

HamSöi



PERSONAL SPACE WEATHER SYSTEM
Central Control System
Functional Specifications

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VERSION HISTORY

Version Number	Implemented By	Revision Date	Approved By	Approval Date	Description of Change
0.1	W. Engelke	6/3/2019			
0.2	W. Engelke	10/11/2019			Added Use Case 3 for data collection; fixed labeling on Fig. 1; Added user privileges and roles discussion; added PII policy; Added ability to recover lost UID; Added Use Cases 6 & 7; Added glossary

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1 INTRODUCTION

This Functional Specification describes the capabilities of the Central Control System which is to be a part of the Personal Space Weather Station (PSWS). In the PSWS, the Tangerine Software Defined Radio (SDR) collects spectrum data (either I&Q data or FFT data from GNURadio preprocessing) and uploads it to a target system for storage and/or analysis. The target system in the typical PSWS will be the Central Control System (“Data Collection Use Case 1”); but optionally could be a server if sufficient bandwidth is available (“Data Collection Use Case 2”). For cases where the user has low upload bandwidth, Use Case 3 allows the uploading of pre-processed GNURadio data, essentially a “waterfall.”

2 SYSTEM OVERVIEW

An overview of the system is shown in Figure 1. This specification is concerned with the Central Control System.

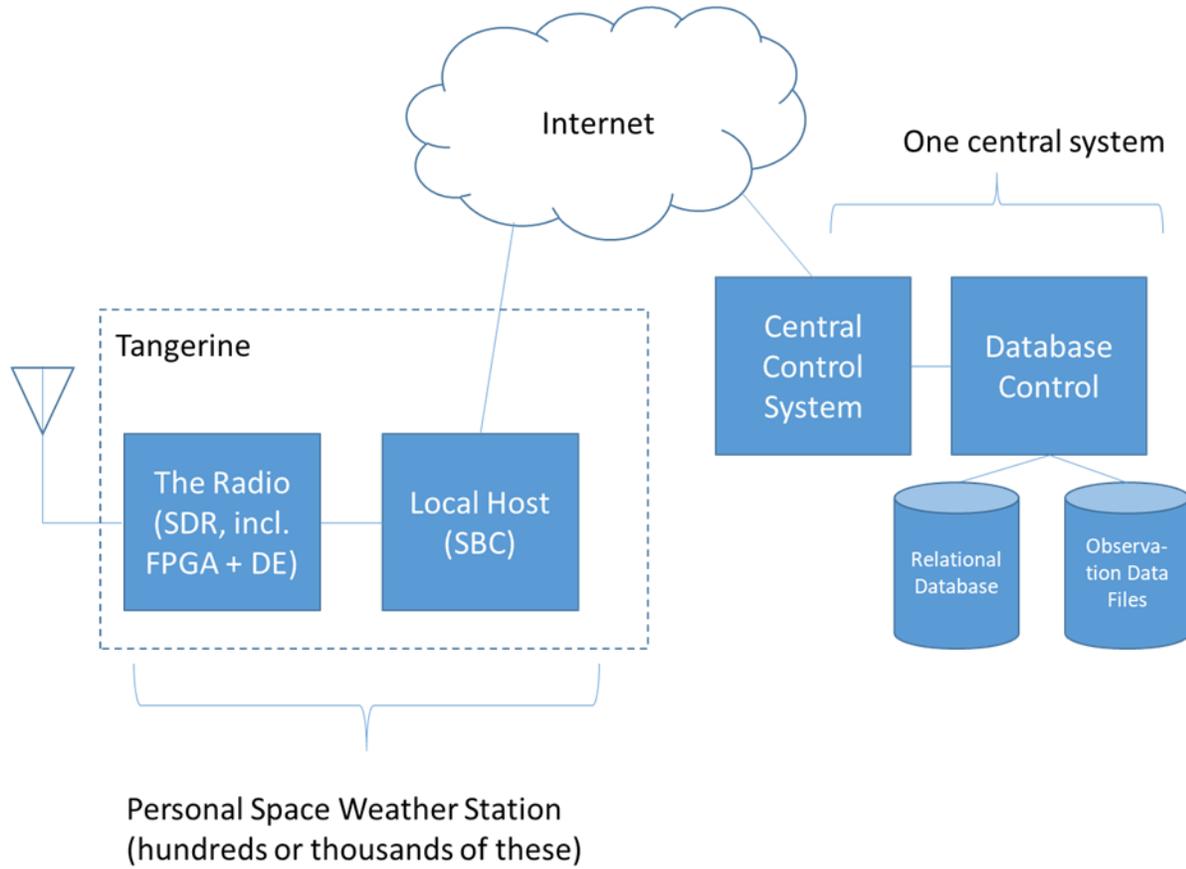


Figure 1. Conceptual overview.

3 FUNCTIONAL REQUIREMENTS

3.1 General Requirements / Overview

Requirements and capabilities of the overall PSWS system are described in a separate document. This Functional Specification covers only the Central Control System which shall have the following capabilities:

3.1.1 Functions for Data Collection Users:

- Allows users to create an account for themselves
- Issues a unique token to each user, which the user enters into the Tangerine to establish its identity
- Provides capability for users to perform functions as follows:
 - Maintain their profile data
 - Mark their system as being active
 - Put their system into mode (inactive, test, production)
 - Observe if their PSWS is handshaking with Central Host (based on heartbeat)
 - Review records on data that has been uploaded from their system (amount of data, number of sessions, etc.)
 - See their activity ranking as compared to other users
 - Create/review selected data analyses on their data, and data of others

3.1.2 Functions for science users

- There are at least 2 privilege level roles for Science Users
 - General Science users
 - PI-level science users (able to execute restricted actions)
 - (this list may be expanded to include additional roles) QQQQ
- Ability to trigger a system-wide (from multiple users) upload of selected data (expected to be in the ring buffers of users) (RESTRICTED ACTION)
- Ability to remotely trigger data collection for home users (users not in firehose data collection) (RESTRICTED ACTION)
- Manage the total collection of data (RESTRICTED ACTION)
- Review statistics for data collection
- Create/review selected data analyses on selected/all user data
- Export/download data for local analysis

For information on screen layouts, database schemas, system configurations, etc., please consult the relevant Detailed Design Specification.
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4 OPERATING ENVIRONMENT

The Central Control System will run in a Linux operating system, provide a web-based user interface, and interact with a back-end database (described separately) for data storage.

4.1 Assumptions and Dependencies

Tentative:

- the specific flavor of Linux will be Centos Linux release 7.3.1611 or higher
- Django will be used as the framework for serving web UI
- Celery will be used for queuing tasks
- MariaDB (open source version of MySQL) will be used as database

Capacity: the Central Control System shall be sized to accommodate at least 500 concurrent users for Phase 1. (Additional expansion is anticipated in future phase, and might require a cloud-based load balancing system).

Internet connectivity: the Central Control system will operate in a DMZ behind a firewall, and connect to the Central Database (which is in a secure zone) through a second firewall.

Packages anticipated to be needed include:

- Docker, docker-compose
- Web server (Django)
- Job queueing (Celery)
- Load leveling
- Security
- Mail server connection (for verifying new accounts)
- Captcha (for rejecting sign-up attempts from bots)

Tentative: Central Control server to be provisioned as a virtual machine with 2 cores, 8 GB RAM

(The above section may be more appropriate in the Detailed Design Specification)

4.2 User Interface Requirements

4.2.1 Guiding Principles

The system will expose a minimum of technical matter to the user. Users interested in the internal functions are expected to look at system content as archived in GitLab.

The system will collect and save a minimum of Personal Identifying Information (PII): only that necessary to determine a user's location (to a 6 -character Maidenhead grid square)

and altitude above sea level. Note that users are free to include in their user-ID their amateur radio callsign (if they have one) which can be used to determine a large amount of PII that is already in the public domain.

4.2.2 Regarding Institutional Policies on PII

- The above assumes the most conservative institutional policy, i.e., giving the user the option to divulge no PII at all (which would entail their use of a non-identifying user-ID and email address, and providing only a 4-character grid square location to obscure their location). In this case, it may be necessary to mark any data such users provide as “anonymous,” in which case the data’s value may be lessened because (a) it can’t be verified and/or (b) credit can’t be given to the user in any relevant journal articles.
- Whether or not the user chooses to enter profile data (user-ID, email, avatar) which can be traced to an individual (amateur radio callsign, for which name and address is in the public domain), the storing system must treat profile data with the same care it uses to handle the institution’s own confidential data.
- Science (spectrum) data, once uploaded to Central Control from a user’s PSWS passes into the joint ownership of the institutions which have built the system using NSF funding, and the NSF itself. Such data may be freely used by science users for analysis and publication, as long as credit is given to the project.
- All statements above are notional and are to be considered valid until and unless the involved institutions issue different (formal, written) policy statements regarding the data, and these statements are accepted by the NSF.

5 PROCESS OF USE

The appearance, layout, and detailed content of pages mentioned below is included in the Detailed Design Specification. The Use Cases below describe the process of using the system (not to be confused with Data Collection Use Cases 1,2 and 3, which describe the two ways of storing collected data).

5.1 Use Case 1: Signup/Login

1. The first time a user browses to the site, the UI will display a base page showing the option to Sign Up or Login. (Later, once the user is signed up and authenticated, this option disappears).
2. A new user uses the Signup page to request an account. The user provides, at minimum, a requested UserID (UID) and valid email address.
3. If the user requests a UID that already exists, the user is prompted to provide an alternate UID. For Phase 1, users will be able to enter their institution (if applicable) as a profile field.
4. The system sends a validation email to the provided email address. The email will include a link including a token the user clicks (upon receiving the email) to validate the email. The token is sent to the system and matched. If it matches, the user is prompted to provide a requested password (PW). The PW must be requested twice, both of which must match. The PW must be at least 8 characters in length. After the user successfully enters their desired PW, they are directed to the sign-in page. The new user now becomes an existing user.
5. Existing users login via the log-in page. An option to request a new PW ("forgotten PW") will direct an email to the email on file for the given UID. If user has forgotten their UID, they can supply an email address; in that case, an email providing the user's UID will be sent to their email.
6. After successfully logging in, the user is shown their Dashboard.

5.2 Use Case 2: Dashboard

1. The purpose of the Dashboard is to give the user a standard starting point for all activities, including:
 - a. An option to edit their profile
 - b. View their status of their station(s) (online, offline, etc.); an account may have one or more stations associated with it
 - c. View their own recent data (collected, uploaded, etc.)
 - d. View data collected/analyzed by others
 - e. Control operation of their station, such as activating, deactivating, connecting to local large server, etc.
2. The dashboard will show the Central Server's view of the user's station status, i.e., if the user station heartbeat is current to the Central Server, the user's station shows as online. (DETAIL: heartbeat once per minute (?))

3. The dashboard will show the status of data collection and any pending uploads. The most recent 10 events will be shown by default (with status of each shown in a list); user will be able to page up and down.
4. If the user has multiple stations, the different stations will be listed, giving the user the ability to independently control them.

5.3 Use Case 3: Edit Profile

1. The user will be able to edit all parameters of their station (this does not include changing UID).

5.4 Use Case 4: Show Stations

2. A list of all user stations will be available so the user can compare their activities to others. This will be filterable by status, and sortable by various columns.

5.5 Use Case 5: Show/Download Observations

1. A list of all observations will be available. This will default to the last 10 (or less) observations made by the user; filtering will be possible to show the observations of other selected user groups (by location), shown 10 to a page, sortable by various columns. TECHNICAL NOTE: for practical reasons, it may become necessary to restrict what is shown here, due to data volumes (TBD). The user will have the option to request a download of selected observations.
2. When the user selects a specific observation, any analysis completed will be viewable. (DETAILS OF ANALYSIS?)

5.6 Use Case 6: Trigger Ring Buffer Upload(s)

1. The science user in privileged mode will have the ability to trigger upload of data from the ring buffers of selected PSW stations. Such data will be uploaded and stored as files, with the file names being kept in the database (as observations).
2. POSSIBLE FEATURE: ability for the highest privilege user to be able to trigger upload of all online stations. Note that if implemented, this has potential to create a system overload unless restricted and also designed to manage system loading.

5.7 Use Case 7: Data Analysis

1. Note: this feature is intended to facilitate the observation of Traveling Ionospheric Disturbances. It is relevant to those PSW stations running "Use Case 3" with automatic 1-second upload to database table.
2. The science user will be able to specify a time frame over which the FFT and associated magnetometer data will be loaded from the database (for selected PWS stations), with extraction of maximum WWV signal and its related doppler shift by geographical area. (Assumption here being that the ionospheric refraction point is halfway between the user's location and WWV). (TBD: this feature needs considerable further definition).

6 OPEN POINTS

Will all users (or just science users) be able to combine observations from multiple stations (say, for mapping TIDs)?

Localization is out of scope for Phase 1.

7 FUTURE FEATURE CONCEPTS

- Institutions to be able to have a single account with subaccounts, where stations are associated to a subaccount

7.1 Glossary

ADC	Analog to digital converter
ARM	Advanced RISC Machine, computer architecture often used for low-power and/or low-cost processors
CODAR	Coastal ocean dynamics applications radar (CODAR) describes a type of portable, land-based, High Frequency (HF) radar developed between 1973 and 1983 at NOAA's Wave Propagation Laboratory in Boulder, Colorado. CODAR is a noninvasive system that permits to measure and map near-surface ocean currents in coastal waters.
CW Skimmer	Program which collects and reports CW stations heard on the air
CWRU	Case Western Reserve University
DASI	Distributed array of small instruments
DB	Database
DCC	Digital Communications Conference (ARRL + TAPR)
DE	Data engine
Digital RF	A data format optimized for storing digitized (I/Q) RF signals; based on HDF5
FFT	Fast Fourier Transform
FPGA	Field programmable gate array
FT8	Digital mode which facilitates contacts at very low signal strength
GB	gigabytes (one billion, or actual 1,024K)
GbS	Gigabit switch
HDF5	Format for storing scientific data
HDMI	High-Definition Multimedia Interface, used for connecting a video display
I&Q	In-phase and Quadrature; used to describe complex format for digitally storing or manipulating RF
MAC Address	A media access control address (MAC address) of a device is a unique identifier assigned to a network interface controller (NIC).
NSF	National Science Foundation

PSK	Propagation reporting using the PSKReporter.info system (in this document). General definition in RF context is phase-shift keying.
PSWS	Personal Space Weather Station
PW	password
RAM	Random-access memory
RBN	Reverse Beacon Network
RMOB	A crowd-sourced network which uses a radio and software to watch for short signals ("pings") related to commercial broadcast station signals, which indicate a meteorite has impacted the atmosphere
SBC	Single-Board computer
SD	Secure Digital, refers to a small data storage card
SSD	Solid-state drive (computer storage)
SuperDARN	A radar system used by scientists to characterize/probe the ionosphere
TB	terabytes (1,024 GB)
UA	University of Alabama
UID	User ID
URL	Universal Resource Locator, used to specify an internet network destination
WSPR	Digital mode used for monitoring RF propagation at very low signal strength
WWV	US Government radio station in Ft. Collins, CO, which transmits precise time data on a set of precise frequencies

8 APPENDIX A: REFERENCES

The following table summarizes the documents referenced in this document.

Document Name	Description	Location
<i>Tangerine SDR Requirements V0.3.pdf</i>	<i>System requirements</i>	<i>https://tangerinesdr.com/TangerineSDR_documents/</i>
<i>Local Host Functional Specification</i>	<i>Functional Specification</i>	<i>TBD</i>