Radar: Basics – scenario 3a

Probability of Detection P(D): Dependence on radio frequency

- The effect of varying radar frequency can be illustrated by using two radars in the same position, measuring the same target.

- Radar-1 is UHF 1.2GHz (25cm wavelength) and Radar-2 is using a lower frequency 180MHz and longer wavelength (167cm) in the VHF range. The Radar Cross Section (RCS) for the same target is smaller at the lower frequency.

- The Fresnel Zone (see scenario 2c) edge for Radar-1 and the target height is 1000km, so the target is well inside and the signals only suffer free-space loss.

- Radar-2 has a Fresnel Zone much closer at 150km due to the longer wavelength and the signals from point B suffer the higher two-ray loss. Point A is still outside the radar horizon.

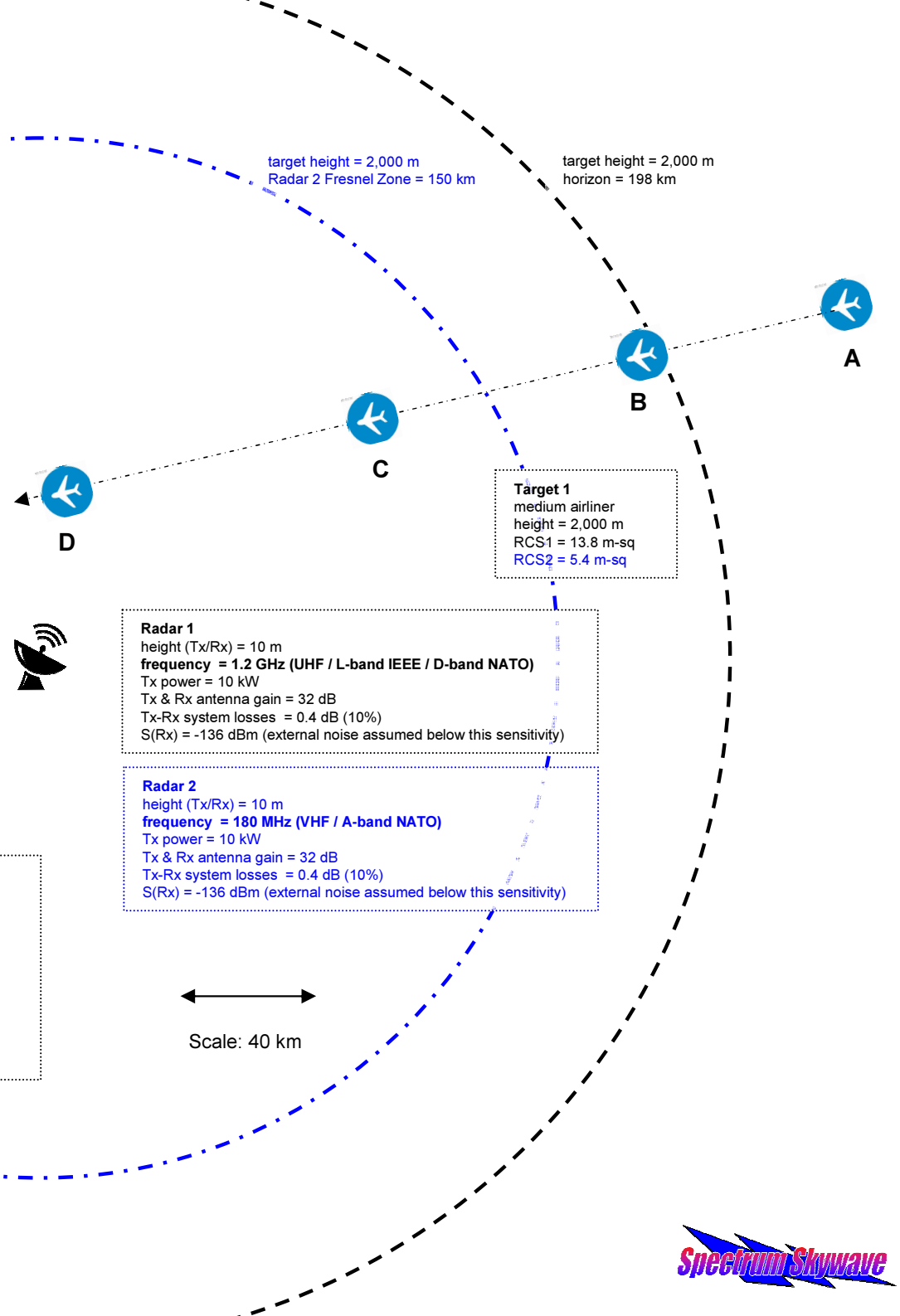
- However, Radar-2 free-space loss is lower than Radar-1 due to the longer wavelength (167cm vs 25cm). Hence the reflected signal is stronger and the target is detected by Radar-2 with 100% probability as soon as it crosses the radar horizon, in comparison with 30% probability for Radar-1.

A: range = 255 km , P1(D) = 0%, P2(D) = 0% (outside radar horizon)

B: range = 197 km, P1(D) = 30%, P2(D) = 100% (crossing horizon)

C: range = 120 km, P1(D) = 90%, P2(D) = 100%

D: range = 50 km, P1(D) = 100%, P2(D) = 100%



Radar: Basics – scenario 3b

Probability of Detection P(D): Dependence on radio frequency

• Radar-1 is the same 1.2GHz UHF (L-band) as scenario 3a and Radar-3 is using a higher frequency 2.5GHz and shorter wavelength (12cm), further up the UHF range (S-band). The RCS3 is higher than RCS1 due to the shorter wavelength.

• The Fresnel Zone (see scenario 2c) for Radar-1 and the target height is within 1000km so the target is well inside and the signals only suffer free-space loss.

• Radar-3 has a Fresnel Zone edge much further out at 8,333 km due to the shorter wavelength, and hence the signals suffer only free-space loss. Point A is outside the radio horizon for all frequencies.

• However, Radar-3 free-space loss is higher than Radar-1 due to the shorter wavelength (12cm vs 25cm). Hence the reflected SNR is much lower and the target is not detected as soon as it crosses the radar horizon.

• A 30% detection probability is only achieved for Radar-3 at a range of 123km compared with 197km for Radar-1. Even at short 50km range (point D) the probability of detection is still below 100% for Radar-3.

A: range = 255 km , P1(D) = 0%, P3(D) = 0% (outside radar horizon)

B: range = 197 km, P1(D) = 30%, P3(D) = 0% (crossing horizon)

C: range = 120 km, P1(D) = 90%, P3(D) = 38%

D: range = 50 km, P1(D) = 100%, P3(D) = 98%