

M HDG 153.0° TRAIL AUTO
0:27 3M

Radar

Many in a series of McGourty-
Rideout Productions

IR1

+153.0°M|0.000NM

SHIP	+CURSOR	WAYPOINT
26.63N	27.26.63N	NO DATA
52.61W	114.52.61W	
7.4KT	TTC 00:00	TTC **:*

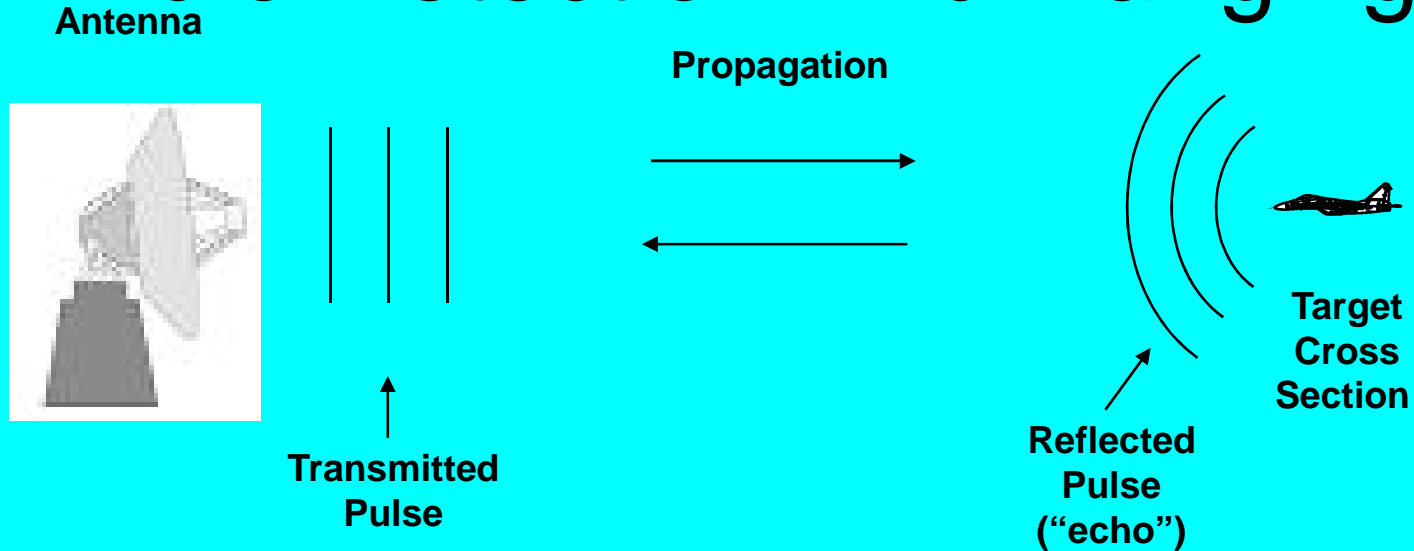
What is Radar?

- RADAR (Radio Detection And Ranging) is a way to detect and study far off targets by transmitting a radio pulse in the direction of the target and observing the reflection of the wave.
- It's basically radio echo



RADAR

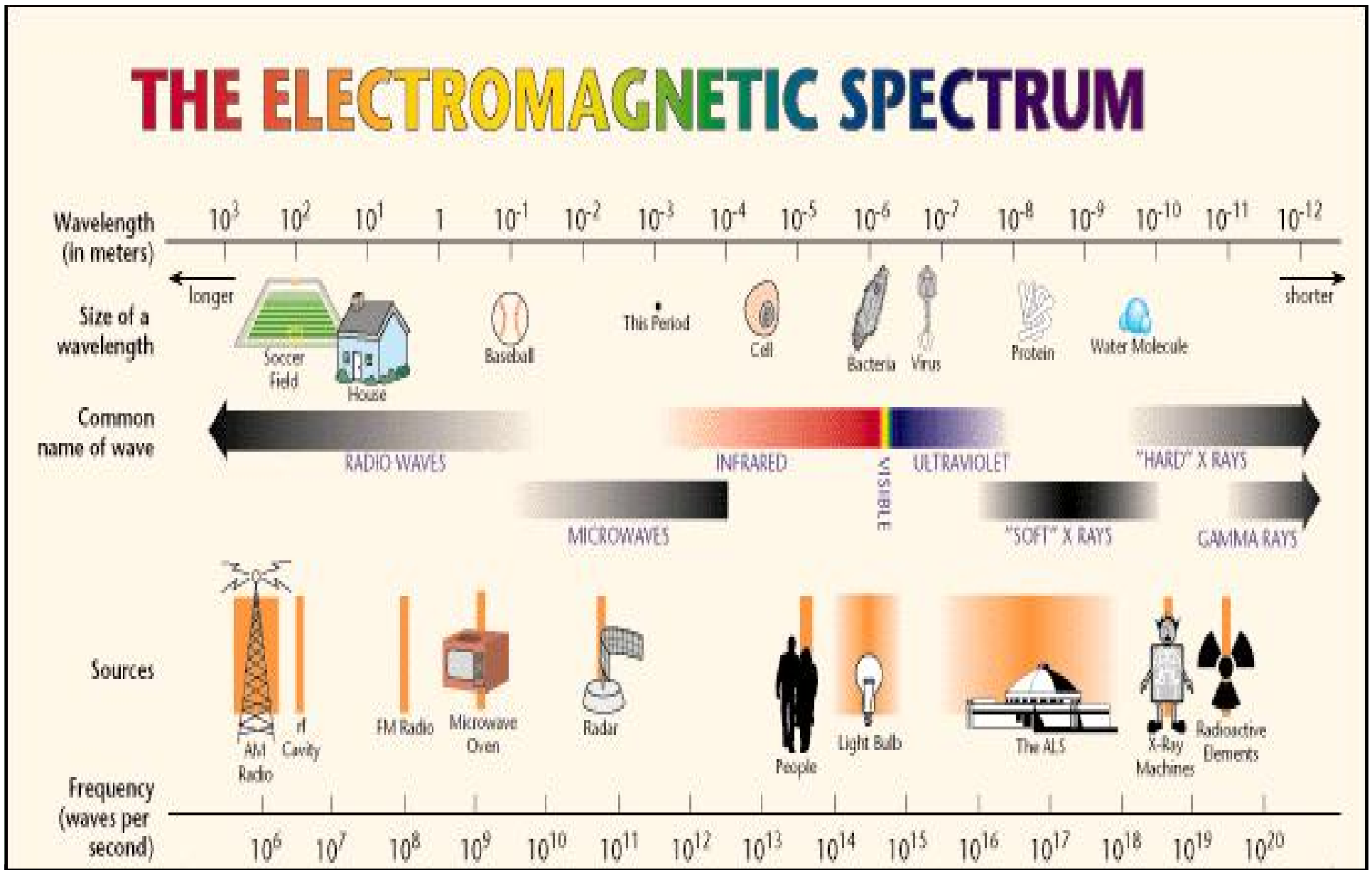
Radio Detection And Ranging



Radar observables:

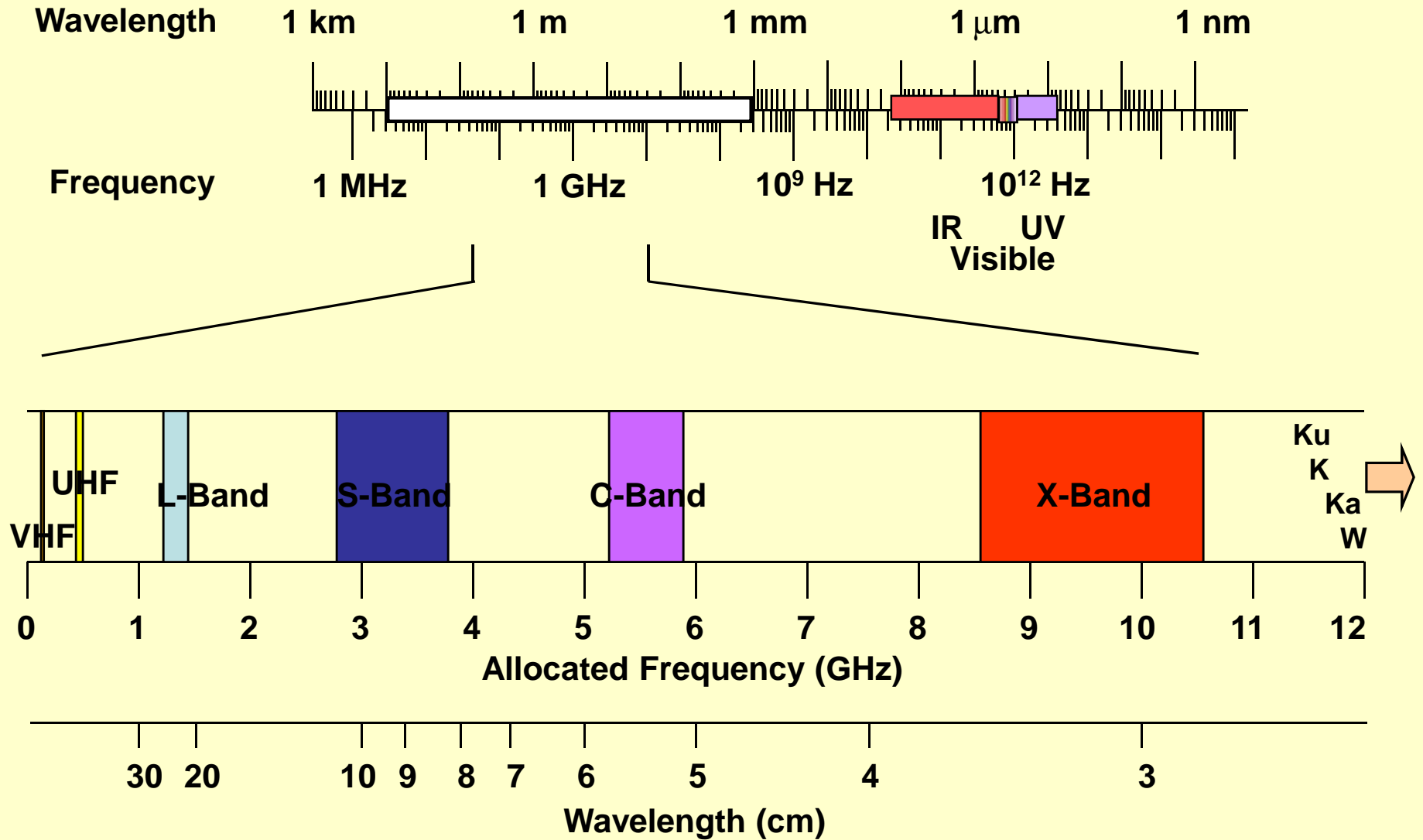
- Target range
- Target angles (azimuth & elevation)
- Target size (radar cross section)
- Target speed (Doppler)
- Target features (imaging)

THE ELECTROMAGNETIC SPECTRUM



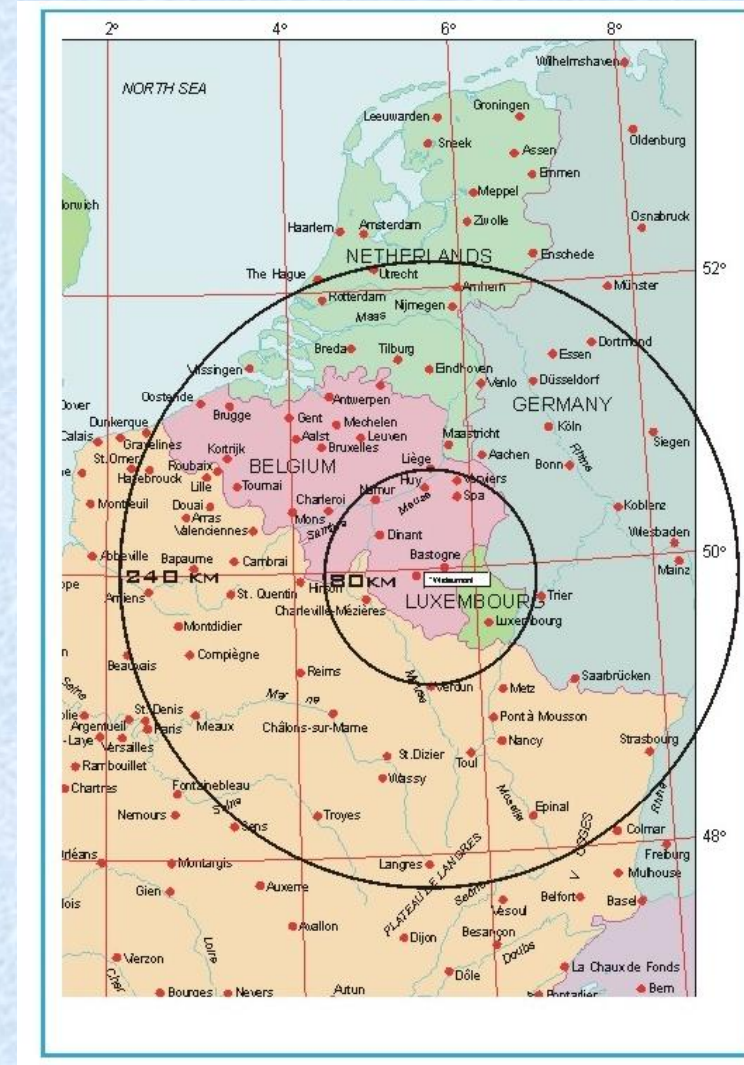
←→
Radar Frequencies

Radar Frequency Bands



The Range

- Distance from the radar
- Measured from time delay between transmitted pulse and returned signal



The Range

- Remember, in general $v=d/t$ and $d=vt$
- The range is just a distance
- Since radio waves travel at the speed of light ($v = c = 300,000 \text{ km/sec}$)

$$\text{range} = c \cdot \text{time} / 2$$

- Why divided by 2?

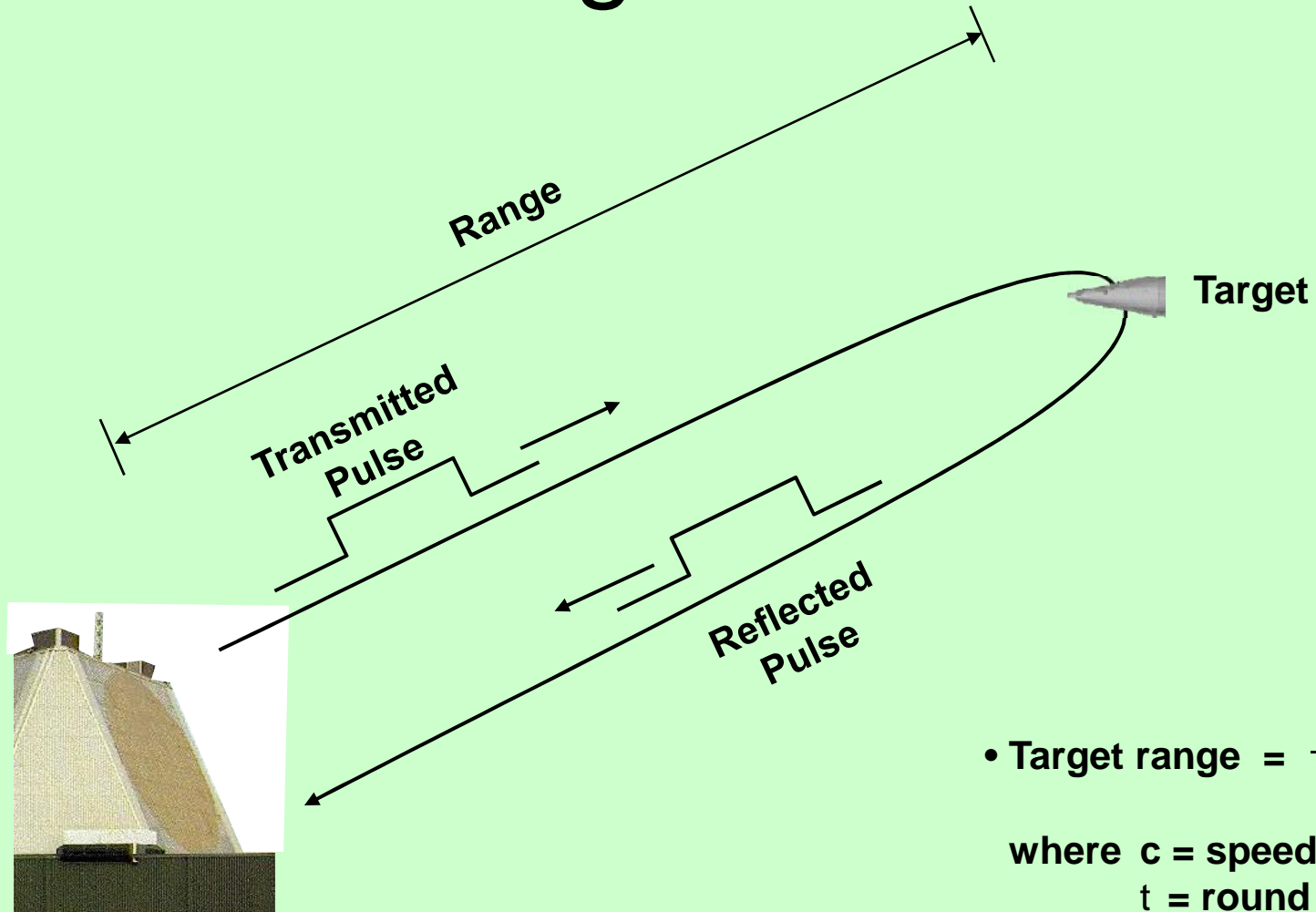


1:00pm EDT 05-JUL-2005

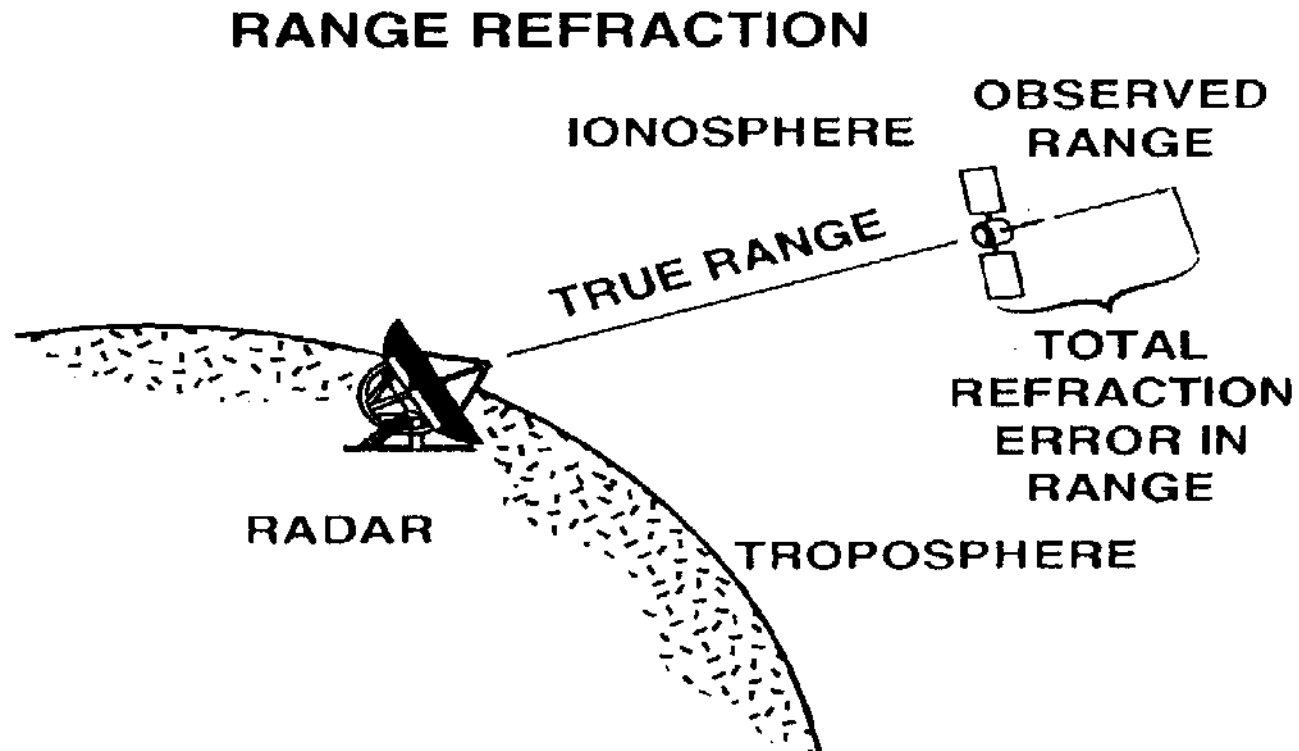
The Range

- The “2” is because the measured time is for a round trip to and from the target. To determine the range, you only want the time to the object, so you take half!

Radar Range Measurement

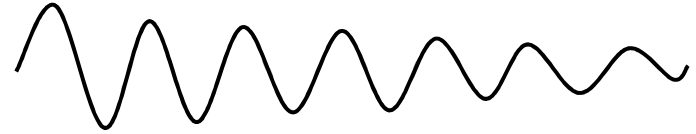


Atmospheric Effects

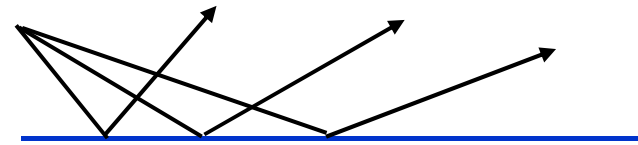


Radar beams can be attenuated, reflected and bent by the environment

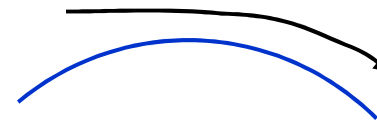
- Atmospheric attenuation



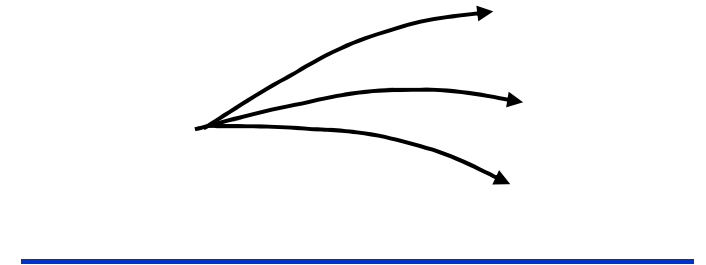
- Reflection off of earth's surface



- Over-the-horizon diffraction



- Atmospheric refraction



Radar

- The range and the direction of the target determine its location, which is what is needed for many [radar](#) applications such as [air traffic control](#).

How Strong Is It?

- The strength of the received echo can also be measured
- This will vary with the distance of the target, its size, its shape and its composition

Types and Uses of Radar

- Search radars scan a large area with pulses of short radio waves
- Targeting radars use the same principle but scan a smaller area more often
- Navigational radars are like search radar, but use short waves that reflect off hard surfaces. They are used on commercial ships and long-distance commercial aircraft

Types and Uses of Radar

- Mapping radar scans a large regions for [remote sensing](#) and [geography](#) applications
- [Wearable radar](#) which is used to help the visually impaired
- [Air traffic control](#) uses radar to reflect echoes off of [aircraft](#)
- Weather radar uses radar to reflect echoes off of clouds

Types and Uses of Radar

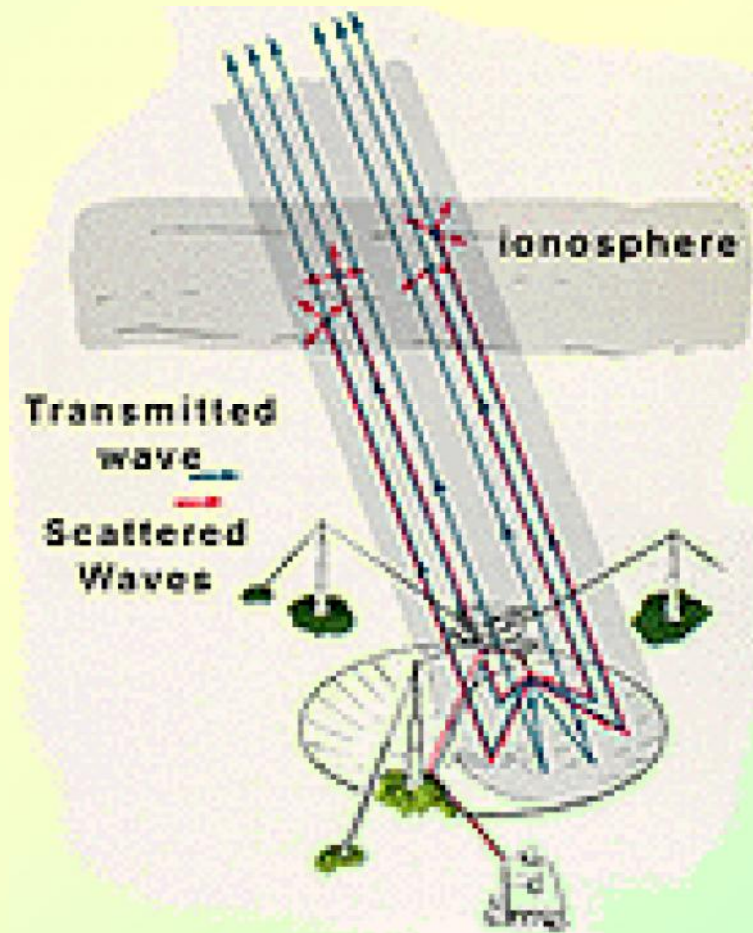
- Weather radars use radio waves with horizontal, dual (horizontal and vertical), or circular polarization
- Some weather radars use the [Doppler effect](#) to measure wind speeds

Incoherent Scatter Radar- A Radar Application

- Used to study the Earth's [ionosphere](#) and its interactions with the upper atmosphere, the magnetosphere, and the solar wind

Incoherent Scatter Echo

- Electrons in ionosphere are radar targets
- These electrons can scatter radio waves

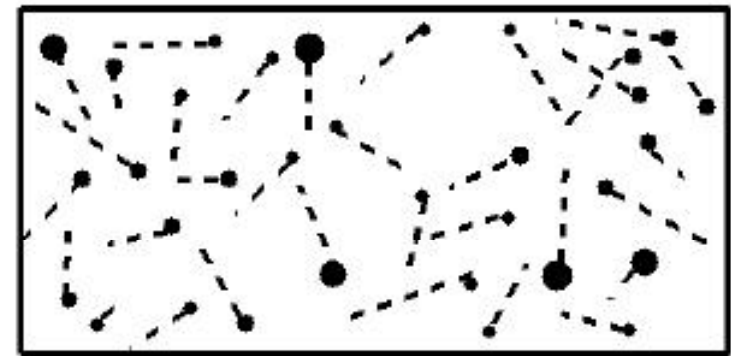


Radar Can Measure Pressure

- The strength of the echo received from the ionosphere measures the number of electrons able to scatter radio waves or what we call electron [pressure](#)

Radar Can Measure Temperature

- Some electrons are moving due to heat - In this case the echo is scattered
- The echo will contain a range of frequencies close to the transmitter frequency
- As the temperature increases, the electrons move faster
- So radar can act like a thermometer and measure the temperature of the ionosphere



Temperature is a measure of the average kinetic energy of the gas molecules.

Radar Can Measure Wind Speed

- When an electron is removed from an atom, the remaining charged atom is called an [ion](#)
- The ion gas can have a different temperature from the electron gas
- The electron/ion mixture is known as a [plasma](#) and is usually in motion (like our wind)
- So incoherent scatter radar can also measure wind speed



Millstone Hill Radar Model Ionosphere

27-Jun-2005

