STERADIAN, GAIN, DIRECTIVITY AND EFFECTIVE LENGTH

Steradian

The steradian (symbol: **sr**) is the SI unit of solid angle. It is used to describe two-dimensional angular spans in three-dimensional space, analogous to the way in which the radian describes angles in a plane.

A steradian can be defined as the solid angle subtended at the center of a unit sphere by a unit area on its surface. For a general sphere of radius *r*, any portion of its surface with area *A* subtends one steradian.

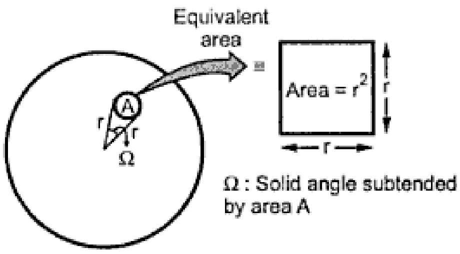

Fig 4 Representation of 1 steradian solid angle

$= r^2$

Analogue to radians:

In two dimensions, the angle in radians is related to the arc length it cuts out:

$$\theta = \frac{l}{r}$$

where , *l* is arc length, and

r is the radius of the circle.

Now in three dimensions, the solid angle in steradian is related to the area it cuts out:

$$\Omega = \frac{S}{r^2}$$

where, *S* is the surface area, and

r is the radius of the sphere.

Directivity

The directivity of an antenna is the maximum value of its directive gain. Directive gain is represented as $D(\theta, \phi)$, and compares the radiation intensity (power per unit solid angle) U that an antenna creates in a particular direction against the average value over all directions:

$$D(\theta, \phi) = \frac{U}{\text{Total radiated power}/\,(4\pi)}$$

where, θ and ϕ are the standard spherical coordinates angles

U is the radiation intensity

The beam solid angle, represented as Ω_A, is defined as the solid angle which all power would flow through if the antenna radiation intensity were constant and maximum value. If the beam solid angle is known, then directivity can be calculated as:

$$D = \frac{4\pi}{\Omega_A}$$

which simply calculates the ratio of the beam solid angle to the total surface area of the sphere it intersects.

Gain

Analogously to the directivity factor, the gain G is the ratio of the radiation intensity F_{max} obtained in the main direction of radiation to the radiation intensity F_{i0} that would be generated by a loss-free isotropic radiator with the same input power P_{t0}

$$G = F_{max} / F_{i0}$$

where, $F_{i0} = P_{t0} / 4\pi$

In contrast to the directivity factor, the antenna efficiency η is taken into account in the above equation since the following applies:

$$G = \eta D$$

Gain and directivity factor are often expressed in a logarithmic form:

g = 10 log G [dB] and d = 10 log D [dB]

Effective length

For antennas which are not defined by a physical area, such as monopoles and dipoles consisting of thin rod conductors, the aperture bears no obvious relation to the size or area of the antenna. An alternate measure of antenna gain that has a greater relationship to the physical structure of such antennas is effective length l_{eff} measured in meters, which is defined for a receiving antenna as:

$$l_{eff} = V_0 / E_s$$

where, V_0 is the open circuit voltage appearing across the antenna's terminals.

E_s is the electric field strength of the radio signal, in volts per meter, at the antenna.

The longer the effective length the more voltage and therefore the more power the antenna will receive. Note, however, that an antenna's gain or A_{eff} increases according to the *square* of l_{eff}, and that this proportionality also involves the antenna's radiation resistance

Source : http://msk1986.files.wordpress.com/2013/09/7ec1_antenna-wave-propagation_unit-1.pdf