Radar: Basics – scenario 6a

Probability of Detection P(D): Effect of external noise background

• The previous scenarios have considered noise backgrounds, at the radar site, below the Rx sensitivity S(Rx). So the radar has been operating in the most favourable noise environment.

• The bandwidth (BW) used by the Rx is important is determining in the external noise passed into the Rx by the antenna, as a wider BW raises the noise admitted and Rx sensitivity. BW = 0.45 kHz = 450Hz will be used initially, which is quite small.

• Often the Doppler shift expected from moving targets determines the required BW. Faster moving air targets requiring a wider BW, than slower moving surface ones, to correctly resolve speeds.

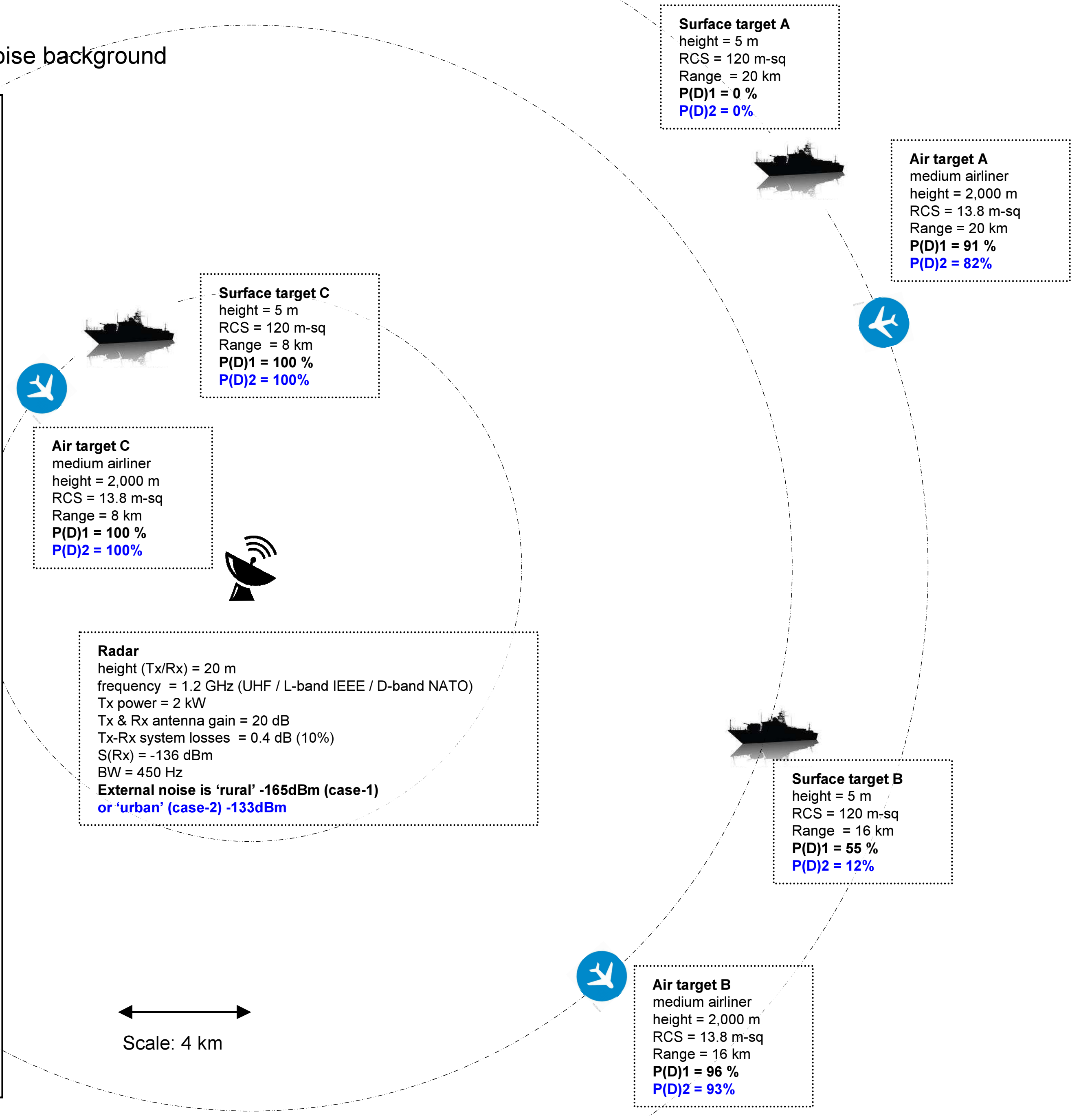
• Case 1 for P(D)1: External noise is the "rural" level of -165dBm at 1.2GHz and Rx bandwidth of 450 Hz. This noise level is 29dB below the S(Rx) and hence the Rx is 'internally noise limited'.

• Case 2 for P(D)2: External noise is "urban" level of -133dBm for the same frequency and BW, which is 3dB above the S(Rx), and so begins to affect the SNR and P(D). The Rx is 'externally noise limited'.

• The P(D)2 for the Air targets are reduced compared with P(D)1, by a greater amount at longer ranges, except for Air target C at 8km where the SNR is still sufficient to overwhelm the extra noise.

• The P(D) for the Surface targets is reduced by a greater amount than the Air targets as there is less SNR margin. This is most evident for Surface target B with a 43% reduction compared with a 3% reduction for Air target B.

• Surface target A was not visible with the lower noise level so raising the level does not improve visibility. For close range Surface target C the SNR is still high enough to overwhelm the extra noise.



Radar: Basics – scenario 6b

Probability of Detection P(D): Effect of high external noise background

• In this scenario the external noise is at the radar is at very high levels of -117 dBm at 1.2GHz and Rx bandwidth of 450 Hz. This noise level is 19dB above the Rx sensitivity and 16dB above 'urban' levels. This may be typical for a ship-borne radar, where there is considerable noise from electrical systems.

• For this level of noise the Surface and Air targets A and B are not detectable. The targets at close range C of 8km are still moderately detectable.

• Unexpectedly, the Surface target C is slightly more visible than the Air target C. Even though the propagation loss is higher for the Surface target, this is compensated by its much higher RCS.

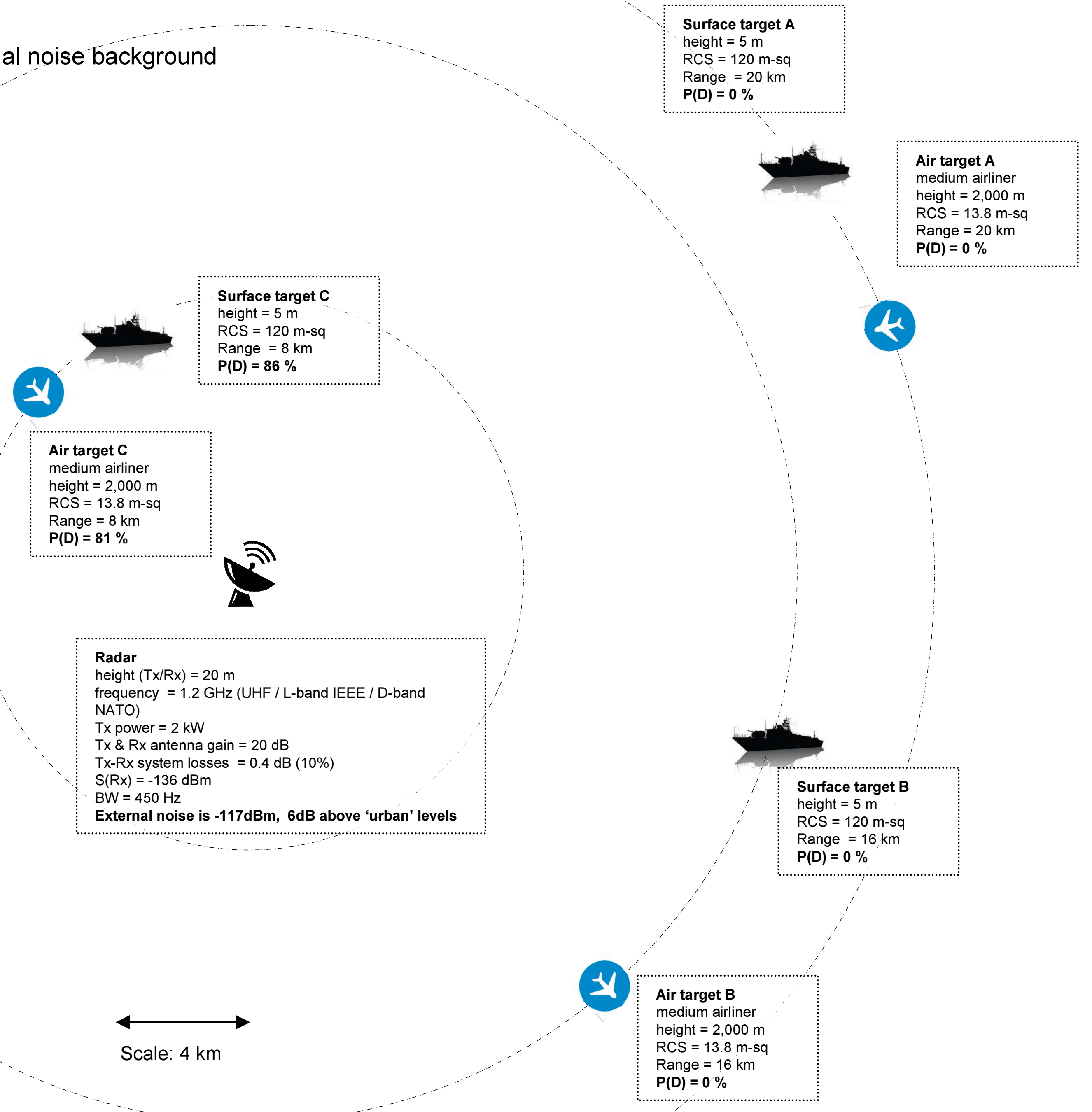
• To raise the signal return levels; the Tx/Rx height could be raised, the antenna gains increased, the Rx BW decreased, or the Tx power increased.

• If the Tx/Rx antenna gain were increased from 20dB to 35dB then Surface target A would be 79% detectable. This would require an increase in diameter for a parabolic dish from 0.8m to 4.5m.

• If Tx power were raised from 2kW to 2MW (1,000 times) then Surface target A would be 79% detectable.

• If the Tx/Rx antenna were raised to 80m height then Surface target A would be 16% detectable. Raising the height further does not improve detection, as at 80m height the Fresnel Zone just reaches Surface target A and the propagation loss drops from two-ray to free space, and remains at free space loss for any further height increase.

• If the Rx BW were reduced from 450Hz to 10Hz then Surface target A would still not be detectable, but Surface Target B would be with a low probability of 22%. However, 10Hz is a very low bandwidth for 1.2Ghz and would only be useable for stationary targets.



Spectrum Skywave