

Antennas

Olga Torstensson
Halmstad University

Key terms

- Lobes
- Directional
- Omnidirectional
- Beamwidth and Bandwidth
- Polarization
 - Vertical
 - Horizontal
- Diversity
- Plane (H and E)
- Fresnel Zone

Definition of Terms

Cisco.com

dB- Decibel- Ratio of one value to another

dBx where x =

- m = compared to 1 **milliwatt** (0 dBm=1 mW)
- i = compare to **isotropic** antenna
- d = compared to **dipole** antenna
- w = compared to 1 **watt** (0 dBw = 1 watt)

© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0-7-3

Important Antenna Concepts

Cisco.com

Important Antenna Concepts

Directionality

- Omnidirectional (360 degree coverage)
- Directional (limited angle of coverage)

Gain

- Measured in dBi and dBd. (0 dBd is equal to 2.14 dBi)
- More gain mean more coverage in certain directions

Polarization

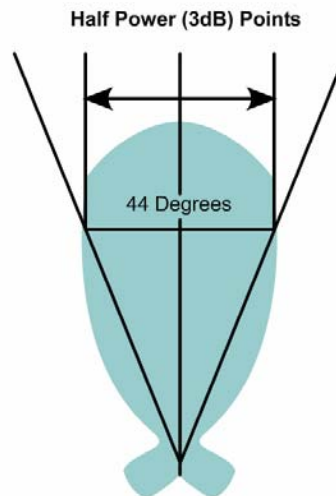
- Cisco Aironet antennas use vertical polarization.

© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0-7-4

Beamwidth

Cisco.com



© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0-7-5

Antenna Concepts

Cisco.com

Directionality

- Omni (360° coverage) directional
- Directional (limited range of coverage)

Gain

- Measured in dBi and dBd (0 dBd = 2.14 dBi)
- More gain means more coverage - in certain directions

Polarization

- Antennas are used in the vertical polarization

© 2003, Cisco Systems, Inc. All rights reserved.

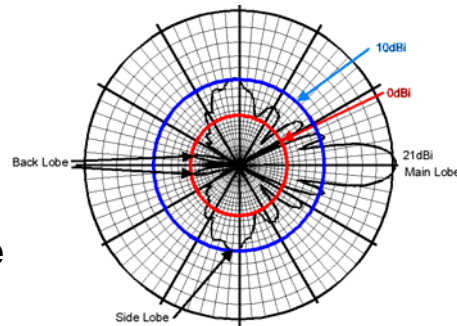
FWL 1.0-7-6

Antenna Issues (cont.)

Cisco.com

Antennas have gain in particular directions

Direction other than the main intended radiation pattern, are typically related to the main lobe gain



© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0-7-7

Antenna Gain

Cisco.com

If the gain of an antenna goes up, the coverage area or angle goes down

Coverage areas or radiation patterns are measured in degrees

Angles are referred to as beamwidth

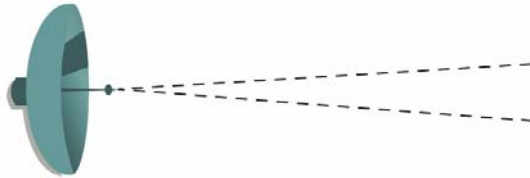
- Horizontal measurement
- Vertical measurement

© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0-7-8

Beamwidth vs. Gain

Cisco.com



Higher-gain antennas have narrower beamwidths and less chance of receiving interference.



Lower-gain antennas have wider beamwidths and a greater chance of receiving interference.

© 2003, Cisco Systems, Inc. All rights reserved.

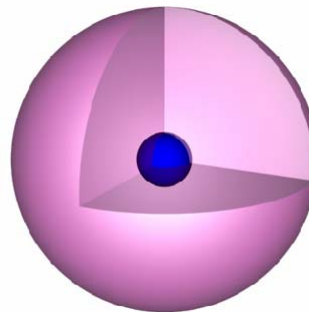
FWL 1.0--7-8

Antenna Theory

Cisco.com

A theoretical isotropic antenna has a perfect 360° vertical and horizontal beamwidth

This is a reference for ALL antennas



© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-10

Antenna Theory- Dipole

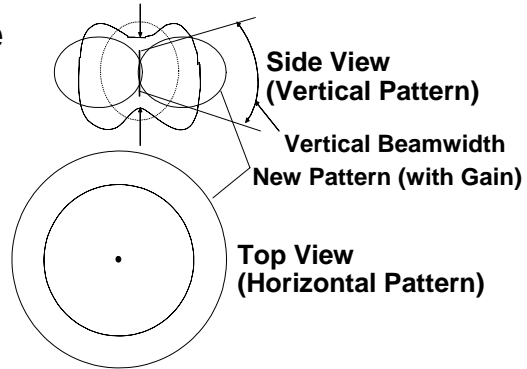
Cisco.com

Energy lobes are
'pushed in' from the
top and bottom

Higher gain

- Smaller vertical beamwidth
- Larger horizontal lobe

Typical dipole
pattern



© 2003, Cisco Systems, Inc. All rights reserved.

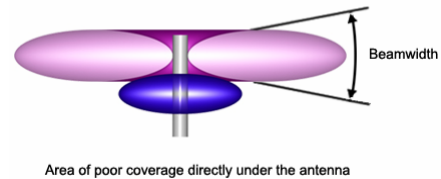
FWL 1.0--7-11

High Gain Omni-Directionals

Cisco.com

More coverage area
in a circular pattern

Energy level directly
above or below the
antenna will become
lower



© 2003, Cisco Systems, Inc. All rights reserved.

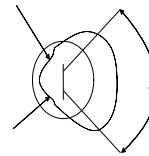
FWL 1.0--7-12

Directional Antennas

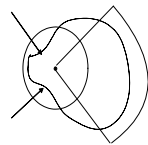
Cisco.com

Lobes are pushed in a certain direction, causing the energy to 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)

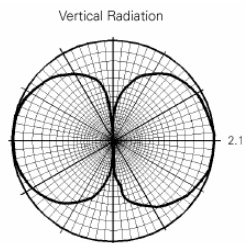
© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-13

2.4 GHz Omni-Directional Antennas

Cisco.com

2 dBi Dipole "Standard Rubber Duck"



Vertical Radiation



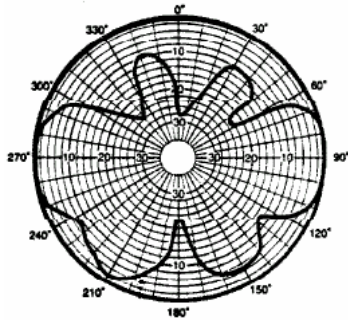
© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-14

2.4 GHz Omni-Directional Antennas

Cisco.com

5.2 dBi Mast Mount Vertical



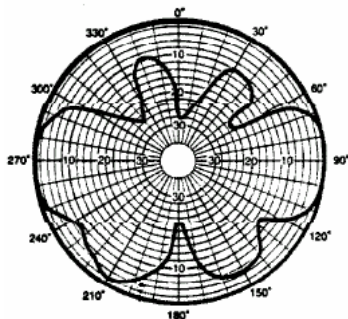
© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-15

2.4 GHz Omni-Directional Antennas

Cisco.com

5.2 dBi Ceiling Mount



© 2003, Cisco Systems, Inc. All rights reserved.

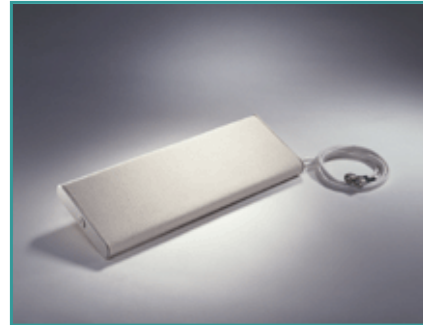
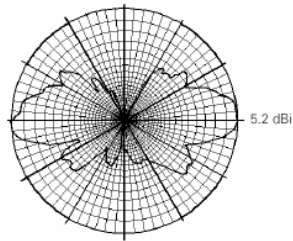
FWL 1.0--7-16

2.4 GHz Omni-Directional Antennas

Cisco.com

5.2 dBi Pillar Mount Diversity

Vertical Radiation Pattern



© 2003, Cisco Systems, Inc. All rights reserved.

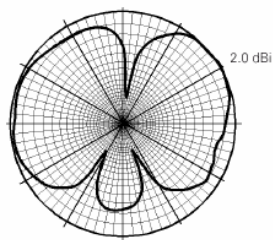
FWL 1.0--7-17

2.4 GHz Diversity Omni-Directional Antennas

Cisco.com

2 dBi Diversity Omni-Directional Ceiling Mount

Vertical Radiation



© 2003, Cisco Systems, Inc. All rights reserved.

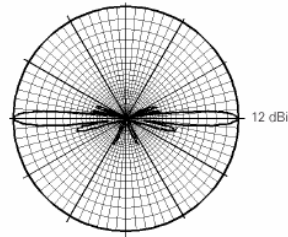
FWL 1.0--7-18

2.4 GHz Omni-Directional Antennas

Cisco.com

12 dBi Omni-Directional (Outdoor only)

Vertical Radiation Pattern



© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-19

5 GHz Omni-Directional Antennas

Cisco.com

9 dBi omni (Vertical polarization)



© 2003, Cisco Systems, Inc. All rights reserved.

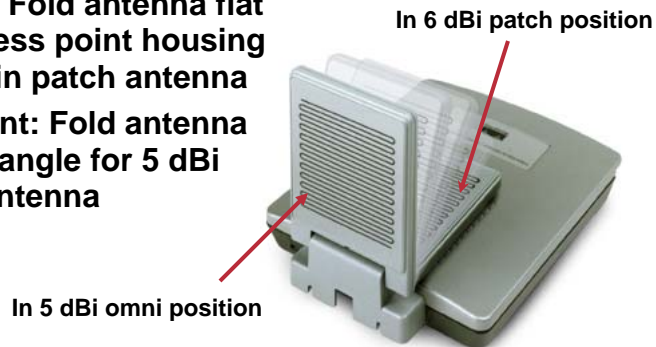
FWL 1.0--7-20

5 GHz Integrated Antenna

Cisco.com

Innovative 5 GHz Combo Antenna:

- **Wall Mount:** Fold antenna flat against access point housing for 6 dBi gain patch antenna
- **Ceiling Mount:** Fold antenna out at a 90° angle for 5 dBi gain omni antenna



© 2003, Cisco Systems, Inc. All rights reserved.

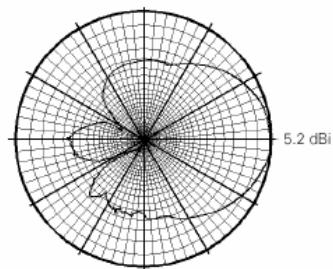
FWL 1.0--7-21

2.4 GHz Diversity Antennas

Cisco.com

6.5 dBi Diversity Patch Wall Mount – 55 degree

Vertical Radiation



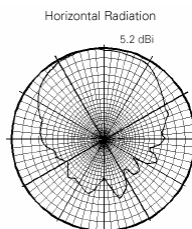
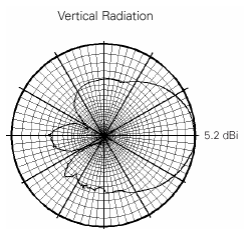
© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-22

2.4 GHz Directional Antennas (cont.)

Cisco.com

6 dBi Patch Antenna – 65 degree



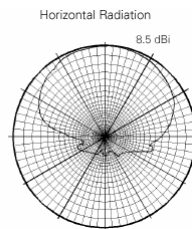
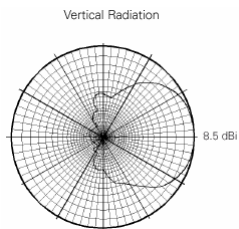
© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0—7-23

2.4 GHz Directional Antennas (cont.)

Cisco.com

8.5 dBi Patch Antenna – 60 degree



© 2003, Cisco Systems, Inc. All rights reserved.

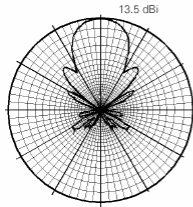
FWL 1.0—7-24

2.4 GHz Directional Antennas (cont.)

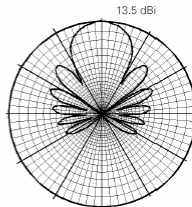
Cisco.com

13.5 dBi Yagi Antenna – 25 degree

Horizontal Radiation Pattern



Vertical Radiation Pattern



© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0—7-25

13.5 dBi Yagi Antenna—Inside view

Cisco.com



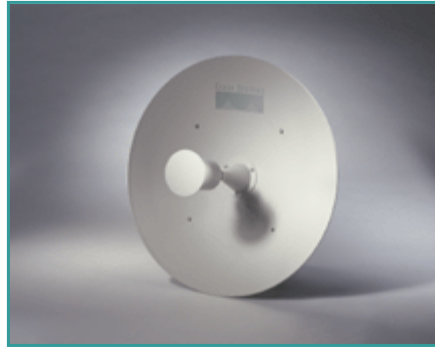
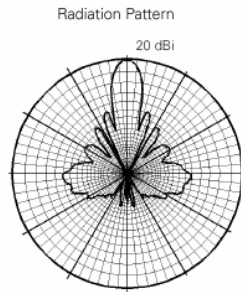
© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0—7-26

2.4 GHz Directional Antennas (cont.)

Cisco.com

21 dBi Parabolic Dish Antenna – 12 degree



© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0—7-27

5 GHz Omni-Directional Antennas

Cisco.com

- 28 dBi dish (H or V polarization)



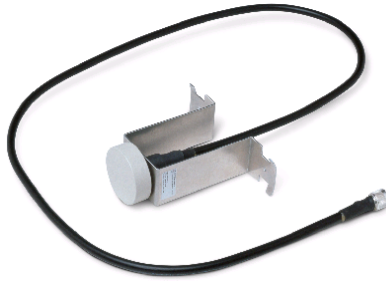
© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0—7-28

5 GHz Antenna

Cisco.com

- 9.5 dBi sector (H or V polarization)



© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0—7-29

Cable and Accessories 2.4 GHz Accessories

Cisco.com



© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0—7-30

RP-TNC Connectors

Cisco.com



© 2003, Cisco Systems, Inc. All rights reserved.

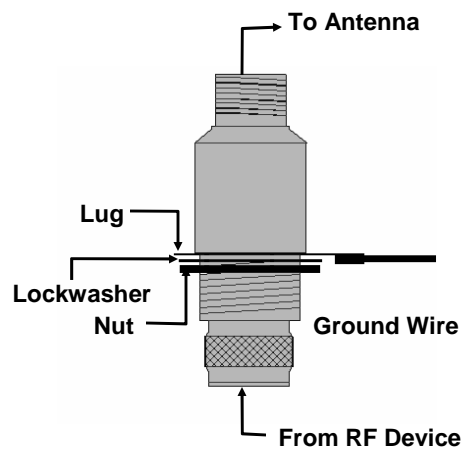
FWL 1.0--7-31

Lightning Arrestor

Cisco.com

Designed to protect LAN devices from static electricity and lightning surges that travel on coax transmission lines

RP-TNC connectors used on all Cisco Antennas



© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-32

Lightning Arrestor

Cisco.com



© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-33

Coax Connection Sealing

Cisco.com

Number one problems
with bridges - water in
the connectors

Proper sealing
is important

Coax Seal is one
product that is
inexpensive and
works great
ces

NEW
HAND MOLDABLE PLASTIC
COAX-SEAL
SEALS COAX FITTINGS
FROM MOISTURE AND
CORROSION

80 inches x 1/2" wide
Will Protect 9 COAX Fittings

- Stays Flexible At Any Temperature
- Permanent-Long COAX Life ... Provides Years of Protection
- Insures Low SWR
- Forms and Seals Over Odd Shaped and Difficult COAX Fitting
- Fast-Easy Seal for All Antenna Connections
- Non-Contaminating
- Non-Conductive

© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-34

Link Engineering and RF Path Planning

Cisco.com

Path Considerations

Radio line of sight

Earth bulge

Fresnel zone

Antenna and cabling

Data rate



© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-35

Line of Sight

Cisco.com

The following obstructions might obscure a visual link:

- Topographic features, such as mountains
- Curvature of the Earth
- Buildings and other man-made objects
- Trees



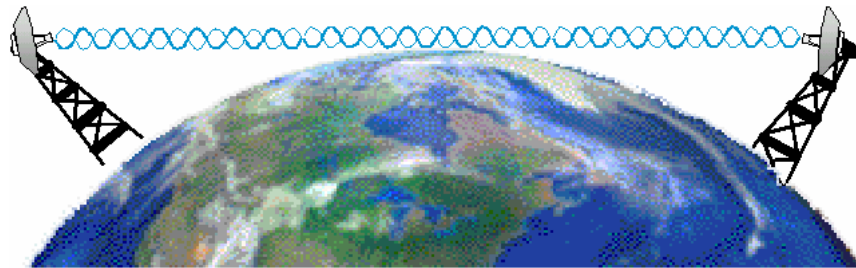
© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-36

Longer Distances

Cisco.com

**Line of Sight disappears at 6 miles
(9.7 Km) due to the earth curve**

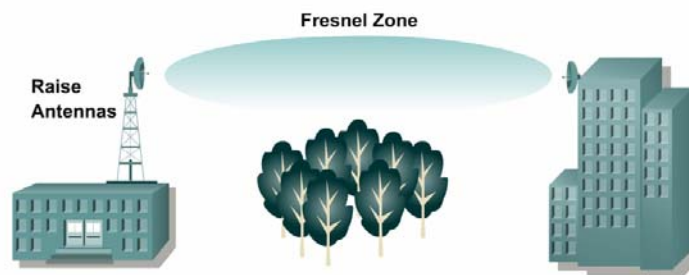


© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-37

Fresnel Zone

Cisco.com



- Raise the antenna mounting point
- Build a new structure i.e. a radio tower, tall enough to mount the antenna
- Increase the height of an existing tower
- Locate a different mounting point, for the antenna
- Cut down problem trees

© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-38

Improving Fresnel Effect

Cisco.com

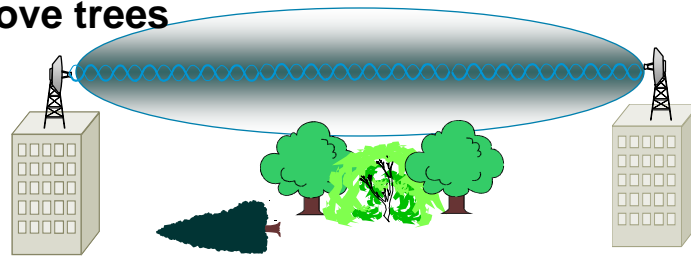
Raise the antenna

New structure

Existing structure

Different mounting point

Remove trees



© 2003, Cisco Systems, Inc. All rights reserved.

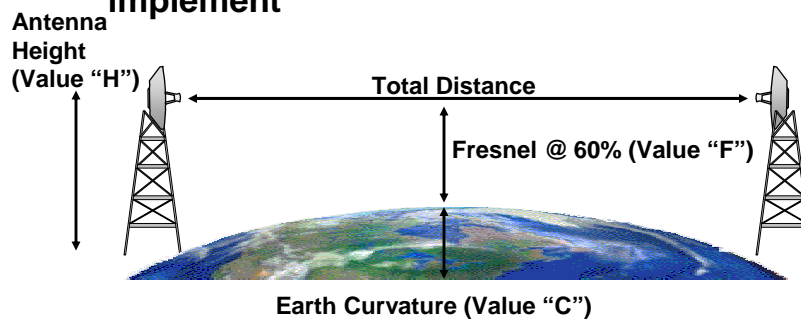
FWL 1.0--7-39

Site to Site Fresnel Zone

Cisco.com

Antenna Height

- Fresnel zone consideration
- Line-of-Sight over 25 miles (40 Km) hard to implement



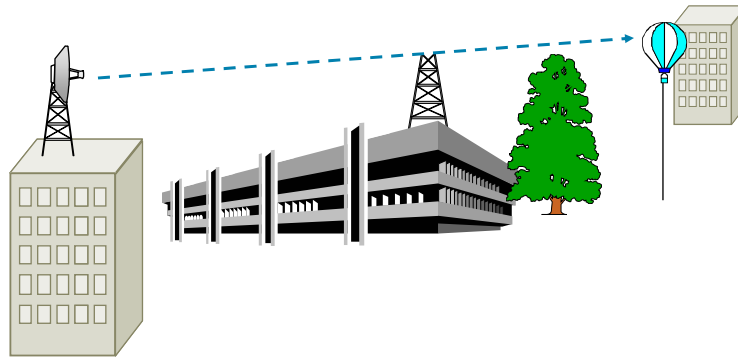
© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-40

Antenna Alignment

Cisco.com

Line of Sight



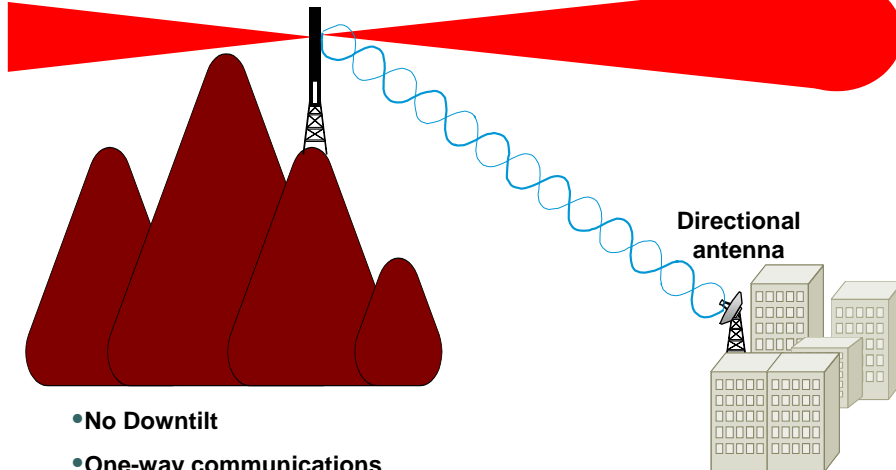
© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-41

Antenna Issues

Cisco.com

High gain omni-directional

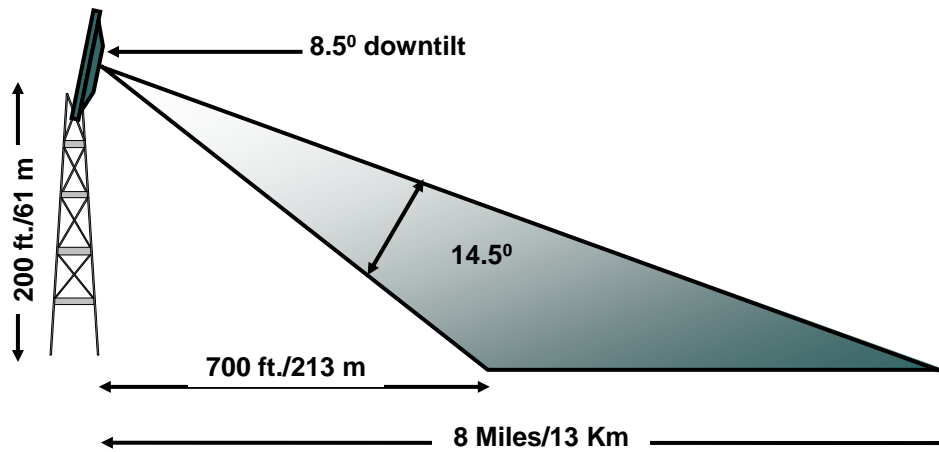


© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-42

Antenna Issues (cont.)

Cisco.com



© 2003, Cisco Systems, Inc. All rights reserved.

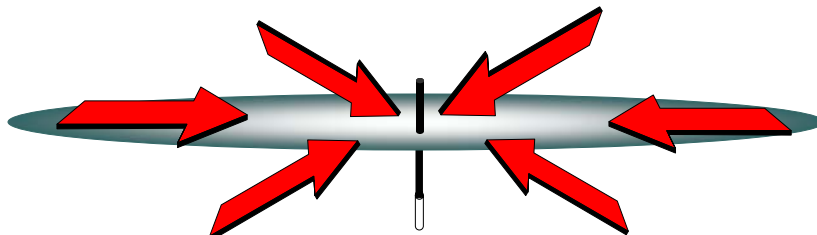
FWL 1.0--7-43

Antenna Issues (cont.)

Cisco.com

Omni-directional antennas provide 360° coverage

Also accepts interference from all directions

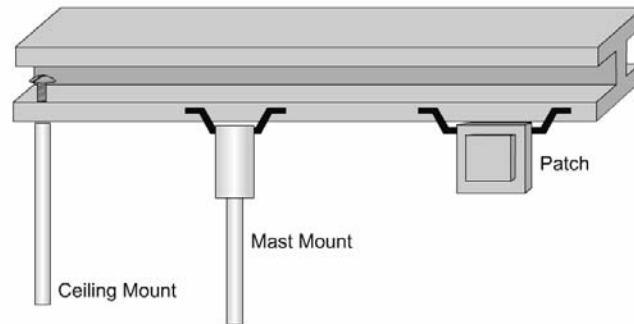


© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--7-44

Antenna Mounting

Cisco.com



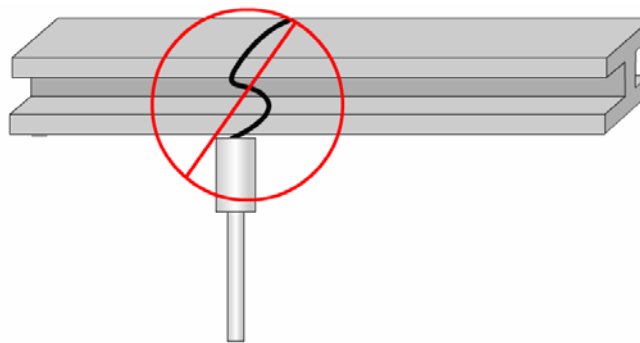
- Some antennas are not shipped with mounting brackets
- Modify brackets to fit your needs
- Modified brackets can be used with a variety of antennas
- Be creative

© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--745

Mounting (Cont.)

Cisco.com



- Make sure the antennas mount is solid and secure
- Do not hang antenna by its cable
- Cable can break or become damaged
- Antenna can sway and provide a "moving cell"

© 2003, Cisco Systems, Inc. All rights reserved.

FWL 1.0--746

