Home Work

Media Access Control, CSMA/CA

Antenna Considerations

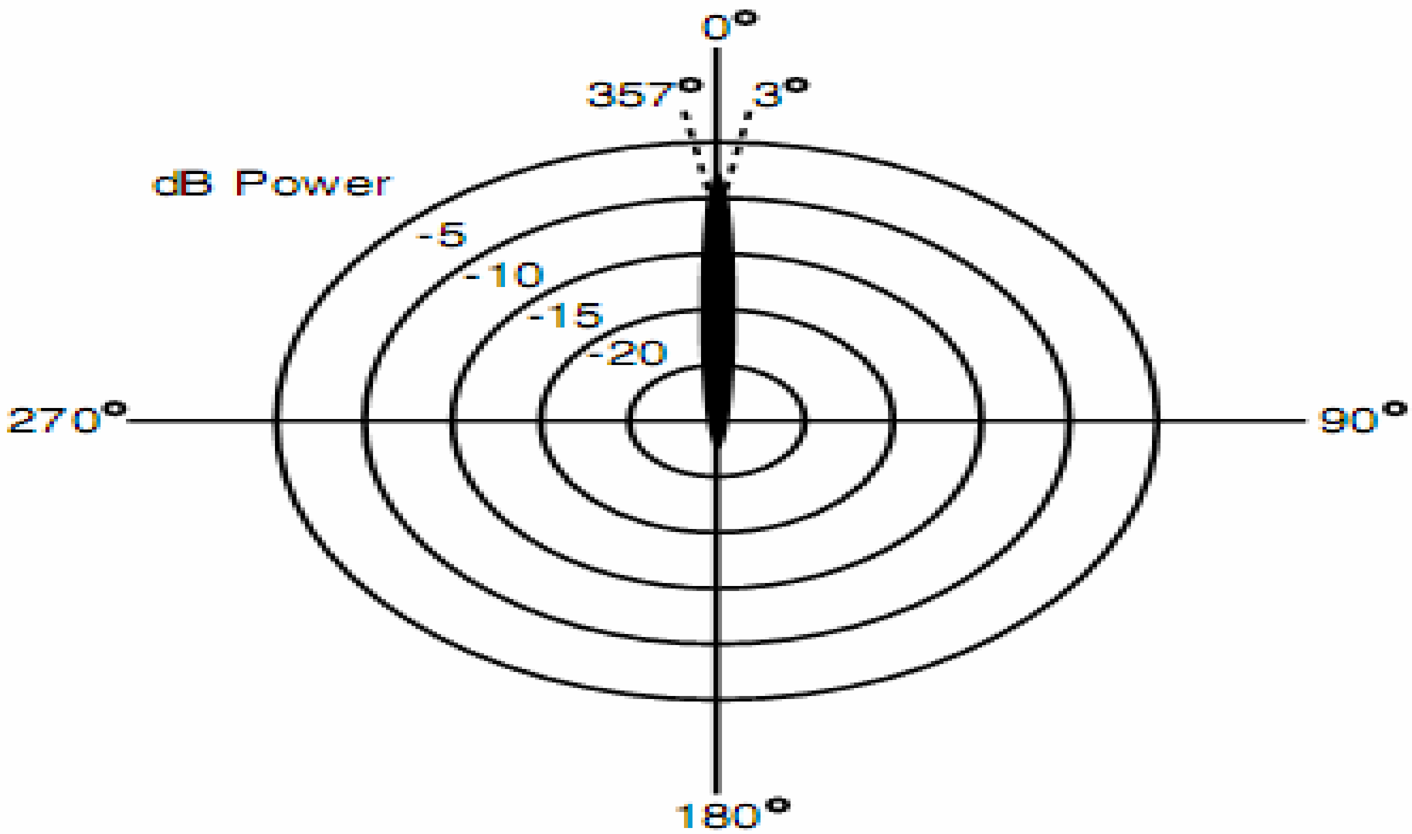
Antenna job is to both transmit a signal as well as shape and focus a received signal so that it can be understood.

Radiation Pattern

- There are many types of antennas they all have a radiation pattern. That pattern indicates the power radiated in any direction relative to the direction of maximum radiation.

- Although the actual radiation pattern of any antenna is a three-dimensional function, when we work with pen and paper the pattern is specified in terms of a two-dimensional/two-dimensional diagram. This two-dimensional/two dimensional pattern illustrates the beam pattern of the antenna with respect to a 360-degree circle.

Figure below illustrates an example of the radiation pattern for a near-directional antenna.



The Radiation Pattern for a Directional Antenna

- Note that most of the antenna’s radiated power is concentrated in a narrow beam. Also note that the concentric circles radiating outward from the center of the circle indicate the signal strength.

Beamwidth

- In the example shown in Figure Above, the beam pattern is relatively narrow, which results from the fact that a directional antenna’s beam pattern is shown.
- The actual beam pattern results from several factors. Those factors can include:
- the shape of the antenna,
- the use of a reflector behind the antenna to focus its transmitted power,
- its angle of elevation,
- and the presence of objects, and
- the ground beneath the antenna.

- These contributing factors result in the radiated signal consisting of the transmitted signal as well as reflected signals. Some of the reflections may cancel one another, while other reflections can be additive. If you carefully examine Figure above, you will note that reflections from about 3 degrees to 357 degrees rapidly dissipate and the beamwidth, which is shown as 6 degrees, ranging from 357 degrees through 3 degrees, represents the direction of maximum radiation.

- An antenna gives the wireless system three fundamental properties: gain, direction and polarization. Gain is a measure of increase in power. Gain is the amount of increase in energy that an antenna adds to a radio frequency (RF) signal. Direction is the shape of the transmission pattern. As the gain of a directional antenna increases, the angle of radiation usually decreases. This provides a greater coverage distance, but with a reduced coverage angle. The coverage area or radiation pattern is measured in degrees. These angles are measured in degrees and are called beamwidths .

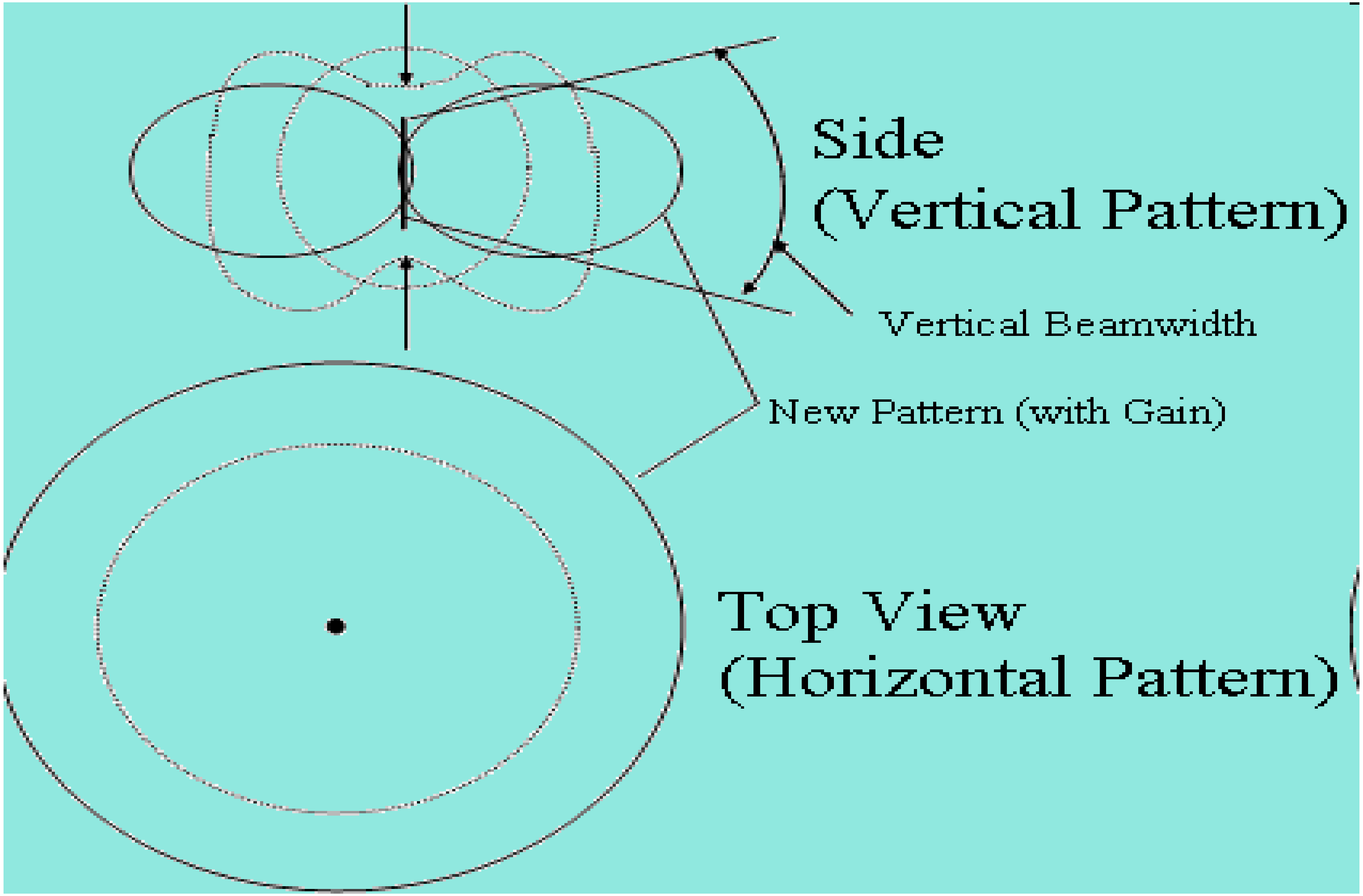
- An antenna is a passive device which does not offer any added power to the signal. Instead, an antenna simply redirects the energy it receives from the transmitter. The redirection of this energy has the effect of providing more energy in one direction, and less energy in all other directions .

- Beamwidths are defined in both horizontal and vertical plains. For an antenna you have horizontal beamwidth and vertical beamwidth.

- Antennas can be broadly classified as omnidirectional and directional antennas, which depends on the directionality .
- The dipole radiation pattern is 360 degrees in the horizontal plane and approximately 75 degrees in the vertical plane (this assumes the dipole antenna is standing vertically) and resembles a donut in shape.
- The higher the gain of the antennas, the smaller the vertical beamwidth is.

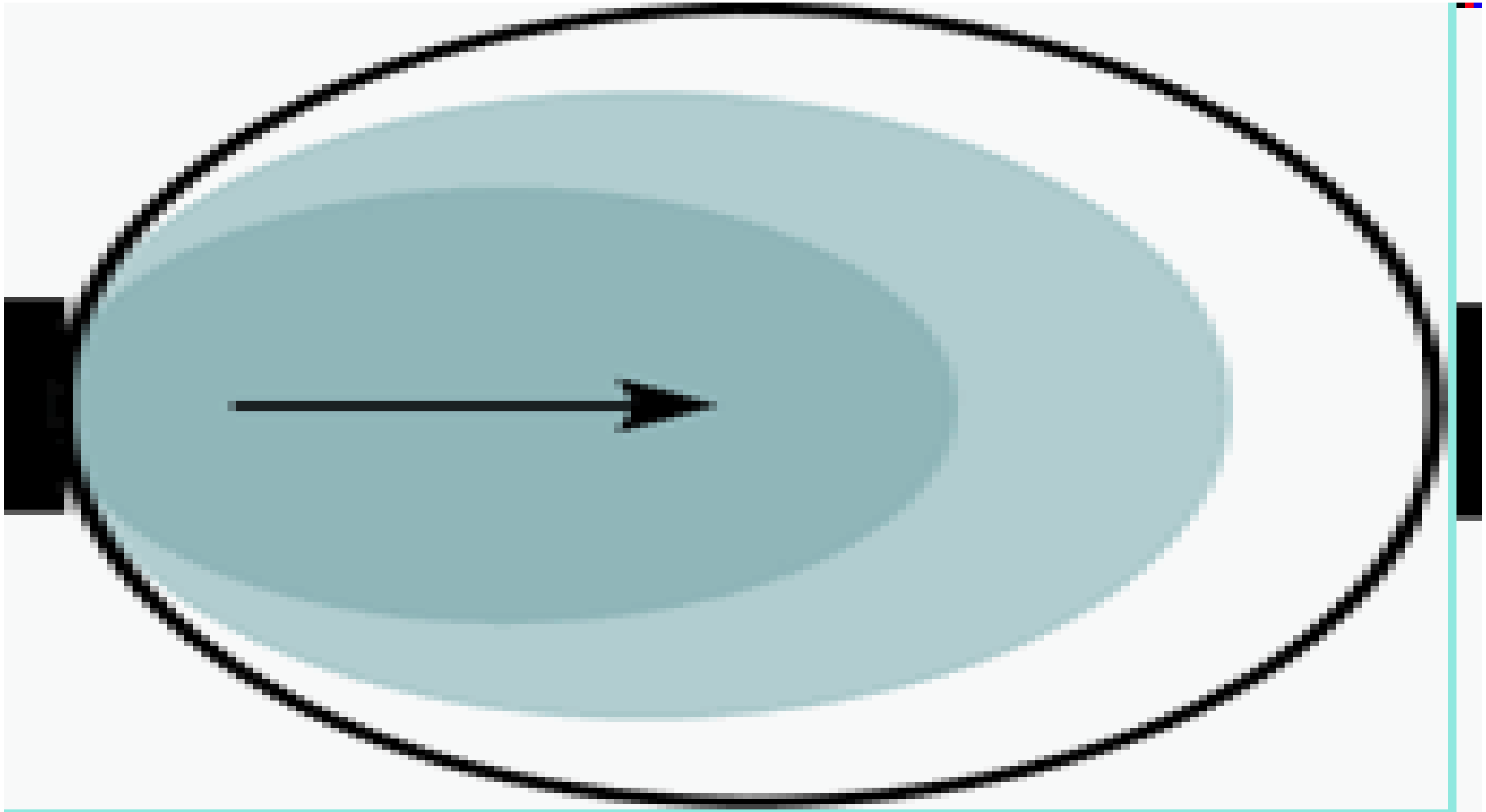
- Imagine the radiation pattern of an isotropic antenna as a balloon, which extends from the antenna equally in all directions. Now imagine that you press in on the top and bottom of the balloon. This causes the balloon to expand in an outward direction, which covers more area in the horizontal pattern, but reduces the coverage area above and below the antenna. This yields a higher gain, as the antenna appears to extend to a larger coverage area.

Radiation Pattern of an Omni Antenna

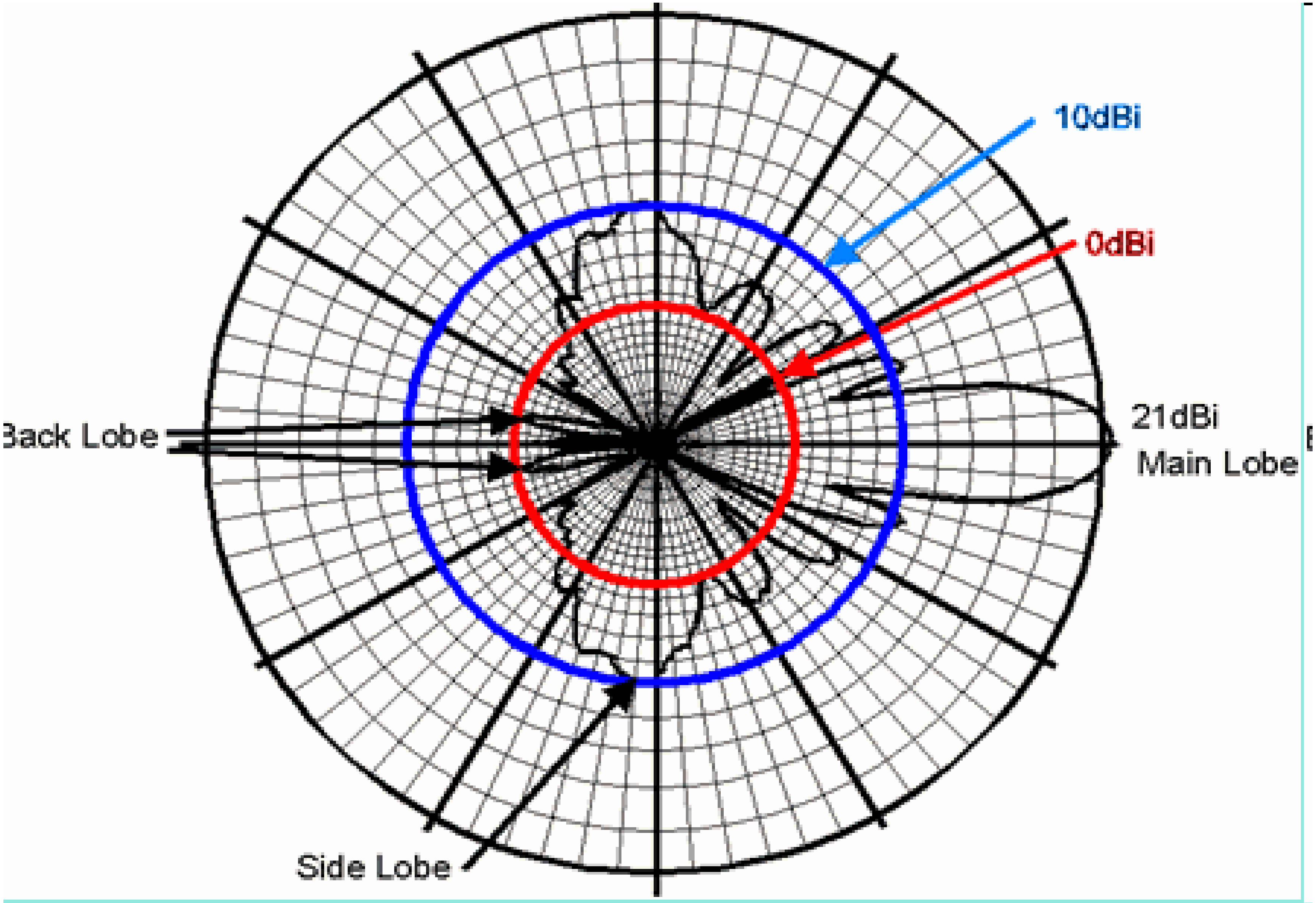


- **Directional antennas** focus the RF energy in a particular direction. As the gain of a directional antenna increases, the coverage distance increases, but the effective coverage angle decreases. For directional antennas, the lobes are pushed in a certain direction and little energy is there on the back side of the antenna .

Radiation Pattern of a Directional Antenna



- Another important aspect of the antenna is the **front-to-back ratio**. It measures the directivity of the antenna. It is a ratio of energy which antenna is directing in a particular direction, which depends on its radiation pattern to the energy which is left behind the antenna or wasted. The higher the gain of the antenna, the higher the front-to-back ratio is. A good antenna front-to-back ratio is normally 20 dB .

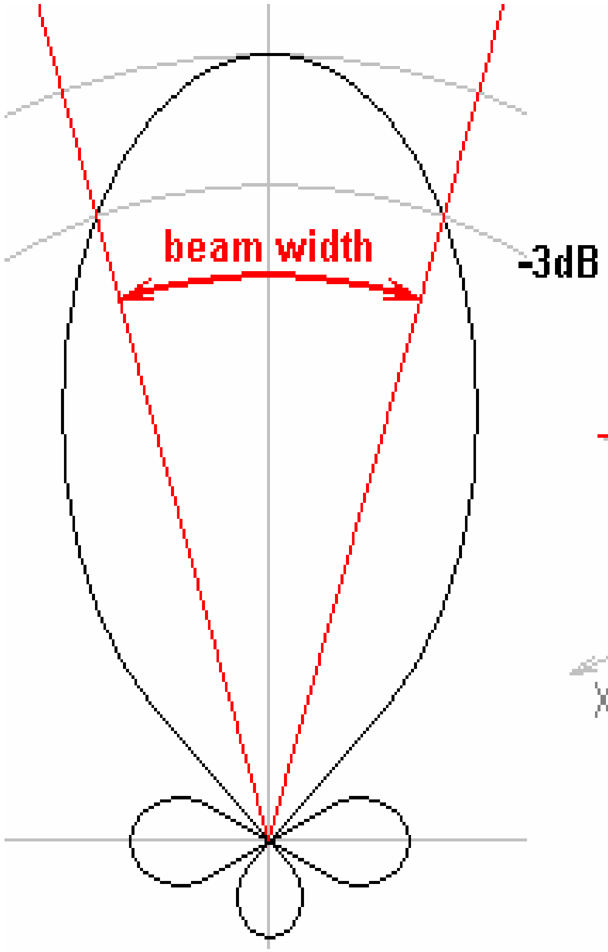

10dBi
0dBi
21dBi
Main Lobe
Back Lobe
Side Lobe

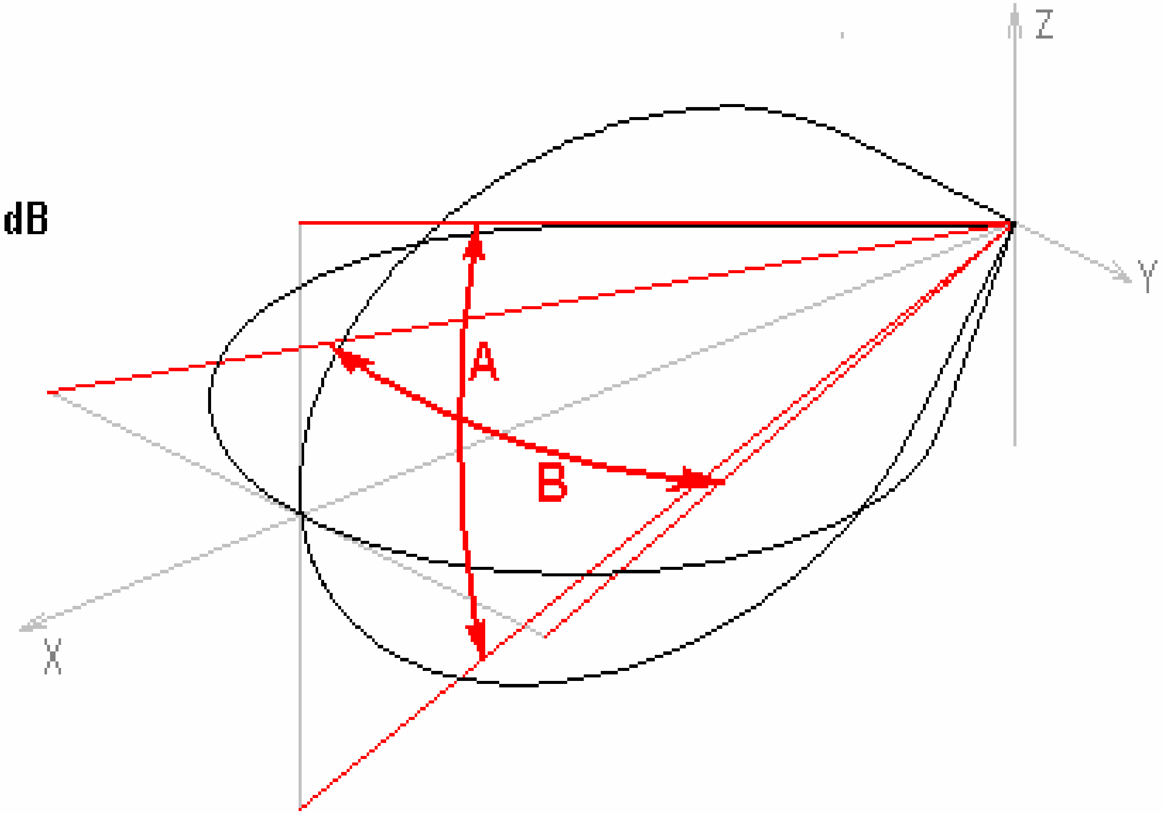
- An antenna can have a gain of 21 dBi, a front-to-back ratio of 20 dB or a front-to-side ratio of 15 dB. This means the gain in the backward direction is 1 dBi, and gain off the side is 6 dBi. In order to optimize the overall performance of a wireless LAN, it is important to understand how to maximize radio coverage with the appropriate antenna selection and placement .

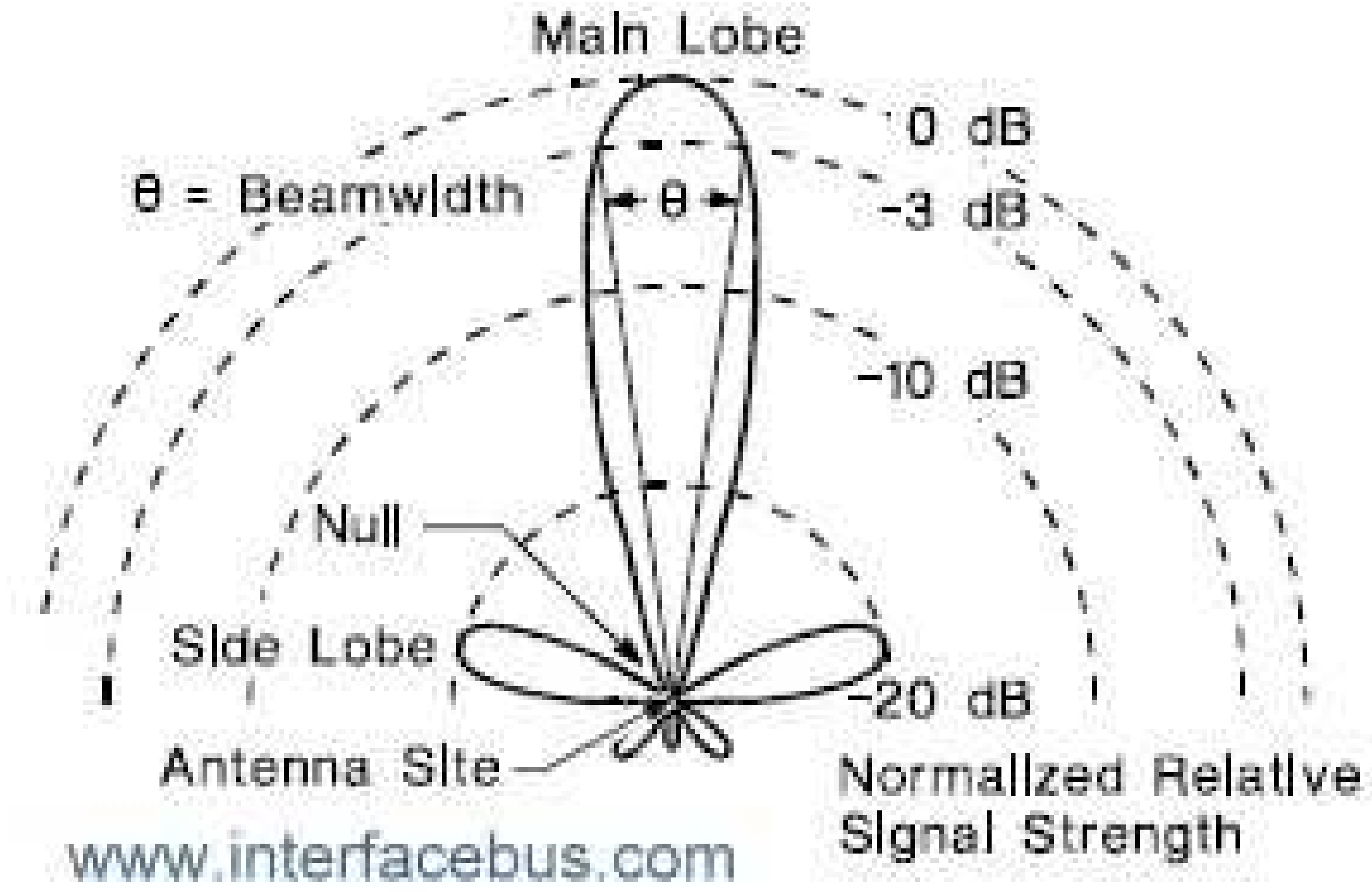
Beamwidth

- Many flashlights have adjustable lenses, allowing the user to widen or tighten the concentration of light that is radiating from them. RF antennas are capable of focusing the power that is radiating from them, but unlike flashlights, antennas are not adjustable .
- Beamwidth is the measurement of how broad or narrow the focus of an antenna is and is measured both horizontally and vertically.

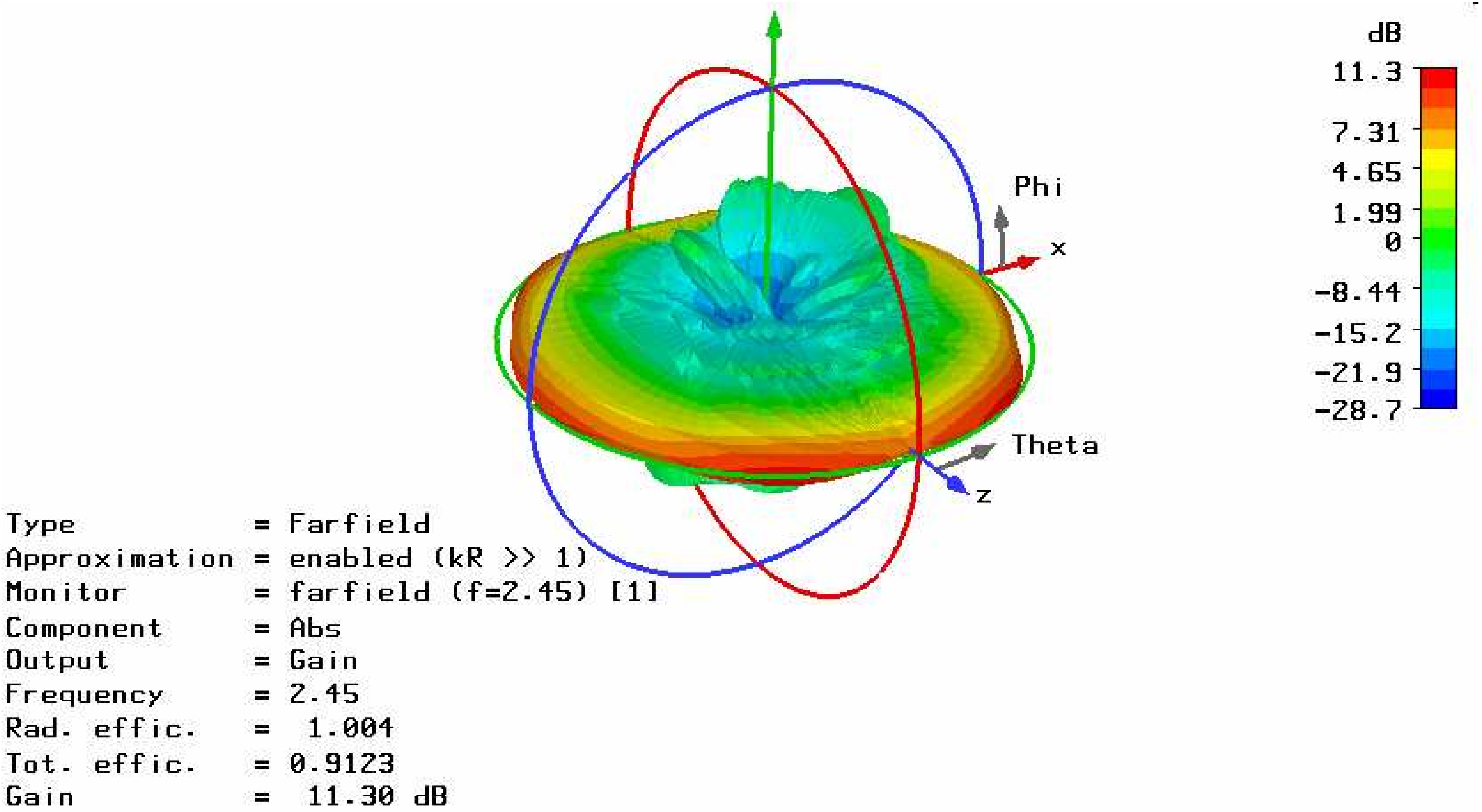
- The beam width is normally measured to the “half-power points .”That is, the beam width is the number of degrees between the points where the gain is 3 dB less than for the antenna’s strongest direction .

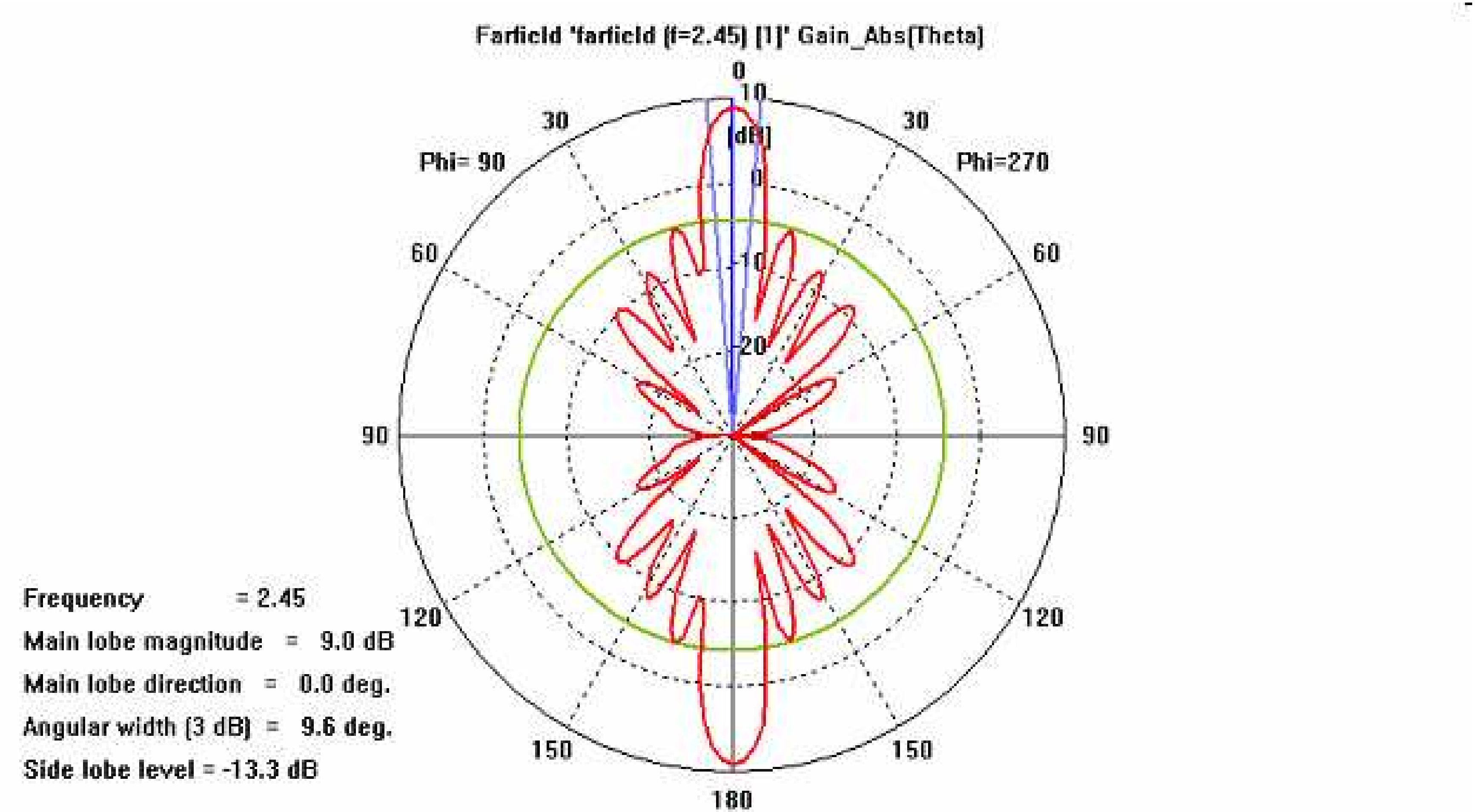

beam width
-3dB


Z
Y
X
A
B

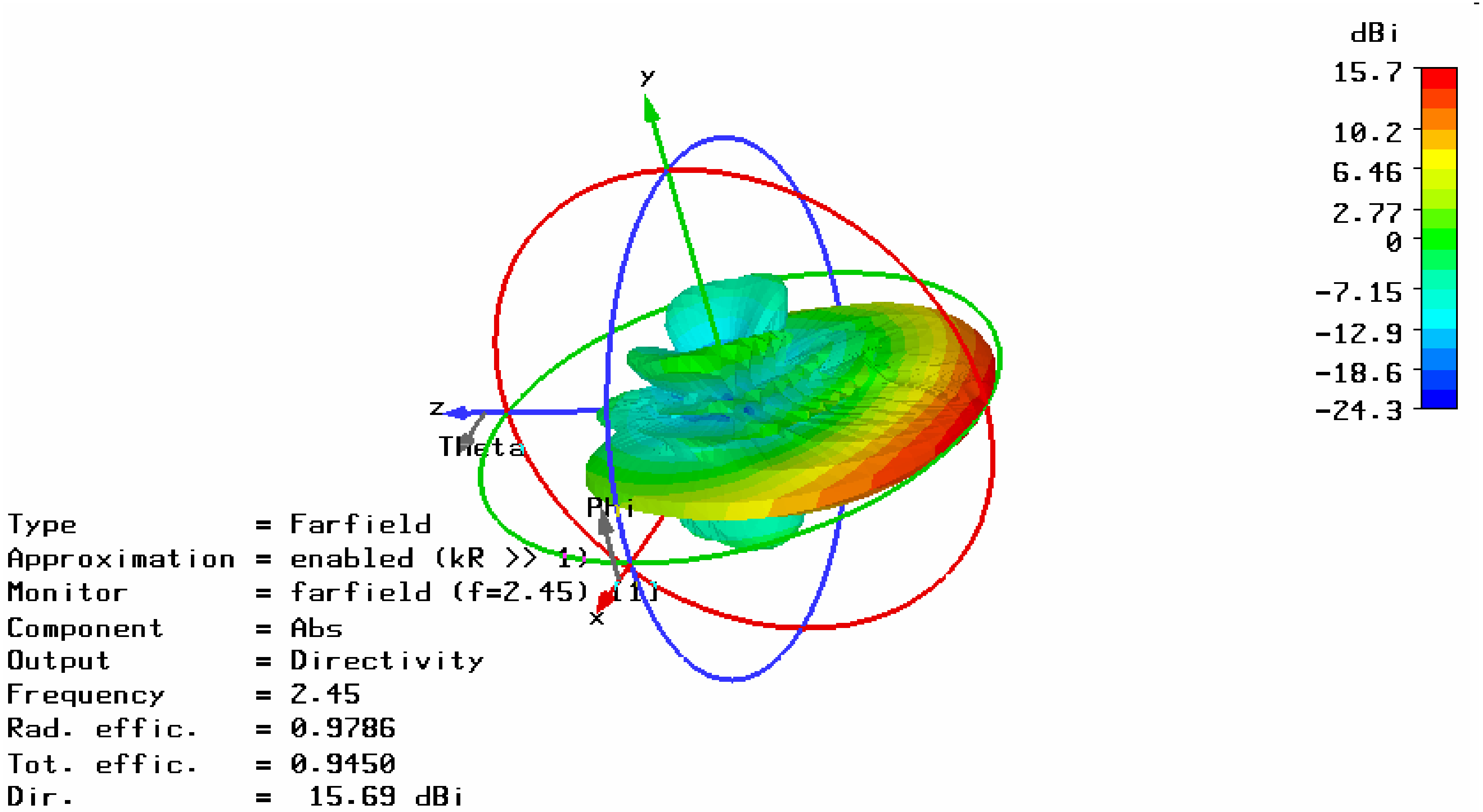

Main Lobe
0 dB
θ = Beamwidth
θ
-3 dB
-10 dB
Null
Side Lobe
-20 dB
Antenna Site
Normalized Relative
Signal Strength
www.interfacebus.com

- **ANTENNA BEAMWIDTH :**The angle, in degrees, between the half-power points (-3 dB) of an antenna beam. This angle is also nearly that between the center of the main-lobe and the first null. The angle is given for both horizontal and vertical planes unless the beam is circular. When so indicated, the term may refer to the angular width of the mainlobe between first nulls [beamwidth between first nulls (BWFN)]. See also Antenna Pattern .


dB
11.3
7.31
4.65
1.99
0
-8.44
-15.2
-21.9
-28.7
Phi
x
Theta
z
Type = Farfield
Approximation = enabled (kR >> 1)
Monitor = farfield (f=2.45) [1]
Component = Abs
Output = Gain
Frequency = 2.45
Rad. effic. = 1.004
Tot. effic. = 0.9123
Gain = 11.30 dB


Farfield 'farfield (f=2.45) [1]' Gain_Abs(Theta)
0
10
[dB]
0
-10
-20
30
30
Phi= 90
Phi=270
60
60
90
90
120
120
150
150
180
Frequency = 2.45
Main lobe magnitude = 9.0 dB
Main lobe direction = 0.0 deg.
Angular width (3 dB) = 9.6 deg.
Side lobe level = -13.3 dB

:A sector antenna would have a beam pattern that looked something like



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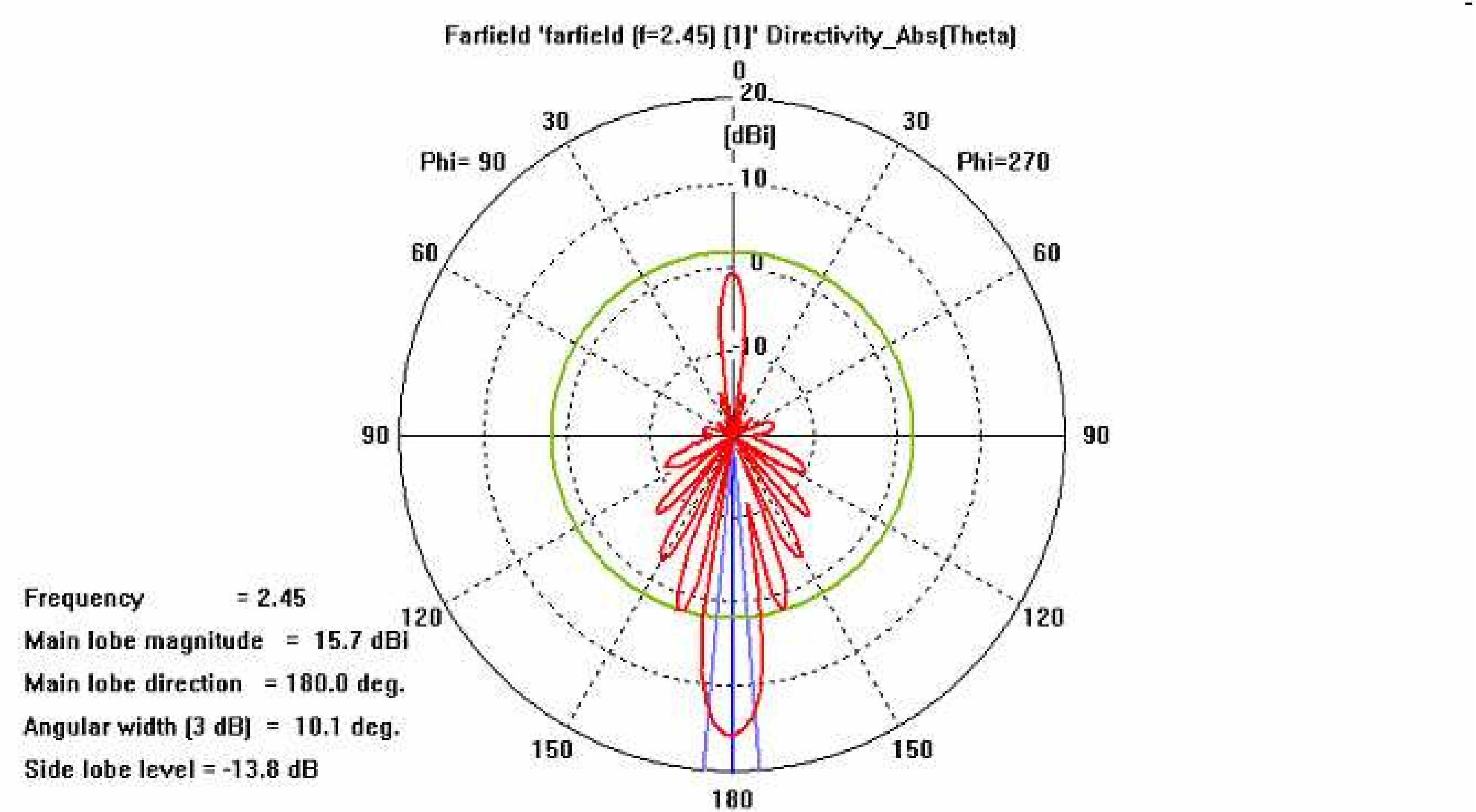
Farfield 'farfield (f=2.45) [1]' Directivity_Abs(Theta)
0
20
[dBi]
10
0
-10
30
30
Phi= 90
Phi=270
60
60
90
90
120
120
150
150
180
Frequency = 2.45
Main lobe magnitude = 15.7 dBi
Main lobe direction = 180.0 deg.
Angular width (3 dB) = 10.1 deg.
Side lobe level = -13.8 dB

This is a plot of a 15dBi directional antenna. The 3db power angles are 33.7 deg and 34.7 deg. If we choose a higher gain directional antenna the 3dB angles will be less. If we choose a lower gain the 3db angles will be more.