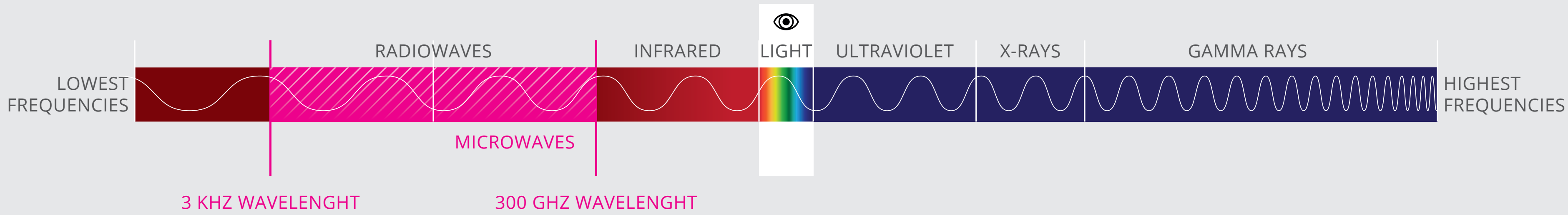
FACTSHEET

APRIL 2017

ELECTROMAGNETIC SPECTRUM



Spectrum is a vital commodity in our everyday lives – from GPS satellites and air traffic control systems, your cable TV and broadband connection right through to your mobile phone and car key remote. Because the spectrum which is available for specific uses is finite and often scarce, there is a fierce advocacy around its usage. This factsheet explains what spectrum is, why it matters and how it's used in electronic communications.

Electromagnetic (EM) spectrum groups all types of electromagnetic radiation, which in turn stands for energy that travels and spreads out as it goes. It sounds high tech, but it's a natural phenomenon. The first scientific discovery within the EM spectrum was visible light, the only part of the Electromagnetic Spectrum seen by the naked eye, which allowed us for the first time to understand how and why the human eye differentiates colour. This 17th century discovery was the first of the seven subsets of spectrum identified today. In addition to visible light, the other subsets of the EM spectrum are Radio, Microwaves, Infrared, Ultraviolet, X-Rays and Gamma Rays.

Cable Europe

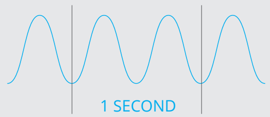
Electromagnetic energy travels in the form of waves very much like the waves generated when we throw a stone into water. Waves on the surface of water are mechanical waves: they need the water in order to travel. Electromagnetic waves are more versatile; they can travel using a medium such as air, or copper cables, or even in a vacuum.

The scientific community identified a set of parameters to describe the electromagnetic wave, which has crests and troughs similar to those of ocean waves.

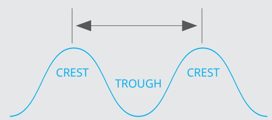
These parameters are:
FREQUENCY / WAVELENGTH / ENERGY

Crucially, these parameters allowed engineers to generate EM waves artificially – and the bedrock of modern communications was formed.

FREQUENCY:
the number of crests that pass a given point within one second



WAVELENGTH:
the distance between crests



ENERGY called electron volts (eV); when moving along the spectrum from long to short wavelengths, energy increases as the wavelength shortens.

ELECTRONIC COMMUNICATION

The artificial generation of electromagnetic signals has been adapted to many purposes – including TV and telecommunications services which use networks made up of electrical conductors, fibre-optic conductors, or wireless media to send messages from one place to another.

These networks operate on the same principle – **translating the message into an electronic signal, transporting it to the destination and reconverting it into the original format**. This process is almost instantaneous irrespective of distance. The more frequencies the network uses the more capacity it has to transmit signals, for example for voice or data services.

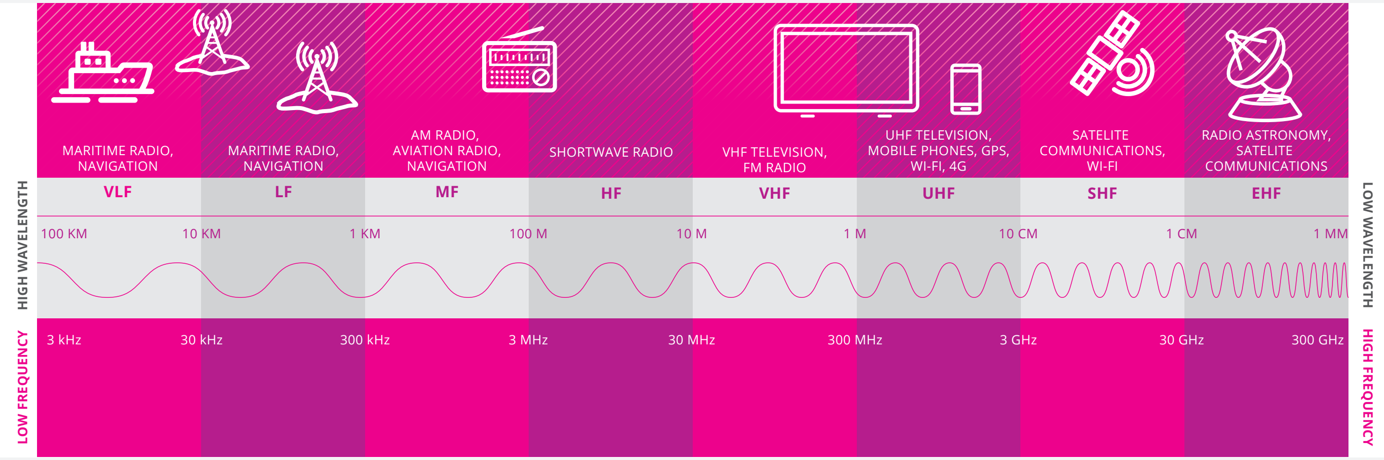
ELECTRICAL CONDUCTORS (eg. coaxial cable, copper pair cable)

OPTICAL MEDIUM (eg. optical fibre)

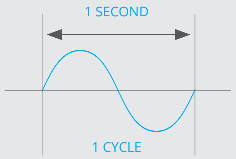
FREE SPACE (eg. radio waves over the air)]

RADIO SPECTRUM

TV and telecommunications use the subset of the EM spectrum called **Radio Spectrum (also known as Radio Frequency). These frequency bands are defined by the ITU – the International Telecommunication Union - and include any frequency in the range from 3 Hz up to 300 GH**z. This range was selected because of its unique and ideal characteristics for covering distance without significant deterioration.



1 Hz (Hertz)
1 waves or cycle per second



1 KHz
1000 Hz

1 MHz
1000 KHz

1 GHz
1000 MHz

1 THz
1000 GHz

DID YOU KNOW THAT:
VLF stands for Very Low Frequency
VHF stands for Very High Frequency
UHF stands for Ultra High Frequency
EHF stands for Extremely High Frequency

PRACTICAL DIFFERENCES BETWEEN LOW AND HIGH FREQUENCIES

Not all radio frequencies are equal: some have characteristics in terms of propagation, range, building penetration and resistance to atmospheric conditions. Lower radio frequencies are favoured when the ability to cover long distance is desirable. This is due to the inverse relationship between the frequency and the wavelength, meaning that the lower the frequency, the longer the wavelength. Lower frequencies (for example UHF band) become doubly attractive when we consider their increased ability to pass through dense objects, such as walls. However, higher frequencies (for example Wi-Fi or Bluetooth) are a smart solution where capacity is prized over range.

HOW IS SPECTRUM ALLOCATED?

Radio spectrum is a finite resource that needs to be managed efficiently to avoid interference between radio waves on the same frequency. In Europe, standards for the allocation of wireless frequencies are governed by two bodies:

- International Telecommunication Union (ITU), a specialised agency of the UN
- European Conference of Postal and Telecommunications Administrations (CEPT)

Frequency bands are allocated according to whether they fall into a **licence exempt** range (e.g. Wi-Fi), where anyone may transmit providing they comply with coexistence rules, or into **licensed capacity** (e.g. GSM), where only the licensed holder is permitted to use the frequency. Government "spectrum auctions" are also common for the most highly prized and scare examples of spectrum. To prevent interference and allow for the most efficient use possible of the radio spectrum, similar services are allocated into predefined bands.

Cable operators use licence exempt spectrum on the same frequency range as mobile services. They transmit using closed networks and therefore work within the co-existence rather than the licensed regime. Cable operators are a key stakeholder in the spectrum allocation process.