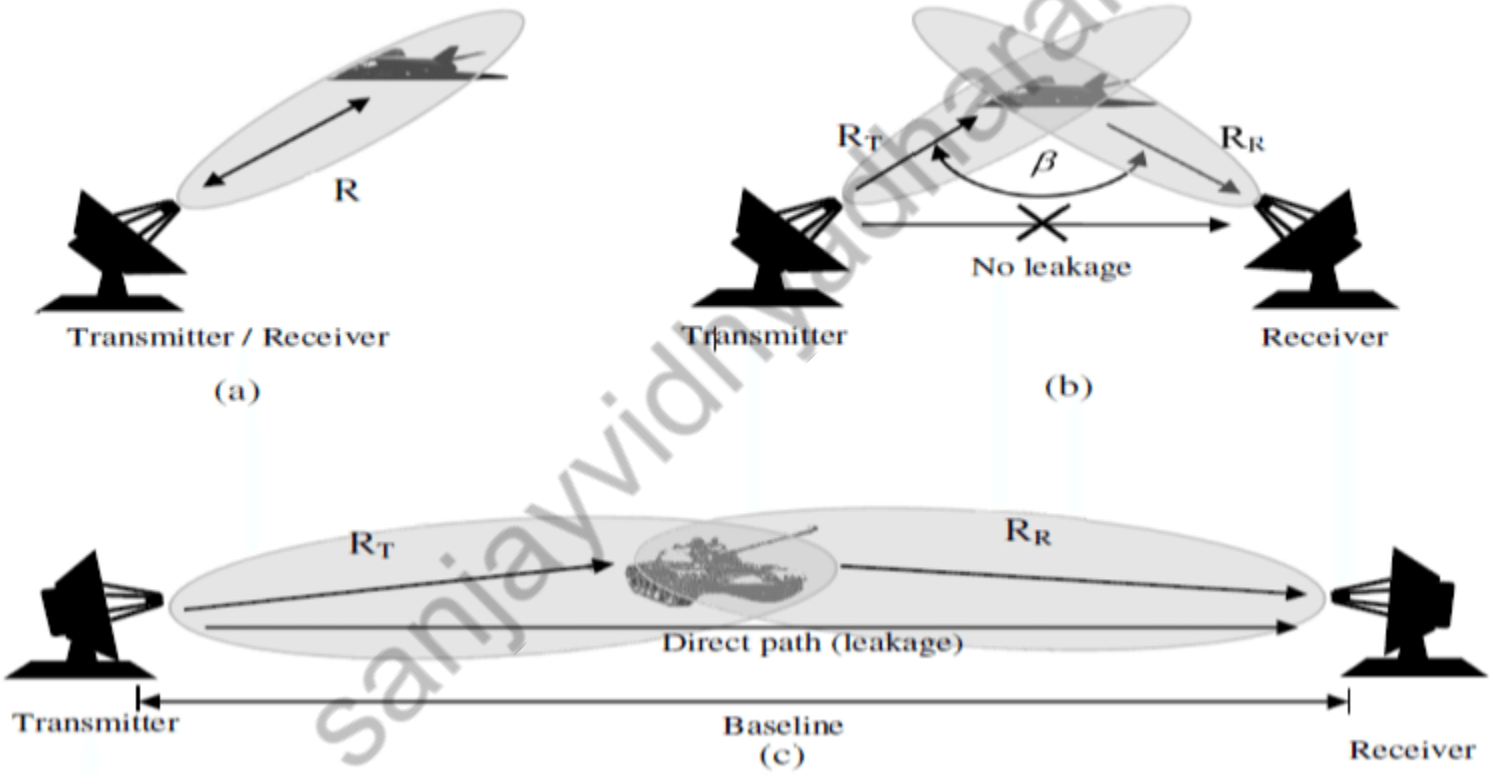
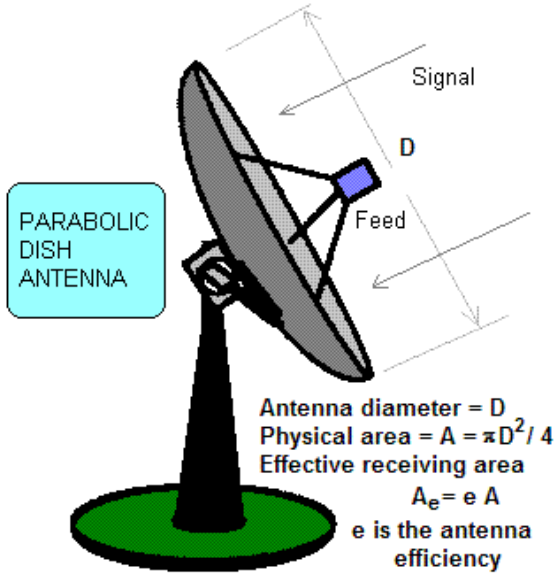
Introduction to Radars
Lecture 2: Modulated CW Radar

By Dr. Sanjay Vidhyadharan

Monostatic and Bistatic Radars



Radar Range Equation



$$Received\ \ Power\ Density\ at\ Radar\ Antenna = \frac{P_t G \sigma}{4\pi R^2}\ X\ \frac{1}{4\pi R^2} \quad (W/m^2)$$

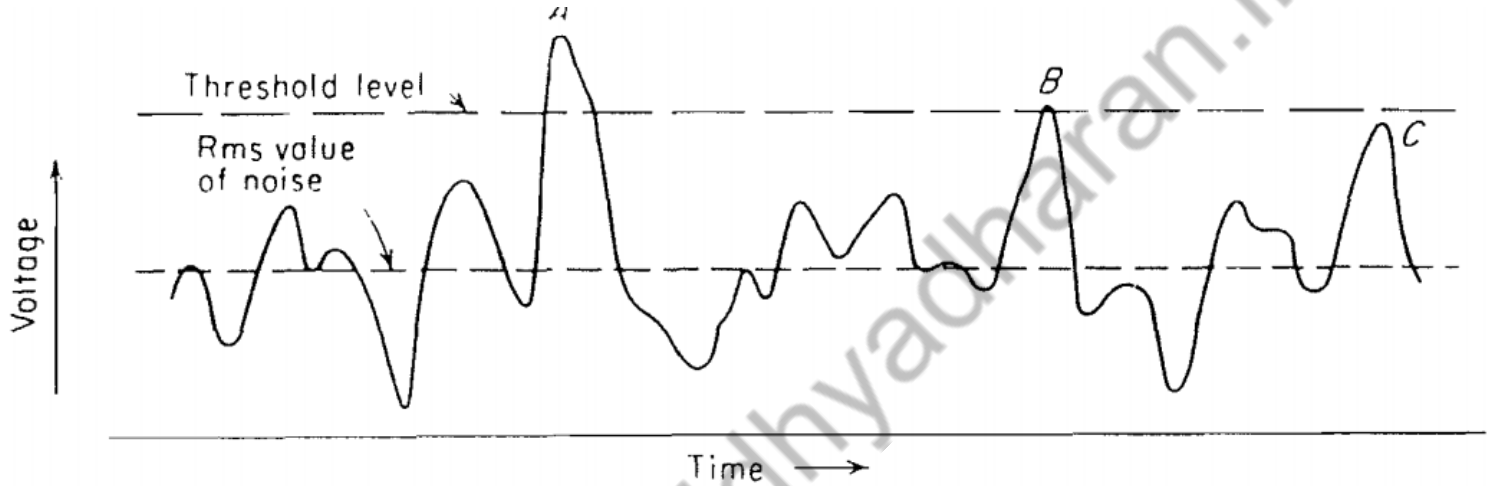
$$Received\ \ Power\ at\ Radar\ Antenna = \frac{P_t G \sigma A_e}{(4\pi)^2 R^4}\ (W) \qquad A_e\ Antenna\ Effcetive\ (m^2)$$

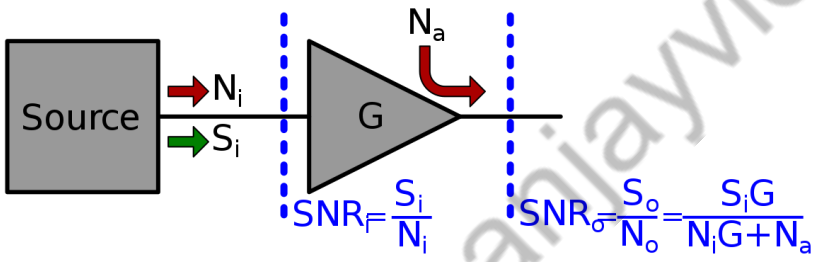
$$Minimum\ Detectable\ Signal\ S_{min} = \frac{P_t G \sigma A_e}{(4\pi)^2 R^4}$$

$$Max\ Radar\ Range\ \ R_{max} = \left[\frac{P_t G \sigma A_e}{(4\pi)^2\ S_{min}}\right]^{1/4}$$

Radar Range Equation

Minimum Detectable Signal S_{min}





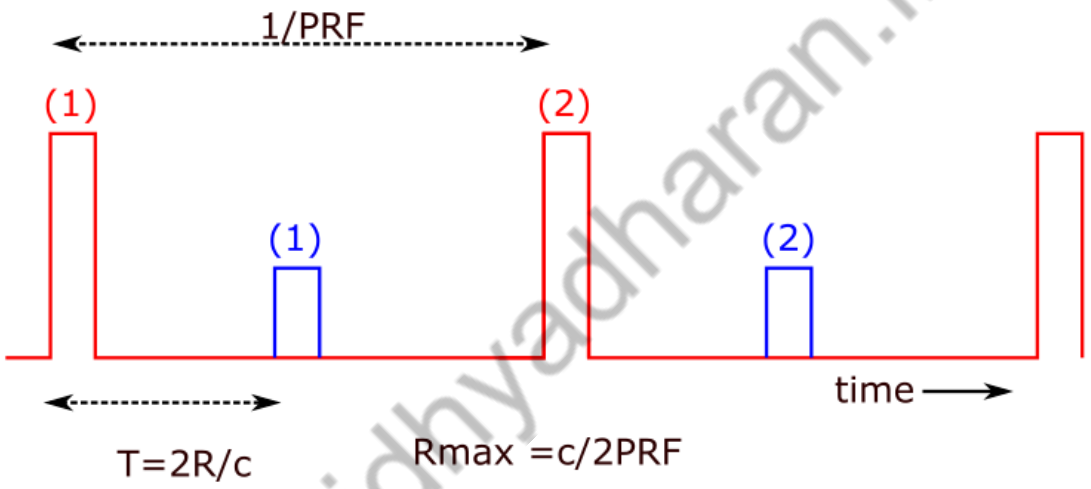
$$N_i = kTB_n$$

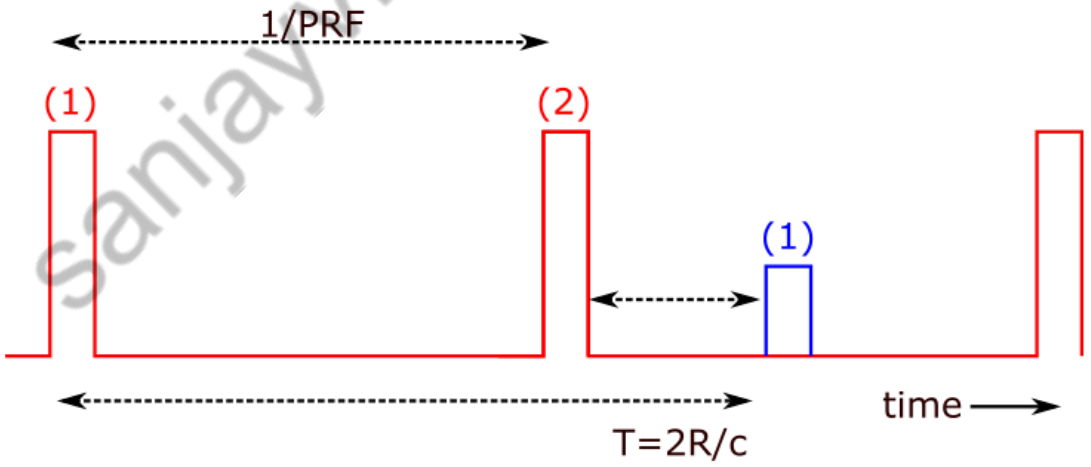
$$F_n = \frac{S_i/N_i}{S_o/N_0} \qquad S_i = F_n kTB_n \left(S_o/N_0\right)$$

$$\text{Max Radar Range } R_{max} = \left[\frac{P_t G \sigma A_e}{(4\pi)^2 F_n kTB_n \left(S_o/N_0\right)_{min}}\right]^{1/4}$$

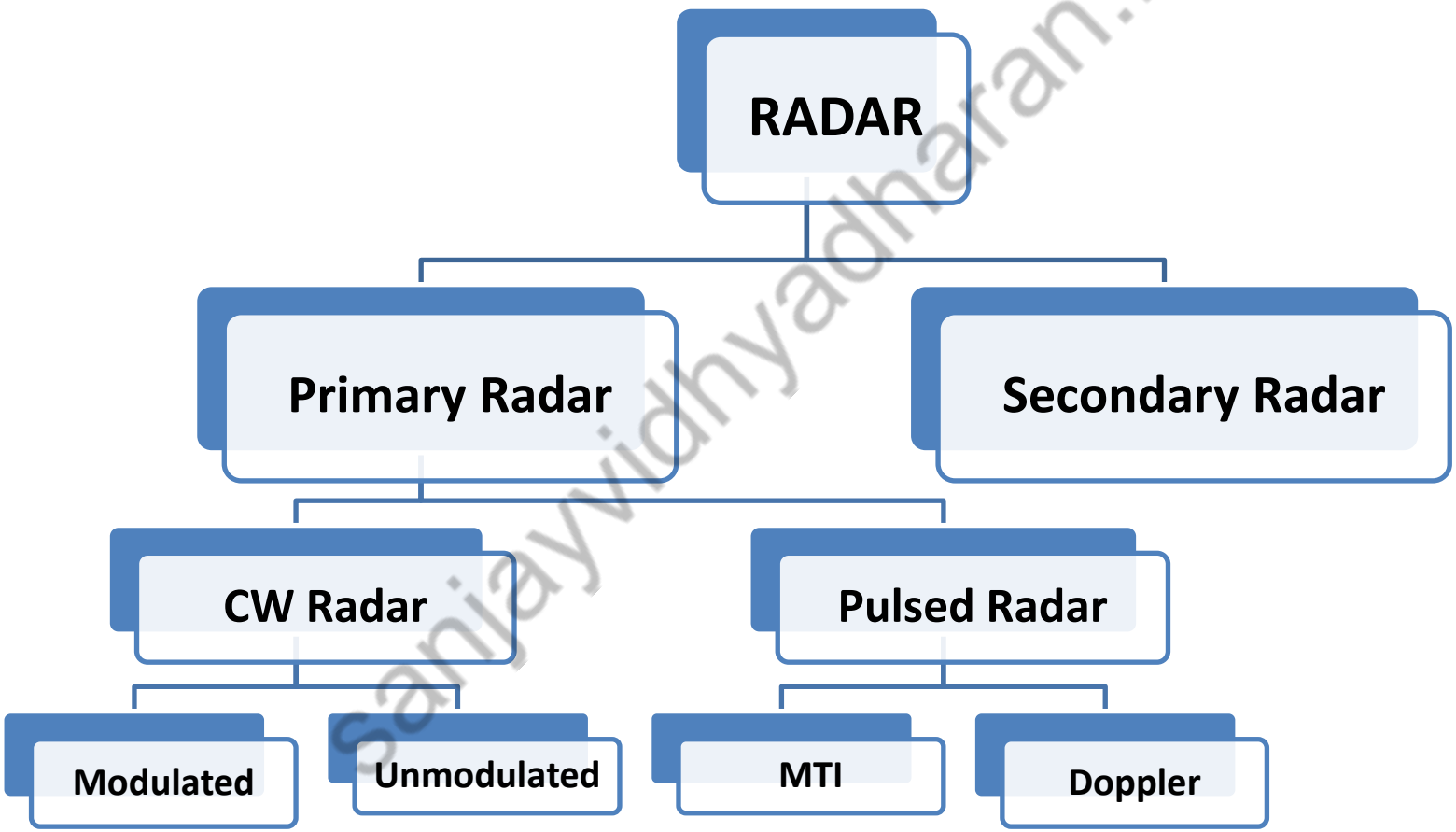
Max Range and PRF

Pulse Repition Frequency PRF





Classification of Radars



Primary and Secondary Radars

Primary Radars

Primary and Secondary Radars

Secondary Radars

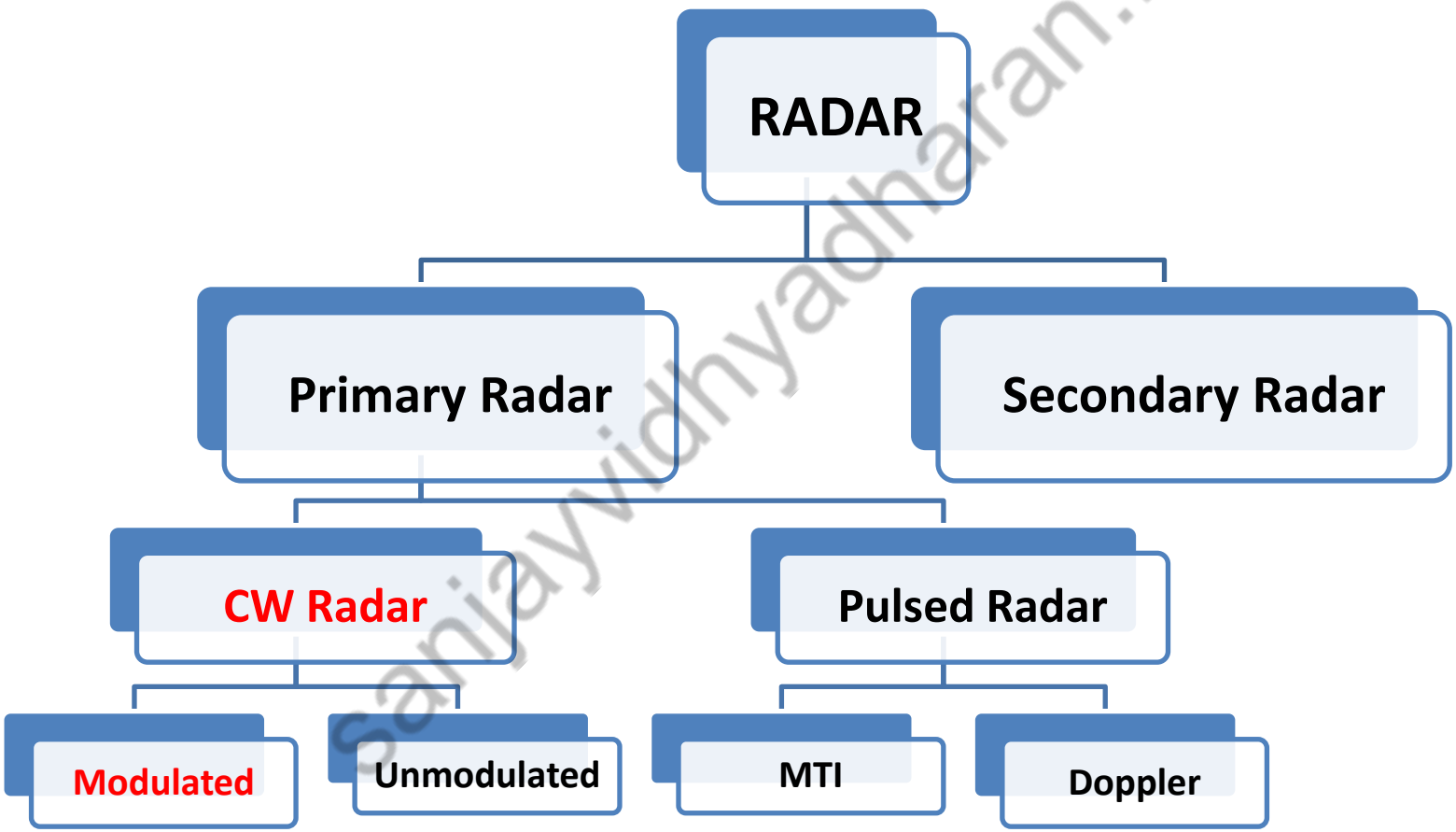
Radar

Target

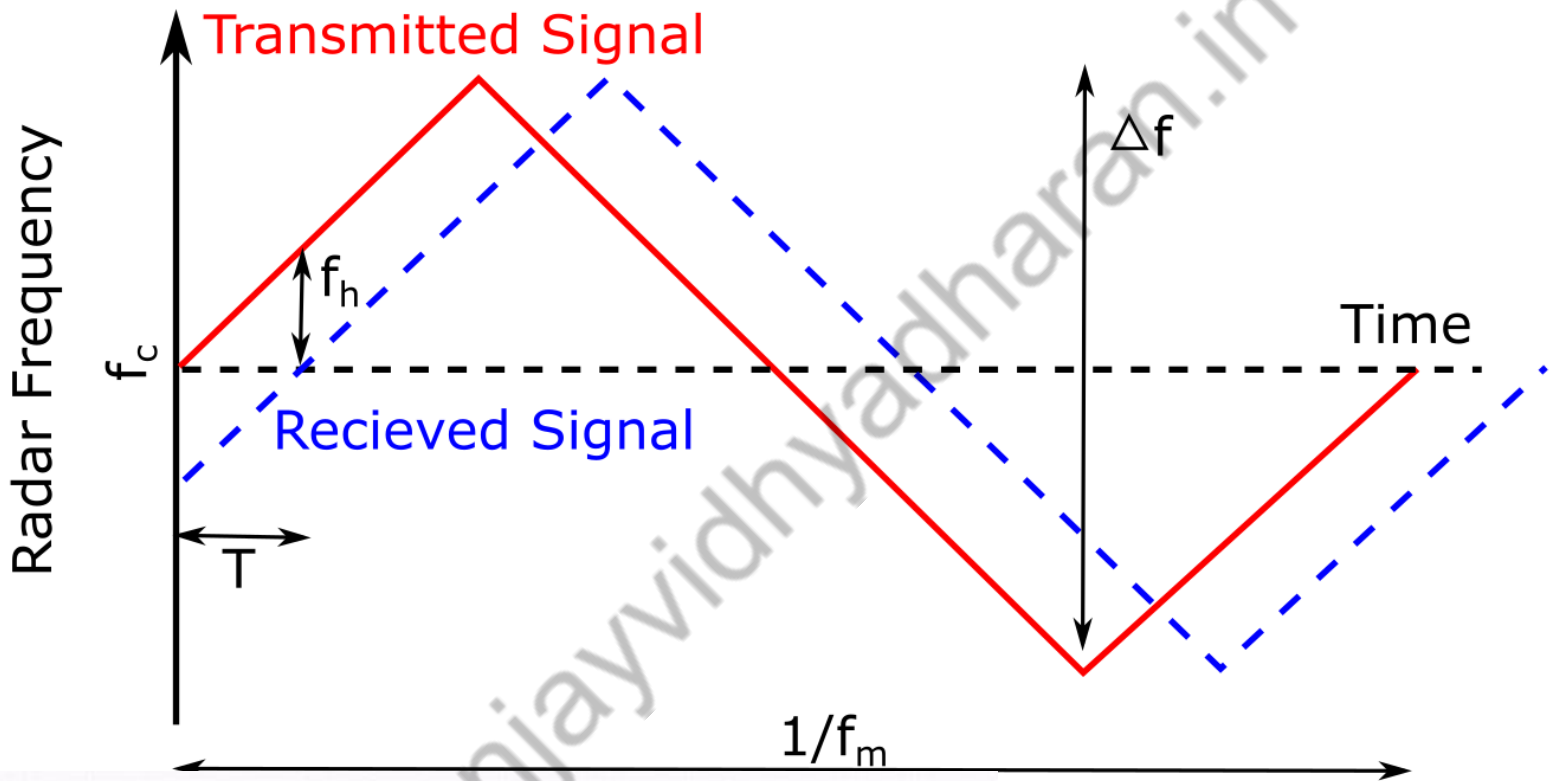
Interrogation Pulse

Response Pulse

Classification of Radars



Modulated CW Radar



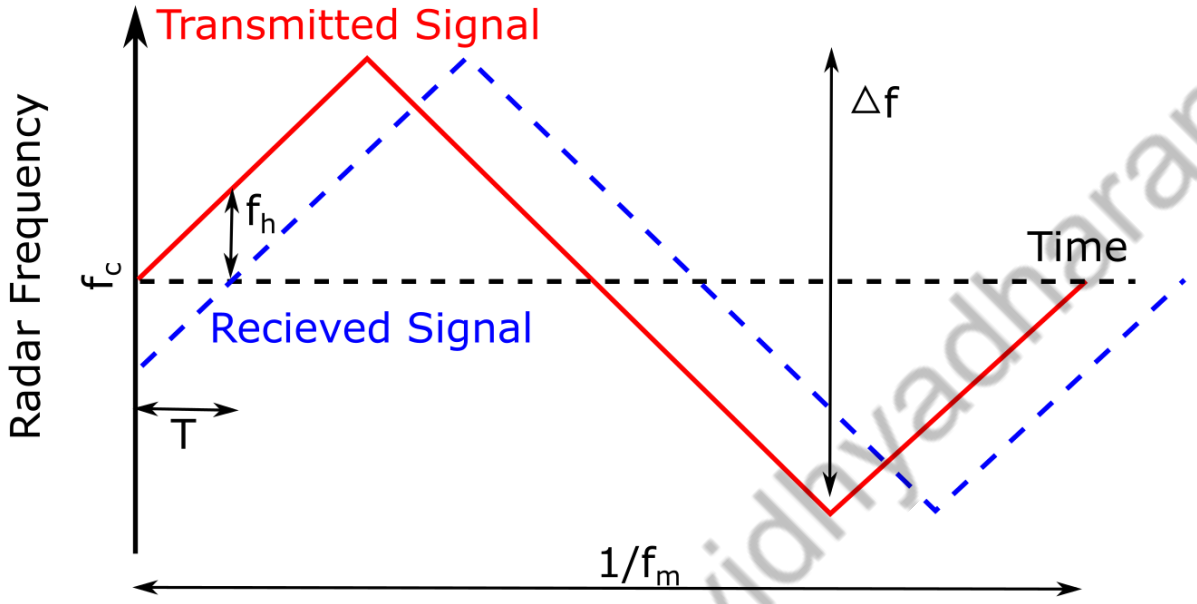
f_c = frequency of carrier wave

f_h = Beat frequency

f_m = frequency of triangular modulating wave

Δf = maximum deviation of carrier frequency

Modulated CW Radar



$$R = \frac{cT}{2}$$

Radio Altimeters

$f_c = 4.2 - 4.4$ **GHz**

$\Delta f = 100 - 200$ **MHz**

$f_m = 50 - 300$ ***Hz***

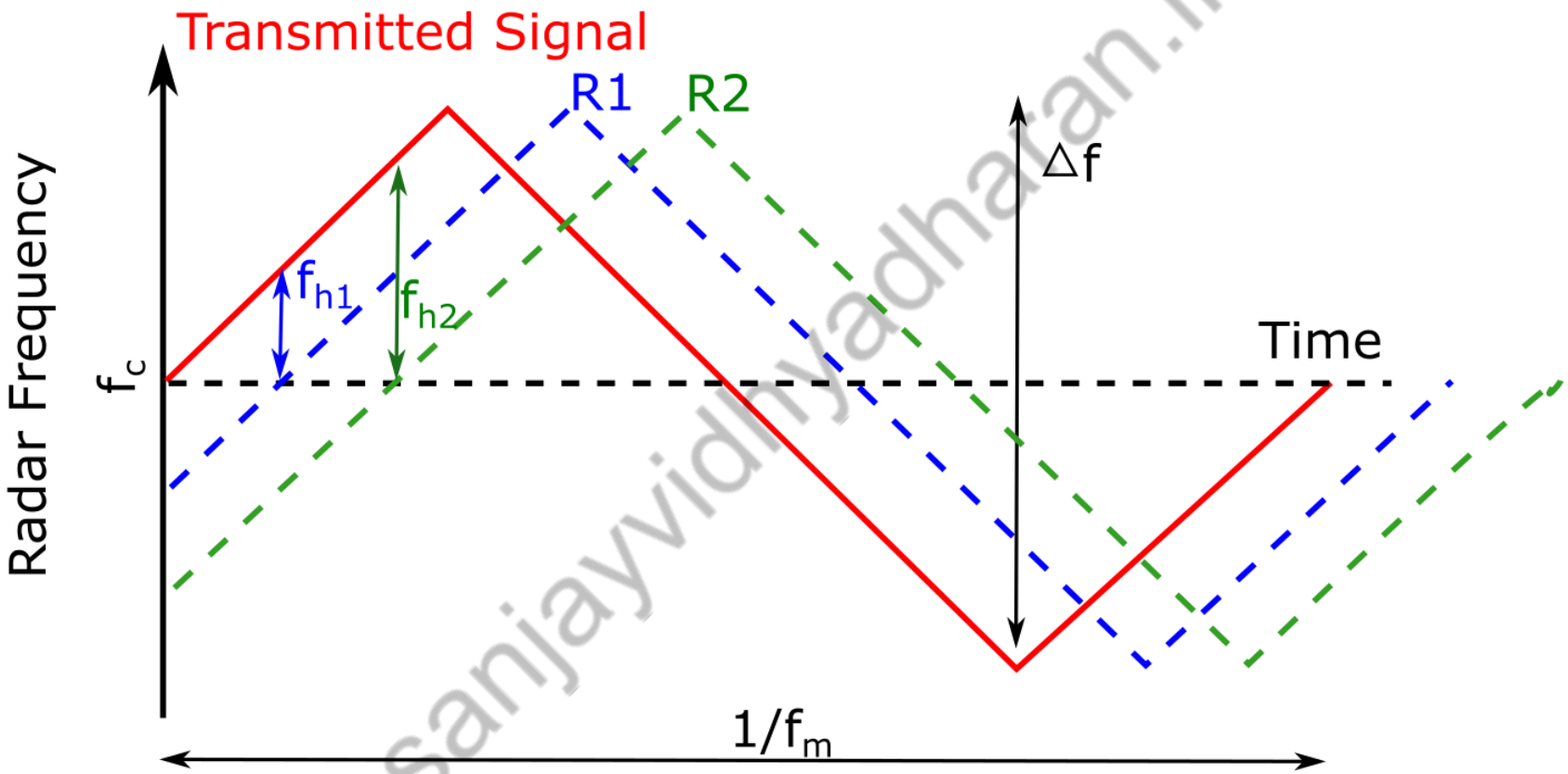
$Range = 1 - 2$ ***Kms***

$$Rate\ of\ Change\ of\ f_c = \frac{\Delta f}{1/2f_m} = 2.\Delta f.f_m$$

$$Change\ in\ f_c\ in\ Time\ T = f_h = 2.\Delta f.f_m\ .T = \frac{2.\Delta f.f_m\ 2R}{c}$$

$$Target\ Range\ R = \frac{cf_h}{4.\Delta f.f_m}$$

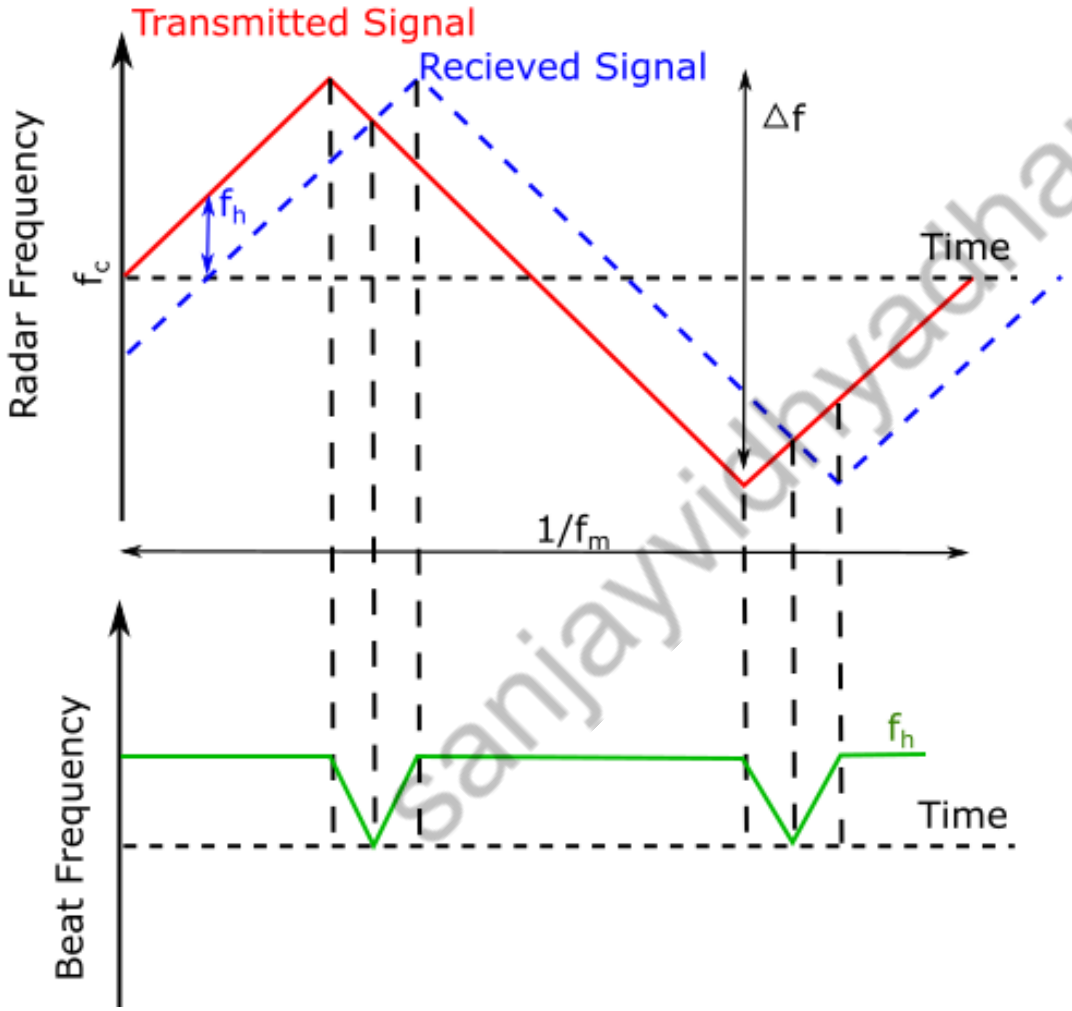
Modulated CW Radar



$$R = \frac{cT}{2}$$

$$Target\ Range\ R = \frac{cf_h}{4.\Delta f.f_m}$$

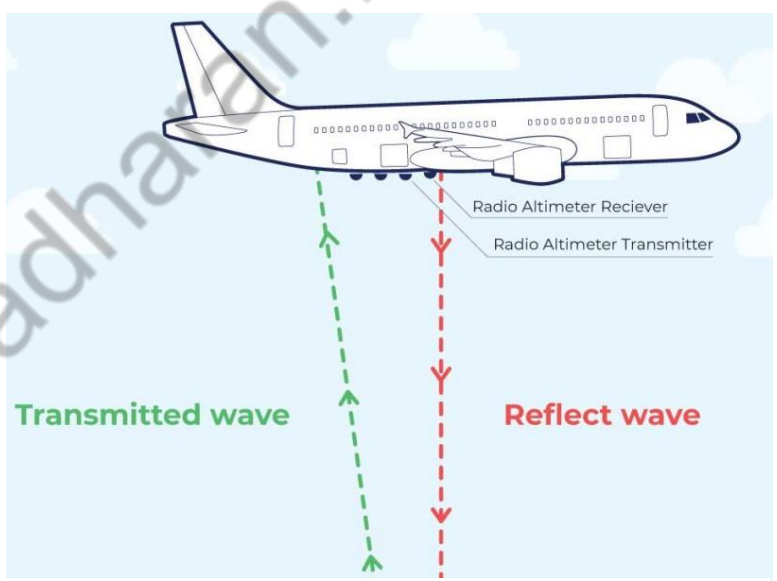
Modulated CW Radar



$$Target\ Range\ R = \frac{cf_h}{4.\Delta f.f_m}$$

Modulated CW Radar

Application: Radio Altimeter



Radio Altimeter

Modulated CW Radar

Block Diagram

Rx Antenna

Mixer

LPF

Frequency Counter

Limiting Amplifier

Power Amplifier

VCO

Modulator

Coupler

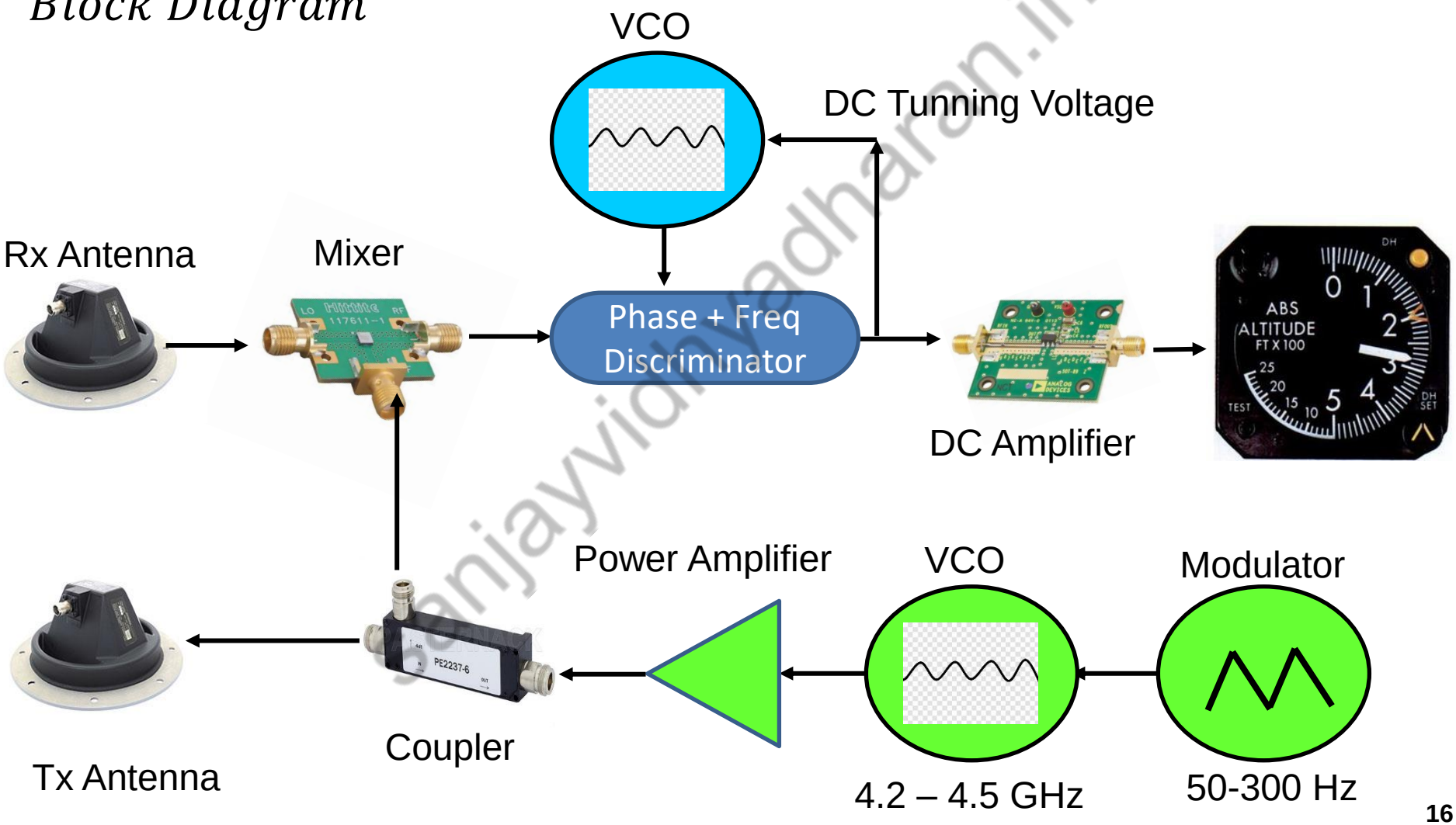
Tx Antenna

4.2 – 4.5 GHz

50-300 Hz

Modulated CW Radar

Block Diagram



Thankyou