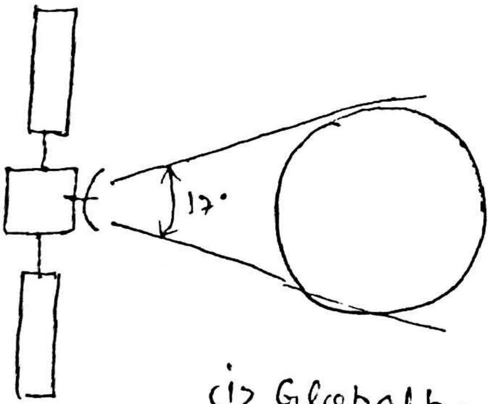
Satellite antennas:- Following main types of anteannas are used on satellite -

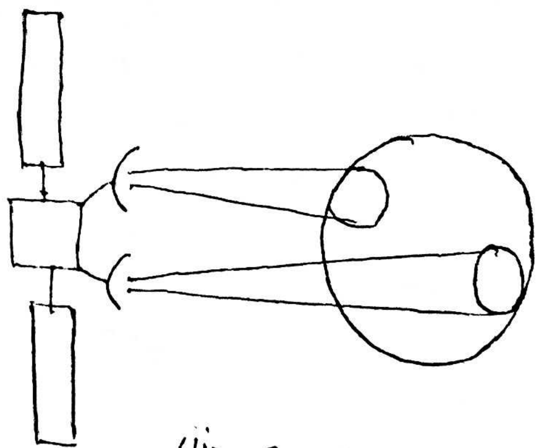
→ 1. Wire antennas
→ 2. Horn antenna
→ 3. Reflector antenna
→ 4. Array antenna

→1. **Wire antenna:-** Wire antennas are used primarly at at VHF and UHF to provide communication for the TTC&M system. They are positioned with great care on the body of the satellite to provide omnidirectional coverage.

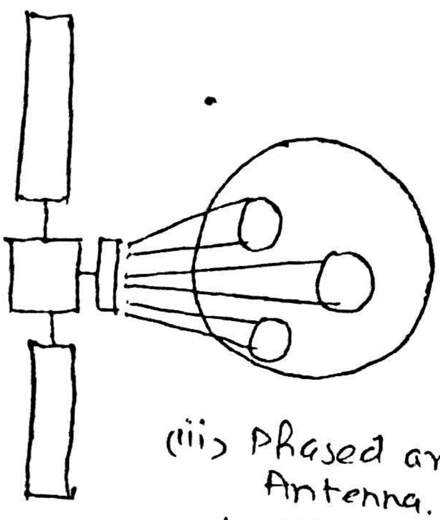
The figure shows typical antenna Pattern and coverage zones.



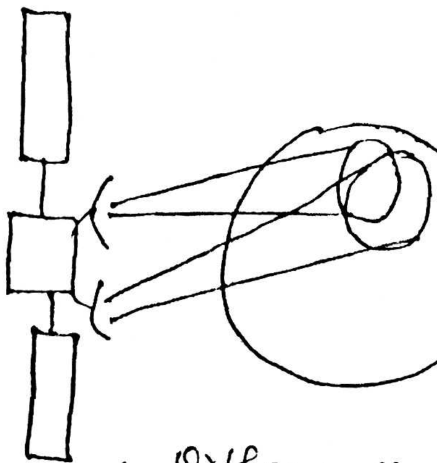
(i) Global beam antenna



(ii) Spot beam antenna



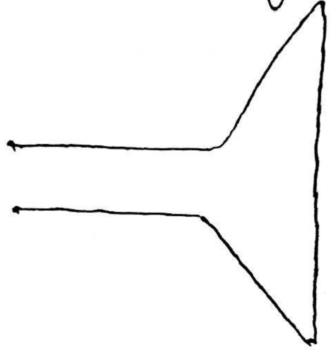
(iii) Phased array Antenna.
multiple spot beams &



(iv) Orthogonally polarized beams

Antenna for global beam is a waveguide horn. The scanning beam and shaped beams are require phased array antennas or reflector antennas with phased array.

Horn antenas are used at microwave frequencies when relatively wide beams are required as for global coverage. The Horn antennas are also used as feeds for reflectors, either singaly or in clusters. Horn and reflectors are examples of aperture antennas. They launch a wave into free space from wave guide.



Horn Antennas

The Gain of aperture antenna can be given by-

$$G = \eta_A \frac{4\pi A}{\lambda^2} \quad \text{------------ (i)}$$

where A = Area of Aperture antenna.

λ = Operating wavelength

η_A = Effeciency of aperture antenna.

The effeciency of aperture antenna can not easily determined but typically it is in the range of 55% to 68%, for reflector antenna with single feeds.

→ If the aperture is circular then equation (i) can be given as-

$$G = \eta_A \left[\frac{\pi D}{\lambda}\right]^2$$

, D = Aperture in meters

→ If aperture is parabolic then Gain can be given as bellow-

$$G = 6\left[\frac{D}{\lambda}\right]^2 \quad , \quad D = \text{Aperture in meters.}$$

The beamwidth between Half power point -

$$\boxed{\phi = \theta_{3dB} \approx \frac{75'\lambda}{D}} \text{ in degree}$$

The beamwidth and gain of antenna are related to each other. For antenna with $\eta_A = 60\%$, the gain is approximately -

$$G \approx \frac{33.000}{[\theta_{3dB}]^2}$$

→ Where θ_{3dB} in degree and G is not in decibels.

Problem :- *: The earth subtends an angle of 17° when viewed from geostationary orbit. What are the dimentions and gain of a horn antenna that will provide global coverage at 4 GHz.

Global beam antenna

Solution :-

Given, $\alpha = 17°$

Global coverage at 4 GHz.

∴ 3-dB beamwidth of 17°.

$$\frac{D}{\lambda} = \frac{75'}{\theta_{3dB}} = \frac{75'}{17} = 4.4$$

at 4 mHz the value of λ -

$$\lambda = \frac{c}{f} = \frac{3\times 10^8 \text{ m/sec}}{4\times 10^9}$$

$$= \frac{3\times 10^{-1}}{4} = \frac{30\times 10^{-2}}{4}$$

$\lambda = 0.0075$ m.

Hence diameter

$D = 4.4 \times \lambda = .330$ m.

Now. The gain of antena.

$$G = \frac{33000}{(\theta_{3dB})^2} \approx \frac{33000}{(17)^2}$$

$= 114.18$

$f = 4$ GHz

$$\lambda = \frac{c}{f}$$

$$= \frac{3\times 10^8 \text{ m/sec}}{4\times 10^9}$$