

Signal Chain Architectures for Efficient Ionospheric Radar Processing

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Powerful remote sensing techniques have been developed over the last several decades by the radio science community for probing of the ionospheric plasma state using radio wave scattering combined with passive or active illuminators. The last three decades have seen huge advances in processing and analysis speed afforded by modern specialized and general purpose computing platforms. Accordingly, elements and architectures in a software radar framework have grown to encompass much of the infrastructure used in modern ionospheric sensing platforms. particularly in applications of RF capture, signal processing, and inverse analysis.

The dominance of software in these platforms has endowed them with new attributes of greatly enhanced flexibility and reconfigurability. If managed carefully, these qualities can be used for improved spatial and temporal resolution, while reducing instrumental effects and improving measurement fidelity. Furthermore, streamlined and maximally generic pattern implementations in the design and execution of overall signal processing flows have the significant advantage of minimizing overhead burdens in implementing new techniques. Finally, these architectures allow for the design of more generic analysis suites which partially insulate the operational facility against RF hardware migrations made necessary by system upgrades and maintenance.

We will discuss strategies and implementations for interconnection of key signal pattern elements in the construction of modern software radar signal chains for reliable ionospheric remote sensing. Our philosophy of design encourages clear separation of key boundaries in the signal processing flow, and speeds coding and debugging by focusing efforts on the essential software radar patterns. It also provides pathways for automated configuration and execution of signal chains for systems with large numbers of RF sensing elements such as phased array configurations. Finally, the presentation will describe a specific implementation of these concepts for a general radar calibration signal chain for incoherent scatter radar platforms, currently under development at the Millstone Hill Geospace Facility.