Antenna Basics

- Basic Antenna Concepts
- Radiation Pattern
- Antenna Gain

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Introduction

- An antenna is an electrical conductor or system of conductors
  - Transmission - radiates electromagnetic energy into space
  - Reception - collects electromagnetic energy from space
- Transmission from Guided to Unguided Media
- An antenna acts as the interface between the BTS feeder cable and the air.

ANTENNA TYPES

Basically two antenna types are used in all mobile telephony systems:

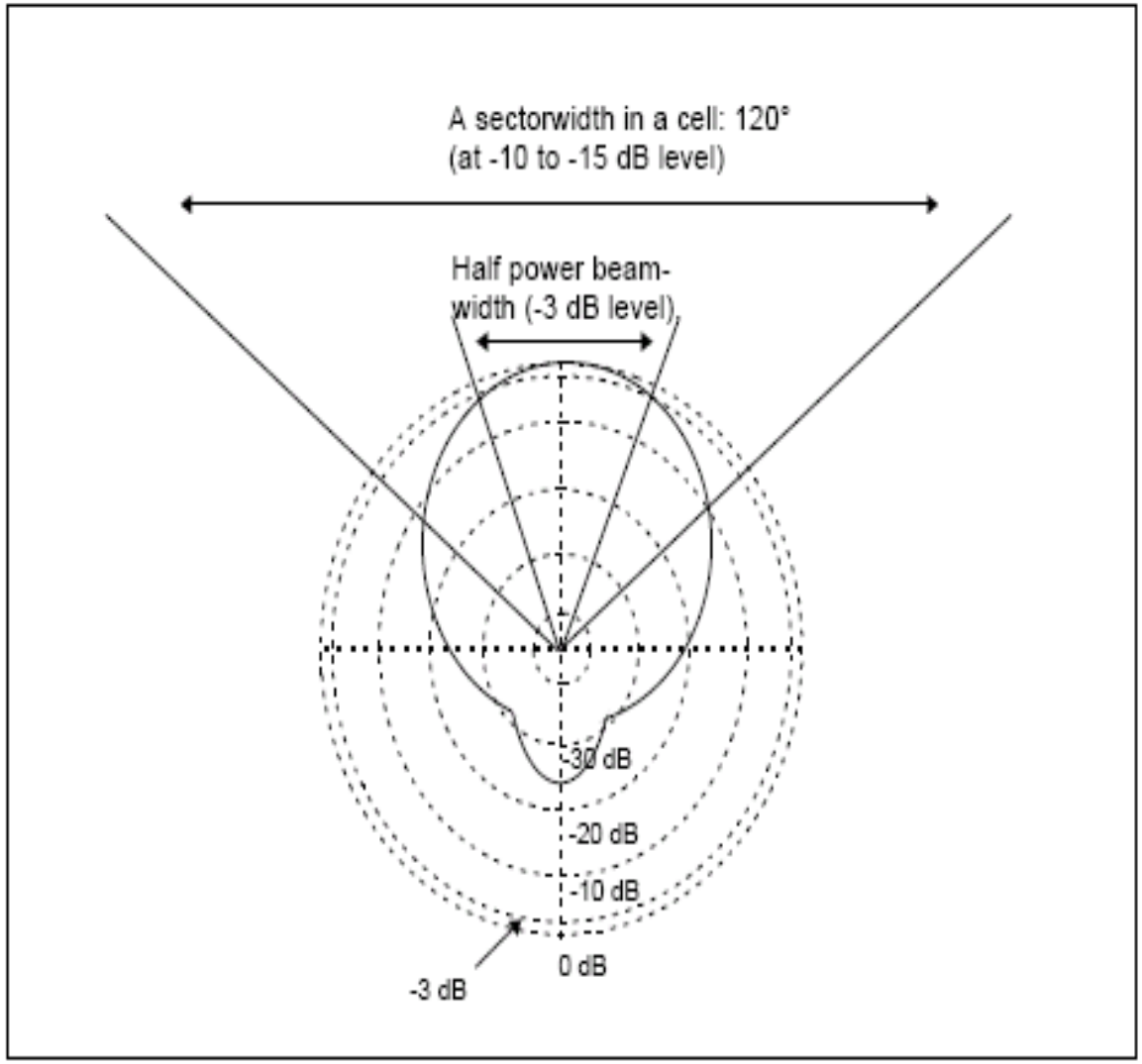
- omni directional and directional (sector) antennas.
- An omni directional antenna radiates equally in the horizontal plane (360°)
- while a directional antenna only radiates in a certain direction (sector).

RADIATION PATTERN

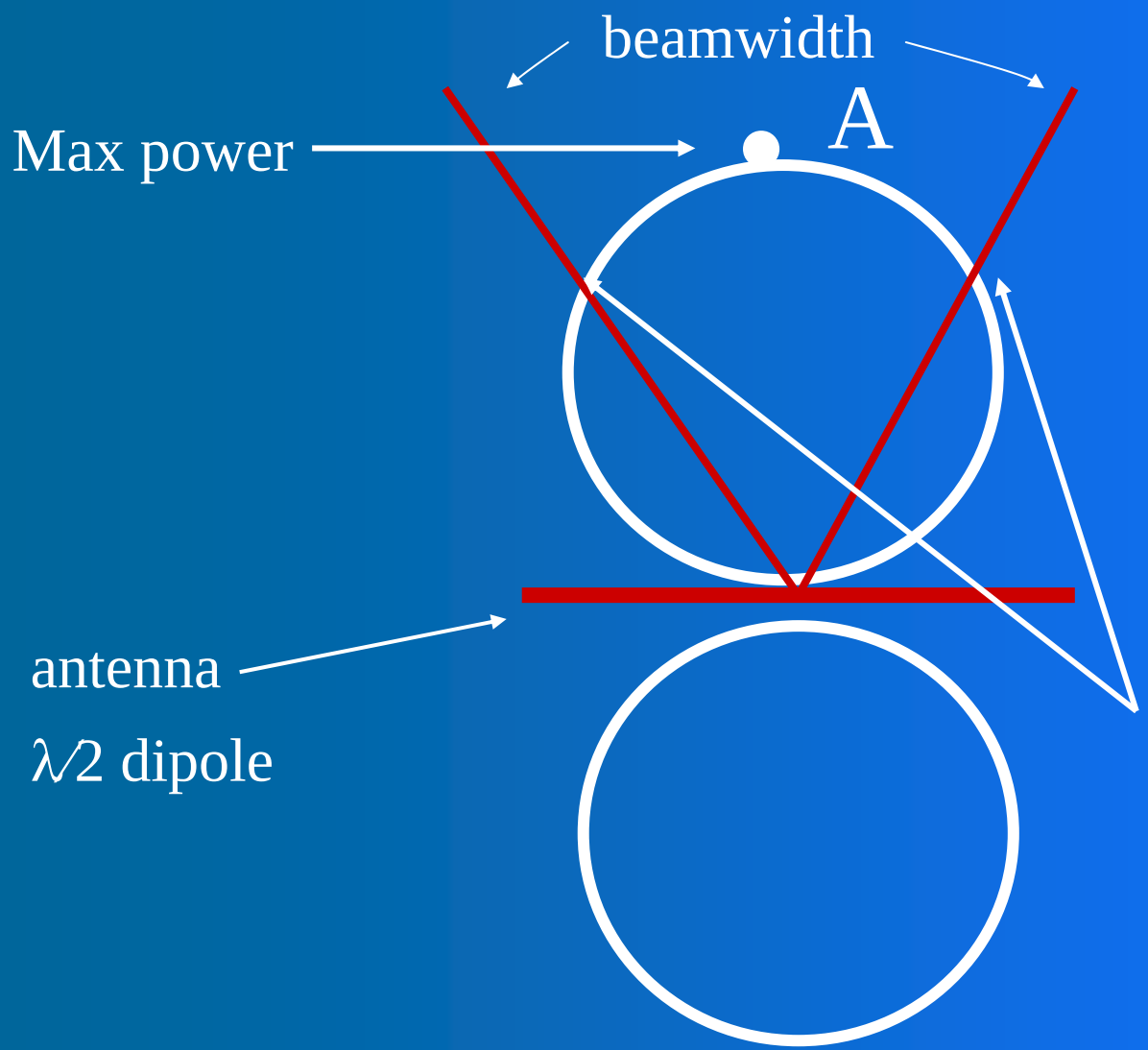
- An antenna in a mobile telephony system shall normally radiate the power from the transmitter as much as possible in the horizontal plane and as little as possible in the vertical plane. How well this is done (the antenna performance) can be seen in the radiation pattern. It is always presented in the horizontal plane but can also be shown in the vertical plane.

Radiation Patterns

- Radiation pattern
  - Graphical representation of radiation properties of an antenna
  - Depicted as two-dimensional cross section
- Beam width (or half-power beam width)
  - Measure of directivity of antenna
- Reception pattern
  - Receiving antenna’s equivalent to radiation pattern


A sectorwidth in a cell: 120°
(at -10 to -15 dB level)
Half power beam-
width (-3 dB level)
-30 dB
-20 dB
-10 dB
0 dB
-3 dB

Directional Antenna



Radiated energy is focused in a specific direction

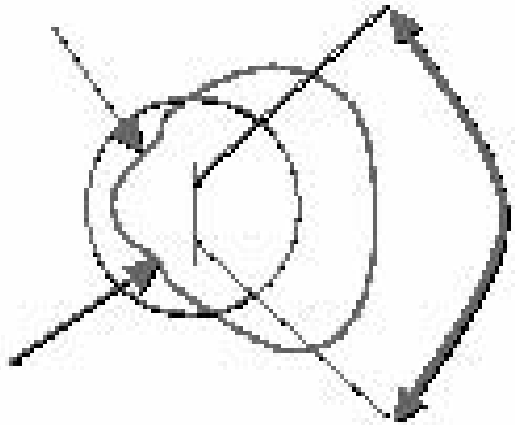
Power 3dB down from maximum point A

Beamwidth

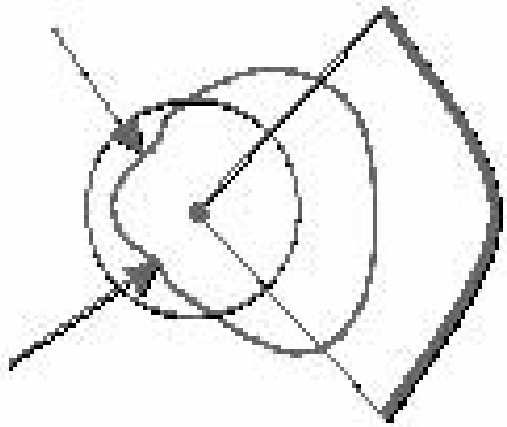
- *Beamwidth* is the angular separation of the half-power points of the radiated pattern.

Directional Antennas

- For directional antennas the lobes are pushed in a certain direction, causing the energy to move be condensed in a particular area
- Very little energy is in the back side of a directional antenna



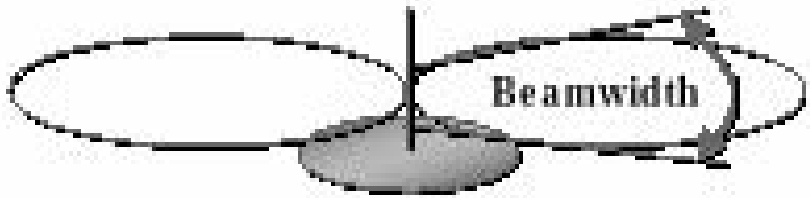
Side View
(Vertical Pattern)



Top View
(Horizontal Pattern)

High Gain Omnidirectionals

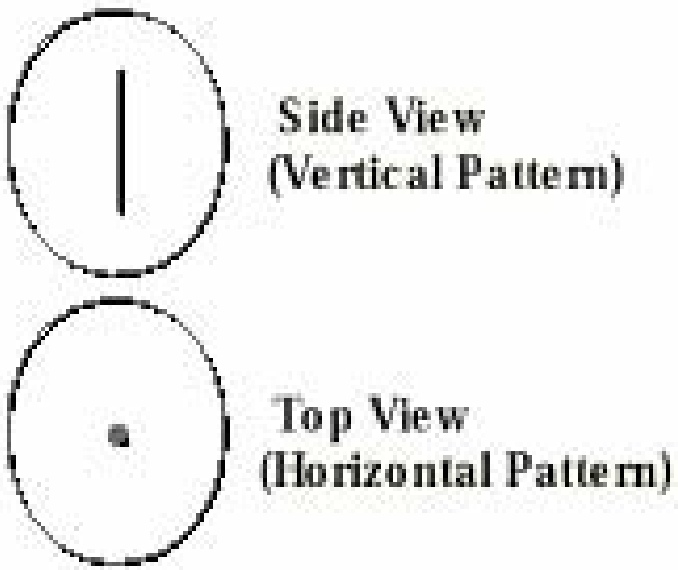
- High gain omnidirectional antennas will create more coverage area in far distances, but the energy level directly below the antenna will become lower, and coverage here may be poor



Area of Poor Coverage Directly Under the Antenna

Antenna Theory

- A theoretical antenna (Isotropic) has a perfect 360 degree vertical and horizontal beamwidth
- This is a reference for all antennas



The Antenna Formula

$$\lambda = c/f = \frac{186{,}000\ mi/sec}{frequency\ of\ the\ signal}$$

- *c is the speed of light*
- *λ is the wavelength of the signal*
- *λ use 3 x 10^8 when dealing in meters for the speed of light*

The Antenna Formula - applied

- If a half-wave dipole antenna needed to be constructed for a 90 Hz signal, how large would it need to be?

$$\lambda = c/f = \frac{186{,}000\ mi/sec}{90} = 2066\ \text{mi}$$

$\lambda/2 = 1033$ miles!

Antenna Gain

- *Antenna gain* is the measure in dB how much more power an antenna will radiate in a certain direction with respect to that which would be radiated by a reference antenna

Antenna Gain

- Relationship between antenna gain and effective area

$$G = \frac{4\pi A_e}{\lambda^2} = \frac{4\pi f^2 A_e}{c^2}$$

  - G = antenna gain
  - A_e = effective area
  - f = carrier frequency
  - c = speed of light (» 3 ´ 10^8 m/s)
  - λ = carrier wavelength

Antenna Gain

- In life you never get 'something for nothing', the same is true in antenna gain
- If the gain of an antenna goes up, the coverage area or angle goes down
- Coverage areas or radiation patterns are measured in degrees
- These angles are referred to as beamwidth, and have a horizontal and vertical measurement

Q&A

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