

*PERSONAL SPACE WEATHER SYSTEM*

*local host*

Functional Specification

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VERSION HISTORY

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| **Version Number** | **Implemented**  **By** | **Revision**  **Date** | **Approved**  **By** | **Approval**  **Date** | **Description of Change** |
| 0.1 | W. Engelke | *5/10/2019* |  |  |  |
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Table of Contents

[1 Introduction 4](#_Toc15555689)

[1.1 System Overview 4](#_Toc15555690)

[2 Functional Requirements 5](#_Toc15555691)

[2.1 GENERAL REQUIREMENTS - overview 5](#_Toc15555692)

[2.1.1 Operating Environment 6](#_Toc15555693)

[2.1.2 Assumptions and Dependencies 6](#_Toc15555694)

[2.2 User Interface Requirements 6](#_Toc15555695)

[2.2.1 Guiding Principles 6](#_Toc15555696)

[2.2.2 A User-friendly Interface 7](#_Toc15555697)

[3 Major Functionalities 7](#_Toc15555698)

[3.1 Configuration and Setup 7](#_Toc15555699)

[3.2 Startup and Connecting to the Tangerine 7](#_Toc15555700)

[3.3 Connecting to the Central Control System 8](#_Toc15555701)

[3.3.1 Central Request / Response / Upload 8](#_Toc15555702)

[3.3.2 Heartbeat 9](#_Toc15555703)

[3.3.3 Local Signal Processing and User Notifications 9](#_Toc15555704)

[3.3.4 (Additional Local Host capabilities TENTATIVE/OPTIONAL) 9](#_Toc15555705)

[3.4 Logging 9](#_Toc15555706)

[3.5 Help 10](#_Toc15555707)

[3.6 Localization 10](#_Toc15555708)

[3.6.1 Remote System Updates 10](#_Toc15555709)

[3.6.2 Accessibility 10](#_Toc15555710)

[4 Logical Data Model 10](#_Toc15555711)

[5 Requirements Traceability Matrix 10](#_Toc15555712)

Figures

[Figure 1. Conceptual Overview. 4](#_Toc8460660)

[Figure 2. Request/Response process model. 8](#_Toc8460661)

# Introduction

This Functional Specification describes the capabilities of the Local Host computer (typically a Single Board Computer, or SBC) which is used for local functions of the Personal Space Weather System (PSWS). By “local” here we mean on the same network as the radio portion (an SDR consisting of the RF front end, ADC, FPGA, and Data Engine, or DE). In this document, we call the radio portion “Tangerine”.

In the PSWS, the Tangerine collects spectrum data (in general I&Q) and uploads it to a target system for storage and/or analysis. The target system in the typical PSWS will be the Local Host; but optionally could be a server if sufficient bandwidth is available.

## System Overview

There is more than one way to for the Tangerine to upload data to the target; the Local Host connection is one of them; this specification documents the capabilities of that Local Host. An overview of the system in this configuration is shown in Figure 1.

Tangerine

(SDR, incl. FPGA + DE)

Local Host (SBC)

Central Control System

Database Control

Internet

Personal Space Weather Station

(hundreds or thousands of these)

One central system

Figure 1. Conceptual Overview.

Spectrum data collected by the Tangerine is uploaded to the Local Host which maintains a ring buffer of 24 hours’ worth of observations. The Central Control System is able to send the Local Host a request to upload selected observation data.

The Local Host configuration is to allow an individual PSWS to participate in crowd-sourced data collection in spite of a low-bandwidth Internet connection, and also to provide some local signal analysis and propagation reporting for the individual PSWS owner. In this case, the Local Host initiates communication with the Tangerine.

In an alternate configuration (not described here), The Tangerine uploads directly to a remote server.

# Functional Requirements

Functional requirements capture and specify intended behavior of the system being developed. They define things such as system calculations, data manipulation and processing, user interface and interaction with the application, and other specific functionality that show how user requirements are satisfied.

## GENERAL REQUIREMENTS - overview

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

* Find and identify all Tangerine devices on the local network (?subnet)
* Issue a connect request to one or more Tangerines [[1]](#footnote-1)
* Send commands to connected Tangerine(s)
* Provide a web browser and web-based interface for user interaction
* Receive uploaded spectrum (I&Q) data from connected Tangerine(s)
* Save uploaded spectrum data to a ring buffer for 24 hours
* Connect to Central Control System
* Respond to commands from the Central Control system to upload data
* Provide a variety of propagation and band-opening information of interest to the radio amateur, including reporting to WSPR, RBN, and PSK networks and email notification when selected (digital) stations are heard (details TBD)
* Can be updated from the Central Control System
* Is able to push firmware updates to the Tangerine [?? Does this include re-flashing FPGA? Need to understand how to do this; doesn’t this require a USB Blaster?]

### Operating Environment

The Local Host is distributed as an image to be burned to a SD or micro-SD card using an imaging utility such as Balena Etcher. The user is expected to supply a SBC compatible with [ Ubuntu (?...] Support will be provided only for the [ Odroid?]; users electing to install and use the system on other types of hardware are on their own.

The SBC should have the minimum features as follows:

* USB-3 port for attached high speed disk or SSD
* Gigabit Ethernet (GbE)
* Quad-core, 2GHz
* 4 GB RAM
* .
* .

### Assumptions and Dependencies

The assumptions and dependencies for the project are as follows:

* User-provided equipment includes the SBC, micro-SD card, attached USB-3 hard drive with at least 4 TB capacity, GbE switch, Internet connectivity with user-configurable router, ability to burn image to micro-SD card
* The Local Host will be on a local network behind a router and not exposed to the public Internet (i.e., it does not need to have a built-in firewall)
* The user will provide a workstation (i.e. a HDMI compatible monitor, keyboard, and mouse) either directly connected to the Local Host or on another PC on the same network as the SBC and Tangerine
* Dependencies for the Tangerine documented elsewhere

## User Interface Requirements

### Guiding Principles

* This system is intended for use by both amateurs and professionals, so it should have default configurations and easy-to-use settings to enable startup of the base use case system by a non-expert; but allow access to advanced functionalities by experts
* Security (access) features roughly equivalent to a modern desktop PC shall be provided (see Assumptions and Dependencies), e.g., a User-ID and password for access, where the system is delivered with standard defaults and the user has the option to change these
* Configurations will be saved in logically named files containing human readable settings.
* System functions will be logged for debugging, and the user will have the option to turn off logging or select circular logging to avoid using up all space
* Major functions and settings will be settable through a web interface
* The same system logos will be used for the Local Host and Central Control System so it will be clear to users that the systems are part of a whole
* Conventions used in related projects (HPSDR, GNUradio, etc.) should be used so users familiar with those systems will have a reduced learning curve

### A User-friendly Interface

* The user should not have to remember things the computer knows. For example, whenever possible, choices should be shown as a drop-down list (rather than requiring user to key in).
* When the user attempts any action, the system must advise the user whether the action was successful or not, and if not, attempt to provide some useful information for troubleshooting.

# Major Functionalities

## Configuration and Setup

The Local Control System (as distributed and burned to SD card) will be preconfigured so that the simplest default configuration should be workable after simply connecting the system (assuming the user has procured the recommended hardware and connected it according to plan).

The user has two interface options:

1. Connect a HDMI-compatible monitor, keyboard and mouse directly to the SBC or
2. Use an existing PC on the same network and browser, and enter the URL of the SBC (which can be determined based on the MAC address of the SBC Ethernet interface).[??]

Once the user has a browser connected via http, they will see the welcome screen of the Local Host with default User id (UID and password (PW).

## Startup and Connecting to the Tangerine

In the initial Local Host web screen, the user will have a button to Discover the Tangerine(s). When clicked, this button will trigger code which will broadcast a Discover Command[[2]](#footnote-2) on the local network [?? Use 255.255.255.255.1024 like with Metis? ]. Tangerines on the network will broadcast a response (see footnote). The Local Host will show the user a list of responding Tangerines, allowing the user to select the Tangerine to connect. (In most cases, this will be only 1).

NOTE:

?? - here we need to decide on the default operation – should it be automatic monitoring of WWV on 2.5, 5, 10, 15 and 20 MHz, with data going to the ring buffer?

Connection of Tangerine directly to a server – details documented elsewhere

## Connecting to the Central Control System

The user will use a browser with Internet access to connect to the Central Control system. (This activity is independent from the Tangerine and Local Host, and serves to let the user make themselves known to the Central system and get an authentication token; complete documentation on this is in another document QQQQ). The user will create an account, be issued a token, and then copy their (unique) token to the Local Host. This will identify the Local Host to the Central Control system. Once the token is entered, the user will have a button to click which checks in with the Central Host and advises the user if the Host connection is complete.

### Central Request / Response / Upload

Tangerine

Local

Control

System

Central

Control

System

Central

Database

Heartbeat

Analyze and/or

Compress Data

Upload

Store in

database

PSWS

Central System

Activate

Observations (user)

Request

Observation (science user)

Store in ring buffer

Collect data & upload

Figure 2. Request/Response process model.

Refer to Figure 2.

1. Once everything is configured (including user account established, token issued and entered into Local Host configuration), the user Activates Observations (thru the Local Host web interface).
2. The Local Host starts sending heartbeats to Central Control. The user can look at their profile on Central Control and see that their Local Host is connected to Central. The heartbeat includes data to tell the Central System that the Local Host is up, whether a Tangerine is connected, whether data is being uploaded from Tangerine to Local Host.
3. The Local Host triggers the Tangerine to start sending observations.
4. The Local Host receives I&Q data and stores into ring buffer.
5. A science user triggers a data collection event. Central Control sends a command to active PSWS systems.
6. The Local Host selects the data as requested from the ring buffer, compresses and uploads.

### Heartbeat

When the Local Host is connected to Central Control, it will send a status message to Central every XX seconds QQQQ. The status message will include data on the Local Host’s connection to the Tangerine, whether the Tangerine is actively uploading spectrum data, data availability in the ring buffer, etc. (Documented separately – the status of a user’s PSWS will be reflected in real time by status information in the user’s profile in Central Control).

### Local Signal Processing and User Notifications

### (Additional Local Host capabilities TENTATIVE/OPTIONAL)

* Ability to manually run GNURadio on SBC and process signals up to capacity of SBC
* Standard GNURadio function to run FFT on I&Q data from Tangerine; upload FFT data (?)
* Ability to set SBC to copy and upload WSPR, RBN, PSK (one at a time) on up to 8 (??) bands at once (+ CW Skimmer?)
* Ability to set SBC to watch for a specific callsign to be copied (or perhaps a list of up to 10 callsigns) (on digital mode. CW??) to be copied (previous item) and send an email to selected email address when call is detected
* Ability to define a rule (rule set?) for user notification when a band opens (need to define what constitutes “open” and how to detect it)

## Logging

Local Host software will optionally output logging information to a configurable location. Each major step in operation will output to the log.

## Help

Describe how Help will be available to user

## Localization

Localization allows an application to respond to the user’s location, language, and similar factors that affect how the application should respond.

SUGGEST TO MAKE THIS A PHASE 2 REQUIREMENT

### Remote System Updates

Need to define what system must be able to do here – e.g., possibly – on startup, handshake with Central Control; if an update package is available, download and install. (Security requirements here) – what level of control should the user have over this? This should be supported only for a standard SBC and O/S – QQQQ

Need to determine/define what type of updating (if any) the Local Host is able to do to the Tangerine – (seems like an easy way to brick the Tangerine)

### Accessibility

If federally funded, there may be some requirements for use by the disabled, i.e., user interfaces to trigger narrator or other voice response, high contrast display option, etc. Check on this

Remaining sections are standard Functional Spec stuff, may not be needed for this project

# Logical Data Model

*[Include the Logical Data Model as an appendix.]*

See Appendix E - <Project Name> Logical Data Model.

# Requirements Traceability Matrix

*[Include the Traceability Matrix as an appendix. In the Requirements Analysis phase, the matrix is populated with requirements identified in the Requirements Definition. It is a living document that should be populated with information throughout design, construction, and test phases, etc.]*

See Appendix F - <Project Name> Requirements Traceability Matrix.

Appendix A: Functional Specifications Definition Approval

The undersigned acknowledge that they have reviewed the ***<Project Name>* Requirements Definition** and agree with the information presented within this document. Changes to this **Requirements Definition** will be coordinated with, and approved by, the undersigned, or their designated representatives.

[List the individuals whose signatures are desired. Examples of such individuals are Business Owner, Project Manager (if identified), and any appropriate stakeholders. Add additional lines for signature as necessary.]

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APPENDIX B: REFERENCES

[Insert the name, version number, description, and physical location of any documents referenced in this document. Add rows to the table as necessary.]

The following table summarizes the documents referenced in this document.

|  |  |  |
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| **Document Name** | **Description** | **Location** |
| *<Document Name and Version Number>* | *<Document description>* | *<URL or Network path where document is located>* |
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APPENDIX C: Business Process Model

The Business Process Model is attached as a separate document. (Master Flow diagram to be included and/or flow charts from EFOTM).

APPENDIX D: Logical Data Model

The Logical Data Model is attached as a separate document.

APPENDIX E: Requirements Traceability Matrix

The Requirements Traceability Matrix is attached as a separate document. (Refer to following spreadsheets):

1. Combined Use Case List for Intervention Release 1-8-10.xls
2. MCA - Intervention Business Requirements and Rules 12-29-09.xls

1. Ability to receive and handle spectrum data from more than one Tangerine concurrently is a function of the Local Host’s speed and is not a hard requirement for the Local Host. [↑](#footnote-ref-1)
2. Command Set defined in Detailed Specification [↑](#footnote-ref-2)