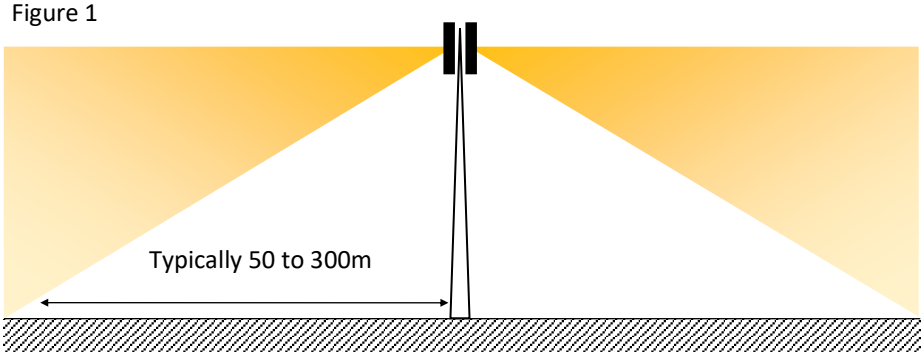
Background information on wireless systems

Wireless systems are used in everyday situations, from GPS, WiFi and Bluetooth to broadcasting radio and television signals into our homes wireless signals are around us most of the time.

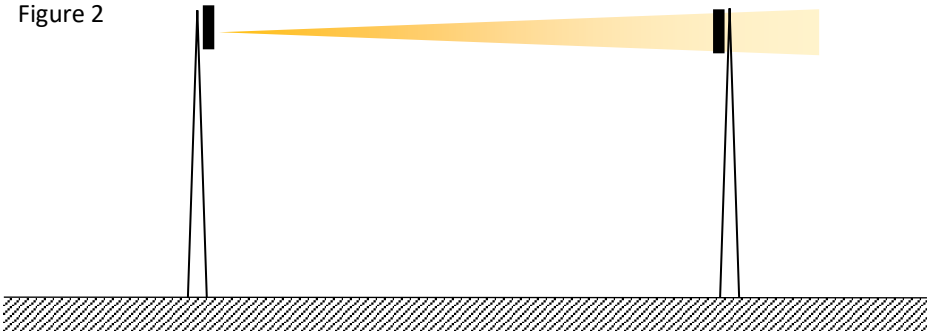
Mobile phone systems utilise a handset communicating with a 'base station' transmitter and vice versa. Because mobile phone handsets (and even the base stations themselves) transmit a relatively low power signal it is necessary to have a large number of base stations to ensure that the handset always has a base station within range. Base stations transmit signals via an antenna system mounted on towers or buildings.
Depending on the design of the system there may be a number of antennas located at a site to ensure the signals are transmitted in all required directions. The most typical configuration is for each antenna to have a reflector that shapes the radio signals to cover a specific area, some antennas do this electrically. The antennas are positioned in such a way to transmit the signal towards the ground within a certain distance. This distance will depend on local topography. Figure 1 shows a simplified picture of this, real antenna patterns do not have such well defined edges but it is important to note that very little is directed directly beneath the antenna.

Figure 1



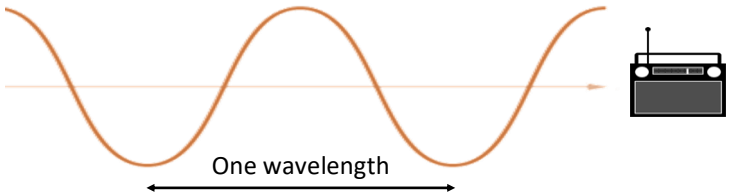
Each base station covers a particular area or 'cell', typically a few kilometres in size. Lower power base stations used to cover smaller areas in cities have a much smaller range. To enable telephone calls to be transferred to other cells as the caller travels into another area it is necessary for the base stations to be able to communicate with each other. This can be by fibre optic cable or via a 'microwave link'. These microwave links use 'dish' type antennas, often seen as a small white drum attached to a radio tower. They invariably transmit a very low power signal in a narrow 'beam' well above ground level (see Figure 2).

Figure 2



The term microwave purely refers to the frequency at which the link operates (frequencies above 1000 MHz are often referred to as microwave). To explain this further, 'radio waves' can be thought of as cycles with frequency referring to how many of these cycles occur in one second. The unit of measurement is Hertz (Hz) and 1 Hz is equal to 1 cycle per second (see Figure 3). Different wireless systems work at different frequencies. For example FM or DAB radio is broadcast in the VHF band (Very High Frequency, 30 to 300 MHz). The prefix 'M' or Mega simply means one million, i.e. 100 MHz is equal to 100 million cycles per second. Mobile phone systems operate over a number of frequency bands typically in the range 700 MHz to 3600 MHz.

Figure 3

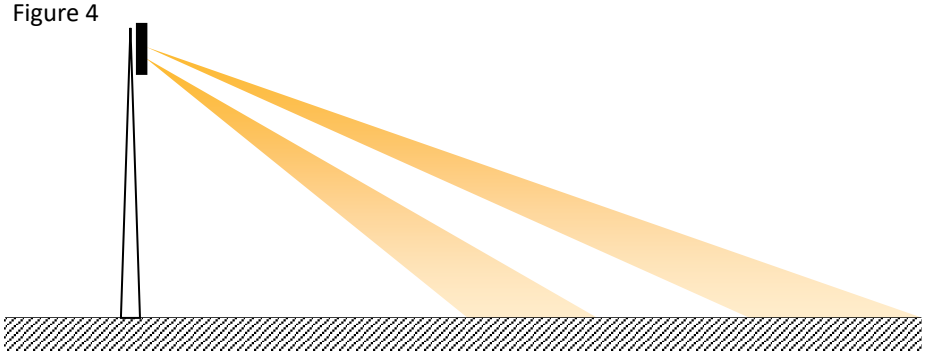


As mentioned previously, along with frequency, radio signals have a power level associated with them. Power is measured in Watts (W). A simple analogy is an electric light bulb; a 100W bulb is brighter than a 60W bulb and will cast light further. The same applies to radio waves, given the same conditions a more powerful signal will travel further. With regard to high frequency safety guidelines power is measured over a given area so the unit of measurement is Watts per square meter (W/m^2). A key point is that the power level or 'field strength' falls very rapidly with distance from the antenna. A distance of even a few metres, certainly a few tens of metres, from base station antennas will have a very big effect on field strength. Often field strengths from nearby base stations will be broadly similar to radio and television signals broadcast at higher powers from a mast much further away.

Recently there has been much controversy over 5G or 5th generation wireless systems. Much of this relates to 5G operating at high frequencies but in reality the vast majority of the 5G network operates over the 700 MHz to 3600 MHz frequency range, similar to other mobile phone or WiFi frequencies.

Other differences relate to the antenna technology that is used. It's designed to make the communication between the handset and the base station more efficient and the base station antenna can produce multiple 'beams' (see Figure 4) to communicate with different user equipment. In comparison with previous systems this could result in a slightly higher field strength at a given location for a certain period of time. However it is really important to note that 5G systems have to meet the same safety levels as previous wireless systems and field strengths are typically tiny in comparison with safety guideline levels.

Figure 4



Safety guidelines are developed by the International Commision on Non-Ionising Radiation Protection (ICNIRP). The most recent ICNIRP guidelines were issued in March 2020 and they represent a thorough assessment of the peer-reviewed scientific literature on the subject. The levels listed in the guidelines are designed to ensure that all people are not exposed to harmful levels of radio frequencies or other electromagnetic fields. The levels are designed to be conservative and incorporate a large safety margin.