NETWORK AND COMPUTATIONAL BURDENS FOR AN ARRAY OF COHERENT PASSIVE RADAR RECEIVERS FINE RANGE STRUCTURE IN METEOR TRAILS AND AURORAL ELECTROJET IRREGULARITIES

Sahr John,Melissa Meyer

Electrical Engineering,University of Washington,Allen Center room AE-103,Seattle,Washington USA

Abstract:

A variety of atmospheric and ionospheric processes may be remotely sensed by illumination at MF, HF, VHF, and UHF wavelengths where scattering cross sections are large. Examples include field-aligned irregularieties in the E and F regions, as well as aerosol or other layers found in the mesosphere and stratosphere. Although radar observations have been performed for decades, persistent logistical challenges have impeded some lines of investigation. These include cost of procurement and operation of 10 kW-class transmitters, licensing, and competition with commercial services for spectrum. With the advent of powerful and affordable computational modelling tools, there is new incentive to establish very widespread, ground-based coverage of remotely sensed atmospheric parameters. Passive radars offer a promising approach to generate this new data, as they can perform some remote sensing tasks with low cost and high performance.

Passive radars rely upon commercial broadcast services for illumination. By coherently detecting transmitter signals separately from weak scattered signals, completely range unambiguous range-Doppler profiles can be constructed with high time and range resolution. For example commercial FM broadcasts at 100 MHz offer range resolution of a few seconds, and range resolution of about 1 km. Initial experiments with digital TV signals at 600 MHz suggest that range resolution of about 30 m should be achievable.

Because passive radars rely upon transmitter signals which are effectively random, the detection algorithm must evaluate the full cross-ambiguity function. Although various optimization are available or are under development, real-time power spectrum estimates require about 200 million math operations per second for the Manastash Ridge Radar which uses 100 MHz broadcasts. Fortunately, this much computation is now readily available.

To date passive radars have been operated in very simple, uncoupled systems. The diagnostic power should increase rapidly once geographically distributed arrays are available, because the number pairwise receiver links increases quadratically with the number of receivers. In addition, the amount of data which must be exchanged will increase.

In this report we will discuss the scaling laws for computational and network burdens for different configurations of passive receiver systems, including geographysical bounds. For example, there is no point in correlating high latitude receiver signals for receivers separated by more than about 2000 km, as there will be no scattering

volume in the field of view for stratosphere, mesosphere, or E region targets (and no visible field aligned irregularities in the F region). We will comment briefly on operating modes which include buffering data without transporting it unless it is needed, and possibilities for aggressively truncating data to conserve network bandwidth.

This study should be useful for planning passive radar operations for the nascent Distributed Arrays of Scientific Instruments (DASI) project, as well as augmenting existing transmitters with supplementary, bistatic receivers.