Digital RF: A Software Package to Implement Effective RF Data Strategies Using Software-Defined Radio Architectures

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Since the 1990s, MIT Haystack Observatory has leveraged software-defined radio architectures for scientific measurements of near-Earth space. These have involved diverse systems including large-aperture, high-power radars (megawatt-acres) and include characterization of variations in the planets ionosphere and its interactions with the neutral atmosphere. Effective execution of these scientific measurements requires precision measurements of very weak received signals that are in some cases at or below the thermal noise floor, along with effective and complete metadata recording in order to provide proper interpretation and extraction of physical information contained in the signals. In some cases, analysis of these signals along with their metadata may take place years or even decades after their collection, requiring long-term stable knowledge of their characteristics.

To achieve these scientific goals, it is useful to have a common software toolkit efficiently implementing quick, time-tagged access to RF voltage-level data with accompanying metadata. MIT Haystack has created an open source product, Digital RF, that addresses these needs. Digital RF allows for the recording and storage of RF voltage data with O(1) retrieval speed. With a companion Digital Metadata format and applications program interface (API), use of this highly configurable software stack considerably speeds the software development process for radio science applications.

The Digital RF software package will be detailed. This will include a description of the structure within the associated file formats for RF data and metadata. A number of examples will be shown, this will include various geophysical sensors which use digital RF as backbone to its processing. This software could also be of use to those outside of the geophysics community, especially users of software define radios in the communication systems research.