
Group 2<Enter team name here>

ST-GroundSS
Software Requirements Specification
Version <1.0>
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Document Control

Approval

The Guidance Team and the customer will approve this document.

Document Change Control

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Distribution List

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Change Summary

The following table details changes made between versions of this document

Version	Date	Modifier	Description
Version 1	12/01/2022	R. DeMarco	Initial document creation
Version 1	12/06/2022	A. Caldwell	General Description & Qualitative Requirements Creation
Version 1	12/06/2022	U. Metalitskaya	Wrote all of section 1
Version 1	12/07/2022	R. DeMarco	Wrote section 3.1.1 User Interfaces
Version 1	12/07/2022	E. Karim	Behavioral Requirements Establishment and Creation
Version 1	12/07/2022	M. Oxamendi	Wrote sections 3.1.2, 3.1.3, 3.1.4
Version 1	12/09/2022	M. Oxamendi	Updated sections 3.1.2, 3.1.3, 3.1.4, contributed to section 3.4
Version 1	12/09/2022	E. Karim	Behavioral Requirements Creation
Version 1	12/09/2022	R. DeMarco	Wrote section 3.4; Final formatting / review for document submission

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1. Introduction

1.1. Purpose and Intended Audience

The purpose of this Software Requirements Specification (SRS) document is to provide a clear understanding of what the functionalities of the ST-GroundSS should have. The intended audience for this system is the users, customer and software developers.

1.2. Scope of Product

The ST-GroundSS system serves as a spacecraft tracking app. The purpose of the system is to allow users to track a spacecraft given the orbit parameters and time to perform the signal reception. The system also allows to prioritize signal reception between several spacecraft using a prioritized list and select the highest priority spacecraft to receive from if they are visible at the same time. Users will be able to interact with the server through the interface where they can display the spacecraft data being received and save the data locally. Furthermore, the users will be able to edit, add or delete satellite specifications. The main users of the system are admins and members of the ground station.

1.3. Definitions, Acronyms, and Abbreviations

1.3.1. Definitions

TERM	DEFINITION
User	Regular user that can have the access data within the ST-GroundSS system. Users will be able to add, delete or download data
Software Provider	Responsible for managing user accounts and performing different operations to them, such as, editing information about the user, creating a new user profile and deleting an existing user profile.
Unauthorized User	Person who doesn't have an account in the database, meaning the system admin hasn't created an account for that user.
Spacecraft/Satellite	A vehicle used for traveling in space

1.3.2. Acronyms

TERM	DEFINITION
APCV	Armored Personnel Carrier Vehicle.
ID	Identification
NORAD	North American Aerospace Defense Command
SRS	Software Requirements Specification
RF	Radio Frequency

1.3.3. Abbreviations

TERM	DEFINITION
ALT	Alternative
ST-GroundSS	Satellite Tracking Ground Station System
Req	Requirement

1.4. Overview

The SRS has the three main sections, Introduction, General Description and Specific Requirements. The Introduction explains the purpose and scope of the product, definition, acronyms, abbreviations of the system, an overview and the references used in this document. The General Description goes over the product perspective, product features, user characteristics, general constraints, assumptions and dependencies of the system. Lastly, the Specific Requirements goes in detail about the requirements including the external interface, behavioral, non-behavioral, and other requirements.

1.5. References

- [1] Requirements Definition for the ST-GroundSS Satellite Tracking Ground Station System Dr. Rojas
- [2] Interview Report
- [3] Model Report

2. General Description

2.1. Product Perspective

ST-GroundSS is a web-based interface that will assist the User with the positioning and tracking of spacecraft using orbit parameters and the prioritization of RF signals. ST-GroundSS is going to be an independent and self-contained product that will integrate with other satellite and spacecraft systems for reception purposes.

2.2. Product Features

A high-level Use Case diagram of the ST-GroundSS is shown in the image below. It depicts the interaction of the system with external interfaces and gives an abstracted overview of system functionalities. In this diagram actors are depicted with the use of stick figures. These actors interact with the system, which is depicted through use cases inside the box. Use cases are shown inside the ovals and briefly describe the system's functionalities. These actors and use cases are connected with lines and arrows to show their relations to each other.

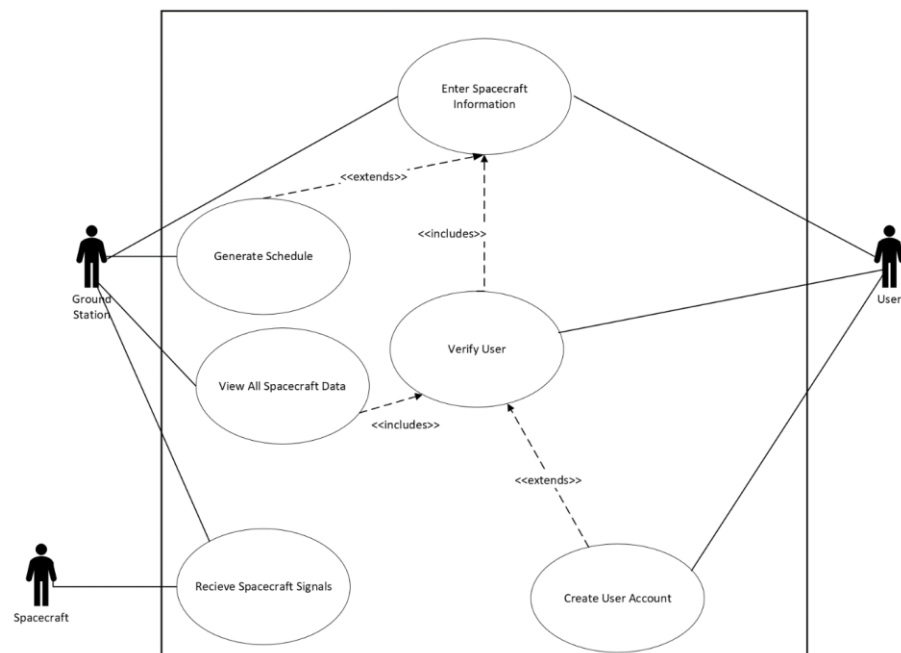


Figure 1. Use Case Diagram

2.2.1 Actors

This section describes the actors in the system.

- **Ground Station**
 - The Ground Station is defined as the physical location of components of the system, including the positioner, antenna, and main computer.
- **Spacecraft**
 - Spacecraft are the tracking targets of the system and may range from satellites to debris.
- **User**
 - The User of the system utilizes the general functionalities provided by the system. These functionalities include the generation of a schedule and reviewal/inputting of data to track specified spacecraft.

2.2.2 Use Cases

- **Enter Spacecraft Information**
 - This use case denotes the capability of the User to utilize the system to enter spacecraft information.
- **Generate Schedule**
 - This use case provides the User with the ability to generate a spacecraft schedule in ST-GroundSS.
- **View All Spacecraft Data**
 - This use case provides the User with a display of all spacecraft data in the ST-GroundSS.

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- **Verify User**
 - This use case provides the system with the capability to validate what privileges the User has and have the correct permissions to access the ST-GroundSS.
- **Receive Spacecraft Signals**
 - This use case denotes the capability of the ST-GroundSS to receive spacecraft signals.
- **Create User Account**
 - This use case allows the User to create a new account for the ST-GroundSS.

2.2.3 Scenarios

This section presents scenarios for each use case, described in the use cases section.

Scenario 1: Enter Spacecraft Information

This scenario is associated with the enter spacecraft information use case.

Description: The user manually inputs information about the spacecraft and its priority.

Actors: User

Pre-Condition: The User logs in and is a verified user.

Trigger Condition: The User wishes to input information about a spacecraft.

Steps:

1. The system prompts the User to input an identifier for the spacecraft
2. The user enters an appropriate identifier
3. The system prompts the User to input information about the spacecraft
4. The User enters the appropriate information about the spacecraft
5. The system prompts the User to set the priority of the spacecraft
6. The User manually selects the priority of the spacecraft
7. End of use case

Scenario 2: Generate Schedule

This scenario is associated with the generate schedule use case.

Description: The system generates a schedule for the orbit.

Actors: Ground Station

Pre-Condition: The spacecraft has been registered in the system.

Trigger condition: The orbit data for the spacecraft is inputted by the user into the system.

Steps:

1. The system calculates a schedule based on the input data.
2. The ground station prompts the system to send the schedule.
3. The system sends the schedule to the ground station.
4. The ground station depicts the orbit schedule to the display.
5. End of use case.

Scenario 3: View All Spacecraft Data

This scenario is associated with the view all spacecraft data use case.

Description: The User can view data associated with one or more spacecraft.

Actors: User and Ground Station

Pre-Condition: The user logs in and is a verified user.

Trigger Condition: The user wishes to view data about the spacecraft.

Steps:

1. The User logs into the system
2. The system displays a prioritized list of satellites to the user
3. The User selects data to be viewed
4. The system retrieves the information

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5. End of use case

Scenario 4: Verify User

This scenario is associated with the verify user use case.

Description: The User has a username and password and logs in to the system.

Actors: User and Ground Station

Pre-Condition: The User already has a username and password.

Trigger Condition: The User types in their username and password and attempts to login to the system.

Steps:

1. The User types in their username
2. The User types in their password
3. The User clicks on a button to login
4. The system checks a database to see if the user is valid
5. The system determines the user is valid
6. The system allows the user to view data
7. End of use case

ALT 1 The system determines the user is invalid

- a. The system informs the user their login is invalid
- b. The system does not allow user to view data
- c. End of use case

Scenario 5: Receive Spacecraft Signals

This scenario is associated with the receive spacecraft signals use case.

Description: The ground station receives the signals the spacecraft sends it.

Actors: Ground Station and Spacecraft

Pre-Condition: The spacecraft is registered in the system and has a schedule created.

Trigger Condition: The spacecraft's scheduled time has arrived.

Steps:

1. The ground station pings the spacecraft to confirm its position
2. The spacecraft responds with a ping of its own. (ALT 1)
3. The ground station prompts the spacecraft to deliver its data.
4. The spacecraft compiles its data and sends it to the ground station.
5. The ground station retrieves the data and adds it to the spacecraft's database.
6. End of use case.

ALT 1 Spacecraft fails to respond to ping

- a. The ground station logs the error and prepares to try again. (ALT 2)
- b. Return to 1.

ALT 2 This is the second error of the spacecraft

- a. The ground station displays an error to notify the user.
- b. End of use case.

Scenario 6: Create User Account

This scenario is associated with the create user account use case.

Description: The User creates a new account in the system

Actors: User

Pre-Condition: The User does not have an account in the system.

Trigger Condition: The User attempts to make a new account.

Steps:

1. The system prompts the User to input a username.
2. The User selects their username.
3. The system prompts the User to input a password.
4. The User selects their password.
5. The system prompts the User to confirm their password.
6. The User re-enters their password.
7. End of use case.

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2.3. User Characteristics

The ST-GroundSS will only support two types of users of the system, Users utilizing the system through a mobile app device and Users utilizing the system through a desktop device. The Mobile App User will have limited access to the functionalities of the system. The Mobile App User will only have access to the satellite tracking and schedule. The Desktop User will have access to all functionalities provided by the ST-GroundSS. The system will primarily be used by engineers that have the technical expertise to properly use the ST-GroundSS to its full extent.

2.4. General Constraints

The constraints for the development of ST-GroundSS are as follows:

- Since the system is a web-based application, ST-GroundSS will be unavailable for use without an internet connection.
- The positioning camera component relies on a camera and consistent video feed, therefore without both, the positioning camera component is unavailable.
- The system will not be available to any unauthorized users.

2.5. Assumptions and Dependencies

The development team has made the following assumptions and dependencies:

- The implementation of the system will include the set-up of a camera and video feed focusing on the antenna.
- The client will provide either the NORAD ID or tracking parameters for the system.
- It is assumed that spacecraft and satellites are terms that may be used interchangeably.

3. Specific Requirements

3.1. External Interface Requirements

This section provides a list of requirements for user interfaces, hardware interfaces, software interfaces, and communication interfaces.

3.1.1. User Interfaces

This section lists the requirements for user interfaces.

REQ 181094 The system shall have a login page for desktop use as depicted in Figure 1. Login Page for Desktop.

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Figure 1. Login Page for Desktop

REQ 181243 The system shall have a login page for mobile app use as depicted in Figure 2. Login Page for Mobile App.



Figure 2. Login Page for Mobile App

REQ 181245 The system shall have a dashboard for desktop use that allows the user to select priority view, schedule view, and antenna view.

REQ 181246 The system shall have a dashboard for mobile app use that allows for the user to select priority view or schedule view.

REQ 181247 The system shall have a dashboard page for desktop use that shows the priority view list of the satellites being tracked and associated maps as depicted in Figure 3. Priority View Desktop.

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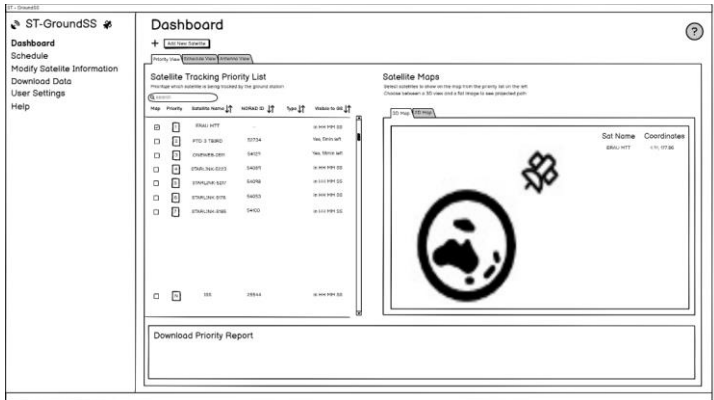


Figure 3. Priority View Desktop

REQ 181249 The system shall have a dashboard page for mobile app use that shows the priority view list of the satellites being tracked and associated maps as depicted in Figure 4. Priority View Mobile App.



Figure 4. Priority View Mobile App

REQ 181252 The system shall have a dashboard page for desktop use that shows the schedule view list of the satellites being tracked and associated maps as depicted in Figure 5. Schedule View Desktop.

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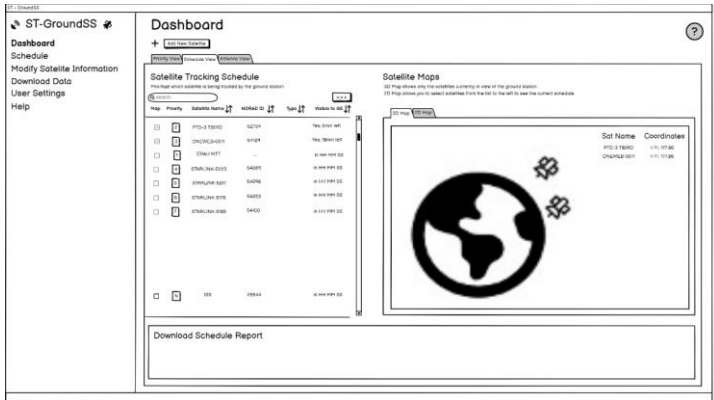


Figure 5. Schedule View Desktop

REQ 181254 The system shall have a dashboard page for mobile app use that shows the schedule view list of the satellites being tracked and associated maps as depicted in Figure 6. Schedule View Mobile App.



Figure 6. Schedule View Mobile App

REQ 181256 The system shall have a dashboard page for desktop use that shows the expanded schedule view list of the satellites being tracked and associated maps as depicted in Figure 7. Expanded Schedule View Desktop.

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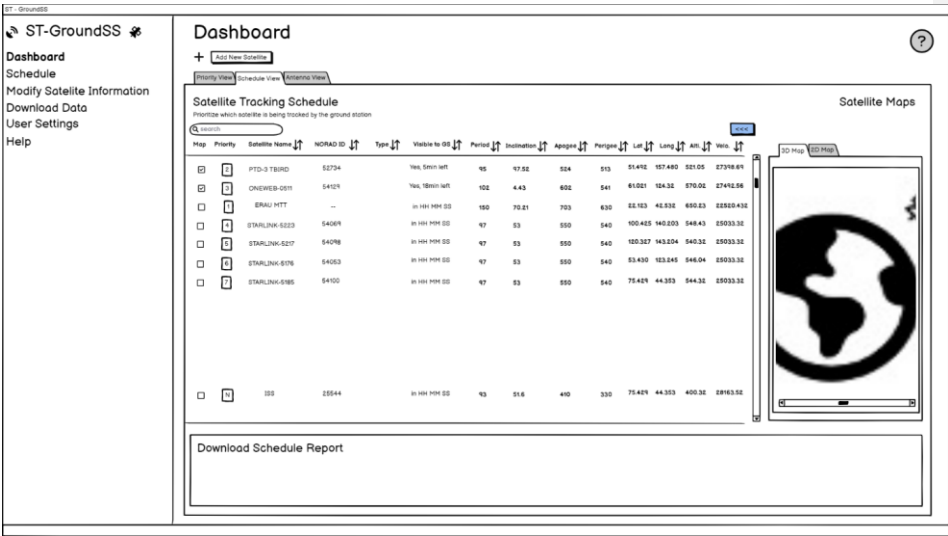


Figure 7. Expanded Schedule View Desktop

REQ 181258 The system shall have a dashboard for desktop that allows the user to see either the associated 3D map or the associated 2D map within the priority and schedule views as depicted in Figure 8. Dashboard Map Selection Desktop.

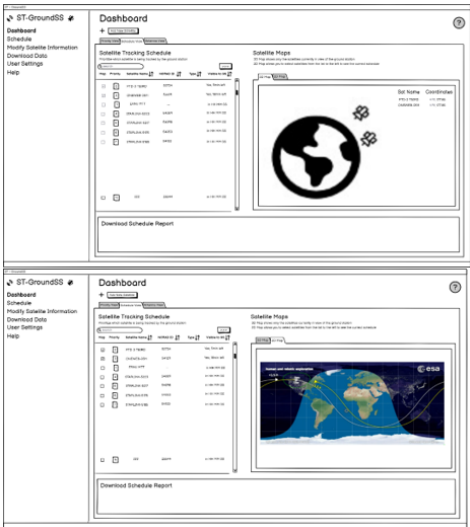


Figure 8. Dashboard Map Selection Desktop

REQ 181260 The system shall have a dashboard for mobile app that allows the user to see either the associated 3D map or the associated 2D map within the priority and schedule views as depicted in Figure 9. Dashboard Map Selection Mobile App.

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Figure 9. Dashboard Map Selection Mobile App

REQ 181262 The system shall have a satellite details page for desktop that allows the user to view satellite information as depicted in Figure 10. Satellite Details Desktop.

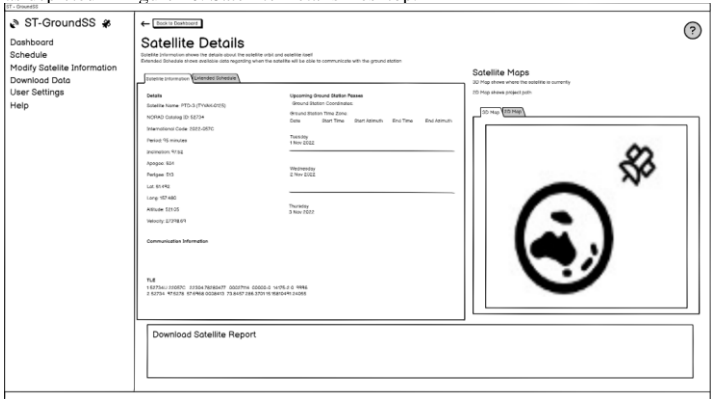


Figure 10. Satellite Details Desktop

REQ 181264 The system shall have a satellite details page for mobile app that allows the user to view satellite information as depicted in Figure 11. Satellite Details Mobile App.

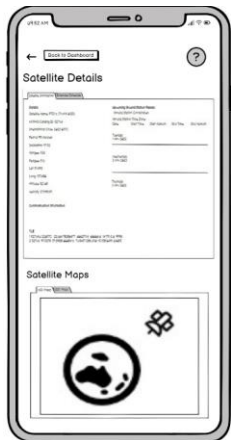


Figure 11. Satellite Details Mobile App

REQ 181266 The system shall have a sidebar menu on the left side of the interface on desktop that allows the user to navigate the system interfaces; this is depicted in multiple figures, including Figure 10 Satellite Details Desktop.

REQ 181267 The system shall have access to a system tutorial and user manual on the desktop as depicted in Figure 12. System Help Desktop.

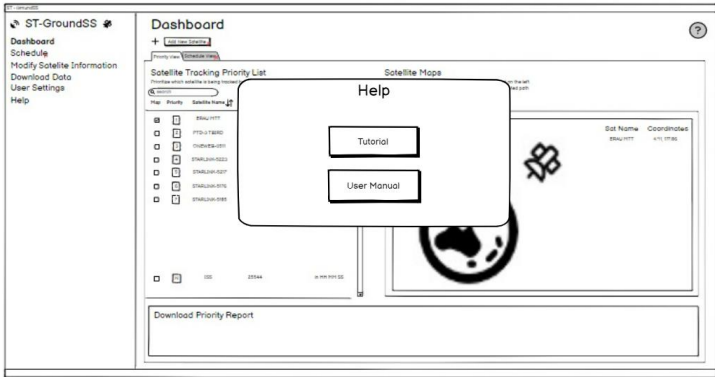


Figure 12. System Help Desktop

REQ 181269 The system shall have access to a system tutorial and user manual on the mobile app as depicted in Figure 13. System Help Mobile App.

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3.1.2. Hardware Interfaces

This section lists the requirements for any and all hardware interfaces.

- REQ 183563 The system shall receive communication data from the on-board antenna array.
- REQ 183564 The system shall check the status of the on-board antenna array.
- REQ 183565 The system shall receive visual data from an onboard camera, pointing at the onboard antenna array.
- REQ 183566 The system shall check the status of the on-board camera on the array.
- REQ 183567 The system shall control the orientation of the antenna array with the use of on-board motors.
- REQ 183568 The system shall check the status of the on-board motors.

3.1.3. Software Interfaces

This section lists the requirements for any and all software interfaces.

- REQ 183570 The system shall access the NORAD Satellite ID Catalog.
- REQ 183571 The system shall receive satellite positioning data from the NORAD Satellite ID Catalog.

3.1.4. Communications Interfaces

This section lists the requirements for any and all communication interfaces.

- REQ 183573 The system shall intercept communication signals from orbiting spacecraft.
- REQ 183574 The system shall receive communication data from orbiting spacecraft.

3.2. Behavioral Requirements

3.2.1. Same Class of User

This section lists requirements that deal with differentiating different user privileges,

- REQ 183576 The system shall have two levels of privilege: Default and Mobile
- REQ 183577 The system shall allow only a Default user to access a maintenance command line through the login menu.
- REQ 183578 The system shall allow only a Default user to add spacecraft.

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REQ 183579 The system shall allow only a Default user to edit spacecraft.

3.2.2. Related Real-world Objects

This section lists requirements related to items needed in the real-world for the user to use the system.

REQ 183581 The system shall be connected to an antenna that is juxtaposed on the rooftop of the building the ground station is located at

REQ 183582 The antenna shall be always operational while the system is powered.

REQ 183583 The system shall be connected to a display monitor.

3.2.3. Stimulus

This section provides a list of requirements related to the stimulus of the user interface.

REQ 181271 If a user clicks on the “Forgot Username” button, the system shall redirect to the forgot username page.

REQ 181274 If a user clicks on the “Forgot Password” button, the system shall redirect to the forgot password page.

REQ 181277 If a user clicks on the “Create Account” button, the system shall redirect to the account creation page.

REQ 181280 If a user clicks on the “Add New Satellite” button, the system shall redirect them to the add satellite screen.

REQ 181281 If a user clicks on the Priority View tab, the system shall display the priority view screen.

REQ 181282 If a user clicks on the Schedule View tab, the system shall display the schedule view screen.

REQ 181283 If a user clicks on the Antenna View tab, the system shall display the antenna view screen.

REQ 181284 If a user clicks on the “?” button, the system shall open the help window.

REQ 181285 If a user clicks on the “User Manual” button, the system shall open a window with the user manual instructions on it.

REQ 181286 If a user clicks on the “Tutorial” button, the system shall begin the tutorial.

REQ 181287 While the tutorial is going, if the user presses the “End Tutorial” button, the system shall terminate the current tutorial instance and return the user to the priority view screen.

REQ 181288 If the user presses the “3D Map” tab, the system shall display the 3D map display.

REQ 181289 If the user presses the “2D Map” tab, the system shall display the 2D map display.

REQ 181290 If the user clicks a checked box on the Priority View for a specific spacecraft, the system shall remove the spacecraft from all maps.

REQ 181291 If the user clicks an unchecked box on the Priority View for a specific spacecraft, the system shall add the spacecraft to all maps.

REQ 181292 If the user double clicks a spacecraft's name, the system shall display the Satellite Details page for that spacecraft.

REQ 181293 If the user clicks the “Extended Schedule” Tab, the system shall display the extended schedule page for that spacecraft.

REQ 181296 If the user presses the “Clear” button, the system shall remove all positional data currently entered.

REQ 181297 If the user presses the “Exit” button on the add satellite page, the system shall return the user to the Priority View screen.

3.2.4. Related Features

This section lists all the related features of the project.

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REQ183607 If a user is on the edit satellite screen and changes the priority of a spacecraft, the system shall reflect this change in the priority view.

REQ183608 If a user is on the edit satellite screen and changes the priority of a spacecraft to an already occupied priority, the system shall shift the priorities of all lower priority spacecraft by one, to make room for the added spacecraft.

REQ 183609 If the user presses the “Export” button, the system shall open the export window.

REQ 183610 If the user inputs a path location, the system shall redirect its export path to this location.

REQ 183611 If the user presses “Confirm” after selecting an export location, the system shall display the data selection screen.

REQ 183612 If the user selects all of the data they want to export and presses “Begin Export”, the system shall compile the data into one zipped file and store it in the export path location.

3.2.5. Functional

This section lists the functional requirements of the project.

REQ 181218 If a user inputs their correct login information and presses the “Submit” button, the system shall permit entry and change to the priority view screen.

REQ 181272 If a user inputs their email and presses the “Submit” button on the forgot username page and it is in the database, the system shall send them an email with their username.

REQ 181273 If a user inputs their email and presses the “Submit” button on the forgot username page and it is not in the database, the system shall display “Account does not exist”.

REQ 181275 If a user inputs their email and presses the “Submit” button on the forgot password page and it is in the database, the system shall send them an email to reset their password.

REQ 181276 If a user inputs their email and presses the “Submit” button on the forgot password page and it is not in the database, the system shall display “Account does not exist”.

REQ 181278 If a user inputs all their information in the create account page and presses the “Create” button, the system shall record this data in the database and redirect the user to the login screen.

REQ 181279 If information is missing in the create account page and the user presses the “Create” button, the system shall return an error, and display “Please fill in all fields”.

REQ 181294 If the user enters a NORAD ID on the add satellite page and presses the “Search” Button, the system shall fill in the positional data with the data of the associated spacecraft.

REQ 181295 If the user enters a NORAD ID on the add satellite page and presses the “Search” Button, while no such satellite exists, the system shall display “No satellite exists under this ID”.

REQ 181298 If the user presses the “Confirm” button on the add satellite page, the system shall enter the satellite using the data provided and then return the user to the Priority View screen.

REQ 181299 When a satellite is created, the system shall generate a schedule for receiving signal data based on its positional data.

REQ 181300 When a satellite is in its scheduled position, the system shall ping the satellite to confirm its data collection.

REQ 181301 When a satellite confirms its ping, the system shall collect data from the satellite, storing it in the local database.

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3.3. Non-behavioral Requirements

3.3.1. Performance Requirements

This section describes all of the performance related requirements of the project.

REQ 183587 The system shall calculate the orbital information for all recorded satellites for up to 3 days in the future.

3.3.2. Qualitative Requirements

This section describes the qualitative requirements of the ST-GroundSS.

3.3.2.1. Availability

[This section describes the factors required in the system that guarantee availability.]

Commented [OC1]: typo?

REQ 183591 The system shall be available to the User if ST-GroundSS has access to an internet connection and a web server to run on. These components are the responsibilities of the user.

3.3.2.2. Security

This section describes the security requirements of the system.

REQ 183593 The system shall encrypt the User's password before storing it.

REQ 183594 The system shall use the email address of the user as a password recovery mechanism.

REQ 183595 The system shall log all spacecraft data and store it for a period of time specified by the user.

3.3.2.3. Maintainability

This section describes the maintenance requirements of the system.

REQ 183597 The system's physical hardware components shall be maintained by the user.

REQ 183598 The system's software components shall be maintained by the software provider.

REQ 183599 The system shall generate error logs for all errors during normal operations.

REQ 183600 The system shall generate error logs for all errors that occur during installation of the system.

3.3.2.4. Portability

This section describes the portability requirements of the system.

REQ 183602 The system shall be accessible for viewing through both mobile and desktop browsers.

3.3.3. Design and Implementation Constraints

This section describes the design and implementation constraints of the system.

REQ 183604 The system shall have physical hardware constraints concerning the selection of motors and of the radio.

REQ 183605 The system is a web based application and therefore will not be successfully implemented without an internet connection

3.4. Other Requirements

This section captures customer requirements in Section 3.4.1.

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3.4.1. Customer Requirements

This section captures customer requirements. These requirements are derived from various sources of information: a requirements definition document from the customer, a customer interview, and a prototype review meeting with the customer.

- REQ 179109 The system shall be able to determine the needed angular position (two angular axes) needed to track a spacecraft given the orbit parameters and time to perform the signal reception.
- REQ 179159 The system shall save a prioritized list, determined by user input, of spacecrafts to receive from.
- REQ 179269 The system shall let the user determine the priority through a numerical ranking.
- REQ 179270 The system shall not allow two or more satellites have the same priority.
- REQ 179268 The system shall compute when a tracked satellite will be visible for the ground station, given the ground station coordinates and the maximum reception angle from the horizon.
- REQ 179258 The system shall compute the expected frequency doppler shift for a given angular position, which is provided to the system define radio code in real-time.
- REQ 179260 The system shall display when data is being received.
- REQ 179264 The system shall show the stream of data being received.
- REQ 179265 The system shall save tracked orbit, city coordinates, angles of the positioner, and received information locally on the main computer until the user deletes the data.
- REQ 179271 The system shall allow the user to export the saved data (tracked orbit, city coordinates, angles of the positioner, and received information) from the main computer.
- REQ 179261 The system shall provide satellite status on a mobile application that communicates with the main computer running the codes.
- REQ 179272 The system shall require users to login with a valid username and password before accessing the system.
- REQ 179262 The system shall display a diagram with the current state of orbits being tracked in 3D graphics.
- REQ 179263 The system shall show a signal reception schedule expected for the next 3 days.
- REQ 179273 The system shall provide the user with a notification that satellite data is erroneous.
- REQ 181613 The system shall save a log of when satellite data is not being received correctly.
- REQ 181295 The system shall provide a tutorial to guide the user on how to use the system.
- REQ 18196 The system shall have a user manual.
- REQ 181384 The system shall have a camera to show the real world view of the ground station antenna.