Radar Equation for Frequency Diversity Radar

The radar equation we have developed is independent of the modulation scheme and in general can be used with each radar unit. In practice, some other variation of the radar equation will be more convenient for system analysis.

In order to increase detection probability of a frequency diversity radar (e.g. ATC radar of type ASR-910) two pulses of different frequency are radiated one after another at very short intervals. Assuming a sufficient gap between the frequency of the pulses radiated exist, echo signals of a fluctuating target are statistically decorrelated. Smoothing of fluctuation can be expressed in terms of signal-to-noise ratio gain, maximum range gain or improved detection probability. This can be either an increased maximum range or an increased probability of detection.

A term Lges is given in the general radar equation for losses. This term includes the fluctuation loss L f. The probability of detection is inversily proportional to the fluctuation loss L f.

The following equation is valid:

$$Lf(ne) = Lf(1) * \exp(1/ne) \qquad (49)$$

ne = Number of the statistically independent samples

Lf (1) = fluctuation loss of a Swerling-I-target

The number of the statistically independent samples is a result of the diversity-bandwidth Δf (this is the frequency spacing between the transmitted pulses) and the correlation-frequency fc of the target.

$$fc = c0 / 2\,Lr \qquad (50)$$

c0 = speed of light

Lr (1) = radial dimension of the aim

Therefore:

$$ne = 1 + \Delta f / fc \qquad (51)$$

Under this condition the decreased fluctuation loss is determined by:

$$Lf(ne)\,[dB] = Lf(1)\,[dB] / ne \qquad (52)$$

By putting aside the power doubling achieved with two transmitters at constant frequencies, the maximum range through frequency diversity mode can never be better due losses caused by fluctuation.

Since the fluctuation loss also rises strongly with the increase in probability of detection, the diversity effect would actually be treated as a contrast enhancement. Strong targets are highlighted further, weak targets (PD von 40...60%) are less influenced. For a probability of detection less than about 35% diversity losses appear.

Source:
http://www.radartutorial.eu/01.basics/Radar%20equation%20for%20frequency%20diversity%20radar.en.html