Intercepted Signals for Ionospheric Science

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Abstract

We will discuss the application of coherent software radio technology to remote sensing of the ionosphere. Using networks of advanced software radio systems it is possible to make observations of the ionosphere with both wide spatial coverage and simultaneous high resolution in space and time. Such observations can be made using a variety of techniques such as active and passive multi-static radar imaging, satellite beacon observations of TEC and scintillation, spectral monitoring, and signal time difference of arrival. Using software radio techniques it is possible to build instrumentation networks which can accomplish these observations using a unified set of hardware and software. While different antennas are often necessary or useful for particular applications the underlying analog and digital hardware systems remain unchanged from application to application. Such multi-role instruments can be highly integrated and can dynamically change their modes of operation and receive antennas precisely relative to a global time reference (e.g. GPS). Networks of such instruments scale rapidly in capability and spatial coverage with increasing number of nodes. The cost of this scaling is primarily in the complexity of control and operations as well as the required computational power needed to analyze data from the software radio array.

The Intercepted Signals for Ionospheric Science (ISIS) Array is a coherent software radio network that has recently been deployed. Nodes of this array are installed along the northern United States, primarily in the Northeast and Northwest regions. The ISIS Array is well positioned for observation of the mid-latitude Geospace environment and the plasmasphere boundary layer during active geomagnetic conditions. The array is capable of making coherent observations over a wide range of frequencies with operations focusing on active radar, passive radar, and satellite beacon observations. For coherent scatter radar applications the array has a field of view that extends over southern Canada. This field of view is well instrumented with complementary data available from the Millstone Hill Incoherent Scatter Radar, GPS total electron content maps, passive optical systems, and the new mid-latitude SuperDARN radars.

We will describe the design of the array, the status of its deployment, and give examples of observations from sites in the field. As part of this discussion we will present coherent scatter observations of E-region irregularities made with the array during the Geomagnetic storm of August 3-5, 2010. We will discuss the characteristics of this event and relate them to previous coherent scatter observations. To conclude we will provide an overview of future capabilities and directions for distributed software radio sensor networks that can be used for studies of the Geospace environment.

978-1-4244-6051-9/11/$26.00 ©2011 IEEE