# 3C5 Telecommunications

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## What have we done to date?

- Introduced to the broad concept of digital radio
- Introduced to radiowaves and we learned something about how they propagate from source to destination

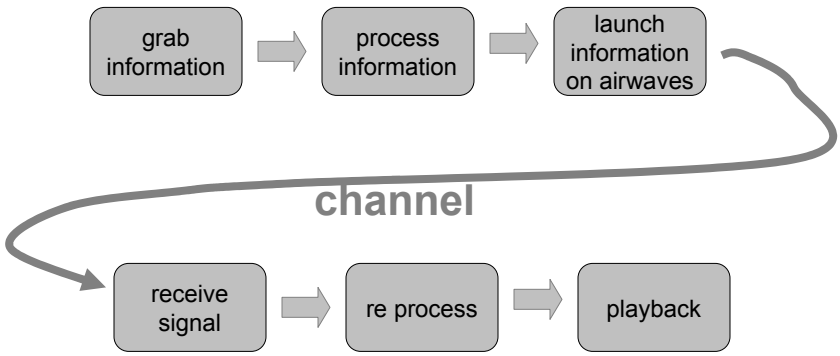
## key ideas

- we need to prepare the signals for their journey
- we need to compress them
- we need to make them robust to the vagrancies of the channel

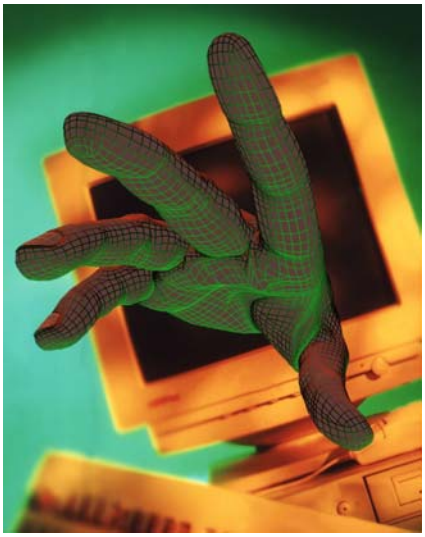
## what now

- we look at some more detail of what happens in the radio …..
- we will return to information theory again later on in the course to unify all our ideas

- information comes in (voice/data/video)
- processed for transmission
- launched onto the airwaves
- received on the other side
- processed again
- played back (voice/data/video)



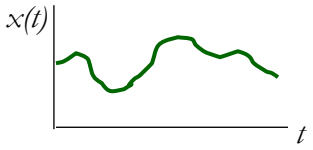
## grab …..



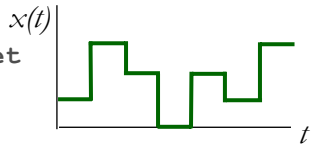
- information to be transmitted is analogue or digital (e.g. voice or data)
- analogue signals are **continuous**
- digital signals are **discrete**
- in an analogue communication system the analogue signals are transmitted over the medium
- in a digital communication either digital information or analogue information that is converted to digital form by sampling and quantisation is processed digitally and then transmitted over the medium in an analogue fashion

## Analogue and Digital Signals

- **Analogue signals**
  - Value varies continuously




- **Digital signals**
  - Value limited to a finite set




## note

- and even though we say digital radio there are parts that are analogue … e.g. the RF frontend has to be.
- so there is a swapping backwards and forwards between digital and analogue

## Process the signal for the journey

- that is basically what we have been looking at before the three week break
- compression and coding

## Launching

## Processing and Launching for Radios

Really what we mean here is that we take the information (analogue or digital) and **embed it in an electromagnetic wave** and launch that wave via an antenna

## how do we embed it in the wave?

- we use a process called modulation – we modulate the data onto the wave
- modulation is the focus of the next couple of weeks

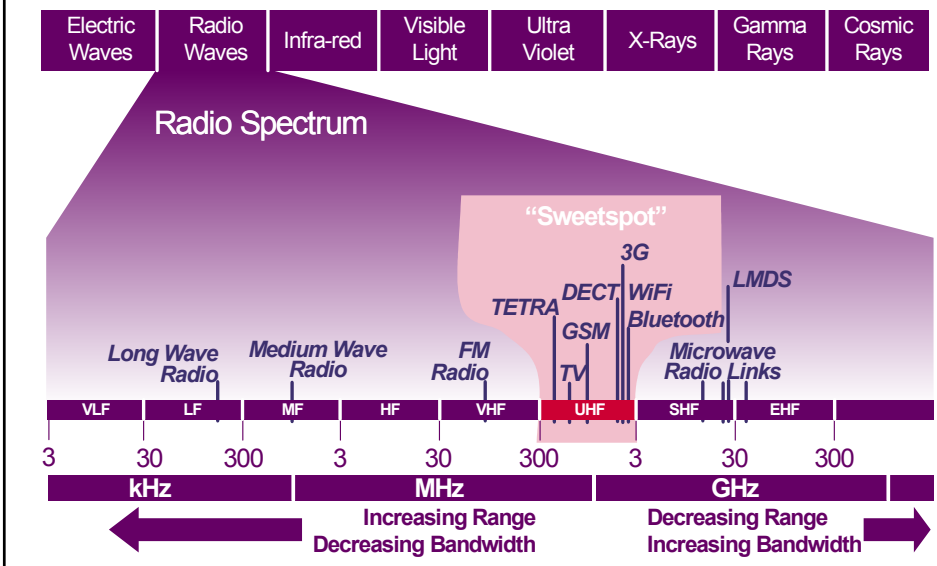
## Modulation

- You may have come across this earlier but essentially you manipulate the properties of the wave to reflect the information you want to send
- At the receiving end the receiver undoes this process (**demodulation**) and recovers the transmitted information.
- The term **carrier** is used to describe the radio wave onto which the information is modulated

But why can't we transmit the information as is? what is wrong with baseband? **Why do we need a carrier?**

Answer 1: not very efficient using baseband

Answer 2: needed to comply with how spectrum is organised


Electric Waves
Radio Waves
Infra-red
Visible Light
Ultra Violet
X-Rays
Gamma Rays
Cosmic Rays
Radio Spectrum
"Sweetspot"
3G
DECT
WiFi
LMDS
TETRA
Bluetooth
GSM
Long Wave Radio
Medium Wave Radio
FM Radio
TV
Microwave Radio Links
VLF
LF
MF
HF
VHF
UHF
SHF
EHF
3
30
300
3
30
300
3
30
300
kHz
MHz
GHz
Increasing Range
Decreasing Bandwidth
Decreasing Range
Increasing Bandwidth

## the wave …..

waves can have different shapes

## 1. narrow band

- A narrow band communication system transmits and receives signals that as the name implies have a narrow bandwidth.
- A GSM network is an example of a narrowband system. In GSM the channels over which communication is established are 200 KHz wide.
- A narrowband system can also be thought of as a single carrier system.

## 2. spread spectrum

- A spread spectrum communication system, is one in which then transmitted signal is spread over a frequency band much wider than the minimum bandwidth needed to transmit the information being sent.
- This technique decreases the potential interference to other receivers and increases the immunity of spread spectrum receivers to noise and interference.
- Spread spectrum uses a number of different techniques such as spreading codes or hopping patterns to spread the normally narrowband information signal over the relatively wide band of frequencies.
- Some cellular networks such as 3G UMTS based systems used spread spectrum techniques.

## 3. multicarrier

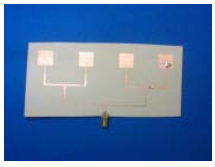
- A multi-carrier communication system is one in which the data to be transmitted is spilt into several components, and each of these components is transmitted over separate carrier signals.
- The individual carriers have narrow bandwidth, but the composite signal has a much larger bandwidth.
- The WiMAX standard is based on a multi-carrier communication technique.

## 4. ultra wide band

- An ultra-Wideband (UWB) communication systems is a system that has bandwidth exceeding the lesser of 500 MHz or 20% of the arithmetic centre frequency of the signal to be transmitted.
- UWB transmissions are very low in power.

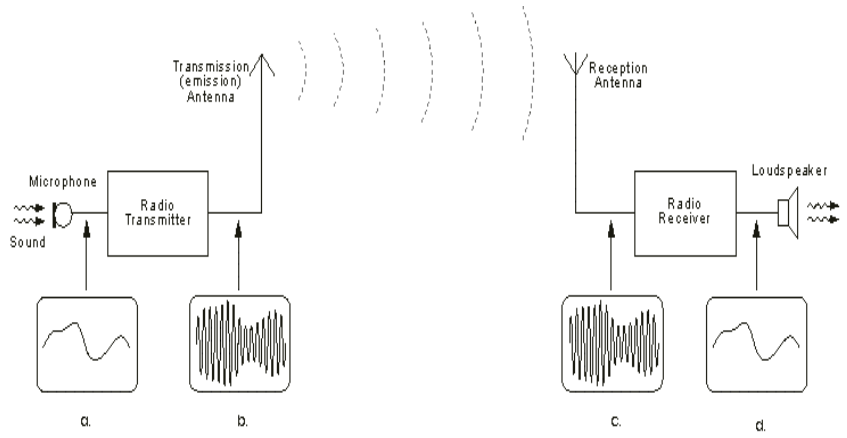
- Antennas 'launch' the signal on to the airwaves
- The size of an antenna must be in the order of the signal's wavelength to be effective.
- For example the wavelength of 1MHz signal is about hundreds of meters; while that of 1GHz signal is about .1 meters.






## at the receiver

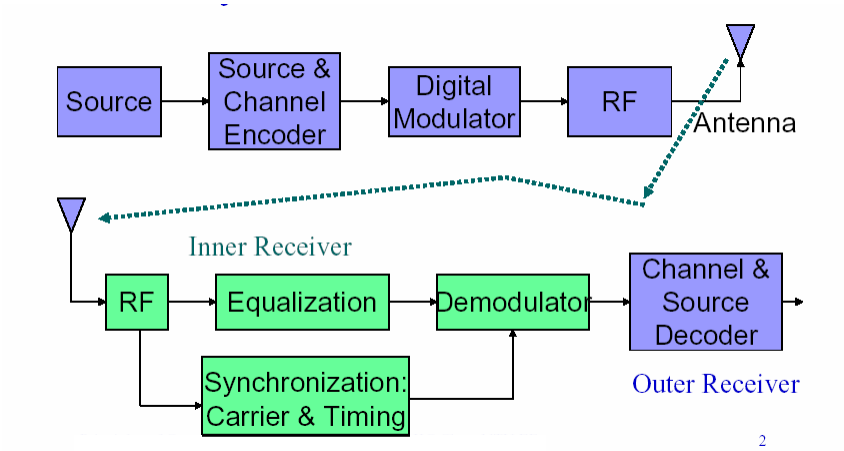
- the process is reversed
- the analogue waveform is received and digitised before this can happen
- the information is demodulated, decoded and decompressed
- we already talked about how you may have to give the receiver relevant information so it can do this

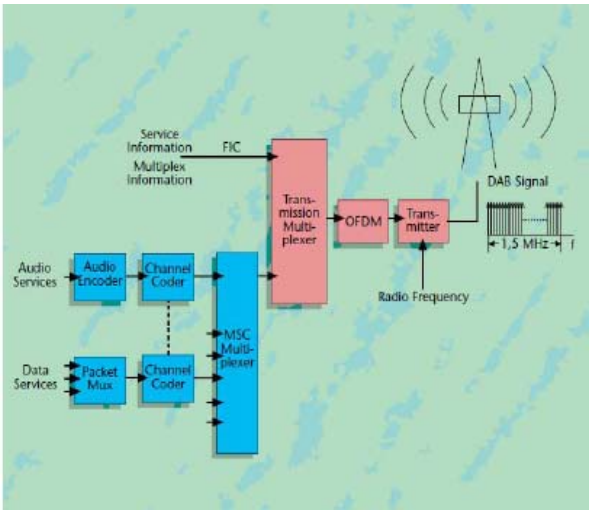


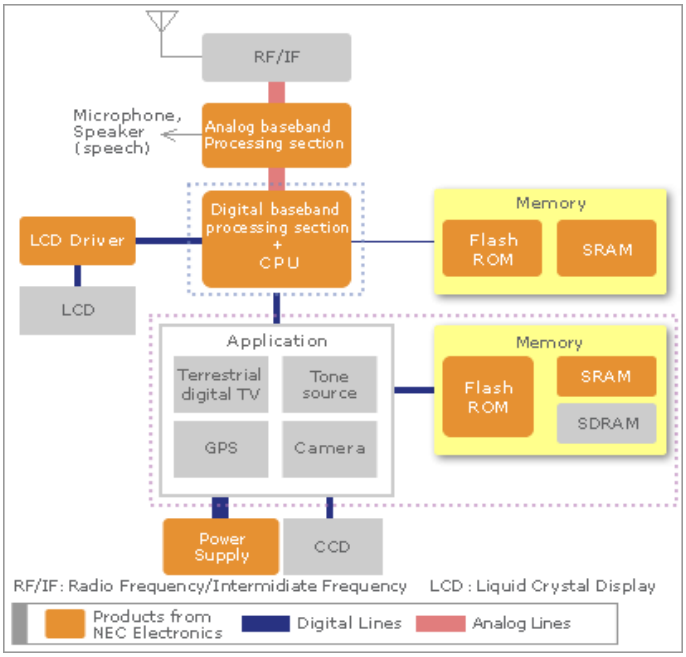

*Pic.2.1. Radio Transmission Block-Diagram*

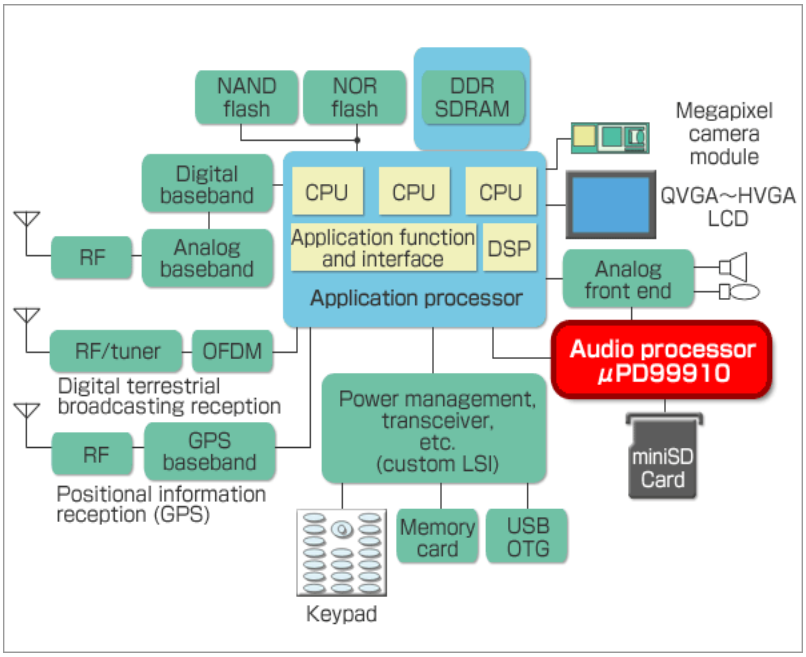
## one other thing

- the airwaves can be shared
- so in other words multiple radios can be on at the same time.
- there are different techniques for doing this – can be dependent on the wave form
- BUT we do not cover this (multiple access)


Source
Source & Channel Encoder
Digital Modulator
RF
Antenna
Inner Receiver
RF
Equalization
Demodulator
Channel & Source Decoder
Synchronization: Carrier & Timing
Outer Receiver
2


Service Information
FIC
Multiplex Information
Trans-mission Multi-plexer
OFDM
Trans-mitter
DAB Signal
1,5 MHz
f
Audio Services
Audio Encoder
Channel Coder
MSC Multi-plexer
Radio Frequency
Data Services
Packet Mux
Channel Coder


RF/IF
Microphone, Speaker (speech)
Analog baseband Processing section
Digital baseband processing section + CPU
LCD Driver
LCD
Memory
Flash ROM
SRAM
Application
Terrestrial digital TV
Tone source
GPS
Camera
Memory
Flash ROM
SRAM
SDRAM
Power Supply
CCD
RF/IF: Radio Frequency/Intermidiate Frequency
LCD : Liquid Crystal Display
Products from NEC Electronics
Digital Lines
Analog Lines


NAND flash
NOR flash
DDR SDRAM
Megapixel camera module
Digital baseband
CPU
CPU
CPU
QVGA~HVGA LCD
RF
Analog baseband
Application function and interface
DSP
Application processor
Analog front end
RF/tuner
OFDM
Digital terrestrial broadcasting reception
Audio processor μPD99910
Power management, transceiver, etc. (custom LSI)
miniSD Card
RF
GPS baseband
Positional information reception (GPS)
Memory card
USB OTG
Keypad

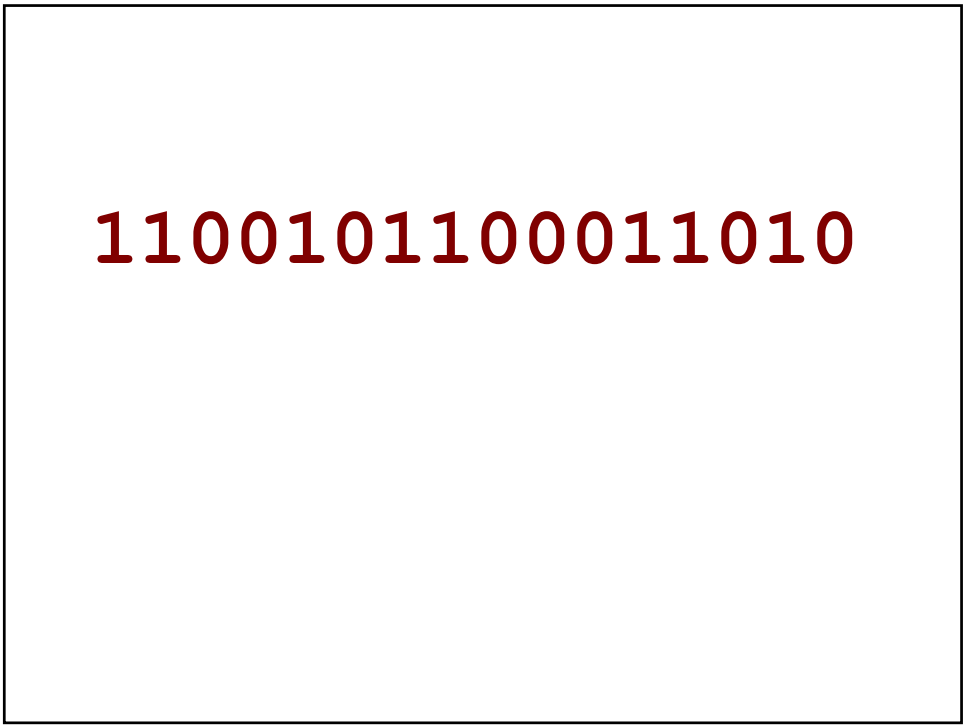
## so recall once more

There are three important elements

- the **source coder** COMPRESSES the data that is to be transmitted – otherwise you would not get the data rates you need
- the **channel coder**, makes the transmitted data more robust so that it can deal with the mess that happens on the way.
- the **modulator** launches the data to be transmitted onto the carrier wave (frequency of the radio system)
- so you go from a series of 1s and 0s (digital) to an analogue waveform that travels through the air to the destination.

## main distinguishing techniques from an engineering perspective

1. what general waveform is in action (narrowband/wideband)
2. what modulation scheme is used (specific kind of technique)
3. what coding is applied
4. how different users share the waves (on a time basis or frequency basis etc.)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