

# Propagation

PROPAGATION IS THE technical term for how radio waves behave once they have left the transmitting antenna.

Radio waves and light waves both belong to a larger family of waves called electromagnetic waves. The term also includes x-rays and many cosmic rays.

Like light, radio waves travel in straight lines unless they are reflected off a suitable surface or are refracted, that is bent in the same way that light is bent in a prism or lens.

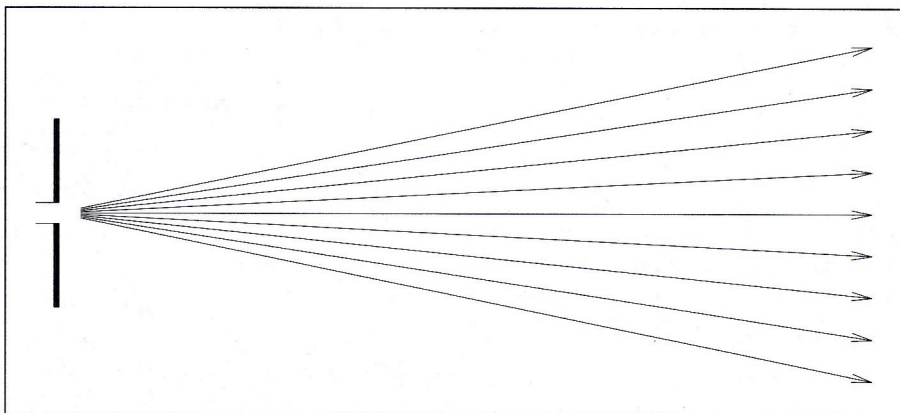


Fig 22: Radio waves, spreading out from a dipole antenna.

## Spreading out

RADIO WAVES ALSO spread out from the antenna, as shown in **Fig 22**.

Close to the antenna they are concentrated, so a receiving antenna will pick up a strong signal. Further away the signal will be weaker. Too far away and the signal will be too weak to be received. The effect is the same as shining a torch beam onto a wall. Close to the wall there is a clear, bright circle of light. As the torch is moved further away the light is more spread out and appears weaker. If moved sufficiently far away, it is not visible at all.

## Buildings

RADIO WAVES CAN penetrate buildings in much the same way as an x-ray will pass through the skin, but bones will leave a shadow. Some of the energy is lost in penetrating the building. In the basement or in the middle of a large building, where there are several walls to pass through, the signal may be too weak to be of use.

The penetrating ability of radio waves depends very much on their frequency. For lower frequencies in the medium wave and HF bands, the wavelengths are large and the buildings 'appear' fairly small in comparison. Such waves penetrate buildings quite easily, but have difficulty with mountains. At higher frequencies, in the VHF and UHF bands, the wavelengths are much shorter and the buildings comparatively bigger. The same building is much more of a problem to VHF and UHF waves than it is for HF.

There is one small advantage for the higher frequencies; if the wavelength is smaller than a window, the window appears as a big enough hole for it to get through. There is then a reasonable signal

in a room with a window on the side facing the transmitter.

The best range with VHF and UHF radio services is achieved when the transmit antenna is mounted high up and clear of local obstructions such as trees and buildings. It helps greatly if the receiving antenna is also sited in a similar way.

Broadcast transmitters have very tall masts supporting the antenna for just that reason. It also helps in getting the signal into the dips behind hills and into valleys. Such places would otherwise be in a bit of a shadow. This effect can be seen on a clear day when the sun is just rising or setting. Even a relatively small hill causes a long shadow, which disappears as soon as the sun is higher in the sky.

## Range

THE RANGE achieved depends on a number of factors. Clearly, a more powerful transmitter will have a greater range. However, the effect is not as noticeable as might be expected. Consider the torch beam again. At double the distance the circle of light is twice as wide and twice as high. It has 4 times the area to cover, so each bit of wall only gets a quarter of the light. To get the same strength as before the beam must be four times as powerful, not twice.

In amateur terms, it is much more effective to use a yagi antenna to focus all the transmitted power in the right direction, than getting a bigger transmitter. Also, the antenna 'gain' is effective on receive, giving us a more sensitive receiver.

Even that is not always the best option, although it is a very good one because it also avoids sending transmit power in all

the wrong directions. The best option, as mentioned previously, is to get the transmit and receive antennas clear of the clutter and above the roof tops. Use a yagi as well and you will have a very capable station.

Frequency affects the range. The higher the frequency, the bigger the buildings and trees appear to the radio wave, and the more the wave is lost in penetrating them. Hills cause shadows and the curvature of the earth also has an effect in making any hills in the middle of the path seem taller. At VHF, and even more so at UHF, the range is not much further than line-of-sight. Depending on the terrain, that may be anything from 10 or 20 km up to 60 to 80km in open country from a hilltop. Between handheld radios, down amongst buildings, even 1km may prove difficult.

