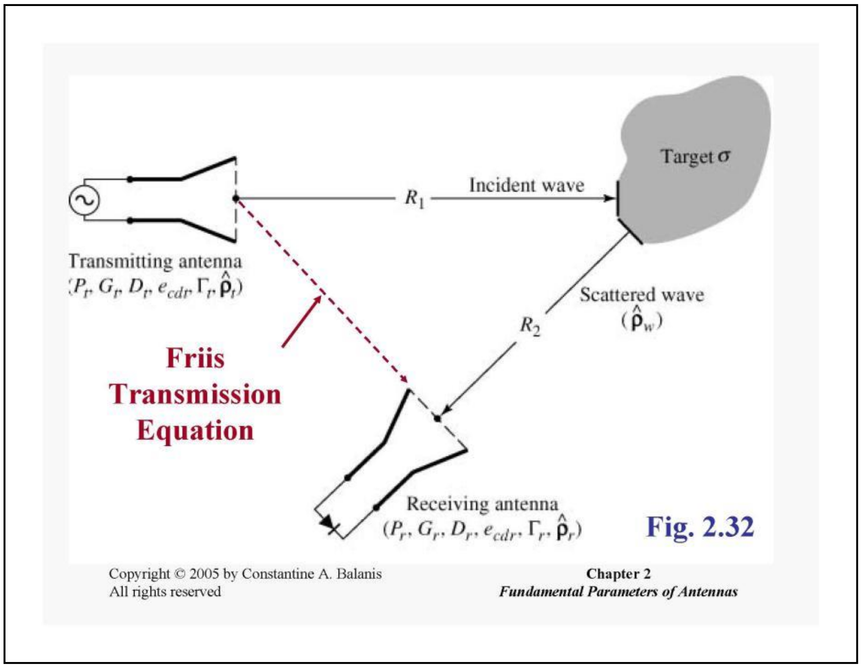
RADAR RANGE EQUATION

Assume that the transmitted power is incident on upon a target.



We introduce a radar cross-sectional area or echo area (m^2), σ, which is the effective area of the target such that it re-radiates the incident power isotropically. (radar cross section)

$G_t(\theta_t,\phi_t)$, $G_r(\theta_r,\phi_r)$ are the gains of transmit and receive antennas in the direction of the target. The power density at the target:

$$W_T = G_t(\theta_t,\phi_t)\frac{P_t}{4\pi R_1^2}$$

So, incident power on target (the captured power):

$$P_T = \sigma W_T$$

As this is assumed to be reradiated isotropically power density at the receive antenna:

$$W_r = \frac{P_T}{4\pi R_2^2}$$

Effective aperture of the receive antenna in the direction of the target:

$$A_r = G_r(\theta_r, \phi_r)\left(\frac{\lambda^2}{4\pi}\right)\text{PLF}$$

Substitute,

$$\frac{P_r}{P_t} = \sigma\left(\frac{\lambda}{4\pi R_1 R_2}\right)^2 \frac{G_t(\theta_t, \phi_t)G_r(\theta_r, \phi_r)}{4\pi}\text{PLF}$$

If the antenna is used to receive and transmit:

$G_r = G_t = G$ and $R_1 = R_2$:

$$\frac{P_r}{P_t} = \frac{\sigma}{4\pi}\left(\frac{\lambda G}{4\pi R^2}\right)^2 \text{PLF}$$

These formulas are correct when there is no atmospheric loss, if there is atmospheric loss we must include in the calculations.