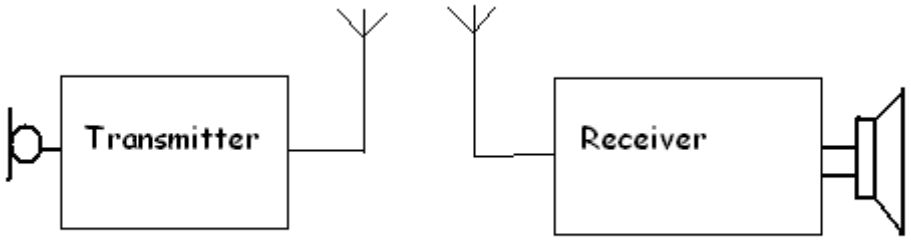
Total transmissions system.

This is a short description of some important specifications of what is important, when you want to make wireless transmissions.

Block diagram of transmissions system:



In a wireless transmission is the following thing to be taken in accounts:

a. The distance

b. Transmitter power

c. Receiver characteristic

d. Antenna systems

e. Transmitter frequency

f. The transmitted frequency spectre

g. Modulations way

h. Propagation

i. ”Intelligens” at the receiver

a. The distance:

The distance between the transmitter and the receiver is a very important factor for transmitting signals through the air.
If you calculate or measure the signal level from the transmitter to the receiver, you very soon find that the level is falling very, very fast.

Some typically signal levels for receiver are:

Very strong signals about 1 mV on the input of the receiver
Strong signals about 100 µV on the input of the receiver
Weak signals around 10 µV on the input of the receiver

For ham radio, they say a signal at 50 µV is S=9, and then the signal falls with 6 dB for every s degree. (HF 1.8-30 MHz)

On VHF they use 5 µV as S=9 (strong signal)

The signal from the transmitter can be so strong, so it makes trouble at the receiver. The radio receiver will act strange and the sound is "funny"/disturbed.
A TV picture will be unstable, "strange". If the signal is modulated in a digital way, the signal will "freeze", or you see some squares on the screen.

It is possible to show that the signal will fall, with the square on the distance between the transmitter and the receiver.

The difference between 2 Km and 10 Km is a factor 5-----but the signal falling 25 times!!!!

In theoretically calculation, you let the transmitter, be in middle of a sphere and located in free space.

In practice will the signal be reflected and attenuated of the earth, houses, and trees and so on. This is the reasons why it is important to put the transmitter antenna in a high and free position.

In general you can say that if the transmitter and the receiver have optical sight, it is possible to make a good connection.
(In practice, this is not always so)

By the way a way to look at the distance:

The distance attenuation: $(\frac{4\pi * D}{\lambda})^2$

Where: λ=wavelength
D= distance between the transmitter and the receiver
4π because it is a sphere

b. Transmitter power:

It is important that the power from the transmitter is high. The power is measured in watt; so called DC input to the output stage (PA).
Sometimes it is measured as ERP; meaning Earth Radiated Power.

ERP is the power put in the "air"; where the output; the loose in the transmissions cable ant the amplification in the antenna system is taken in account.
The transmitter power ranges from around 10-100 mW in a wireless internet (LAN and Wan) system, weather system (rain, temperature, wind, e.t.c.), Bluetooth and so on.

Local radio FM transmitters are in the range 10-500 Watt; where the frequencies are between 88-108 MHz.

Region FM and TV transmitters are in the range 1KW to 100 KW.

c. Receiver characteristics:

It is very important, that the receiver have a high sensitivity, so it is important to receive a very low signal.

It is also important, that the receiver only receive the signal you want to receive.
This means that it is important that your receiver have some good filters, which take the unwanted signal away; so the unwanted do not run through the receiver system.

d. Antenna systems:

It is important to think about which antenna you will use for a certain transmission system.
It is very important that the transmitter is connected to a very good antenna system, which is high in the air and that there a free sight around the antenna.
If the transmitter have to transmit in all direction it is difficult to let the antenna make amplification in all directions.
A dipole has a length of half the wavelength of the transmitted frequency and is feed in the middle of the core (Rod). In practice the core has to bee shorter with 0.95 times. It is because the signal is running slower in the material, than in air.
The antenna can be polarized horizontal or vertically; but it is important that the signal is the **same polarization at both transmitter and receiver**.

If the communication is between two parts, it can be an advantage to use direction antennas. The signal coming from other directions is attenuated (weakened). Further more is the signal becoming stronger then you can use lees power.
A lot of people think that it is not necessary to use an antenna for a lot of purpose. (Clock radios, mobile phones, wireless connection for PCs e.t.c.)

A walkman uses the earphone connection as an antenna!

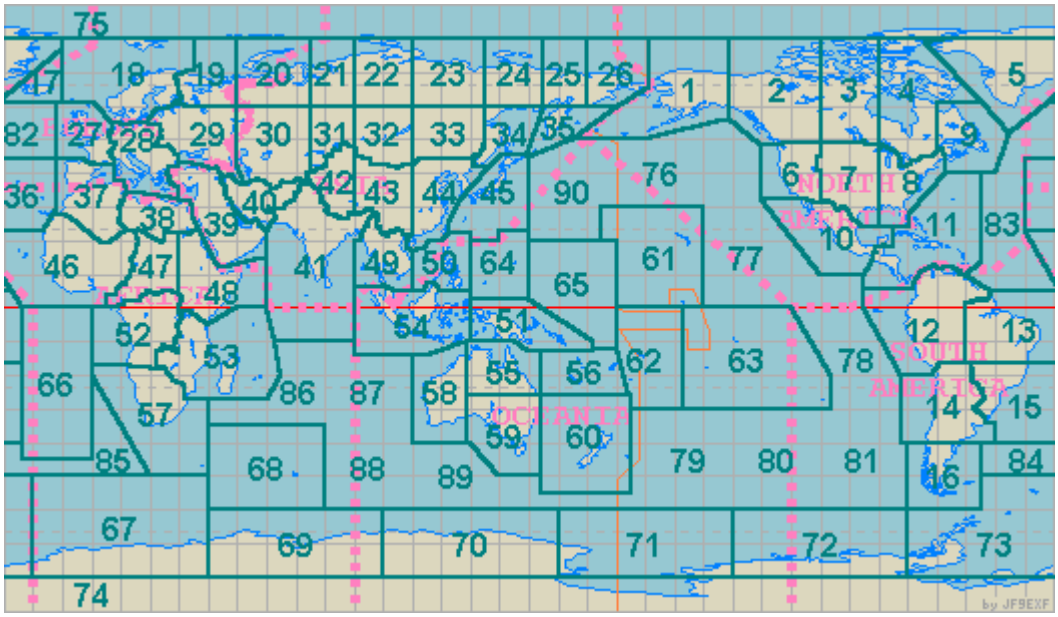
In a mobile phone the antenna is put inside the phone. Remember at old days, if you se old film then the mobile phone have an antenna outside.

The mobile phone is driven the power up and down, when it is necessary, because of change in the distance to the mobile antenna system and when the signal increase and fall.

e. Transmission frequency:

When you have to find a frequency it is important to choose one with "care".
The attenuation is increasing at increasing frequency. The antenna has to be at least one half wavelengths, but it is sometimes difficult, when the frequency is very low. For the Danish transmitter in Kalundborg 100 km west of Copenhagen, the frequency for long wave transmission is 1200 meter. In practice it is not possible to make the antenna so long. (About 600 meter long)
When the transmission frequency is determent you also have to think about, what propose the transmitter have. (AM Radio, FM radio, TV, e.t.c.)
The use of frequency is determent of the World Administrative Radio Conference. They made a conference every 4.Year, where every country in the world is represented by a committee.

The WARC have decided what every frequency has to be used for. It is possible to find the map for USA on the internet, while the frequency for Europe is made as a very big table.



The world is divided in **90 zones**. You can see it on the map below:

It is the ministry of IT which decides for Denmark. They have to talk with the neighbour country, such as Sweden, Norway, Germany, UK and so on.
A lot of people think that the radio station decides the frequency, but they have to use the frequencies which are assigned for that use in Denmark.
It is important that the different country use the same frequency area so you can take your receiver to other country without problems.
The FM band from 88 MHz to 108 MHz is used in a lot of countries. Then the factory can produce a FM radio for many countries.
It is the same situation, when we think about Mobil phones, clock radios, TV set, satellite receivers, communication equipment and so on.
Everybody have to follow the "norm".

f. The transmitted frequency spectre:

In general is the transmitted spectre depending on what modulations art you use and how fast you have to transmit the signal.
In general it is possible to use more bandwidth, when you go up in frequency. The so called modulations bandwidth (the wide of a transmitted signal).

On the MB band from 500 KHz to 1500 KHz is the bandwidth 9 KHz wide, for every station. The bandwidth on the FM band is about 225 KHz wide, TV on VHF is 6 MHz wide and on UHF it is 7 MHz wide(analogue TV).
Digital modulation is in principle very wide, but now a day is it possible to reduce the bandwidth. But some of the digital modulations are very complicated.

Analogue signals do not use the bandwidth all the time, but digital modulation is very effective, and uses all the bandwidth. (DVB contra analogue TV) The DVB uses all the bandwidth all the time.

g. Modulations way:

The transmission is depended of what modulations art which is used.

The first modulations art was CW(Continues Wave) for Morse code, AM(Amplitude Modulation), FM(Frequency Modulation) and PM(Phase modulation). But to day there are a lot of other modulations arts.

Here I will sum up some of the types: AM, FM, PM, SSB, DSB, VSB, ASK, FSK, PSK, CPFSK, MSK, FFSK, GMSK, QPSK, DQPSK, QAM and a lot of other.
When you use one modulations art it is necessary to use a demodulator (detector), which is used in connection with the modulation art you receive.
It is possible to encrypt the signal, so no stranger can understand the information. Mobile Phones is in some way encrypt, so it impossible to understand the information, if you listen direct on the transmitted frequencies.

h. propagation:

The propagation of the signal is very much depending of the transmitted frequency. In old day, everybody thought that the signal only could be propagated in straight lines, and never come below the horizon.
The time has shown that the ionosphere is very important when we have to find out have long a radio signal will “travel”. The ionosphere is from 40 Km to 560 Km above the surface of the earth.

A very important part of the radio signal is the so called earth wave, which is transmitted along the surface of the earth. The distance is depending of the visible horizon, the distance it is possible to “see”.
Here are some examples:

The transmitter is 10 meter above the earth, and then the distance is: 13 Km.
The transmitter is 100 meter above the earth, and then the distance is: 41 Km.
The transmitter is 200 meter above the earth, and then the distance is: 58 Km.
The transmitter is 300 meter above the earth, and then the distance is: 71 Km.

An other part of the transmitted signal is called the reflected wave. This means that the signal is reflected in the ionosphere. Normally we say that

the earth wave is to be used up to 3 MHz. At frequency between 3-30 MHz the signal **can** be reflected in the ionosphere and can be received around the earth. (Everywhere)

The signal travel 7.5 times around the earth in 1 second!!
It travel with the speed of light 300 000 Km/sec.
The propagation is a **very complicated case**, where we to day do not have all information!!
The propagation is depending of the following things: The time of the day, frequency, the sun, sunspots, day/night, the place where the transmitter and receiver are located, the power of the transmitter, and the antennas radiation diagram, together with the frequency. And much more---

i. "Intelligens" at the receiver:

It is known that a good radio operator can receive very noise and weak signal, which normally people have difficult to receive.

That was one of the reasons to that Russia under the cold war, let radio amateur work in the whole country. (It was possible to talk with radio amateur in whole Russia under the cold war.) But they were under supervision of the government. (KGB!)

To day it is possible to receive signals below the noise. The reason for this, is that the "computer" have made it possible to "draw the signal" out of noise.

A way to do this is to transmit the signal several times and "get" it out of the noise.

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