TangerineSDR

Personal Space Weather Station

Use Cases

System Document

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VERSION HISTORY

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0.1	T. McDermott	July 21, 2023			Original Issue

1. Introduction

1.1. Scope

This document briefly outlines several use cases for the Personal Space Weather Station (PSWS). The intention is to broadly guide the selection and implementation of physical hardware systems that support the PSWS.

Additional systems supporting PSWS are emerging. This document is intended to help the implementers of those systems adapt their implementations to the needs of the Personal Space Weather Station.

This document does not cover detailed requirements. Those should be covered in specific system or module level documents.

2. Use Cases

2.1. Use Case 1 – Wideband LF-HF sampling

One of the use cases for HAMSCI to record radio spectrum for later analysis is outlined in this document.

1. HAMSCI wishes to record raw IQ samples of down-converted HF radio spectrum. These samples are then stored in DigitalRF format (an HDF5 type of format). The format records meta data about the samples, and time-marks the sample buffers. The resultant files (from multiple stations) are stored in a large repository. Minimum desired channel bandwidth is on the order of 200 KHz. Multiple different channels may be recorded.

   There are tools that the science community uses to analyze and process DigitalRF format data. In the future these historical samples may be examined as part of some new science hypothesis.

   For example oblique ionosonde data chirping over relatively wide swaths of the HF spectrum are useful.

   Lossless recording of samples is preferred. It is not known what RTP Payload Type is used for raw IQ lossless with high sample rates.

   NB: Currently Gnuradio is used to capture the IQ samples, perform some additional processing, then convert to DigitalRF file format and store. Gnuradio

has a very limited toolset for networking, supporting UDP and TCP sockets. There is no native RTP support in Gnuradio.

2. The recorded spectrum needs to be accurately time-marked or time-stamped, and needs to have accurately frequency-aligned downconversion. The desire is to have time marking within a few to tens of nanoseconds (except during periods of exceptional GPS error). This includes GPS PPS timing error, sample clock error, etc.

3. In phase 2, multiple receivers need to be downconverted such that the outputs of the downconversion process are phase and time coherent between the multiple receivers. One application is interferometry.

2.2. Use Case 2 – Narrowband LF-HF sampling

This use case is a more narrow band case intended for providing data for studies such as WWV Doppler analysis, LF analysis, etc.

1. HAMSCI wishes to record raw IQ samples of (sometimes multiple) spectra in the LF through HF spectrum. These data are used to determine over longer periods of time things such as the Doppler shift and amplitude of WWV carriers across the HF range. Typically milliHertz resolution and accuracy of the carriers is needed.

2. Various bandwidths in the range from 10 Hz to perhaps 10 KHz are useful for these applications. Audio can be sent to independent analysis programs to determine the carrier frequency with milliHertz level accuracy. This implies that the downconversion process needs to be accurate to milliHertz levels. The signals need to be accurately time stamped commensurate to their captured bandwidth.

3. The data from these spectrum may also be captured and stored with DigitalRF for later analysis. There are tools that the science community uses to analyze and process DigitalRF format data. In the future these historical samples may be examined as part of some new science hypothesis.

   Lossless recording of samples is preferred.

   NB: Currently Gnuradio is used to capture the IQ samples, perform some additional processing, then convert to DigitalRF file format and store. Gnuradio has a very limited toolset for networking, supporting UDP and TCP sockets. There is no native RTP support in Gnuradio.

2.3. Use Case 3 – VLF sampling

This use case is for more extensive VLF frequency acquisition for analyzing various VLF phenomenon.

1. HAMSCI wishes to record raw ADC baseband samples from (almost) DC to about 100 KHz. These do not need to be digitally downconverted. Due to the need for low noise, low frequency acquisition it is likely that the samples may be acquired with an analog to digital converter used primarily for audio frequency conversion. The receiver needs special attention to things like lightning protection, grounding, antenna connection, etc.

2. The signal bandwidth needed is on the order of 100 KHz or so. The samples will be sent between the ADC and specialized VLF processing software directly integrated perhaps in a non-networked manner.

3. Acknowledgments / Other Information

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