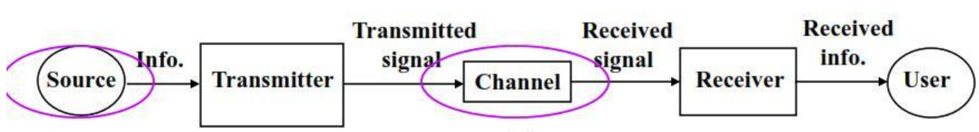
THE PROBLEM OF SPECTRUM

- The Spectrum Policy Task Force (FCC) identifies the following problems:

  - Many frequencies are largely unoccupied.
  - Others are partially occupied.
  - Some are heavily used and crowded.
  - On average, regulated spectrum used up to 15% of capacity.

HOW SPECTRUM LOOKS LIKE?!!

HOW DO WE COMMUNICATE



- Text
- Voice
- Image

- Cable
- EM wave
- Fiber

- Transmitter: Converts electrical signal into a very suitable form of signal to match transmission requirements.
- Receiver: To recover the original signal form the corrupted received.

SOURCE AND CHANNEL

Source

- Text, Voice, images ….
- How to model the Source?
  - Analog System: How to represent the source information as a superposition of sinusoidal waves.
  - Digital System: How to represent the source information as a series of bits

Channel

- Cable, EM waves, Optical Fiber ….
- How to model the Channel?
  - Baseband/Bandpass channel: How to properly modulate the signals to pass the channel without distortion?
  - Additive White Gaussian Noise Channel (AWGN): How to properly demodulate the signals to remove the effect of noise?

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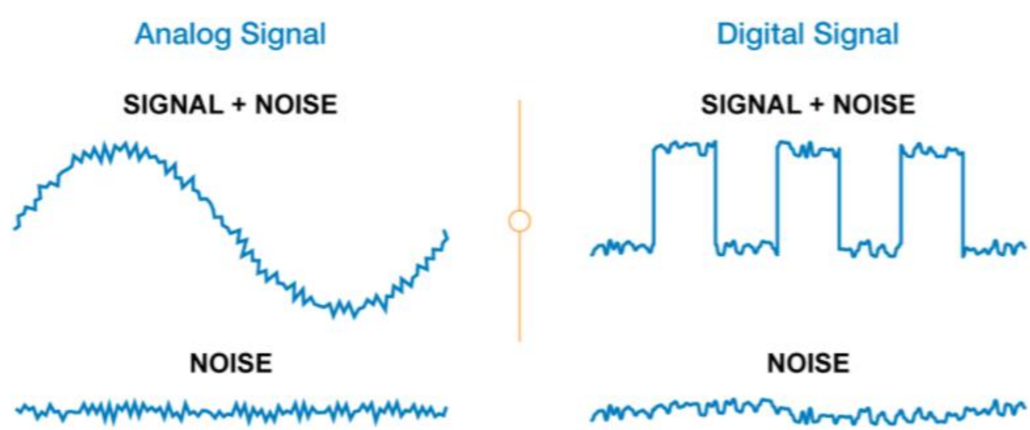
CHANNEL IMPAIRMENTS - NOISE



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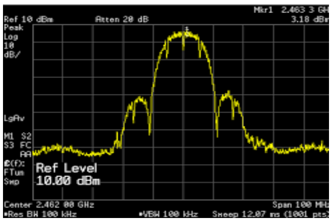
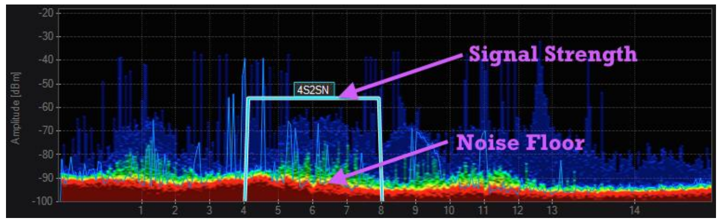
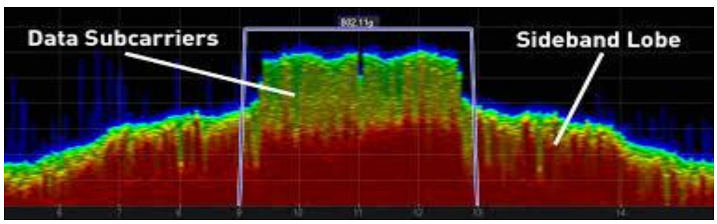
CHANNEL IMPAIRMENTS – NOISE FLOOR







THANK YOU

SEE YOU NEXT LECTURE WITH SIGNALS AND SYSTEMS