HamSCI

PERSONAL SPACE WEATHER SYSTEM
CENTRAL CONTROL SYSTEM
DETAILED DESIGN SPECIFICATIONS

Version Number: 0.32

Version Date: Oct. 190, 202019

VERSION HISTORY

Version Number	Implemented By	Revision Date	Approved By	Approval Date	Description of Change
0.1	W. Engelke	*9/13/2019*			
0.21, 0.3	W .Engelke	10/9/2020			Clarify version#; added account design, instrument maintenance

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CONTENTS

1. INTRODUCTION

This Detailed Design Specification describes how the Central Control server will be used (user interface, or UI), as well as its detailed internal design. It is organized into two parts:

- **Use Cases**, which illustrate the user's experience, how the system will work behind the scenes to execute the user's wishes, and processes

- **Technical Details**, which describe the technical approach, software tools, configurations, required software packages, interoperations, and interconnections required to carry out the required functionality.

Figure 1 shows an overview of the system architecture. This document is concerned with the detailed UI, operation, and technical considerations of the Central Control System.
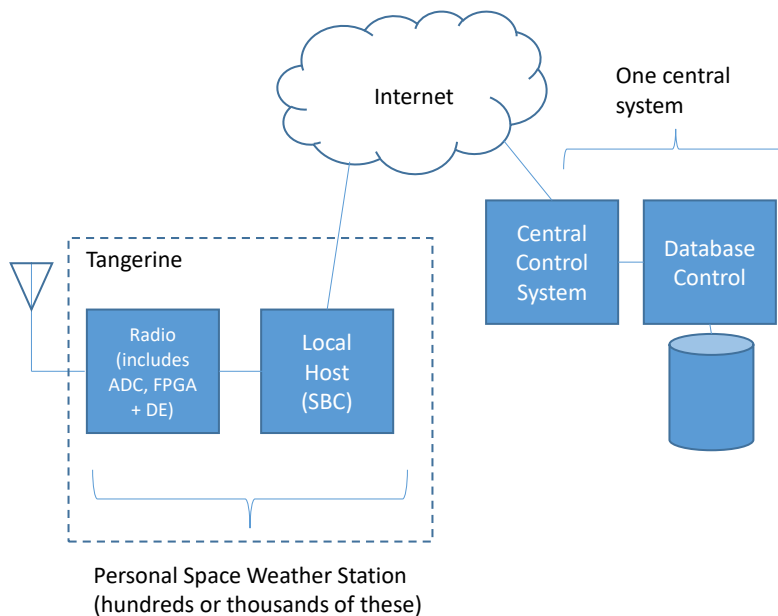
Figure 1. Conceptual Overview.

2. USE CASES

2.1. ABOUT THIS SECTION

The Use Cases section starts with showing how the user will interact with the Central Control System through its web site and continues on to describe the automated features that operate on the Central Control System as background processes not directly viewable by the user.

2.2. UI USE CASES

This section describes User Interface uses cases, focusing on the user experience, with references to sections in Technical Details on notional approaches for how to implement the described functionality.

2.2.1. USE CASE – User Welcome / Sign-Up /Sign-In Screen

SWX network   Sign In   Sign Up   Stations   Data

Iceland
Norway
Canada

United States

Mexico
Cuba
Guatemala
Nicaragua
Panama
Colombia   Guyana

Peru   Brazil

Morocco   Tunisia
Western Sahara   Algeria
Senegal   Mali   Niger
Guinea   Ghana   Nigeria   Cameroon

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PSWS Network   Home   About   Stations   Observations   Sign Up / Log In

Canada

North Pacific Ocean

United States

1801 - EA1

Cuba
Honduras
Costa Rica
Venezuela   Suriname
Peru   Brazil
Bolivia

Crowd-sourced ionospehric research   Join us!

© Mapbox © OpenStreetMap
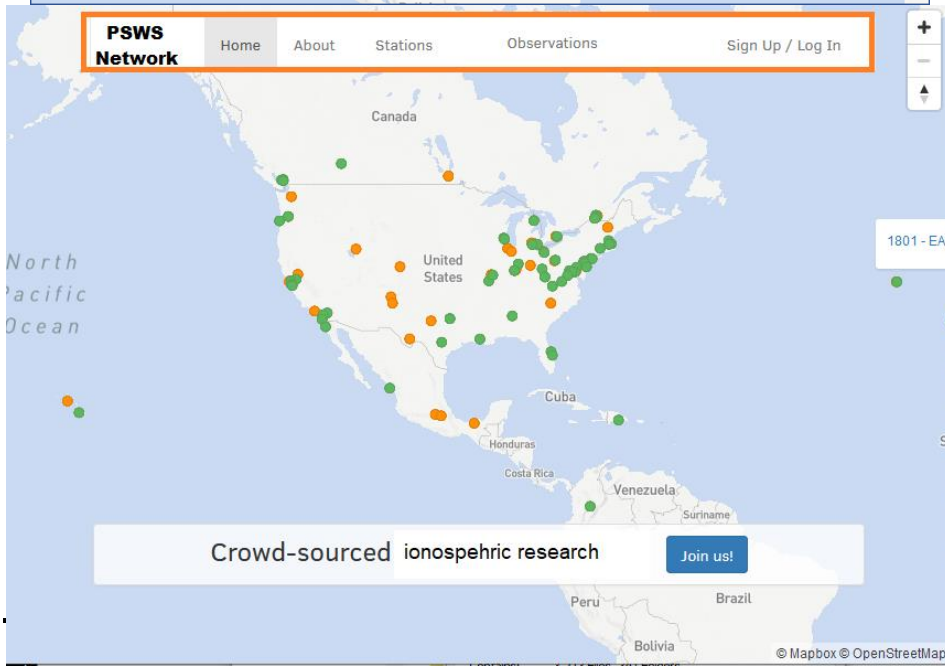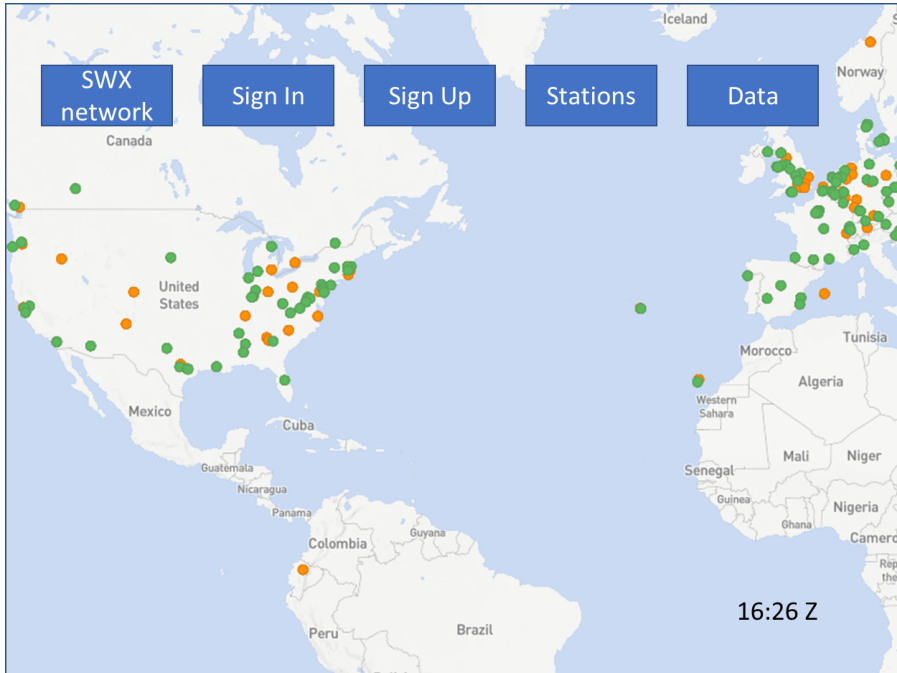
Figure 2. Welcome Screen.

Notes:

- The map in the background shows a world map with dots indicating PSWS stations; green to show online (Central Control received a heartbeat within the last 2 minutes), orange to show configured, but not receiving heartbeats. This is copied from SatNOGS design. Refer to technical details in Section 3.1.1.
- Tentative design: note that this is derivative of the SatNOGS welcome screen; there may be some need to differentiate it. Necessary functions are shown; redesign the look if deemed appropriate.
- Most users will have a single station associated with their account, which will be initialized when the UID is created. "Power users" (e.g., most often institutions) may create additional stations. A station is associated with a single Tangerine. Refer to Section 2.2.2 for a discussion of Account and Station management.
- See Technical Details for discussion of administrative management of User IDs, user roles, and privileges.
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2.2.1.1.　　　Sign In / Sign Up

(Note: there is expected to be an additional logo, or two, next to the tangerine – one is grape, for the low cost PSWS station)

Log In – (button/link) allows user to enter their user-ID (UID) and password; when successful, takes them to their User Home screen (Use Case 2.2.2).

Sign Up – (button/link) allows user to enter a UID and requested password. If the verified UID already exists, or if the password does not meet minimum password standards, show the appropriate error. If the UID does not already exist, trigger a series of actions as follows:

1. Create a new user account (if database entry already exists, link to the existing account record) – create one new station with unique station# (sequentially increasing from 1)
2. Create a security token
3. Send an email with a verification link to the supplied UID (email address)
4. Mark account status as pending verification
5. Optional: "I'm not a robot" captcha

Station(s): (button/link) go to List of Stations (see use case)

Observations/Data: (button/link) go to Data Page

2.2.1.2.   Account/Station management

For home systems, an account is associated with a person. For organizational (i.e., at a school) the account is associated with the organization, but managed by one person (for Phase 1, multiple persons may have the organizations UID/PW. An account is identified by its Token.

An account may have multiple stations each with its own unique Node#.

A station may have one to n instruments, each identified by its serial#.

This shows the logical architecture of the Account – Station – Instrument relationship.

- An Account is associated with a person (for home stations) or an organization (for schools, universities, other organizations). In Phase 1, it is allowable for multiple persons to share the log-in credentials for their organization; multi-person management is deferred to future Phase.
- An account may have 1 to n Stations. The station is associated with a location (Maidenhead grid square and lat-long), and is what is shown as online or offline on the home page map. Each station has a unique Node# (issued by PSWS Management Team – U of Scranton, CWRU, UA).[1]
- A Station may have 1 to n instruments, which may be TangerineSDRs, GrapeSDRs, magnetometers, weather stations, all-sky cameras, ionosondes, transceivers, etc. Each instrument has a unique serial number – for TangerineSDR-based devices these numbers are assigned at time of manufacture, stored in device ROM, and queried as part of telemetry.

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[1] At time of this writing CWRU has already started issuing Node numbers for stations they have implemented. Future Node numbers must be coordinated and issued by central authority to avoid conflict.

2.2.3.2.2.2.   USE CASE - Home Screen (user)

Refer to figure below.

The Home Screen provides a variety of functions that let the user work with their account, settings, and data. It is the usual starting point after sign in. Items shown *in italics* are documentation comments, not something the user will see.

User-ID 12234

Stations

ID Node#	Location	Observations	Status	
NNNNNNN	Grid XXXXXXXX	NNNNNNN	STATUS	*Scrollable list*

Add Station   Settings   Token

Observations

ID	Timeframe	Station ID Node#		
NNNNN	DateTime	NNNNNN	STATUS	
NNNN	DateTime	NNNNNN	STATUS	*Scrollable list*
NNNNN	DateTime	NNNNNN	STATUS	
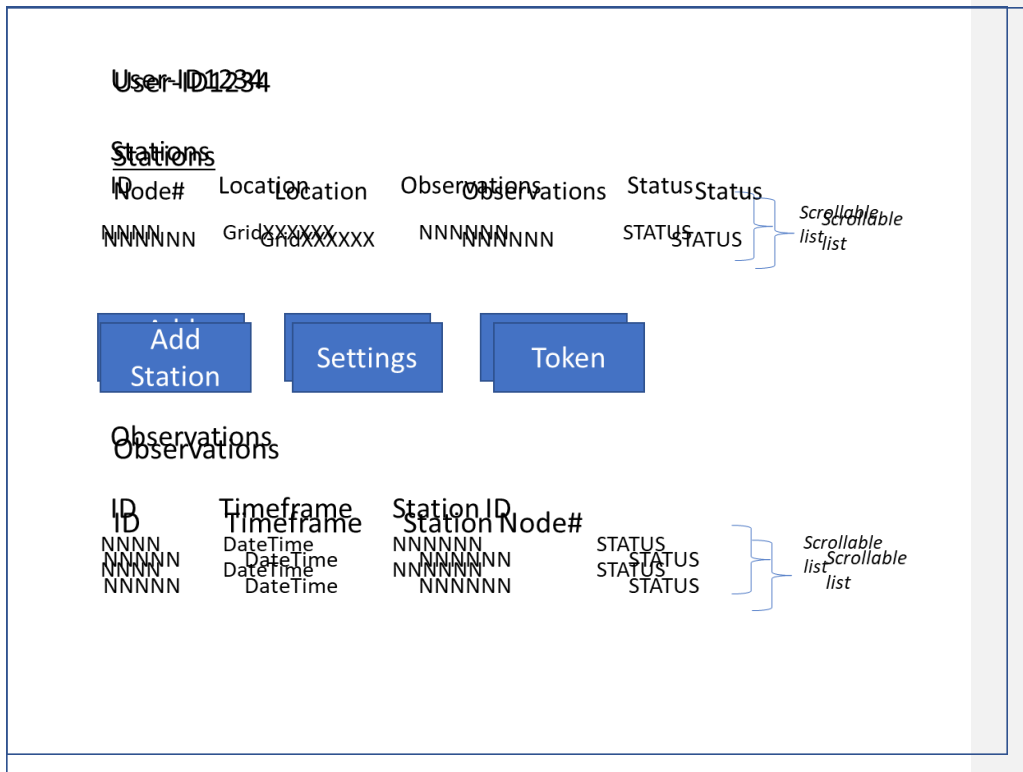
Figure 3. User Home Page.

Stations: List of Account's stations – (scrollable list) shows the User's PSWS Stations.. Most users will have only one. Each station in the list is clickable to take the user to the Station Configuration page that allows them to configure the characteristics of that station.

Add Station (button/link): takes user to web page allowing user to add a new station (see related Use Case) – when a user creates a new Account, one new station is automatically added. In those cases where a user will have more than one station

under a single account, the user clicks here to go to that web page. NOTE: a given Tangerine (SDR) is allowed to be connected with one and only one Account-Station relationship, to avoid confusion in Central Host logic.

Settings (button/link): takes user to web page for making settings for this account; see related Use Case

Token (button/link) – displays the unique security key for this account. (Note that this token must be entered into each [Tangerine] station associated with this account).

Observations: (scrollable list) – list of uploading and uploaded observations; if an observation upload is in progress, this will be the topmost entry in this list; previous uploads are shown with descending DateTime.

2.2.4.2.2.3. USE CASE - Station Configuration

Figure 4. Station Configuration.

Refer figure above. Here, underlined denotes a value that the system computes (or looks up in database); italic denotes a value that the user can edit, or field behavior. Both italicized and underlined denotes that the user may select from a drop-down list.

Fields:

Station nickname – string – station name assigned by user

Account ID – account# with which this station is associated

Station QTH – the 6-character Maidenhead Grid Square where station is physically located

Elevation – station elevation in meters

#Observations Uploaded – number of observations successfully uploaded to

#Observations Uploaded – number of observations successfully uploaded to Central Control from related station

Created Date – date the station was added

Station Status – Online (green) indicates heartbeat received within the last 2 minutes; offline (orange) otherwise

Instruments/Radios – a scrollable list of "instruments," i.e., radios such as TangerineSDR, GrapeSDR, other devices; the Add/Delete/Edit Instruments takes user to a page to manage their instruments.

Save – Button – saves data

Cancel – Button – discards any changes

Display only case: if station configuration is viewed by anyone but the station owner, information is display only and cannot be edited.

2.2.5.2.2.4.   USE CASE - Settings for Account

Refer to figure below.

Account - AccountID

User Name	*User name*
Public Nickname	*User nickname*

[Save]   [Cancel]

Figure 5. Settings for Account.

AccountID – account ID assigned at time of original account creation; from database.

User Name and Nickname – self explanatory, user choice.

2.2.6.2.2.5.   USE CASE - List of Stations

This is a list of all PSWS stations in the system, filterable by status, location, antenna, and owner; with the list being sortable by any column.

ID – Station ID

Name – station name assigned by owner

Owner – nickname of station owner. If no nickname set, use name

Location – 6 character Maidenhead grid square assigned by user

Observation – number of observations successfully uploaded

Antennas – Antenna 1 type, Antenna 2 type (blank if only one antenna)

Status – Online: heartbeat received within last 2 minutes, otherwise Offline

If user clicks on a station, Station Configuration is displayed (see Use Case), but nothing is editable.

Stations

ID	Name	Owner	Location	Observations	Antenna(s)	Status
NNNN	xxxxx	xxxxxxxxx	GridXXXXXX	NNNNN	ANT1 ANT2	Status
NNNN	xxxxx	xxxxxxxxx	GridXXXXXX	NNNNN	ANT1 ANT2	Status
NNNN	xxxxx	xxxxxxxxx	GridXXXXXX	NNNNN	ANT1 ANT2	Status
NNNN	xxxxx	xxxxxxxxx	GridXXXXXX	NNNNN	ANT1 ANT2	Status

Scrollable list

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.
.

Figure 6. List of Stations.

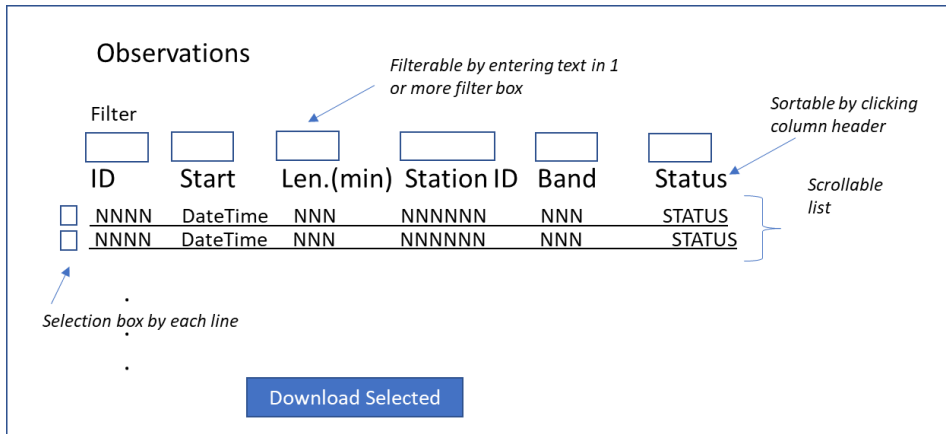### 2.2.7.2.2.6. USE CASE – Data (Observations)

Figure 7. Data (observations).

Presents a list of successfully uploaded observations and uploads in progress (spectrum data in HDF5 format) which is scrollable and sortable by any column, containing:

  ID – observation ID

  Timeframe – start and end DateTime of observation

  StationID – name of station which collected the data

  Status – Uploaded, Uploading, Failed Upload

Filter function: if user enters text into filter field (above column header), the list will be filtered by that field.

This list will grow to be very long; needs to be able to be paged by showing a certain number on each page (e.g., 25), and allow paging between screens.

If user clicks on the selection box at left of line and hits the Download Selected button, a download dialog is shown which allows the user to select local location for the download, and to start the download. Note that many of these downloads will be very lengthy (hours) – need to be able to be restarted from point of failure. The download dialog allows user to select compression by by zip or tar.

2.2.8.2.2.7.   USE CASE - Create New Station

Create New Station

AccountID   AccountID

Station Nickname   *Station Nickname*
Station QTH (Grid)   *Grid*   Computed lat-long

Elevation   *Elevation*

Antenna 1   *Antenna 1 type*
Antenna 2   *Antenna 2 type*

Save   Cancel

Figure 8. Create New Station.

When a user creates a new account, the system automatically creates a station for them. In the (many) cases where the account will be associated with only one station, the user will not need to use this function. It is for adding additional stations beyond the one default station.

Fields are the same as for Station Configuration; lat-long is not editable but is computed from Maidenhead Grid Square and is displayed. The entered Maidenhead Grid Square must be a valid, possible value; if user enters an invalid Grid Square (or none), display an error and prevent saving.

Elevation is in meters. If user enters no elevation, assume sea level.

2.2.8. USE CASE - Add/Delete/Edit Instruments

Manage Instruments

| Station Nickname | Station Nickname |
| Station QTH (Grid) | Grid   Computed lat-long |

| Add | Edit | Delete |

Scrollable list

	Type	Serial#	Antenna 1	Antenna 2
☐				

| Save | Cancel |

This page allows user to add, delete, and edit instruments. The left column allows user to select instrument to work with.

Add – click button, a small dialog appears with a drop-down list of type, and field to enter serial number. Note: it may be necessary to later populate this field, as user may not know the s/n at time of adding the instrument, and the s/n is to be included in metadata coming from this instrument. (Details TBD)

Select an instrument, then click Edit: user can edit the selected instrument; click Delete, and this instrument will be deleted.

In all cases, changes do not take effect until user clicks the Save button; if user clicks Cancel, all changes are discarded.("Intentionality")

(TBD) Antennas: The user can edit these on the Local Host at a given instrument – need to decide on way to upload/populate these – probably via metadata like the serial#; hold space open in database for these.

2.2.9. USE CASE – Trigger Mass Data Upload

This transaction is to be available only to Science Superusers.

Trigger Mass Upload

Time Frame
◉ Starting at: [   ] UTC   For [   ] Hours [   ] Minutes
◯ All Available

Data Source Selection

◯ All Available
◉ Pick Station(s)
◯ Within a Lat-Long rectangle

[Start]   [Cancel]

Figure 9. Trigger Mass Upload.

Time Frame – radio button – picks one of:

Starting At: - UTC of start time, for NN hours and NN minutes – note that this automatically refers to a start time within the last 24 hours

All Available: - any and all data collected

Data Source – radio button – picks one of:
All Available – all online stations
Pick Station – a list of online stations will be shown, with a checkbox next to each; user can select the stations from which to attempt to upload data
Within a lat-long rectangle: input fields for two lat-long pairs will be shown. The user enters the upper left and lower right extremities of the area of interest, and data collected by stations within the rectangle will be requested.

Once a data collection task is started, the user will be shown a list of stations that are in the progress of uploading; with each, an estimated percent complete (assumes most recent upload speed continues).

USE CASE – Mass Download

Concept here is that the Science user should be able to request a download of a large portion of available observations (maybe all) – this is somewhat redundant with the Download feature in the Observations use case, but would offer selection of a large batch of data with fewer clicks. (This could produce a huge download task – may be unwieldy for both the user and the server – need to discuss --- ??_

⎯TECHNICAL DETAILS

⎯

~~5.~~3. TECHNICAL DETAILS

~~4.1.~~3.1. GENERAL

3.1.1. Welcome Screen

This screen is based on the design for the welcome screen of the SATNOGS system (see https://network.satnogs.org/). It has a banner across the top with links to the major system functions; there is a lower banner with an invitation to join, which takes user to signup page (same as Signup above). The top banner has an orange color code (thicker border) to distinguish the web page from the SATNOGS page.

The map shown is provided by linking in Mapbox / OpenStreetMap; station locations are shown, with online stations in green and member station (offline) are shown in orange.("Online" is based on receiving heartbeat messages to the server API).

3.1.2. Heartbeat and Data Request

Each station must have at least one instrument capable of sending a heartbeat to the Central Host, which uses this signal to know if that station is online or not. The instrument (typically the TangerineSDR or GrapeSDR) can be configured to send the heartbeat at a given interval, typically 180 seconds. The heartbeat is an http POST message sent to port 5000/apikey, with a URL similar to:

https://pswsnetwork.caps.ua.edu:5000/apikey=token&node=node#

Central Control will receive these heartbeats and update a table for that station indicating the datetime of the last heartbeat. Maps and other queries that indicate whether a stations is "online" or not will make that determination based on whether the system has received a heartbeat within the last 10 minutes. (This is accurate as long as the server and clients all have ntp installed and running).

When Central Control receives a heartbeat, it checks to see if there is a pending Mass Upload order placed by a Science Superuser. If so, it replies to the heartbeat with a data request containing:

DR   Request#   Start DateTime   End DateTime

The Request# is a (unique) campaign number, issued by the system (at time when an authorized request is made), so that a station can determine (in case of multiple

requests for the same data) if the upload is (a) new, (b) in process, or (c) completed, and start a new upload only if the request is new.

Data Uploads

~~THIS SECTION TO BE FILLED IN NEXT~~

3.1.3. Data Uploads

Data uploads are of the following types:

- Ringbuffer – (raw spectrum data) in response to a Data Request, a block of observations are put into a tar file and sent by `lftp` to the Central Control server. Each user has their own secure upload directory area. Central Control monitors these upload directories for files to appear (a tool such as Watchman File Watching Service is to be used). When a file appears (important: ensure the entire file is completely uploaded before processing, as this may take hours) it is unpacked (from tar), metadata is read, and the data package is moved to its archival area, with cross reference information being store in the database.
- Firehose_R (Continuous Upload) (raw spectrum data) – when a user puts their system into Firehose_R mode, the Local Host begins sending a series of files to Central Control using the `rsync` protocol. Central Control detects and handles these files similarly as with Ringbuffer uploads (the difference being that Firehose_R is initiated by the station owner and Ringbuffer upload is triggered by a Science Superuser.
- Snapshotter – (pre-processed data, narrow band in frequency domain) – when a user puts their system into snapshotter mode, a line of data (typically 200 to 600 values of csv data) is uploaded approximately every 45 to 85 seconds. Method of transfer is (TBD) – possibly JSON; the data may be stored in a live table (instead of as files) for real time use.

3.1.4. User Roles~~Types~~ & Privileges

Administrator –

  Add, Delete & Edit User

  Edit email address

  Edit Privileges (cannot remove Administrative privileges from self)

Science User –

  Upload

Download Selected Observations

Science Superuser --

Trigger Mass or Selected Upload

Trigger Mass or Selected Upload

Mass Download

General User

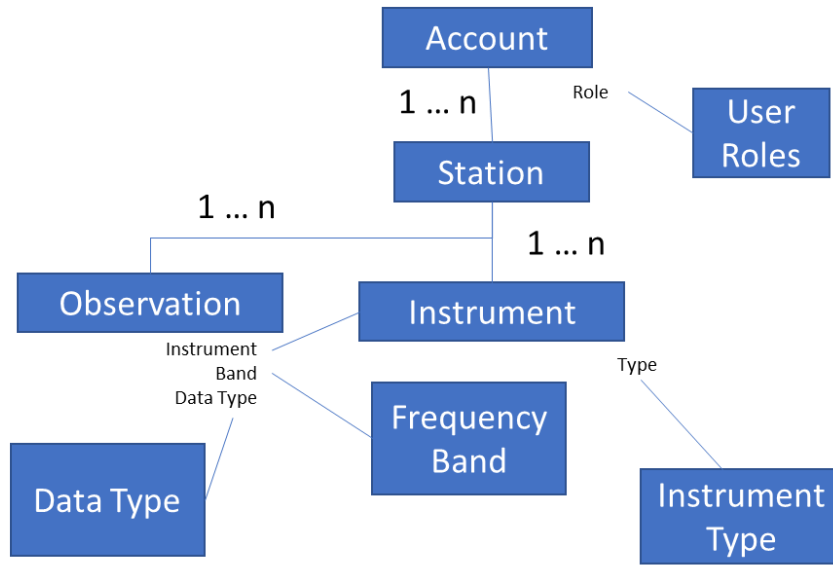General User

Upload

Download Selected

LOGICAL DATA MODEL

10.4. LOGICAL DATA MODEL

The following figure shows a notional logical data model to provide general guidance. The development team may adjust according to requirments.

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Account

1 … n   Role

User
Roles

Station

1 … n

1 … n

Observation   Instrument

Instrument
Band   Type
Data Type

Frequency
Band

Data Type

Instrument
Type

11.5. REQUIREMENTS TRACEABILITY MATRIX

~~See Appendix F - <Project Name> Requirements Traceability Matrix.~~ To be added

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1. 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.]

Signature:		**Date:**
Print Name:		
Title:		
Role:		

Signature:		**Date:**
Print Name:		
Title:		
Role:		

Signature:		**Date:**
Print Name:		
Title:		
Role:		

6. APPENDIX B: REFERENCES

6. ~~APPENDIX B:~~ REFERENCES

The following table summarizes the documents referenced in this document.

Document Name	Description	Location
Tangerine SDR Requirements V0.3.pdf	*System requirements*	*https://tangerinesdr.com/TangerineSDR_documents/*

~~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~~