HamSCI

PERSONAL SPACE WEATHER SYSTEM

TIME STAMPING

CONCEPT

Version Number:1.0

Version Date: Oct. 17, 2019

VERSION HISTORY

Version Number	Implemented By	Revision Date	Approved By	Approval Date	Description of Change
0.1	W. Engelke	*10/17/2019*			

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1. INTRODUCTION

A vital part of data collection for the Personal Space Weather Network is proper recording of time. Spectrum data will be collected from all around the world and later analyzed as a collection, so it is important that all stations use a common time standard, to a known level of accuracy. Some types of analysis (e.g., interferometry) require that all stations also mark their data with extremely high accuracy; for valid results, it is critical to know, for each station, how accurate their clock was during data collection. This paper addresses the PSWS project (Phase 1) approach to recording these timing data.

1.1. SYSTEM OVERVIEW

Figure 1 shows an overview of the system architecture. This document is concerned with how time stamping will be arbitrated between the DE and the SBC (within the TangerineSDR), and later saved as part of the data uploaded to the observational database (within the Central Host).

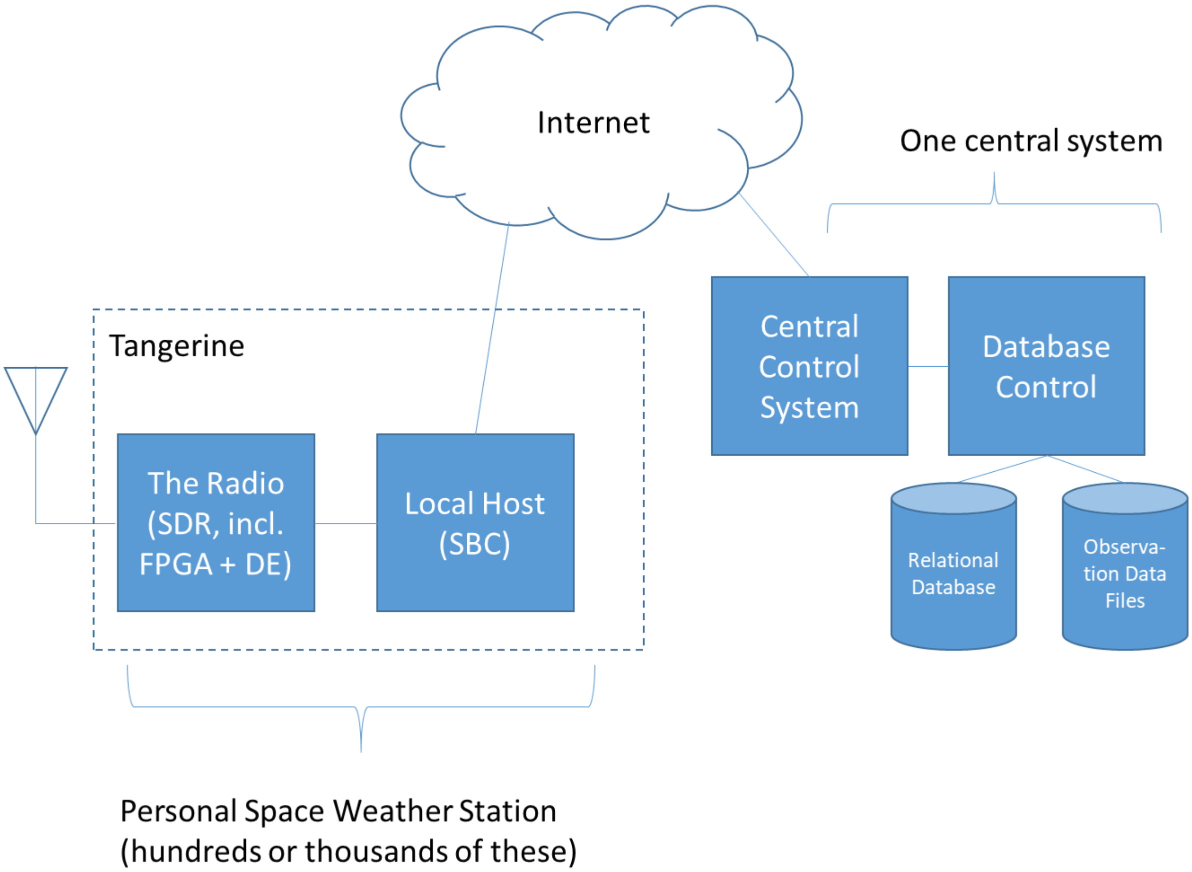


Figure 1. Conceptual Overview.

2. HANDING TIME STAMPS

TIME DETERMINATION

Timing for PSWS data collection may be generated in a variety of ways, but for Phase 1, there are two. This has to do with how the DE determines what time it is (so that time stamps can be included with collected spectrum data), which happens one of two possible ways:

- A GPSDO connected to the DE generates a UTC time stamp. This is expected to be highly accurate, to within the accuracy limits of the GPS constellation. Claimed to be within 40 nsec. 95% of the time.[1]
- The SBC maintains a “best effort time” in UTC using NTP, and informs the DE. This may be fairly accurate, within the accuracy limits of the NTP cloud, but may have an inaccuracy of up to 1 second.

[1] https://www.gps.gov/systems/gps/performance/accuracy/

After the DE "knows" what time it is (by being informed either by GPSDO or from the SBC) it can begin collecting spectrum data from its ADC and inserting time stamps as appropriate into the data passed to the SBC.

TIME AND DATA FORMAT

At the start of a data collection session (uninterrupted data collection period), the SBC and DE agree on the Epoch, which is Unix time (number of seconds since 00:00 UTC on 1 Jan 1970). After that the DE will pass time stamps to the SBC as a **64-bit integer which is the number of "ticks" since the Epoch**, where each sample is a tick; so

Time-stamp = (#seconds since Epoch) X (sample rate per second)

For timing purposes, it is assumed that, when multiple channels are sampled, they are all sampled simultaneously.

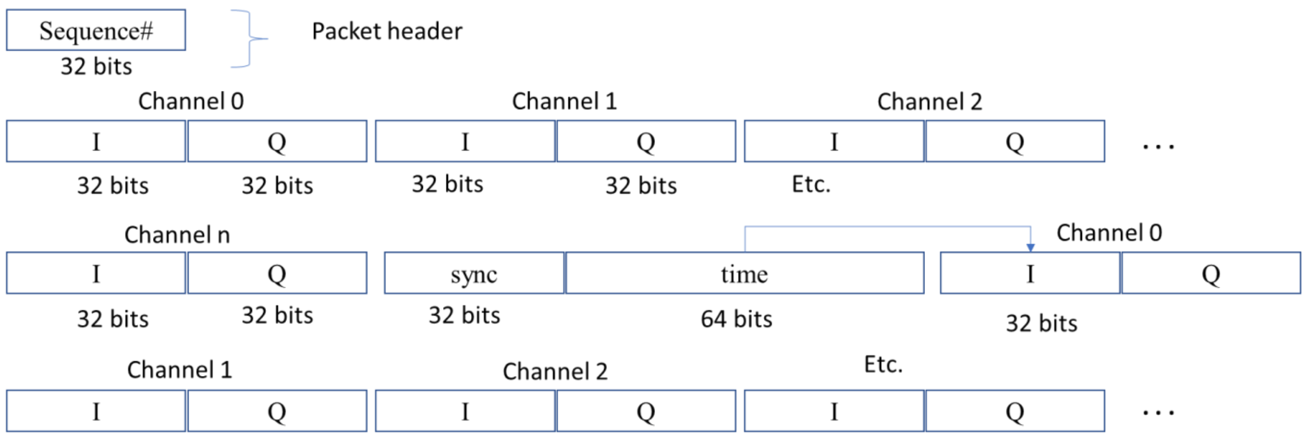
During data collection, the DE sends to the SBC packets each containing 1,024 I/Q samples (this is for convenient FFT processing, as it is a power of 2); each packet also includes a header containing a 4-byte unsigned integer sequence number (for detection of dropped packets). The I/Q samples are each 32-bit floating point values. When a time stamp is to be inserted into the data stream, it is preceded by a sync block. A sync block is a 32 bit NaN[2] value indicating that metadata is following, and the significand indicates the type of metadata[3]. Various data items may follow a sync block, but in the case where the metadata is a time stamp, the sync block will be followed by the 64-bit time stamp as described above. Note: even though the data block sent in the packet contains 1,024 8-bit I/Q samples (8,192 bytes) the actual final packet will be slightly larger due to the presence of metadata (such as the time stamps described here) and the packet header (which contains the packet sequence number). The time stamp is assumed to refer to the time of the immediately following I/Q data.

The following illustration shows the concept:

[2] The IEEE standard floating-point NaN where NaN is represented by an exponent of all ones and a non-zero significand.

[3] Refer to the LCC ICD for definitions of metadata types.

Data coming from DE to SBC looks like so:



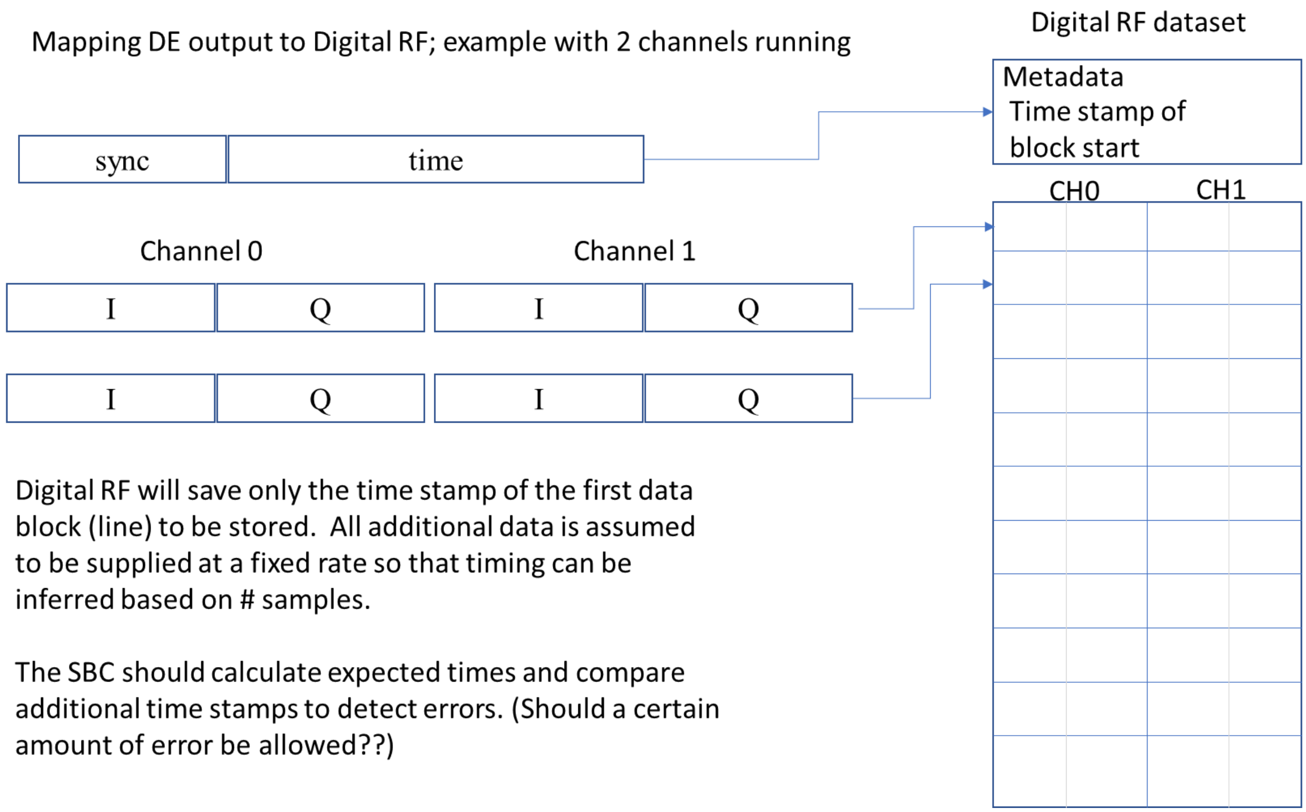
The 64-bit time stamp is associated with the immediately following channel I/Q.
Sync may start at top of packet or elsewhere.
Packets to contain 1,024 I/Q values (65,536 kbits or 8kbytes) plus inserted sync & time blocks

SAVING DATA INTO DIGITAL RF FORMAT

Digital RF saves timing data as metadata. In this model, a single time value is associated with a table, where the columns are the channels and the rows are the observations. The time stamp in the metadata gives the time of the first row of data. The time for all following data can be inferred by knowing the sample rate.

For starting a data collection session, the SBC will receive a data packet and read through it until it finds the first time stamp. At that point, it will start building a Digital RF dataset, where the time stamp indicates the first data row. The SBC will ignore all further time stamps until recording is interrupted. Digital RF will automatically create additional files and directories as needed. For this project, if data is missed for any reason (dropped packet, etc.) Digital RF will continue to record at the established sampling rate, putting NaN in for missing values; this way, timing for the remaining data can always be accurately inferred.

Here is an illustration showing the concept:


Mapping DE output to Digital RF; example with 2 channels running
Digital RF dataset
Metadata
Time stamp of block start
sync
time
Channel 0
Channel 1
I
Q
I
Q
I
Q
I
Q
CH0
CH1
Digital RF will save only the time stamp of the first data block (line) to be stored. All additional data is assumed to be supplied at a fixed rate so that timing can be inferred based on # samples.
The SBC should calculate expected times and compare additional time stamps to detect errors. (Should a certain amount of error be allowed??)