7. ANTENNAS – NR6H

Chapter 7 Part 1 of 2

ARRL General Class
Sections 7.1, 7.2

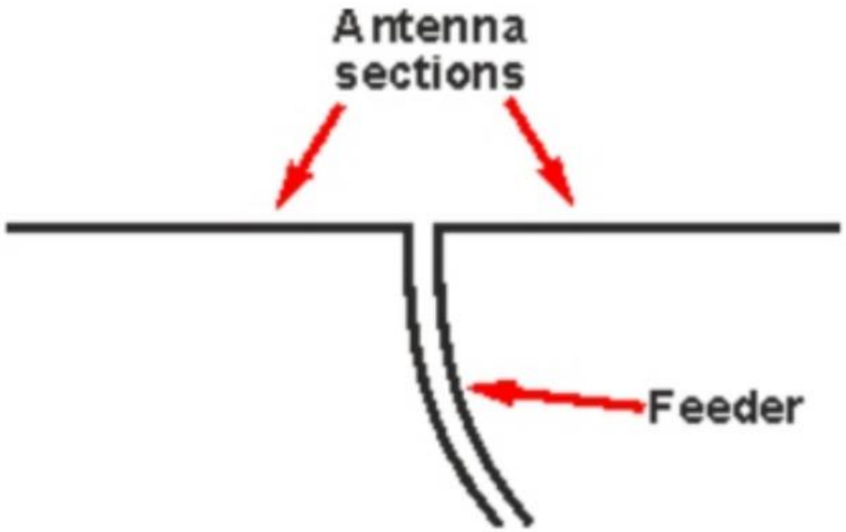
Dipole antenna

Dipole

1/2 wavelength (λ/2) long from end-to-end

Feed point in the middle : 72 Ohm

High impedance at the ends



Frequency → Wavelength

Speed of light (c)

- 300 million meters per second (Mm/s)
- 984 million feet per second (Mft/s)

Frequency (f) in MHz → get rid of the 'M'

Wavelength in meter : **300 / f** (MHz)

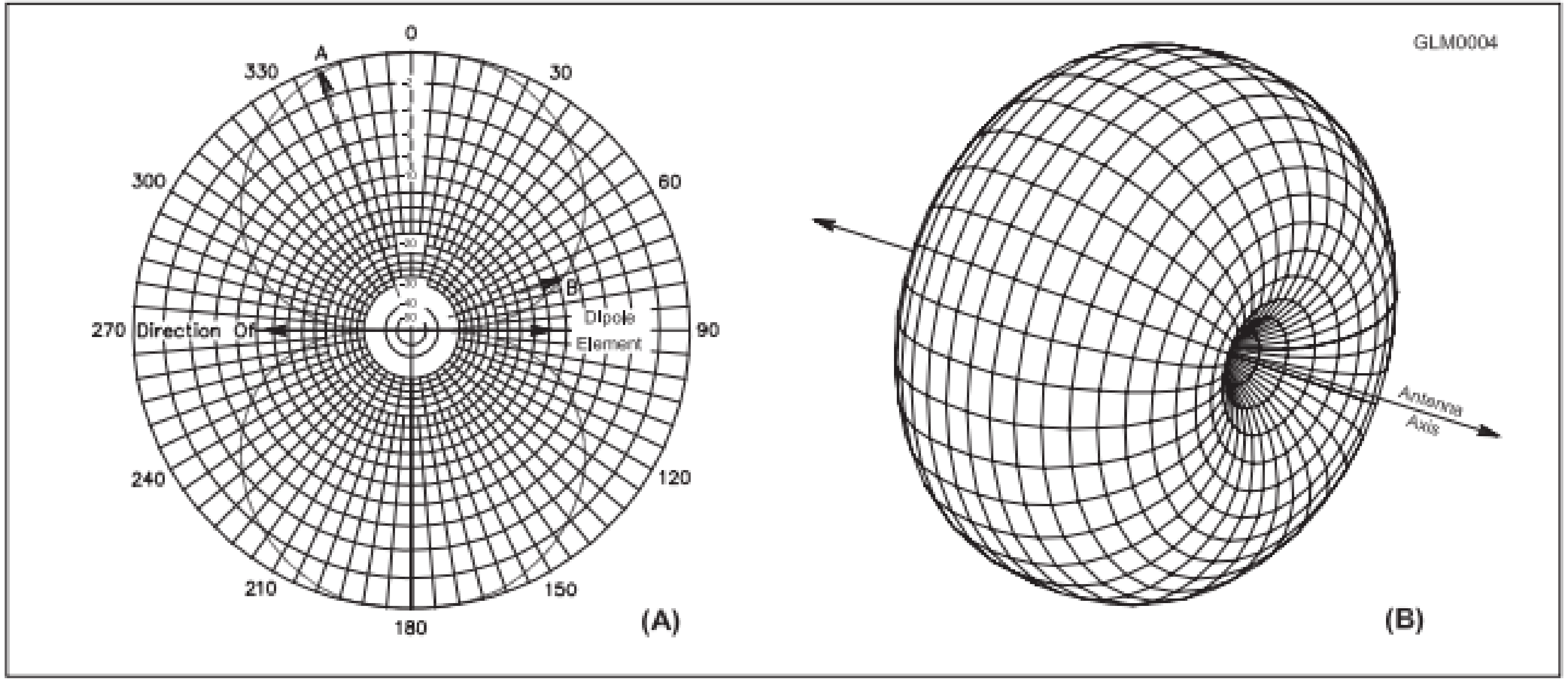
Wavelength in feet : **984 / f** (MHz)

What is the approximate length in feet of a 1/2-wave dipole for 14.250 MHz?

f = 14.250 MHz

(984 / 14.25) / 2 = 34.5 ft

Dipole radiation pattern



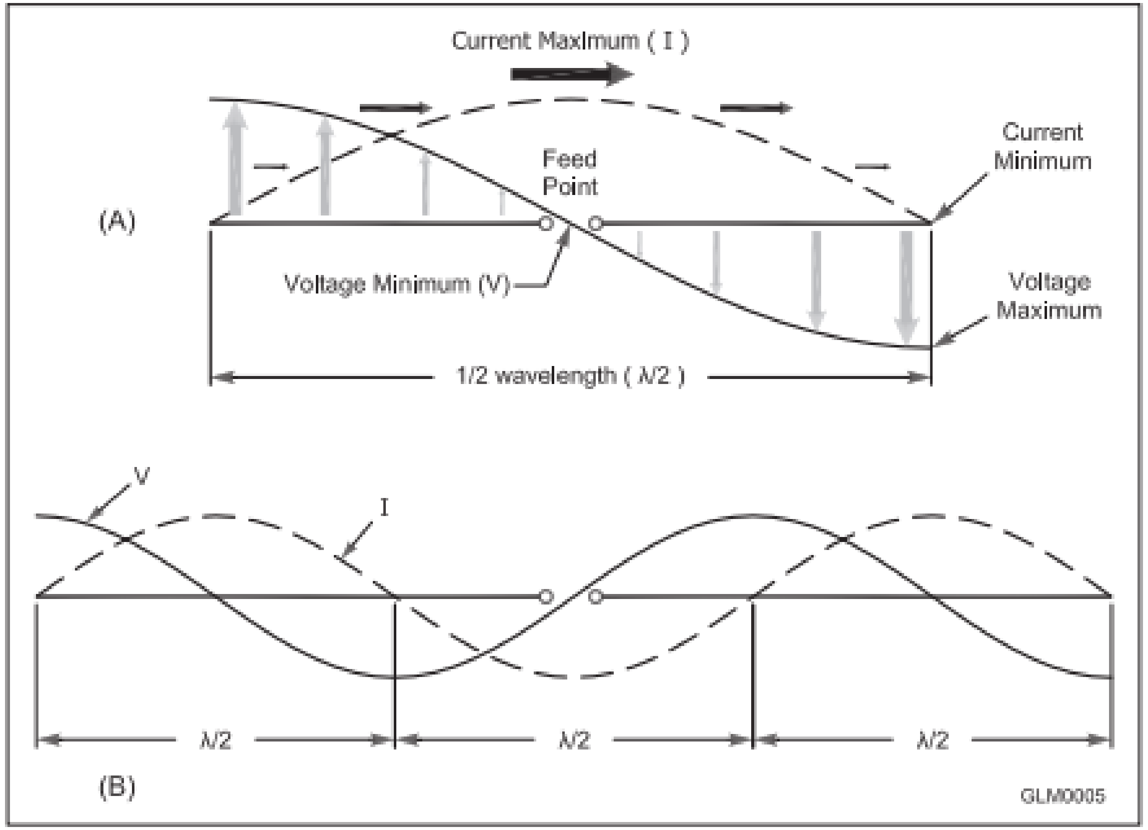
Part **A** shows the radiation pattern in the plane of a dipole located in **free space**
Part **B** shows the three-dimensional radiation pattern in all directions around the dipole.

Dipole – Currents and Voltages

Center has the highest current
- ..and lowest voltage
- ..72 Ohm

Ends have the highest voltage
- ..and lowest current
- ..high impedance (multiple kOhm)

Resonance at odd harmonics
- ..but feed point impedance will be lower



Reference antennas - Dipole and Isotropic

Gain compared to a dipole is measured in **dBd**

- **dBd** = "dB compared to a dipole"

Isotropic antenna

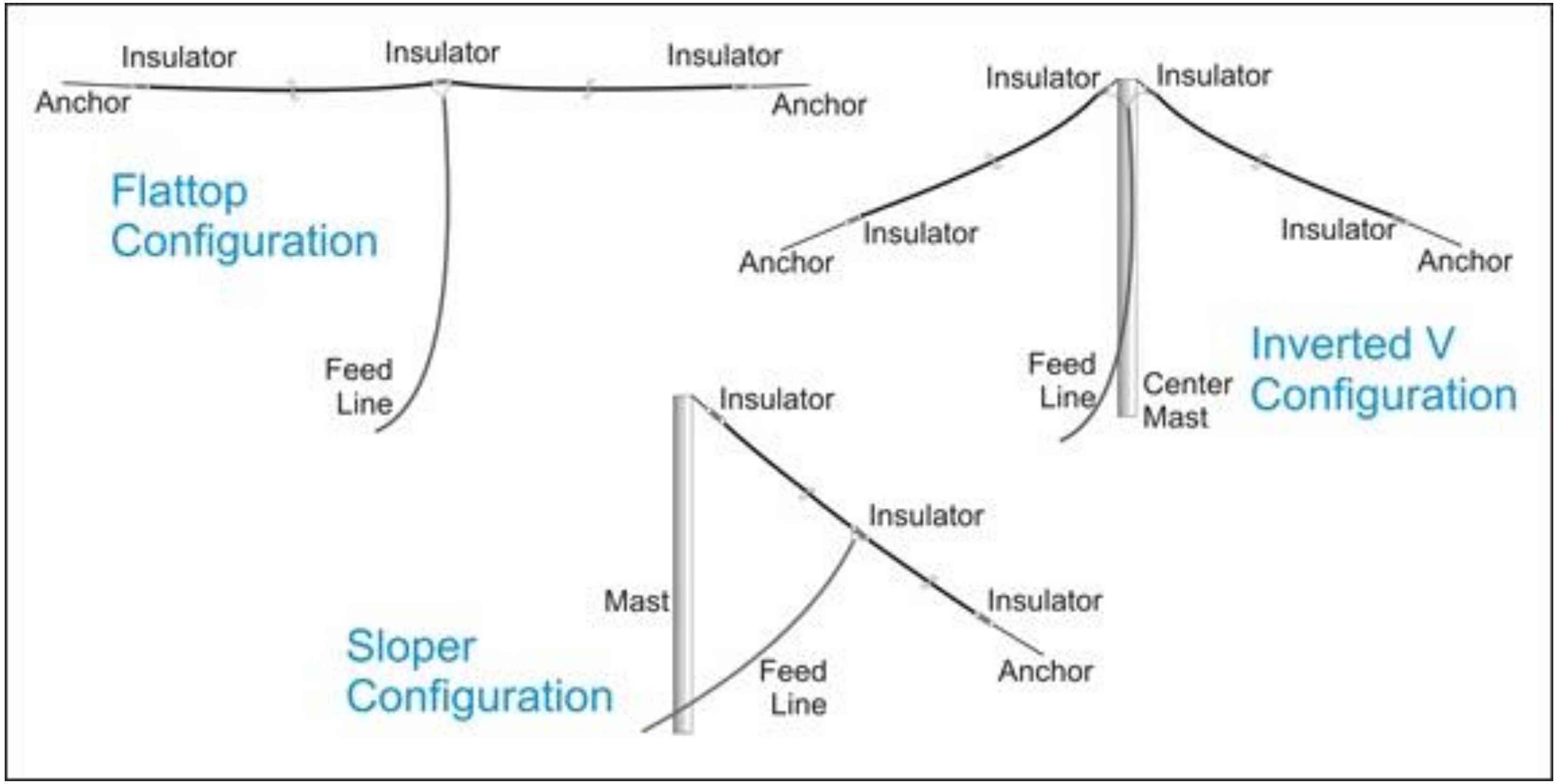
- Theoretical 'point' antenna. Radiates equally in all directions. Does not physically exist.
- **dBi** = "dB compared to an isotropic antenna"
- **2.15dB less** gain than a dipole
- 0dBi = -2.15dBd ..or.. 0dBd = 2.15dBi

Check the data sheet!

- 4.5-2.15 = 2.35 dBd

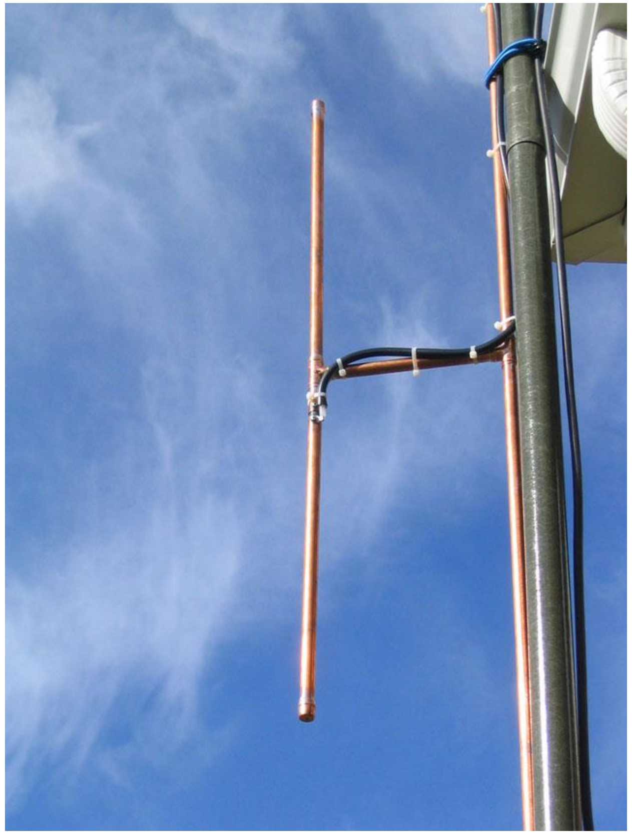
Band Coverage	Frequency Coverage Range	Vertical Antenna Gain
2 meters	144-148 MHz	4.5 dBi
70 cm	440-450 MHz	7.2 dBi

Dipole configuration

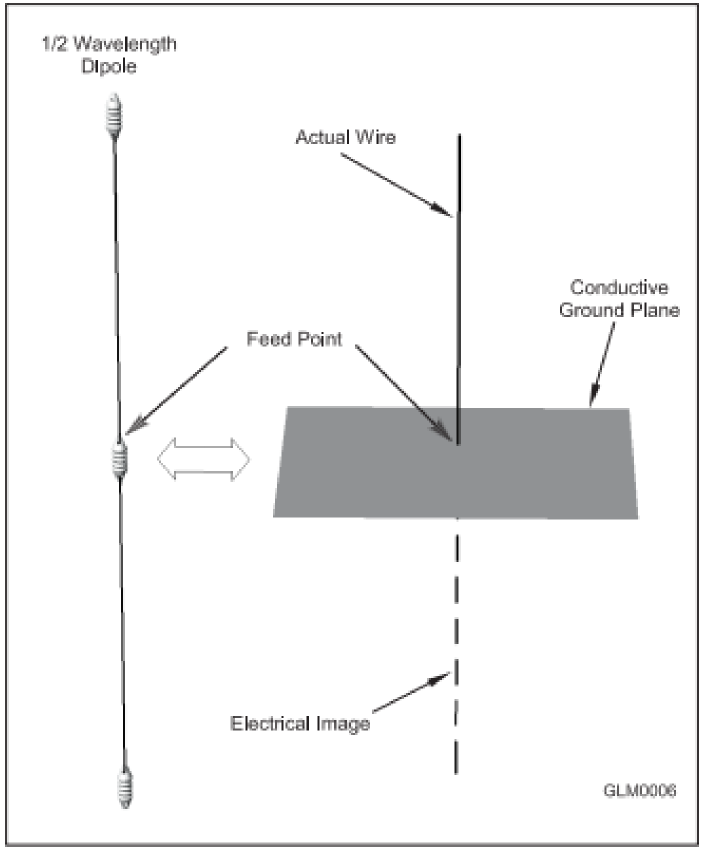


Verticals

Vertical dipole



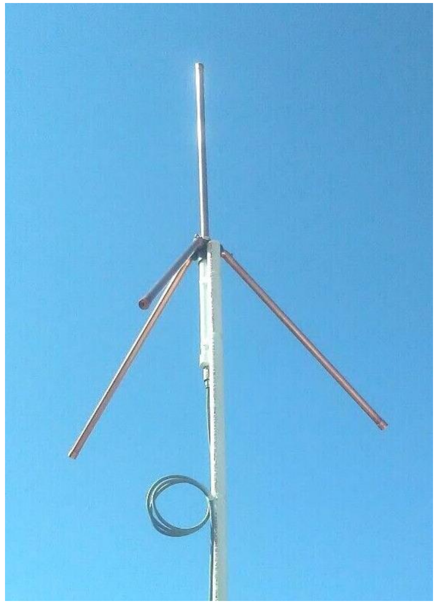
Ground plane

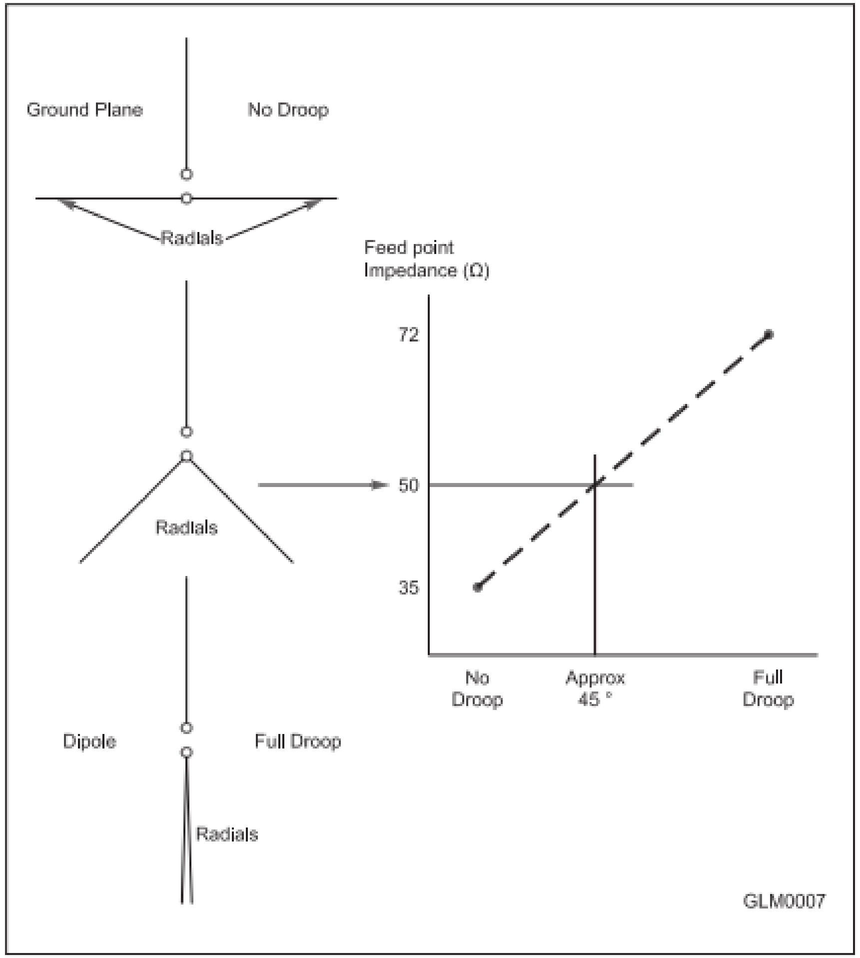


Ground Plane

Ground plane can be wires (”radials”)

- Dipole feed point = 72 Ohm
- Ground plane feed point = 35 Ohm
- **45 degree ground plane = 50 Ohm**





Frequency to Wavelength again…

What is the approximate length in feet of a 1/4-wave monopole antenna cut for 28.5 MHz?

f = 28.5 MHz

(984 / 28.5) / 4 = 8.6 ft

Mobile HF Antennas

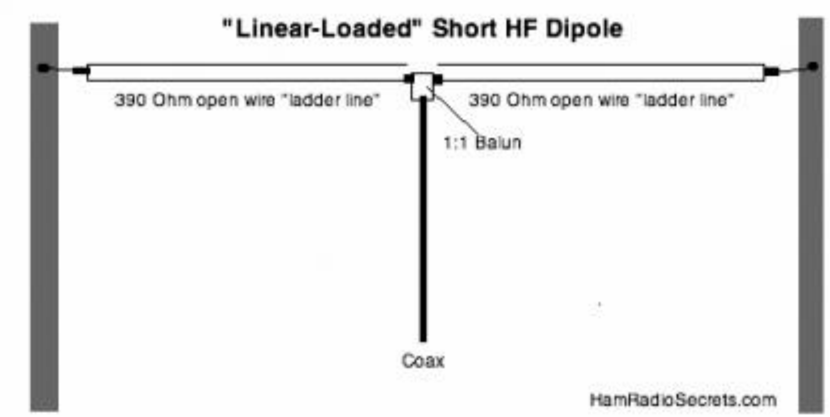
Mobile HF antennas are often some form of vertical ground-plane

A full-sized λ/4 mobile whip is not feasible on bands below 28 MHz (too long)

“Loading” to increase their electrical length

- **Loading coils**: A coil added at base or somewhere along the length
- **Capacitance hats**: Spokes or a wheel-shaped structure is added near the top of the antenna
- **Linear loading**: Part of the antenna is folded back on itself
- **Corona ball** : avoid arcing



Effects of ground

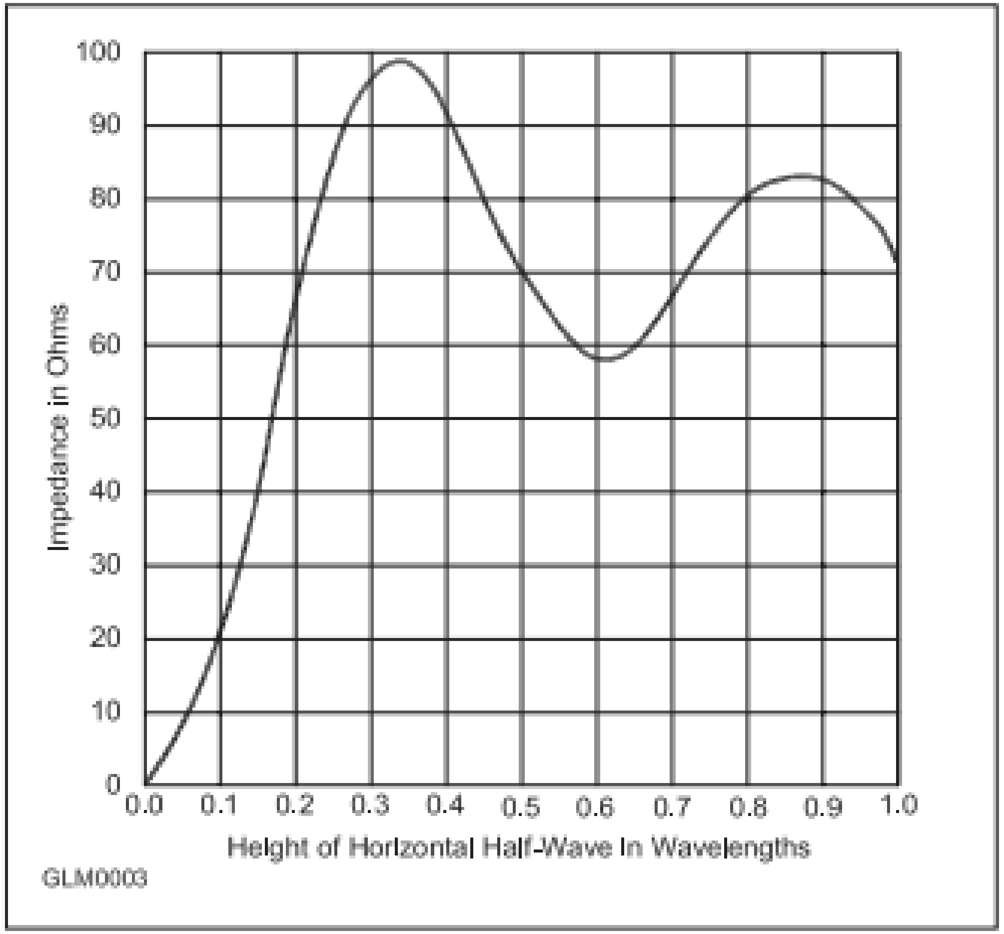
Dipole in free space

- Feed point impedance = 72 Ohm

Dipole with feed point at ground

- Feed point impedance = 0 Ohm

Under 1⁄4 λ, the impedance approaches 0



Effects of ground

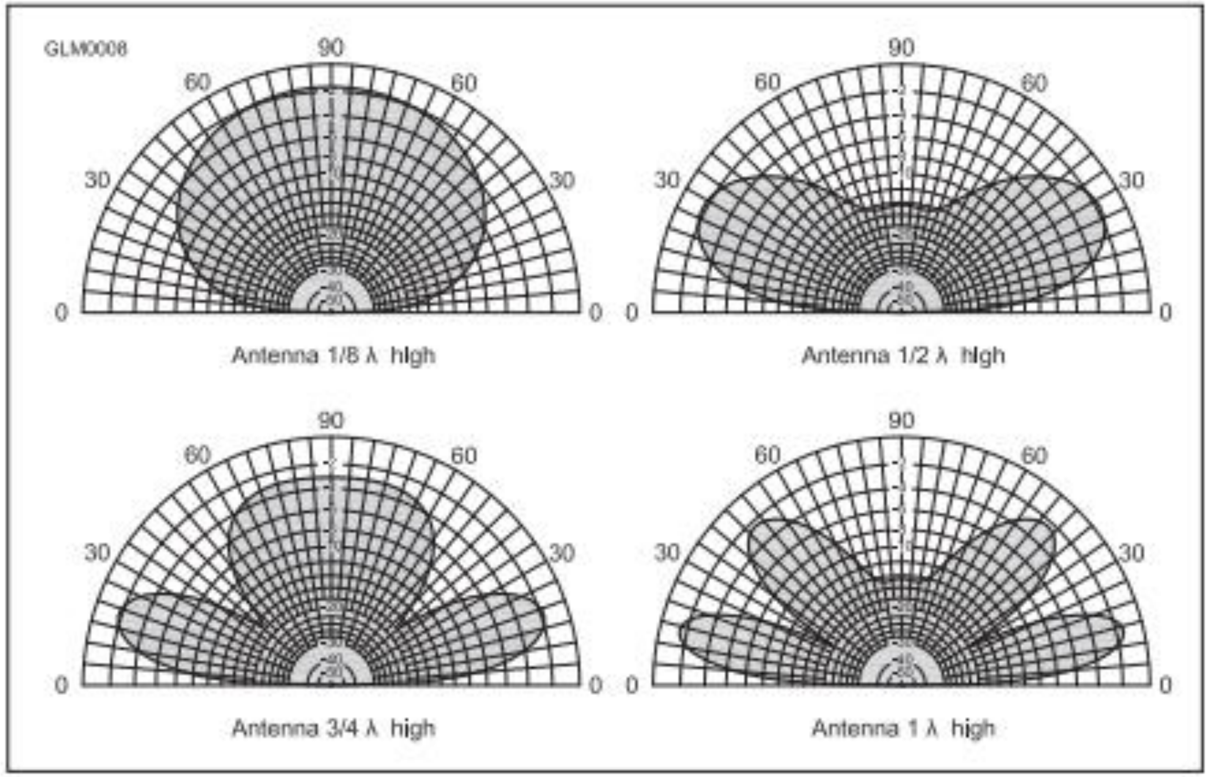
Ground reflections cancels/add

- 1/8 λ : Mostly vertical and omnidirectional
- 1/2 λ : Vertical null (ground reflection cancels)
- 3/4 λ : New vertical lobe
- 1 λ : Vertical null and multiple lobes

Lower than 1/2 λ = mostly vertical

- Useful for NVIS
  Near-Vertical Incidence Sky-wave
- NVIS works on low frequencies only

Horizontally polarized signals have **less loss** when reflected by ground = better propagation



Directional Antennas

All antennas are directional
(..except the theoretical Isotropic antenna)

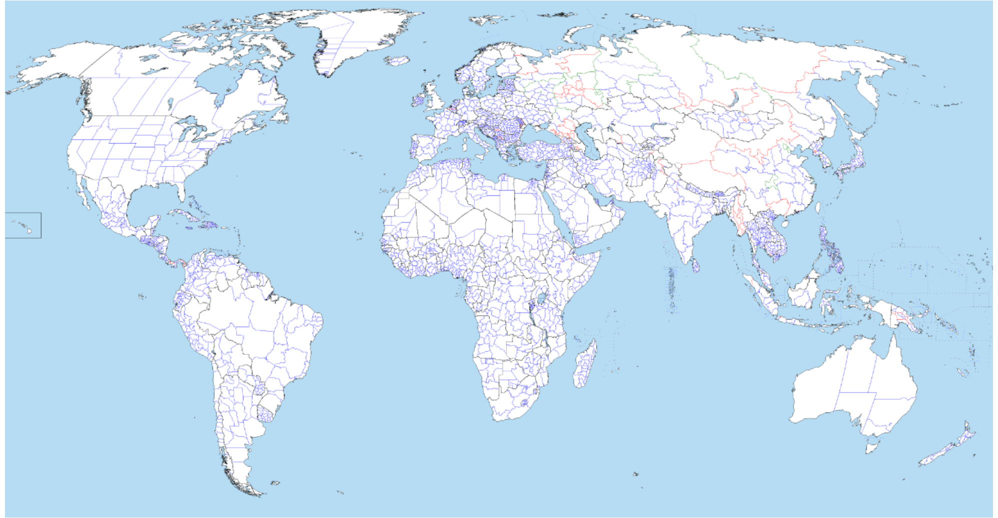
Directional antennas create gain by focusing the power in some direction

The direction where most of the power is focused is called the **main lobe**

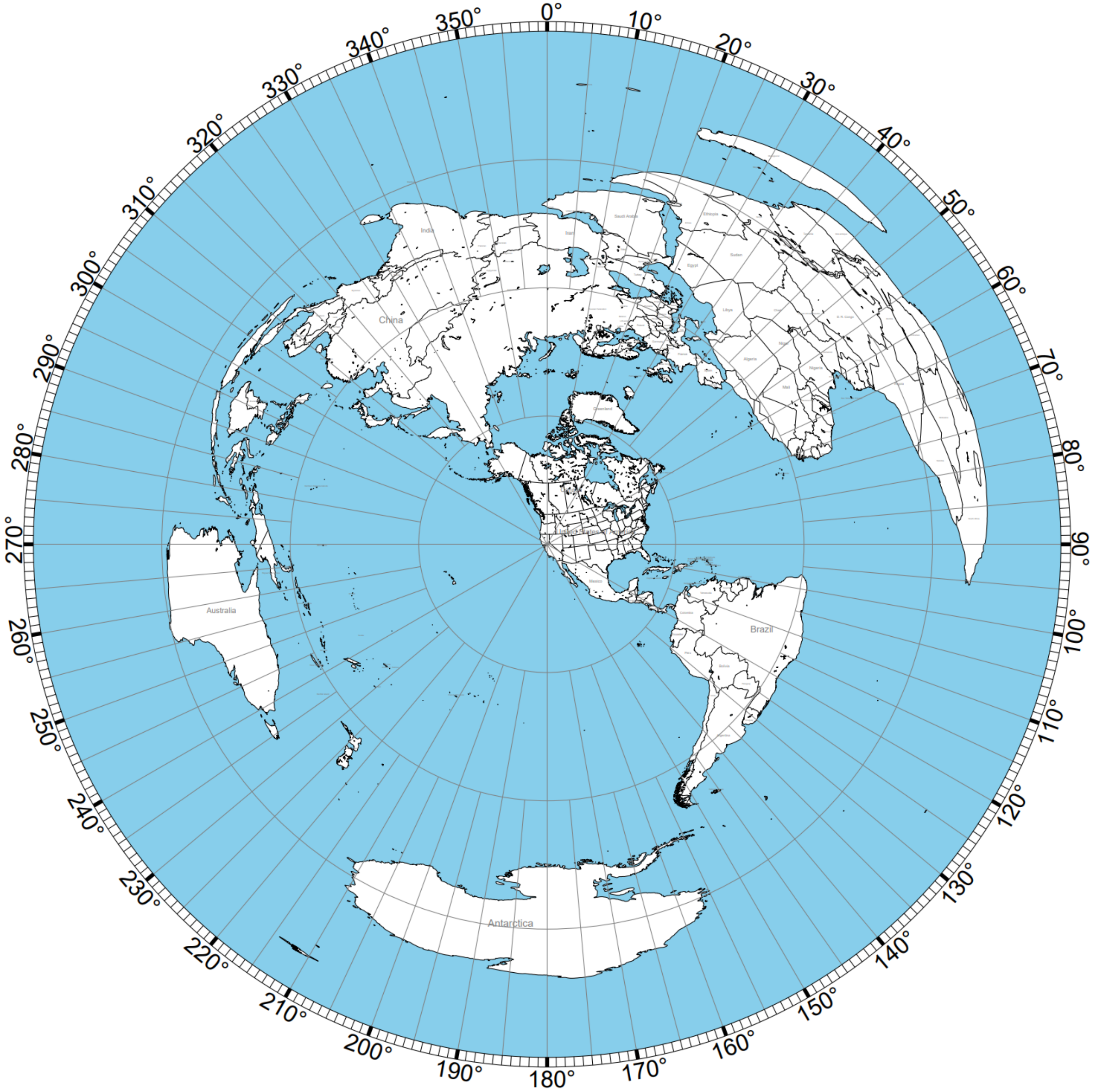
Receiving is also improved in the gain direction

..and signals from other directions are attenuated!

Which way?
The azimuthal map



Courtesy of Tom (NS6T)



Directional Antennas – Arrays of Elements

Two types of arrays: driven and parasitic

- **Driven array**
  All of the antenna elements are connected to the feed line
- **Parasitic array**
  One or more of the elements are not connected to the feed line but influence the antenna's pattern by interacting with the radiated energy from the driven element(s)

Whether an array is driven or parasitic, its radiation pattern is determined by constructive and destructive interference

- If in phase, they will reinforce each other
- If out of phase, they will cancel

Yagi
(Yagi-Uda)

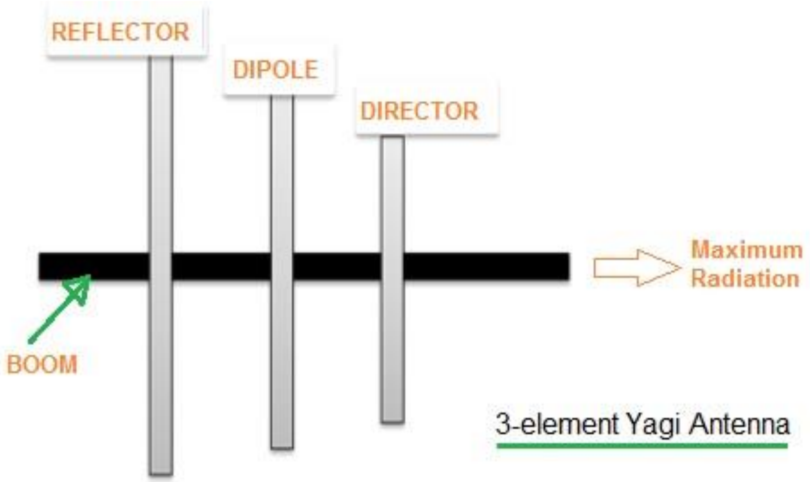
Driven Element is a resonant dipole

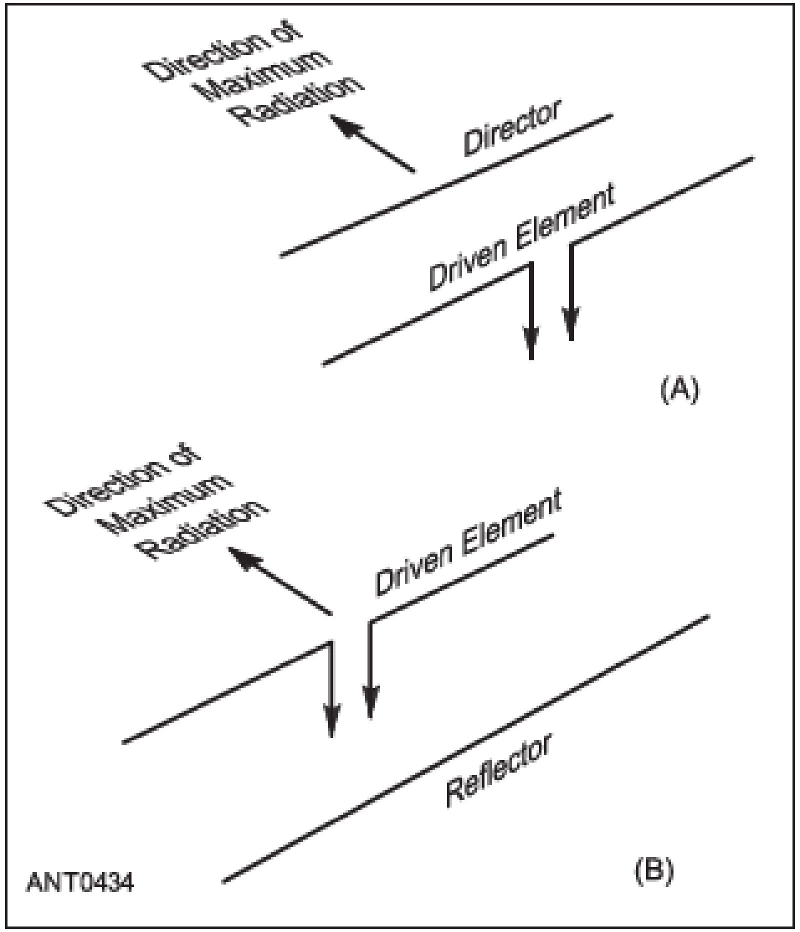
Director(s)

- Parasitic element(s) in the direction of max gain

Reflector(s)

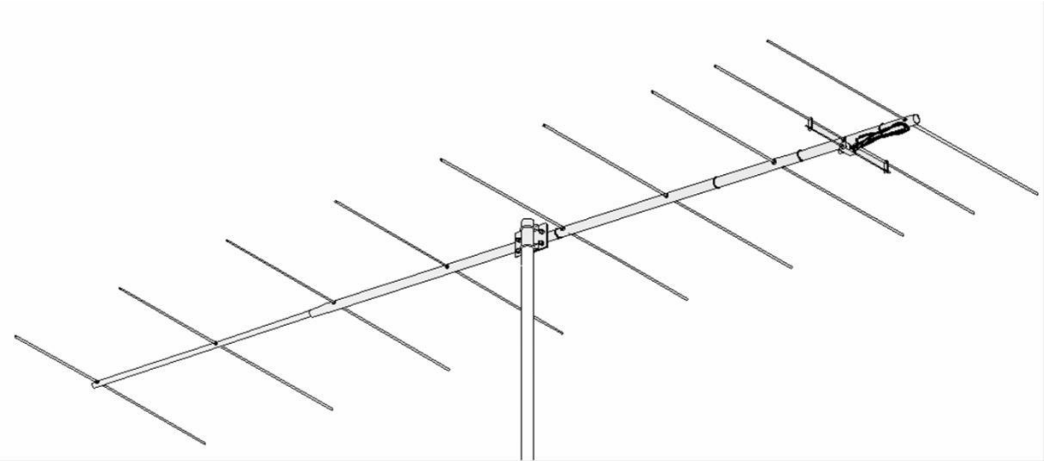
- Parasitic element(s) in the direction of min gain

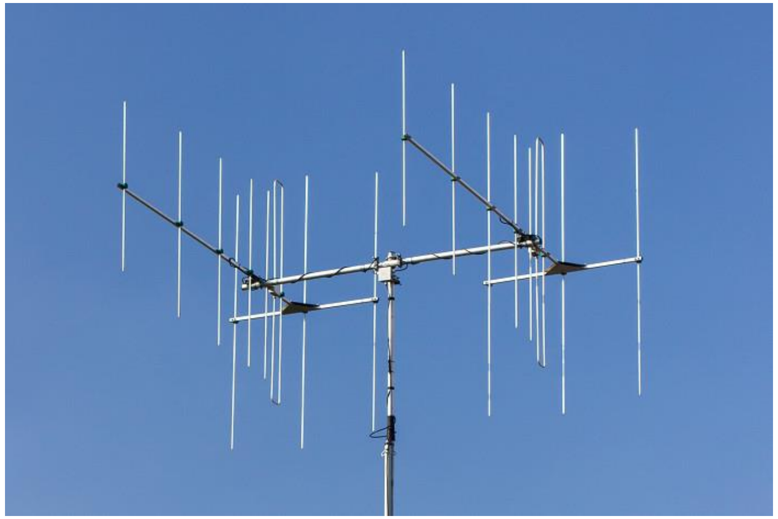




Yagi Design Tradeoffs

- More directors increase gain
- A longer boom with increases gain (up to a maximum)
- Larger diameter elements increases bandwidth
- Placement and tuning of elements affects gain and feed point impedance



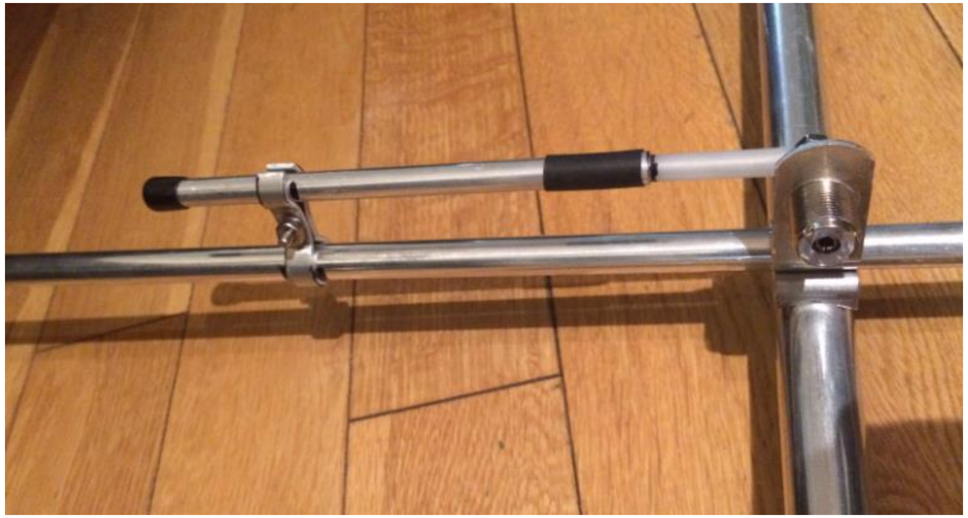


Yagi Impedance Matching

Yagi feed point impedance typically 20-25 Ohm

There are many solutions for how to match it to 50 Ohm

Gamma match



Hairpin / Beta match

QUESTIONS?

ONLINE EXAM REVIEW AND PRACTICE QUESTIONS:

http://www.arrl.org/examreview