UK Foundation Amateur Radio License

Antennas and Feeders (Transmission Lines)

David Collins – Centre for High Frequency Engineering

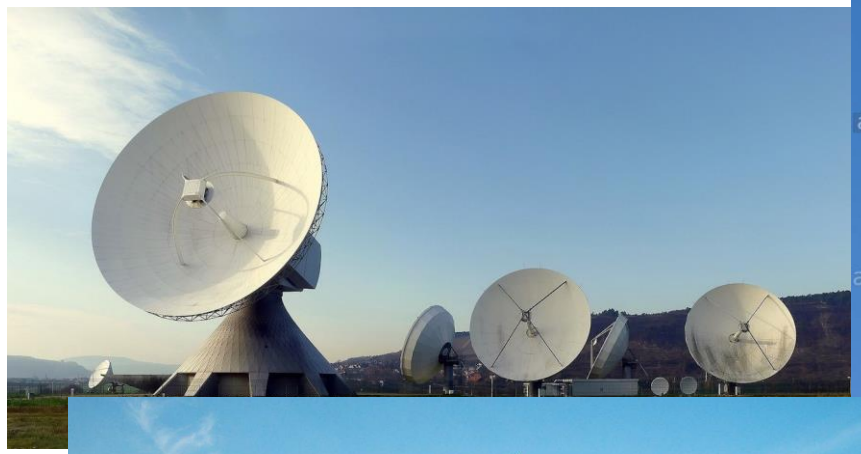
Course Structure

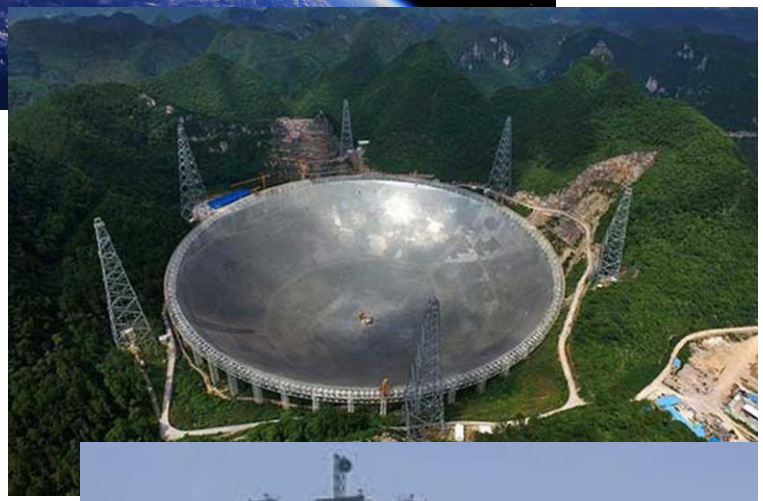
- **Part One Antennas**
  - What is an antenna and how does it radiate?
  - Antenna theory
  - Types of antenna and antenna gain
- **Part Two Feeders** (transmission lines)
  - What are transmission lines
  - Types of transmission lines
  - Connectors
  - Dummy loads

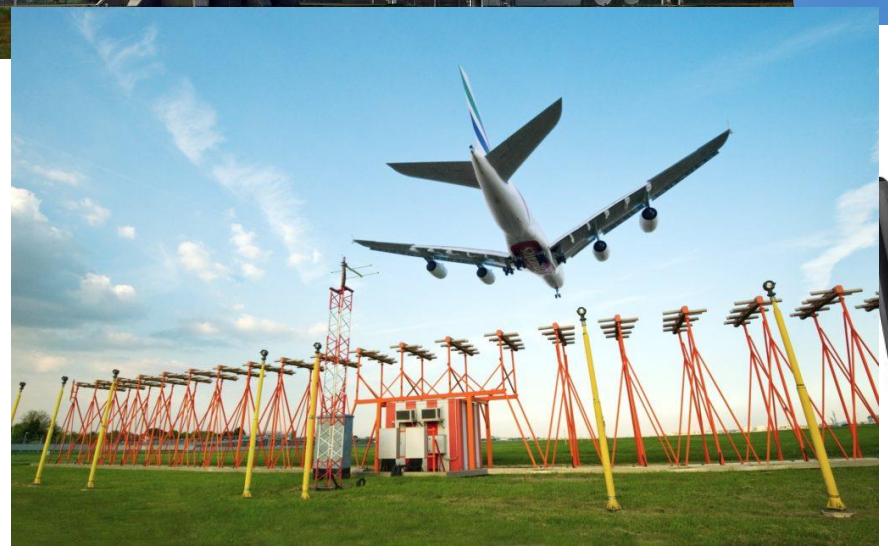
Electrical signals are carried between points in one of two ways

- Via a transmission line to which the signal and its associated EM wave is bound
- Or through free space where antennas are used as the terminals

Part 1 Antennas







What is an antenna?

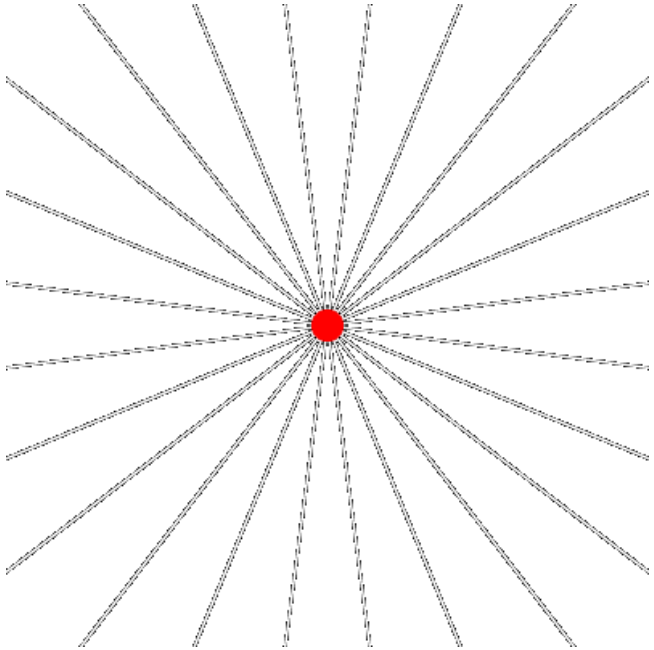
The IEEE defines an antenna as "That part of a transmitting or receiving system that is designed to radiate or to receive electromagnetic waves"

Or you can think of an antenna as a transducer that converts a guided (or bound) wave on a transmission line to a free space electromagnetic wave (in the case of a transmitter) or vice versa (for the receiving case).

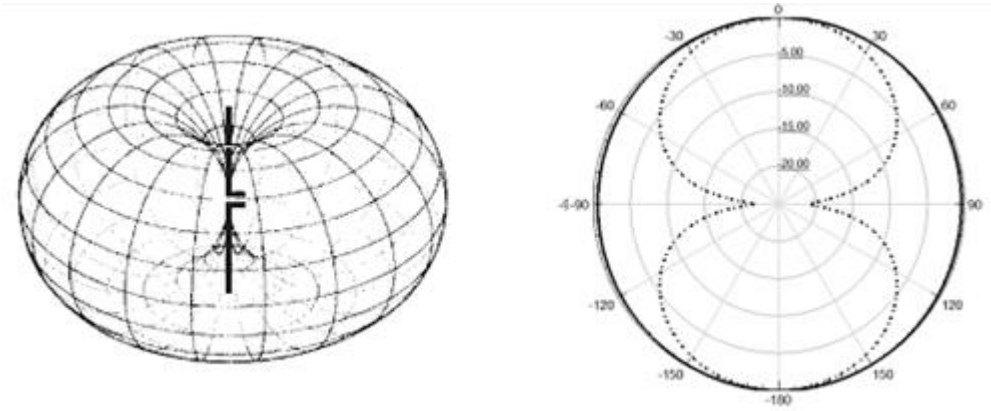
NB. for an antenna to be efficient, its physical extent must be at least an appreciable fraction of a wavelength at the operating frequency.

How does an antenna radiate?

- An antenna radiates via the change in field caused by the acceleration of charge along the antenna



Radiation pattern



Ideal Dipole Isotropic radiation pattern

Antenna Gain

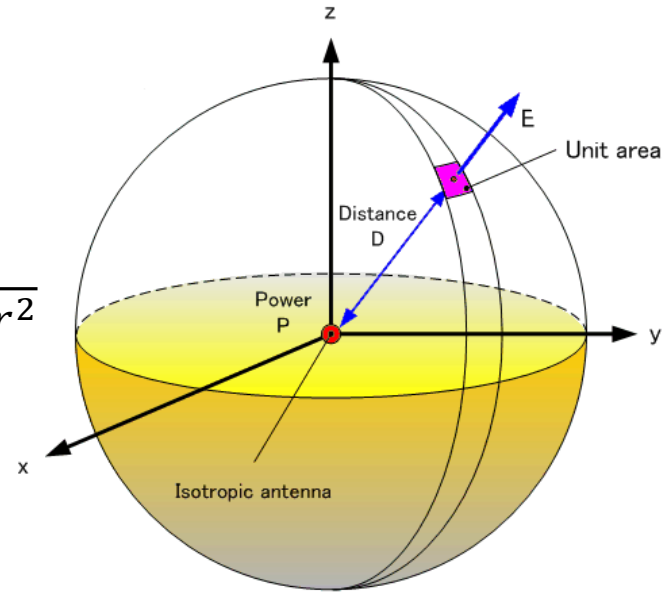
$$G = \varepsilon_r \mathrm{D}$$

Directivity, D: the ratio of the power density at the power peak to the average power density at the same distance.

Radiation Efficiency, ε_r: how efficiently the antenna coverts electrical power to radiated power (antenna have I^2R losses)

Power Density

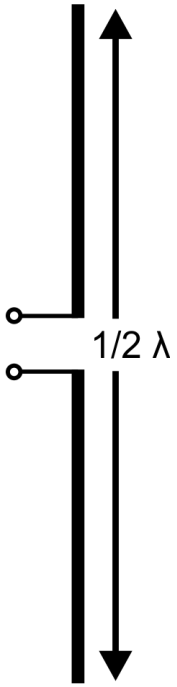
$$P_D = \frac{P}{4\pi r^2}$$



Radiated power density decreases with the ratio $1/r^2$

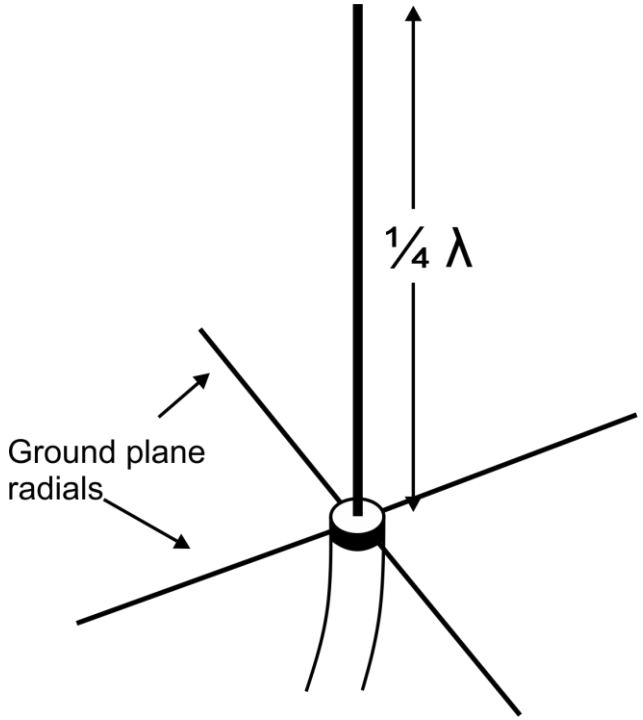
Antenna Types 1

Dipole



- The radiating/active element is ¼ λ long
- The radials create a virtual RF ground which reflects the radio waves

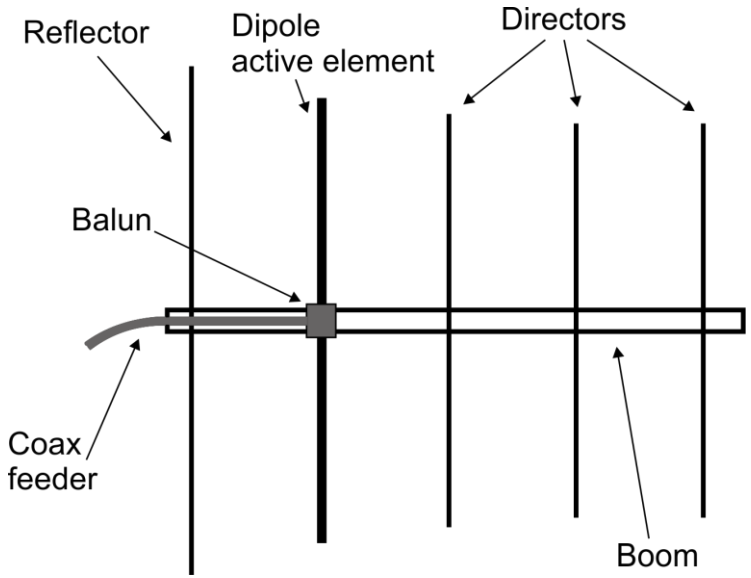
¼ λ ground plane



- The radiating/active element is ¼ λ long
- The radials create a virtual RF ground which reflects the radio waves

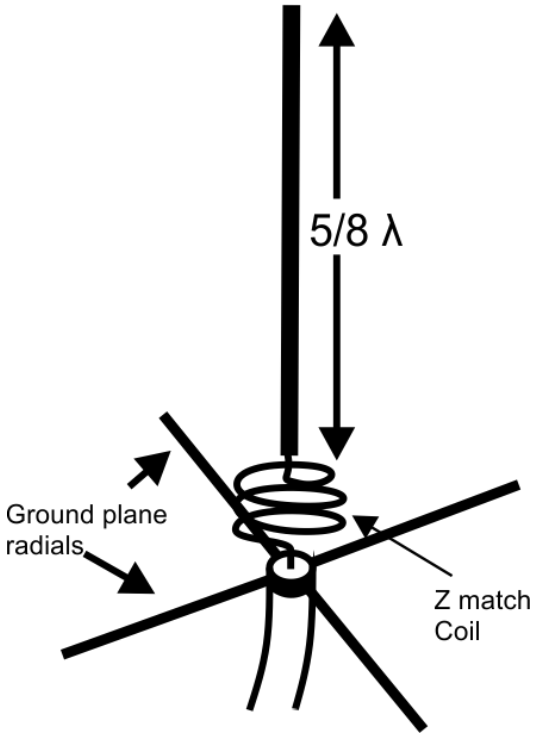
Antenna Types 2

Yagi



- The radiating/active element is ¼ λ long
- The radials create a virtual RF ground which reflects the radio waves

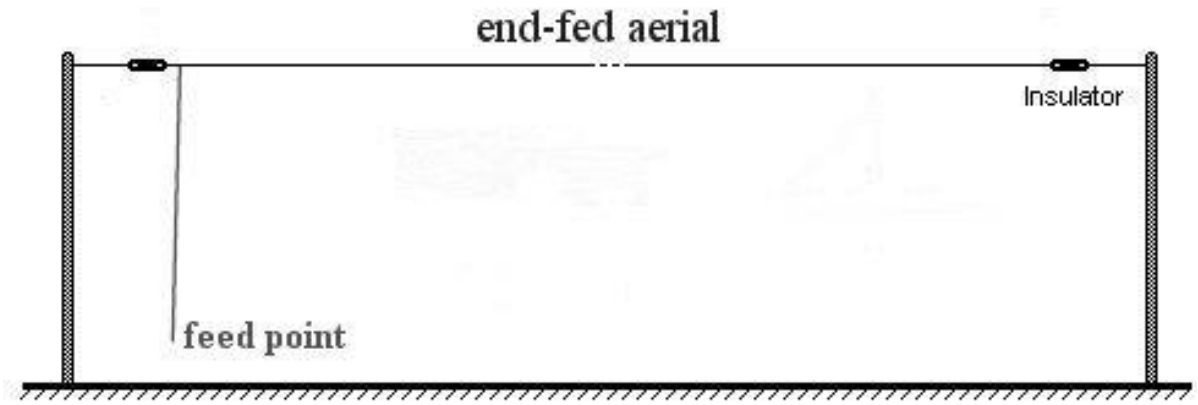
$^{5}/_{8}$ λ ground plane



- The radiating/active element is ¼ λ long
- The radials create a virtual RF ground which reflects the radio waves

Antenna Types 3

End-fed



- One of the simplest forms of antenna
- For HF broadband applications where space is limited.
- Not a tuned antenna and often of random lengths,
- Requires external matching circuits when used as a transmission antenna.
- Can have EMC issues