RADAR COMMUNICATIONS

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RADAR

* **RADAR** – Radio Detection & Ranging
* Radar is an Electromagnetic System for the detection and location of objects
* Radar operates in microwave region
  * 100MHz – 36 GHz, max up to 240GHz

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Operation of Radar

* Radar radiates energy into space and detect the echo signal reflected from an object/target.
* Location and presence of the object both are detected by comparing the received echo signal with the signal that was transmitted.

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Radar Attributes

* It can operate in :
  * Darkness
  * Haze
  * Fog
  * Rain
  * Snow
* Its ability to measure distances with high accuracy and in all weather is one of the major attributes.

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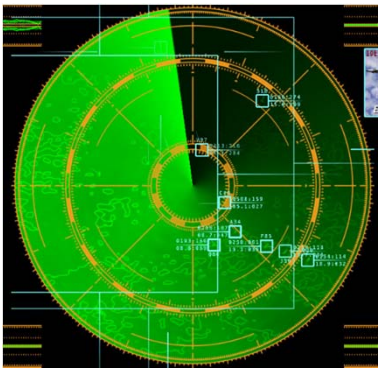
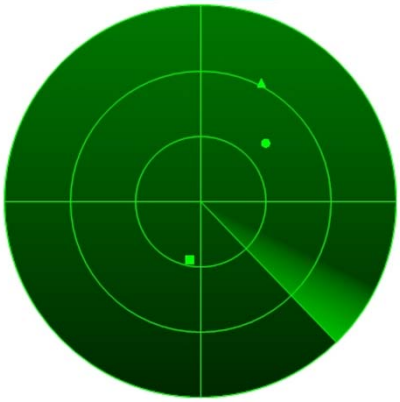
Radar Images





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Basic Principle of Radar Communication

* Transmitter generates Electromagnetic signal (such as short pulse sine wave) radiated into space by an antenna.
* Portion of the transmitted energy is intercepted by the target and re-radiates in many directions
* The re-radiated directed back towards the radar is collected back by the radio antenna, which delivers it to the receiver.

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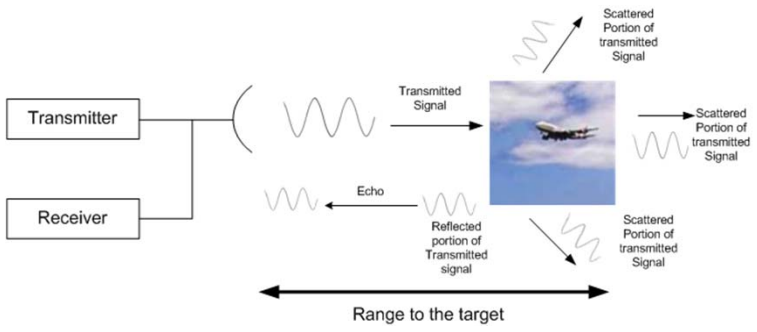

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Doppler Effect

- If the target is in motion, there is a shift in the frequency of the echo signal due to Doppler effect.
- The frequency shift is proportional to the velocity of the target relative to the radar
- **Doppler Effect:**
  - A change in the observed frequency of a wave, as of sound or light, occurring when the source and observer are in motion relative to each other.
  - The frequency increases when the source and observer approach each other and decreases when they move apart.

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Range to the Target

- Range to the target is determined by the time T_R it takes the Radar signal to travel to the target and back
- Electromagnetic energy in free space travels with the speed of light $c=3x10^8$ m/s
- Time for the signal to travel to a target located at R distance.
- Total distance travelled by wave is 2R, with wave travelling with speed of light
  - $T_R = 2xR/c$
  - Or $R= c \times (T_R) / 2$

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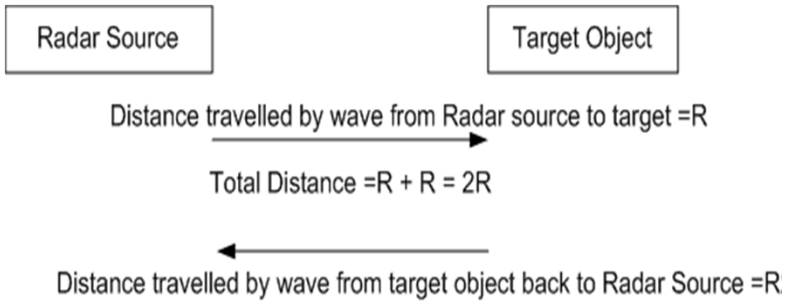

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Beam width

- The angle between the half power (-3dB) of main lobes.
- Expressed in degrees
- The main lobe, or main beam, of an antenna radiation pattern is the lobe containing the maximum power. This is the lobe that exhibits the greatest field strength.

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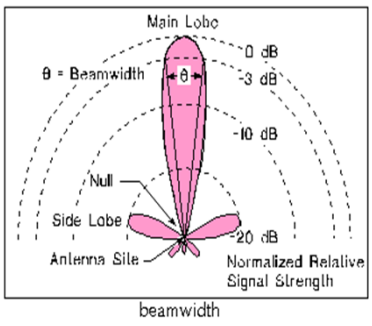

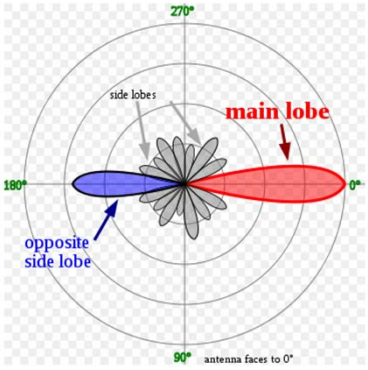

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Beam width Vs. Accuracy

- The size of the width of the beam (beam-width) determines the accuracy of the radar.
- From drawing we see that the target could be any where in the beam to produce a return.
- Ship B can more accurately determine where the target really is.
- Tracking or targeting radars require more accuracy (narrow beam- widths)

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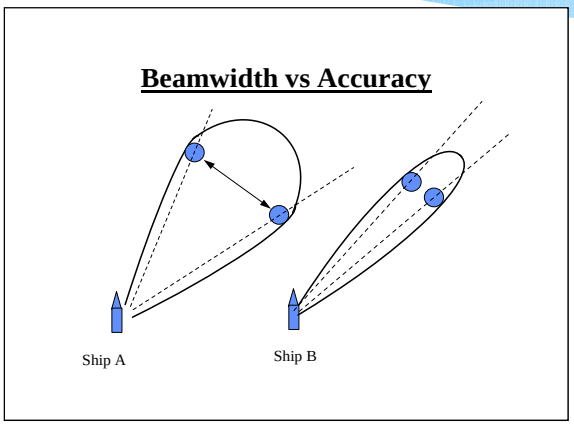

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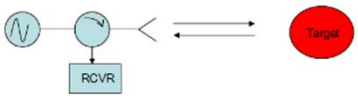
Types of Radar

Types of Radar

Two Basic Systems:

1. Monostatic
   (1 antenna)



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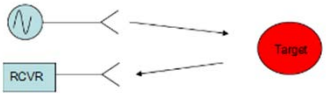
2. Bistatic
   (2 antennas)



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Radar Transmissions

* Pulse Transmission
* Continuous Wave
  * Pulse - RADAR transmits a series of pulses separated by non-transmission intervals during which the radar "listens" for a return.
  * Continuous Wave - Constantly emitting radar. Relative motion of either the radar or the target is required to indicate target position. Frequency shift.

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Pulse Transmission

* Pulse Width (PW)
  * Length or duration of a given pulse
* Pulse Repetition Time (PRT=1/PRF)
  * PRT is time from beginning of one pulse to the beginning of the next
  * PRF is frequency at which consecutive pulses are transmitted.
* PW can determine the radar's minimum detection range; PW can determine the radar's maximum detection range.
* PRF can determine the radar's maximum detection range.

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Pulse Transmission

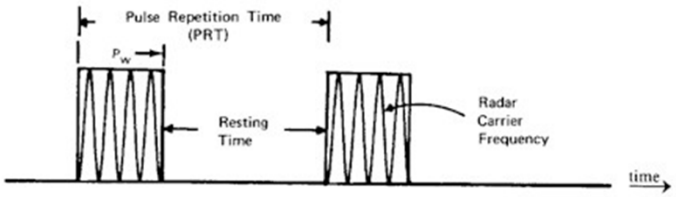

Figure 2–1. Pulse transmission.

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Factors That Affect Radar Performance

* Signal Reception
* Signal to Noise Ratio
* Receiver Sensitivity
* Power Relation
* Beam Width
* Pulse Repetition Frequency
* Antenna Gain
* Receiver Sensitivity
* Carrier Frequency
* Antenna aperture

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- **Signal Reception** :The weaker the signal the receiver can process, the greater the effective range.
- **Receiver Sensitivity:** Indicates how faint an RF signal can be successfully received by the receiver.

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Applications

- Ground based Radars: applied to detect, locate and track of air crafts/ space targets.
- Ship Board Radars: are used in navigation and safety device to locate shorelines and ships
- Airborne Radars: used to detect other aircrafts ships/ land vehicles.
- ATC (Air traffic Control)
- Ship Safety
- Law Enforcement: used to measure the speed of automobile traffic by highway police
- Military Use

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