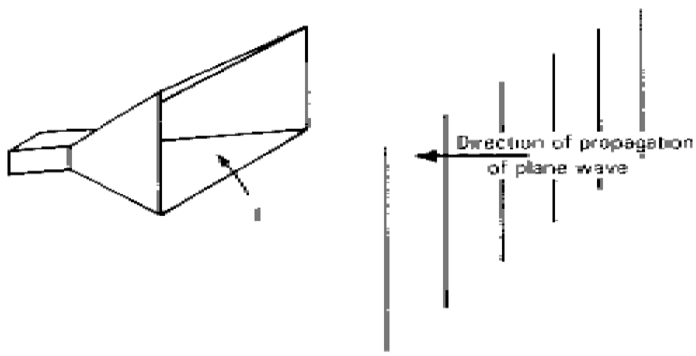
EFFECTIVE APERTURE

Aperture Concept: Aperture of an Antenna is the area through which the power is radiated or received. Concept of Apertures is most simply introduced by considering a Receiving Antenna. Let receiving antenna be a rectangular Horn immersed in the field of uniform plane wave as shown,



Let the poynting vector or power density of the plane wave be S watts/sq –m and let the area or physical aperture be A_p sq-m.If the Horn extracts all the power from the Wave over it's entire physical Aperture A_p, Power absorbed is given by $P=SA_p=(E^2/Z)A_p$ Watts, S is poynting vector ,

Z is intrinsic impedance of medium, E is rms value of electric field

But the Field response of Horn is not uniform across A_p because E at sidewalls must equal zero. Thus effective Aperture Ae of the Horn is less than Ap.

Aperture Efficiency is as follows:

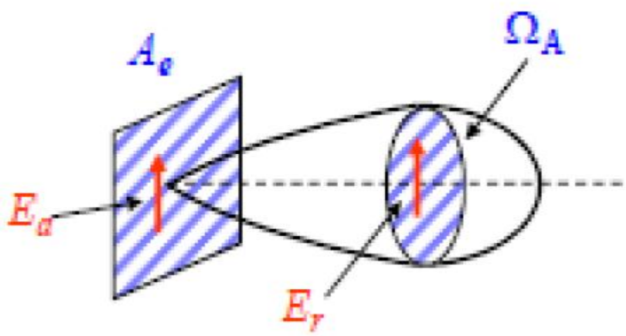
$$\varepsilon_{ap} = \frac{A_e}{A_p}$$

The effective antenna aperture is the ratio of the available power at the terminals of the antenna to the power flux density of a plane wave incident upon the antenna, which is matched to the antenna in terms of polarization. If no direction is specified, the direction of maximum radiation is implied**.** Effective Aperture (Ae) describes the effectiveness of an Antenna in receiving mode, It is the ratio of power delivered to receiver to incident power density

It is the area that captures energy from a passing EM wave

An Antenna with large aperture (Ae) has more gain than one with smaller aperture(Ae) since it captures more energy from a passing radio wave and can radiate more in that direction while transmitting

Effective Aperture and Beam area: Consider an Antenna with an effective Aperture A_e which radiates all of it's power in a conical pattern of beam area Ω_A, assuming uniform field E_a over the aperture, power radiated is



$$P = \frac{E_a^2}{z_0} A_e$$

Assuming a uniform field E_r in far field at a distance r, Power Radiated is also given by $P = \frac{E_r^2}{z_0} r^2 \Omega_A$

Equating the two and noting that $E_r = E_a A_e / r\lambda$ we get Aperture –Beam area relation $\lambda^2 = A_e \Omega_A$

At a given wavelength if Effective Aperture is known, Beam area can be determined or vice- versa

Directivity in terms of beam area is given by $D = \frac{4\Pi}{\Omega_A}$

Aperture and beam area are related by $\lambda^2 = A_e \Omega_A$

Directivity can be written as $D = \frac{4\Pi}{\lambda^2} A_e$

Source : http://elearningatria.files.wordpress.com/2013/10/ece-vi-antennas-and-propagation-10ec64-notes.pdf