

A Service Portal for the Integrated SCA_N Network

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The Space Communication and Navigation (SCa_N) program office owns the assets and services provided by the Deep Space Network (DSN), Near Earth Network (NEN), and Space Network (SN). At present, these individual networks are operated by different NASA centers—JPL for DSN—and Goddard Space Flight Center (GSFC) for NEN and SN—with separate commitments offices for each center. In the near future, SCa_N's program office would like to deploy an integrated service portal which would merge the two commitments offices with the goal of easing the task of user planning for space missions requiring services of two or more of these networks. Following interviews with subject matter experts in this field, use cases were created to include the services and functionality mission users would like to see in this new integrated service portal. These use cases provide a guideline for a mock-up of the design of the user interface for the portal. The benefit of this work will ease the time required and streamline/standardize the process for planning and scheduling SCa_N's services for future space missions.

I. Introduction

THE integrated Space Communications and Navigation (SCa_N) network seeks to place the three prime NASA space communication networks, the Deep Space Network (DSN), Near Earth Network (NEN), and Space Network (SN), under a single management and system engineering umbrella¹. The DSN is an internationally distributed network of large antennas and communication facilities that support interplanetary spacecraft missions and radio and radar astronomy observations². It provides the vital two-way communications link that guides and controls the spacecraft, and brings back the images and new scientific information that has been collected³. The NEN provides Telemetry, Tracking, and Commanding (TT&C) services for orbital communications support for Near-Earth orbiting customer platforms. It provides services to a wide variety of mission customers at multiple frequency bands through all the phases of a mission's lifetime⁴. The SN is a data communication system comprised of a constellation of Tracking and Data Relay Satellites (TDRS) and various ground terminal complex employing high-gain microwave antennas to support Earth orbiting spacecraft communication. The combination of elements comprising SN allows Electronic Systems Command (ESC) to offer 24/7 support to customers, including

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global telecommunication services for TT&C between low earth orbit spacecraft and customer control, and data processing facilities⁵.

The DSN is operated by the Jet Propulsion Laboratory (JPL), and the NEN and SN are operated by Goddard Space Flight Center (GSFC). As a result of the separate ownerships, the DSN has its own commitments office, DSN Commitments Office (DCO), and the NEN and SN share a commitments office, Networks Integration Management Office (NIMO). Currently, the two commitments offices operate separately from one another; for example, they require separate mission documents, including agreements, for the user interfaces.

Occasionally, missions are scheduled that require the use of multiple networks that require interactions with both NIMO and the DCO. Currently, in order for a user to schedule this mission, they must go through two different processes to complete all the required documents and to obtain the necessary agreements and services for the mission. According to NASA headquarters' survey of mission users, this process is complicated, time consuming, costly, and confusing to the user who must plan the mission⁶. Resultantly, there is a conceptual framework in place that needs to be further refined to standardize and centralize user interactions with all three networks.

My job for the summer was to create a user centric mock-up of a web-based user interface for the SCaN integrated planning portal, a subset of all of the envisioned services for a future SCaN integrated service portal. I followed a user centered design approach, which is an approach that involves the user throughout the design process⁷, in order to produce a mock-up of a website. In order to create the prototype web design, I had to conduct interviews with subject matter experts in this domain, create scenarios from examples in the interviews, form personas based on these experts, and then generate use cases and an activity diagram that describe the desired functionality. This process allowed the architecture of a planning portal to be abstracted using SysML⁸.

II. Subject Matter Expert Interviews

Interviews were conducted with subject matter experts (SMEs) to capture how they use the current DSN network portal and discover what they want the integrated SCaN service portal to include. One co-mentor, Peter Shames, provided me with the information about how NIMO plans their missions, and what they would need included in the portal. I interviewed SMEs from the DSN, as my co-mentors work with DSN staff and were able to introduce me to their co-workers. These interviews allowed me to understand how the current DSN portal worked, as well as what those users wanted in the new SCaN integrated portal. I also conducted the interviews and many brainstorming sessions with my co-mentor, Mike Levesque, as he is a SME in this domain, and I was able to ask follow up questions to obtain better detailed responses.

The first interview was with Steve Waldherr, a mission commitments manager for the DSN. He is responsible for planning and committing DSN services to missions. He came prepared to the interview with a chart he had made along with a previous SCaN study team to show the necessary steps the portal would need to accomplish in order to integrate the services.

The second interview was with Felicia Sanders, a mission interface manager (MIM). She is responsible for interfacing with flight missions who are interested in receiving DSN tracking support, and understanding the mission requirements and how those affect the capabilities that the DSN can provide to missions. Felicia also had multiple suggestions for creating a more user friendly portal, especially for beginner users, such as providing a virtual tour to explain the services of each network.

Following the interview with Felicia was an interview with Jim Erickson, the DSN mission services planning and management program manager. He is responsible for the 9X office which performs service planning and management for both the DSN and Multimission Ground Data System (MGDS). Jim was able to give examples of past users, and explain exactly what the integrated portal would need to provide.

The last interview that I conducted was with Belinda Arroyo, the DSN planning and scheduling manager. She was experienced with the planning and scheduling processes and tools, and was able to define the DSN internal planning needs of the scheduling team. She explained what would need to occur within the portal in order for the users to plan and schedule the mission.

III. Scenarios

Following the completion of the SME interviews, a set of scenarios were produced. These scenarios reflected the information that the SMEs gave as examples of what the portal would need to

provide for the mission users. The scenarios were created to compress the useful data collected into easily accessible “stories” that would preview how a user would use the portal. An example scenario for the SCaN user mission communication is provided.

“Once the customer acknowledges the need for communication, they will directly contact SCaN. SCaN will then contact the specific network needed for the mission based on the information the customer provided. This information will have been provided from an initial questionnaire asked on the service portal which will determine the requirements the mission needs to fulfill, as well as the functions the user will need the ground stations and communication relay nodes to accomplish.

As SCaN determines the specific network the user should contact, the user should review the SCaN service catalog. This explains and advertises the services SCaN can provide. They should also review the DSN service catalog, as well as the SN and NEN user’s guides, which will explain the services that each individual network can provide. These guides are periodically updated as the standard services change.

Missions would like to see the portal have all of the service catalogs and user guides as an introduction for the user after they fill out a questionnaire stating their needs. Users should be able to view each network for an explanation of the services of each. There should also be a FAQ page to increase the user friendliness of the portal. This page will exist to divert some questions from SCaN or the specific network contact. This contact will have their information on the portal home page so the user will know who to contact when they have questions. The portal will also have an archive with all the necessary documents. It will give a short explanation of what each document is and when they are used. Once the customer begins completing the documents, they should move forward by contacting the network representative and having peer to peer contact.

The SCaN portal should have a checklist to provide status updates. This will allow the customer to see how far along their paperwork and mission is. There also needs to be peer to peer status updates. The customer and SCaN should both be reviewing the schedule to ensure that they are on task.”

IV. Personas

The interviews also led to the creation of primary personas for the users of the portal. Examples of these personas are the commitments office, mission service user, and the missions interface manager. The personas allowed me to generalize the role of each subject matter expert and explain the goals they hope to accomplish in using the portal. These personas were placed in the model with the use cases; the description is placed under documentation for the actor they personified, as shown in Figure 1. It was important for the persona to be placed within the model as that was a way to ensure the persona and their needs would always be satisfied and not forgotten.

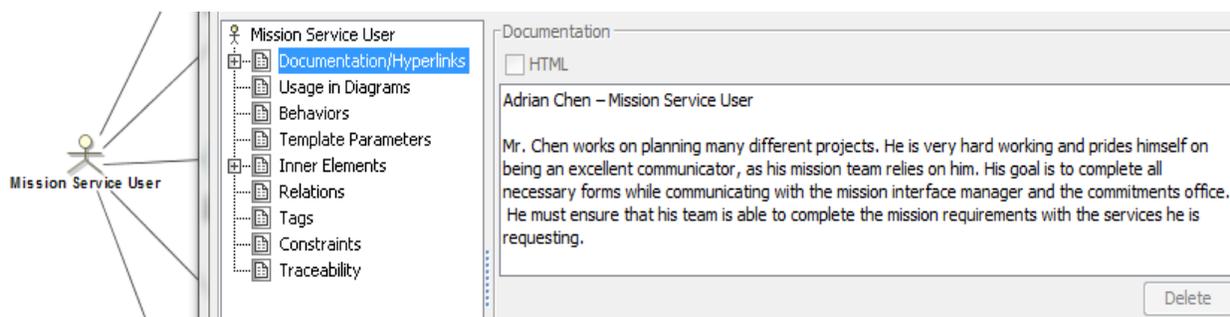


Figure 1. Persona Captured in Model

V. Use Cases

The scenarios and personas led to the creation of use cases using SysML notation in the MagicDraw⁹ modeling tool. These use cases were created by key action verbs and tasks that were stated during the SME interviews. The use cases were written as user centric, where the main actions were tasks the user would like to complete, such as discover network capabilities. This overall use case, as shown in Figure 2, was created with the help of my co-mentor, Peter Shames, and mentor, Oleg Sindiy. I worked with

Peter to create a hand drawn use case on a poster board to get the ideas and concept down. I later transferred the information into MagicDraw with the help of Oleg, added more tasks, and refined the

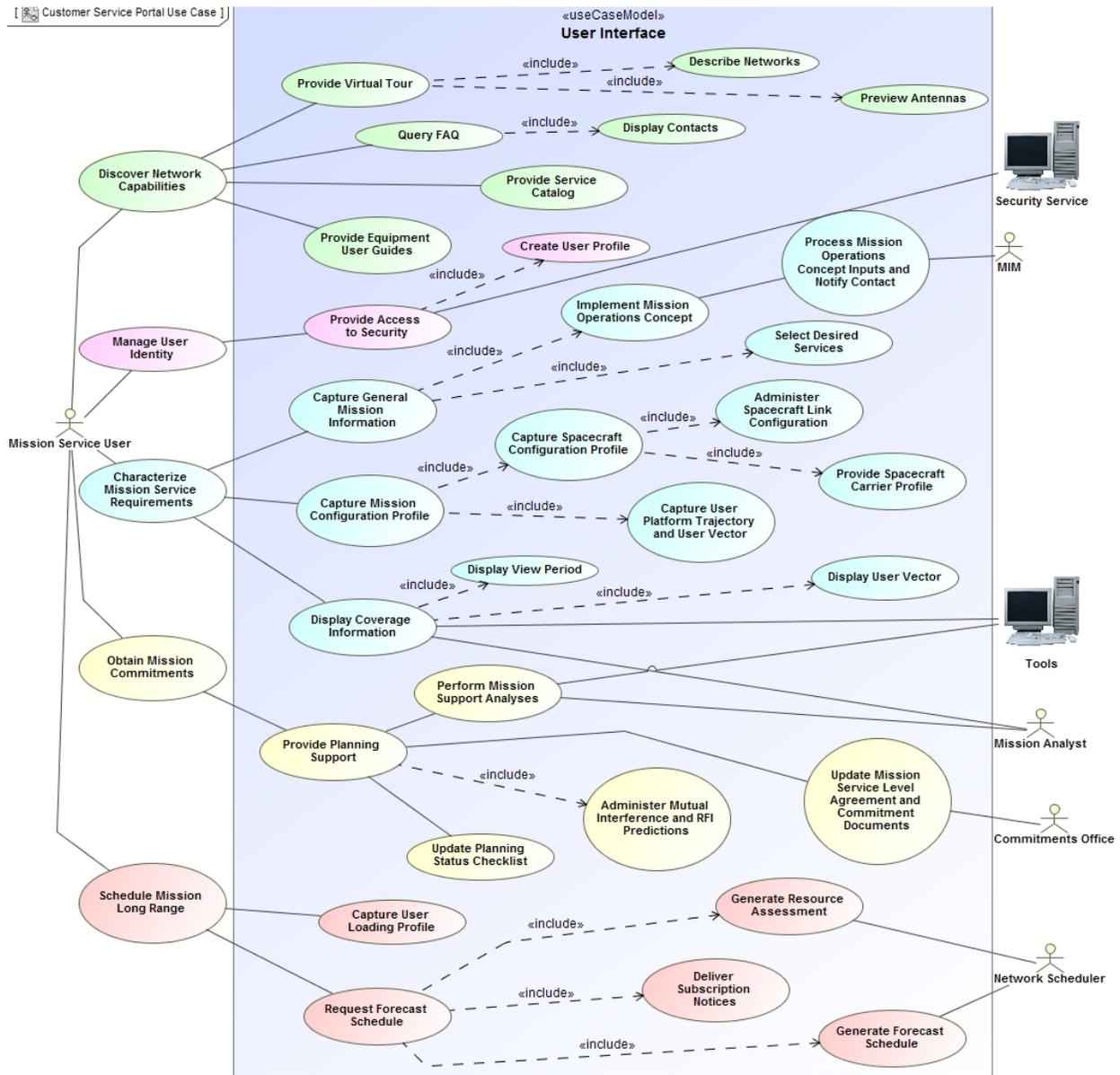


Figure 2. General Use Case Diagram

specific details.

These main actions then linked to a new, individual use case, displayed in Figure 3, which expanded the tasks available to the user. These individual use cases were displayed separately, as the general, overall use case became too large and complicated to easily view and study as one. The action the user will aim to complete became the name for the individual use case, and the functions they would need to perform within the user interface to complete this action became the actions within the use case. The individual use cases are colored differently as a way to signify where each use case began and ended. These tasks were included in the use cases because they were either already available in the current portal, or were tasks one or more of the subject matter experts mentioned in their interview that they wanted to see in the portal.

Under the documentation tab of each use case action within specification is a description of the task. For example, under virtual tour, there is a description that states, “the virtual tour provides a description of

the different networks and displays visuals of the antennas. The tour should be able to be understood by

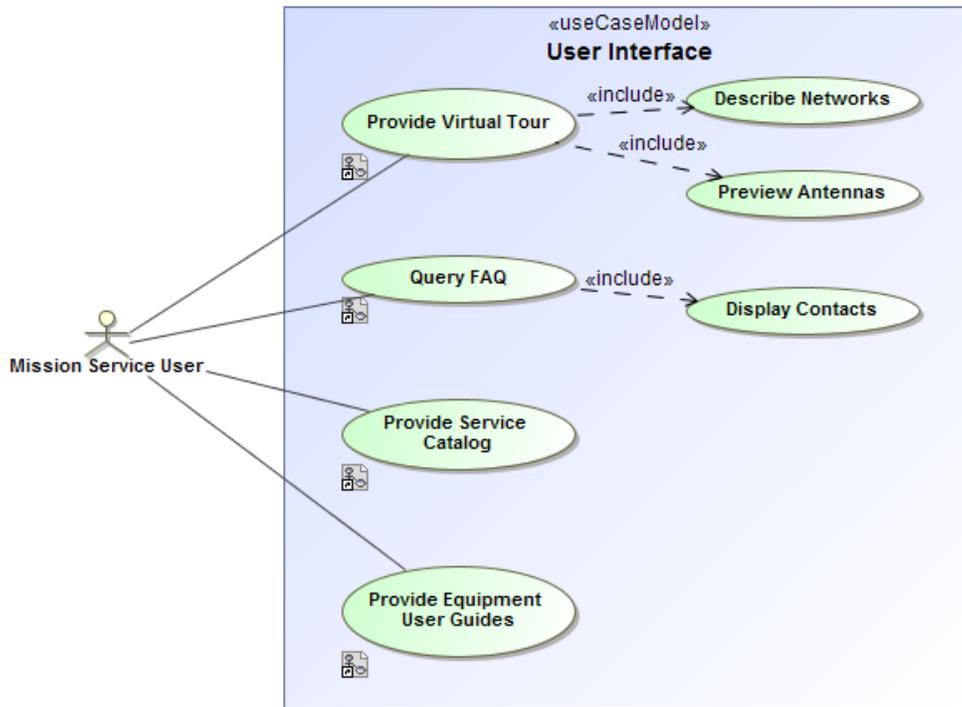


Figure 3. Individual Use Case

users with any or no experience planning and scheduling a mission.” These descriptions exist as there are many views of the model, and each task was needed to be self explanatory. The documentation is

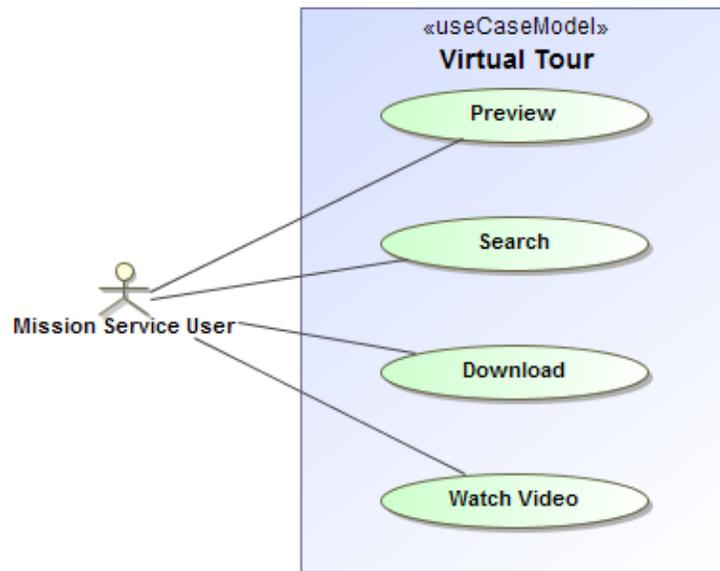


Figure 4. User Actions Use Case

placed within the model to ensure it is not forgotten, and always easily accessible.

The use cases then went one step further, as shown in Figure 4. Each task linked to a new use case which described what the user should be able to do with each task. These use cases ensured that the user was always kept in mind, and was used as a reference for when the prototype design of the interface began.

VI. Activity Diagram

While adding the use cases, I began to update a functional activity diagram that was already in the project model. I worked in the initiate mission planning part of the diagram, because that was the scope of my summer task. The different functions and actions were separated by swimlines, meaning I had to decide where the new functions and actions should be located, which proved to be difficult. The edited functional activity diagram is shown in Figure 5.

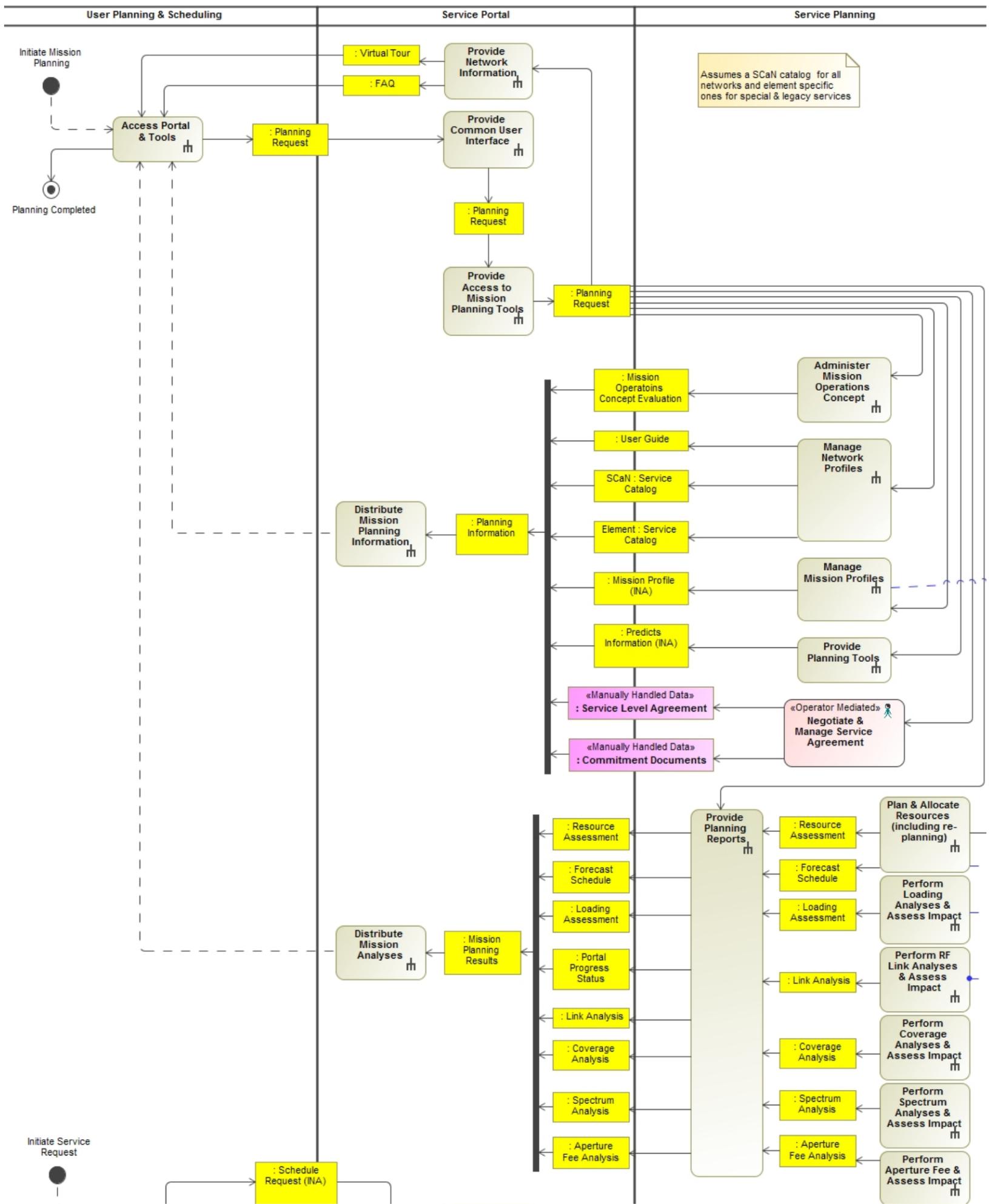


Figure 5. Activity Diagram

The use cases and activity diagram needed to be compared with each other to confirm there were no discrepancies between them. Each activity box from the activity diagram was compared with the use case to ensure the activity would fit within an use case action. This did not always occur, which led to updates within the use case. These updates included expanding the use case, and added more detail to specific actions, such as tasks that were included in another action. Once the actions were accounted for, the use cases actions were compared to the functions of the activity diagram. The only discrepancy that arose while making the comparison this way occurred with the login authentication. However, even though there was not an exact function for the login, there were other functions that could contain it and the activity diagram was not changed. The table comparing the activity diagram functions to the use case is shown in Table 1.

Table 1. Activity Function to Use Case Action Table

Name (Activity Diagram Function)	Owned Attribute (Use Case Action)
Provide Network Information	Provide Virtual Tour : Discover Network Capabilities : Query FAQ
Manage Network Profiles	Provide Service Catalog : Provide Equipment User Guides
Administer Questionnaire	Capture General Mission Information
Distribute Mission Planning Information	Process Questionnaire Inputs and Notify Contact
Manage Mission Profiles	Capture Mission Configuration Profile
Negotiate & Manage Service Agreement	Obtain Mission Commitments : Update Mission Service Level Agreement and Commitment Documents
Provide Access to Mission Planning Tools	Manage User Identity : Provide Login Authentication : Enforce User Sign-In : Create User Profile
Provide Common User Interface	Characterize Mission Service Requirements
Plan & Allocate Resources (including re-planning)	Schedule Mission Long Range : Request Forecast Schedule : Capture User Loading Profile
Provide Planning Tools	Display Coverage Information : Provide Planning Support
Provide Planning Reports	Perform Mission Support Analyses : Update Planning Status Checklist

VII. Block Definition Diagram for the Planning Request Data Model

After the comparisons were completed, a block definition diagram was updated from the current model. This update including adding the specifics that were included under each major request for planning. The definition blocks were created by searching the current model for existing activities and determining which activity fit under each request. These activities were then recreated as active activities, such as request contacts. The diagram is shown in Figure 6.

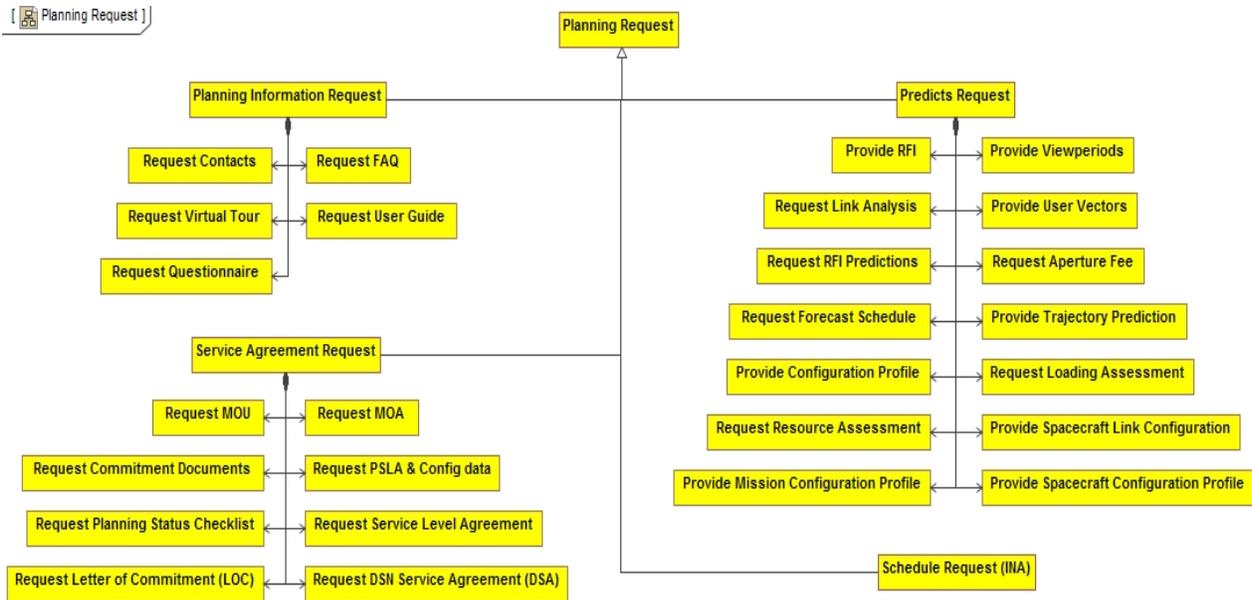
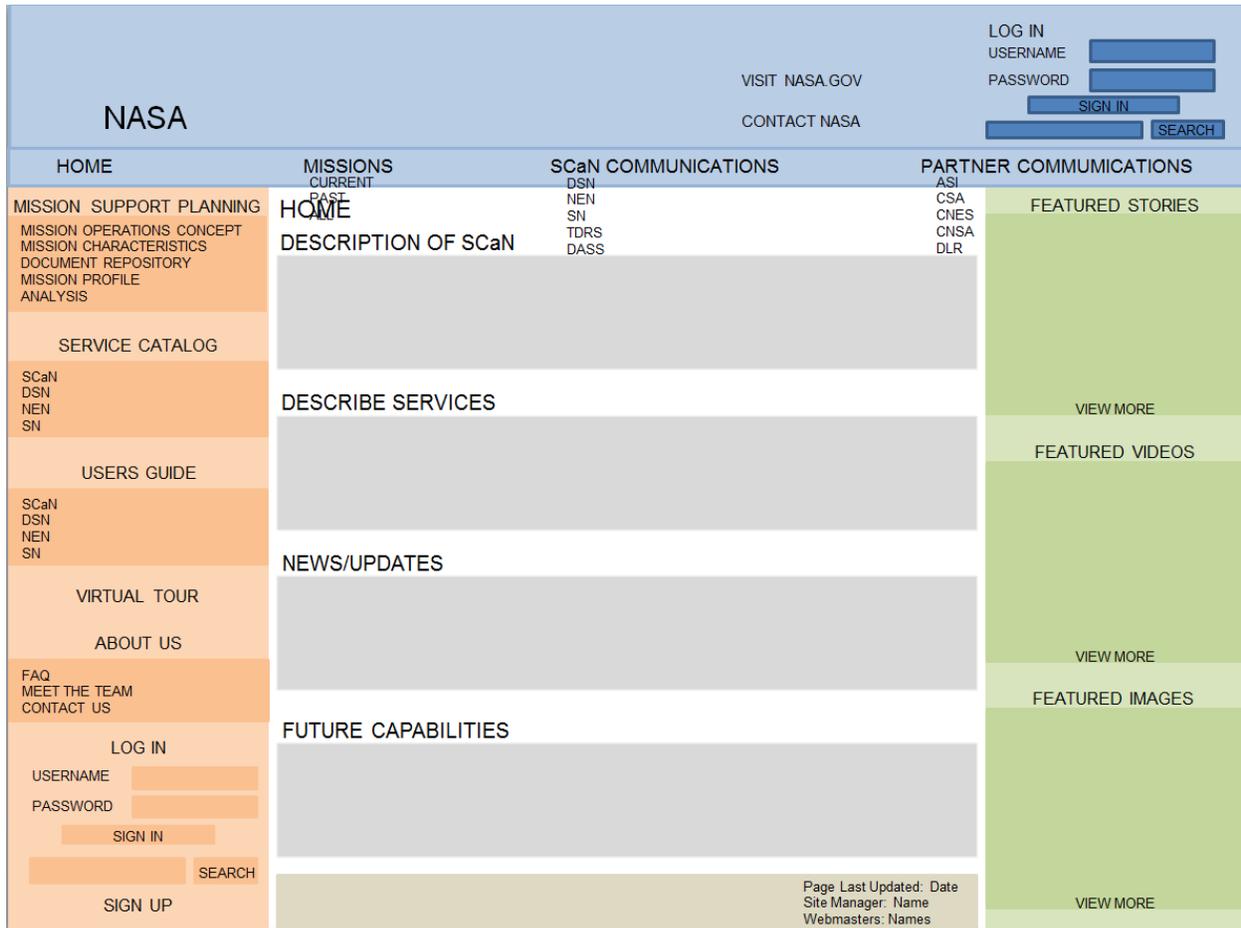


Figure 6. Block Definition Diagram for the Planning Request Data Model

VIII. Prototype Design

Lastly, the prototype design for the user interface was created. It began with a low-fidelity design; i.e., hand sketches that were scanned in order to display and review them. A majority of the pages were designed by reviewing current NASA websites, such as the JPL, GSFC, and SCan web pages to ensure the sketches followed the NASA requirements for website outlines.

Meetings with members of the integrated service planning portal working group led to discussions about what information should be displayed on each page and updates to each page were created following each meeting. The sketches would eventually lead to a high-fidelity working model of the web interface, which would be created by working with a web designer. However, to ensure that nothing was lost between the hand sketches and the working model, I created a mock-up of the updated sketches in PowerPoint and wrote notes to go with each slide to explain how everything would work. Figure 7 shows an example of the design for the home page with the notes.



HOME

The top blue section will be the banner with NASA. Visit NASA.gov and contact NASA are both links. Contact NASA will link to the contact us page. The lower blue section is the home banner, the smaller text underneath the sections (missions, SCA N communications, partner communications) will be a part of a drop down menu for each individual section. The orange section is the other main navigator. Again, the smaller text under each section will be a drop down menu for each specific section. In the box under featured stories will be links to specific stories that will be updated periodically, and view more is a link that will link to more stories. It will be the same for featured videos and featured images, except instead of links to stories and additional stories, it will be videos and images respectively. Under the middle section (gray) titles, ex: description of SCA N, describe services, news/updates, future capabilities, will be a textual description of describing the title.

Figure 7. Home Page Mock-Up

Once the draft of the outlines were completed, I began to look through some of the information on the DSN website in order to determine what should be included on specific pages in the portal. Follow up meetings were scheduled with the subject matter experts succeeding this step, and the webpage outlines and page information were discussed to ensure I had included all of the details they had suggested.

I also began to compare existing documents, such as the DSN Service Agreement (DSA) and the Project Support Level Agreement (PSLA) and noted the similarities and differences. In the current system, the DSA is completed for missions needing the DSN at JPL, and the PSLA is completed for missions requiring the SN or NEN at GSFC. As one goal of the the integrated SCA network is to merge the commitments offices, they need to merge the two documents and create one Service Level Agreement (SLA). During my comparison, I discovered the DSA covers more of the technical information that will be used by the DSN, whereas the PSLA is more descriptive and describes the services the network provides. Table 2 shows the comparison table created in the MagicDraw model.

Table 2. PSLA and DSA Comparison Table

Name	Owned Attribute
Included in Both	Sponsor : Purpose : List of Tables : Key Mission Dates : Needed Signatures : Orbit/Flight Path Data : Effectivity/Expiration Date : Launch/Flight Information : Standard Services Provided : Referenced Documents/Websites : Change Control : Mission Objectives : History/Change Log : Funding Responsibility : Antenna/Coverage Usage : Acronyms & Abbreviations : Mission Phases/Requirements : Custom/Non-Standard Services with Cost
Included in DSA	Distribution List : User Loading Profiles : Cost Calculation Sheets : Tracking and Support Profile : TTC Central Adaptation Costs : Spacecraft Parameters and Notes : Controlling Documentation : Antenna Usage Aperture Fee : Telecommunication Parameters : Ground Communication Services and Costs
Included in PSLA	NISN Services : Points of Contact : Maturity Assessment : Flight Dynamics Services : Customer Integration/Test : Estimated Services for Future Years : Formulation/Implementation Start Dates : Range Services : Estimated Lifetime : Lifetime Limiting Factor : Customer Requirements : Projected Documentation Set : Launch/Mission Critical Support Items

After the commitment documents were compared, I compared the activity chart from Steve Waldherr which was created in a prior SCA network working group to plan the integrated portal with the use cases I created, in order to confirm there were no discrepancies between the two. Again, this lead to updates in the use cases and sketches, and in order to show the process followed, I created sequence diagrams. The sequence diagrams focused on specific tasks that needed to be accomplished, such as complete the questionnaire or signing up for a user name. The sequence diagram for a new user is shown in Figure 8.

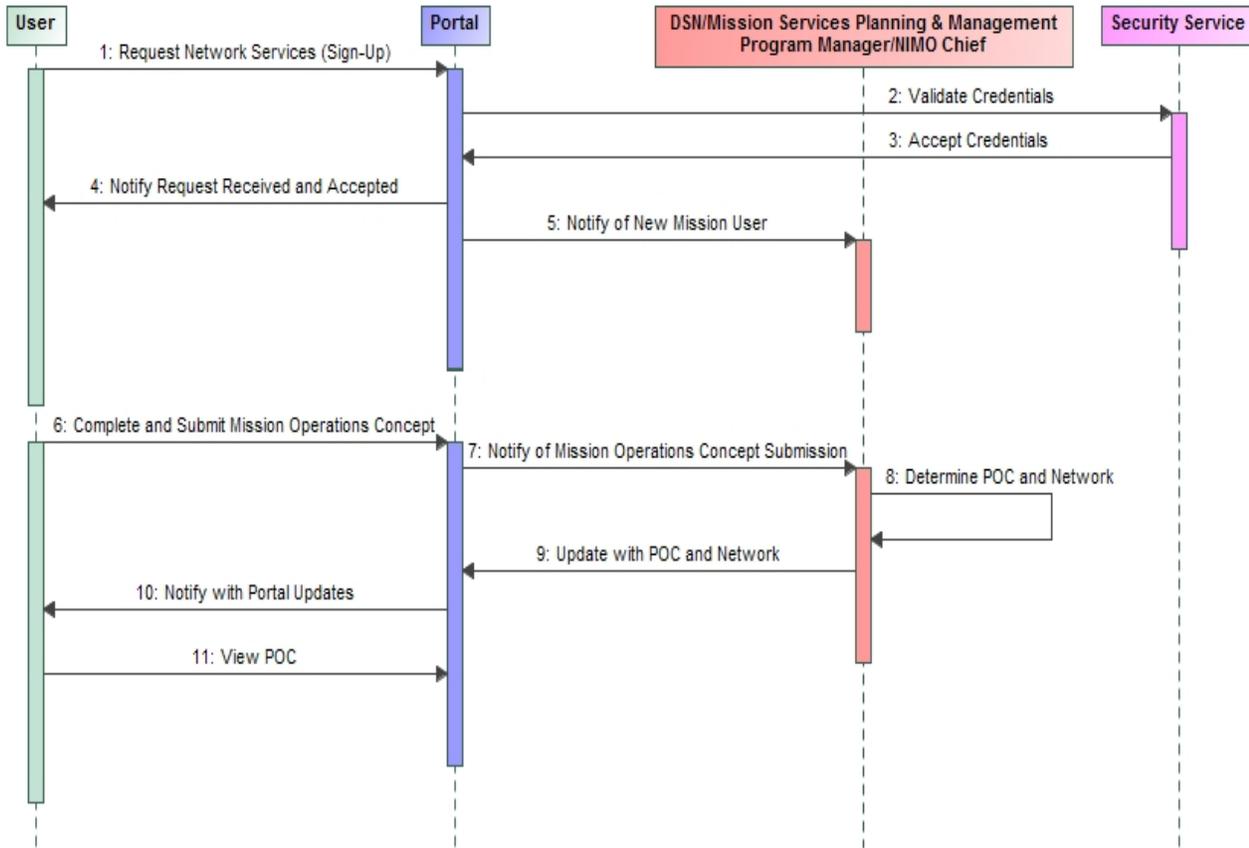


Figure 8. New User Sequence Diagram

IX. Conclusion

In the first phase, the integrated portal will provide all the necessary information for planning under one site. It has yet to combine documents, however, with the interface providing links to necessary sites, it will save time and decrease the difficulty of planning a mission. The process that I followed helped me get a better understanding of the project and DSN services. The interviews helped explain the services that the DSN provides, as well as the required steps to plan and schedule a mission. For this reason, I recommend that if an intern takes over the scheduling process, or the next phase of the integrated portal, that they follow this process.

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