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Modelling a Networked Over the Horizon Radar

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We have proposed an over the horizon radar (OTHR) architecture with receiving systems which are truly relocatable and mobile. This networked OTHR (NOTHR) is based on a beamforming on transmit concept. It proposes a very large aperture antenna on transmit and a very small aperture antenna on receive. As a consequence, the receive system is cheap to manufacture, physically small and could be deployed on a ship. In principle the receivers are truly relocatable. One consequence of this architecture is that many receivers can be deployed and operated in conjunction with one transmitter, operating bistatically to measure target velocities as well as speed. Such a system will be able to detect and track a wide variety of targets which range from slow to very fast moving.

While this architecture has a number of advantages it also has a number of challenges, notable of which are frequency management and coordinate registration over bistatic paths for which backscatter sounding will not be possible. Consequently, NOTHR requires a real-time ionospheric model, based on data from a variety of ionospheric sensors which may be part of, or independent from the NOTHR facilities. The ionospheric model is an important element of the frequency management system which will control the radar operating frequency so that the transmitter both illuminates the target and the target scattered signal travels to the receiving stations.

The paper will first briefly describe an HF Radar Model (HFRM) which has been developed to evaluate the NOTHR concept. The HFRM will be used to evaluate the performance of the NOTHR in terms of its sensitivity, as quantified by the Minimum Detectable Radar Cross Section (MDRCS), across a surveillance region. Models of target radar cross section will be described and the concept of Target Visibility introduced. The latter describes the probability of a MDRCS threshold being exceeded for all incident, scattered and polarisation angles, and provides an accessible metric of target detectability at an arbitrary aspect angle.

The paper will finally calculate the standard deviation of the signal loss by ray tracing through hourly ensembles of ionospheres derived from the Advanced Ensemble electron density Assimilation System (AENeAS). Ensemble members will be selected to represent the breadth of different ionospheres applicable to the region of interest and their distribution will describe the likelihood of those ionospheres occurring. The standard deviation of ensemble loss will finally be used to directly quantify the MDRCS standard deviation and indirectly the Visibility standard deviation.