2.9 RADAR LOSSES

For our last radar range equation-related topic we want to address radar losses. In our previous discussions we have discussed some of the causes of losses, and it future discussions we will discuss more. At this point we will provide a summary of various loss terms. We will not address all possible loss terms since their number can be very large. See the Skolnik's text and Radar Handbook for a more complete discussion of losses

- **Transmit Losses** – Typically associated with the feed, waveguides and other components between the power amplifier and the antenna. These are typically 1 to 2 dB in a well designed radar.

- **Receive Losses** – Typically associated with the feed, waveguides and other components between the mouth of the feed and RF amplifier. These are also typically 1 to 2 dB for a well designed radar. If the noise figure is referenced to the antenna terminals, receive losses are included in the noise figure. This is something to be careful of.

- **Atmospheric Losses** – These are losses due to absorption by the atmosphere. They are dependent upon the radar operating frequency, the range to the target and the elevation angle of the target relative to the radar. Both Skolnik's text and Radar Handbook have graph depicting these losses.

- **Scanning or Beamshape Loss** – This loss term accounts for the fact that, as the beam scans across the target, the signal amplitudes of the pulses coherently, or non-coherently, integrated varies. Because of this, the full integration gain of the integrator can't be realized. From the Skolnik Radar Handbook typical values are

  - 1.6 dB for a scanning, fan beam radar

  - 3.2 dB for a thinner beam, scanning radar

  - 3.2 dB for a phased array radar wherein the beams of a search sector overlap at the 3-dB beam positions.

- **Range-Gate Straddling Loss** – If the radar samples in range at a rate of once per range resolution cell the loss is usually taken to be 3 dB.

- **Doppler Straddling Loss** – The loss associated with forming the Doppler dimension of a range-Doppler map. Its particular value depends upon the specific Doppler processor implementation but typical values are 1 to 2 dB.

- **Collapsing Loss** – If the coherent or non-coherent integrator integrates only noise over some if its integration time (due to the fact that the beam has moved fairly far off of the target) the radar will incur a loss that is given by

  $$L_c = \frac{n+m}{n}$$

  where n is the number of pulses containing signal-plus-noise and m is the number of pulses containing only noise.

- **Signal Processing Loss** – If the radar uses an MTI with a staggered PRF waveform, and a good MTI and PRF stagger design, it will suffer 0 to 1 dB signal processing loss.

- **Miscellaneous Loss** – Radar designers and analysts usually include an additional 1 to 2 dB loss to account for various factors they forgot to consider.

This completes our study of the radar range equation. As was indicated at the start of this class, the radar range equation is an equation that appears to be very simple but, in fact, is very complex. In closing this part of the course we will summarize some of the observations associated with the radar range equation