NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

SYSTEMS ENGINEERING CAPSTONE PROJECT REPORT

DESIGN OF A COMPETENCY ADMINISTRATION TOOLSET (CAT)

by

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March 2017

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REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** March 2017	**3. REPORT TYPE AND DATES COVERED** Capstone project report

4. TITLE AND SUBTITLE
DESIGN OF A COMPETENCY ADMINISTRATION TOOLSET (CAT)

5. FUNDING NUMBERS

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey, CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES)
N/A

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB number _2016.0146-DD-N_.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release. Distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (maximum 200 words)

The project budget, schedule, and manpower management practices currently used within the Naval Air Systems Command (NAVAIR) rely heavily on manual data extraction and processing, which is perceived to be inefficient in both time and cost. The purpose of this systems engineering project was to design a web-based system that collects, collates, and formats financial, schedule, and status information for multiple projects, making it easier and quicker for different levels of management to access project information and make decisions. The proposed software system is referred to as the Competency Administration Toolset (CAT).

To design CAT, the team followed a modified version of the Unified Process life cycle. By following this process, the team was able to work frequently with stakeholders to define system requirements and receive feedback. The products of this analysis included an interactive proof-of-concept graphical user interface (GUI) and multiple systems engineering artifacts, including user stories, use cases, requirements documentation, and a functional architecture. The project's stakeholders approved the final versions of these products. It is envisioned that the stakeholders' software development teams will use the design artifacts to fully develop and operationally deploy the CAT system at a later date.

14. SUBJECT TERMS systems engineering, unified process, project management, system design, graphical user interface, GUI, agile			**15. NUMBER OF PAGES** 259
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UU

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

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DESIGN OF A COMPETENCY ADMINISTRATION TOOLSET (CAT)

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

from the

NAVAL POSTGRADUATE SCHOOL
March 2017

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ABSTRACT

The project budget, schedule, and manpower management practices currently used within the Naval Air Systems Command (NAVAIR) rely heavily on manual data extraction and processing, which is perceived to be inefficient in both time and cost. The purpose of this systems engineering project was to design a web-based system that collects, collates, and formats financial, schedule, and status information for multiple projects, making it easier and quicker for different levels of management to access project information and make decisions. The proposed software system is referred to as the Competency Administration Toolset (CAT).

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LIST OF ACRONYMS AND ABBREVIATIONS

ATO	authority to operate
BFM	Budget Financial Manager
BH	Branch Head
CAC	common access card
CAT	Competency Administration Toolset
CON	chargeable object number
DAWIA	Defense Acquisition Workforce Improvement Act
DOD	Department of Defense
DODI	Department of Defense instruction
DON	Department of the Navy
DOTMLPF-P	doctrine, organization, training, materiel, leadership and education, personnel, facilities and policy
EARS	Easy Approach to Requirements Syntax
eDACM	electronic Defense Acquisition Career Management
ERP	enterprise resource planning
GUI	graphical user interface
HSI	human systems integration
IPR	in-process review
IRB	Institutional Review Board
IT	information technology
LML	Life Cycle Modeling Language
MBSE	model-based systems engineering
NAVAIR	Naval Air Systems Command
NERP	Navy Enterprise Resource Planning
NIPRNET	NMCI Non-Secure Internet Protocol Router
NMCI	Navy Marine Corps Intranet
NPS	Naval Postgraduate School
PDR	preliminary design review
PEO(U&W)	Program Executive Office for Unmanned Aviation and Strike Weapons

PM	Project Manager
RTM	Requirements Traceability Matrix
SE	systems engineering
SL	Senior Leadership
TPOC	technical point of contact
UCD	user-centered design
URL	uniform resource locator
UP	Unified Process
UX	user experience design
VBA	Visual Basic for Applications

EXECUTIVE SUMMARY

Many of the current methods utilized within the Naval Air Systems Command (NAVAIR) for estimating project budget, personnel allocation, and scheduling data result in inaccurate estimates for decision making. Most methods rely heavily on manual data extraction and processing, which can be inefficient in both time and cost. One NAVAIR competency recognized these constraints and expressed the need for a new information technology (IT) system that provides a consistent and accurate method of gathering and viewing project-related financial, schedule, and labor metrics. The purpose of the systems engineering (SE) project described in this report was to design a web-based system that collects, collates, and formats project financial, schedule, and status information for multiple projects, reducing the level of effort required for management personnel to access project information and make decisions. The final web-based system prototype created for this project is referred to as the Competency Administration Toolset (CAT).

To begin the design process, the SE team had in-depth discussions with the competency stakeholders to define the problem space of the current system, as well as to define the requirements for the new system. One primary requirement emphasized by the stakeholders was that the new software system be web-based. Knowing this, the team determined that the best SE approach was the Unified Process (UP), which is an iterative process developed for software engineering that allows stakeholders to provide frequent feedback to the system design. With UP allowing for an iterative approach to obtain and integrate feedback, Team CAT deemed this process to be a more suitable choice, compared to the traditional “waterfall” processes. Team CAT modified the UP approach to better suit the needs of this project; however, the concept of iterative development remained a focus of the design process.

One of the biggest challenges for Team CAT was to ensure that the authoritative source data pulled from multiple sources, specifically the Navy Enterprise Resource Planning (NERP) and Command Staffing databases, was accurately pulled, stored, and processed. To ensure the pulled data fulfilled stakeholders’ needs, Team CAT focused on developing unambiguous SE artifacts from the start. The team identified stakeholders’

requirements, then mapped the flow of data and functionality within the system. After conducting additional stakeholder interviews, the team was able to develop the necessary artifacts, which included user stories, use cases, requirements, and a functional architecture composed of action diagrams. The collaborative model-based systems engineering (MBSE) toolset used to develop these artifacts was “Innoslate.”

Another challenge for Team CAT was to determine how to display the data of interest for multiple stakeholders, each with his or her own priorities and preferences, in a way that was intuitive and user-friendly. The team decided the best approach was for CAT to have separate, customized dashboard displays for each user type, based on the role within the NAVAIR competency. The team developed several iterative prototypes of these dashboards, each with increased detail and complexity. The dashboards began as wireframe models drawn on paper, to general dashboard arrangements using Microsoft PowerPoint, and then progressed to a detailed website with interactive interfaces using HTML and PHP. Each dashboard version received feedback from stakeholders regarding preferences for how the information should be organized and displayed. The iterative design improvements continued until the stakeholders agreed on a final version of the dashboards.

The result was an interactive, comprehensive graphical user interface (GUI) layout, validated by all stakeholder groups. These stakeholders also reviewed and approved all SE artifacts necessary for eventual system development. With the development groundwork successfully established by Team CAT, the competency’s software development team will be able to align the desired user experience, represented by the prototype GUI, with the user functionality needs captured in the SE artifacts.

I. INTRODUCTION

A Naval Air Systems Command (NAVAIR) competency has expressed the need for a new information technology (IT) system that provides a consistent and accurate method of gathering and viewing project-related financial, schedule, and labor metrics. Such a system would provide a more informed decision-making process for project managers and competency leadership. The project described in this report focuses on developing systems engineering (SE) artifacts to design a prototype system that satisfies these needs. This system is named the Competency Administration Toolset (CAT), with project members referred to as "Team CAT." The focus of Chapter I is to discuss the problem areas that generated the need for this project, highlight the project's goals and scope, and describe the technical approach used to design the system.

A. PROBLEM STATEMENT

The project management practices implemented by the stakeholders did not provide project management information to the competency with sufficient speed, consistency, or accuracy for satisfactory management decision making. In the context of this report, the term "competency" refers to a department that represents a specific functional area of expertise within NAVAIR. Due to the heavy dependence on manual data input, the competency's current project management system suffers from several significant shortcomings, including *long lead times* to obtain project-specific data, *non-standardized* methods of document generation, and *manual creation* of charts for metrics communication. All of these inefficiencies ultimately result in a lack of confidence in data accuracy.

Discussion with stakeholders made clear that the current process for collecting, processing, and disseminating data remains a manual process because the data sources and databases are in multiple, disparate formats, which are neither readily compatible with each other, nor well integrated. The stakeholder competency's Budget Financial Managers (BFMs) used two independent data repositories, including Navy Enterprise Resource Planning (NERP) and the Command Staffing Tool, to obtain project funding

and competency manning data. NERP is the Department of the Navy (DON) financial system of record, meaning it provides reliable information for Navy leadership to keep moving forward (U.S. Navy 2017). The Command Staffing Tool solicits all planned work and apportions NAVAIR competency personnel to execute program offices' acquisition plans (Department of the Navy, Naval Inspector General 2012). Access to these databases is controlled by Big-IP, which helps validate user credentials in accordance with Department of Defense (DOD) security requirements (F5 Networks 2017).

The competency's BFMs use data from the two aforementioned databases to create spreadsheets for tracking and managing projects' funding details, including projects' account charging numbers known as "chargeable object numbers" (CONs), technical points of contact (TPOCs), as well as the amount and type of funds remaining for each project. When requested by competency leadership, the BFMs also create graphs and charts from these metrics. However, the data presented to competency leadership and decision makers is often outdated and inaccurate, due to infrequent source data refreshes combined with long lead times in the manually intensive process of collecting, processing, and disseminating the data.

An additional problem with the original system derives from the lack of a uniform method to format and present project data. Within the competency, each branch head supervises multiple project managers, each of whom has his or her own methods to track projects' funding, schedule, and status data. Prior to reporting up the chain of command to senior leadership, branch heads are required to reformat, standardize, and recompile the project managers' data. According to the stakeholders, the inefficient processes and rework cost valuable time that otherwise could have been invested in more productive tasks.

B. STAKEHOLDERS

There were several groups within the NAVAIR competency who had a stake in how CAT was designed, including the Budget Financial Managers (BFMs), the Project Managers (PMs), the Branch Heads (BHs), and Senior Leadership (SL). Each group

represented a different management level, with differences in technical expertise, priorities, and level-of-detail involvement.

BFMs perform specific financial-management tasking for all competency projects and support the data needs for the competency. Each project in the competency is assigned a PM who oversees and tracks the technical execution and finances of the project. Correspondingly, BHs manage the work performed by the PMs, and BHs are managed by the competency's SL. The term "SL" is a broad category that includes the division heads who manage the long-term goals of divisions in the competency, as well as competency technical, military, and operations directors. Team CAT decided to combine these multiple types of upper-management within one SL group, since all roles receive similar data from the lower levels of competency management. Chapter II, Section B provides additional details on the definition and roles of each stakeholder group.

C. GOALS AND OBJECTIVES

The goals of this project were to (i) design a project management system to track and manage the cost, schedule, and status of the stakeholder competency's unclassified projects, (ii) develop a system architecture to trace stakeholder needs down to specific system functionality, and (iii) develop a prototype as a proof of concept for the system functionality and user interface. Development of the actual CAT system was not a goal for this project. The focus was solely on designing the unambiguous system engineering artifacts to support the eventual development and deployment of CAT by the competency's software development team.

At the start of the analysis for the system design, the stakeholders emphasized the high-level objectives for the CAT system. After eliciting stakeholder needs, it was determined that the CAT system should be able to:

1. Provide a Navy Marine Corps Intranet (NMCI) compatible, web-based graphical user interface (GUI).
2. Track and report key project schedule items.
3. Track and report project funding levels and expenditure rates.

4. Track and report project status.
5. Track and report projects' personnel usage and allocation.

The CAT-generated reports would include project details such as progress on deliverables and funding status. Ideally, when developed, CAT will create these up-to-date reports on-demand, using the most updated source data. The stakeholder competency also suggested that, once this system has proven successful at the competency level, CAT has the potential to grow, adapt, and expand to serve other NAVAIR competencies and improve the command's overall project management processes.

D. PROJECT SCOPE

When the stakeholders first approached the SE team to develop the CAT system, they provided a detailed list of desired capabilities and functions. However, due to the restricted timeline and resources available to Team CAT, it was important to prioritize the capabilities and establish a scope that was realistically achievable for the project.

Figure 1 illustrates the envisioned scope of how CAT would fit into the stakeholders' current project management processes, the different databases that CAT would obtain data from, as well as the users that would interact with the CAT system. The context diagram in Figure 1 was used to (i) communicate expectations on scope with stakeholders, (ii) document the types of data that will be required to import/export for/ from the system, and (iii) specify the types of interactions stakeholders could expect with the system. It also served as the foundation for all follow-on discussions and SE artifacts that Team CAT created during the system design process.

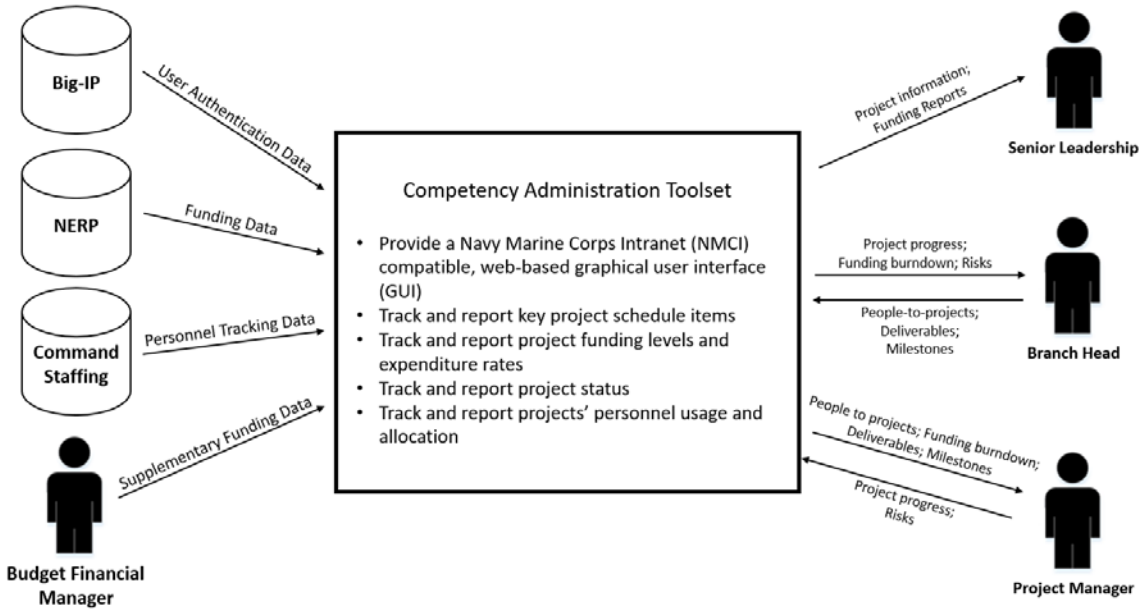

Figure 1. CAT Context Diagram

Through discussion with the stakeholders, it was determined that the scope of this project focused on providing the stakeholders with the following deliverables:

1. List of stakeholders' needs represented as user stories
2. List of operational-level use cases
3. Architectural artifacts to define and establish the system's functional and data flows
4. An interactive, prototype GUI based on stakeholder inputs and human systems integration (HSI) best practices to demonstrate how users can expect to interact with the system. This GUI was meant to be a prototype of the system

The team determined that other tasking, additional iterations, and further system improvements were outside the limited scope of this project. The scope included designing the SE artifacts and an interactive GUI prototype, so that a future software development team could take over the actual development and deployment of the system. It is intended that, once developed and deployed, the use of CAT will enable competency leadership to access the most updated project information, such as project funding levels, project status, or personnel project support levels. CAT will also generate uniformly formatted graphs and visuals, providing a consistent reporting process.

E. ASSUMPTIONS AND CONSTRAINTS

The primary constraint for CAT was the stakeholder's request for a *web-based toolset* as part of the materiel solution. By conducting doctrine, organization, training, materiel, leadership and education, personnel, facilities and policy (DOTMLPF-P) analyses, alternatives other than CAT could have been considered as solutions to the problem; however, the customer insisted on the use of a web-based materiel solution. As a result, Team CAT assumed the request for a material solution to be valid and did not conduct an analysis of alternatives.

As a result of the CAT system having to be web-based and capable of handling for official use only (FOUO) information, the CAT system needed to be compatible with the NMCI network, including all corresponding firewall and cybersecurity requirements. Team CAT created the system design with the assumption that, during future development and deployment of CAT, the competency's software programming team would have the ability to establish all required live connections to external databases and corresponding security measures, as they have done for other projects within the competency. Additionally, Team CAT designed alternate methods of transferring data into CAT, in the event that these live connections were not immediately available. Appendix A provides a more detailed discussion of what Team CAT recommends as a deployment strategy, including what to consider when obtaining live connections to external databases. However, in general, deployment of the system itself was outside the scope of this project.

F. TECHNICAL APPROACH – THE UNIFIED PROCESS

Team CAT designed the CAT system by following the technical approach known as the Unified Process (UP) (Pressman and Maxim 2015, 55). This approach was used so that the team could iteratively deliver SE artifacts and prototype GUIs to stakeholders, elicit detailed feedback, and then immediately use that feedback to improve the artifacts and prototypes. The iterative nature of this process reflects the core philosophy and principles of the UP, which is defined as "use case driven, architecture-centric, iterative and incremental" process (Pressman and Maxim 2015, 53). Using UP, versions of

products are delivered incrementally over time; rather than one final product at the end of the project as seen with the waterfall approach.

Team CAT believed that the most important way for this project to remain valid (i.e., satisfy stakeholder needs) was by frequently including customer communication in the design process. By following the UP, Team CAT successfully included frequent customer inputs regarding the design of the SE artifacts. The following sections provide a brief explanation of the traditional UP, the modified process followed by Team CAT, and how the team created and updated SE artifacts in a specific order related to the modified UP.

1. Traditional Unified Process

As displayed in Figure 2, the traditional UP has "phase" and "activity" components. The overarching phases correspond to the broad goals of the project, while the activities represented in the boxes correspond to specific actions that are performed iteratively throughout the project. The phases and activities are repeated iteratively together; however, the transitions between phases do not directly correlate with the transition of activities.

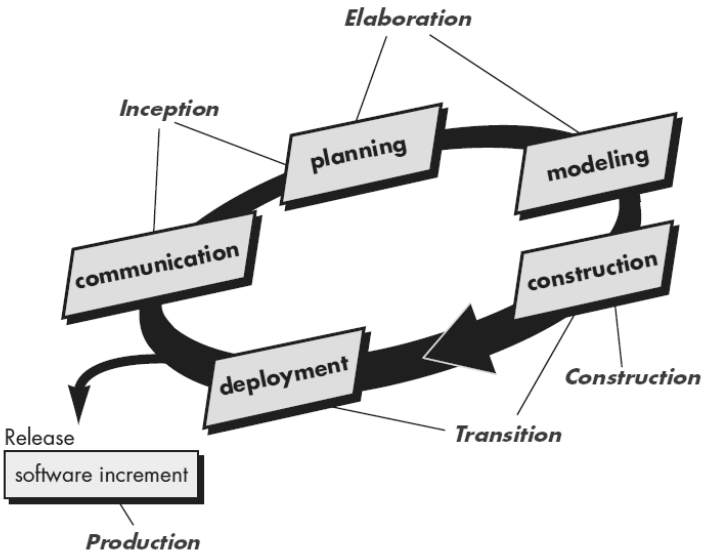

Figure 2. The Unified Process. Source: Pressman and Maxim (2015, 57)

The four overarching phases of the UP include Inception, Elaboration, Construction, and Transition (Pressman and Maxim 2015). The UP also includes a fifth phase, Production, as needed (Ambler 2006). The Inception phase includes the initial communication and planning activities performed for each iteration. The goal of the Inception phase is to identify the scope of work to perform, identify potential architectural representations for the system, and receive initial stakeholder acceptance. The Elaboration phase includes additional communication activities, combined with initial modeling activities. The goal of the Elaboration phase is to develop and verify that the system architecture meets the stakeholder requirements. The Construction phase includes further modeling, construction, and testing activities. The goal of the Construction phase is to build a working product that meets the highest-priority needs of project stakeholders. The Transition phase includes the latter stages of both modeling and construction activities, with the goal of validating the final system for that version. Lastly, the Production phase includes deployment of the system's version into its end-use environment. In some references, the UP includes a combined Production and Transition phase (Ambler 2006).

2. Modified Unified Process

For the design of the CAT, the team placed a greater emphasis on the progression of activities performed within each UP phase, rather than the phases themselves. They performed the communication, planning, modeling, and construction activities in the same order for all iterations of the CAT design project.

- *Communication activities* included working with stakeholders, such as the competency's BFMSs, PMs, BHs, and SL, to define and refine user stories and requirements, as well as to propose and refine the architecture views of the system. These activities also included further elaboration and decomposition of the system's functional requirements. By communicating with the stakeholders often, Team CAT obtained a better understanding of the underlying problem and the stakeholders' requirements. As the primary

customers and future users of the system, these stakeholders held crucial information and opinions from distinct perspectives.

- *Planning activities* built directly upon communication activities. These activities primarily consisted of drafting or refining functional decomposition models and other SE artifacts. Planning activities also included analyzing interfaces between users, analyzing CAT's interfaces to external systems, researching human system integration concerns, and refining the project schedule. As the project matured, the planning activities also included refining the SE artifacts into a set of models that represented the stakeholder-requested architectural views of the system (Pressman and Maxim 2015).
- *Modeling activities* included using the black-box models created in the earlier activities to create white-box system models represented with action diagrams. The action diagrams represented both data and functional flow, thereby replacing traditional data flow and functional flow block models (Da 2013).
- *Construction activities* focused on the development and refinement of the prototype GUI. Team CAT developed the first version of the prototype using hand-drawn wireframe diagrams. Then, based on stakeholder input, the team converted the wireframe diagrams to a Microsoft PowerPoint layout to determine how to arrange elements of the interface. Finally, the team developed a web-based prototype GUI using HTML and PHP scripting languages. By creating the web-based prototype, the team intended to provide more detailed user interaction to elicit more focused user input to the design. In the future, the stakeholder competency's software development team will use the final GUI prototype, combined with the other SE artifacts, to build the actual functioning version of CAT.

Figure 3 illustrates and summarizes the flow of activities followed for both iterations of the CAT design process. Since Team CAT focused on developing the system architecture and the GUI prototype, they did not perform the deployment activity, which is traditionally part of the UP. The grayed-out boxes in Figure 3 illustrate the activities

that the traditional UP usually includes (Figure 2), but that the team did not include for this project.

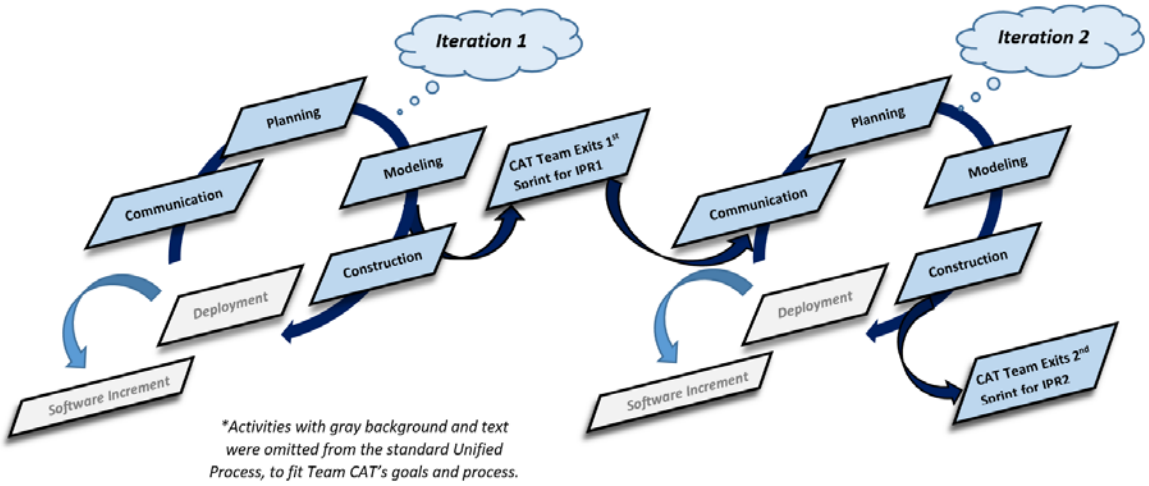

Figure 3. Team CAT's Modified UP

Team CAT focused on performing two iterations of the modified UP for this project. After the completion of each iteration, Team CAT validated the SE artifacts they had developed by holding formal in-process reviews (IPRs) with all project stakeholders. The goals of conducting IPRs were to (i) ensure that the project continued to adhere to all the stakeholders' needs for the system and (ii) elicit new design direction from the stakeholders by presenting the SE artifacts and prototypes. In this way, each IPR also aligned with the project's progression into the next UP iteration.

3. Logical Progression of SE Artifact Development

As Team CAT received input from the users and stakeholders during communication activities, they refined and updated the SE artifacts, leading to the eventual update of the prototype GUI. Figure 4 illustrates the order in which Team CAT created and updated these SE artifacts during both iterations of the modified UP. Occasionally, earlier SE artifacts needed to be updated as concepts became more refined. For example, after exploring constraints set forth by interface requirements, Team CAT modified the use cases so that all artifacts were aligned and fully traceable to each other.

Note that each SE artifact roughly aligns with each of the UP activities performed during the iterative design process.

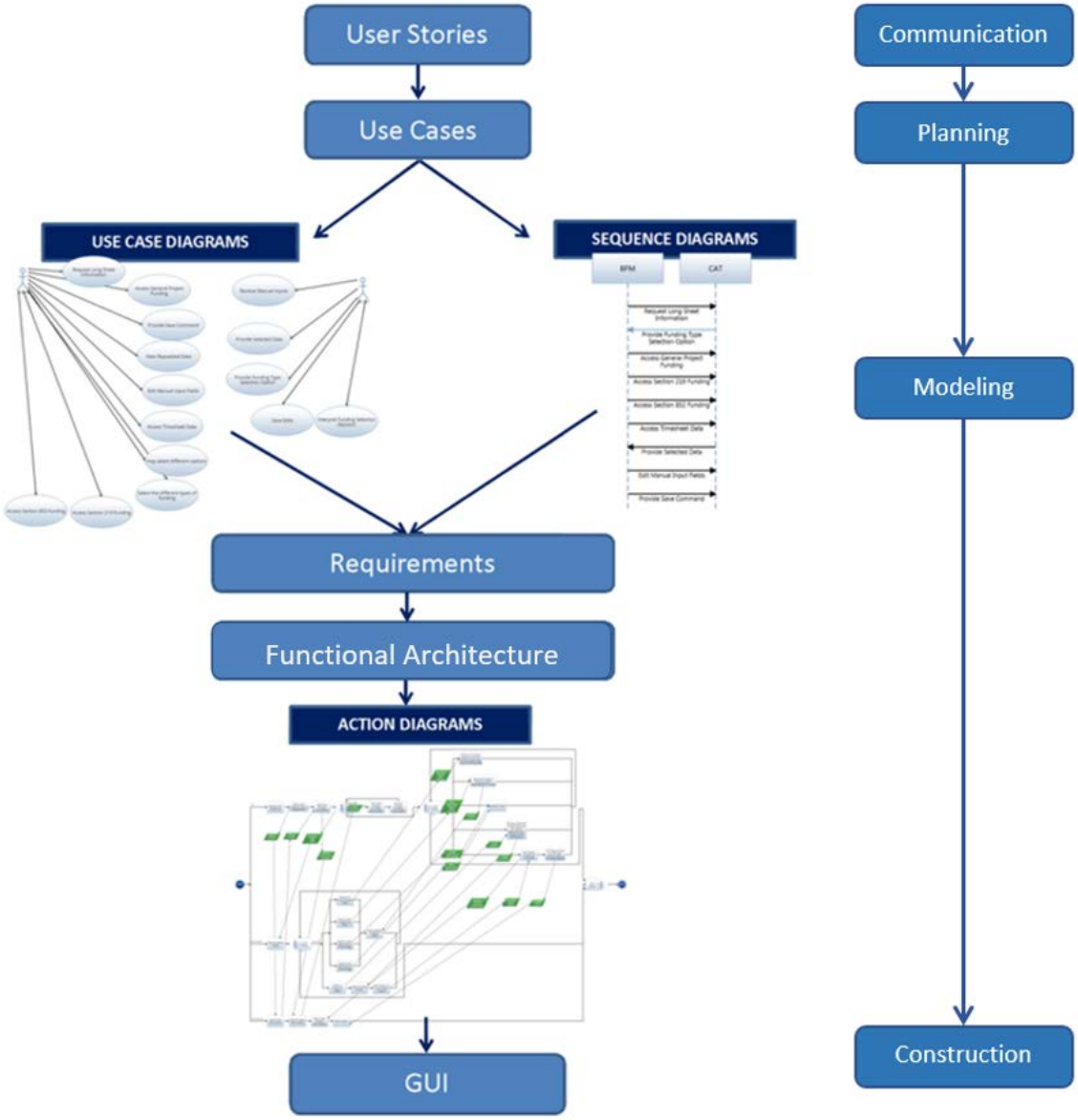

Figure 4. SE Artifacts Created for CAT Design

By applying the UP to the design of the CAT system, Team CAT was able to coordinate continuously with stakeholders to obtain feedback, which resulted in the development of several mature SE artifacts and a prototype GUI that met stakeholder

needs. In the future, the stakeholders' software development team will be able to use the provided SE artifacts and prototype GUI to develop and deploy CAT.

4. Model-Based Systems Engineering Tool to Create SE Artifacts

Team CAT used the model-based systems engineering (MBSE) toolset Innoslate as the central repository for all the SE artifacts created during the design process. Innoslate is a web-based collaborative MBSE toolset developed by Spec Innovations to serve as a project's single source for MBSE analysis. By using Innoslate, Team CAT was able to document the traceability between use cases, user stories, requirements, and functions. Furthermore, in addition to using Innoslate for traceability purposes, Team CAT used Innoslate to create action diagrams to represent functional flow and data transformation through the system. Appendix B contains the detailed Life Cycle Modeling Language (LML) ontology built into Innoslate, which was used by the team for the model's traceability relationships.

G. REPORT ROADMAP

The structure of this report reflects the flow of activities as they occurred during one iteration of the UP. Rather than decomposing the report into two iterations and repetitively describing the activities as they occurred in each separate iteration, each chapter is based on the SE artifacts discussed in Section F.3 of Chapter I.

Chapter II describes the results of the communication and planning activities, including the definition of the problem space, description of stakeholders, definition of user stories, and development of use cases. Chapter III describes the derivation and decomposition of the CAT requirements. Chapter IV describes the functional analysis using architecture views. Chapter V describes the best practices followed by Team CAT for prototype GUI design, as well as the progression of the GUI design. Finally, Chapter VI summarizes the project accomplishments and proposes future growth opportunities.

II. PROBLEM SPACE EXPLORATION

A. BACKGROUND

As discussed in Chapter I, a NAVAIR competency sponsored this project to design a solution to the issues surrounding the current project management process. The competency accepts and completes many small-scale engineering and analysis projects which may vary in length from a couple weeks to several years. The number of personnel assigned to each project can range anywhere from one person per project to multiple cross-domain teams per project.

One of the main problems with the current project management system stems from the fact that each level of management requires different degrees of project details to review. Additionally, each Budget Financial Manager (BFM), Project Manager (PM), Branch Head (BH), and Senior Leadership (SL) has his/her own preferences and priorities that govern the presentation and display of project data. Currently, to work around these issues, each level of management uses valuable time to consolidate and reformat all information received from subordinates. There is no standardized method governing document generation and formatting. Figure 5 illustrates the relative degree of detailed project knowledge and data required by each level of management.

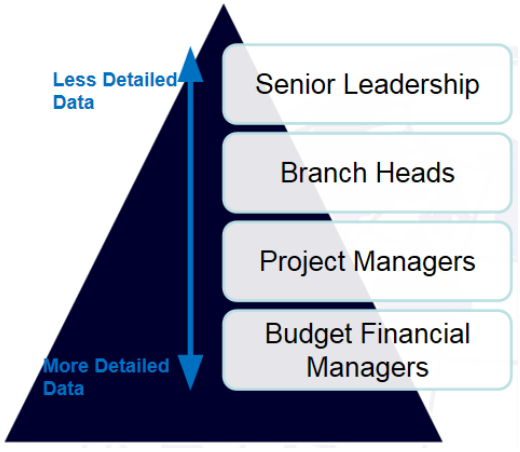

Figure 5. Relative Level-of-Detail Required per Level of Management

1. Current Management Processes in the Competency

The current project management process followed by the NAVAIR competency relies heavily on the data collection, processing, and dissemination tasks performed by the BFM. Figure 6 provides a high-level illustration of how data flows from source databases, through the BFM, to the competency end users.

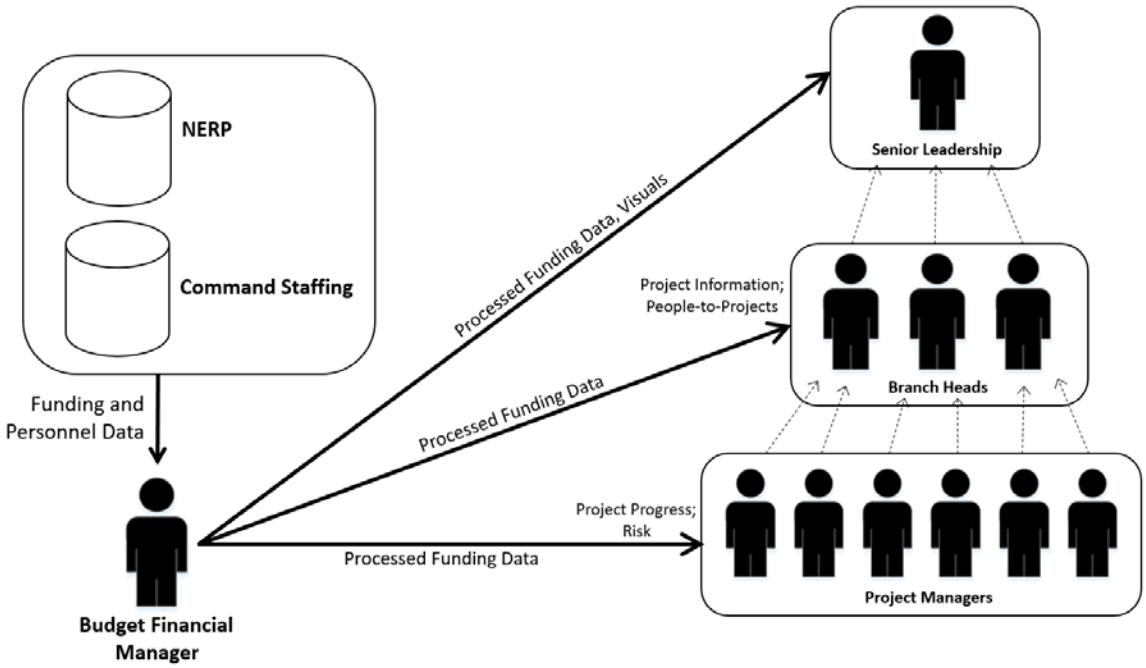

Figure 6. Current Competency Management Process Context Diagram

The following sections describe the processes performed by each stakeholder group, as part of the competency's current project management process. Team CAT obtained this information by conducting informal interviews with the stakeholders. Appendix C includes a list of the type of questions asked of each stakeholder group. The Naval Postgraduate School's (NPS) Institutional Review Board (IRB) reviewed these questions and approved their use.

a. Current BFM Processes

The BFMs begin by downloading, processing, and distributing project financial and personnel data, some of which is individualized to fulfill specific requests made by

PMs, BHs, or SL stakeholders. Downloading the source data involves specifying and retrieving information from several databases, including NERP and Command Staffing. The raw data is downloaded as multiple Microsoft Excel files and reformatted using Visual Basic for Application (VBA) macros. The time required to download and reformat all project data from just one of these databases takes anywhere from two to three hours. Furthermore, due to the inherent structure of the VBA macros and processing limitations on the BFMs' computers, the BFMs are unable to perform any other tasking on their computers during this interval.

Once the BFMs obtain project data from the source databases, they convert the information into Microsoft Excel workbooks. Occasionally, requests necessitate generation of a full report with graphics. For example, SL stakeholders have been known to ask for the breakdown of manning levels within the competency, which are displayed using bar charts. Figure 7 provides an example of what the manning level bar charts typically look like. Additional SL requests can include a breakdown of project sponsors by funding amount, as well as a breakdown of overhead funding levels within the competency. The amount of time required to create the required visuals depends on the amount of detail required by the specific requests from SL.

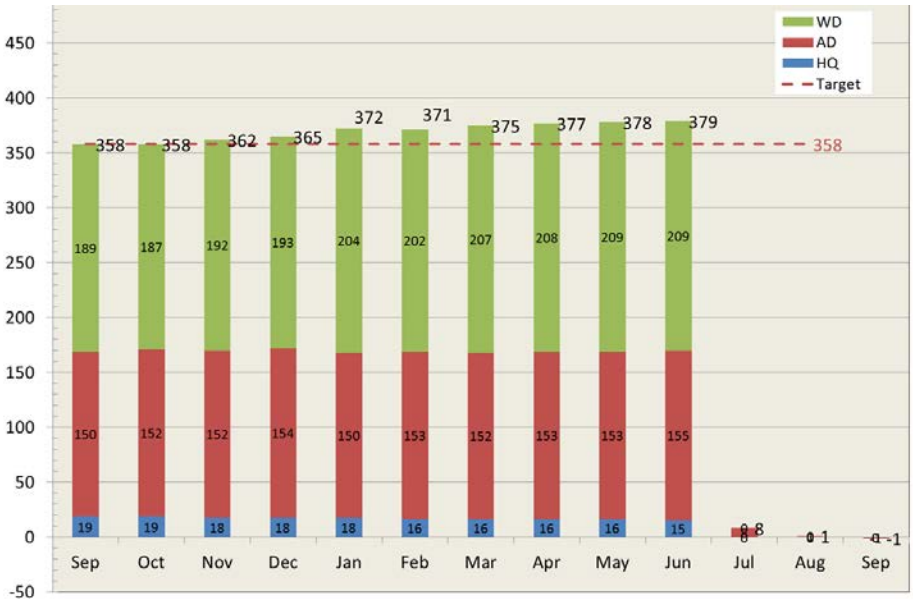

Figure 7. Example of Competency Manning Levels Chart

Regardless of individual data requests, the BFMs routinely develop and distribute a Microsoft Excel Workbook containing all projects' funding details. This is done approximately every two to three weeks and depends upon the BFMs' workload as well as the amount of change that has occurred in the data since the previous distribution. The workbook provides the funding information for every project in the competency. Due to the excessive amount of manual effort required to accomplish the required reformatting, the process can take up to a week. By that time, the information provided to PMs, BHs, or SL may no longer be accurate or useful for decision making purposes. To protect proprietary data, this report does not include specific data from the workbook; however, Appendix D provides an example of an empty funding status sheet, commonly referred to as a "Longsheet."

b. Current Project Manager Processes

PMs require insight into project cost, schedule, and status to oversee projects competently. Within the sponsoring competency, the tracking and management processes vary amongst the PMs. Through interviews with PMs, Team CAT determined that the most common method used to track cost information involves a combination of Microsoft Excel spreadsheet products, Microsoft Project, and the BFM-provided Longsheets.

BHs require status information from PMs on a recurring basis to maintain insight into projects' status. Team CAT determined from stakeholder interviews that each time BHs send out a request for updated project management data, PMs have to specially prepare and refine management data products. Preparation may involve organizing or reorganizing existing data products, creating PowerPoint briefs, or extracting and summarizing points of interest for the project. This process is always manual, causing the PMs to spend more time than desired to keep their BH informed, rather than actively managing their projects and leading project personnel.

c. Current Branch Head Processes

The BH process begins by consolidating all of the project information (typically quad charts) sent by the individual PMs for all the projects in the branch. The BH then performs a review of the data, ensuring that deliverables, milestones, project statuses, and

financial spending meet the branch's goals. The BH also reformats the information from all individual PMs to prepare for forwarding up the chain of command to SL stakeholders. The process of reformatting this data is time consuming and requires the BH to produce data visualization products for SL manually.

In addition, the BH is responsible for managing how to assign personnel to each of the branch's projects, using the People to Project tracker—a spreadsheet tool that maps each employee to the projects that he or she supports. Since all employees within the competency charge their time directly to the project accounts, maintaining this tool eventually translates into direct funding management for the branch.

Even though the current People to Project tracker is the primary tool to communicate personnel allocation to projects in the competency, the tool is limited in its capabilities. For example, there is currently no method to assign personnel to a project for a specified period. As a result, it is difficult for BHs to determine who is over-allocated, or when a person might have better availability in the year for additional tasking. There have been cases of employees' project assignments totaling more than one work year, which results in perceived over-tasking for the year, when in fact, the projects may run simultaneously for only a couple months of the year.

Since many of the BHs are not satisfied with the current capabilities of the People to Project tracker, they will also often have alternate, individual tracking methods, such as using whiteboards, Excel spreadsheets, or just notebooks, to manage project assignments. Despite all of the ways in which BHs try to manage which workers are assigned to which projects, an ideal tool or method that provides all the desired capabilities is not currently available.

d. Current Senior Leadership Processes

As mentioned in Chapter II, Section A.1.c., BHs consolidate PMs' status inputs into summaries for SL, which are usually in Microsoft Word format. Any supporting data visualizations are often custom-made and prepared in either Microsoft PowerPoint or Microsoft Excel format. On a weekly basis, all updates for every project in the competency are sent to SL. As such, the amount of incoming data saturates SL

stakeholders, who do not have any specific method to quickly parse through the updates. To address this problem, SL began to ask each of the BHs to provide quad-charts with project schedule, risk, and funding information once per month. This request levies additional manual work on BHs and PMs.

SL stakeholders are also interested in exploring the number of personnel in the competency by division and branch. Insight into the manning distribution allows SL to make more informed hiring decisions. Additionally, SL require insight into the high-level allocation of personnel to projects. SL currently receive updates on personnel allocation and utilization once or twice per year from the People to Project spreadsheets that BHs maintain.

2. Qualitative Capability Gaps

Each of the current processes discussed in Chapter II, Section A.1 are insufficient for meeting each group of stakeholders' needs. They require manual work and rework at all levels of management. Additionally, due to their lack of integration, the current processes are unable to take advantage of modern data processing and chart-generation capabilities. The qualitative capability gaps between the current processes and a system that can leverage modern technology can be broken down into three distinct problem areas: time delay due to lead times to process data, rework of management products, and inaccuracy in the data products. The following paragraphs described each of these in more detail.

a. Time Delay

The manual nature of the current data entry processes inhibits the efforts to effectively maintain an accurate and current picture of the competency's funds, personnel and schedule status. Although BFMs have integrated the use of macros for data fusion, these macros have proven to be: (i) difficult to implement, because of the steps required to prepare the data to use the macro and (ii) inefficiently coded to the degree that the computer periodically freezes. Since there is no central file location for storing project data within the competency, and there is no integration between the databases outside of the competency, the BFMs must manually download data, process the information, enter

additional data, and send the finished product to recipients. The amount of time required to perform these steps results in data latency, which is a capability gap. The result is that PM, BH, and SL stakeholders do not have access to the most accurate and updated information when making decisions.

In addition to the delays on the BFM side, there is also a time delay on the PM side when they collate project data to provide to BHs on a weekly basis. Another time delay occurs when BHs collate and process the data from the various PMs to provide to SL. These delays add up, making the process increasingly slower.

The final time delay concern relates to the People to Project spreadsheet, which BHs have stated is cumbersome to use when managing personnel on a periodic basis. The reason they continue to use it is that SL stakeholders want to see percentage utilization of personnel. The People to Project spreadsheet allows BHs to do that; however, the steps necessary to populate the tracker and pull the desired information from the tool are time consuming. During Team CAT's interviews, the BHs suggested adding a feature to view time dimensions with respect to personnel assignments to projects.

b. Rework

Since the current process relies heavily on manual data input, it becomes necessary to also manually update the data points and metrics used to monitor competency progress whenever the data changes. The BFMs must frequently refresh the data, since the information of interest, such as changing funding levels of each project in the competency, changes on a recurring basis. The amount of rework this creates deters BFMs from their main task of managing the financial interests of the competency. This process is not an effective use of manpower in NAVAIR's current resource-constrained environment.

BFMs are not the only stakeholders plagued by this rework cycle. Each time BH stakeholders receive input from PMs, they are required to reprocess/rework that data to ensure that SL only receive the most relevant and up-to-date information in the desired format.

c. Inaccurate

In addition to decisions having to be made with delayed data, the inaccuracy of that data is another problem that is present at all levels of management. Not only does the process of manual data entry increase the potential for input errors, but the ad-hoc nature of PM to BH reporting means that there is no common reporting format or standard. As a result, it falls to each BH to collate and reformat the various inputs from his or her PMs, which adds another potential opportunity to introduce errors. All these factors combine to increase the perceived likelihood of delivering inaccurate data.

B. STAKEHOLDER ANALYSIS

Team CAT believed that frequent stakeholder communication was a key factor for designing the CAT system. The following sections describe the assumptions and processes followed by the team to identify specific stakeholders, define the needs of each stakeholder group, and translate those needs into user stories.

1. Stakeholder Identification

As discussed in the previous sections, Team CAT decided to include all levels of management within the competency as stakeholders for this project: BFMs, PMs, BHs, and SL. Each person using, viewing, or interacting with the data in CAT could provide valuable insight into the capabilities that would be necessary for CAT to possess, as well as prioritization of data appearing on CAT's dashboards. These stakeholders are natural users of the CAT because they either have decision making responsibilities and are therefore frequent users of the provided data, or they otherwise have responsibilities that warrant interaction with project metrics.

2. Stakeholder Needs as User Stories

The first SE artifacts developed for this project consisted of the user stories for each type of stakeholder. Each user story describes the specific needs elicited from the stakeholders. As seen in Figure 8, Team CAT grouped the user stories into five categories: funding, general needs, status items, personnel, and schedule items. Each of these categories is discussed in more detail in the following sections.

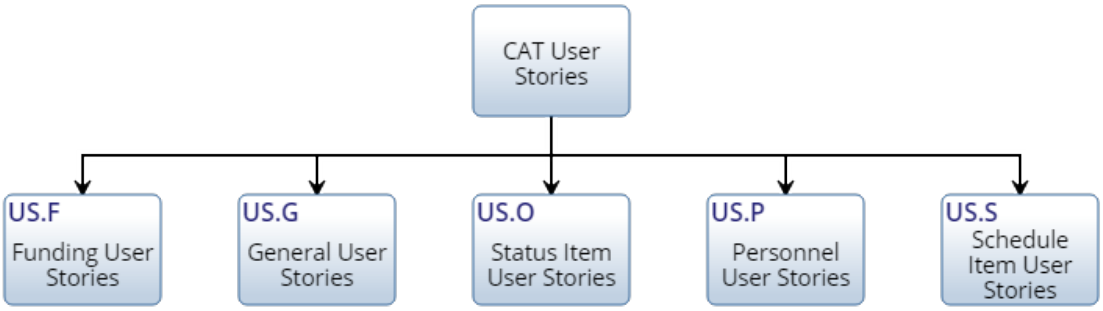

Figure 8. CAT User Stories Categories

a. Funding User Stories

This section provides the list of funding-related user stories. The Funding User Story Hierarchy Diagram (Figure 9) shows the stories associated with managing competency funding. Table 1 provides a description of each user story. For funding management, the stakeholders requested that they be able to view a graph that showed planned versus executed project funding. This would allow stakeholders to determine if a project was over- or under-expending as compared to a planned amount. Furthermore, the BFM stakeholders also expressed the need to be able to edit all the fields in the funding status sheets in CAT. Lastly, the stakeholders expressed that oftentimes they did not know when their projects' funds were expiring since different funds expire at different times. As such, they expressed a need to view when funding was expiring to be able to plan appropriately.

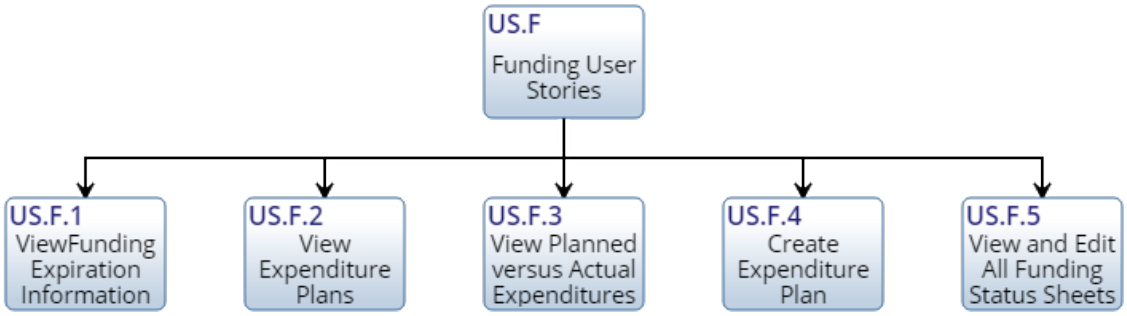

Figure 9. Funding User Stories Hierarchy Diagram

Table 1. Descriptions of Funding User Stories

Name	Number	Description
View Funding Expiration Information	US.F.1	As the PM, BH or SL, I want to view projects' funding expiration dates
View Spend Plans	US.F.2	As the PM, BH or SL, I want to view projects' spend plans
View Planned versus Actual Expenditures	US.F.3	As the PM, BH or SL, I want to view projects' planned versus actual expenditures. I want to know, based off my current project expenditure rate, if I will over- or under-expend.
Create Spend Plan	US.F.4	As the PM, I want to be able to create a spend plan in the system.
View and Edit All Funding Status Sheets	US.F.5	As the BFM, I want to view and edit a web-based copy of the funding status sheets (i.e., "Longsheets").

b. Status Items User Stories

This section provides the list of user stories for entering and viewing project status information. The term "status items," when used in relation to CAT, refers to any general information item that PMs wish to communicate to their BHs. For example, a PM may want to inform the BH that the project team is on schedule to meet a specific deliverable or that the team needs additional personnel resources. The stakeholders also requested that they be able to use the colors red, yellow, or green, to indicate subjectively whether or not a status item was either (i) one that needed immediate attention, (ii) one that the PM and BH should keep an eye on, or (iii) one that was just a general update requiring no additional actions. The Status Item User Stories Hierarchy Diagram (Figure 10) shows the main user stories associated with managing projects' status items. Table 2 provides a description of each user story.

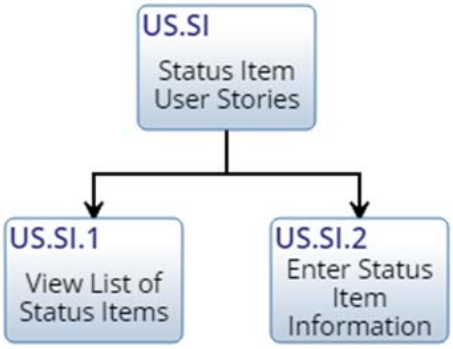

Figure 10. Status Item User Stories Hierarchy Diagram

Table 2. Description of Status Item User Stories

Name	Number	Description
View List of Status Items	US.SI.1	As the PM, BH, or SL, I want to view projects' status items with priority subjectively labelled as red, yellow, or green.
Enter Status Item Information	US.SI.2	As the PM, I want to input project status item information.

c. Personnel User Stories

This section provides the list of user stories for managing personnel within the competency. The BH stakeholders expressed several capabilities they wanted CAT to perform, including (i) the ability to assign personnel to different projects, (ii) the ability to view how each employee will be utilized throughout the year, and (iii) the ability to assign specific projects to project managers.

Additionally, SL stakeholders expressed their own desired capabilities for CAT, including the ability to view how many people are in each competency's divisions and branches, and the ability to view the personnel utilization data managed by BHs. The Personnel User Story Hierarchy Diagram (Figure 11) shows the user stories associated with managing competency personnel. Table 3 provides a description of each user story.

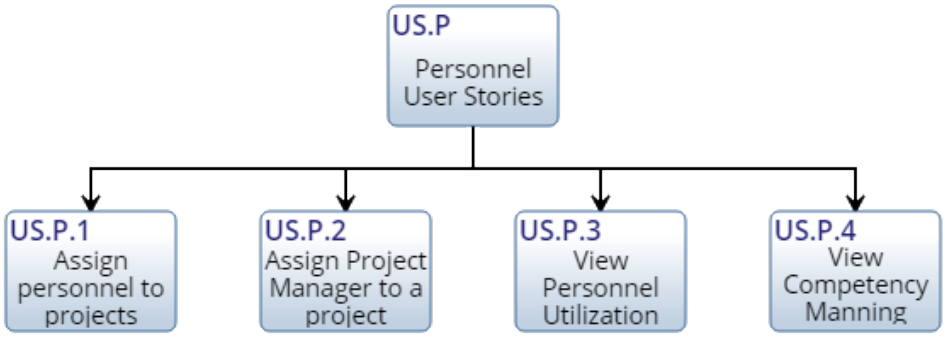

Figure 11. Personnel Management User Story Hierarchy Diagram

Table 3. Descriptions of Personnel Management User Stories

Name	Number	Description
Assign personnel to projects	US.P.1	As the BH, I want to assign personnel to projects.
Assign Project Manager to a project	US.P.2	As the BH, I want to assign project managers to projects.
View Personnel Utilization	US.P.3	As the BH or SL, I want to view personnel utilization for projects over a period of time.
View Competency Manning Levels	US.P.4	As the SL, I want to view the competency's manning levels.

d. Schedule Item User Stories

This section describes and provides the list of user stories related to managing and viewing project schedule items. PM and BH stakeholders expressed the need to specify and track key project milestone dates (such as a preliminary design review (PDR)) or deliverable due dates (such as a project Study Plan). They requested that CAT display this information in both tabular and timeline format.

Additionally, each time a user created a schedule item, stakeholders requested that the item require approval from a BH. They requested for the BH to receive alerts anytime

a schedule item was coming due or if a project manager indicated completion of a particular status item. The Schedule Item User Story Hierarchy Diagram (Figure 12) shows the user stories associated with managing schedule items. Table 4 provides a description of each user story.

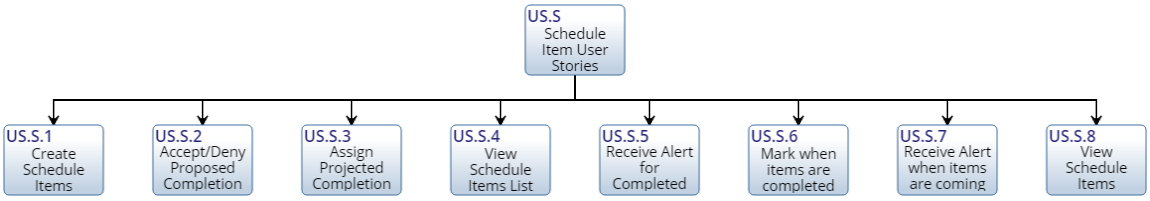

Figure 12. Schedule Item User Story Hierarchy Diagram

Table 4. Descriptions of Schedule Items User Stories

Name	Number	Description
Create Schedule Items	US.S.1	As the PM or BH, I want to be able to create schedule items.
Accept/Deny Proposed Completion Dates	US.S.2	As the BH, I want to be able to accept or deny schedule items' completion dates proposed by the PM.
Assign Projected Completion Dates	US.S.3	As the PM or BH, I want to assign projected completion dates for all schedule items.
View Schedule Items List	US.S.4	As the PM, BH or SL, I want to view projects' schedule items.
Receive Alert for Completed Schedule Items	US.S.5	As the BH, I want to receive alerts when schedule items are marked as complete.
Mark when items are completed	US.S.6	As the PM, I want to mark when schedule items are completed.
Receive Alert when items are coming due	US.S.7	As the BH, I want to receive alerts when schedule items are marked as complete.
View Schedule Items Timeline	US.S.8	As the PM, BH, or SL, I want to see projects' schedule items on a timeline.

e. General User Stories

This section provides the list of miscellaneous user stories that did not fit into any of the aforementioned categories, including general functions available to all users in CAT. The stories include the capability for users to view all projects of interest, as well as to export reports. In the scenario where a user story applied to all users, Team CAT documented the user story as "As the user, I want…" as opposed to incorporating each user type at the start of the story. Figure 13 illustrates the hierarchy for these general user stories, and Table 5 provides a description of each user story.

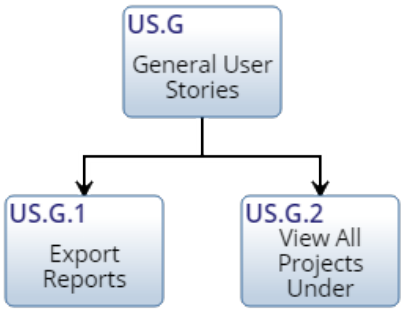

Figure 13. General User Stories Hierarchy Diagram

Table 5. Descriptions of General User Stories

Name	Number	Description
Export Reports	US.G.1	As the user, I want to export reports for all artifacts from the system.
View All Projects Under Purview	US.G.2	As the PM, BH, or SL, I want to see all projects for which I have permission.

C. USE CASE DEVELOPMENT

After eliciting and analyzing the user stories, Team CAT derived use cases to better understand the interactions between the users and the CAT system at the operational level. This included tracing all use cases to user stories. To communicate to each stakeholder how he or she would interact with CAT, the team delivered the use cases in the form of use case diagrams and sequence diagrams. During IPR 1, Team CAT referred to these diagrams directly, which helped to focus the stakeholders' feedback. By confirming or denying the use cases, the stakeholders provided Team CAT with critical design guidance to make the system a valid one.

Additionally, Team CAT leveraged the use cases to generate requirements, maintain traceability, and verify that every requirement traced back to a use case and user story. Section C.2 further discusses the traceability between user stories and use cases, while Chapter III, Section E discusses the traceability between the developed use cases and requirements.

To remain consistent with NAVAIR standards, Team CAT used the Program Executive Office for Unmanned Aviation and Strike Weapons' (PEO(U&W)) standard template for capturing use cases (PEO(U&W) n.d.). Using the template allowed Team CAT to identify (i) the exact purpose of each use case, (ii) the stakeholders that would require permissions within CAT to execute that use case, and (iii) the interactions required between the users and CAT to execute each use case. Figure 14 illustrates the PEO(U&W) template.

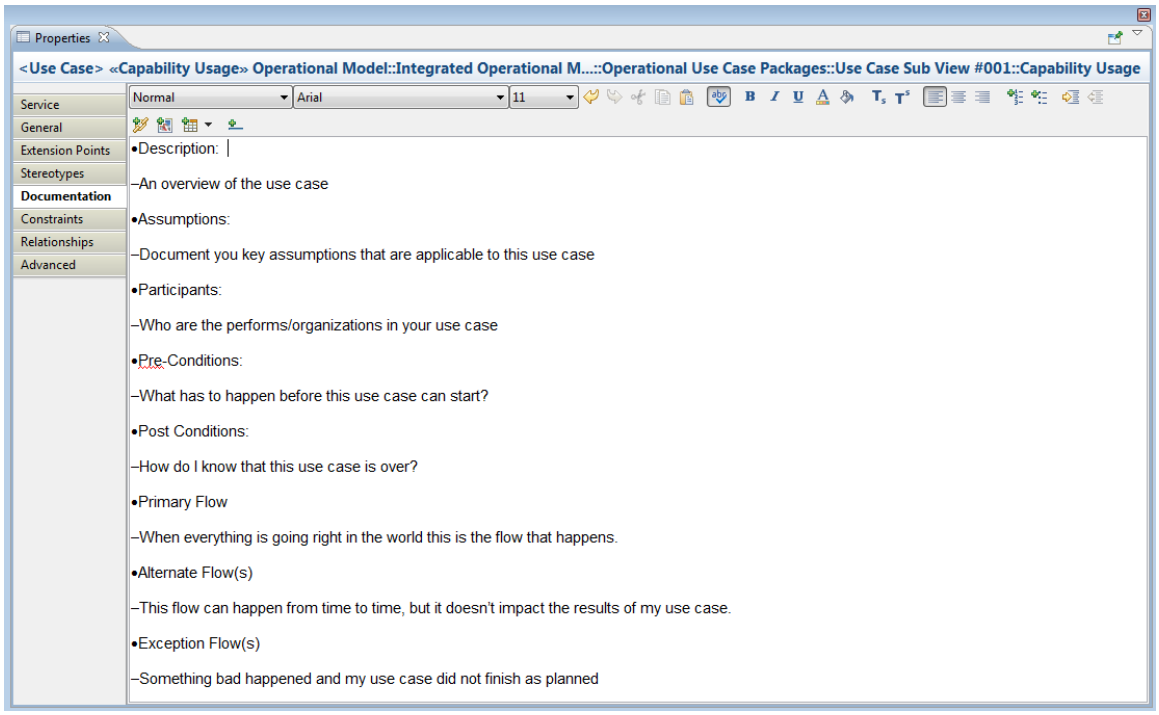

Figure 14. PEO(U&W) Use Case Template

1. Example Use Case

By using the PEO(U&W) use case standard, Team CAT remained consistent with NAVAIR practices, while accentuating the system design process. This emphasis afforded the team the opportunity to better understand the functionality CAT would require to support interactions with external entities such as NERP, Command Staffing, and the users. To identify the interactions, Team CAT converted each of the use cases' activity flows to sequence diagrams, resulting in a graphical representation of each use case. The following page includes an example text-based use case following the PEO(U&W) standard. Appendix E provides the exhaustive set of use cases.

Example Text-Based Use Case

UC.ALL.1 EXPORT REPORTS

User Story:

As the user, I want to export reports for all artifacts from the system.

Description: CAT users request the option to export information for printing or saving. The user needs to be able to choose which information should be included in the exported file by selecting information, such as funding graphs, personnel lists, or funding sheets, from his or her dashboard and selecting the destination for the exported file. Depending on the type of report, the format will either be in Microsoft Excel (.xlsx), Microsoft Word (.docx), or Microsoft PowerPoint (.pptx) formats.

Assumptions: CAT contains the information required for the artifact the user wants.

Participants: All users

Pre-conditions: The user is logged into the system.

Post-conditions: CAT provides the exported artifact to the user in the required format.

Flows:

- Primary Flow:
  - User requests to export a CAT artifact
  - CAT provides options of artifacts that can be exported
  - User selects artifact(s) to export
  - User selects format of artifacts to export
  - CAT requests location to download artifact
  - User provides location
  - CAT provides exported artifact

Team CAT created the use case diagram shown in Figure 15 to capture the use cases in an architecture. Although the diagram appears simple, it formally establishes the relationship between the specific use case and its performer. In this scenario, the "Any User" actor represents the BFM, PM, BH, and SL users.

Figure 15. Use Case Diagram for "Export Reports" Use Case

In addition to modeling use cases with use case diagrams, Team CAT modeled the interactions discussed in each use case using sequence diagrams. By using sequence diagrams, Team CAT was able to explore, derive, and communicate interface requirements with the stakeholders. The sequence diagram in Figure 16 demonstrates the flow progression present in the Example Text-Based Use Case.

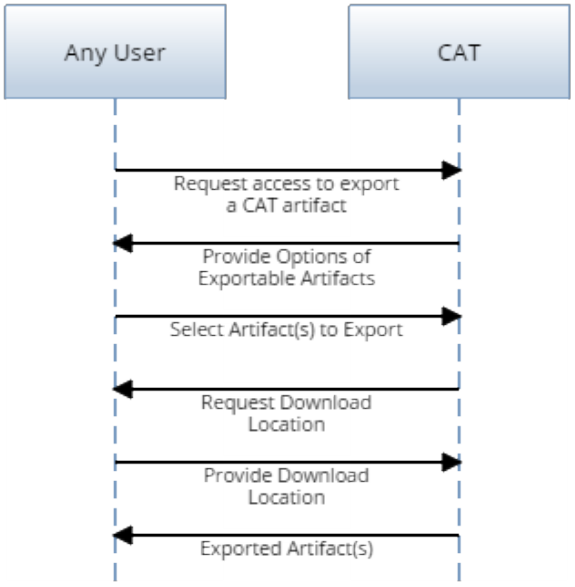

Figure 16. Sequence Diagram for "Export Reports" Use Case

2. Traceability between User Stories and Use Cases

Figure 17 illustrates how Team CAT traced each use case to at least one user story, while Appendix F provides a readable tabular layout of the traceability depicted in Figure 17. By auditing the traceability between user stories and use cases, Team CAT determined that some user stories did not have any use cases, and reversely, some use cases referred to by stakeholders were not represented in the user stories. This led to a refinement of the artifacts through a process of iterative evaluation. This iterative evaluation also enabled Team CAT to determine whether specific use cases and user stories needed to be combined because of similarities or whether the team had identified realistic gaps in the model.

Lastly, Team CAT developed the use case-numbering schema to reflect the primary actors in the given story. Note that some use cases traced to multiple user stories simply because the stories were similar in nature and could be fulfilled by a singular use case.

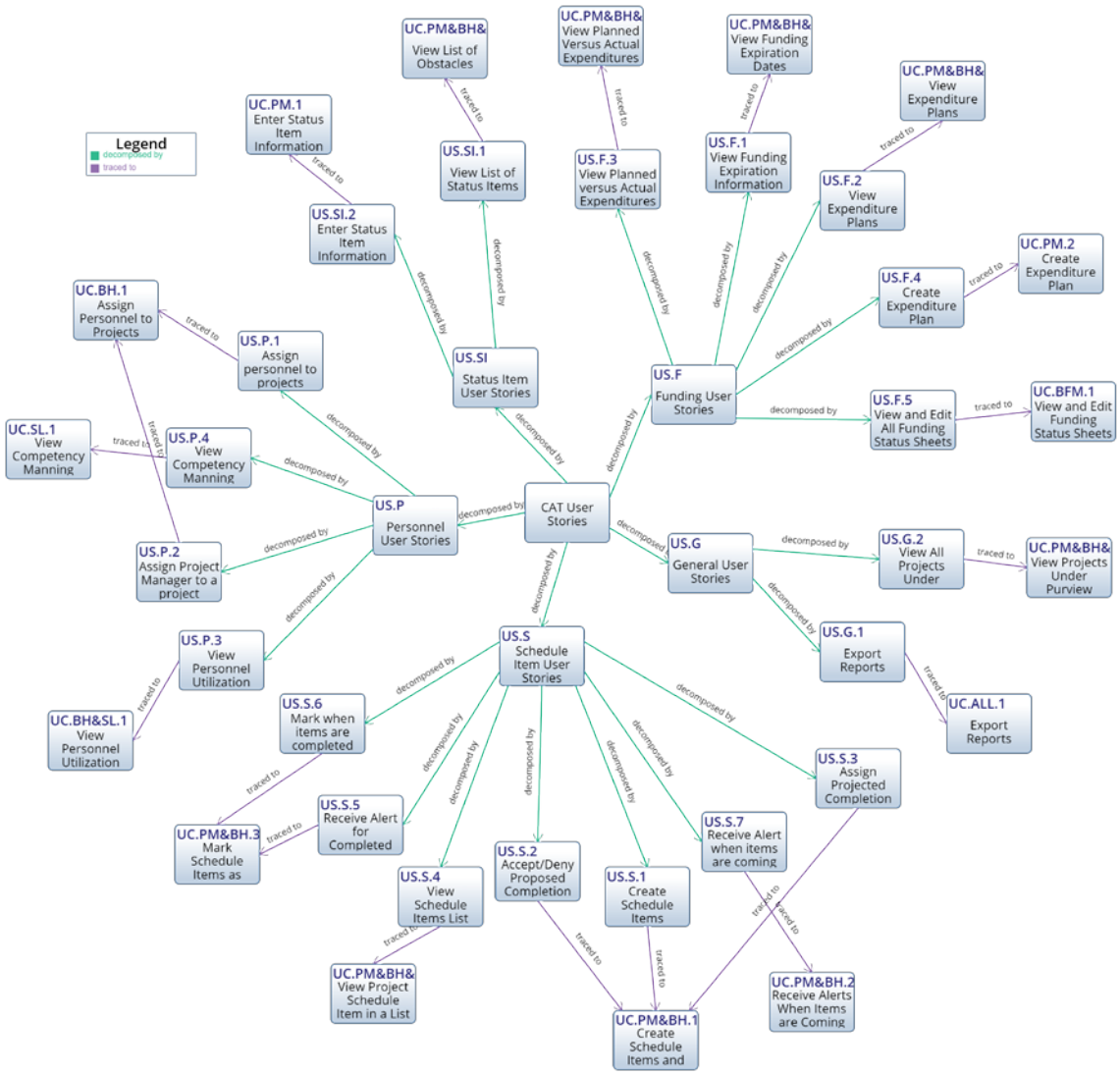

Figure 17. Traceability Between Use Cases and User Stories

D. CHAPTER SUMMARY

Team CAT implemented the UP by first identifying the processes currently being followed by the stakeholder competency. The team noted that each level of management within the competency was interested in reviewing different degrees of project detail, which led to different preferences in formatting and content for reports. From these observations, Team CAT was able to identify three significant qualitative capability gaps: time delay, rework, and higher risk of data inaccuracy. Since it was evident that each competency management role could provide valuable insight into the expected

capabilities of CAT, the team decided to include all levels of management as stakeholders.

The user stories were the first SE artifact developed, with each user story describing the needs of each management role. Team CAT grouped these user stories into five categories: funding, general needs, status items, personnel, and schedule items. From the information provided in the user stories, the team was able to develop use cases to better understand the interactions between the users and the system at an operational level. Use cases included textual elements describing the use case, use case diagrams, and sequence diagrams. From the use cases, Team CAT was able to generate requirements, maintain traceability, and verify that every requirement traced back to a use case and user story.

The team placed emphasis on tracing each use case to at least one user story. By auditing the traceability between user stories and use cases, Team CAT discovered that some user stories did not have use cases. Conversely, some use cases were not represented in the user stories. This led to a refinement of the artifacts through a process of iterative evaluation.

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III. REQUIREMENTS ANALYSIS

Following the documentation of user stories and use cases, Team CAT proceeded to analyze those SE artifacts iteratively, by deriving and decomposing the system requirements. The team used these requirements to establish the conditions the system needed to meet to satisfy stakeholder needs. The requirements analysis process served to formally define system behavior and expectations in a way that was quantifiable, relevant, detailed, and fully traceable to parent artifacts.

Section A of this chapter discusses how affinity diagramming was used to group requirements into logical categories for ease of analysis. Section B discusses how the Easy Approach to Requirements Syntax (EARS) method was used to write testable requirements. Section C provides examples of specific derived requirements used to decompose the top-level requirements into lower-level behavior in greater detail. Section D discusses how the top-level requirements were traced to CAT use cases. Lastly, Section E provides a short summary of the entire requirements analysis phase of the CAT system development process.

A. AFFINITY DIAGRAMMING TO CATEGORIZE REQUIREMENTS

In chapter 6 of the book *The Engineering Design of Systems: Models and Methods* (Buede 2009), the author suggests the use of a requirements organization framework to help define and group requirements. The use of this framework also aids in the decomposition of requirements into functions and facilitates the verification and validation of traceability.

Team CAT started the affinity diagramming process by using the online collaboration tool RealtimeBoard. The team explored the relationships between use cases and user stories and grouped them into top-level hierarchical parent categories with children subgroups. With RealtimeBoard's virtual sticky notes, Team CAT was able to organize the thoughts, ideas, and inputs from each stakeholder group without attributing them to a specific user. This approach resulted in a logical organization schema for requirements, which ensured that every requirement could be traced back to a use case

and user story. The RealtimeBoard affinity diagram for the CAT system is presented in Figure 18, with Appendix G (Figures G-1 to G-7) providing a detailed visual representation of each grouping. The affinity diagram served as the baseline requirements structure in which Team CAT could define the CAT system's specific inputs, outputs, and internal functions.

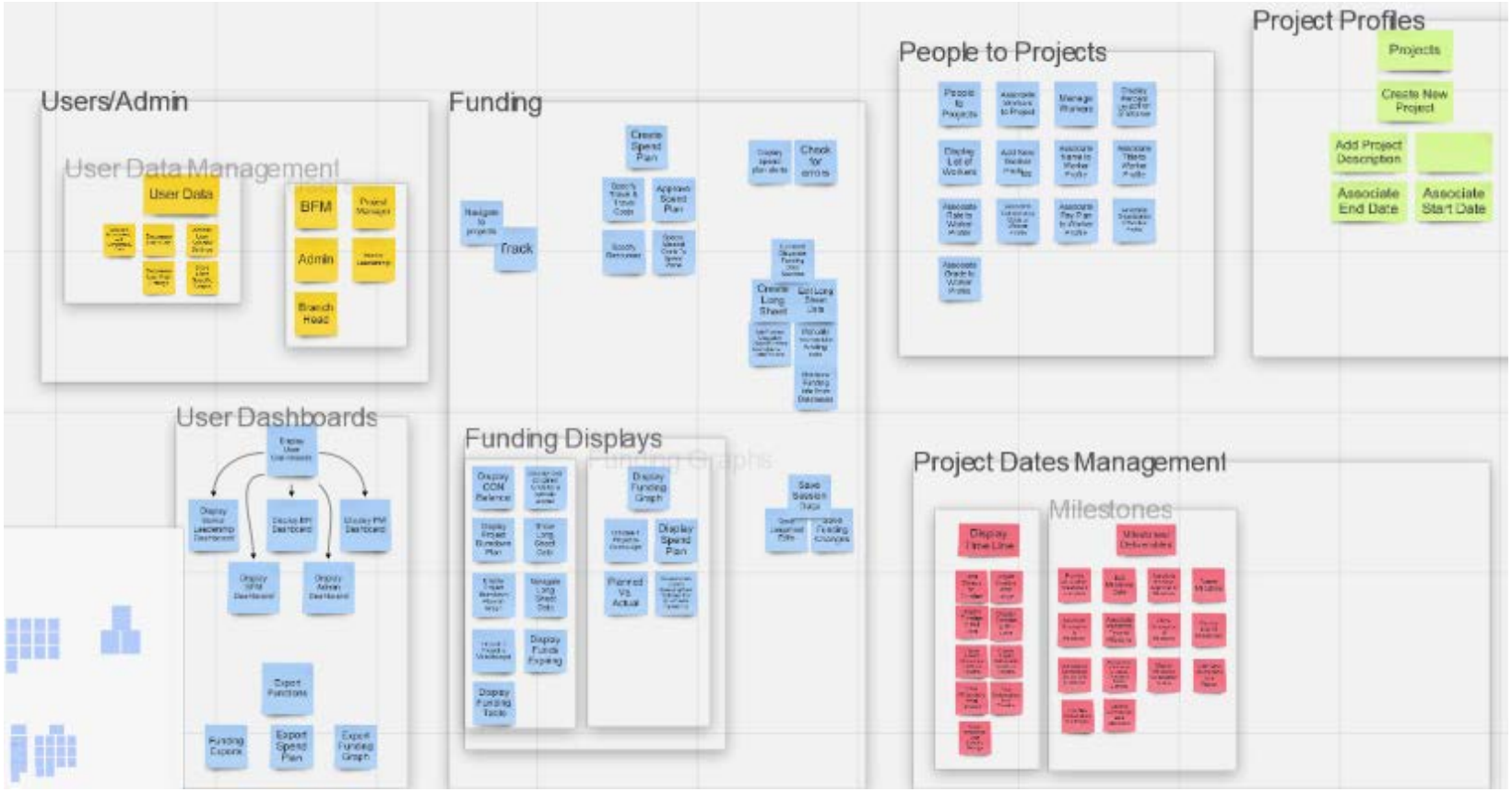

Figure 18. Initial “RealtimeBoard” Affinity Diagram for the CAT System

Using the results of the affinity diagramming exercise, as well as the material from Buede's book, Team CAT categorized the requirements into five main categories:

1. User profile requirements
2. Project schedule item requirements
3. Project funding requirements
4. People to project requirements
5. Project status item reporting requirements

The team then decomposed these five requirement categories further, into the following subcategories:

- System input requirements
- System output requirements
- System functional requirements

Team CAT defined *system input requirements* to include the inputs the CAT system must receive from external entities, *system output requirements* to include the outputs the CAT system must produce, and *system functional requirements* to include the specific functions the CAT system must perform while transforming the inputs into outputs.

One additional category referred to by Buede is "System-wide Requirements." These system-wide requirements typically characterize the CAT system as a whole and are usually non-functional in nature. In chapter 6, section 5.4 of his book, Buede (2009) states:

> System-wide requirements (often called ''-ilities'') are characteristics of the entire system; examples include availability, reliability, maintainability, durability, supportability, safety, trainability, testability, extensibility (growth potential), and affordability (e.g., operating cost)

Team CAT created generic system-wide placeholders for the non-functional requirements category. To stay within project scope, the team decided to decompose only a subset of

these system-wide requirements, specifically those related to compatibility, usability, and security.

To define fully the system functionality, Team CAT decomposed the top-level requirements at the parent categories into derived requirements. Derived requirements are those that may not have been explicitly stated or requested by the stakeholders, but are still necessary to satisfy the intent and expected functionality of the proposed system. They differ from gold-plating or requirements creep in that they are not wants or "nice to haves," but critical to the success of the system meeting the stakeholder needs and required system capabilities.

B. STANDARDIZATION OF REQUIREMENTS

During the requirements documentation process, Team CAT came to the realization that, in order to maintain high quality and constancy, a standardized method of writing requirements was necessary. The standard requirements wording used for physical systems (such as aircraft requirements of distance, fuel capacity, or speed) did not fit the context of a software system, in which each requirement may not have an allocated numerical measure of performance or effectiveness. Before arriving at this realization, the initial set of requirement statements generated by Team CAT were overly verbose, repetitive, and their inherent testability was questionable. To fix these issues, the team decided to use the Easy Approach to Requirements Syntax (EARS) method to communicate unambiguous requirements clearly and consistently. The use of the EARS method is one of the recommended methods of requirements documentation by the SE community, because it consists of "reusable statements and reusable formats" and results in the elimination of "complexity, omission, duplication, implementation and untestability" problems (Mavin et al. 2009).

The EARS method uses six types of requirements to specify a system: ubiquitous, event-driven, unwanted behaviors, state driven, and optional. The most common types of requirements encountered by Team CAT were ubiquitous and event-driven. Ubiquitous requirements have "no preconditions or trigger" and are "always active." The EARS method has a "general form" or "syntax" for each requirement type. The syntax for

ubiquitous requirements is as follows: “The <system name> shall <system response>.” (Mavin et al. 2009, 319). For CAT, this type of requirement takes the form of: “The CAT system shall <system response>.” The remaining syntax used by Mavin et al. are as follows:

- “Generic requirements... <optional preconditions> <optional trigger> the <system name> shall <system response>” which follows “temporal logic” in that it implies the preconditions or trigger must be true before the response occurs” (Mavin et al. 2009, 319).
- “Event-driven requirements... [take the form:] WHEN <optional preconditions> <trigger> the <system name> shall <system response>.”
- “Unwanted behaviours… [take the form:] IF <optional preconditions> <trigger>, THEN the <system name> shall <system response>.”
- “State-driven requirements… [take the form:] WHILE <in a specific state> the <system name> shall <system response>.”
- “Optional features… [take the form:] WHERE <feature is included> the <system name> shall <system response>” (Mavin et al. 2009, 320).

Team CAT used the EARS method to write all requirements, using the corresponding syntax for the type of requirement being defined. While there are few testable parameters events within CAT’s requirements, the EARS format contains an implicit binary style of testing, as the requirements define a condition or behavior that can be falsifiable. When any one of these requirements is tested or demonstrated, it can either be true or false and is therefore testable.

C. CAT SYSTEM REQUIREMENTS

The following sections summarize the requirements categories used as the starting point for deriving the full list of functional requirements found in the Requirements Traceability Matrix (RTM), presented in Appendix H. Figure 19 provides an illustration of the CAT requirements categories. Team CAT traced each of these categories back to use cases, and in turn to user stories, to ensure requirements traceability. Chapter III, Section D provides further discussion on the traceability between requirements and use cases.

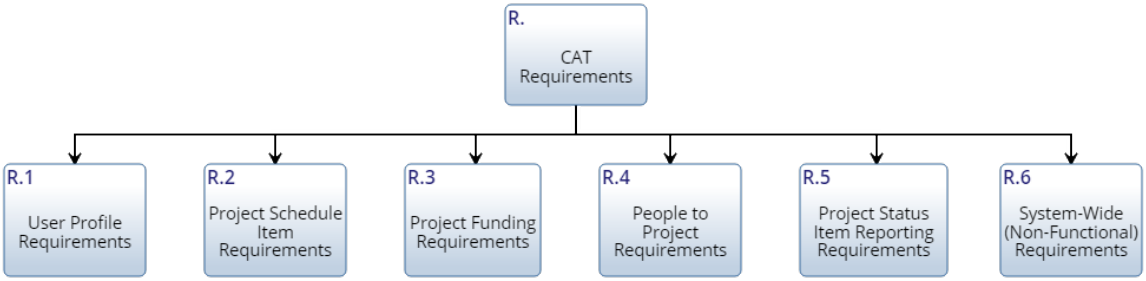

Figure 19. CAT System Design Requirements Categories

While decomposing requirements, Team CAT determined that software systems rely heavily on non-functional requirements that define suitability constraints. Since suitability was considered out of scope for this project, the team did not decompose the non-functional requirements in detail. Chapter III, Section C.6 briefly discusses non-functional requirements and how the few example non-functional, system-wide requirements decompositions can be used as an initial baseline to guide additional non-functional requirements decomposition.

1. User Profile Requirements [R.1]

To meet the specific requests of each stakeholder, Team CAT determined that the CAT system shall be capable of establishing a user profile for each user. Within this profile, the user shall be able to provide inputs to the CAT system, store data specific to the user, and display that data. The user profiles allow the creation of new projects within CAT and serve as the customized interface for each stakeholder.

To satisfy these top-level requirements, Team CAT had to also derive additional requirements. For example, one top-level requirement was for CAT to have the capability to create a new project. The team also derived the requirement for CAT to be capable of accepting the input of a project start date, end date, and project description inputs. Another example includes the requirement for CAT to be capable of storing user data. From this requirement, the team developed the derived requirement of CAT being capable of saving data from user inputs and external databases. All of these derived requirements served to define further the functionality that stakeholders expect from user profiles.

2. Project Schedule Item Requirements [R.2]

The project schedule item requirements resulted from the stakeholders' need to manage project milestone and deliverable dates. These requirements provide the users with the means to monitor and track projects' key deliverables and schedule items.

To satisfy the top-level requirement of managing scheduling items, Team CAT had to derive additional requirements. For example, one of the top-level schedule item requirements related to receiving alerts for upcoming milestones or deliverables. To expand upon this further, Team CAT derived the requirement that CAT must first be able to calculate the time until the deliverable/milestone due date, then display the alert. Another example includes the requirement for CAT to be capable of displaying a project timeline containing schedule items. From this top-level requirement, the team derived the requirements that CAT must also be able to sort and filter schedule items, to display the information in a manner tailored by the user.

3. Project Funding Requirements [R.3]

As a result of the stakeholders expressing the desire to manage project funding execution, CAT had to be capable of meeting specific requirements for displaying funding status. Firstly, the stakeholders requested that CAT be compatible with external funding databases (i.e., NERP) and funding data file formats so that CAT may ingest funding data. Secondly, the stakeholders expressed the desire to be able to create and manage spend plans for specific projects. The capability to display actual expenditures and projected funding information would allow all stakeholders to monitor project expenditures in a single system.

To satisfy these funding requirements, Team CAT had to derive additional requirements. For example, in order for CAT to be able to display a planned versus actual expenditure chart for a specific project, the team determined that the system must be able to calculate current expenditures, allow for creating spend plans with planned spending, pull data from a spend plan, and also calculate the amount of over/under spending.

The stakeholders also requested the capability to view when a project's funding expired. To derive the requirements for this functionality, Team CAT had to create

sample expenditure calculation spreadsheets. This helped determine how to calculate funding burndown and illustrate funding expiration to users. Chapter IV, Section B provides further discussion of this process, and Appendix J provides the screenshots of the spreadsheets with example calculations.

4. People to Project Requirements [R.4]

By developing the user stories and use cases, Team CAT was able to identify requirements related to managing the personnel supporting each competency project. Stakeholders requested that CAT have the capability to allow users to view and manage the number of personnel assigned to a specific project. They also desired the capability to determine each employee's availability for project assignment. These people-to-project features would provide stakeholders with a better awareness of personnel utilization.

To satisfy these personnel management requirements, Team CAT had to derive further requirements. For example, for the requirement that CAT be able to display which personnel are available for tasking, Team CAT derived the requirement that CAT must first be able to calculate the percentage allocation/utilization of personnel on projects.

5. Project Status Item Reporting Requirements [R.5]

CAT must also be able to provide a means for Project Managers to communicate project status items to Branch Heads and Senior Leadership. This would include project risks, updates, or simple binary status changes such as "project funding not yet received." to "project funding now received." The intent of CAT meeting project status reporting requirements is to have functionality that will allow leadership to be aware of notable items for a project and to react early to resolve potential chokepoints within the project management process.

To elaborate on status item reporting requirements, Team CAT further decomposed the top-level requirements. For example, for the requirement that CAT must be able to alert Branch Heads on new status items, Team CAT developed the derived requirement that CAT accept a specific user input that actually creates the status item,

using the CAT interface. Additionally, it was determined that CAT must accept textual input from the Project Manager to explain each status item to the Branch Head.

6. System-Wide (Non-functional) Requirements [R.6]

During initial interviews with stakeholders, each stakeholder group expressed the desire for the system to be compatible with the current infrastructure, intuitive to use, and able to protect sensitive information. Team CAT considered these non-functional requirements to be beyond the scope of this project; however, the team has documented the stakeholders' desires for the CAT system to be usable, reliable, maintainable, sustainable, and affordable. Documenting the desires of the stakeholder groups for elaboration on the non-functional requirements ensures that future development teams can further explore those areas. Team CAT minimally addressed compatibility and security as part of the initial baseline; however, the stakeholder competency should explore the remaining system-wide requirements during follow-on work. Chapter VI contains further discussion on potential areas for future work. Figure 20 illustrates the set of non-functional requirements that serve as a starting point for further exploration of non-functional requirements.

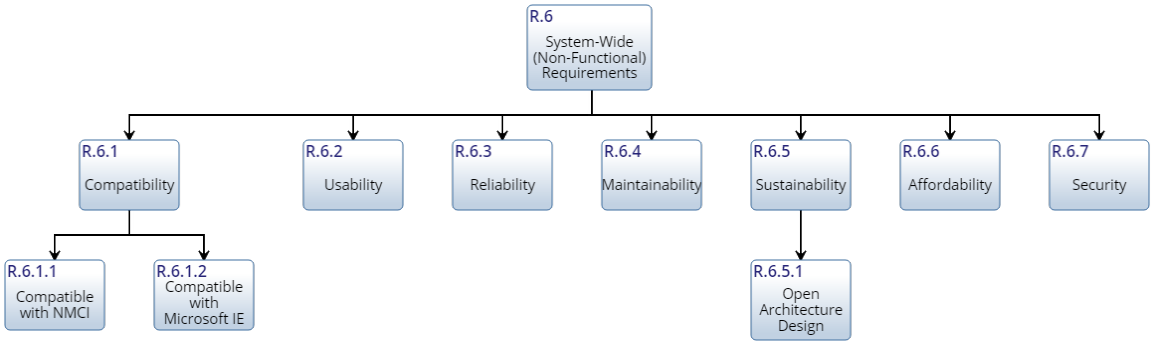

Figure 20. System-Wide Non-functional Requirements Hierarchy

D. TRACEABILITY TO USE CASES

Team CAT documented the traceability of top-level requirements to the use cases presented in Chapter II. The traceability ensures that each requirement has a purpose (i.e., fulfills a specific use case) and that no superfluous requirements exist (i.e., requirements not traced to use cases).

Figure 21 illustrates how the top-level requirements trace to at least one of the sixteen use cases captured for this project. Note that the system-wide non-functional requirements do not trace to use cases, since they (i) are included as placeholders for follow-on work and (ii) are non-functional requirements, which may not necessarily trace to any functions that would support a given use case. Table 6 lists the use-cases to requirements traceability illustrated in Figure 21.

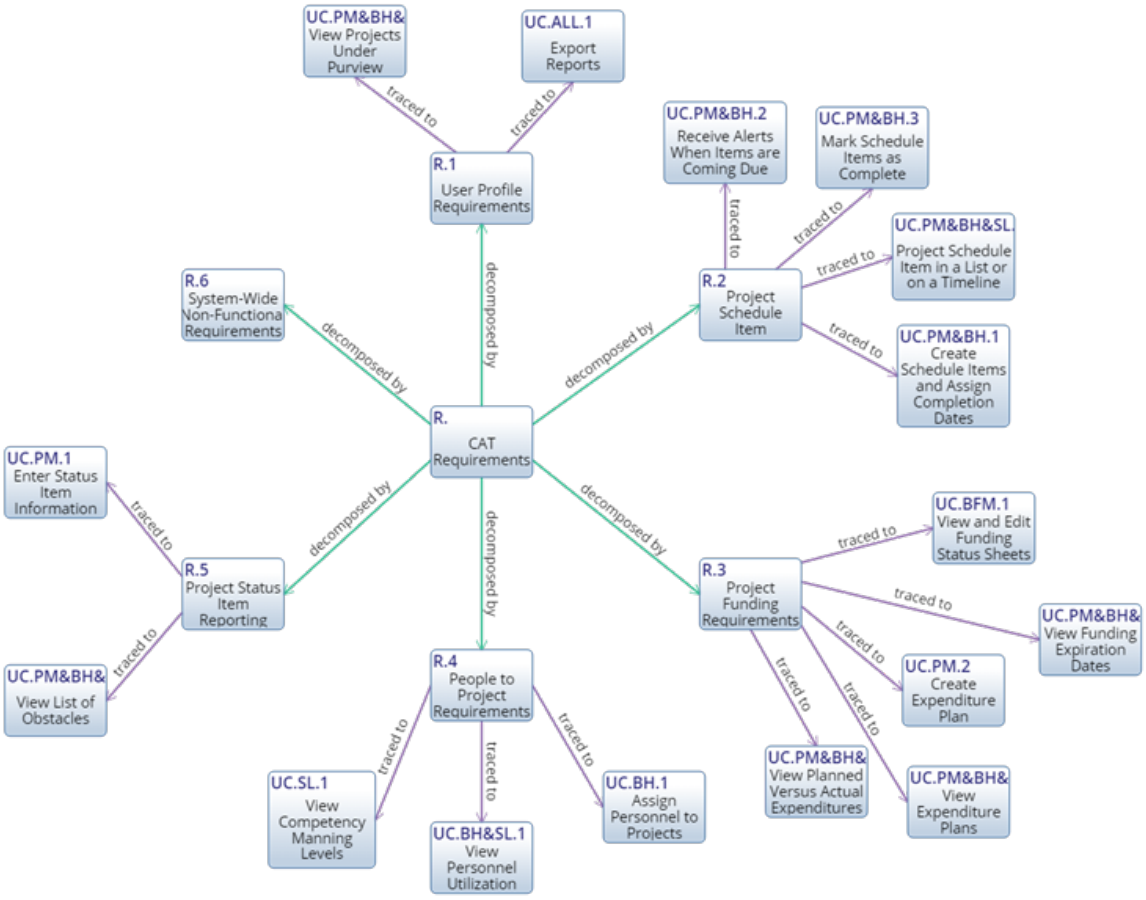

Figure 21. CAT Requirements Traced to User Stories

Table 6. Requirements to Use Case Traceability and Detailed Description

Requirement Number	Requirement Name	Use Case Number	Use Case Name
R.1	User Profile Requirements	UC.ALL.1	Export Reports
		UC.PM&BH&SL.2	View Projects Under Purview
R.2	Project Schedule Item Requirements	UC.PM&BH&SL.1	Project Schedule Items in a List or on a Timeline
		UC.PM&BH.1	Create Schedule Items and Assign Completion Dates
		UC.PM&BH.2	Receive Alerts When Items are Coming Due
		UC.PM&BH.3	Mark Schedule Items as Complete
R.3	Project Funding Requirements	UC.BFM.1	View and Edit Funding Status Sheets
		UC.PM&BH&SL.4	View Spend Plans
		UC.PM&BH&SL.5	View Funding Expiration Dates
		UC.PM&BH&SL.6	View Planned Versus Actual Spending
		UC.PM.2	Create Spend Plan
R.4	People to Project Requirements	UC.BH&SL.1	View Personnel Utilization
		UC.BH.1	Assign Personnel to Projects
		UC.SL.1	View Competency Manning Levels
R.5	Project Status Item Reporting Requirements	UC.PM&BH&SL.3	View List of Status Items
		UC.PM.1	Enter Status Item Information

E. CHAPTER SUMMARY

Team CAT was able to define and organize the CAT requirements effectively, based on the user stories and use cases presented in Chapter II. The team used RealtimeBoard to execute affinity diagramming methods, which enabled the team to define the relationships between use cases and user stories, group them accordingly, and begin categorizing requirements. This resulted in five categories of requirements: user profile requirements, project schedule item requirements, project funding requirements, people to project requirements, and project status item reporting requirements. Additionally, the team decomposed each of the five main categories into three

subcategories: system input requirements, system output requirements, and system functional requirements.

Although Team CAT considered and developed several non-functional requirements, including compatibility, usability, and security, the team did not further decompose these requirements, due to limited project scope. The team also determined that CAT required several derived requirements to satisfy specific top-level requirements. These included mostly software-specific system requirements, such as the capability to accept inputs or the capability to calculate percentages.

To clearly and consistently communicate unambiguous requirements, Team CAT used the EARS method to write all requirements with the corresponding syntax. The use of EARS, which contains an implicit binary style of testing of “true” or “false,” ensured each requirement was testable. Lastly, the team documented the traceability of top-level requirements to the originating use cases, which ensured limitation of unnecessary, excessive requirements.

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IV. FUNCTIONAL ARCHITECTURE DEVELOPMENT AND ANALYSIS

After Team CAT established the system requirements, they were able to develop the high-level functional architecture for the system, tracing every function to at least one requirement. This ensured the architecture fulfilled each of the functional requirements in terms of both function and data flow. The team created a functional decomposition first to allow hierarchical organization of the system functions. This also permitted the team to define all the functions needed to fulfill each requirement. Team CAT then arranged the functions from the decomposition into action diagrams to model both the data flow and functional flow through the system.

Section A of this chapter contains the functional decomposition with example action diagrams. Section B describes informal modeling of personnel allocation and funding calculations that Team CAT used to verify the identification of a complete set of requirements and functions. Lastly, Section C contains a description of the requirements traceability matrix (RTM), which the team used to verify that every functional requirement was traced to at least one function, and vice versa.

A. FUNCTIONAL DECOMPOSITION AND FUNCTIONAL FLOW/DATA TRANSFORMATION MODELS

This section presents the high-level functional decomposition and action diagrams for CAT, while Appendix I contains the fully detailed functional decomposition and action diagrams. Team CAT used the requirements derived in Chapter III as the foundation for conducting the functional decomposition, to trace each system function to at least one requirement. The purpose was to decompose the functionality of CAT into its constituent parts, then further decompose each sub-function into progressively more detailed sub-functions. Further functional architecture development in the form of action diagrams supports each level of functional decomposition. The action diagrams provide a functional model to define and communicate the data flow between functions, and to elaborate the interaction between assets and resources (Steiner 2016, 23). The action

diagrams for the first two levels of the functional decomposition hierarchy are included in this chapter, while Appendix I contains additional, more detailed action diagrams.

The highest level function of the functional decomposition, function F.0, captures the overarching project mission. It encompasses the performance of all subfunctions required for the operation of CAT. Figure 22 shows function F.0 and its first-level decomposition into four broad sub-functions. The first function, F.1, is *"perform sign-on functions."* This function supports the requirements that specify a user must be able to use his or her credentials to gain access to the system.

Once CAT recognizes and grants access to a user, the system invokes function F.2 to match the user to his or her profile. This function also provides the custom competency management tools that encompass the core functionality of CAT. Upon completion of the user's competency management tasks, function F.3 provides session termination, and function F.4 provides data storage and retrieval.

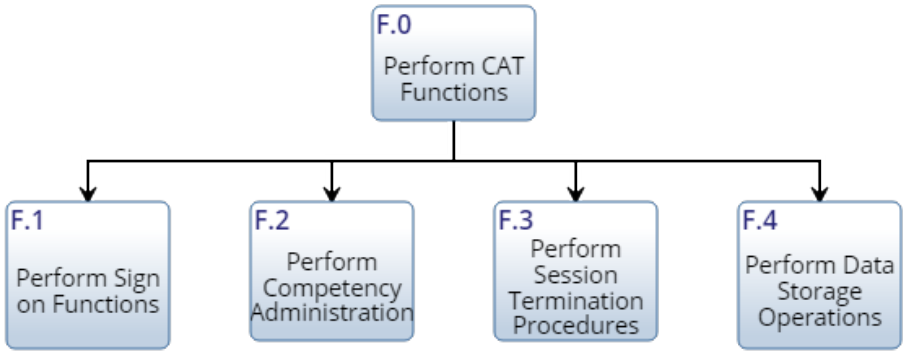

Figure 22. First-Level F.0 Functional Decomposition

The F.0 action diagram shown in Figure 23 illustrates the interplay of data transfer between the CAT functions as the user progresses through a CAT session. The first three functions are linear: the user logs-in, uses the system, and logs-out. The fourth function, F.4, includes data storage relating to functions F.2 and F.3. The *"perform data storage"* function accounts for retrieval of the user profile and for modifications to the individual users' dashboard information. As such, the *"perform competency*

administration" and *"perform session termination"* functions utilize and rely directly on the data storage function.

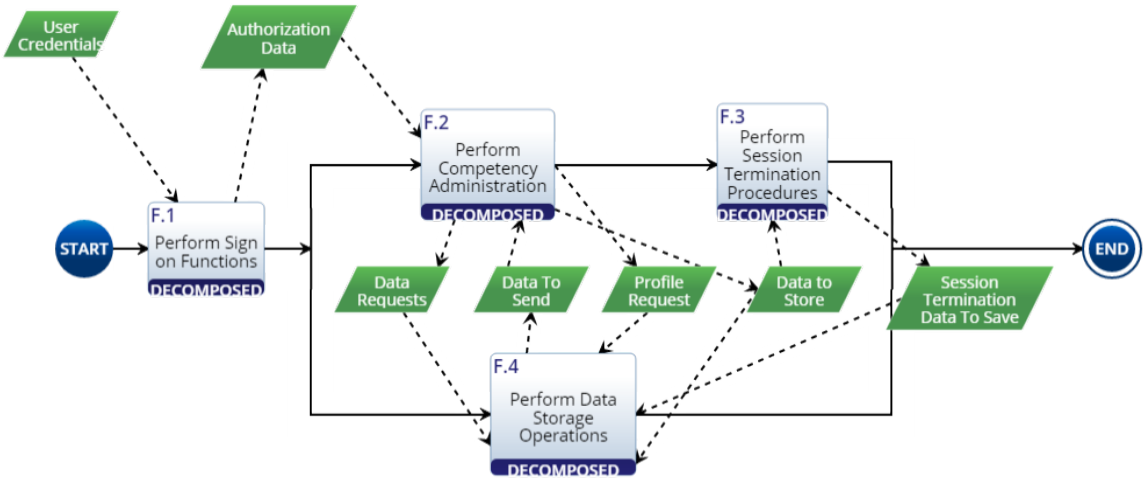

Figure 23. F.0 Action Diagram

1. Perform Sign-On Functions [F.1]

Function F.1, shown in Figure 24, consists of four sub-functions. The purpose of this particular parent function is to provide the user access to the human-computer interface (i.e., to allow the user to log-in [function F.1.1]). The user initiates log-in by inserting the DOD common access card (CAC) into the computer. CAT requests the user's CAC credentials in the form of electronic certificates. CAT transmits the user's credentials to the BIG-IP automated data controller platform for verification and authentication. Once the log-in and authentication processes are complete, CAT grants the user access to the system. Figure 25 provides the action diagram with the data flow that models the user log-in process.

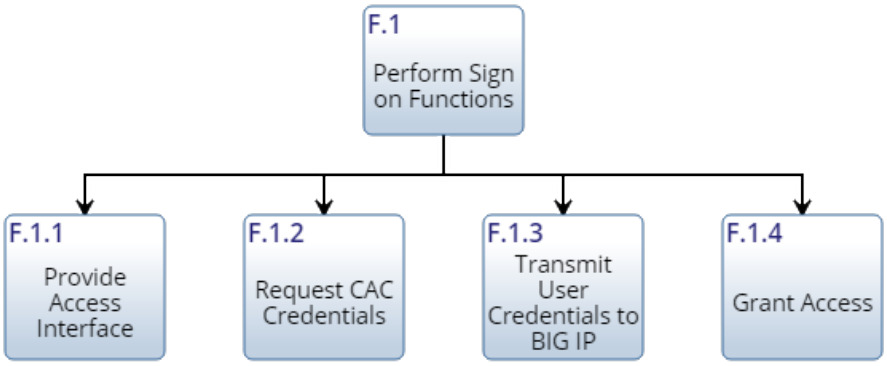

Figure 24. Functional Decomposition of F.1

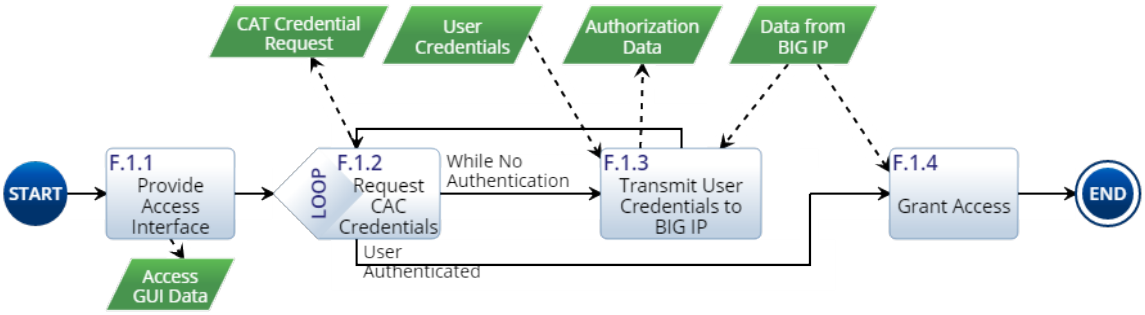

Figure 25. F.1 Action Diagram

2. Performance Competency Administration [F.2]

Five sub-functions decompose the F.2 function, "Perform Competency Administration" (Figure 26). As CAT grants the user system access in function F.1.4, the CAT system uses BIG-IP's user authentication and the user's CAC credentials to access and load user specific data from the CAT database. The system retrieves the individualized user profile and the accompanying CAT settings that the data storage function (F.4) links to the user's credentials. This user profile specifies the appropriate GUI function from F.2.3, which can include either the BFM, PM, BH, or SL dashboards. The user can then access the required project monitoring functions via the GUI display. The main project monitoring functions include people-to-project tracking, schedule tracking, funding tracking, and obstacle management.

The last two F.2 sub-functions relate to user options within CAT. Function F.2.4 allows for creating a new profile or editing an existing profile's preference settings. Function F.2.5 allows the user to save and export CAT data in one of four formats: Microsoft PowerPoint (*.pptx) file, Excel (*.xlsx) file, CAT (*.cat) file (useful for sending to another user or archiving data) or exporting to a printer. Figure 27 shows the action diagram with user requests and data flow amongst the sub-functions.

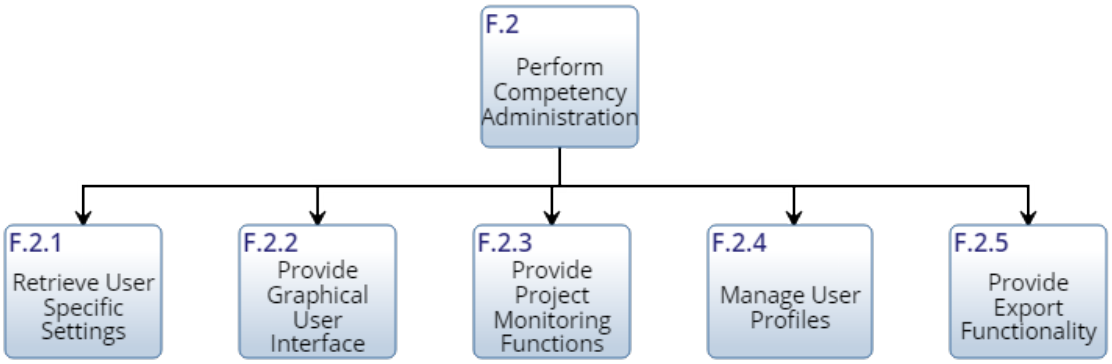

Figure 26. Functional Decomposition of F.2

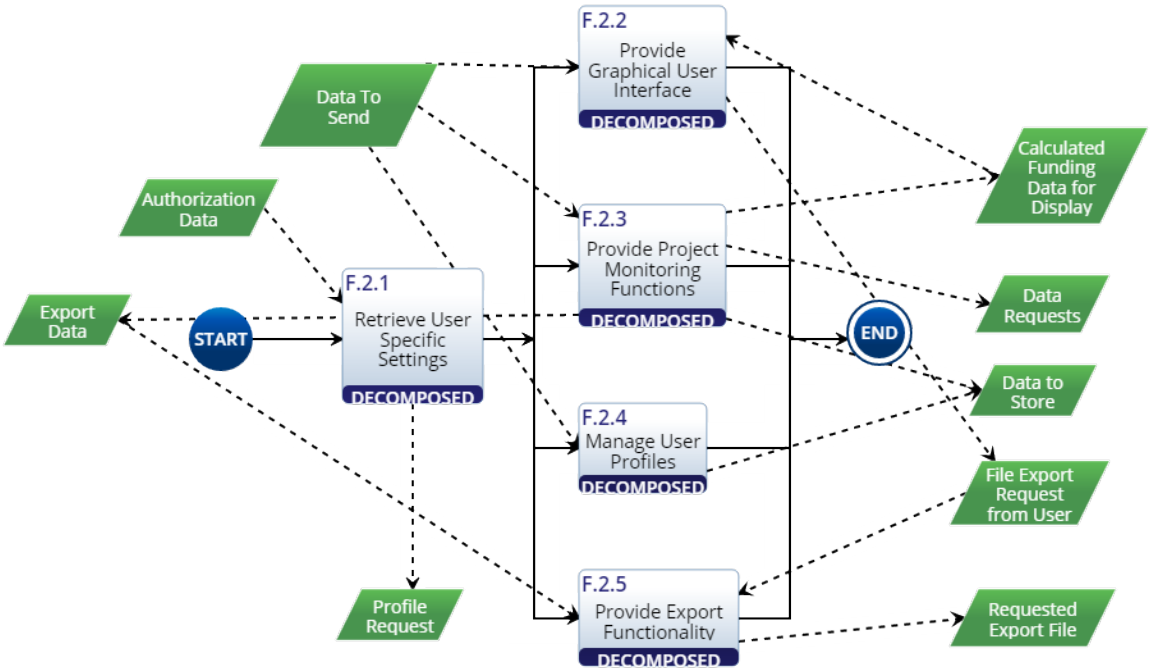

Figure 27. F.2 Action Diagram

3. Perform Session Termination [F.3]

F.3 encompasses the functions to terminate a user session and to log-out of CAT. Figure 28 displays the F.3 functional decomposition. The first two sub-functions include the two options to accomplish session termination: user-initiated exit or session time-out. In a user-initiated exit, the user would make the deliberate decision to end the CAT session and take the steps to log-out of the system. If CAT determines that the user made changes since the last save, CAT sends a save prompt (function F.3.5) and saves user data (function F.3.6). In session time-out, CAT initiates closure of the user session after a period of inactivity and automatically saves use data (function F.3.6). CAT logs the user off, thereby terminating the session (function F.3.7). The action diagram in Figure 29 shows the data flow and logic of each sub-function's contribution to user session termination.

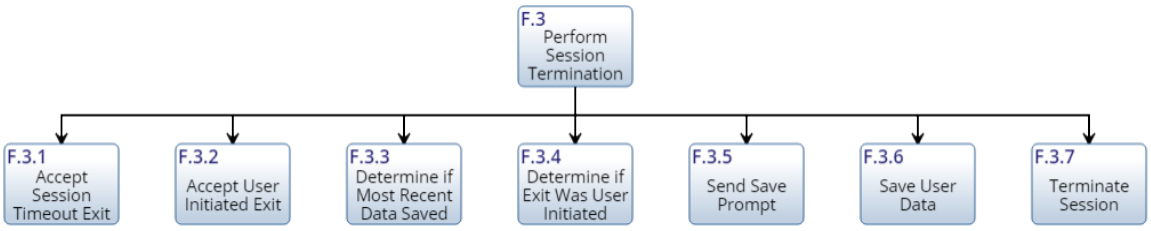

Figure 28. Functional Decomposition of F.3

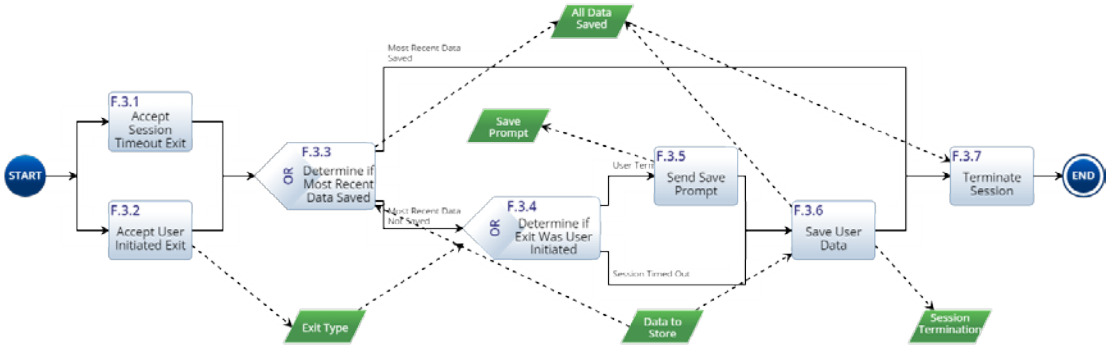

Figure 29. F.3 Action Diagram

4. Perform Data Storage Operations [F.4]

The F.4 “Perform Data Storage Operations” function, illustrated in Figure 30, consists of six sub-functions. During use of the system, users need CAT to accept data storage requests (function F.4.1), including compiled spend plans, people to project associations, and new project creations. CAT must be able to store the information that the users create and edit and make it available for subsequent sessions. CAT must accept the data storage request and perform function F.4.2, Store Data, to ensure this is the case. At future log-ins, CAT accepts data requests (function F.4.3), retrieves the stored data (function F.4.5) from CAT memory, and retrieves and saves information from the interfaced ERP database. CAT then sends the data (function F.4.4) to the GUI in a useable format. Function F.4.5 is also responsible for retrieving user profile data and user-specific dashboard when a user initiates a session. Finally, CAT provides file upload functionality (function F.4.6) to import information into CAT from outside, un-interfaced sources, as needed. This functionality exists as a temporary solution, in the event that live

connections cannot be immediately setup with the external databases. Figure 31 illustrates the data and functional flow.

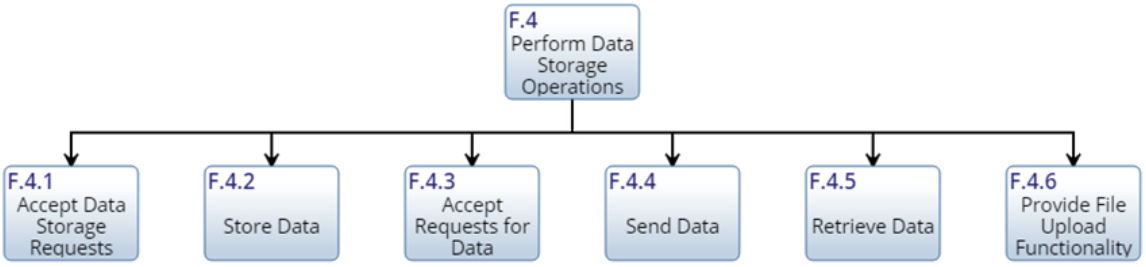

Figure 30. Functional Decomposition of F.4

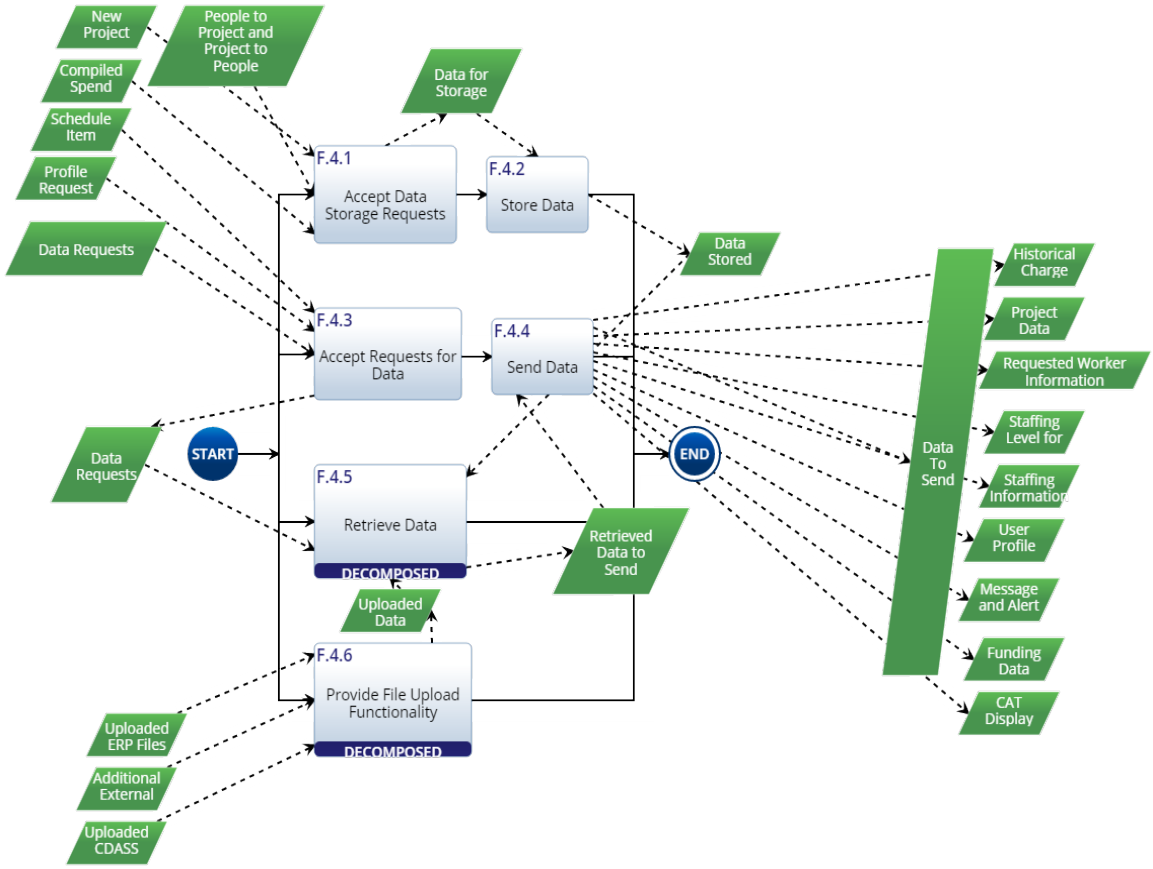

Figure 31. F.4 Action Diagram

B. MODELING OF PERSONNEL ALLOCATION AND FUNDING CALCULATION FUNCTIONALITY

Team CAT accounted for the requirements to display the personnel assigned to each project, display worker utilization data, and create funding graphs for certain users' dashboards in the functional architecture. Team CAT created a sample people-to-project execution chart to verify that none of the relevant requirements or functions were missed, and that the calculations CAT had to perform were well understood. By using the informal Excel spreadsheet products to instantiate an example of people-to-project allocation calculations and funding execution calculations, Team CAT was able to better understand the functionality that the stakeholders required of the aforementioned CAT features, as well as the data transformation and functional flow that the architecture would need to specify for CAT development. Screenshots of the Excel spreadsheets are included in Appendix J.

A. FUNCTIONAL ANALYSIS WITH REQUIREMENTS TRACEABILITY MATRIX

Requirements traceability is a requirements analysis method that measures the degree to which system requirements can be linked to system functions. The purpose of requirements traceability is to ensure that the planned system functions are sufficient to meet all of the requirements, and that there are no superfluous functions that are not mandated by a requirement. At this point in the process, Team CAT had developed the requirements presented in Chapter III and established the functions discussed in Chapter IV, Section A. As the team developed the functional architecture, they used a specific feature in Innoslate to automatically map the requirements to the appropriate functions and export the results to Microsoft Excel. The product, known as the Requirements Traceability Matrix (RTM), consisted of a single spreadsheet that captured the correlation in the many-to-many relationship between requirements and functions. As the Excel file was well over 500 lines long, use of Innoslate undoubtedly saved the team much time and energy, while ensuring accuracy based on previous functional architecture inputs.

The auto-generated RTM also increased the number of requirement-to-function tracing iterations that could be accomplished. After the first RTM iteration, Team CAT

realized there were some orphan functions that did not trace back to any parent requirements. The team added the missing derived requirements, and the next RTM made clear the need for additional functions to support the additional derived requirements. The relative ease of creating new RTMs in Innoslate, the ease of verifying functions to requirements traces with the RTM, and the resultant iterative nature of requirements and functions tracing ultimately resulted in a more complete model and a better overall product than would otherwise have been feasible without access to these tools. The improvements effected by this iteration illustrate the obvious benefit of adherence to MBSE best practices. The following paragraph provides an example of the RTM output for one specific requirement, while Appendix H contains the complete RTM.

The first parent requirement, R.1, contains all user profile requirements. It is decomposed by the requirement to save user data (i.e., requirement R.1.1.1). This requirement captures the need for CAT to be able to save input data from a user during a session. As can be seen in Figure 32, R.1.1.1 traces to several sub-functions, as well as to a main parent function. The subfunctions F.2.2.16, F.2.2.10, F.2.2.7, and F.2.2.4 accept and save the input data for the BFM, PM, BH, and SL user profiles, respectively. F.2.4.5, as a sub-function of the F.2.4 function to manage user profiles, generalizes the function "Accept User Input from GUI Module," to ensure that each user's data is associated to, and stored under, his or her individual profile. Lastly, Team CAT traced the parent function F.4, "Perform Data Storage Operations," and its sub-functions F.4.2, F.4.3, and F.4.5 to the requirement to "save user data." Although the example in the paragraph is not expanded and discussed in full detail, Team CAT did confirm that at least one function was traced to every requirement and at least one requirement was traced to every function.

Requirements		Traced to		
Number	Name	Description	Number	Name
R.1.1.1	Save user data	The CAT system shall be capable of accepting the input request to save data.	F.2.2.4	Accept Senior Leadership Input From GUI
			F.2.2.7	Accept BH Input from GUI
			F.2.2.10	Accept Project Manager Input from GUI
			F.2.2.13	Accept Administrator Input from GUI
			F.2.2.16	Accept BFM Input from GUI
			F.2.4.5	Accept User Input from GUI Module
			F.4	Perform Data Storage Operations
			F.4.2	Store Data
			F.4.3	Accept Requests for Data
			F.4.5	Retrieve Data

Figure 32. RTM Excerpt for "Save User Data" Requirement

B. CHAPTER SUMMARY

This chapter explains the processes Team CAT used to develop the CAT functional architecture. Section A presented the functional architecture itself, which consisted of two parts: the functional decomposition and the action diagrams. The first step employed to create the functional decomposition was to identify, define and logically organize the functions required to achieve each CAT requirement. The overall function of the CAT system breaks down into the performance of four main sub-functions: sign-on, competency administration, session termination and data storage. Team CAT then further divided these first-level functions into successively more detailed sub-functions to complete the system's functional decomposition. For the second part of the functional architecture, Team CAT used the organization of the sub-functions to create action diagrams. The main purpose of the action diagrams was to model the flow of data through the system.

Section B provided a description of spreadsheet modeling for people-to-project allocation and funding execution calculations. Team CAT deemed modeling of these two CAT functions essential to better understand both the stakeholder needs and the data transformation required for the calculations within CAT to meet those needs. Section C presented the RTM, a critical part of the functional analysis, which Team CAT used to verify completion of the requirements to functions traceability. The next chapter

discusses how the SE artifacts presented up to this point helped create GUI dashboards that bridged the gap between the SE documentation and the stakeholders' needs.

V. GRAPHICAL USER INTERFACE DEVELOPMENT

One of the primary focuses of this project was to define the way project funding, schedule, status, and personnel information would be displayed to the user. The different capabilities requested by the stakeholders (BFM, PM, BH, SL) led Team CAT to design four separate user dashboards, one for each user type. This design approach provided flexibility to satisfy the needs of each user type and allowed for a streamlined design, where users would only see the data they needed to perform their duties.

Team CAT developed the four GUIs by following the CAT SE products described in Chapters II, III, and IV. To make the dashboards intuitive and easy to use for the users, Team CAT researched and applied human systems integration (HSI) best practices, described in detail later in this chapter. Once Team CAT established the initial GUI prototype, the team was able to use that prototype to facilitate the elicitation of valuable feedback from stakeholders. This stakeholder feedback was critical to the process of fine-tuning the design for each successive iteration of the GUI.

Team CAT followed the UP iterative process to obtain frequent stakeholder feedback using increasingly refined GUI prototypes. This allowed Team CAT to continue to engage in a process of rapid and continuous product improvement that delivered increased value to the stakeholders. Positive feedback from stakeholders served as validation of GUI design decisions, and any recommendations provided further design direction in the iterative GUI development process.

Section A summarizes the HSI best practices that Team CAT followed to support GUI development. Section B provides an overview of the evolution of the GUI as it was iteratively refined. Sections C and D describe the stakeholder feedback and design direction post IPR 1 and IPR 2 respectively. Finally, Section E is a detailed description of the features and components of the final GUI design.

A. HSI DASHBOARD DEVELOPMENT BEST PRACTICES

Since CAT's initial intended users are NAVAIR personnel, Team CAT strove to ensure that the design of the GUI followed the appropriate DOD guidance. Department of

Defense Instruction (DODI) 5000.02, which governs defense acquisition, requires the consideration of HSI during program development: “The goal will be to optimize total system performance and total ownership costs, while ensuring that the system is designed, operated, and maintained to effectively provide the user with the ability to complete their mission (Under Secretary of Defense (AT&L) 2015, 118).”

Human Systems Integration is a crucial component of the defense acquisition process because military systems are dependent on operators who often use the equipment for long periods, in adverse environmental conditions, or in hostile environments. Thus, the system must be designed to best fit the operator for safety and optimal performance. The DODI further specifies: “System designs will minimize or eliminate system characteristics that require excessive cognitive, physical, or sensory skills; entail extensive training or workload-intensive tasks; result in mission-critical errors; or produce safety or health hazards” (Under Secretary of Defense (AT&L) 2015, 118). It is thus incumbent on system designers, engineers, and managers to ensure that the system is developed to best serve the intended operators, while using taxpayer dollars effectively throughout the life of the system.

The DOD uses many diverse GUIs to accomplish a wide range of missions. The parent systems are often mission-critical, and their misuse has the potential to cause major equipment damage or catastrophic loss of life. The GUI acts as a force-multiplier and enables the operator to better achieve the mission, but the system is only as good as its interface. In their 2013 usability study of U.S. Army GUIs, Abrams, Dooley and Saboo (2013) note:

> While GUIs are designed to optimize system functionality, efficiency of software code, and information assurance, their usability... is often overlooked until too late in acquisition to make the design changes necessary to address deficiencies. Training is then proposed as remediation for usability problems, but when GUIs are poorly designed, training may not be effective. (44)

The lesson, then, is to incorporate user values into the design from the start and to allow ample time for iterative refinement, usability assessment, and end-user testing. For the CAT development, the team captured user values during stakeholder interviews and

reinforced them during the IPRs. The knowledge gained from the prospective users helped inform the development team of the qualities and capabilities that the user found most desirable.

Although CAT is not for use in hostile or hazardous environments, it remains crucial that the system interface support quick and easy user initiation, familiarization, and navigation. To achieve such a design requires a high level of usability. The five components of computer usability are defined as follows: time to learn, performance speed, user error rate, subjective user satisfaction, and retention over time (Shneiderman 1998, 15). Inclusion of these components results in a design that is intuitive and takes advantage of established symbols and content organization. As a result, the user does not have to be taught how to use the interface, nor does he need to spend very long familiarizing himself with the tool's functionality. The goal of the design is for the user interface to remain unnoticed, since it should work seamlessly with the user's existing experience.

While users of any online system must be proficient in basic computer knowledge (e.g., use of a mouse, scrolling, manipulating menus, activating buttons, and properly interpreting symbols), there are specific GUI design characteristics that best enable the user to accomplish his or her task (Gibfried 2005, 20). To that end, Team CAT researched recommendations and best practices for developing an effective and highly usable GUI. From this research, Team CAT incorporated two important suggestions for effective user interface design. The first was the selection of a common layout that was used consistently throughout the tool (Mooshage, Thun and Schweingruber 2006, 7). A quad-type layout worked equally well for the PM, BH and SL dashboards; however, the unique qualities of the BFM role necessitated a separately-designed interface. The team intended to use a common design wherever possible to keep the user experience similar among user roles. This approach resulted in improved communication and easier job transitions when promoting leads or managers to higher roles.

The second suggestion that Team CAT incorporated was the use of only frequently-used and task-critical data in the top-level dashboard view (Lulue, Kammerer and Croft 2009, 11). As such, each PM, BH, and SL dashboard contained a quad-style

design, supplemented with a schedule at the bottom. The system defaults to an overview of the user's purview, but the user can easily increase the level of detail by selecting a project or branch to expand for more information.

1. Specific Principles Driving User Dashboard Design

Since a variety of users with differing management roles and responsibilities will utilize CAT, the team decided the best approach was for CAT to have a separate, custom dashboard display for each user type. In this instance, a dashboard is a data visualization tool that consolidates and presents the information that is most valuable to a particular user. The dashboard is the first screen presented to the user upon successful log-in to the system. According to Tableau Software's "Top 5 Best Practices for Creating Effective Dashboards and the 7 Mistakes You Don't Want to Make," the ideal dashboard is objectives-focused, visual, interactive, relevant, current, and accessible to its audience. According to Tableau, displayed metrics should be selected to optimize the available space and to best suit the needs of the user and the objectives of the tool. An emphasis on visual displays improves comprehension over text, but the graphics should be well-designed and chosen carefully to match organizational objectives (Tableau Software 2016).

Team CAT incorporated these recommendations and best practices into the design and architecture of each dashboard. In particular, the team selected the most meaningful metrics and graphics for each user, based on stakeholder inputs, and designed the dashboards to be interactive for the highest degree of customization possible. The user-centered customizations included:

- Setting simple graphs and charts as the focal point of each dashboard
- Allowing users the ability to interact directly with charts and timelines
- Requiring financial data to be pulled daily from databases
- Designing the system to be web-accessible by the user

Team CAT also accounted for the users' prior experience to ensure the best possible GUI experience. For the BFM, whose role and responsibilities differ significantly from those of other user types, Team CAT designed the dashboard to

incorporate the Longsheet. Since the BFMs already used that format, they were comfortable with it, and it worked well.

2. Incorporating User-Centered Design Principles and Wireframe Diagrams

Another way to improve design effectiveness from a usability standpoint is by following user-centered design (UCD) principles. According to the U.S. Department of Health and Human Services' UCD Basics, UCD is a framework in which the knowledge of users, their tasks, their needs, their preferences, and their limitations is used to create a design with the best user experience. The iterative process has four steps: Context, Requirements, Design, and Evaluation. In the first step, the UCD team defines the context of the user population, as well as the functions and conditions under which each user will use the product. Next, the team identifies the requirements for success and constructs design solutions. Finally, the design is evaluated by a sample of actual users (U.S. Department of Health & Human Services 2016).

A standard UCD best practice is to use wireframe models. These models are an inexpensive way to provide a tangible product to users. Since development is cheap and the design remains easy to change, the practice supports iteration (Lulue, Kammerer and Croft 2009, 17). Furthermore, since iteration with the UP was a central tenant of Team CAT's approach, development of the GUI design using UCD followed naturally.

Beyond designing for users and their tasks, the most important principles of UCD are clarity and consistency in the user's actions to interface with the system (U.S. Department of Health & Human Services 2016). For example, CAT maintains a fixed routine of drop-down boxes to select projects, programs, or departments and consistently uses check boxes to filter events on schedules.

Team CAT also included Usability Net's UCD recommendation to use simple and natural dialogue (Usability Net 2016) by including the status item "stoplight chart," discussed in the GUI development sections below. The team modified the name of the chart from "Obstacles" to "Status" to capture the nature of the display and the language used by the stakeholders more accurately and simply. In addition, Usability Net

recommends arranging the components of the interface to discriminate the required information using a consistent presentation with the proper level of detail. Team CAT captured this advice in the dashboards by using overviews with the ability to view more detailed organization information as desired.

3. Incorporating Morville's User Experience

Although all of the previously discussed best practices are helpful, they do not provide an adequate "big picture" of how the components of GUI design relate to each other. Team CAT decided to incorporate several of the philosophies of Information Architect Peter Morville to help bridge the gap. Morville's User Experience Design (UX) describes the architecture of the user-based design as the balance between "business goals and context, user needs and behavior, and content" (Morville 2016a). Figure 33 illustrates this relationship between the three main components.

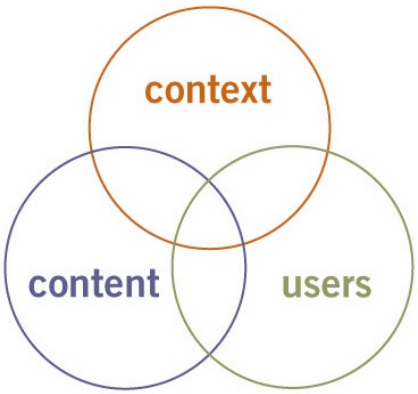

Figure 33. Morville's User Experience Information Architecture

In a comment on his blog "Interwingled," Morville argues that "usability is necessary but not sufficient" (Morville 2016a). Usability is a key ingredient in a successful interface, but it is only part of the solution, so designers should view user interaction with a system through a wider lens. He takes UX a step further in his "user experience honeycomb," seen in Figure 34, to enumerate the crucial qualities that define user experience.

Figure 34. Morville's User Experience Honeycomb. Adapted from Morville (2016b).

The expectation is that system architects who consider these characteristics during the design phase will produce a GUI that is best adapted to suit the needs of its user community. Team CAT used these seven adjectives, with an emphasis on value, to guide the architecture, efforts which ultimately resulted in a successful, user-centric GUI that fulfilled the stakeholders' needs.

As previously mentioned, through effective use of the described HSI design principles, as well as through frequent elicitation of stakeholder feedback, Team CAT was able to ensure that the final GUI design was familiar, intuitive, and easy to use. The team was able to develop a comprehensive, yet uncluttered, visual representation of the project metrics of interest for each user type. The following sections describe each stage the team progressed through during development of the GUI prototype design, before ultimately achieving the final design.

B. PROTOTYPE GUI EVOLUTION IN ITERATION 1 (PRE-IPR 1)

Team CAT began developing the GUI prototype by drawing simple shapes in Microsoft PowerPoint to represent what should be displayed to the user based on the initial decomposition of stakeholder needs. The simple outlines in Figures 35 and 36 helped Team CAT understand how the parent-level requirements related to what each user type needed to see. As mentioned in the previous section, Team CAT's design

approach included developing and tailoring different dashboards for each user type, even in the early stages of GUI conceptualization.

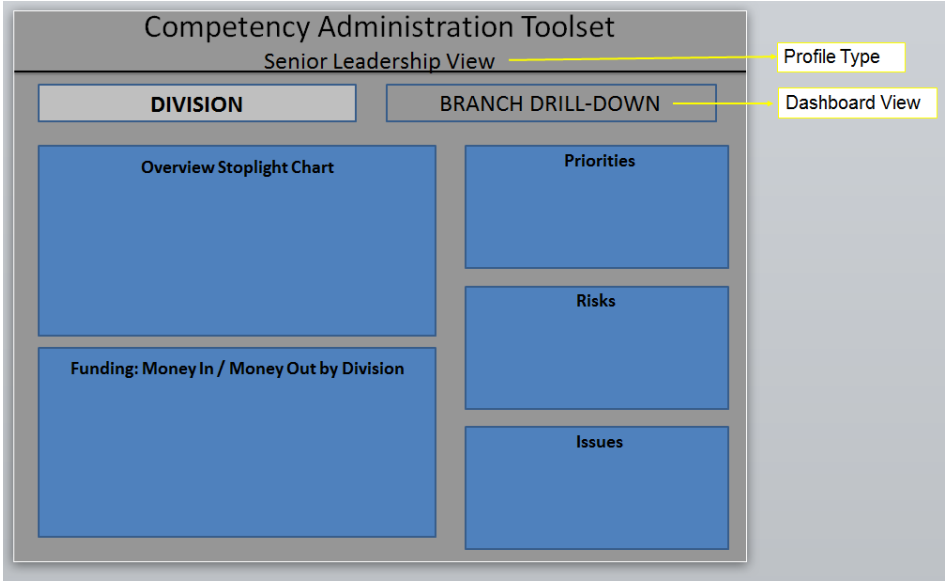

Figure 35. Initial GUI Prototype Using Microsoft PowerPoint – Senior Leadership Dashboard

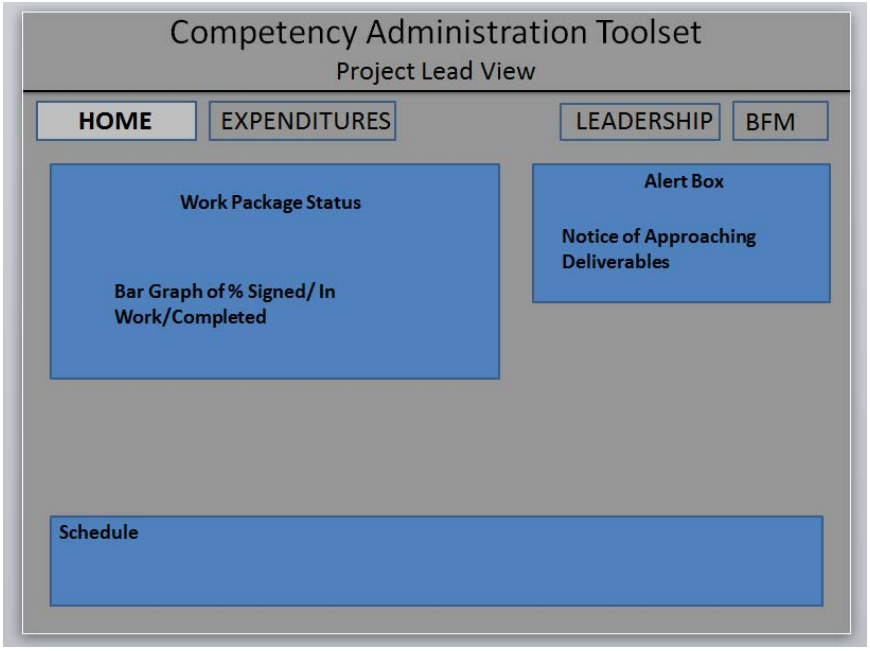

Figure 36. Initial GUI Prototype Using Microsoft PowerPoint – Project Manager Dashboard

During initial design meetings, the team relied on the user-centric design best practice of utilizing hand-drawn wireframe models, like the ones shown in Figure 37. Wireframe models were fast and easy to produce, and they allowed Team CAT to explore the different ideas for how to design the dashboards. The focus of the wireframe diagrams was to explore design decisions on how to best lay out the dashboard views, as well as what specific elements would be used to fulfill stakeholder requirements. For example, from the requirements and architecture views, Team CAT knew that the stakeholders needed some way of comparing actual versus planned expenditures. It was not until the exploration of wireframe diagrams that Team CAT determined how the comparison of actual versus planned expenditures would appear to the users. By using hand-drawings, Team CAT was able to quickly draft and change the GUI as necessary to best meet the stakeholders' needs.

In these hand-made drafts, some of the final design elements begin to take shape:

- The PM, BH, and SL dashboards began including the project cost, status, and schedule charts that the competency is accustomed to seeing.
- The BFM dashboard took the format of the Longsheets that the BFMs are accustomed to using.
- The team included the ability to filter data by date or type.
- The team included the use of visual alert cues for new or updated information.

Figure 37 illustrates the first set of wireframe models developed by Team CAT.

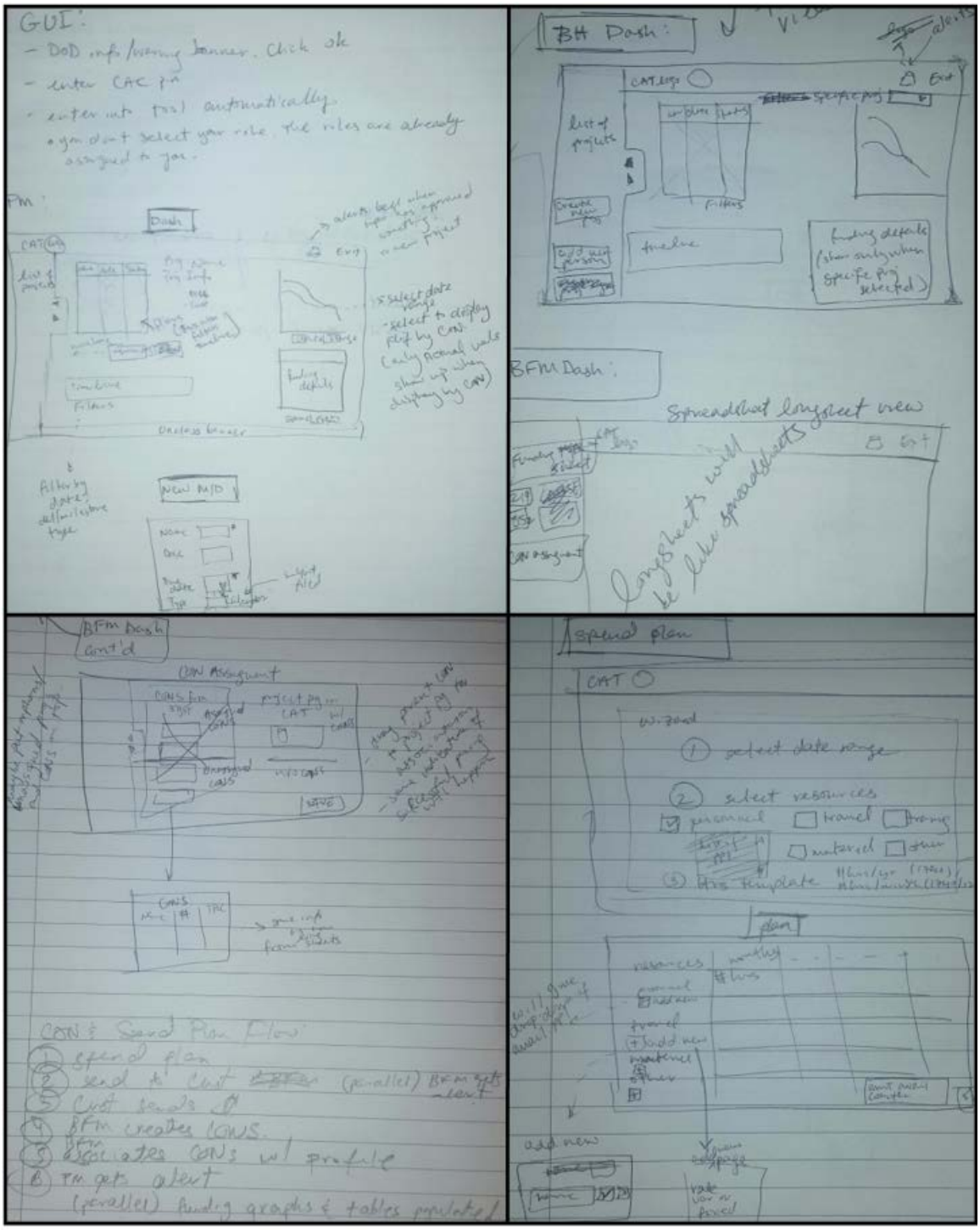

Figure 37. Hand-Drawn CAT Wireframe Models

These hand-drawn wireframe models continued to be improved and refined in an iterative fashion until achieving a higher level of maturity as can be seen in the hand-drawn wireframe SL dashboard shown in Figure 38. The dashboard in this figure shows a modified quad-chart format, which the Team adjusted and refined before confirming the design. The dashboard also includes the idea of a "stoplight" chart that displays project-related status items with a corresponding stoplight color (red, yellow, green) for a quick overview, a personnel tracking chart, and a rough outline of a finances chart.

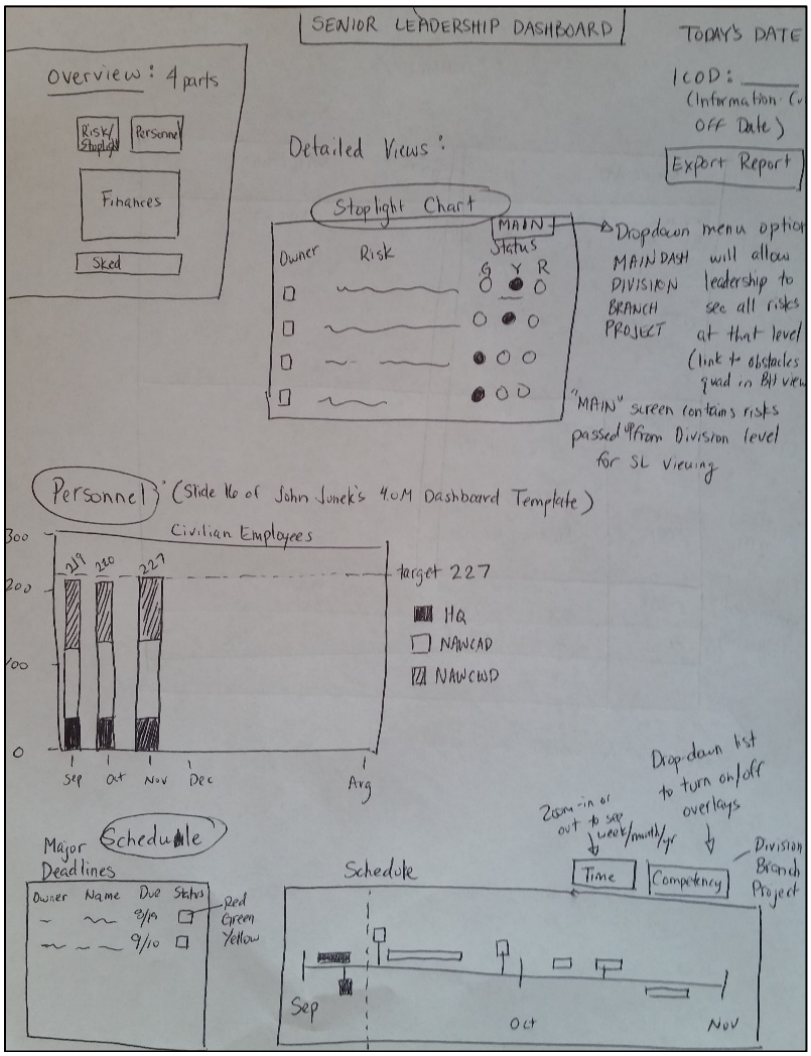

Figure 38. Wireframe Senior Leadership Dashboard

After several rounds of creating hand-drawn wireframe diagrams to refine the GUI, the prototype design had matured enough to warrant investing resources to create a clean version that could be formally presented to the stakeholders for feedback at IPR 1. Team CAT constructed this new version as an interactive web-based prototype, illustrated in Figure 39. This prototype was a much more refined version of the GUI, compared to the initial PowerPoint prototype that served as the GUI starting point. It featured a header with logos, a customizable pre-filtered timeline, the funding expenditure graphics, and interactive drop down menus. Appendix K includes additional screenshots of the finalized prototype designs.

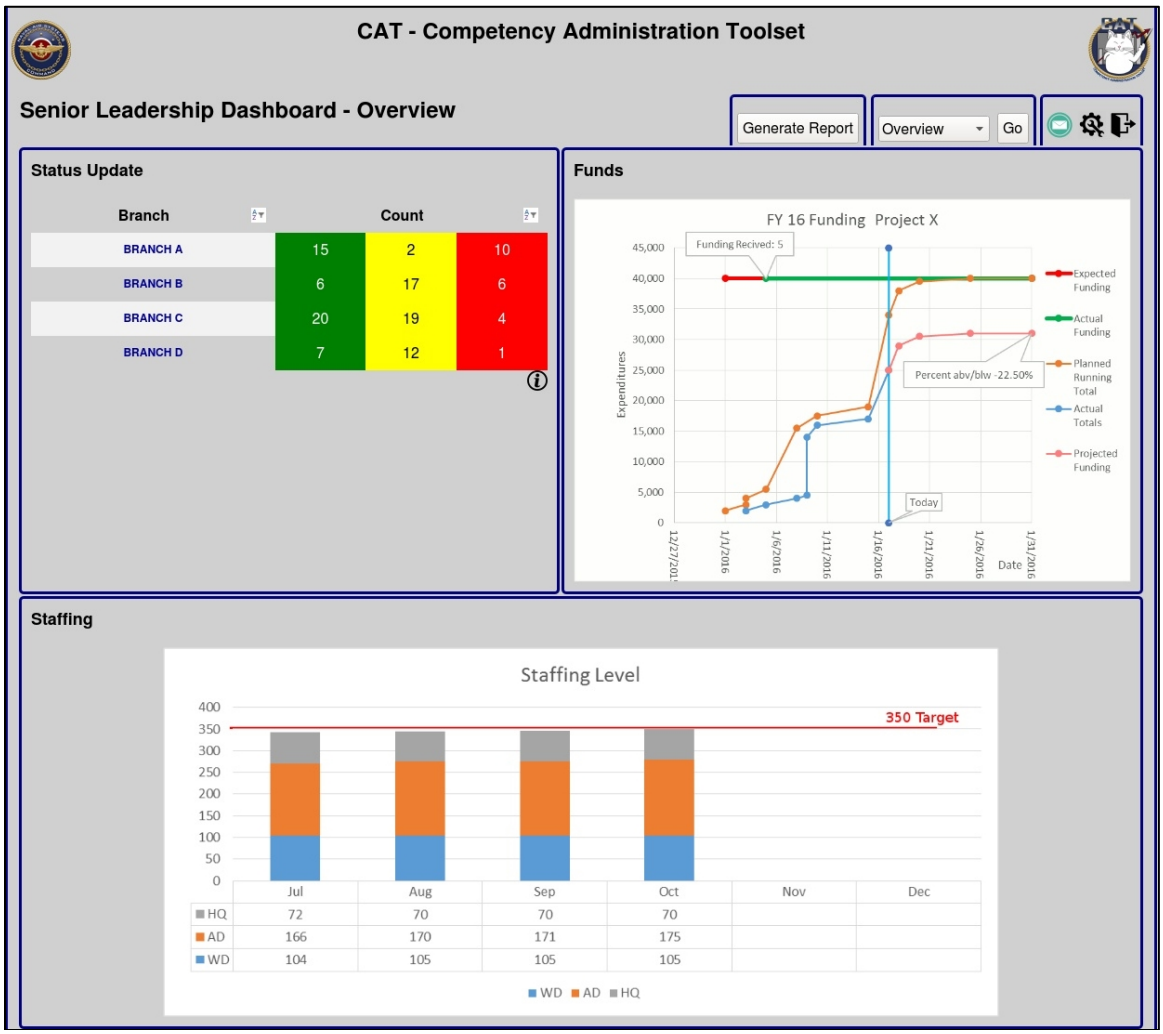

Figure 39. Partial Screenshot of Senior Leadership Dashboard Overview

It is important to note that the more refined web-based versions of the dashboards endured two distinct rounds of formal adjustment and refinement (post-IPR 1 and post-IPR 2) before arriving at the final GUI design that is fully described at the end of the chapter. Dashboard layout, functional grouping, color choice, spacing, and headings were just some of the design elements that Team CAT considered and refined.

In summary, prior to IPR 1, Team CAT used the SE artifacts presented in Chapters II-IV to begin prototyping the CAT GUI. The GUI consisted of four dashboards, one for each user type, to provide each user with the functionality needed to be effective in his or her role. Team CAT began by using a Microsoft PowerPoint version of the GUI to lay out the specific placeholders of functionality that would meet the requirements presented in Chapter III. Team CAT then used wireframe diagrams to plan quickly and easily how specific placeholders from the Microsoft PowerPoint version of the GUI could be populated.

C. DESIGN DIRECTION IMPLEMENTED IN ITERATION 2 (POST-IPR 1)

IPR 1 represented the first opportunity to formally present Team CAT's work and receive substantial feedback from stakeholders. At this point, Team CAT began to tailor the design of the product and specific GUI layouts to meet the expectations and preferences of the different user groups.

In some instances, the feedback received from the stakeholders helped to refine high-level system behavior, but it also required revisiting and revising requirements and functional architecture items. Eventually, the changes would flow down to the GUI level. Fortunately, the majority of design changes were interface related, so Team CAT were able to adopt the modifications without the need to change higher level SE artifacts. Tables 7-11 contain representative examples of the GUI-related design direction received from the different stakeholders at IPR 1 that the team considered for incorporation into later iterations of the GUI.

Table 7. IPR 1 Design Feedback for BFM Dashboard

Design Direction Title	Design Direction Description
BFM Dashboard Changes	Add new columns to fully match the Longsheet format and make every cell and field editable by the users.

Table 8. IPR 1 Design Feedback for PM Dashboard

Design Direction Title	Design Direction Description
Spend Plan Changes	Add inputs fields for material cost, labor cost, and personnel cost when creating a project spend plan.
Funding Graph Changes	Indicate the projected date that all funds will be expended, based on the current burn rate. Allow the insertion of 'call-outs' to explain major changes in the spend plan or burndown.

Table 9. IPR 1 Design Feedback for BH Dashboard

Design Direction Title	Design Direction Description
Personnel Tracker Changes	Refine use of colors, make it so that clicking on a worker opens a window with task loading details, visually indicate over-allocated workers, show what the historical/actual allocation of a worker on a project has been.
Funding Graph Changes	Allow the insertion of "call-outs" to explain changes in the spend plan or burndown.
Timeline Changes	Allow changing the date range and scrolling the timeline.
Create New Project Option	Provide a "create new project" button for BH users to be able to create new projects.

Table 10. IPR 1 Design Feedback for SL Dashboard

Design Direction Title	Design Direction Description
Status Item Sorting and Filtering	Provide sorting and filtering options for list of status items.

Table 11. IPR 1 Design Feedback for General Items (Not User-Specific)

Design Direction Title	Design Direction Description
User Settings Window Changes	Provide a button for users to be able to change their personal settings, such as when he or she should be alerted of upcoming schedule items, or over-/under-expenditure of funding.
Export Items Option	Provide an export button that allows for users to print, save and email a "quad-chart style" report for each project, show major status of the project when hovering mouse over a project name, when a specific project is selected provide a place to record notes or comments against a milestone or deliverable.

D. DESIGN DIRECTION FOLLOWING IPR 2

For IPR 2, Team CAT presented the updated GUI dashboards that incorporated the functionality and design change requests received during IPR 1. The hands-on nature of the interactive web-based GUI, along with the live demonstration at IPR 2, provided stakeholders the opportunity to inspect the GUI and provide additional feedback to the team. The positive feedback received from the stakeholders during IPR 2 served as an informal validation of the GUI design decisions. The number of requests for improvement and new design direction received during IPR 2 were minimal, helping to confirm the maturity of the GUI design. Table 12 contains the list of GUI changes carried forward from IPR 2 and incorporated into final prototype GUI design.

Table 12. IPR 2 Design Feedback for General Items (Not User-Specific)

Design Direction Title	Design Direction Description
Rename Obstacle to Status Update	Rename “obstacle” list to a “status update” list to better reflect the intended use of capturing both positive and negative status items instead of only obstacles or hindrances.
Remove Share CON	Remove the “share CON” email button from the GUI as this is a future work functionality.

E. RECOMMENDED FINAL DESIGN

This section describes the finalized dashboards in detail for each user type. Appendix K contains additional screenshots of the finalized GUI.

1. Budget Financial Manager Dashboard

Team CAT designed the BFM dashboard as an interface that would be familiar to a BFM user. As such, the BFM dashboard mimics the look and feel of the Longsheets, which had been the standard product to track competency funding. As in the Longsheet, the BFM dashboard offers the convenience of capturing comments against any data cell, time-stamping those comments, and tracking each user’s comment history. Figure 40 illustrates the general look of the BFM dashboard, while Appendix K, Figure K-2 shows a larger version of the figure and its details.

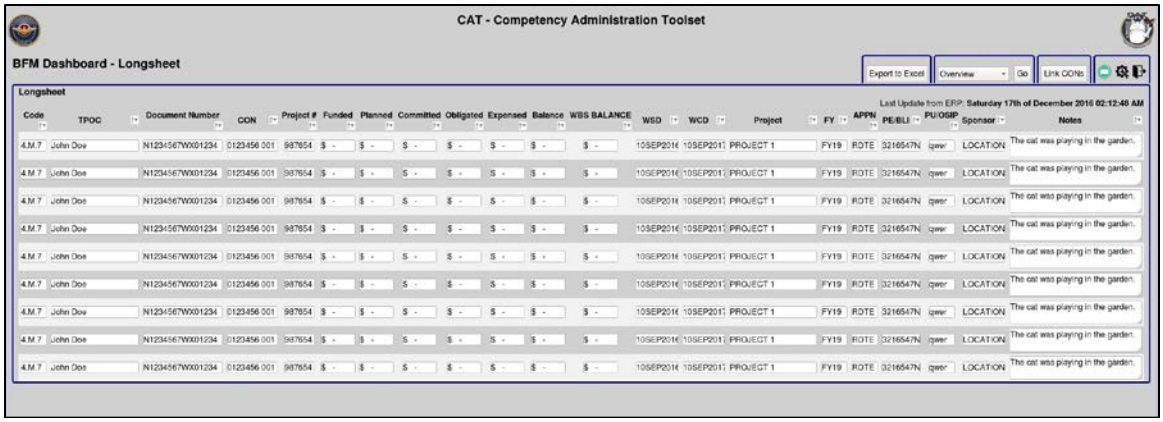

Figure 40. BFM Dashboard Screenshot from CAT Prototype

2. PM Dashboard

Similar to the BFM dashboard, Team CAT designed the PM dashboard as an interface that would be familiar to the PM users, basing it on the competency's quad-chart format that presents project status. If more than one project has been assigned to a PM, a drop-down menu in the upper right allows selection of which project to display. Figure 41 illustrates the general look of the PM dashboard, while Appendix K, Figure K-3 contains a larger version of the figure and its details.

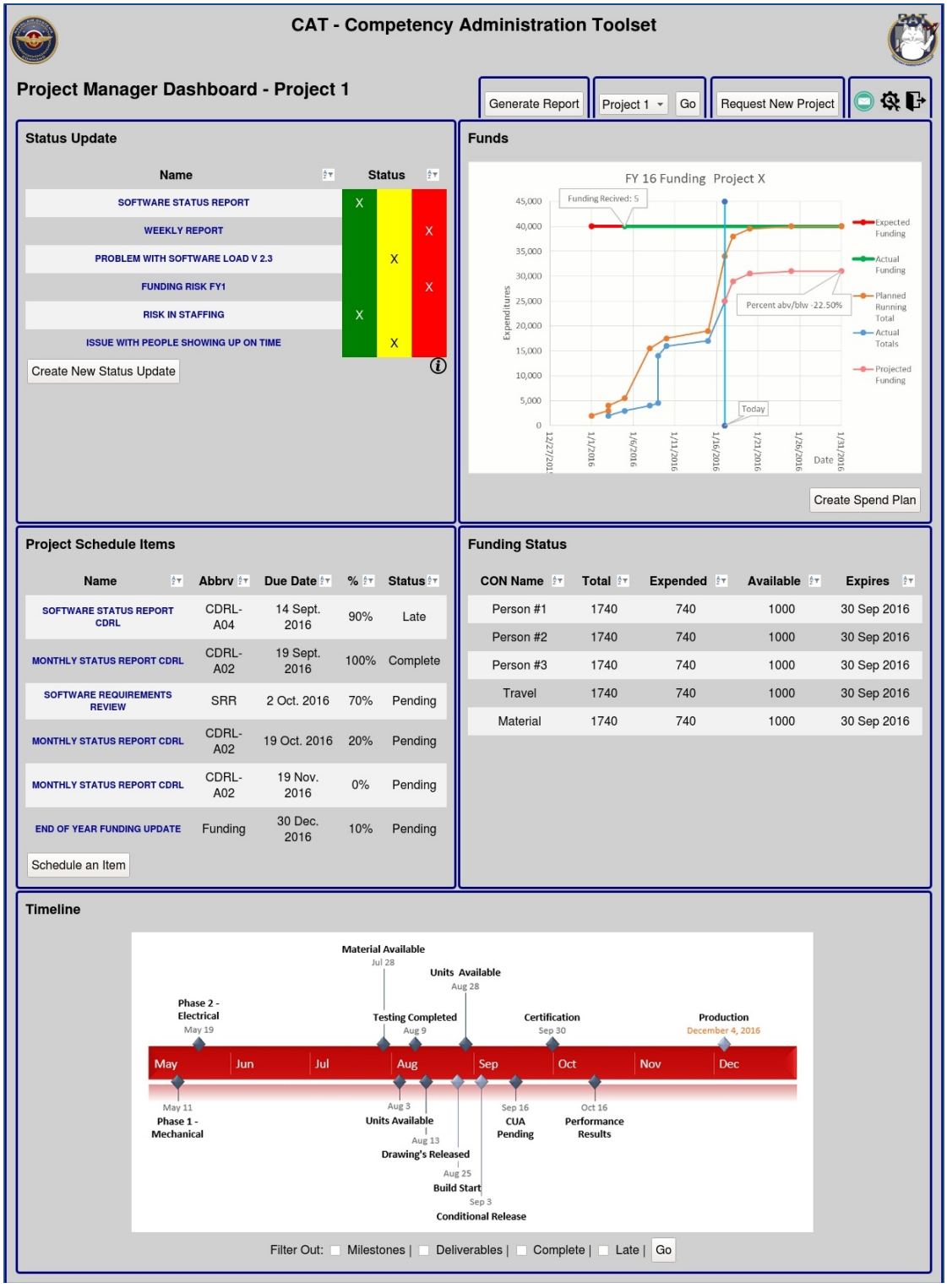

Figure 41. PM Dashboard Screenshot from CAT Prototype

Once a user selects a project or the first/default project is showing, the upper left quadrant displays a list of project status-items color-coded to easily determine current status. The upper right quadrant shows a funding graph of planned expenditures versus actual expenditures, as well as a projection of when funding is expected to be fully used up. The “Create Spend Plan” button below the graph allows users to create and view their planned expenditures. The lower left quadrant displays a list of project schedule items, such as milestones and deliverables, with the due date and status of each. The lower right quadrant displays a list of the project’s chargeable object numbers (CONs), including information on the account’s balance and expiration dates. Finally, below the four quadrants, a project-specific timeline provides a visual depiction of the schedule items. The timeline is filterable, with color-coded artifacts that visually show the project milestones and deliverables in an intuitive manner.

3. BH Dashboard

The BH dashboard borrows the top two quadrants and the timeline from the PM dashboard; however, the default view aggregates the data from all of the BH’s assigned projects into a single dashboard, rather than displaying metrics from a single project. For example, the planned versus actual expenditures in the upper right quadrant are no longer a single project’s funding status; instead, the graph now represents an aggregate of all projects under the BH’s authority. A BH can choose to filter the data to a single project using the top right drop-down menu. When a BH selects a specific project to focus on, CAT provides the user with a project-specific dashboard identical to the PM’s view.

Another major difference between the PM and BH dashboards is that the BH is presented with an interactive people-to-project tracker that graphically presents the allocation of the BH’s personnel to available projects. This people-to-project tracker graph allows the BH to identify actual or projected over-allocation or under-allocation of personnel resources within the branch. The “people” table in the display (Figure 42) shows the allocation of each person at any given time in the fiscal year. The “project” table, on the other hand, displays whether projects have assigned workforce at the level needed. In more detailed views, the BH is able to assign workers to projects while

simultaneously viewing their individual allocation during a specific period. Figure 42 illustrates the general look of the BH dashboard, while a larger version of the figure and its details is in Appendix K, Figure K-6.

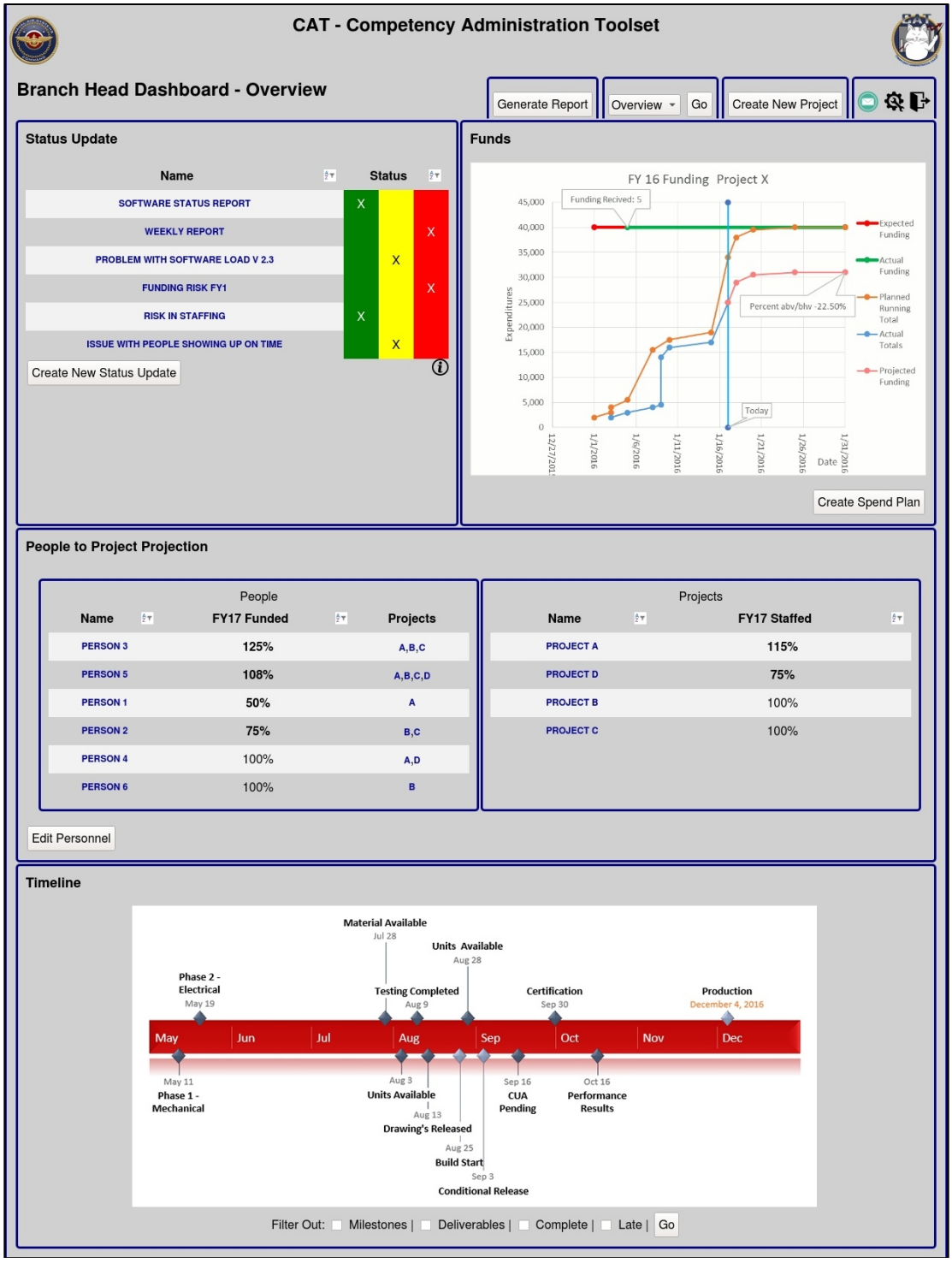

Figure 42. BH Dashboard Screenshot from CAT Prototype

4. SL Dashboard

The SL dashboard follows the pattern of the PM and BH dashboards; however, the data presented at the initial default view for SL is at a higher level of abstraction. CAT aggregates the data displayed in the default SL dashboard across all of the branches within the competency. Like the BH dashboard, users can filter the SL dashboard to display specific branches or projects, depending on the level of detail desired. The filter option is useful to allow SL to focus on specific areas of the competency, while the default unfiltered SL dashboard home screen presents a condensed snapshot of the overall competency health. The default view is intended to quickly convey the most essential information for decision making, per the guidance obtained from the HSI best practices discussed in Chapter V, Section A. Figure 43 illustrates the general look of the SL dashboard, while a larger version of the figure and its details is in Appendix K, Figure K-8.

Figure 43. SL Dashboard Screenshot from CAT Prototype

As can be inferred from the different dashboard descriptions, Team CAT provided significant consideration to accommodate each user's specific data needs while keeping the user interface clean and uncluttered, heeding HSI design best practices. The stakeholder competency's software development team will use these validated prototype dashboards to inform the development of the working version deployed GUI and help guide the actual programming of the CAT functionality.

F. CHAPTER SUMMARY

One of Team CAT's primary objectives was to find an effective method of displaying data to the different user types. Chapter V summarizes Team CAT's HSI best practices research and the multiple iterations of GUI prototypes that informed the final GUI design for each four different user types' dashboards. Section A summarized those HSI best practices that informed Team CAT's GUI design. Section B presented the initial evolution of the first conceptual Microsoft PowerPoint GUI model to more detailed wireframe models and the first iterations of the pre-IPR 1 web-hosted GUI. Section C contained descriptions of the iterative refinement of the GUI based on considerable stakeholder feedback during IPR 1, while Section D described additional, but subtler changes from stakeholder feedback and design direction post-IPR 2. Section E provided an in-depth narrative and pictures of the final GUI design.

Ultimately, Team CAT maintained GUI design momentum through compliance with the UP and reliance on frequent stakeholder reaction to improve GUI prototypes. By incorporating the users within the design process, Team CAT was able to produce a design that fulfilled the various stakeholders' needs, resulting in verbal validation from all four stakeholder groups.

VI. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION AND FINAL THOUGHTS

In keeping with the initial goals and objectives of this study, Team CAT has successfully performed the following: (i) designed a project management system to track and manage the cost, schedule, and status of the stakeholder competency's unclassified projects, (ii) developed a system architecture to trace stakeholder needs down to specific system functionality, and (iii) developed a prototype GUI as a proof of concept for the system functionality. Evident through this report, all objectives have been met. Confirmation from all levels of the stakeholder representatives indicated that Team CAT successfully met the project's objectives stated in Chapter I. Based on the stakeholders' responses and enthusiasm for the design, the team anticipates the system will meet the needs of stakeholders once it is developed. The fact that CAT will have the capability to calculate and compile critical project information, then generate graphs and reports from that information, will allow management to make better-informed, data-driven decisions.

Once the system has proven successful within the stakeholder competency, CAT has the potential to grow and support other NAVAIR competencies. Furthermore, CAT could eventually extend to support other non-NAVAIR, DOD organizations as well, if source-data dependencies, such as dependencies on NERP financial data, were either changed or expanded upon. Overall, with the numerous tools that the government adapts, CAT can serve as a single tool to bind concepts together—benefiting other areas of the project management process and eventually the Naval Aviation Enterprise.

B. RECOMMENDATIONS FOR FUTURE WORK

The following section will briefly discuss areas in which there may be potential for future work, specifically relating to the system's non-functional requirements and capability enhancements.

1. Exploring Non-functional Requirements

Team CAT recommends that future development teams perform further research on the system-wide non-functional requirements discussed in Chapter III. This project focused on the functional design of the CAT system, but the non-functional areas of compatibility, usability, security, reliability, availability, maintainability, sustainability, and affordability are also critical for the system to be suitable to the users. By obtaining a high level of detail in these non-functional areas, the future software development will (i) ensure that CAT is compatible with the current IT infrastructure, (ii) maintain the system's intuitive nature and ease of use, and (iii) ensure the system's ability to protect sensitive information. The following paragraphs describe the team's recommendations for future work with regard to reliability, availability, maintainability, sustainability, and affordability.

a. Reliability

Unlike hardware reliability, software reliability is not a function of time. Software does not wear out or age like the physical faults found in hardware, but rather software reliability is a function of software design. Reliability issues that need to be avoided early in the software development process are typically due to specification misinterpretations and ambiguities. Knowing these risks, Team CAT worked to be as thorough and clear as possible in requirements definition and system functional analysis. Furthermore, the software development team will also have to ensure that their processes contribute towards software reliability.

b. Availability

Team CAT recommends that future development teams establish availability requirements to ensure the CAT software system can be used during times of needed operation. At a minimum, these requirements should include backup methods of accessing external data and ensuring compliance with interoperability constraints. Software maintainability requirements are critical and should include the capability to modify the software after delivery. This flexibility allows software maintainers to

continue to improve CAT performance, correct faults, test newly developed hardware, or adapt to future requirements as the operational environment evolves.

c. Sustainability

Team CAT recommends that future software sustainment requirements include the processes, procedures, people, materiel, and information needed to support and maintain all software aspects of the CAT system. Sustainment requirements go beyond just software "maintenance" needs and should include appropriate levels of required documentation, training, help desk support, and technology refresh. Future developers should determine when the CAT system would enter a sustainment phase during its life cycle and what the entry criteria will be to do so.

d. Affordability

Lastly, Team CAT recommends performing a cost-benefit analysis to quantify the life-cycle cost savings of the CAT system, when compared to the current process. The future development team should evaluate the CAT system to quantify the number of man-hours saved, as well as to define costly mistakes to avoid when implementing the new system. The competency could then use this data to verify affordability requirements and determine which software features would reduce costs further. This data would also support the business case for potentially expanding the system to a NAVAIR enterprise level.

2. Future Expansion

Developing the user stories and use cases with stakeholders allowed Team CAT to document additional desired capabilities and features; however, the team did not explore these features due to scope limitations. Team CAT believes the additional capability areas are worth exploring more deeply, when the scope allows. They include the following: additional connectivity with external IT systems, additional funding tracking features, and a more robust personnel tracking system.

a. Connection to Microsoft Office Applications

The stakeholders expressed an interest to connect to Microsoft Office applications through CAT. For example, they discussed how they may want CAT populate Microsoft Outlook calendars of key leadership personnel with project milestones and deliverable dates. The stakeholders also expressed the need for CAT to interface with Microsoft Project as well, to connect schedule items in CAT to their projects' work breakdown structures. The expanded connectivity features will allow SL and BHs to have an increased awareness of their projects without always having to directly log into the CAT system.

b. Expansion of Financial Tracking Features

Expanding upon the financial tracking features can also permit better funds' management, specifically at the level of SL. Currently the CAT system design only tracks funding allocated to specific projects. An added capability for future research is the capability to track competency overhead funding shared between competency resources. Specific overhead spending includes common materials, supplies, and funding for general training. The added capability to include overhead funding management opens the aperture to larger scale management vice being limited to the needs of specific projects.

c. Expansion of Personnel Tracking Features

SL and BHs have also expressed the need for CAT to go beyond tracking personnel assigned to a specific project and include a means of tracking personnel professional development. Specifically, the stakeholders have requested the capability to track personnel professional qualifications, education, and time on the job. For example, BH and SL stakeholders expressed the need to view when specific personnel are due for Defense Acquisition Workforce Improvement Act (DAWIA) certification in his or her primary career track and what DAWIA certifications he or she have already obtained. By connecting with the electronic Defense Acquisition Career Management (eDACM) database, which manages DAWIA training records, future development teams could integrate this capability into the CAT dashboards. Having a convenient way to view an employee's prior education, expertise, training, and education information would allow

BHs to assign the most qualified person to a competency project. It would also allow them to ensure their employees stay current with their professional development requirements.

BHs have also indicated that improvements to employee timecard management would be a welcome addition to CAT. Since CAT's recommended design includes the capability to communicate with NERP, CAT could potentially serve as the primary tool for managing personnel timecards. With this added capability, CAT would be able to write data back into NERP, instead of simply pulling and reading data. Using CAT as an interface tool for timecard management would allow the competency to have greater flexibility to add additional time-management features, since their own in-house software development team would be the ones developing the interface.

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APPENDIX A. RECOMMENDED SOFTWARE IMPLEMENTATION STRATEGY

Team CAT's intent was for this report, the SE artifacts created throughout the project, and the final prototype GUI to serve as a solid foundation for development of a more capable management tool in the future. The team hopes that this tool will eventually be utilized not just within the stakeholder competency, but also at the enterprise level. To increase the likelihood of success, Team CAT has developed a potential implementation strategy, which will be discussed in the following sections.

A. SOFTWARE DEVELOPMENT STRATEGY

The stakeholder competency communicated that once Team CAT delivered the SE artifacts for this project, the competency's software development team would use the artifacts to create a fully functional software system. The software development team has demonstrated prior experience with iterative software development life-cycle processes. As such, the software team specifically requested documentation of user stories that traced to the system architecture, so that they may use the products to develop the system. The software development team plan to use the prototype GUI, displayed in Chapter V and Appendix K, to develop the first iteration of the software. Furthermore, although Team CAT will have completed this project by the time CAT is actually being built, Team CAT's Project Lead will maintain communication with the stakeholder competency to help clarify any questions that might arise from the software development team through the development process.

The software development team should also focus on successfully establishing live connections to external databases and complying with the corresponding security measures, which they have done for past projects within the competency. Team CAT, along with the software development team, has determined that in order to expedite the process of making CAT functional, the development team will begin creating manual data upload capabilities to the software, while they are simultaneously executing the

process of obtaining live connections to the external systems. As such, Team CAT has specified the manual upload capability in the system functional architecture.

The process of obtaining live connections includes submitting paperwork describing the reason for the automated data pulls, as well as providing certification from NAVAIR that CAT has an authority to operate (ATO) on the NMCI Non-Secure Internet Protocol Router Network (NIPRNET). The stakeholder competency has strategized that, upon completion of CAT's first prototype, they will present the CAT concept and prototype to NAVAIR business management leadership. The prototype will have the capability for BFMs to manually upload the raw NERP and Commanding Staffing data to CAT, to demonstrate the capabilities of the system. The intent will be to show that, if the competency were able to establish live connections, the BFMs would no longer have to manually download data from the source databases and upload to CAT; instead, they could simply access the most updated data from within CAT.

The competency has had success with a similar strategy in the past to obtain live database connections. Having the tool readily available to demonstrate allows command leadership to more easily see the need for a tool like CAT at the enterprise level. Team CAT believes that the process of obtaining access to live databases will be much easier after gaining NAVAIR command leadership support. If successful, this strategy will allow for expansion of CAT to a NAVAIR enterprise level.

B. SOFTWARE TESTING STRATEGY

To perform acceptance testing on the software, developers will need to translate the user stories captured by Team CAT into pass/fail criteria. The software development team will then create a software test plan to (i) analyze the CAT software objectives, (ii) determine what tests are necessary to meet those objectives, and (iii) ensure the data obtained during the tests will allow thorough completion of the objectives. The largest portion of the test plan would likely consist of software interoperability objectives and constraints, since the CAT system will rely on data from external sources to operate.

Software verification and validation will be the final stage of testing. This will ensure that the CAT system meets both the specifications and the intended purpose of all

stakeholders. The requirements generated from Team CAT's SE efforts will serve as direct verification criteria. Based on verbal confirmation by all levels of stakeholders during IPR 2, the team anticipates that software validation efforts will be minimal.

C. DEPLOYMENT STRATEGY

The stakeholder competency has demonstrated prior experience with hosting web services for use throughout the Navy. For the first iteration of CAT development, the stakeholder competency has planned on hosting CAT on server space that is already used for other web-based products. CAT users will be provided with a ."navair.navy.mil" uniform resource locator (URL) to access CAT. Team CAT anticipates that, as CAT development continues and more data is hosted within CAT, the stakeholder competency will procure additional hosting services through their current service provider.

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APPENDIX B. LIFE-CYCLE MODELING LANGUAGE ONTOLOGY

The following table illustrates the detailed Life cycle Modeling Language (LML) ontology built into Innoslate (LML Steering Committee 2016).

	Action	Artifact	Asset (Resource)	Characteristic (Measure)	Connection (Conduit, Logical)	Cost	Decision	Input/Output	Location (Orbital, Physical, Virtual)	Risk	Statement (Requirement)	Time
Action	decomposed by* related to*	references	(consumes) performed by (produces) (seizes)	specified by	-	incurs	enables results in	generates receives	located at	causes mitigates resolves	(satisfies) traced from (verifies)	occurs
Artifact	referenced by	decomposed by* related to*	referenced by	referenced by specified by	defines protocol for referenced by	incurs referenced by	enables referenced by results in	referenced by	located at	causes mitigates referenced by resolves	referenced by (satisfies) source of traced from (verifies)	occurs
Asset (Resource)	(consumed by) performs (produced by) (seized by)	references	decomposed by* orbited by* related to*	specified by	connected by	incurs	enables made responds to results in	-	located at	causes mitigates resolves	(satisfies) traced from (verifies)	occurs
Characteristic (Measure)	specifies	references specifies	specifies	decomposed by* related to* specified by*	specifies	incurs specifies	enables results in specifies	specifies	located at specifies	causes mitigates resolves specifies	(satisfies) spacifies traced from (verifies)	occurs specifies
Connection (Conduit, Logical)	-	defined protocol by references	connects to	specified by	decomposed by* joined by* related to*	incurs	enables results in	transfers	located at	causes mitigates resolves	(satisfies) traced from (verifies)	occurs
Cost	incurred by	incurred by references	incurred by	incurred by specified by	incurred by	decomposed by* related to*	enables incurred by results in	incurred by	located at	causes incurred by mitigates resolves	incurred by (satisfies) traced from (verifies)	occurs
Decision	enabled by result of	enabled by references result of	enabled by made by responded by result of	enabled by result of specified by	enabled by result of	enabled by incurs result of	decomposed by* related to*	enabled by result of	located at	causes enabled by mitigated by result of resolves	alternative enabled by traced from result of	date resolved by decision due occurs
Input/Output	generated by received by	references	-	specified by	transferred by	incurs	enables results in	decomposed by* related to*	located at	causes mitigates resolves	(satisfies) traced from (verifies)	occurs
Location (Orbital, Physical, Logical)	locates	locates	locates	locates specified by	locates	locates	locates	locates	decomposed by* related to*	locates mitigates	locates (satisfies) traced from (verifies)	occurs
Risk	caused by mitigated by resolved by	caused by mitigated by references resolved by	caused by mitigated by resolved by	caused by mitigated by resolved by specified by	caused by mitigated by resolved by	caused by incurs mitigated by resolved by	caused by enables mitigated by results in resolved by	caused by mitigated by resolved by	located at mitigated by	caused by* decomposed by* related to* resolved by*	caused by mitigated by resolved by	occurs mitigated by
Statement (Requirement)	(satisfied by) traced to (verified by)	references (satisified by) sourced by traced to (verified by)	(satisified by) traced to (verified by)	(satisified by) specified by traced to (verified by)	(satisified by) traced to (verified by)	incurs (satisified by) traced to (verified by)	alternative of enables traced to results in	(satisified by) traced to (verified by)	located at (satisfied by) traced to (verified by)	causes mitigates resolves	decomposed by* traced to* related to*	occurs (satisified by) (verified by)
Time	occurred by	occurred by	occurred by	occurred by specified by	occurred by	occurred by	date resolves decided by occurred by	occurred by	occurred by	occurred by mitigates	occurred by (satisfies) (verifies)	decomposed by* related to*

APPENDIX C. STAKEHOLDER RESEARCH QUESTIONS

A. FOR BUSINESS FINANCIAL MANAGER (BFM)

Introduction: We are conducting a systems engineering analysis on the current data management processes used by the BFM department to support AIR-4.0M personnel and senior leadership. In particular, we are interested in learning about user-specific information related to the step-by-step procedures used to pull sets of data and metrics from existing databases.

1. Funding Data

a. How many different databases do the BFMs interact with to pull information for funding data? What are the names of these databases?

b. What data products are used from the aforementioned databases?

c. How often does the BFM department interact with those databases to pull information for administrative data?

d. How many labor hours are required on a weekly basis to collect, update, and maintain administrative data?

e. What are the longest, shortest, and average times are on this process?

f. How long does it take to conduct the routine data pulls from ERP?

g. What are the longest, shortest, and average times are on this process?

h. How long does it take to conduct any ad-hoc/specific data pulls from ERP?

i. What are the longest, shortest, and average times are on this process?

j. After pulling the data, how long does it take to process that data into a format that could be sent to leadership?

k. What are the longest, shortest, and average times are on this process?

l. How often is data updated for the competency?

m. How often is that updated data distributed to the competency?

n. Please describe the step-by-step processes of collecting, processing, and sending off the data.

o. How is the data provided to the competency? (Ex: email, SharePoint, printed reports, etc.)

p. Is there a documented process that the CAT team can review to better understand the interactions with the external databases?

q. Are there examples of data artifacts that the CAT team can review to better understand the data and final data products?

r. Are there products that that are considered useful that your department currently does not use?

s. Is there any data that needs to be entered manually by a BFM since it is not available in any other databases?

t. If so, how much time does it take to populate manual entries for each of your processes?

2. Tools

a. What specific software tools does the BFM department use to download, process, compile, and distribute the funding data?

b. If a tool existed to assist in the administrative process, what are the most important attributes and characteristics it would need to have? Examples may include: ease of use, readability of output, flexibility of product, tailorability, network accessibility, degree of automation, and time to pull data and generate the report?

c. Does the BFM department currently use the Command Staffing system to access or edit staffing data? What advantages or disadvantages does this particular tool have? What data is used from this system? How is

the data used? How is this data used for tracking/managing personnel and/or projects?

3. Constraints

a. What type of constraints should the CAT team be aware of when analyzing the current processes and designing a system such as CAT?

4. After Paper Prototype Development

a. What features/functions are missing?

b. Are any features/functions in here that are not useful or are unnecessary?

c. Are there any features/functions that seem to be in the wrong place or are distracting?

d. Are there any changes needed to make this prototype easier to use?

B. FOR BRANCH HEADS AND PROJECT MANAGERS

Introduction: We are conducting a systems engineering analysis on the current processes used by the BFM department to obtain funding and project-related data for AIR-4.0M leadership and project managers, as well as the processes used by project managers to collect and report project metrics. In particular, we are trying to refine an idea for a software tool that provides project status and funding information on demand. The purpose of this proposed tool is to assist leadership and project managers with decisions they must make regarding anything from individual projects to large-scope branch and/or division personnel planning.

The questions below are intended to (1) help our team understand the current process you follow to obtain project- or funding-related information, and (2) help define what you, as users, consider most important for the type of system we are proposing.

1. Data Collection

a. What administrative project-related data is collected on a routine basis?

   i. Why is this data collected on a routine basis?

   ii. How is this data used?

b. What administrative/project data does your office or department request from BFMs on a routine basis? Is this information already available in the Longsheets in some way?

c. Can we have examples of completed projects with the original plans, schedule, tracking data (EVM or other methodology)? Could you please walk us through a completed example?

d. What are some suggested improvements to the way AIR-4.0M currently tracks and manages projects?

e. Does your office or department use the Command Staffing system to access or edit staffing data? What advantages or disadvantages does this particular tool have? What data is used from this system? How is the data used? How is this data used for tracking/managing personnel and/or projects?

2. Data Reporting

a. How does project administrative data get compiled prior to it being sent to your department for review? What type of file formats? What types of charts/graphs are used on a routine basis?

   i. When administrative data is received, does it come in one specific uniform format, or must it be re- processed or reformatted prior to sending it further up the chain of command?

   ii. How long does the “re-processing/reformatting” take in a normal week?

b. How is project administrative data compiled and reported up the chain of command? What type of file formats? What types of charts/graphs are sent up the chain of command on a routine basis?

c. On average, how many projects' data are compiled and reported up the chain of command on a weekly basis?

d. What reporting tasks does your office or department routinely perform?

   i. How often are reporting tasks performed?

e. How often does administrative data have to be reported? Or is there a standard time such as the end/start of each week the data is provided?

   i. Are there any examples of ad-hoc data requests? How often does this happen? How long does it take to prepare answers for these ad-hoc requests?

3. General Management

a. How does a new request for a project arrive? Is it in a format of a document or a telephone call? What immediate steps must be taken to begin to "set up" the project?

   i. Are there any steps that are repetitive each time a new project is set up?

   ii. Which of those steps could be automated?

b. How are personnel assigned to new projects?

c. How is project funding managed and tracked?

   i. Are the BFM's fund status sheets used to manage and track funding? How?

   ii. Does project funding ever get broken down into multiple accounts for management purposes? For example, does the total

amount on a chargeable object get broken into separate charge codes for project aspects such as training, travel, materiel, etc.?

iii. Does your office create unique artifacts or methods to track status of projects?

1. What tools are used to do this?

d. How are project risks managed and tracked? How are those risks reported?

e. Are there standard project deliverables that must be produced for every project? (ROM, schedule, task statement, etc.)

i. What tools are used to create those deliverables?

ii. Where and how are those deliverables stored? SharePoint? Local drive?

f. What are some high priority project management areas that create significant problems if not managed properly? For example, if funds get expended too quickly, or an account is overcharged, could there be trouble? How severe of a problem is missing an important customer milestone? What are the repercussions and how are these problems avoided? Are any of these management procedures that are repetitive/ tedious and could they be automated?

g. As a project lead or branch head, what are the top three concerns with regards to managing people, projects and funding?

h. One potential feature being considered for the tool is a “stoplight” indicator for project status.

i. When projects deviate from planned costs, at what percent or amount deviation would your department consider a project in a “yellow” status?

ii. At what percent or amount deviation would your department consider a project in a “red” status?

iii. Similarly, for planned project schedules, at what percent or amount of time deviation would your department consider a project in a “yellow” status? At what percent or amount of time deviation would your department consider a project in a “red” status?

4. Constraints

a. What type of constraints should the CAT team be aware of when analyzing the current processes and designing a system such as CAT?

5. After Paper Prototype is Developed

a. What features/functions are missing?

b. Are any features/functions in here that are not useful or are unnecessary?

c. Are there any features/functions that seem to be in the wrong place or are distracting?

d. Are there any changes needed to make this prototype easier to use?

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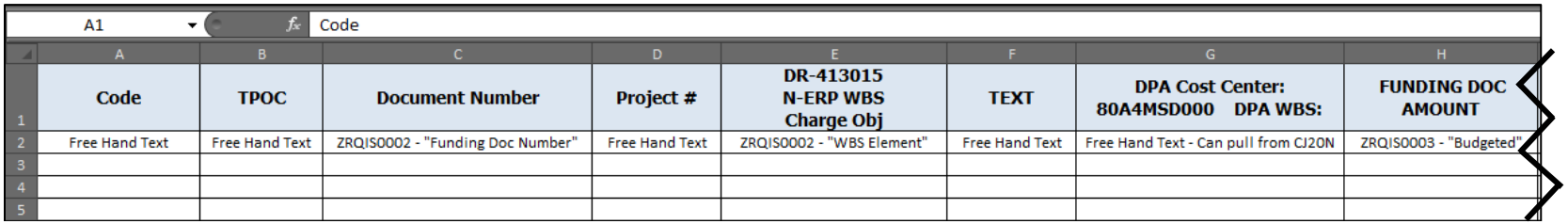
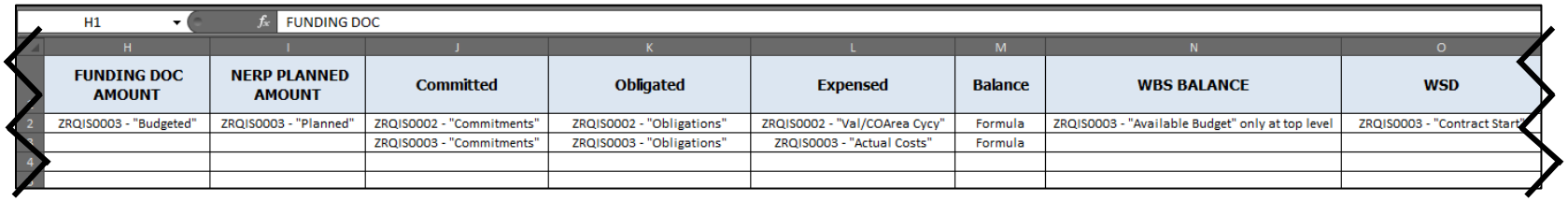
APPENDIX D. EXAMPLE BFM LONGSHEET

The following figures provide a snapshot of the format and type of information contained in the BFM Longsheets. The Longsheet content and formatting was used as the basis for developing the BFM dashboard in CAT.



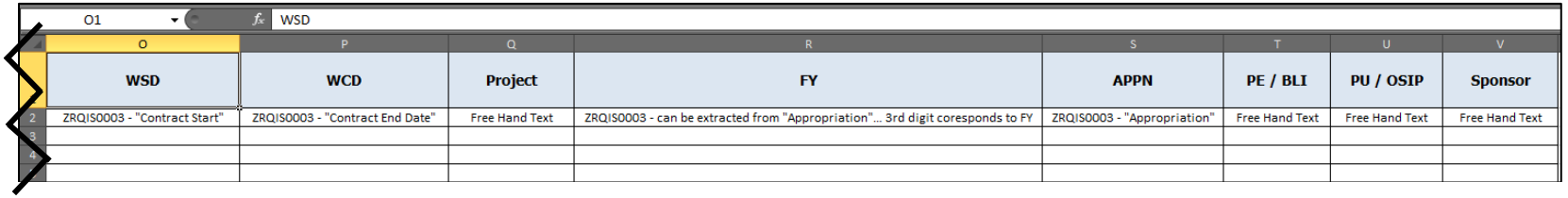
	A	B	C	D	E	F	G	H
1	**Code**	**TPOC**	**Document Number**	**Project #**	**DR-413015 N-ERP WBS Charge Obj**	**TEXT**	**DPA Cost Center: 80A4MSD000 DPA WBS:**	**FUNDING DOC AMOUNT**
2	Free Hand Text	Free Hand Text	ZRQIS0002 - "Funding Doc Number"	Free Hand Text	ZRQIS0002 - "WBS Element"	Free Hand Text	Free Hand Text - Can pull from CJ20N	ZRQIS0003 - "Budgeted"
3								
4								
5								

(…vertical break in spreadsheet…)



	H	I	J	K	L	M	N	O
1	**FUNDING DOC AMOUNT**	**NERP PLANNED AMOUNT**	**Committed**	**Obligated**	**Expensed**	**Balance**	**WBS BALANCE**	**WSD**
2	ZRQIS0003 - "Budgeted"	ZRQIS0003 - "Planned"	ZRQIS0002 - "Commitments"	ZRQIS0002 - "Obligations"	ZRQIS0002 - "Val/COArea Cycy"	Formula	ZRQIS0003 - "Available Budget" only at top level	ZRQIS0003 - "Contract Start"
3			ZRQIS0003 - "Commitments"	ZRQIS0003 - "Obligations"	ZRQIS0003 - "Actual Costs"	Formula		
4								
5								

(…vertical break in spreadsheet…)



	O	P	Q	R	S	T	U	V
1	**WSD**	**WCD**	**Project**	**FY**	**APPN**	**PE / BLI**	**PU / OSIP**	**Sponsor**
2	ZRQIS0003 - "Contract Start"	ZRQIS0003 - "Contract End Date"	Free Hand Text	ZRQIS0003 - can be extracted from "Appropriation"... 3rd digit coresponds to FY	ZRQIS0003 - "Appropriation"	Free Hand Text	Free Hand Text	Free Hand Text
3								
4								
5								

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APPENDIX E. USE CASES

A. UC.ALL.1 EXPORT REPORTS

User Story:

As the user, I want to export reports for all artifacts from the system.

Use Case:

Description: CAT users request the option to export information for printing or saving. The user needs to be able to choose which information should be included in the exported file by selecting information, such as funding graphs, personnel lists, or funding sheets, from his or her dashboard and select the destination for the exported file. Depending on the type of report, the format will either be in Microsoft Excel (.xlsx), Microsoft Word (.docx), or Microsoft PowerPoint (.pptx) formats.

Assumptions: CAT contains the information required for the artifact the user wants.

Participants: All users

Pre-conditions: The user is logged into the system.

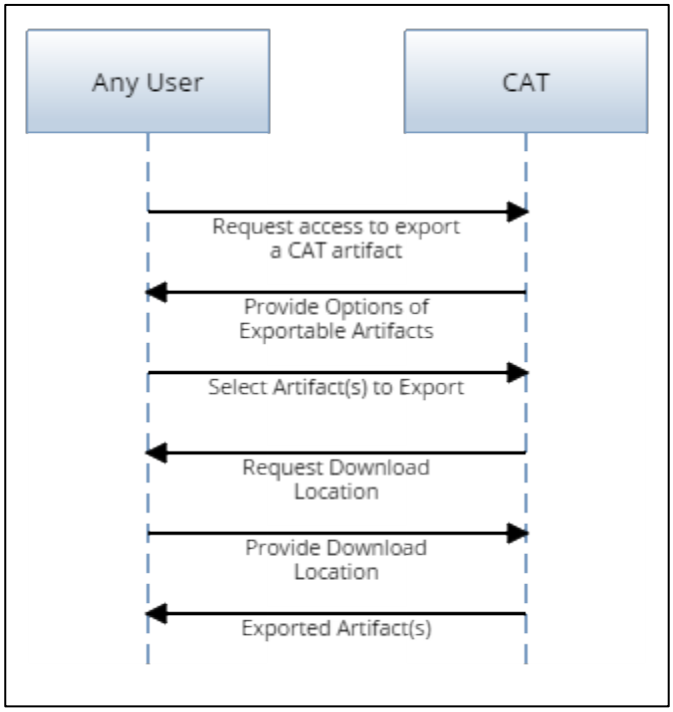
Post-conditions: CAT provides the exported artifact to the user in the required format.

Flows:

- Primary Flow:
    - User requests to export a CAT artifact
    - CAT provides options of artifacts that can be exported
    - User selects artifact(s) to export
    - User selects format of artifacts to export
    - CAT requests location to download artifact
    - User provides location
    - CAT provides exported artifact

- Use Case Diagram

- Sequence Diagram



B. UC.BFM.1 VIEW AND EDIT FUNDING STATUS SHEETS

User Story:

As the BFM, I want to view and edit a web-based copy of the funding status sheets (i.e., “Longsheets”).

Use Case:

Description: The BFM users want to be able to view a web-version of the Longsheets. The Longsheets, which are traditionally displayed in Microsoft Excel, include spreadsheets with projects’ funding information, Section 219 funding, Section 852 funding, expired funding, as well as time card expenditures. To enable the system to display the Longsheets, the system must first in some way ingest data from the different data sources, and then process and reformat the data. The Longsheets view should also be able to accept and save BFM textual input to the system.

Assumptions: The funding status data for the different projects has been provided to CAT.

Participants: BFM users

Pre-conditions: BFM is logged into CAT. The funding status data for the different projects has been provided to CAT.

Post-conditions: BFM user has completed making edits to Longsheets

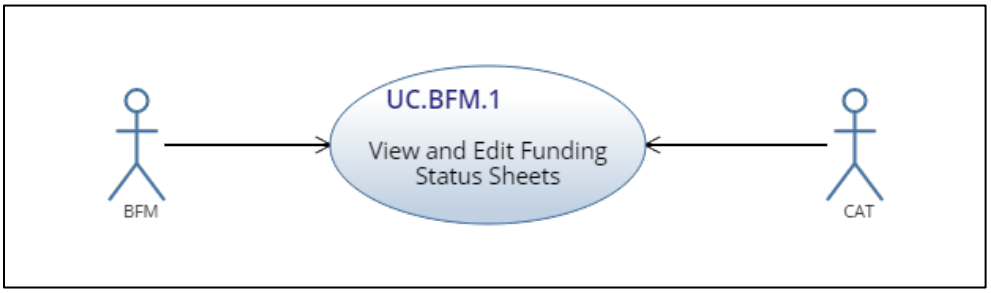
Flows:

- Alternative flow 1:
    - BFM requests Longsheet information
    - CAT provides funding type selection option
    - BFM requests projects’ Longsheet data
    - CAT provides general project funding information
    - BFM makes textual edits to fields requiring manual input
    - BFM provides save request
    - CAT provides save functionality
    - BFM requests Section 219 funding information.

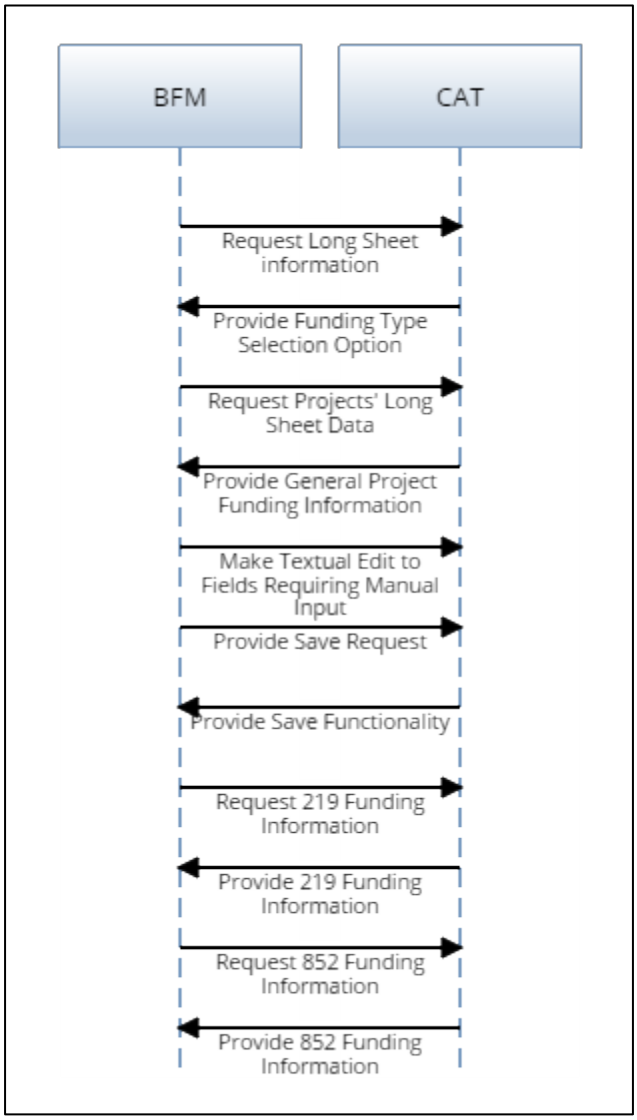
- CAT provides Section 219 funding information
- BFM requests Section 852 funding information
- CAT provides Section 852 funding information

- Alternate flows 2-n:
  - BFM requests Longsheet information
  - CAT provides funding type selection option
    - BFM may choose any combination in which to view the different areas of funding information. BFM may also choose to edit and save manual fields in any order.

- Use Case Diagram



- Sequence Diagram



C. UC.PM&BH.1 CREATE SCHEDULE ITEMS AND ASSIGN COMPLETION DATES

User Story:

- As the PM or BH, I want to be able to create schedule items.
- As the PM or BH, I want to assign projected completion dates for all schedule items.
- As the BH, I want to be able to accept or deny schedule items' completion dates proposed by the PM.

Use Case:

Description: CAT will allow for project manager and branch head users to create schedule items such as milestones and deliverables to track project schedule. Milestones and deliverables will be treated the same by the system; however, to the users, a deliverable will represent an artifact that is the output a specific project. A milestone, on the other hand, will represent meetings and reviews of interest.

For the purposes of CAT, schedule items are items with specific dates and names. They are tied to a specific project and are currently typically created by a PM in a project plan that is submitted to the BH. CAT will simply retain and present the names and dates associated with the milestone or deliverable; not the actual work being conducted to satisfy a milestone or deliverable. This functionality is considered to be beyond the scope of CAT.

BH users will provide specific milestone and deliverable items they expect a project manager to meet or complete. PM users will be able to create additional schedule items that are agreed upon by the project customer. PM users will also assign projected completion dates to each of the milestone/deliverable items created by the BH, as well as those created by the PM. The updated list of milestone/deliverable items with completion dates will be submitted to the branch head for approval.

It is anticipated that in most cases, the PM will create the plan for a project that consists of the schedule items, submit the plan (via CAT) to the BH, who then approves

the milestones, deliverables, and their associated dates, or possibly makes changes as he sees fit. CAT will inform the PM of approval, changes, or rejections to the PM's plan.

Assumptions: PM and BH users need to create schedule items for a project. Project profiles have been created in CAT.

Participants: PM and BH users

Pre-conditions: User is logged in.

Post-conditions: Branch head has approved all projected completion dates

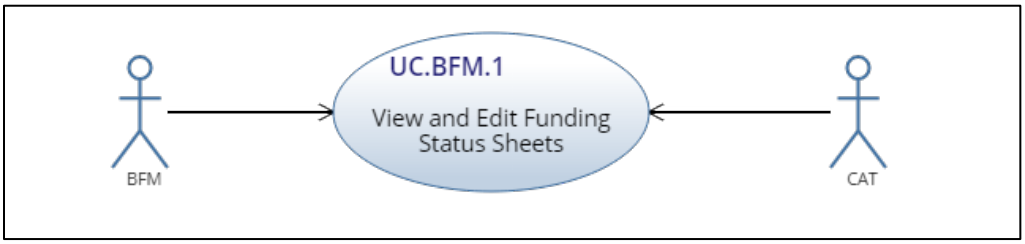
Flows:

- Primary Flow:
    - BH selects a specific project
    - BH requests option to enter schedule items
    - CAT provides option to enter schedule items
    - BH enters schedule items name
    - BH specifies whether the item is a milestone or a deliverable
    - BH requests schedule item be sent to PM
    - CAT sends new schedule item to PM
    - CAT alerts PM of a new schedule item
    - PM enters projected completion date for schedule item
    - PM requests projected completion date be sent to BH
    - CAT sends projected completion date to BH
    - CAT alerts BH of an updated projected completion date
    - BH approves projected completion date
    - CAT alerts PM of approval
- Alternate Flow: PM enters new schedule item
    - PM requests option to enter schedule item
    - CAT provides option to enter schedule item
    - PM enters schedule item name
    - PM specifies whether the item is a milestone or a deliverable

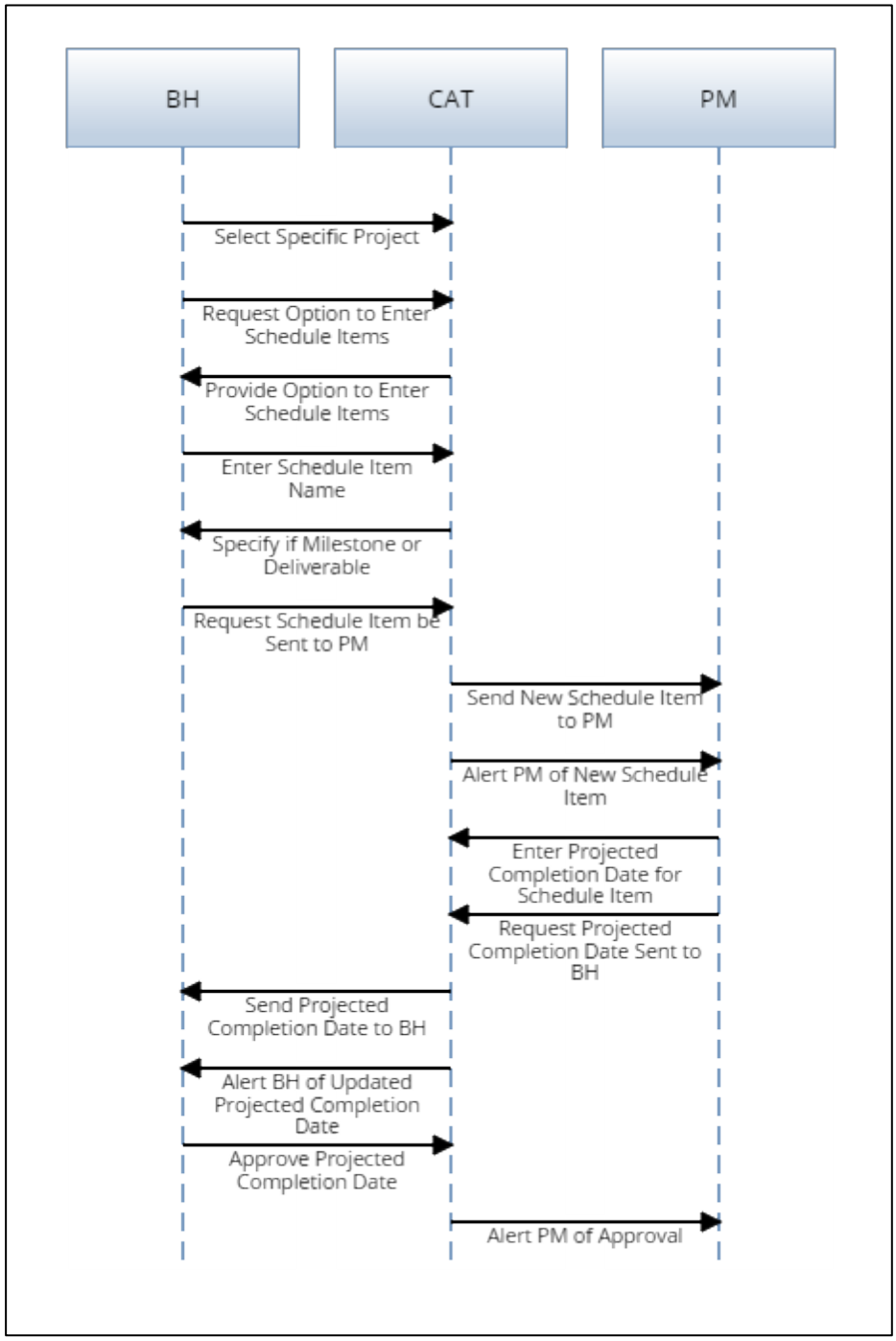
- PM enters projected completion date
- PM indicates completion of entering schedule item
- CAT sends new schedule item to BH
- CAT alerts BH of a new schedule item
- BH approves new schedule item
- CAT alerts PM of approval

- Alternate Flow: BH rejects schedule item
  - BH selects alert
  - CAT displays project page with required options to change, accept, or reject project items created by the PM
  - BH rejects new schedule item or a projected completion date
  - BH provides an explanation
  - CAT informs PM of rejected schedule item
  - CAT provides PM the BH explanation

- Use Case Diagram



- Sequence Diagram



D. UC.PM&BH.2 RECEIVE ALERTS WHEN ITEMS ARE COMING DUE

User Story:

As the PM or BH, I want to receive alerts when schedule items are marked as complete.

Use Case:

Description: PM and BH users request that CAT alert them when an item is coming due. The PM and BH users will have to specify how long before an item is due that CAT should alert them. Users may specify in their user settings the default time period for this which can be changed when creating a new milestone or deliverable. The alert can also be turned off.

Assumptions: The milestone or deliverable is already in CAT. The users have specified how long before an item is due that he or she should be alerted. CAT will know what date it is and will be able to calculate when the next milestone/deliverable is coming due.

Participants: PM and BH users

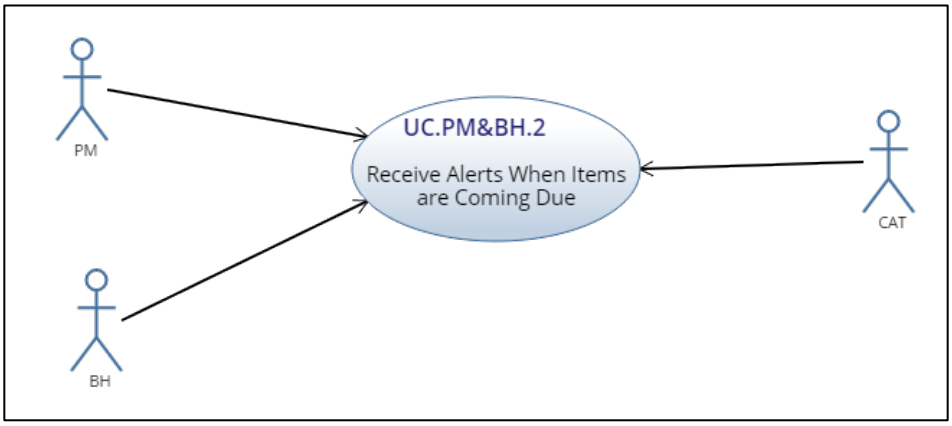
Pre-conditions: User is logged in.

Post-conditions: A due-date alert has been sent to the PM and BH users

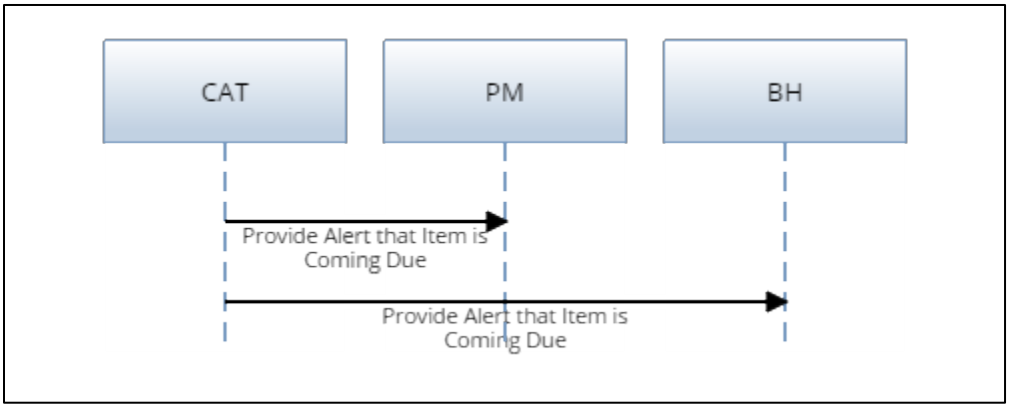
Flows:

- Primary Flow:
    - CAT provides alert to PM user that an item is coming due
    - CAT provides alert to BH user that an item is coming due

- Use Case Diagram



- Sequence Diagram



E. UC.PM&BH&SL.1 VIEW SCHEDULE ITEMS TIMELINE

User Story:

As the PM, BH or SL, I want to see projects' schedule items on a timeline.

Use Case:

Description: PM, BH, and SL users request the option to be able to see all project schedule items in a list and in a timeline view. The list will have the name of the item, whether the item is a milestone or a deliverable, as well as its projected completion date. The timeline will display the same information; however, it will display the information chronologically in a timeline.

Assumptions: The milestone/deliverable has been entered into CAT, and has been approved by the BH user.

Participants: PM, BH, and SL users

Pre-conditions: The milestone/deliverable has been entered into CAT, and has been approved by the BH user.

Post-conditions: The user has completed viewing the schedule items

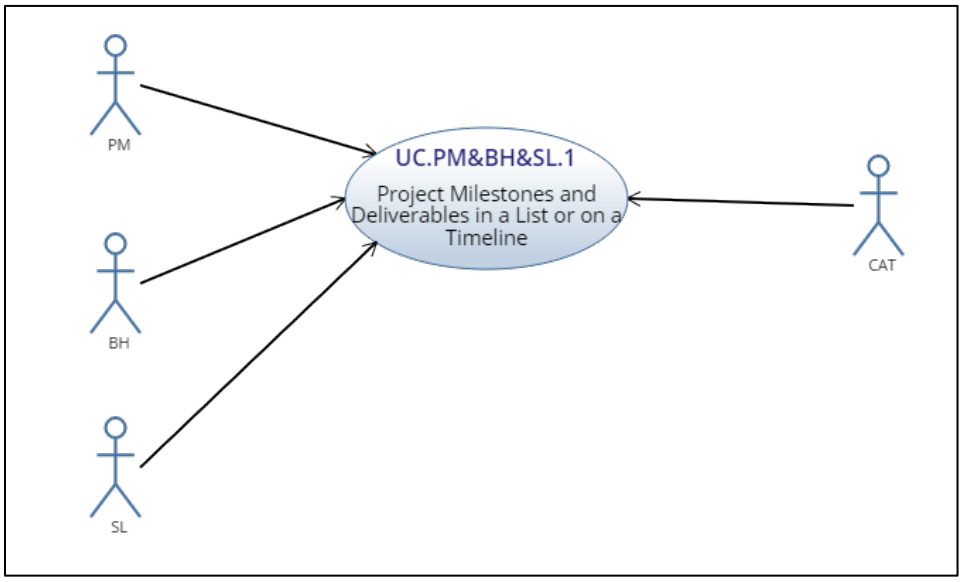
Flows:

- Primary Flow: PM view
    - PM requests a view of schedule items for the project
    - CAT provides a tabular view
    - CAT provides a timeline view
    - PM specifies date range to view schedule items
    - CAT displays schedule items for the specific date range
- Primary Flow: BH view
    - BH requests a view of schedule items
    - CAT provides a tabular view of multiple projects' schedule items
    - CAT provides an aggregated timeline view of multiple projects' schedule items

- BH requests schedule items for a specific project
- CAT provides a tabular view
- CAT provides a timeline view
- BH specifies date range to view schedule items
- CAT displays schedule items for the specific date range

- Primary Flow: SL view
  - SL requests a view of schedule items
  - CAT provides a tabular view of multiple projects' schedule items
  - CAT provides an aggregated timeline view of multiple projects' schedule items
  - SL requests milestones/deliverables for a specific project
  - CAT provides a tabular view
  - CAT provides a timeline view
  - SL specifies date range to view schedule items
  - CAT displays schedule items for the specific date range

- Use Case Diagram



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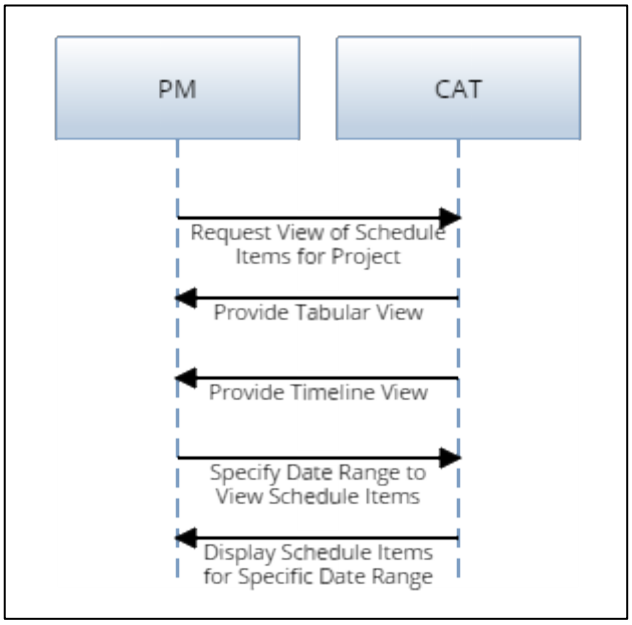


F. UC.PM&BH.3 MARK SCHEDULE ITEMS AS COMPLETE

User Story:

- As the PM, I want to mark when schedule items are completed.
- As the BH, I want to receive alerts when schedule items are marked as complete.

Use Case:

Description: BH users request receiving alerts when a schedule items is marked as complete.

Assumptions: Milestone or deliverable exists in CAT

Participants: PM and BH users

Pre-conditions: User is logged in.

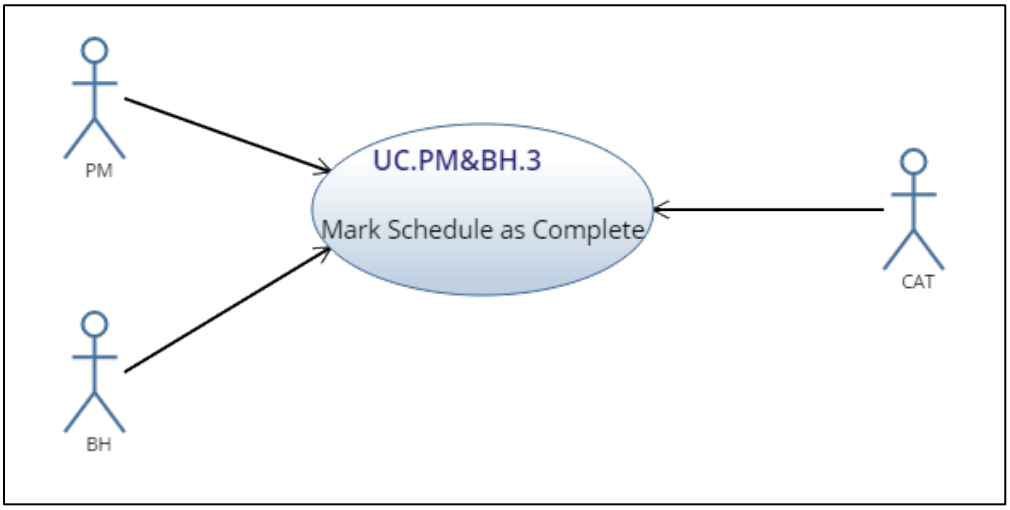
Post-conditions: An alert has been sent to the BH user

Flows:

- Primary Flow:
  - PM requests project schedule items list
  - CAT provides schedule items list
  - PM marks schedule items as complete
  - CAT sends completion alert to BH
- Alternate Flow: Due date has occurred
  - CAT alerts PM if a schedule item's due date has occurred
  - PM marks schedule item as complete
  - CAT send completion alert to BH
- Alternate Flow:
  - CAT alerts BH if a schedule items due date is past due
  - CAT provides option for BH to send message to appropriate PM inquiring as to status of schedule items
  - BH selects option to send PM status inquiry

- PM views status inquiry alert
- PM sets new projected completions date
- CAT sends alert to BH with new projected completion date

- Use Case Diagram



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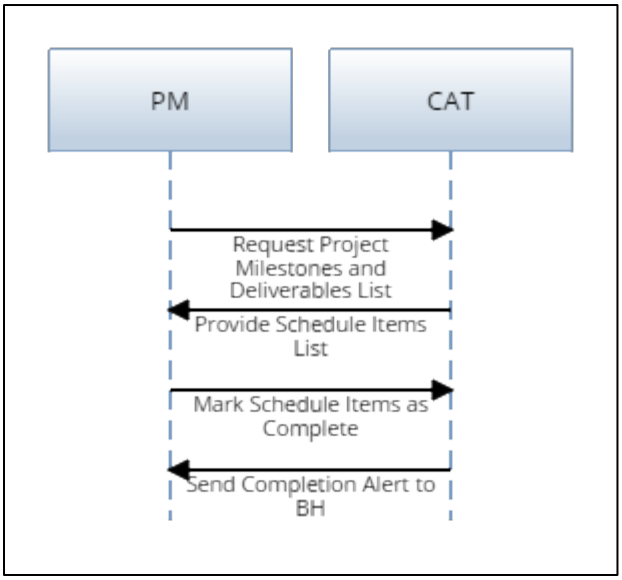


G. UC.BH&SL.1 VIEW PERSONNEL UTILIZATION

User Story:

- As the BH or SL, I want to view personnel utilization for projects over a period of time.

Use Case:

Description: To make decisions regarding hiring levels, project manning, BH and SL users request insight into percentage utilization of personnel by project. BH users request insight for all projects that are in the specific branch; whereas SL request information for all projects. To avoid being overwhelmed by the number of projects, SL requests a view for aggregated percentage utilization versus the ideal utilization of personnel by division and by branch. The ideal utilization should be 100% for each worker for each fiscal year. BH users also request a percentage utilization versus ideal utilization indicator for their specific branch. This information allows for a quick understanding of how much effort is potentially available for new projects, and if hiring decisions need to be considered.

Assumptions: Personnel have been assigned to projects at the branch level.

Participants: PM and SL users

Pre-conditions: User is logged in.

Post-conditions: User has completed viewing personnel utilization. User is aware of whether the branch/competency is under/overmanned.

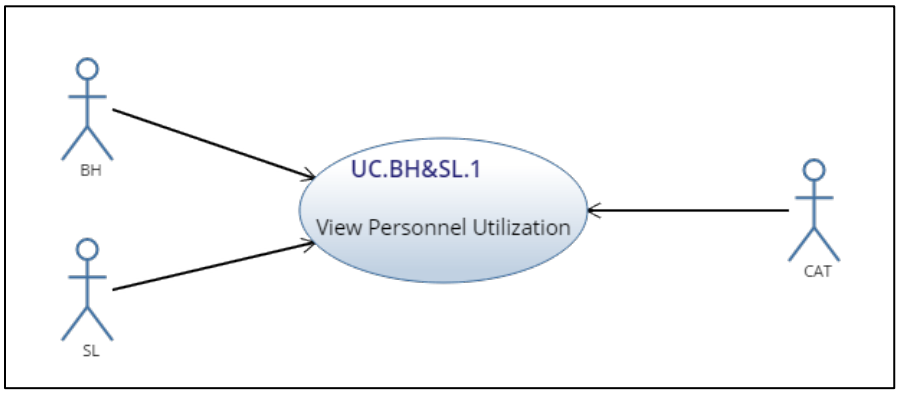
Flows:

- Primary Flow: BH views utilization
    - BH requests personnel utilization for the branch
    - BH provides a specific date range
    - CAT provides actual versus ideal utilization
    - CAT displays a list of personnel with their percentage utilization and assigned projects

- BH requests to view a personnel assignment information for a specific project
- CAT displays workers on a specific project
- CAT displays percentage of workers' time assigned for project

- Alternate Flow: SL views utilization
  - SL requests utilization of personnel for the competency
  - SL provides a specific date range
  - CAT provides actual versus ideal utilization at the competency level
  - SL requests utilization of personnel at the division level
  - CAT provides actual versus ideal utilization at the division level
  - SL requests utilization of personnel at the branch level
  - CAT provides actual versus ideal utilization at the branch level
  - SL requests utilization for a specific branch
  - CAT provides actual versus ideal utilization for the branch
  - CAT provides a list of personnel with their percentage utilization and assigned projects

- Use Case Diagram



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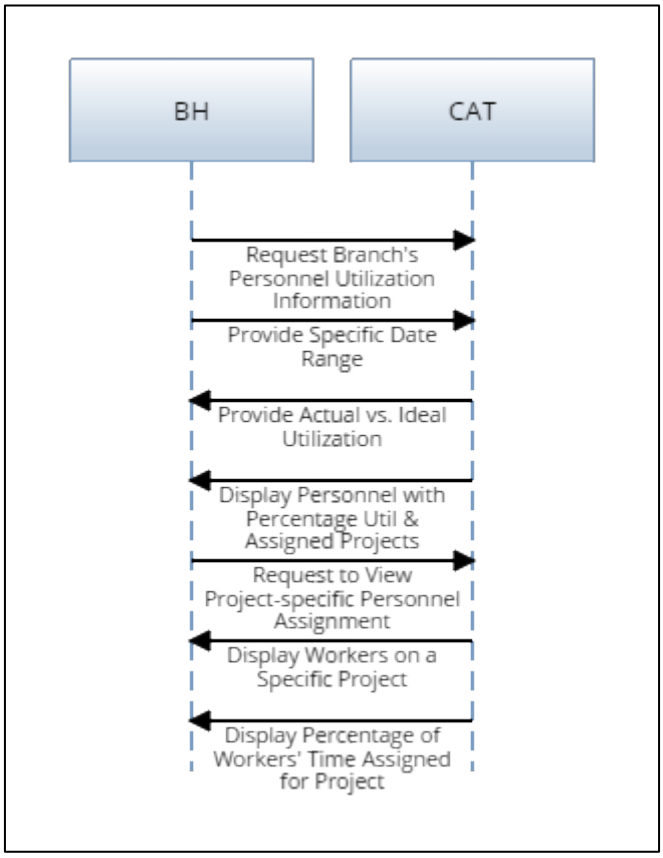


H. UC.BH.1 ASSIGN PERSONNEL TO PROJECTS

User Story:

- As the BH, I want to assign personnel to projects.
- As the BH, I want to assign project managers to projects.

Use Case:

Description: The Branch Head manages which personnel are assigned to which projects. When a new project comes up or people are added to the competency, people must be assigned to a project. People may be assigned to more than one project. If so, a certain amount of their time will be assigned to one project and a certain amount of time to another. The BH is responsible for making these decisions. The Branch Head needs to be able to see what people have available time for an upcoming project and for how much of that project ‘ll have time available. Workers may be over 100% utilized. In this case, CAT shall inform the BH of that status.

Assumptions: Personnel and projects exist in CAT

Participants: BH users

Pre-conditions: User is logged in.

Post-conditions: BH has completed assigning people to projects

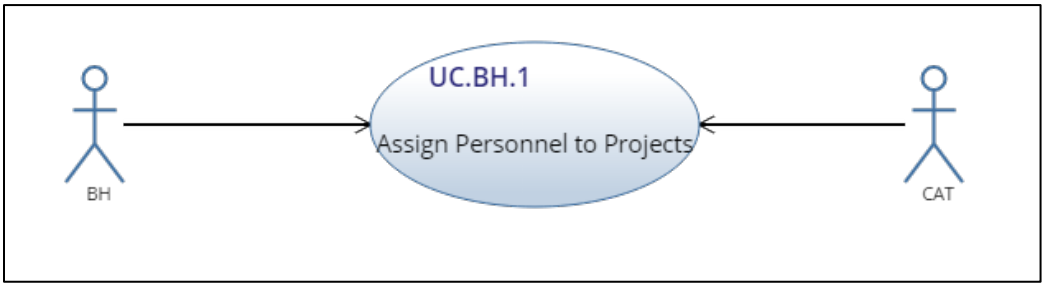
Flows:

- Primary Flow:
    - BH requests list of projects
    - CAT provides BH a list of projects
    - BH requests a list of personnel
    - CAT provides BH a list of personnel
    - BH assigns a person to a project
    - BH assigns a time period for the person
    - BH assigns percentage utilization for the person
    - BH indicates that personnel assignment is complete

- Alternate Flow: Person Over-allocated
    - BH requests list of projects
    - CAT provides BH a list of projects
    - BH requests a list of personnel
    - CAT provides BH a list of personnel
    - BH assigns a person to a project
    - BH assigns a time period for the person
    - BH assigns percentage utilization for the person
    - CAT indicates that the person is over-utilized
    - BH indicates that assignment is complete
- Alternate Flow: Assign PM to a project
    - BH requests list of projects
    - CAT provides BH a list of projects
    - BH requests a list of personnel
    - CAT provides BH a list of personnel
    - CAT provides BH utilization for each person
    - BH assigns a person to a project
    - BH indicates that the person is a PM
    - BH assigns a time period for the person
    - BH assigns percentage utilization for the person
    - BH indicates that assignment is complete
    - PM receives a notification of being assigned
- Alternate Flow: BH assigns projects to person
    - BH requests list of personnel
    - CAT provides BH a list of personnel
    - CAT provides BH utilization for each person
    - BH requests a list of projects
    - CAT provides BH a list of projects
    - BH assigns a project to a person
    - BH assigns a time period for the assignment

- BH assigns percentage utilization for the person
- BH indicates that assignment is complete

- Use Case Diagram



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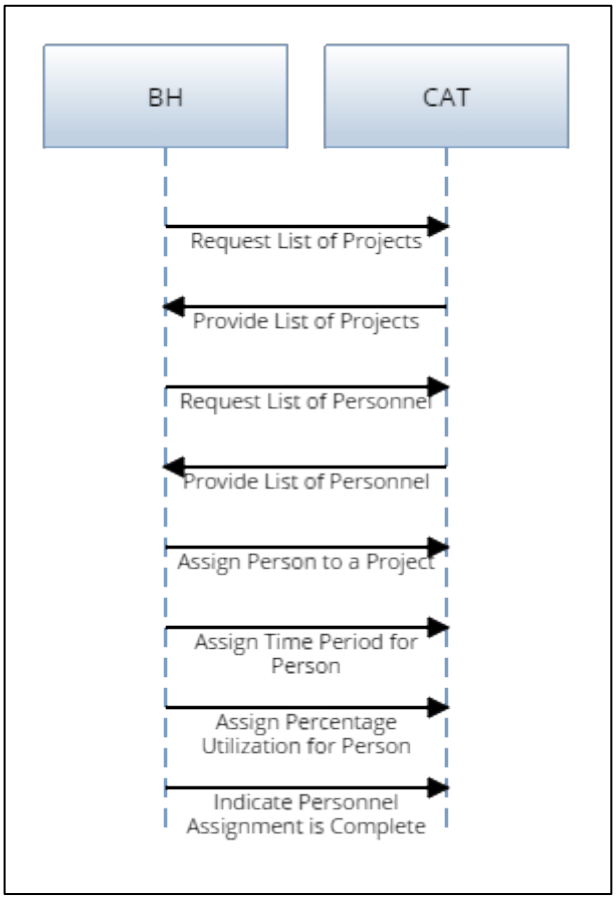


I. UC.SL.1 VIEW COMPETENCY MANNING LEVELS

User Story:

As SL, I want to view the competency's manning levels.

Use Case:

Description: At the highest competency level, senior leadership requests to track staffing allocation. Staffing consists of the civilian personnel assigned to the competency, broken down into NAVAIR Headquarters (HQ) employees as well as the workforce of the two major NAVAIR divisions- the Naval Air Warfare Center Aircraft Division (NAWCAD) and Naval Air Warfare Center Weapons Division (NAWCWD). Each component has a target manning level, which needs to be compared to the actual current employee population, and tracked over the course of the fiscal year to ensure each division is properly manned over time. Current and target civilian staffing levels are imported into CAT from Command Staffing.

Assumptions: A live connection exists between CAT and Command Staffing

Participants: SL users

Pre-conditions: Personnel information has been pulled from Command Staffing by CAT and assigned to division and branch levels. Division and branch breakdown has been specified in CAT.

Post-conditions: SL has completed viewing manning levels

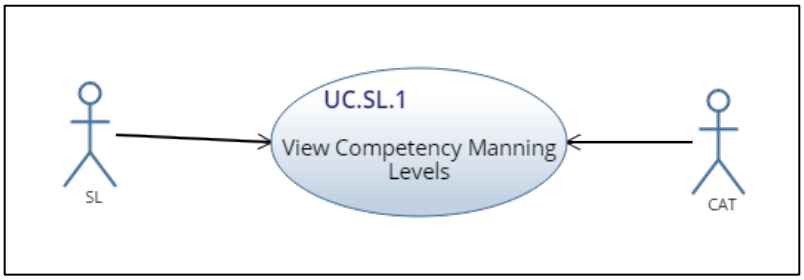
Flows:

- Primary Flow:
    - SL requests the number of people breakdown by NAWCAD versus NAWCWD versus NAVAIR HQ
    - CAT provides a breakdown of people by NAWCAD versus NAWCWD versus NAVAIR HQ
    - CAT provides a target manning level
    - SL requests the number of people by division
    - CAT provides a breakdown of people by division

- SL requests the number of people by branch
- CAT provides a breakdown of people by branch

- Alternate Flow: CAT needs to access Command Staffing for a list of personnel
  - SL requests the number of people breakdown by NAWCAD versus NAWCWD versus NAVAIR HQ
  - CAT requests Command Staffing to provide a list of all competency personnel
  - CAT provides a breakdown of people by NAWCAD versus NAWCWD versus NAVAIR HQ
  - CAT provides a target manning level
  - SL requests the number of people by division
  - CAT provides a breakdown of people by division
  - SL requests the number of people by branch

- Use Case Diagram



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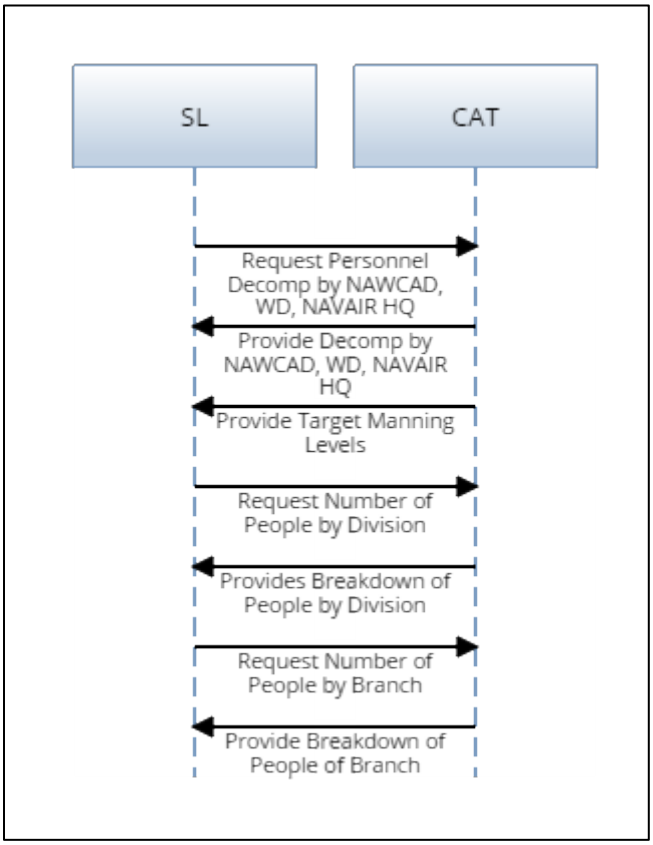


J. UC.PM.1 ENTER STATUS ITEM INFORMATION

User Story:

As the PM, I want to provide project status item information.

Use Case:

Description: BH and SL users request that PM users provide project status item information that has the name of the status item, as well as the urgency. CAT is not intended to be a risk management tool; as such, instead of associating project risks with likelihood and consequence values, CAT will only require urgency information. The urgency will subjectively be labelled with green, yellow, or red colors. This will quickly allow for the different levels of management to view status item information at a glance. Once a status item is specified by the PM, CAT will provide an alert to the BH user indicating a new status item has been entered into CAT.

Assumptions: PM users need to enter project status updates for their BHs to view

Participants: PM and BH Users

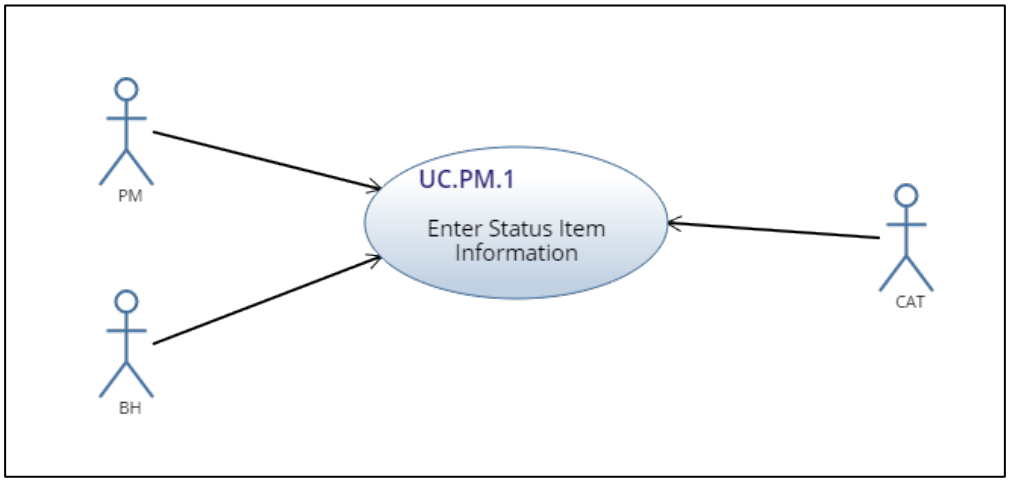
Pre-conditions: Project has been created within CAT

Post-conditions: An alert has been sent to the BH user

Flows:

- Primary Flow:
    - PM requests option to enter status items
    - CAT provides option to enter status items
    - PM provides status item name
    - PM provides status item description
    - PM provides status item urgency status
    - PM indicates completion of entering status items information
    - CAT alerts BH of a new status item

- Use Case Diagram



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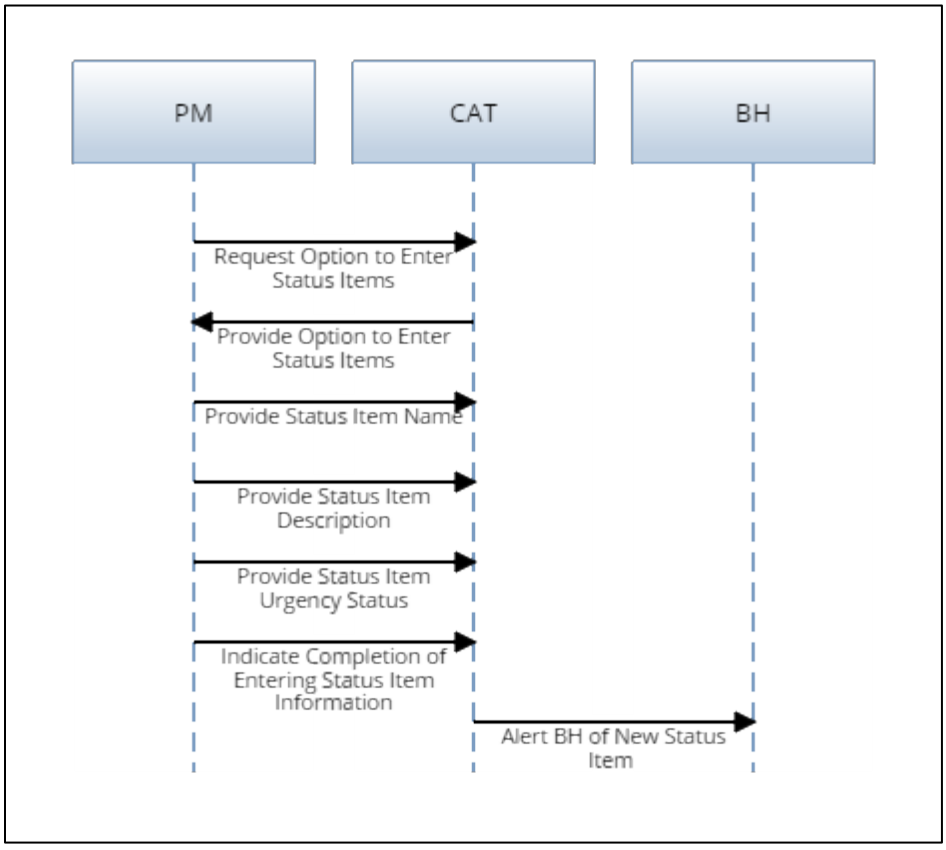


K. UC.PM&BH&SL.3 VIEW LIST OF STATUS ITEMS

User Story:

As the PM or BH, or SL, I want to view projects' status items with priority subjectively labelled as red, yellow, or green.

Use Case:

Description: BH and SL users request the capability to view all status items that a PM has entered for a project. Project managers input the status item name, description, and an urgency status to provide awareness to BH and SL users on potential issues during a project execution. Urgency status will be demonstrated by the colors red, yellow, green, with red representing the most urgent status item requiring attention and green representing the least urgent items requiring simply awareness from upper leadership.

Assumptions: Status Items are entered into CAT

Participants: PM, BH, and SL users

Pre-conditions: Status Items are entered into CAT

Post-conditions: User has completed viewing Status Items

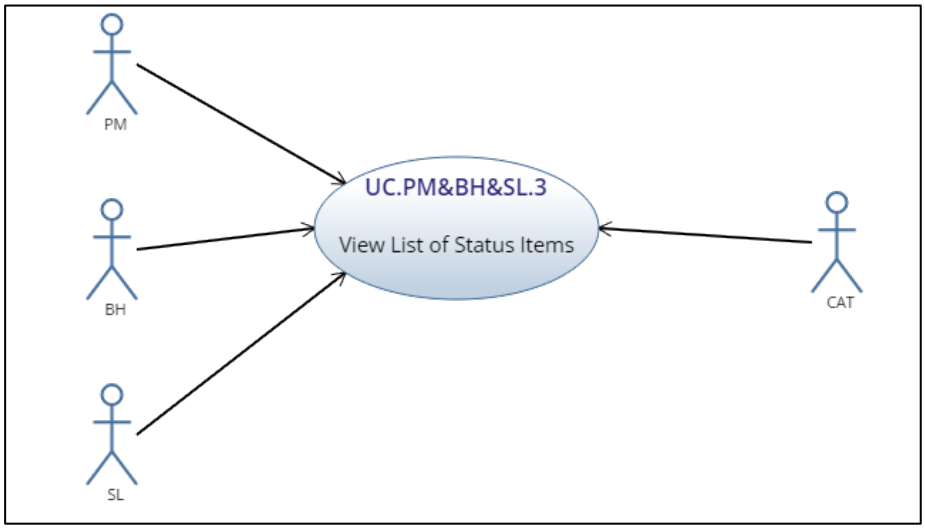
Flows:

- Primary Flow:
    - PM requests a view of project Status Items
    - CAT provides a tabular view of project Status Items
    - PM specifies specific type of urgency to view
    - CAT displays Status Items of only a certain urgency
- Primary Flow: BH view
    - BH requests a view of obstacles for branch's projects
    - CAT provides a tabular view of multiple projects' obstacles
    - BH requests Status Items for a specific project
    - CAT provides a tabular view of Status Items for a specific type
    - BH specifies specific type of urgency to view

    - CAT displays Status Items of only a certain urgency

- Primary Flow: SL view
    - SL requests a view of Status Items
    - CAT provides a tabular view of multiple projects' Status Items
    - SL requests Status Items for a specific project
    - CAT provides a tabular view of Status Items for a specific type
    - SL specifies specific type of urgency to view
    - CAT displays Status Items of only a certain urgency

- Use Case Diagram



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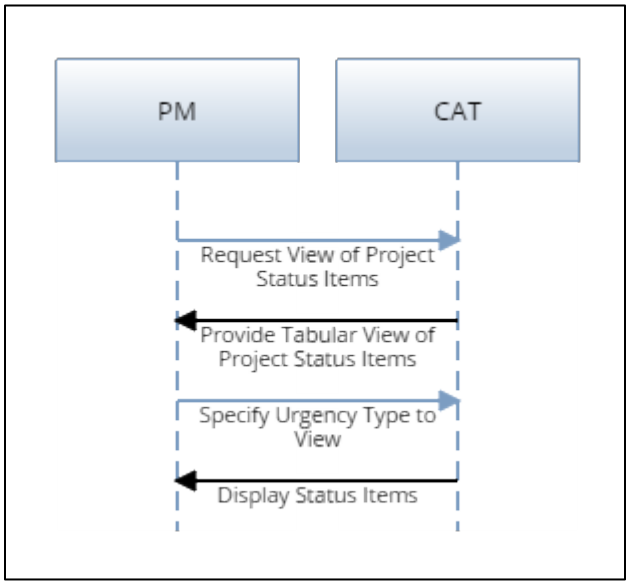


L. UC.PM.2 CREATE SPEND PLAN

User Story:

As the PM, I want to be able to create a spend plan in the system.

Use Case:

Description: To determine how to execute funds for a given project, PMs are required to create spend plans. Spend plans are used to track funding burndown. Such plans plan for expenditures by categories such as personnel labor, material, travel, or training. These plans are usually created for a given fiscal year and provided to BHs for approval.

Assumptions: PM users know the types of expenditures they are likely to incur in a fiscal year. Project exists in CAT.

Participants: PM, BH

Pre-conditions: User is logged in.

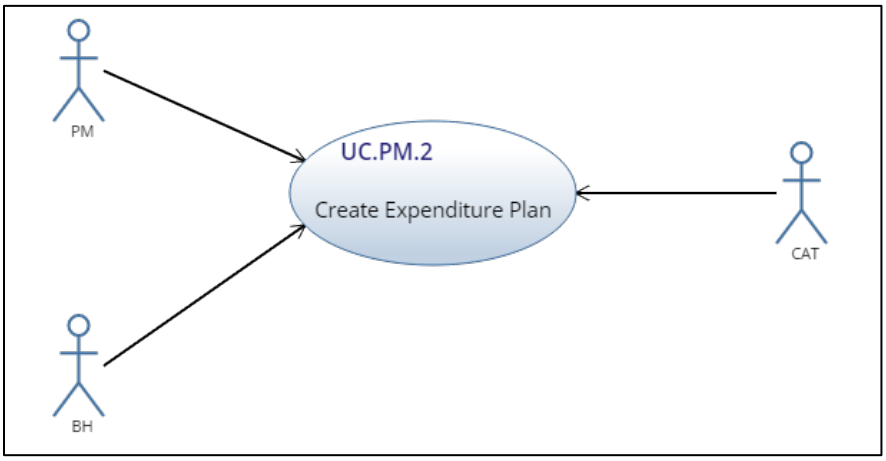
Post-conditions: BH is alerted regarding a new spend plan

Flows:

- Primary Flow:
  - PM requests spend plan creation option
  - CAT provides spend plan creation option
  - PM specifies plan start/end dates
  - PM specifies expenditure types
  - PM specifies expenditure amount
  - CAT provides summation calculation of expenditures
  - PM indicates completion of spend plan
  - CAT provides alert to BH
- Alternate Flow: Spend plan rejection
  - BH selects alert for new spend plan
  - CAT provides options to change, accept, or reject spend plan

- BH rejects spend plan
- BH provides an explanation
- CAT provides PM alert for spend plan
- PM selects alert
- CAT informs PM of rejected spend plan
- CAT provides PM the BH explanation

- Use Case Diagram



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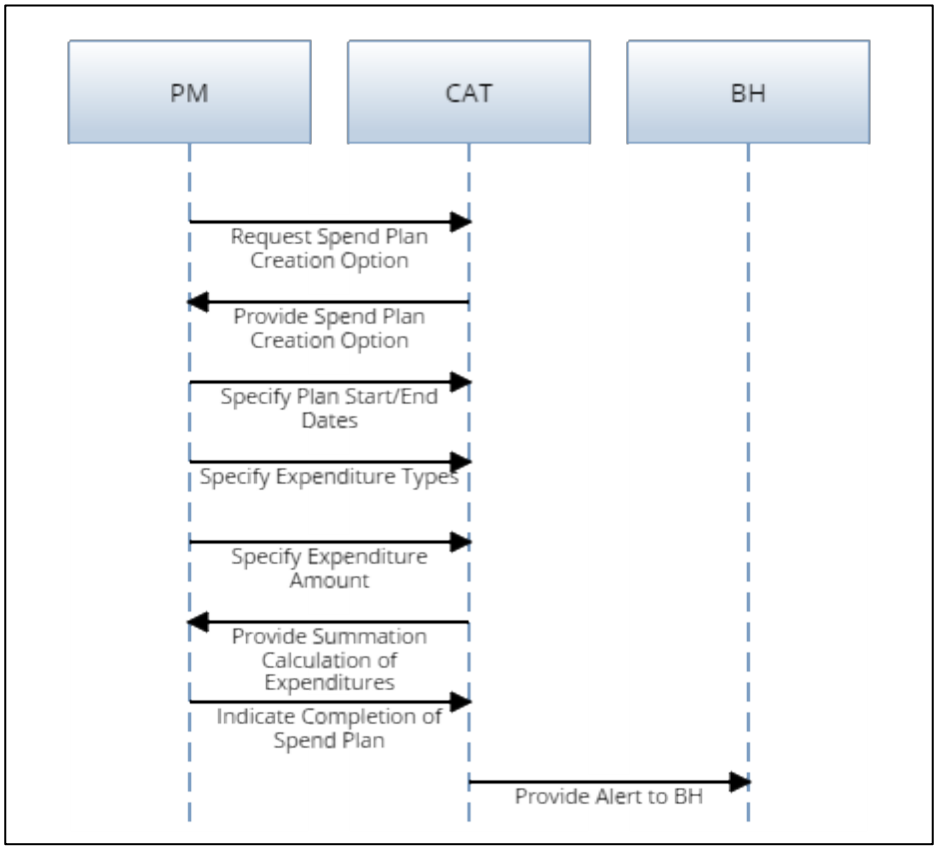


M. UC.PM&BH&SL.4 VIEW SPEND PLANS

User Story:

As the PM, BH or SL, I want to view projects' spend plans.

Use Case:

Description: To determine how to execute funds for a given project, PMs are required to create spend plans. Spend plans are used to track funding burndown. Such plans plan for expenditures by categories such as personnel labor, material, travel, or training. BH and SL users may want to view spend plans to verify that funding and resources have been appropriately accounted for in the planning of funding execution.

Assumptions: Spend plan has already been created and approved

Participants: PM, BH, SL

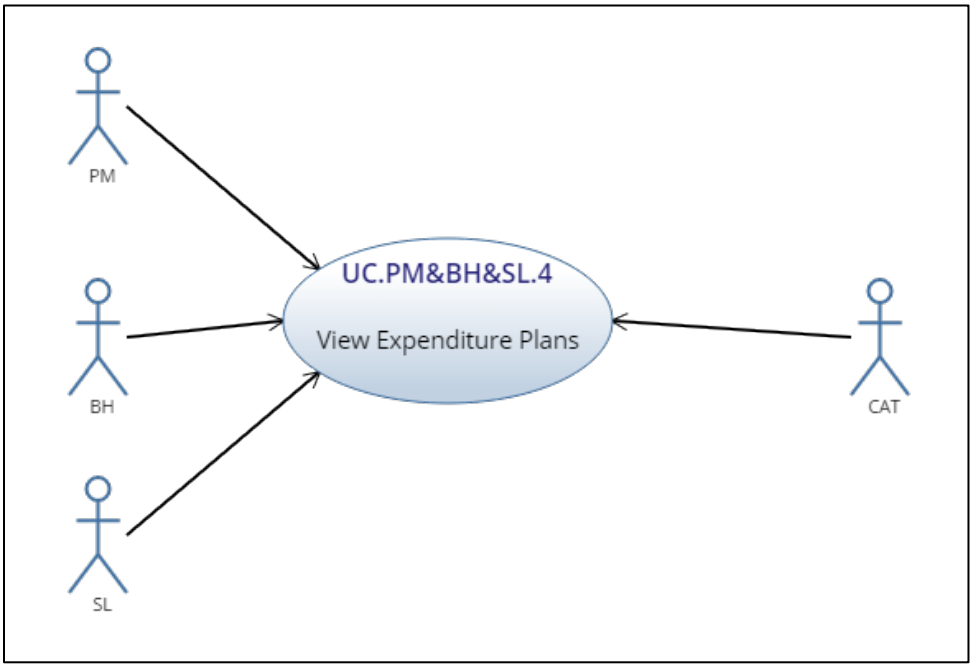
Pre-conditions: Spend plan has already been created and approved

Post-conditions: User is finished viewing spend plan

Flows:

- Primary Flow: PM View
  - PM requests spend plan
  - CAT provides spend plan
- Primary Flow: BH View
  - BH requests spend plan for specific project
  - CAT provides spend plan
- Primary Flow: SL View
  - SL requests spend plan for specific project
  - CAT provides spend plan

- Use Case Diagram



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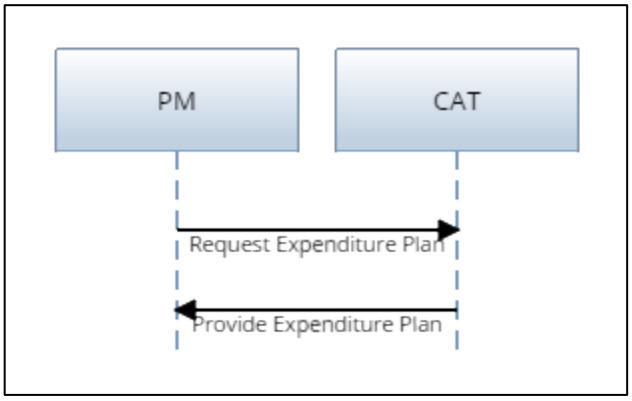


N. UC.PM&BH&SL.5 VIEW FUNDING EXPIRATION DATES

User Story:

As the PM, BH or SL, I want to view projects' funding expiration dates.

Use Case:

Description: Project funds have expiration dates that occur towards the end of a fiscal and/or calendar year. PM, BH, and SL request that CAT provide information regarding expiring funds so that resource allocation decisions may be made so that by the time funds are expiring the PM has executed close to 100% of project funds. PM and BH users also request that they receive alerts prior to funds expiring. Each user would specify to the system exactly how long before funds expiry the system should provide an alert.

Assumptions: Chargeable object numbers (CONs) exist and have been associated with specific projects. Each CON provides a balance for how much funding is available, as well as when that funding is expiring. CAT tracks the current date and determines if funds are close to expiring.

Participants: PM, BH, SL

Pre-conditions: User is logged in.

Post-conditions: User is finished viewing CONs' expiring funds

Flows:

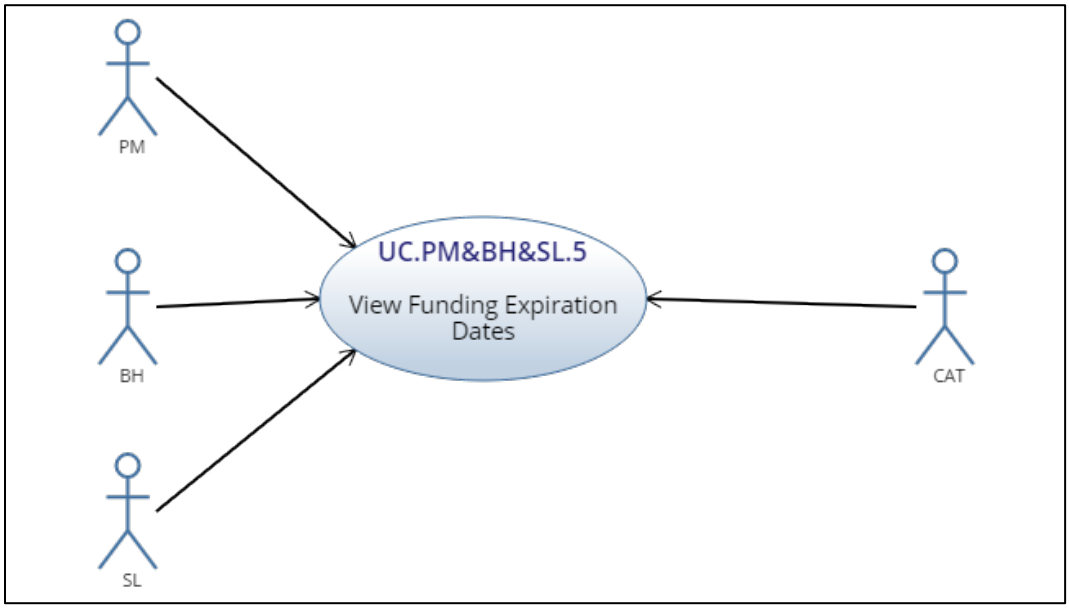
- Primary Flow: PM View
    - PM requests CON details
    - CAT provides CON name
    - CAT provides CON number
    - CAT provides CON balance
    - CAT provides CON expiration date
- Primary Flow: BH View
    - BH requests list of CONs associated with projects
    - CAT provides CONs associated with projects

    - BH requests CON details for specific project
    - CAT provides CON name
    - CAT provides CON number
    - CAT provides CON balance
    - CAT provides CON expiration date

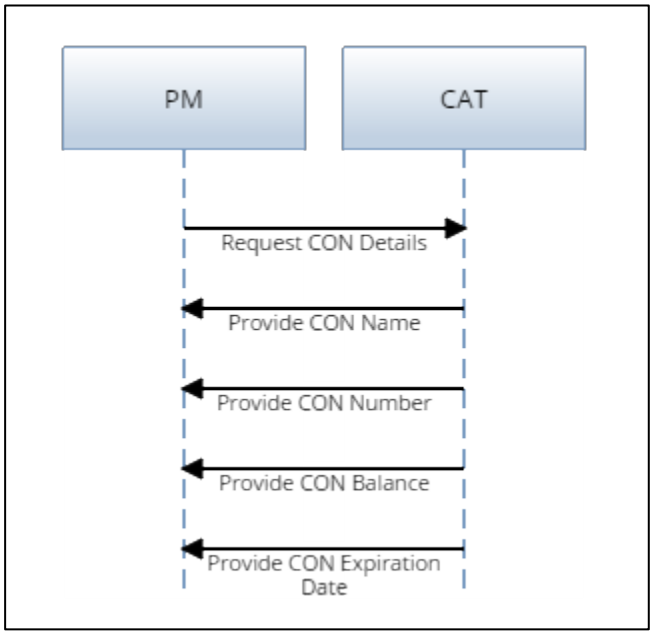
- Primary Flow: SL View
    - SL requests list of CONs associated with projects
    - CAT provides CONs associated with projects
    - SL requests CON details for specific project
    - CAT provides CON name
    - CAT provides CON number
    - CAT provides CON balance
    - CAT provides CON expiration date

- Alternate Flow: Expiration Alert
    - CAT provides alert to PM about expiring funds
    - CAT provides alert to BH about expiring funds

- Use Case Diagram



- Sequence Diagram



O. UC.PM&BH&SL.6 VIEW PLANNED VERSUS ACTUAL EXPENDITURES

User Story:

As the PM, BH or SL, I want to view projects' planned versus actual expenditures. I want to know, based off my current expenditure rate if I will over or under expend.

Use Case:

Description: To execute project funds as close to 100% as possible, PMs require an understanding of how their actual expenditures compare to their planned expenditures. BH and SL users also want to see aggregated planned versus actual expenditures at the division and branch levels, in addition to viewing planned versus actual expenditures at the project level. CAT should be able to indicate when funding will be fully expended, based on spending habits. Furthermore, CAT should also be able to calculate how far above or below the planned expenditure rate a project is and alert the user if it meets a user specified criteria.

Assumptions: Chargeable object numbers (CONs) exist and have been associated with specific projects. CAT has a live connection to external databases, such as NERP, to obtain updated expenditure information on CONs. A spend plan has already been created in the system.

Participants: PM, BH, SL

Pre-conditions: User is logged in

Post-conditions: User is finished viewing planned versus actual expenditures

Flows:

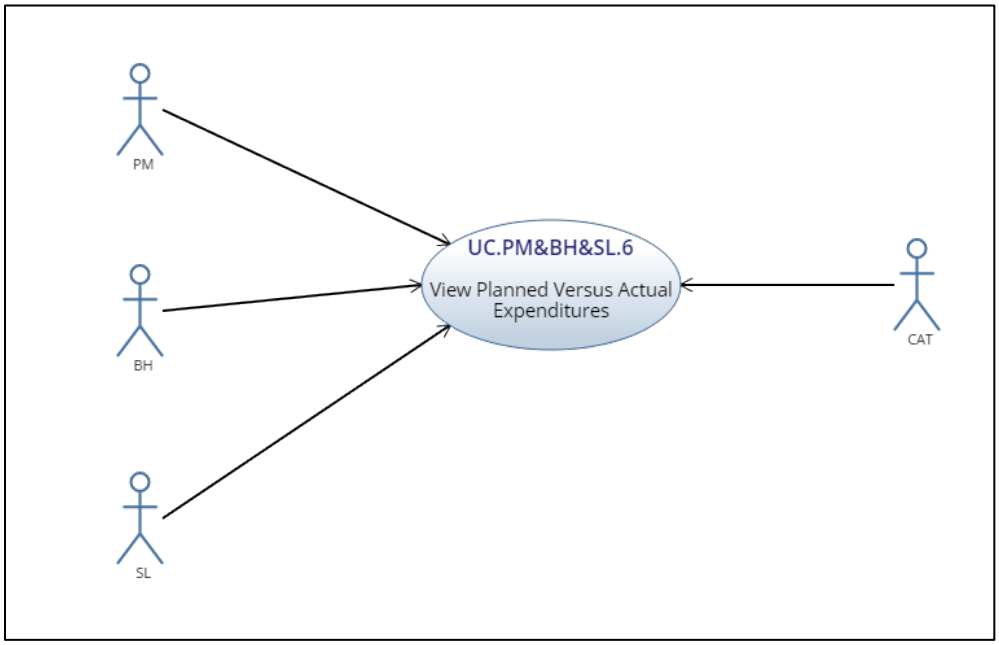
- Primary Flow: PM View
    - PM requests planned versus actual expenditures for a specific project
    - CAT displays planned versus actual expenditures
    - CAT displays forecasted projected funding completion date

    - CAT displays over/under-expenditure bounds

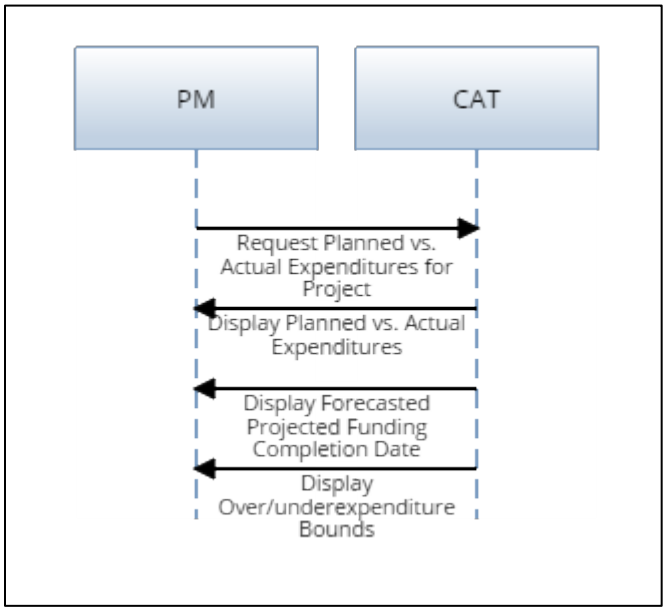
- Primary Flow: BH View
    - BH requests aggregated planned versus actual expenditures at the branch level
    - CAT displays aggregated planned versus actual expenditures at the branch level
    - BH requests planned versus actual expenditures for a specific project
    - CAT displays planned versus actual expenditures
    - CAT displays forecasted projected funding completion date
    - CAT displays over/under-expenditure bounds

- Primary Flow: SL View
    - BH requests aggregated planned versus actual expenditures for a specific division
    - CAT displays aggregated planned versus actual expenditures at the division level
    - BH requests aggregated planned versus actual expenditures for a specific branch
    - CAT displays aggregated planned versus actual expenditures at the branch level
    - SL requests planned versus actual expenditures for a specific project
    - CAT displays forecasted projected funding completion date
    - CAT displays over/under-expenditure bounds

- Use Case Diagram



- Sequence Diagram



P. UC.PM&BH&SL.2 VIEW PROJECTS UNDER PURVIEW

User Story:

As the PM, BH, or SL, I want to see all projects for which I have permission.

Use Case:

Description: In order for users to obtain the information that they need to make management decisions, they need to be able to view all the projects' profiles that they have permission to view. Furthermore, the system must be able to ensure that any users that do not need to view other users' projects are not able to view those projects.

Assumptions: Project profile exists, and a schema has been set up to determine who has access to view specific projects' profiles and data.

Participants: PM, BH, SL

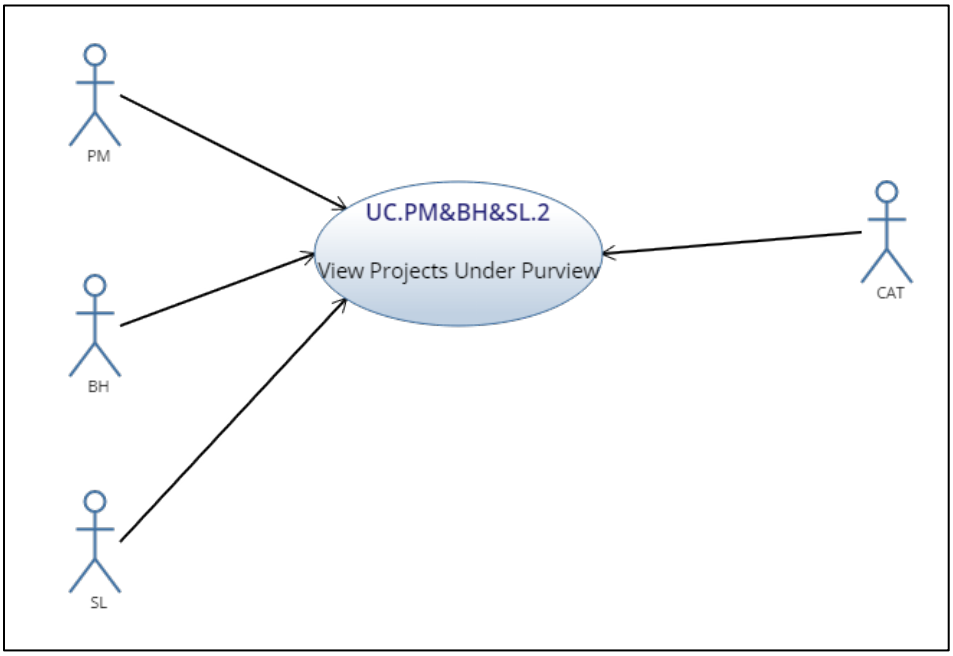
Pre-conditions: User is logged in

Post-conditions: User is finished viewing project

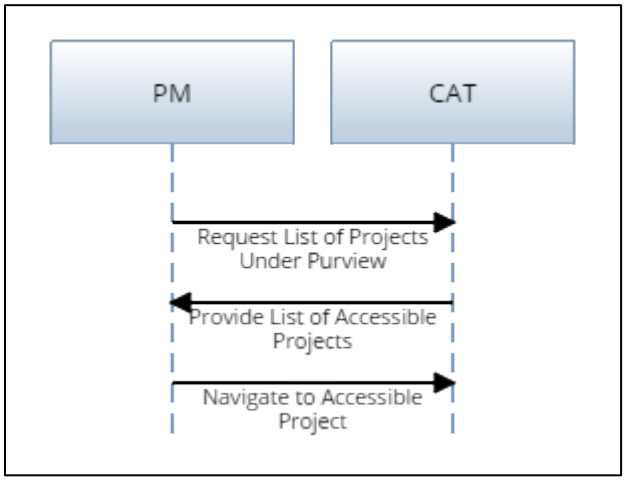
Flows:

- Primary Flow: PM
    - PM requests list of projects under purview
    - CAT provides list of accessible projects
    - PM navigates to accessible project
- Primary Flow: BH
    - BH requests list of projects under purview
    - CAT provides list of accessible projects
    - BH navigates to accessible project
- Primary Flow: SL
    - SL requests list of projects under purview
    - CAT provides list of accessible projects
    - SL navigates to accessible project

- Use Case Diagram



- Sequence Diagram



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APPENDIX F. TRACEABILITY BETWEEN USER STORIES AND USE CASES

User Story Number	User Story Name	Use Case Number	Use Case Name
US.F.1	View Funding Expiration Information	UC.PM&BH&SL.5	View Funding Expiration Dates
US.F.2	View Spend plans	UC.PM&BH&SL.4	View Spend plans
US.F.3	View Planned versus Actual Expenditures	UC.PM&BH&SL.6	View Planned Versus Actual Expenditures
US.F.4	Create Spend plan	UC.PM.2	Create Spend plan
US.F.5	View and Edit All Funding Status Sheets	UC.BFM.1	View and Edit Funding Status Sheets
US.G.1	Export Reports	UC.ALL.1	Export Reports
US.G.2	View All Projects Under Purview	UC.PM&BH&SL.2	View Projects Under Purview
US.SI.1	View List of Status Items	UC.PM&BH&SL.3	View List of Status Items
US.SI.2	Enter Status Item Information	UC.PM.1	Enter Status Item Information
US.P.1	Assign personnel to projects	UC.BH.1	Assign Personnel to Projects
US.P.2	Assign Project Manager to a project	UC.BH.1	Assign Personnel to Projects
US.P.3	View Personnel Utilization	UC.BH&SL.1	View Personnel Utilization
US.P.4	View Competency Manning Levels	UC.SL.1	View Competency Manning Levels
US.S.1	Create Schedule Items	UC.PM&BH.1	Create Schedule Items and Assign Completion Dates
US.S.2	Accept/Deny Proposed Completion Dates	UC.PM&BH.1	Create Schedule Items and Assign Completion Dates
US.S.3	Assign Projected Completion Dates	UC.PM&BH.1	Create Schedule Items and Assign Completion Dates
US.S.4	View Schedule Items List	UC.PM&BH&SL	Project Schedule Items in a List or on a Timeline

User Story Number	User Story Name	Use Case Number	Use Case Name
US.S.5	Receive Alert for Completed Schedule Items	UC.PM&BH.3	Mark Schedule as Complete
US.S.6	Mark when items are completed	UC.PM&BH.3	Mark Schedule as Complete
US.S.7	Receive Alert when items are coming due	UC.PM&BH.2	Receive Alerts When Items are Coming Due
US.S.8	View Schedule Items Timeline	UC.PM&BH&SL	Project Schedule Items in a List or on a Timeline

APPENDIX G. CAT AFFINITY DIAGRAMS

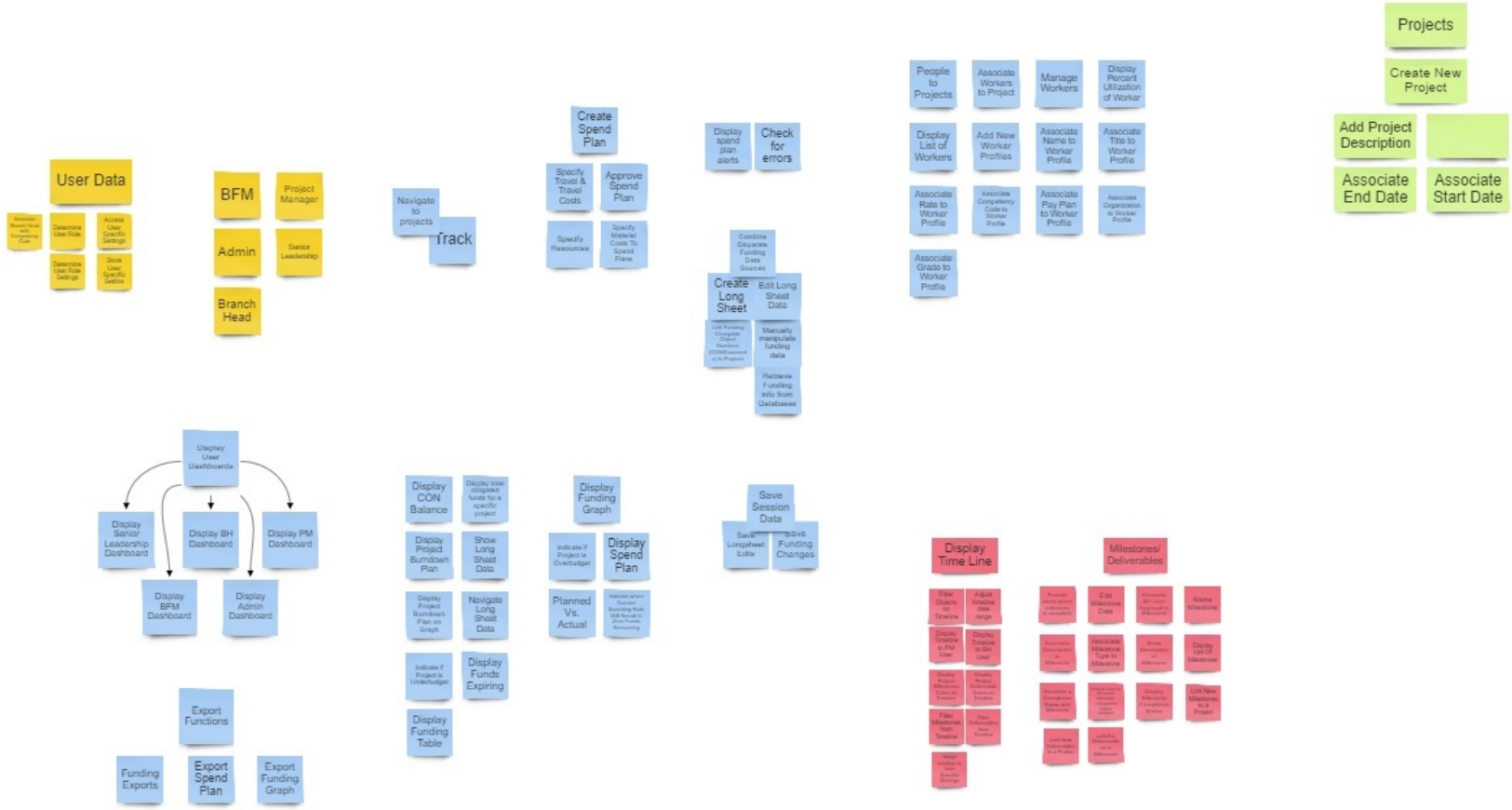

Figure G-1. Initial “RealtimeBoard” Affinity Diagram for the CAT system

Figure G-2. Initial Affinity Diagram of Requirements Data: Project Profiles

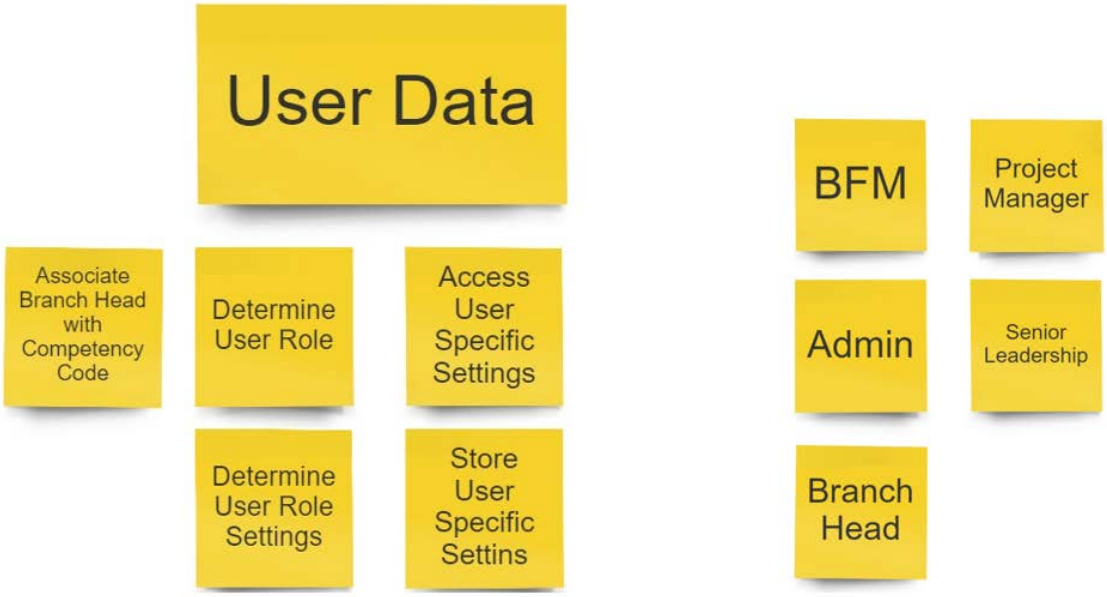

Figure G-3. Initial Affinity Diagram of Requirements Data: Users/Administration

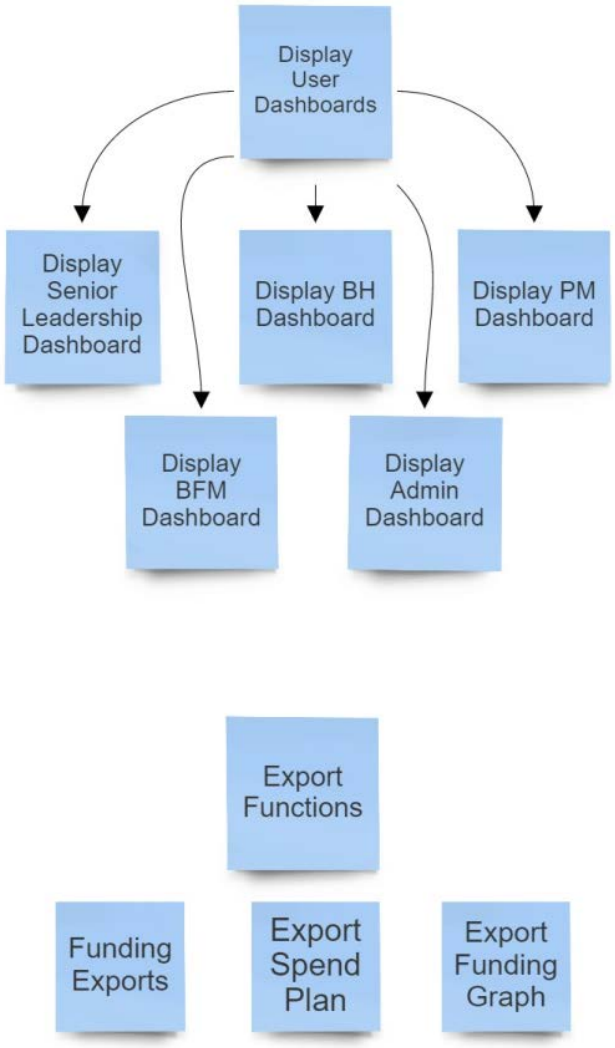

Figure G-4. Initial Affinity Diagram of Requirements Data: User Dashboards

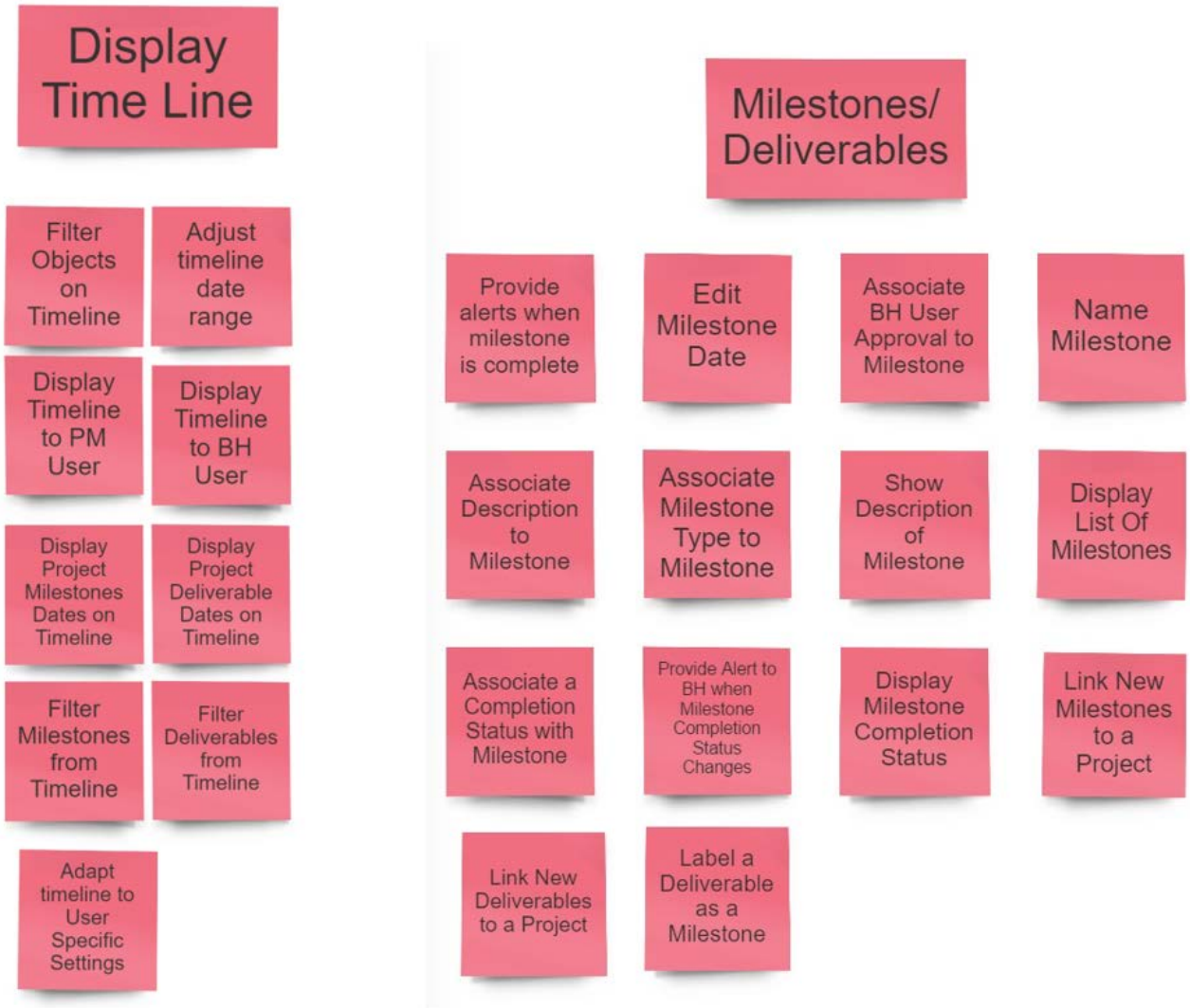

Figure G-5. Initial Affinity Diagram of Requirements Data: Project Dates Management

Figure G-6. Initial Affinity Diagram of Requirements Data: Funding

Figure G-7. Initial Affinity Diagram of Requirements Data: People To Projects

APPENDIX H. CAT REQUIREMENTS TRACEABILITY MATRIX

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
R.	CAT Requirements		F.	Perform CAT Functions
R.1	User Profile Requirements		UC.ALL.1	Export Reports
			UC.PM&BH&SL.2	View Projects Under Purview
R.1.1	User Profile Inputs			
R.1.1.1	Save user data	The CAT system shall be capable of accepting the input request to save data.	F.2.2.4	Accept Senior Leadership Input From GUI
			F.2.2.7	Accept BH Input from GUI
			F.2.2.10	Accept Project Manager Input from GUI
			F.2.2.13	Accept Administrator Input from GUI
			F.2.2.16	Accept BFM Input from GUI
			F.2.4.5	Accept User Input from GUI Module
			F.4	Perform Data Storage Operations
			F.4.2	Store Data
			F.4.3	Accept Requests for Data
			F.4.5	Retrieve Data
R.1.1.2	User login credentials	The CAT system shall be capable of accepting the input of user login credentials.	F.1	Perform Sign on Functions
			F.1.1	Provide Access Interface
			F.1.2	Request CAC Credentials
R.1.1.3	Create new project for user	The CAT system shall be capable of accepting the input of creating a new project for the user.	F.2.2.5.3.2.4	Provide Interface to Create New Project
			F.2.2.5.3.2.4.1	Display New Project Interface
			F.2.2.5.3.2.4.1.1	Allow for Project Name to be Specified
			F.2.2.5.3.2.4.1.4	Allow a Project Manager to be Specified
			F.2.2.5.3.2.4.1.5	Does Project Have a Name?
			F.2.2.5.3.2.4.1.6	Inform User Project Cannot be Created without a Name

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
			F.2.2.5.3.2.4.2	Save New Project Data
R.1.1.3.1	Assign project description	The CAT system shall be capable of accepting the input of associating a project description to a project.	F.2.2.5.3.2.4.1.3	Allow for a Project Description to be Specified
R.1.1.3.2	Assign start/end date to a project	The CAT system shall be capable of accepting the input of associating a start/end date to a project.	F.2.2.5.3.2.4.1.2	Allow for Project Date Range to be Specified
R.1.1.4	Edit user requested outputs	The CAT system shall be capable of accepting the input to edit user requested data outputs.[u][/u]	F.2.2.4	Accept Senior Leadership Input From GUI
			F.2.2.10	Accept Project Manager Input from GUI
			F.2.2.13	Accept Administrator Input from GUI
			F.2.2.16	Accept BFM Input from GUI
			F.2.4.5	Accept User Input from GUI Module
R.1.1.4.1	Edit user displayed graphs	The CAT system shall be capable of accepting the input of editing user displayed graphs.	F.2.2.4	Accept Senior Leadership Input From GUI
			F.2.2.10	Accept Project Manager Input from GUI
			F.2.2.13	Accept Administrator Input from GUI
			F.2.2.16	Accept BFM Input from GUI
			F.2.4.5	Accept User Input from GUI Module
R.1.1.4.2	Edit user displayed Longsheets	The CAT system shall be capable of accepting the input of editing user displayed Longsheets.	F.2.2.4	Accept Senior Leadership Input From GUI
			F.2.2.10	Accept Project Manager Input from GUI
			F.2.2.13	Accept Administrator Input from GUI
			F.2.2.16	Accept BFM Input from GUI
			F.2.4.5	Accept User Input from GUI Module
R.1.1.4.3	Edit user displayed timelines	The CAT system shall be capable of accepting the	F.2.2.4	Accept Senior Leadership Input From GUI
			F.2.2.10	Accept Project Manager Input from GUI

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
		input of editing user displayed timelines.	F.2.2.13	Accept Administrator Input from GUI
			F.2.2.16	Accept BFM Input from GUI
			F.2.4.5	Accept User Input from GUI Module
R.1.1.4.4	Edit user displayed lists	The CAT system shall be capable of accepting the input of editing user displayed lists.	F.2.2.4	Accept Senior Leadership Input From GUI
			F.2.2.10	Accept Project Manager Input from GUI
			F.2.2.13	Accept Administrator Input from GUI
			F.2.2.16	Accept BFM Input from GUI
			F.2.4.5	Accept User Input from GUI Module
R.1.1.5	Terminate User Session	The CAT system shall be capable of accepting the input to terminate a user session.	F.3	Perform Session Termination Procedures
			F.3.1	Accept Session Timeout Exit
			F.3.4	Determine if Exit Was User Initiated
			F.3.7	Terminate Session
R.1.1.6	Create User Message	The CAT Systems shall be capable of accepting the input of user entered message data to be sent to another user.	F.2.2.5.7.2	Display Option to Send another User a Message
			F.2.3.4.5	Provide Message Transfer Service
R.1.1.6.1	Associate Message to Project	The CAT System shall be capable of accepting the input of associating a user message to a project.	F.2.3.4.5	Provide Message Transfer Service
R.1.1.7	Create New User Profile	When the CAT system displays the log on interface, it shall be capable of accepting the input to create a new user profile.	F.2.1.3	Create New User Profile

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
R.1.2	User Profile Functional Requirements			
R.1.2.1	Verify user credentials	The CAT system shall be capable of verifying user credentials.	F.1	Perform Sign on Functions
			F.1.2	Request CAC Credentials
			F.1.3	Transmit User Credentials to BIG IP
			F.2.1.2	Determine User Type
			F.2.3.1.1.2.1	Determine Division User is Responsible For
R.1.2.2	Grant user access	The CAT system shall be capable of granting user access.	F.1	Perform Sign on Functions
			F.1.4	Grant Access
			F.2.1.2	Determine User Type
			F.2.3.1.1.2.1	Determine Division User is Responsible For
R.1.2.3	Store data	The CAT system shall be capable of storing data.	F.2.1.3	Create New User Profile
			F.2.4.1	Create New User Profile
			F.3.6	Save User Data
			F.4.1	Accept Data Storage Requests
			F.4.2	Store Data
			F.4.3	Accept Requests for Data
			F.4.4	Send Data
			F.4.5	Retrieve Data
R.1.2.3.1	Save user inputs	The CAT system shall be capable of saving user inputs.	F.3.6	Save User Data
			F.4	Perform Data Storage Operations
			F.4.2	Store Data
R.1.2.3.2	Save data elements from external sources	The CAT system shall be capable of saving data elements from external sources.	F.4.5.1	Retrieve and Save Data From ERP Every Week
R.1.2.3.3	Save user profile	The CAT system shall be	F.2.1.4	Request User Settings

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
	settings	capable of saving, changing and updating a user's profile settings.	F.2.1.5	Provide Local User Settings
			F.2.2.5.3.2.7.1	Retrieve User Data from Profile Manager Module
			F.2.2.11.1	Apply User Specific Settings to Admin Dashboard
			F.2.4.2	Change Existing User Profile
			F.2.4.3.1.2	Edit User Type
			F.2.4.3.2	Edit User Specified Settings
			F.2.4.3.2.2	Manage Default User Settings
			F.2.4.4	Save User Profile
R.1.2.3.3.1	Save Senior Leadership's profile settings	The CAT system shall be capable of saving the Senior Leadership's profile settings.	F.2.4.4	Save User Profile
			R.1.2.3.3	Save user profile settings
R.1.2.3.3.2	Save Branch Head's profile settings	The CAT system shall be capable of saving the Branch Head's profile settings.	F.2.4.4	Save User Profile
R.1.2.3.3.3	Save Project Manager's profile settings	The CAT system shall be capable of saving the Project Manager's profile settings.	F.2.4.4	Save User Profile
R.1.2.3.3.4	Save Budget Financial Manager's profile settings	The CAT system shall be capable of saving the Budget Financial Manager's profile settings.	F.2.4.4	Save User Profile
R.1.2.3.3.5	Save CAT Administrator's	The CAT system shall be capable of saving the	F.2.2.11.1	Apply User Specific Settings to Admin Dashboard

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
	profile	CAT Administrator's profile settings.	F.2.4.4	Save User Profile
R.1.2.4	Customize privilege/restriction settings	The CAT system shall be capable of customizing data field privilege/ restriction settings for each profile.	F.2.1.1	Determine User Status
			F.2.2.1	Determine User Type
			F.2.2.14.1	Apply User Specific Settings to BFM Dashboard
			F.2.3.1.1.1	Determine Level of Aggregation
			F.2.4.3.2.1	Manage User Settings for a Specific Project
R.1.2.5	Detect user errors	The CAT system shall be capable of detecting user errors.	F.2.2.5.3.2.4.1.6	Inform User Project Cannot be Created without a Name
			F.2.2.6	Validate Input from BH
R.1.2.6	Logoff user	When requested by the user to terminate the session, the CAT system shall logoff the user.	F.3.1	Accept Session Timeout Exit
			F.3.2	Accept User Initiated Exit
			F.3.4	Determine if Exit Was User Initiated
			F.3.7	Terminate Session
R.1.2.7	Send Messages from one user to another	The CAT System shall be capable of sending user message to an existing user's profile.	F.2.2.5.7.2	Display Option to Send another User a Message
			F.2.3.4.5	Provide Message Transfer Service
R.1.2.8	Data Validation	The CAT System shall be capable of validating user input to ensure it is in an acceptable format.	F.2.2.3	Validate Input from SL
			F.2.2.6	Validate Input from BH
			F.2.2.9	Validate Input from PM
			F.2.2.12	Validate Input from Administrator
			F.2.2.15	Validate Input from BFM
R.1.3	User Profile Outputs			
R.1.3.1	Provide Graphical User Interface	The CAT system shall be capable of providing a user graphical interface to	F.2	Perform Competency Administration
			F.2.1.2	Determine User Type
			F.2.2	Provide Graphical User Interface

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
		the user.	F.2.3.3.3.2	Send Data to GUI for Display
R.1.3.1.1	Display Senior Leadership's dashboard	The CAT system shall be capable of displaying the Senior Leadership's dashboard.	F.2.2.2	Display Senior Leadership GUI
			F.2.2.2.5	Display Manning View
			F.2.3.1.1.2	Generate Staffing Level View Data
			F.2.3.1.1.2.1	Determine Division User is Responsible For
			F.2.3.1.1.2.2	Determine Staffing Target Level
			F.2.3.1.1.2.3	Determine Branches in Division
			F.2.3.1.1.2.5	Determine Historical Staffing Levels
			F.2.3.1.1.2.6	Determine Current Staffing Levels
			F.2.3.1.1.2.7	Compile Staffing Level Data
			F.2.3.1.1.2.8	Send Staffing Level Data to GUI Module
			F.2.3.3.8	Is user Senior Leadership?
			F.2.3.3.9	Aggregate Funding Curves on a Competency Level
			F.4.5.2	Retrieve Data from CAT Storage
R.1.3.1.2	Display Branch Head's dashboard	The CAT system shall be capable of displaying the Branch Head's dashboard.	F.2.2.5	Display BH GUI
			F.2.2.5.3	Display BH People to Projects Dashboard GUI
			F.2.2.5.3.2	Provide BH People to Project Display Ancillaries
			F.2.2.5.5	Display BH Funding Graph
			F.2.2.5.5.1	Accept Branch Head Request for Funding Rollup or Projects Specific Funding Graph
			F.2.2.5.5.2	Display Branch Rollup Funding Graph
			F.2.2.7	Accept BH Input from GUI
			F.2.3.1.1.4	Generate Branch Head People to Projects Dashboard View Data

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
			F.2.3.1.1.5	Send Branch Head People to Projects Dashboard View Data to GUI Module
			F.2.3.3.6	Is user a Branch Head?
			F.2.3.3.7	Aggregate Funding Curves on a Branch Level
			F.4.5.2	Retrieve Data from CAT Storage
R.1.3.1.3	Display Project Manager's dashboard	The CAT system shall be capable of displaying the Project Manager's dashboard.	F.2.2.8	Display Project Manager GUI
			F.2.2.8.2.5	Display Funded Amount
			F.2.2.8.3	Display PM Funding Status Table
			F.2.2.8.3.5	Display Labor Estimate
			F.2.2.8.5	Display PM Project Deliverable Table
			F.4.5.2	Retrieve Data from CAT Storage
R.1.3.1.4	Display Budget Financial Manager's dashboard	The CAT system shall be capable of displaying the Budget Financial Manager's dashboard.	F.2.2.14	Display BFM GUI
			F.2.2.14.1	Apply User Specific Settings to BFM Dashboard
			F.2.2.14.2	Retrieve Data for BFM Dashboard
			F.2.2.14.3	Display BFM Dashboard
			F.2.3.3.11	Associate BFM Notes to Project Data
R.1.3.1.5	Display CAT Administrator's dashboard	The CAT system shall be capable of displaying the CAT Administrator's dashboard.	F.2.2.11	Display Administrator GUI
			F.2.2.11.1	Apply User Specific Settings to Admin Dashboard
			F.4.5.2	Retrieve Data from CAT Storage
R.1.3.2	Display user profile information	The CAT system shall be capable of displaying user profile information.	F.2.1	Retrieve User Specific Settings
			F.2.1.3	Create New User Profile
			F.2.4.1	Create New User Profile
R.1.3.2.1	Apply User Settings	The CAT system shall be	F.2.1.4	Request User Settings

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
	to Dashboard	capable of displaying the dashboard with the user customized settings applied	F.2.2.5.3.2.7.1	Retrieve User Data from Profile Manager Module
R.1.3.3	Display selected projects for user	The CAT system shall be capable of displaying selected projects for the user.	F.2.2.2.1	Apply User Specific Settings to SL Dashboard
			F.2.2.5.2	Apply User Specific Settings to BH Dashboard
			F.2.2.8.1	Apply User Specific Settings to PM Dashboard
			F.2.2.8.7.1	Display Option to Select a Specific Project to Display
			F.2.3	Provide Project Monitoring Functions
R.1.3.4	Display user project alerts	The CAT system shall be capable of displaying user project alerts.	F.2.2.5.3.2.4.3	Trigger Alert to Assigned Project Manager of New Project Assignment
			F.2.2.5.7	Display BH GUI Support Features
			F.2.2.8.7	Display PM GUI Support Features
R.1.3.4.1	Display “new project created” alert	When a new project is created, the CAT system shall provide an alert to specified user profiles.	F.2.2.5.3.2.4.3	Trigger Alert to Assigned Project Manager of New Project Assignment
			F.2.2.5.7	Display BH GUI Support Features
			F.2.2.8.7	Display PM GUI Support Features
R.1.3.4.2	Display Prompt to Save Unsaved Data	When a user session is terminated, the CAT System shall be capable of displaying a prompt to ensure unsaved data is not inadvertently lost.	F.3.3	Determine if Most Recent Data Saved
			F.3.5	Send Save Prompt
			F.3.6	Save User Data
			F.3.7	Terminate Session

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
R.1.3.5	Export project data	The CAT system shall be capable of exporting user project data.	F.2.5	Provide Export Functionality
R.1.3.5.1	Export in MS Excel format	The CAT system shall be capable of exporting user project data in the Microsoft Excel format.	F.2.5.3	Excel Data File
R.1.3.5.1.1	Export Raw Data	The CAT system shall be capable of exporting raw data to Excel for user manipulation	F.2.3.3.3.3	Make Data Available for Export to Excel
R.1.3.5.2	Export in MS PowerPoint format	The CAT system shall be capable of exporting user project data in the Microsoft PowerPoint format.	F.2.5.2	Export Data into PowerPoint
R.1.3.5.3	Export in CAT File Format	The CAT system shall be capable of exporting user project data in the CAT file format.	F.2.5.4	Export Data in a CAT File Format
R.1.3.5.4	Export data to a network printer	The CAT system shall be capable of exporting user project data to a network printer.	F.2.5.1	Export Data for Printing
R.1.3.6	Display a Message Received from Another User	The CAT System shall be capable of displaying a message received from another user.	F.2.2.5.7.2	Display Option to Send another User a Message
			F.2.3.4.5	Provide Message Transfer Service

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
R.1.3.6.1	Display Message Association	The CAT System shall be capable of displaying the project name/number associated with a message.	F.2.3.4.5	Provide Message Transfer Service
R.2	Project Schedule Item Requirements		UC.PM&BH&SL.1	Project Schedule Item in a List or on a Timeline
			UC.PM&BH.1	Create Schedule Items and Assign Completion Dates
			UC.PM&BH.2	Receive Alerts When Items are Coming Due
			UC.PM&BH.3	Mark Schedule Items as Complete
R.2.1	Schedule Item Inputs			
R.2.1.1	Link schedule items to a project	The CAT system shall be capable of accepting the input of linking a schedule items to a project.	F.2.3.2.1	Accept Schedule Item Data
R.2.1.2	Assign a name to schedule items	The CAT system shall be capable of accepting the input of assigning a name to schedule items.	F.2.3.2.1.1	Accept Schedule Item Name
R.2.1.3	Assign a description to schedule items	The CAT system shall be capable of accepting the input of assigning a description to schedule items.	F.2.3.2.1.5	Accept Schedule Item Description

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
R.2.1.4	Assign a date to schedule items	The CAT system shall be capable of accepting the input of assigning a date to schedule items.	F.2.3.2.1.3	Accept Schedule Item Date
R.2.1.5	Assign project duration	The CAT system shall be capable of accepting the input of assigning a project duration.	F.2.2.5.3.2.4.1.2	Allow for Project Date Range to be Specified
R.2.1.6	Assign a note to schedule items	The CAT system shall be capable of accepting the input of assigning a note to schedule items.	F.2.3.2.1.4	Accept Schedule Item Note
R.2.1.7	Assign a schedule item as complete	The CAT system shall be capable of accepting the input of assigning a schedule item as complete.	F.2.3.2	Provide Schedule Item Tracking Functions
R.2.1.8	Accept/Reject a proposed schedule item date	The CAT system shall be capable of accepting the input of accepting/ rejecting a proposed schedule item date.	F.2.2.5.5.5	Send Schedule Item Inputs to Approval Authority
			F.2.3.2.3	Retrieve Schedule Item Approval Status
R.2.1.9	Filter schedule item data	The CAT system shall be capable of accepting the input of filtering schedule item data.	F.2.2.2.4.3	Display DH Schedule Item Filter Options
			F.2.2.5.6.3	Display BH Schedule Item Filter Options

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
R.2.1.10	Assign a schedule item as either a milestone or deliverable	The CAT system shall be capable of accepting the input of assigning a schedule item as a milestone or deliverable.	F.2.3.2.1.2	Accept Schedule Item Type
R.2.2	Schedule Item Functional Requirements			
R.2.2.1	Organize schedule item data	The CAT system shall be capable of organizing schedule item data.	F.2.2.5.3.2.3	Provide Sort Function
R.2.2.1.1	Sort schedule item data chronologically	The CAT system shall be capable of sorting schedule item data chronologically.	F.2.2.5.3.2.3	Provide Sort Function
R.2.2.1.2	Sort schedule item data alphabetically	The CAT system shall be capable of sorting schedule item data alphabetically.	F.2.2.5.3.2.3	Provide Sort Function
R.2.2.1.3	Sort schedule item data by project duration	The CAT system shall be capable of sorting schedule item data by project duration.	F.2.2.5.3.2.3	Provide Sort Function
			F.2.2.5.3.2.3.5	Sort by Date Range
R.2.2.1.4	Sort schedule item data by type	The CAT system shall be capable of sorting schedule item data by type.	F.2.2.5.3.2.3	Provide Sort Function

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
R.2.2.2	Calculate time until the date of a schedule item	The CAT system shall be capable of calculating the time until the date of a schedule item.	F.2.3.2.4	Calculate Schedule Item Information for Display
R.2.3	Schedule Item Outputs			
R.2.3.1	Display schedule item timeline	The CAT system shall be capable of displaying a schedule item timeline.	F.2.2.2.4.1	Display Division Schedule Item Timeline
			F.2.2.5.6.1	Display Branch Schedule Item Timeline
			F.2.2.8.5	Display PM Project Deliverable Table
			F.2.3.2.1.7	Compile Schedule Item Data
R.2.3.1.1	Display multiple projects on one schedule item timeline	The CAT system shall be capable of displaying multiple projects on one schedule item timeline.	F.2.2.2.4.1	Display Division Schedule Item Timeline
			F.2.2.5.6	Display BH Timeline
			F.2.2.5.6.1	Display Branch Schedule Item Timeline
			F.2.2.8.6	Display PM Timeline
R.2.3.2	Display list of schedule item dates	The CAT system shall be capable of displaying a list of schedule item dates.	F.2.2.8.5	Display PM Project Deliverable Table
			F.2.3.2.1.7	Compile Schedule Item Data
R.2.3.3	Display list of schedule item names	The CAT system shall be capable of displaying a list of schedule item names.	F.2.2.2.4.1	Display Division Schedule Item Timeline
			F.2.2.5.6	Display BH Timeline
			F.2.2.5.6.1	Display Branch Schedule Item Timeline
			F.2.2.8.6	Display PM Timeline
R.2.3.4	Display schedule item descriptions	The CAT system shall be capable of displaying schedule item descriptions.	F.2.2.2.4.2	Display Division Schedule Item Table
			F.2.2.5.6.2	Display Branch Schedule Item Table
R.2.3.5	Display schedule item types	The CAT system shall be capable of displaying	F.2.2.2.4.1	Display Division Schedule Item Timeline
			F.2.2.2.4.2	Display Division Schedule Item Table

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
		schedule item types.	F.2.2.5.6.1	Display Branch Schedule Item Timeline
			F.2.2.5.6.2	Display Branch Schedule Item Table
			F.2.3.2.1.7	Compile Schedule Item Data
			F.2.3.2.4	Calculate Schedule Item Information for Display
R.2.3.6	Display schedule item durations	The CAT system shall be capable of displaying schedule item durations.	F.2.2.2.4	Display Division Schedule Items
			F.2.2.2.4.1	Display Division Schedule Item Timeline
			F.2.2.2.4.2	Display Division Schedule Item Table
			F.2.2.5.6.1	Display Branch Schedule Item Timeline
			F.2.2.5.6.2	Display Branch Schedule Item Table
			F.2.3.2.4	Calculate Schedule Item Information for Display
R.2.3.7	Display schedule item notes	The CAT system shall be capable of displaying a schedule item note associated to a project.	F.2.2.2.4	Display Division Schedule Items
			F.2.2.2.4.1	Display Division Schedule Item Timeline
			F.2.2.2.4.2	Display Division Schedule Item Table
			F.2.2.2.4.3	Display DH Schedule Item Filter Options
			F.2.2.5.6.1	Display Branch Schedule Item Timeline
			F.2.2.5.6.2	Display Branch Schedule Item Table
			F.2.2.5.6.3	Display BH Schedule Item Filter Options
R.2.3.8	Display schedule item alerts	The CAT system shall be capable of displaying schedule item alerts.	F.2.2.5.7	Display BH GUI Support Features
			F.2.2.8.7	Display PM GUI Support Features
			F.2.3.2.1.6	Provide Schedule Item Alerts
			F.2.3.2.1.6.1	Accept Alert Type Selection
			F.2.3.2.1.6.2	Provide New Date Alert
			F.2.3.2.1.6.3	Provide New Schedule Item Alert
R.2.3.8.1	Display alert when	When a schedule item is	F.2.2.5.7	Display BH GUI Support Features

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
	schedule item is upcoming	upcoming, the CAT system shall be capable of displaying an alert.	F.2.2.8.7	Display PM GUI Support Features
R.2.3.8.2	Display alert when a schedule item is past due	When a schedule item is past due, the CAT system shall be capable of displaying an alert.	F.2.2.5.7	Display BH GUI Support Features
			F.2.2.8.7	Display PM GUI Support Features
R.2.3.8.3	Display alert when a schedule item is complete	When a schedule item is complete, the CAT system shall be capable of displaying an alert to the PM	F.2.2.2.6	Display SL GUI Support Features
			F.2.2.5.7	Display BH GUI Support Features
R.3	Project Funding Requirements		UC.BFM.1	View and Edit Funding Status Sheets
			UC.PM&BH&SL.4	View Expenditure Plans
			UC.PM&BH&SL.5	View Funding Expiration Dates
			UC.PM&BH&SL.6	View Planned Versus Actual Expenditures
			UC.PM.2	Create Expenditure Plan
R.3.1	Funding Inputs			
R.3.1.1	Accept uploaded funding files	The CAT system shall be capable of accepting the input of an uploaded funding file.	F.4.6	Provide File Upload Functionality
			F.4.6.1	Accept ZRQS Files
			F.4.6.2	Accept NISE Files
			F.4.6.3	Accept CN41 Files
			F.4.6.4	Accept CDASS Files
R.3.1.1.1	Accept ZRQIS file formats	The CAT system shall be capable of accepting ZRQIS file formats.	F.4.6.1	Accept ZRQS Files

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
R.3.1.1.2	Accept CN41 file formats	The CAT system shall be capable of accepting CN41 file formats.	F.4.6.3	Accept CN41 Files
R.3.1.1.3	Accept NISE file formats	The CAT system shall be capable of accepting NISE file formats.	F.4.6.2	Accept NISE Files
R.3.1.1.4	Accept CDASS file formats	The CAT system shall be capable of accepting CDASS file formats.	F.4.6.4	Accept CDASS Files
R.3.1.2	Create a spend plan	The CAT system shall be capable of accepting the input to create a spend plan associated with a project.	F.2.2.8.8	Display Spend Plan Input View
			F.2.2.8.8.3	Provide for Spend Plan Date Range Input
			F.2.2.10.1	Accept Spend Plan Inputs
			F.2.2.10.1.1.4	Assign as Training
			F.2.2.10.1.6	Accept Date Range of Use
			F.2.2.10.1.7	Accept Cost Estimate
			F.2.3.3.5.2	Retrieve Spend Plan Data
			F.2.3.3.10	Associate Spend Plans with Project
			F.2.4.3.1.5	Edit Assigned Hourly Cost
R.3.1.2.1	Assign funding to personnel labor per project	The CAT system shall be capable of accepting the input of assigning funding to personnel labor per project.	F.2.3.1.1.11	Gather Utilization Data for Specified Users
			F.2.3.1.2	Accept People to Project Assignment Data

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
R.3.1.2.2	Assign funding to personnel travel per project	The CAT system shall be capable of accepting the input of assigning funding to personnel travel per project.	F.2.2.10.1.1.3	Assign as Travel
R.3.1.2.3	Assign funding to materials required per project	The CAT system shall be capable of accepting the input of assigning funding to materials required per project.	F.2.2.8.8.1	Provide for Cost Type Input Options
			F.2.2.10.1.1.2	Assign as Materiel
R.3.1.2.4	Assign funding to specific accounts per project	The CAT system shall be capable of accepting the input of assigning funding to specific accounts per project.	F.2.2.8.8.1	Provide for Cost Type Input Options
			F.2.2.8.8.2	Provide for Cost Input Name Assignment
			F.2.2.8.8.5	Provide for Cost Amount Input
			F.2.2.10.1.1	Accept Cost Input Type Assignments
			F.2.2.10.1.2	Accept Cost Input Name Assignment
R.3.1.2.5	Assign funding CONS per project	The CAT system shall be capable of accepting the input of assigning funding CONS per project.	F.2.2.8.8.1	Provide for Cost Type Input Options
			F.2.2.8.8.5	Provide for Cost Amount Input
			F.2.2.10.1.1	Accept Cost Input Type Assignments
			F.2.2.10.1.2	Accept Cost Input Name Assignment
R.3.1.2.6	Assign funding expiration dates	The CAT system shall be capable of accepting the input of assigning an expiration date to funds.	F.2.2.8.8.4	Provide for Cost Date Range of Use Input
			F.2.2.14.3.1.8	Display Edit Options for All Funding Aspects
R.3.1.2.7	Assign funding note	The CAT system shall be capable of accepting the input of assigning a funding note to a project.	F.2.2.14.3.2	Display Options to Add Notes to Funding Sheets

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
R.3.1.2.8	Filter funding data	The CAT system shall be capable of accepting the input of filtering funding data.	F.2.2.14.3.1.7	Filtering and Sort of All Funding Aspects
R.3.1.2.9	Assign funding to custom items	The CAT System shall be capable of accepting the input of assigning funding to a user custom cost.	F.2.2.10.1.1.5	Assign as “Custom” Cost
R.3.1.2.10	Assign Cost Type as Fixed or Variable	The CAT System shall be capable of accepting the input of assigning a cost type as fixed or variable.	F.2.2.10.1.3	Determine Fixed or Variable Cost
			F.2.2.10.1.5	Accept Variable Rate Cost
R.3.1.2.11	Assign funding to training per project	The CAT system shall be capable of accepting the input of assigning funding to personnel Training per project.	F.2.2.10.1.1.4	Assign as Training
R.3.1.3	Approve spend plan	The CAT system shall be capable of accepting the input to approve a spend plan associated with a project.	F.2.2.5.5.4	Provide Approval/Disapproval Display
			F.2.2.5.5.5	Send Schedule Item Inputs to Approval Authority
			F.2.2.8.8.6	Compile & Send Data for Project Association
			F.2.2.10.1	Accept Spend Plan Inputs
			F.2.2.10.1.7	Accept Cost Estimate
R.3.1.4	Accept ERP data inputs	The CAT system shall be capable of automatically	F.2.3.3.2	Request Current ERP Data for User’s Branch

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
		accepting actual expenditure inputs from ERP on a weekly basis.	F.4.5.1	Retrieve and Save Data From ERP Every Week
R.3.2	Funding Functional Requirements			
R.3.2.1	Organize funding data	The CAT system shall be capable of organizing funding data.	F.2.2.14.3.1.7	Filtering and Sort of All Funding Aspects
R.3.2.1.1	Sort data by funding type	The CAT system shall be capable of sorting data by funding type.	F.2.2.14.3.1.7	Filtering and Sort of All Funding Aspects
R.3.2.1.2	Sort data by funding expiration date	The CAT system shall be capable of sorting data by funding expiration dates.	F.2.2.14.3.1.7	Filtering and Sort of All Funding Aspects
R.3.2.1.3	Sort data by CON balance	The CAT system shall be capable of sorting data by CON balance.	F.2.2.14.3.1.7	Filtering and Sort of All Funding Aspects
R.3.2.1.4	Filter funding data	The CAT system shall be capable of providing funding filter capability.	F.2.2.14.3.1.7	Filtering and Sort of All Funding Aspects
R.3.2.2	Calculate current expenditures	The CAT system shall be capable of calculating current expenditures.	F.2.3.3	Provide Funding Tracking Functions
			F.2.3.3.5	Calculate Funding Curves
R.3.2.3	Calculate expenditure burn rates	The CAT system shall be capable of calculating expenditure burn rates.	F.2.3.3	Provide Funding Tracking Functions
			F.2.3.3.5	Calculate Funding Curves
			F.2.3.3.12.2.1	Calculation of Over/Underspending
R.3.2.4	Calculate when	The CAT system shall be	F.2.3.3	Provide Funding Tracking Functions

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
	expenditures are expected to be exhausted	capable of calculating when expenditures are expected to be exhausted.	F.2.3.3.5	Calculate Funding Curves
R.3.2.5	Calculate over/ under spending	The CAT system shall be capable of calculating the amount of over/under spending.	F.2.3.3	Provide Funding Tracking Functions
			F.2.3.3.5	Calculate Funding Curves
			F.2.3.3.12.2.1	Calculation of Over/Underspending
R.3.2.6	Combine ZRQIS and CN41 reports	The CAT system shall be capable of combining ZRQIS and CN41 reports.	F.2.3.3.2.1	Request ZRQIS Report From Data Management Module
			F.2.3.3.2.2	Request CN41 Report From Data Management Module
			F.2.3.3.2.3	Combine ZRQIS and CN41 Data Into Single Report
			F.4.6.3	Accept CN41 Files
R.3.3	Funding Outputs			
R.3.3.1	Display spend plan	The CAT system shall be capable of displaying a spend plan associated with a project.	F.2.2.8.2.3	Display Spend Plan Data
			F.2.2.8.3.5.4	Display Labor Rates
			F.2.2.10.1.1.1	Assign Resource Type
			F.2.2.10.1.4	Accept Fixed Cost
			F.2.3.3.5.2	Retrieve Spend Plan Data
			F.2.3.3.12.2.1	Calculation of Over/Underspending
R.3.3.2	Display funding graphs	The CAT system shall be capable of displaying funding graphs.	F.2.2.5.5	Display BH Funding Graph
			F.2.2.5.5.1	Accept Branch Head Request for Funding Rollup or Projects Specific Funding Graph
			F.2.2.5.5.2	Display Branch Rollup Funding Graph
			F.2.2.5.5.3	Display Selected Project Funding Graph
			F.2.2.8.2	Display PM Funding Graph
			F.2.2.8.2.1	Display Funding Zeroing Date
			F.2.2.8.2.5	Display Funded Amount

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
			F.2.2.8.2.6	Display Cost Projection Curve
			F.2.2.8.3.5	Display Labor Estimate
			F.2.3.3.4	For Requisite Projects:
			F.2.3.3.5.1	For Each Project
			F.2.3.3.5.4	Create Actual Spending Curve
			F.2.3.3.6	Is user a Branch Head?
			F.2.3.3.7	Aggregate Funding Curves on a Branch Level
			F.2.3.3.8	Is user Senior Leadership?
			F.2.3.3.9	Aggregate Funding Curves on a Competency Level
			F.2.3.3.12.2.1	Calculation of Over/Underspending
R.3.3.2.1	Display “planned vs expended” data	The CAT system shall be capable of displaying planned vs. expended data on funding graphs	F.2.2.8.2.3	Display Spend Plan Data
			F.2.2.8.2.4	Display Historical Spending Curve
			F.2.2.8.3	Display PM Funding Status Table
			F.2.3.3.1	Request Historical Funding Data for User’s Branch
			F.2.3.3.5.3	Create Planned Spending Curve
R.3.3.2.2	Display calculated burn rates	The CAT system shall be capable of displaying calculated burn rates on funding graphs.	F.2.2.8.2.4	Display Historical Spending Curve
			F.2.2.8.2.7	Display Burn Rates

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
R.3.3.2.3	Display under/over expenditure according to user specified value	When displaying the funding graph, the CAT System shall be capable of displaying the user specified percent above or below the planned expenditure for the current date.	F.2.3.3.12.1	Retrieve User Specified Over/Under Spending Values
R.3.3.2.4	Display Division Funding	The CAT System shall be capable of displaying division funding data on the Division Funding Graph on the Division Head View	F.2.2.2.2	Display Division Funding Graph
R.3.3.3	Display funding Longsheets	The CAT system shall be capable of displaying funding Longsheets.	F.2.2.14.3.1	Display Funding Sheets
			F.2.2.14.3.1.1	Select Funding Sheet to Display
			F.2.2.14.3.1.2	Display 852 Long Sheet
			F.2.2.14.3.1.3	Display CIP Long Sheet
			F.2.2.14.3.1.4	Display Expired Funds Long Sheet
			F.2.2.14.3.1.5	Display 219 Projects Long Sheet
			F.2.2.14.3.1.6	Display Projects Long Sheet
			F.2.2.14.3.4	Display Options to Sort by All Data Items in Longsheet
			F.2.3.3.3	Perform Long Sheet Functions
			F.2.3.3.3.1	Compile Data for Long Sheet
			F.2.3.3.3.1.1	Request Long Sheet Data Compilation

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
			F.2.3.3.3.1.2	For Each Project In Branch
			F.2.3.3.3.1.3	Does Project Have a CON Associated with It?
			F.2.3.3.3.1.4	Retrieve Associated CON
			F.2.3.3.3.1.5	For Each Project in Branch Retrieve:
			F.2.3.3.3.1.6	Associated Code
			F.2.3.3.3.1.7	Associated TPOC
			F.2.3.3.3.1.8	Associated Document Number
			F.2.3.3.3.1.9	Associated Project Number
			F.2.3.3.3.1.10	Funded Amount
			F.2.3.3.3.1.11	Planned Amount
			F.2.3.3.3.1.12	Committed Amount
			F.2.3.3.3.1.13	Obligated Amount
			F.2.3.3.3.1.14	Expensed Amount
			F.2.3.3.3.1.15	Associated Balance
			F.2.3.3.3.1.16	Associated WBS Balance
			F.2.3.3.3.1.17	WSD
			F.2.3.3.3.1.18	WCD
			F.2.3.3.3.1.19	Project Name
			F.2.3.3.3.1.20	Fiscal Year
			F.2.3.3.3.1.21	APPN
			F.2.3.3.3.1.22	PE/BLI
			F.2.3.3.3.1.23	PU/OSIP
			F.2.3.3.3.1.24	Sponsor
			F.2.3.3.3.1.26	Request Association (from user via GUI)
R.3.3.3.1	Display expended	The CAT system shall be	F.2.2.8.2.2	Display Projected Over/Under Expenditure

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
	funding for each chargeable object	capable of displaying expended funding for each chargeable object.	F.2.2.14.3.1	Display Funding Sheets
R.3.3.3.2	Display current balance of each chargeable object	The CAT system shall be capable of displaying the current balance of each chargeable object.	F.2.2.14.3.1	Display Funding Sheets
R.3.3.3.3	Display allowable funding	The CAT system shall be capable of displaying a list of allowable funding.	F.2.2.14.3.1	Display Funding Sheets
R.3.3.3.4	Display a list of available funding	The CAT system shall be capable of displaying a list of available funding.	F.2.2.14.3.1	Display Funding Sheets
R.3.3.4	Display CONS associated to projects	The CAT system shall be capable of displaying CONS associated to projects.	F.2.2.8.3.1	Display CON Name
			F.2.2.8.3.2	Display CON Balance
			F.2.2.8.3.3	Display CON Expenditures
			F.2.2.8.3.4	Display CON Expiration Date
			F.2.2.14.3.1	Display Funding Sheets
			F.2.3.3.3.1.27	Associate CONs with Project
R.3.3.5	Display funding associated to date of expiration	The CAT system shall be capable of displaying funding associated to date of expiration.	F.2.2.8.8.4	Provide for Cost Date Range of Use Input
			F.2.2.14.3.1	Display Funding Sheets

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
R.3.3.6	Display funding associated with funding type	The CAT system shall be capable of displaying funding associated with funding type.	F.2.2.14.3.1	Display Funding Sheets
R.3.3.7	Display funding fiscal years associated with projects	The CAT system shall be capable of displaying funding fiscal years associated with projects.	F.2.2.14.3.1	Display Funding Sheets
R.3.3.8	Display funding fiscal years associated with types of funding	The CAT system shall be capable of displaying funding fiscal years associated with types of funding.	F.2.2.14.3.1	Display Funding Sheets
R.3.3.9	Display an uploaded funding file	The CAT system shall be capable of displaying an uploaded funding file.	F.2.2.14.3.3	Display Options to View Uploaded Funding Files
			F.4.6.1	Accept ZRQS Files
			F.4.6.2	Accept NISE Files
			F.4.6.3	Accept CN41 Files
			F.4.6.4	Accept CDASS Files
R.3.3.9.1	Display ZRQIS file formats	The CAT system shall be capable of displaying ZRQIS file formats.	F.2.3.3.2.3	Combine ZRQIS and CN41 Data Into Single Report
			F.4.6.1	Accept ZRQS Files
R.3.3.9.2	Display CN41 file formats	The CAT system shall be capable of displaying CN41 file formats.	F.2.2.14.3.1	Display Funding Sheets
			F.2.3.3.2.2	Request CN41 Report From Data Management Module

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
			F.2.3.3.2.3	Combine ZRQIS and CN41 Data Into Single Report
			F.4.6.3	Accept CN41 Files
R.3.3.9.3	Display NISE file formats	The CAT system shall be capable of displaying NISE file formats.	F.2.2.14.3.1	Display Funding Sheets
			F.4.6.2	Accept NISE Files
R.3.3.9.4	Display CDASS file formats	The CAT system shall be capable of displaying CDASS file formats.	F.2.2.14.3.1	Display Funding Sheets
			F.4.6.4	Accept CDASS Files
R.3.3.10	Display funding note	The CAT system shall be capable of displaying a funding note associated to a project.	F.2.2.14.3.2	Display Options to Add Notes to Funding Sheets
			F.2.2.16.1	Accept BFM Input Data
			F.2.3.3.3.1.25	Notes
			F.2.3.3.11	Associate BFM Notes to Project Data
R.3.3.11	Display funding alerts	The CAT system shall be capable of displaying funding alerts.	F.2.2.2.6	Display SL GUI Support Features
			F.2.2.5.7	Display BH GUI Support Features
			F.2.2.8.7	Display PM GUI Support Features
			F.2.3.3.12	Provide Funding Alerts
R.3.3.11.1	Display alert when there is an over budget condition	When there is an over budget condition, the CAT system shall be capable of displaying an alert.	F.2.2.2.6	Display SL GUI Support Features
			F.2.2.5.7	Display BH GUI Support Features
			F.2.2.8.2.2	Display Projected Over/Under Expenditure
			F.2.2.8.7	Display PM GUI Support Features
			F.2.3.3.12	Provide Funding Alerts
			F.2.3.3.12.2	Calculate Over/Under Spending
			F.2.3.3.12.3	Provide Funding Alerts
R.3.3.11.2	Display alert when there is an under budget condition	When there is an under budget condition, the CAT system shall be capable of displaying an	F.2.2.5.7	Display BH GUI Support Features
			F.2.2.8.2.2	Display Projected Over/Under Expenditure
			F.2.2.8.7	Display PM GUI Support Features
			F.2.3.3.12	Provide Funding Alerts

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
		alert.	F.2.3.3.12.2	Calculate Over/Under Spending
			F.2.3.3.12.3	Provide Funding Alerts
R.3.3.11.3	Display alert when project is projected to result in zero/ negative funding	When a project is projected to result in zero or negative funding, the CAT system shall be capable of displaying an alert.	F.2.2.5.7	Display BH GUI Support Features
			F.2.2.8.7	Display PM GUI Support Features
			F.2.3.3.12	Provide Funding Alerts
			F.2.3.3.12.2	Calculate Over/Under Spending
			F.2.3.3.12.3	Provide Funding Alerts
R.3.3.11.4	Display alert when projected project burndown rate is off-track	When a projected project burndown rate is off-track by 10% or greater, the CAT system shall be capable of displaying an alert.	F.2.2.5.7	Display BH GUI Support Features
			F.2.2.8.7	Display PM GUI Support Features
			F.2.3.3.12	Provide Funding Alerts
			F.2.3.3.12.2	Calculate Over/Under Spending
			F.2.3.3.12.3	Provide Funding Alerts
R.4	People to Project Requirements		UC.BH&SL.1	View Personnel Utilization
			UC.BH.1	Assign Personnel to Projects
			UC.SL.1	View Competency Manning Levels
R.4.1	People to Project Inputs			
R.4.1.1	Assign a person's name to a project	The CAT system shall be capable of accepting the input of assigning a person's name to a project.		Worker Name
			F.2.2.5.3.2.5	Provide New Worker Option
			F.2.3.1.1.11.4	Determine Project Assignments
			F.2.3.1.2	Accept People to Project Assignment Data
			F.2.3.1.3	Associate Personnel to Project
			F.2.3.1.5	Associate Project to Personnel
			F.2.3.1.7	Perform Ghost Worker Assignment Functions
			F.2.3.6	Store Project to Personnel Correlation
			F.2.4.3.1.1	Edit User Name
			F.2.4.3.1.4	Edit Assigned Projects

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
R.4.1.2	Assign a person's competency	The CAT system shall be capable of accepting the input of assigning a person's competency to a person's name.	F.2.2.5.3.2.5	Provide New Worker Option
			F.2.4.3.1	Manage User Assignments
			F.2.4.3.1.3	Edit Assigned Competencies
R.4.1.3	Assign a rate/grade	The CAT system shall be capable of accepting the input of assigning a rate/ grade to a person'+C510s name.	F.2.4.3.1.6	Edit User Rate/Grade
R.4.1.5	Assign the level of effort	The CAT system shall be capable of accepting the input of assigning the level of effort required by each person assigned to a project.		Percent Allocation Worker Assigned to Date Range for Specified Project
			F.2.3.1.1.11	Gather Utilization Data for Specified Users
			F.2.3.1.1.11.8	Determine Utilization Level
			F.2.3.1.1.11.9	Compile Utilization Data
			F.2.3.1.2	Accept People to Project Assignment Data
R.4.1.6	Assign personnel note	The CAT system shall be capable of accepting the input of assigning a personnel note to a project.	F.2.2.5.3.2.5	Provide New Worker Option
			F.2.4.3	Change User Profile
			F.2.4.3.1.7	Edit Note Space
			F.2.4.4	Save User Profile
R.4.1.7	Filter personnel data	The CAT system shall be capable of accepting the input of filtering personnel data.	F.2.2.5.3.2.3	Provide Sort Function
			F.2.2.5.3.2.3.1	Accept Sort Request
			F.2.2.5.3.2.3.2	Sort by Worker Name

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
R.4.1.8	Ghost Worker Capability	The CAT System Shall be Capable of accepting the input of assigning a place holder user to all aspects of a project.	F.2.2.8.3.5.1	Display Ghost Worker
R.4.2	People to Project Functional Requirements			
R.4.2.1	Organize personnel data	The CAT system shall be capable of organizing personnel data.	F.2.2.5.3.2.3	Provide Sort Function
			F.2.2.5.3.2.3.1	Accept Sort Request
			F.2.2.5.3.2.3.2	Sort by Worker Name
			F.2.2.5.3.2.3.4	Sort by Worker Availability
R.4.2.1.1	Sort by % utilization	The CAT system shall be capable of sorting data by % utilization.	F.2.2.5.3.2.3	Provide Sort Function
			F.2.2.5.3.2.3.3	Sort by Average Worker Allocation
R.4.2.1.2	Sort by number of personnel	The CAT system shall be capable of sorting data by number of personnel assigned to a project.	F.2.2.5.3.2.3.3	Sort by Average Worker Allocation
R.4.2.2	Calculate % utilization	The CAT system shall be capable of calculating % utilization of personnel.	F.2.3.1.1.11	Gather Utilization Data for Specified Users
			F.2.3.1.1.11.8	Determine Utilization Level
			F.2.3.1.1.11.9	Compile Utilization Data
R.4.3	People to Project Outputs			
R.4.3.1	Display personnel information	The CAT system shall be capable of displaying personnel information on	F.2.2.5.3.2.6	Trigger Profile Manager Module Functions
			F.2.2.5.3.2.7	Display Profile Manager Module
			F.2.2.5.3.2.7.2	Display User Profile Information

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
		the profile manager module residing within the People to Project Interface.	F.2.4	Manage User Profiles
			F.2.4.4	Save User Profile
R.4.3.1.1	Display a person's name	The CAT system shall be capable of displaying a person's name.	F.2.2.5.3.1	Display BH People to Project Interface
			F.2.2.5.3.2.6	Trigger Profile Manager Module Functions
			F.2.2.5.3.2.7	Display Profile Manager Module
			F.2.2.5.3.2.7.2	Display User Profile Information
			F.2.2.8.3.5.2	Display Assigned Personnel
			F.2.4	Manage User Profiles
			F.2.4.3.1	Manage User Assignments
			F.2.4.4	Save User Profile
R.4.3.1.2	Display a person's rate/grade	The CAT system shall be capable of displaying a person's rate/grade.	F.2.2.5.3.1	Display BH People to Project Interface
			F.2.2.5.3.2.6	Trigger Profile Manager Module Functions
			F.2.2.5.3.2.7	Display Profile Manager Module
			F.2.2.5.3.2.7.2	Display User Profile Information
			F.2.4	Manage User Profiles
			F.2.4.3.1	Manage User Assignments
			F.2.4.4	Save User Profile
R.4.3.1.3	Display a person's competency	The CAT system shall be capable of displaying a person's competency.	F.2.2.5.3.1	Display BH People to Project Interface
			F.2.2.5.3.2.6	Trigger Profile Manager Module Functions
			F.2.2.5.3.2.7.2	Display User Profile Information
			F.2.4	Manage User Profiles
			F.2.4.3.1	Manage User Assignments
			F.2.4.4	Save User Profile
R.4.3.2	Display personnel associated to each project	The CAT system shall be capable of displaying personnel associated to	F.2.2.5.1	Retrieve Branch Head People to Projects Dashboard View Data
			F.2.2.5.3.1	Display BH People to Project Interface

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
		each project.	F.2.2.8.3.5.2	Display Assigned Personnel
			F.2.3.1	Provide People to Project Tracking Functions
			F.2.3.1.1.6	Determine Workers in Selected Project
			F.2.3.1.1.8	Send Project Allocation View Data to GUI Module
			F.2.3.1.1.9	Generate Worker Detail Allocation View Data
			F.2.3.1.1.10	Send Worker Detail Allocation View Data to GUI Module
			F.2.3.1.4	Send Project Assignments to Project Data
			F.2.3.1.6	Send Project Assignments to Profile Management Module
R.4.3.3	Display personnel associated to amounts of funding	The CAT system shall be capable of displaying personnel associated to amounts of funding.	F.2.2.5.1	Retrieve Branch Head People to Projects Dashboard View Data
			F.2.2.5.3.1	Display BH People to Project Interface
			F.2.2.8.3.5.3	Display Assigned Labor Hours
R.4.3.4	Display personnel associated with his or her current DAWIA certifications	The CAT system shall be capable of displaying personnel associated with his or her current DAWIA certifications.	F.2.2.2.6	Display SL GUI Support Features
			F.2.2.5.7	Display BH GUI Support Features
			F.2.2.8.7	Display PM GUI Support Features
R.4.3.5	Display required date for a person's next DAWIA certification level	The CAT system shall be capable of displaying personnel and the required date for the next DAWIA certification level.	F.2.2.2.6	Display SL GUI Support Features
			F.2.2.5.7	Display BH GUI Support Features
			F.2.2.8.7	Display PM GUI Support Features
R.4.3.6	Display personnel associated with % utilization	The CAT system shall be capable of displaying personnel associated with	F.2.2.5.1	Retrieve Branch Head People to Projects Dashboard View Data
			F.2.2.5.3.1	Display BH People to Project Interface

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
		% utilization.	F.2.3.1.1.2.4	For Each Branch
			F.2.3.1.1.10	Send Worker Detail Allocation View Data to GUI Module
			F.2.3.1.1.11.1	For all Workers
			F.2.3.1.1.11.5	For Each Project Assignment
			F.2.3.1.1.11.7	For Each Date Range
R.4.3.7	Display personnel associated to level of effort	The CAT system shall be capable of displaying personnel associated to level of effort for a project.	F.2.2.5.1	Retrieve Branch Head People to Projects Dashboard View Data
			F.2.2.5.3.1	Display BH People to Project Interface
			F.2.3.1.1.7	Generate Project Allocation View Data
R.4.3.8	Display personnel associated with availability for tasking	The CAT system shall be capable of displaying personnel associated with availability for tasking.	F.2.2.5.1	Retrieve Branch Head People to Projects Dashboard View Data
			F.2.2.5.3.1	Display BH People to Project Interface
			F.2.2.5.3.2.3.4	Sort by Worker Availability
R.4.3.9	Display personnel associated with duration of time assigned to projects	The CAT system shall be capable of displaying personnel associated with duration of time assigned to projects.	F.2.2.5.1	Retrieve Branch Head People to Projects Dashboard View Data
			F.2.2.5.3.1	Display BH People to Project Interface
			F.2.3.1.1.2.4	For Each Branch
			F.2.3.1.1.11.5	For Each Project Assignment
			F.2.3.1.1.11.7	For Each Date Range
R.4.3.10	Display personnel associated with funding sponsor information	The CAT system shall be capable of displaying personnel associated with funding sponsor information.	F.2.2.5.1	Retrieve Branch Head People to Projects Dashboard View Data
			F.2.2.5.3.1	Display BH People to Project Interface
R.4.3.11	Display a personnel note	The CAT system shall be capable of displaying a personnel note associated to a project.	F.2.2.5.1	Retrieve Branch Head People to Projects Dashboard View Data
			F.2.2.5.3.1	Display BH People to Project Interface

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
R.4.3.12	Display personnel alerts	The CAT system shall be capable of displaying personnel alerts.		
R.4.3.12.1	Emphasize an over-utilized worker	When a person is over-utilized, the CAT system shall be capable of visually emphasizing the over utilization	F.2.2.5.3.2.2	Emphasize Over-allocated Personnel
R.4.3.12.2	Emphasize an under-utilized worker	When a person is under-utilized, the CAT system shall be capable of visually emphasizing the under utilization	F.2.2.5.3.2.1	Emphasize Under-allocated Personnel
R.4.3.12.3	Display alert when a person's DAWIA certification qualification is coming due	When a person's DAWIA certification qualification is coming due, the CAT system shall be capable of displaying an alert.	F.2.2.2.6	Display SL GUI Support Features
			F.2.2.5.7	Display BH GUI Support Features
			F.2.2.8.7	Display PM GUI Support Features
R.4.3.13	Display People to Projects GUI	The CAT System shall be capable of displaying the People to Project GUI	F.2.3.1.1	Generate Personnel Views Data
			F.2.3.1.1.3	Determine Workers in Branch
			F.2.3.1.1.7	Generate Project Allocation View Data
			F.2.3.1.1.8	Send Project Allocation View Data to GUI Module
			F.2.3.1.1.11.2	Request Historical Charge Data from CDASS via Data Management Module
			F.2.3.1.1.11.3	Receive Historical Charge Data

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
			F.2.3.1.1.11.6	Determine Date Range Assigned to Project
R.5	Project Status Item Reporting		UC.PM&BH&SL.3	View List of Obstacles
			UC.PM.1	Enter Status Item Information
R.5.1	Status Item Reporting Inputs			
R.5.1.1	Assign a status item to a project	The CAT system shall be capable of accepting the input of assigning a status item to a project.	F.2.2.10.2	Accept Schedule Item Data Input
R.5.1.2	Assign an Status Item reporting note	The CAT system shall be capable of accepting the input of assigning an Status Item reporting note to a project.	F.2.3.4	Provide Status Item Management Functions
			F.2.3.4.1	Enter New Status Item?
			F.2.3.4.2	Receive New Status Item Information
			F.2.3.4.3	Create Alert for New Status Item
R.5.2	Status Item Reporting Functional Requirements			
R.5.2.1	Sort risks/issues	The CAT system shall be capable of sorting risks/ issues assigned to a project.	F.2.2.8.4	Display PM Obstacles View
R.5.3	Status Item Reporting Outputs			
R.5.3.1	Display status reports	The CAT system shall be capable of displaying status reports associated to a project.	F.2.2.2.3	Display Division Obstacles View
			F.2.2.5.4	Display Branch Obstacles View
			F.2.2.8.4	Display PM Obstacles View
			F.2.3.4	Provide Status Item Management Functions

Requirements		Traced to		
Number	**Name**	**Description**	**Number**	**Name**
			F.2.3.4.4	Compile Data Status Item Information for Display
			F.2.3.4.4.1	Display Status Item Name
			F.2.3.4.4.2	Display Status Item Status
			F.2.3.4.4.3	Display Status Item Entry Date
R.5.3.2	Display Status Item reporting alerts	The CAT system shall be capable of displaying Status Item reporting “flag” alerts.	F.2.2.2.6	Display SL GUI Support Features
			F.2.2.5.7	Display BH GUI Support Features
			F.2.2.5.7.1	Display Alerts
			F.2.2.8.7	Display PM GUI Support Features
			F.2.3.3.12.3	Provide Funding Alerts
			F.2.3.4.4.1	Display Status Item Name
			F.2.3.4.4.2	Display Status Item Status
R.5.3.2.1	Display alert when project is assigned a status item	When a project is assigned a status item, the CAT system shall be capable of displaying an alert.	F.2.2.5.4	Display Branch Obstacles View
			F.2.2.5.7	Display BH GUI Support Features
			F.2.2.5.7.1	Display Alerts
			F.2.3.4	Provide Status Item Management Functions

APPENDIX I. CAT ACTION DIAGRAMS

This appendix contains a complete set of the CAT action diagrams, including those that are in Chapter IV.

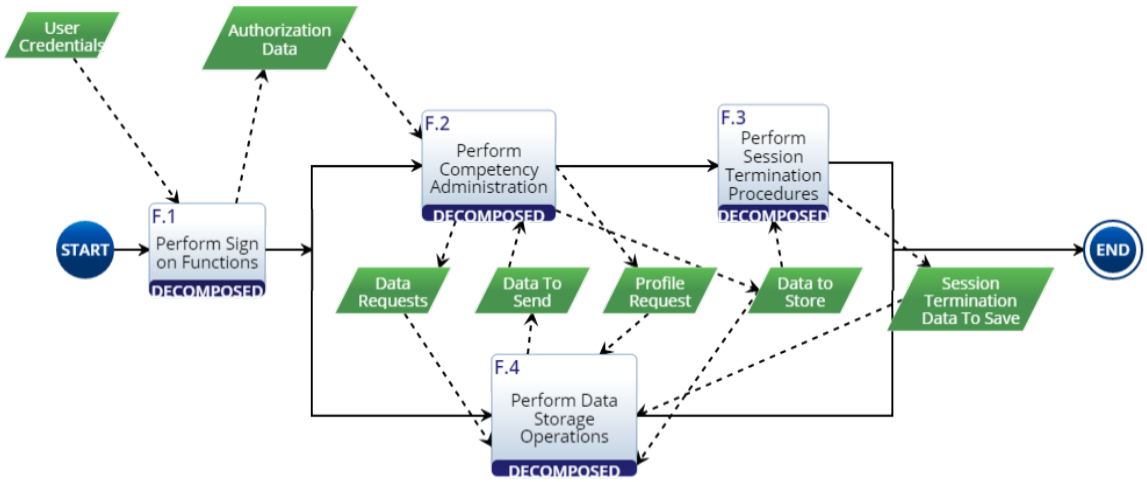

Figure I-1. F.0 Action Diagram

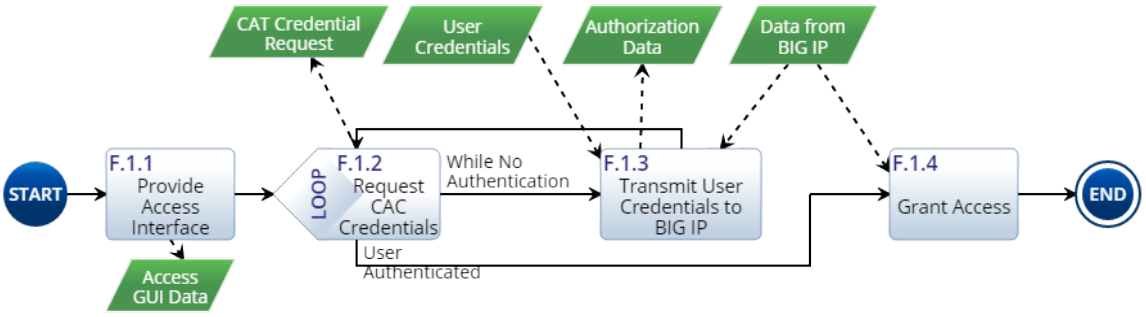

Figure I-2. F.1 Action Diagram

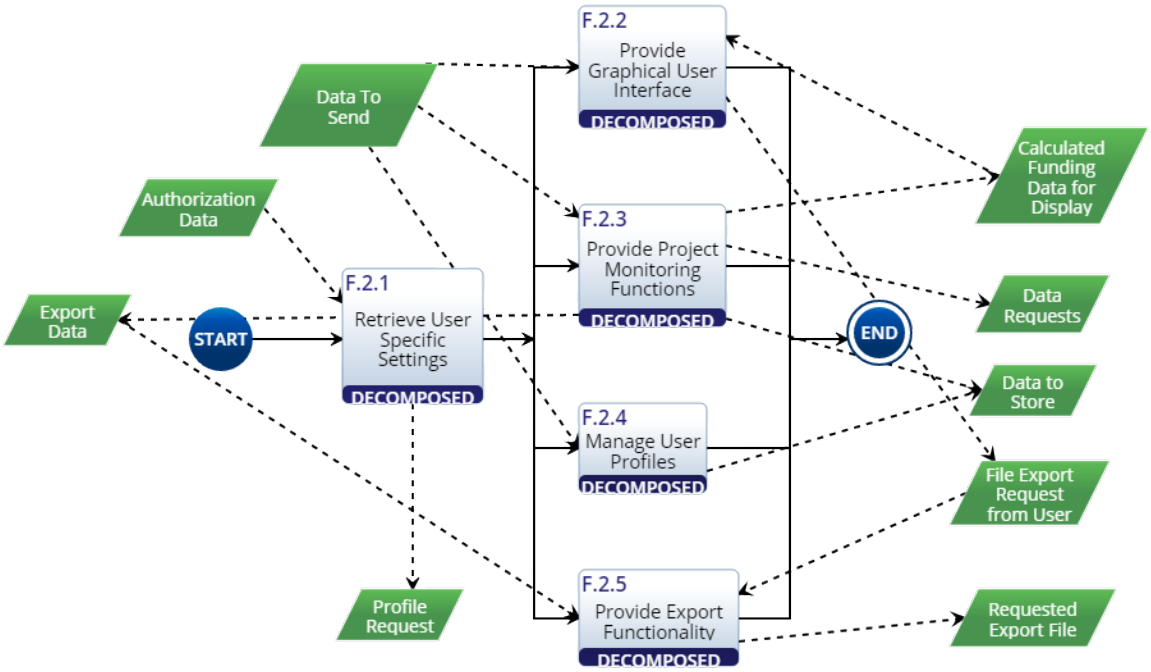

Figure I-3. F.2 Action Diagram

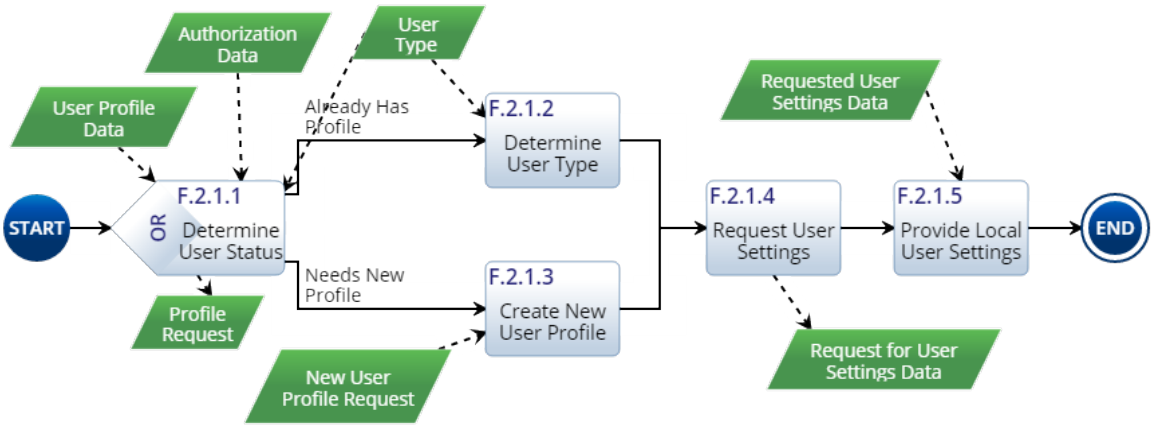

Figure I-4. F.2.1 Action Diagram

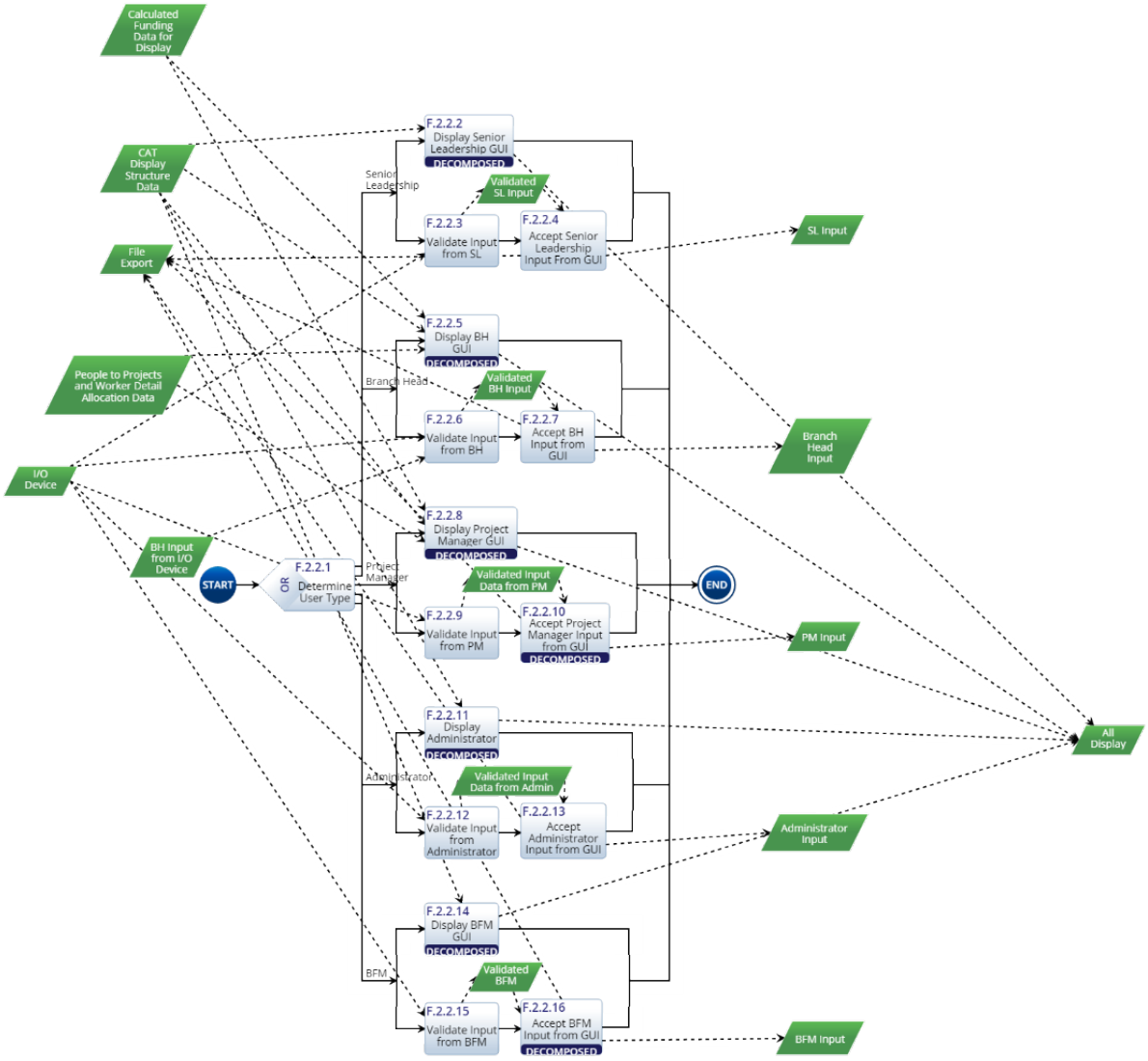

Figure I-5. F.2.2 Action Diagram

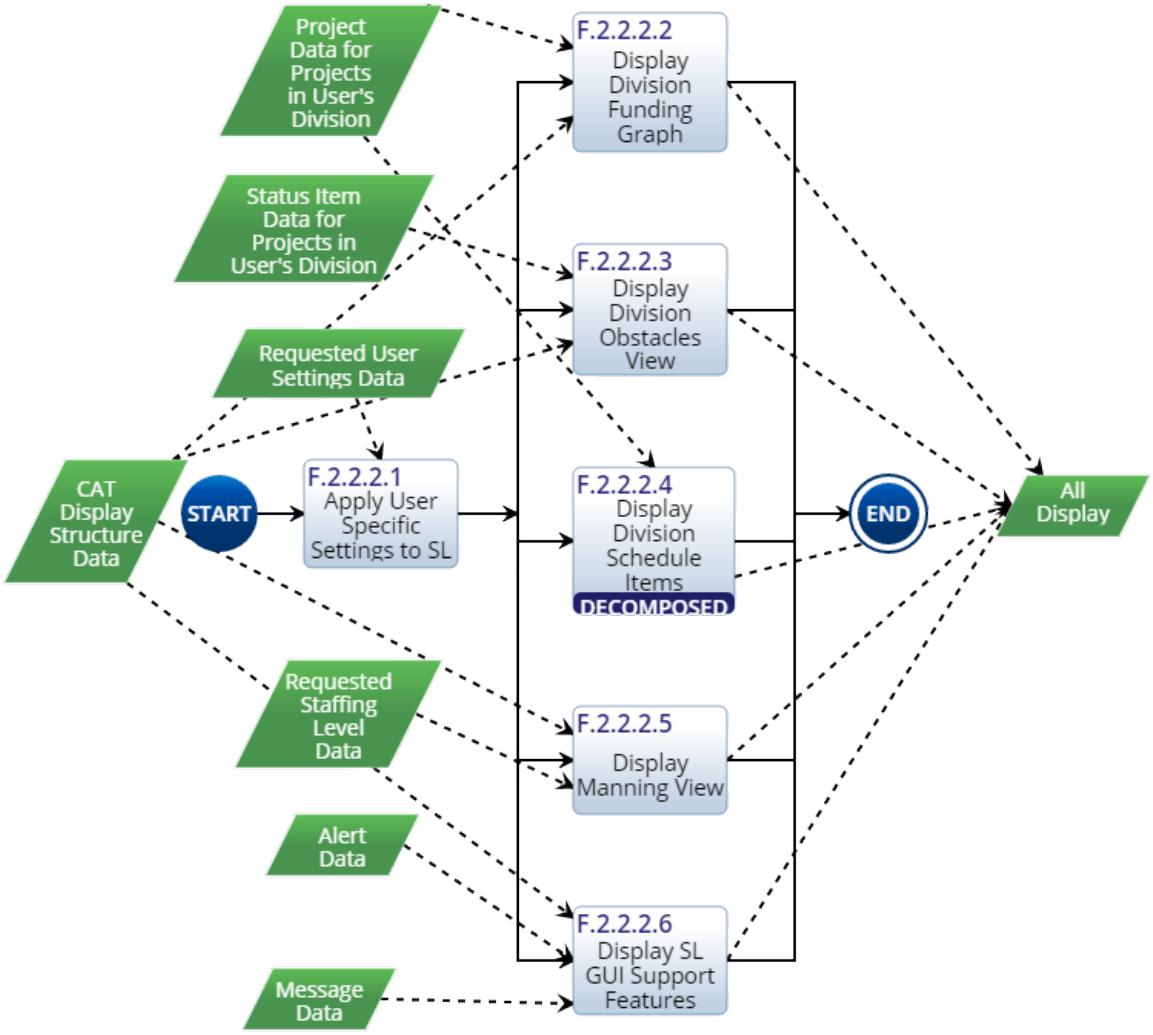

Figure I-6. F.2.2.2 Action Diagram

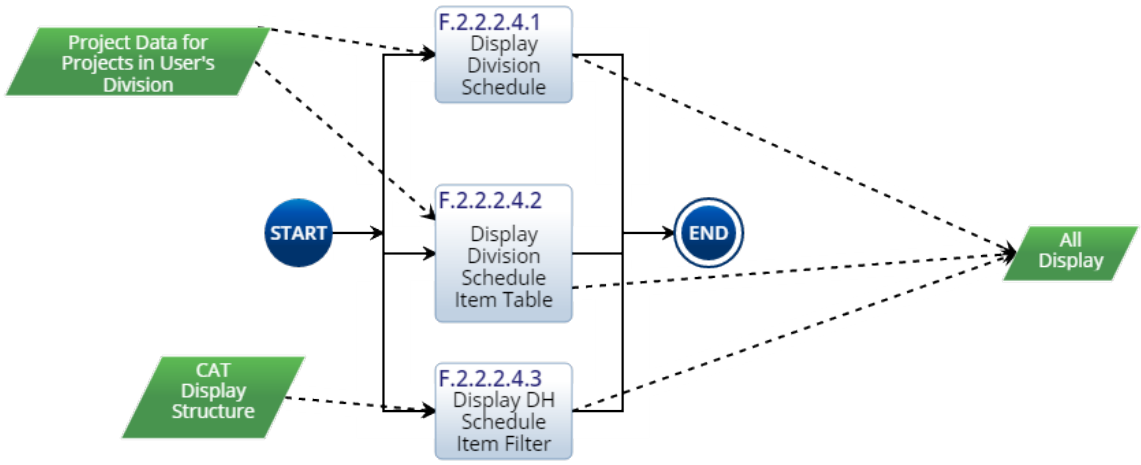

Figure I-7. F.2.2.2.4 Action Diagram

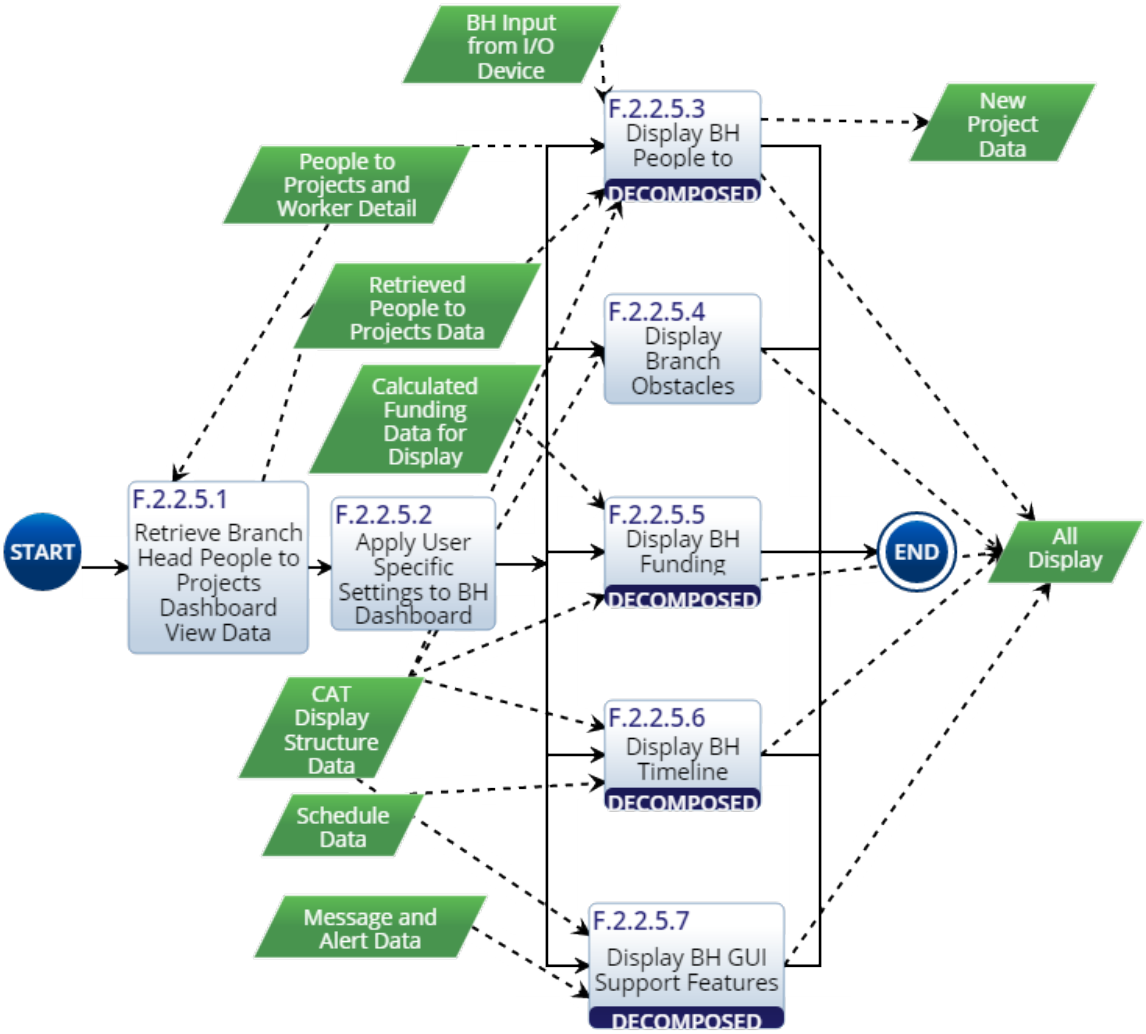

Figure I-8. F.2.2.5 Action Diagram

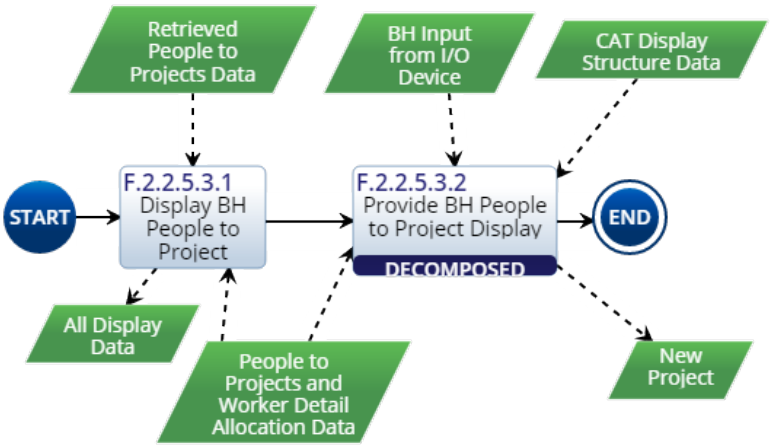

Figure I-9. F.2.2.5.2 Action Diagram

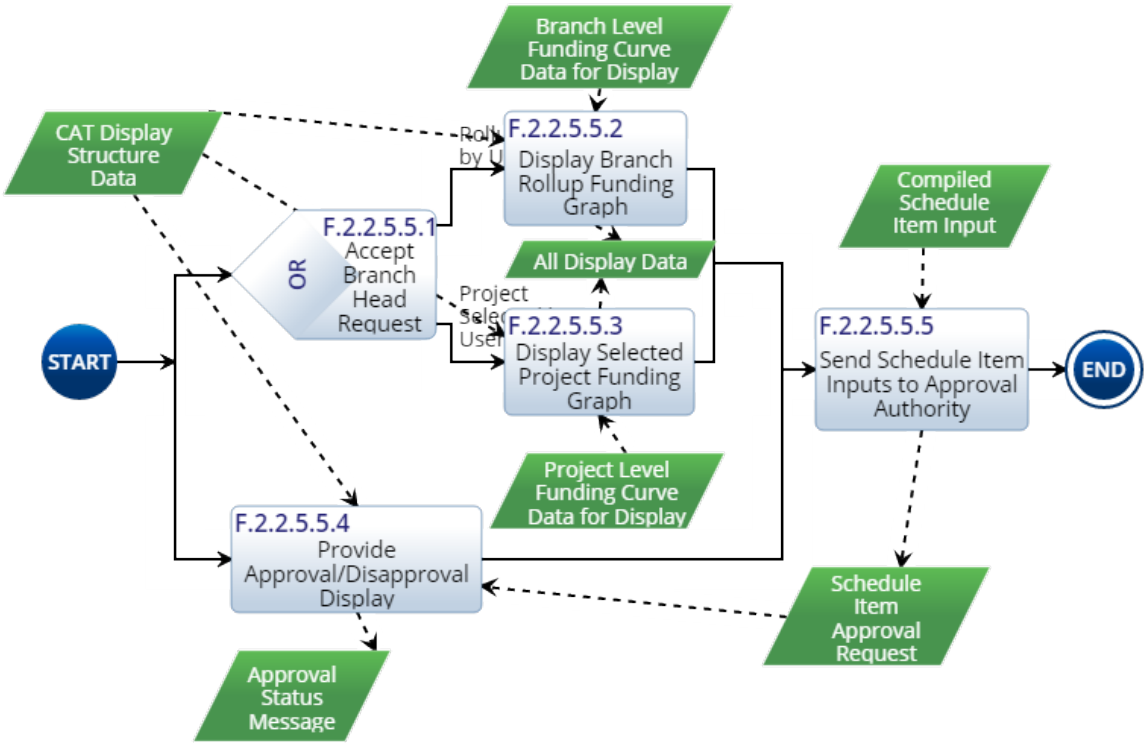

Figure I-10. F.2.3.2 Action Diagram

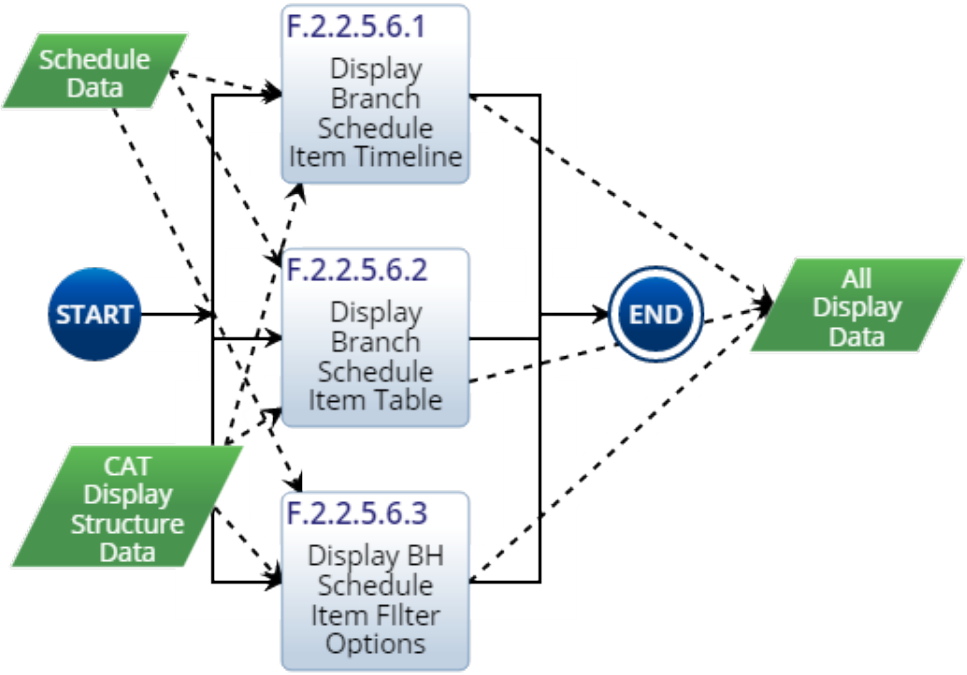

Figure I-11. F.2.2.5.5 Action Diagram

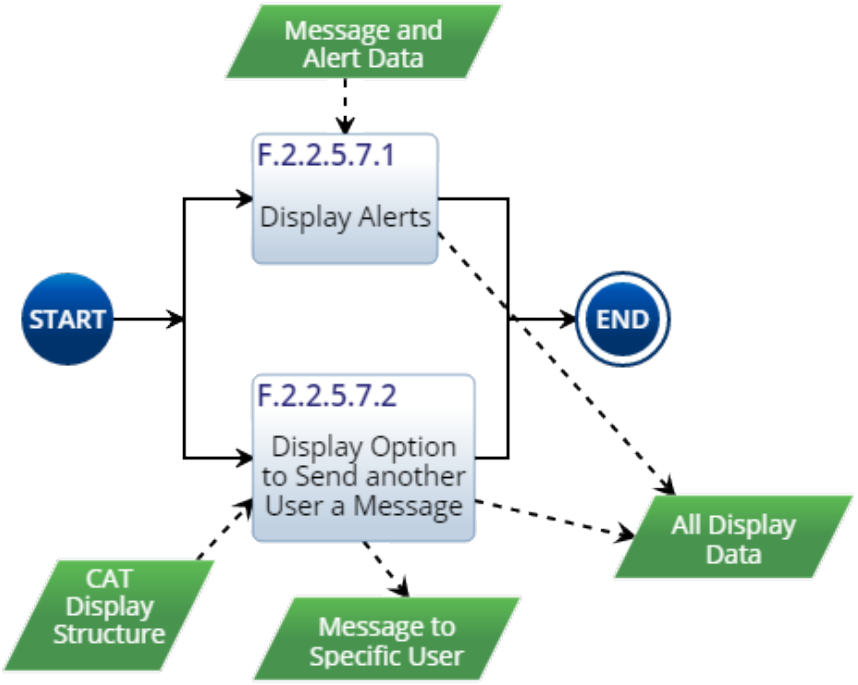

Figure I-12. F.2.2.5.6 Action Diagram

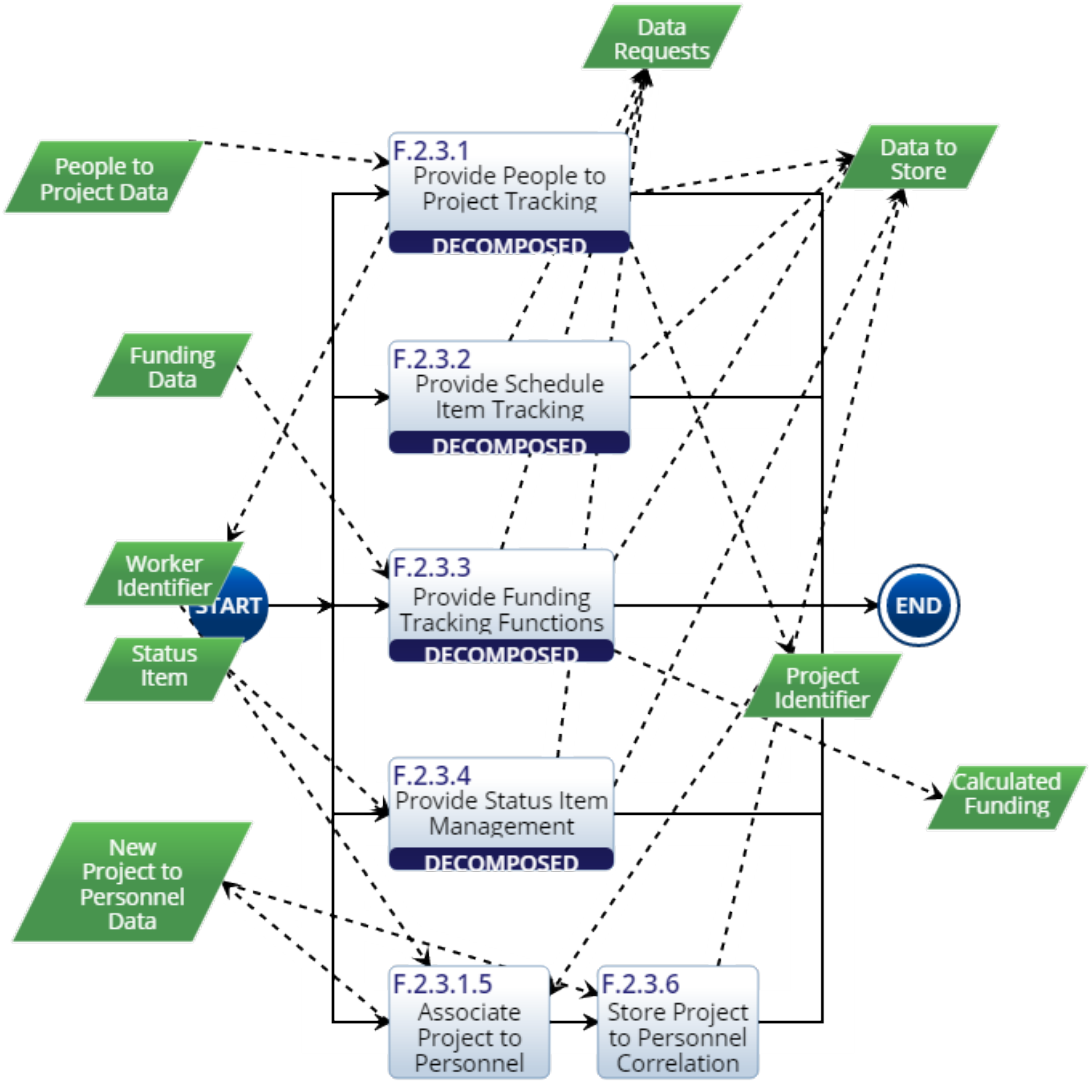

Figure I-13. F.2.3 Action Diagram

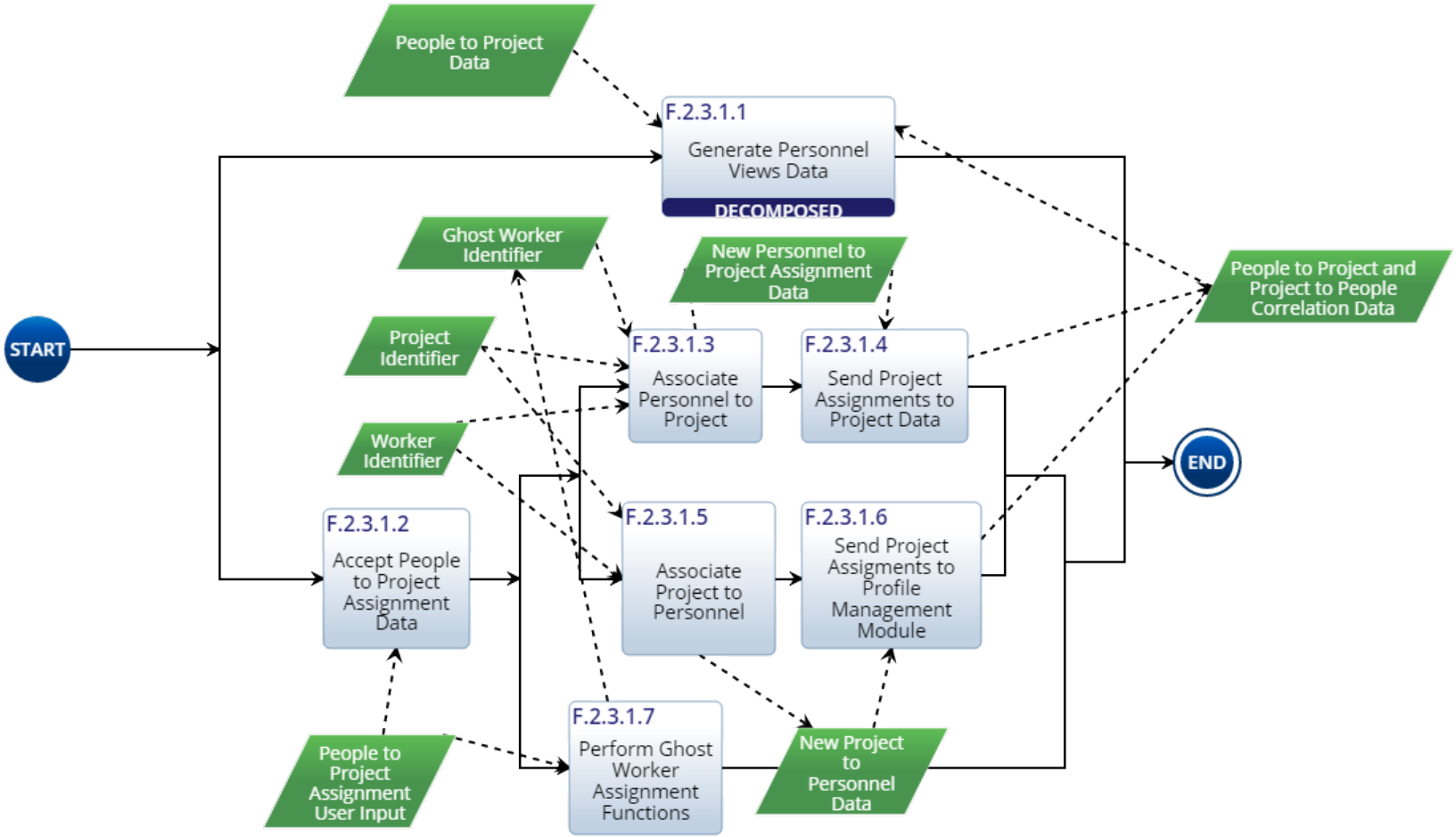

Figure I-14. F.2.3.1 Action Diagram

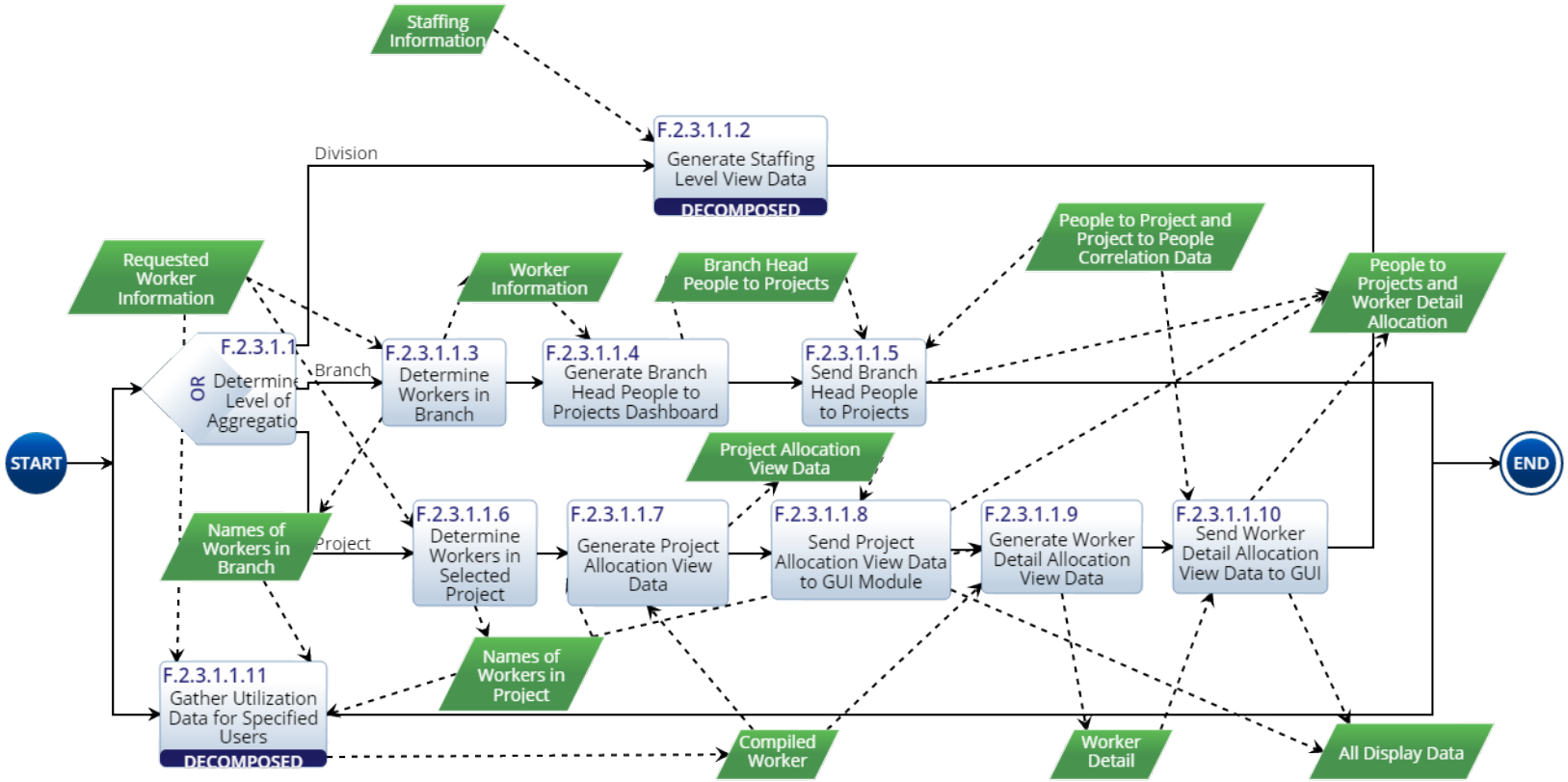

Figure I-15. F.2.3.1 Action Diagram

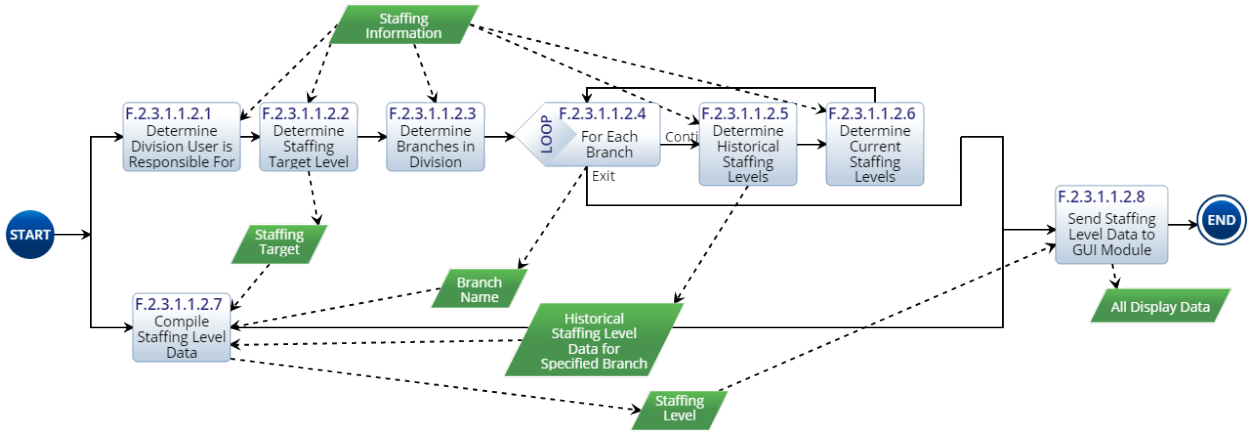

Figure I-16. F.2.3.1.1 Action Diagram

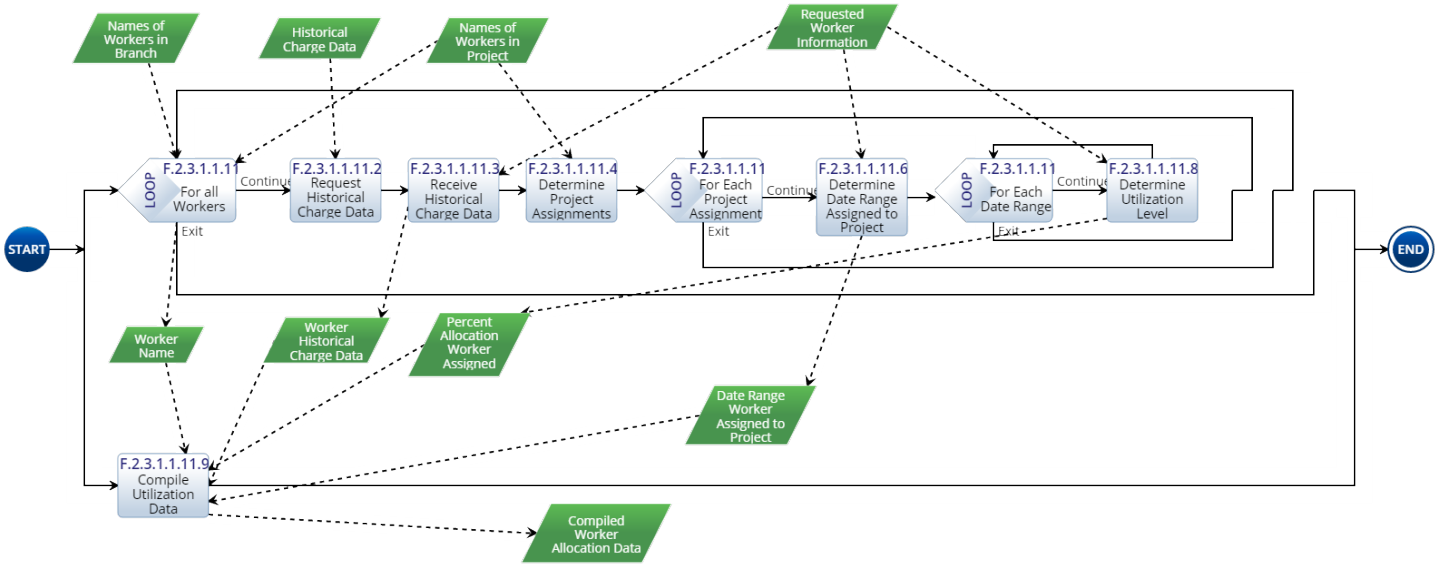

Figure I-17. F.2.3.1.1.11 Action Diagram

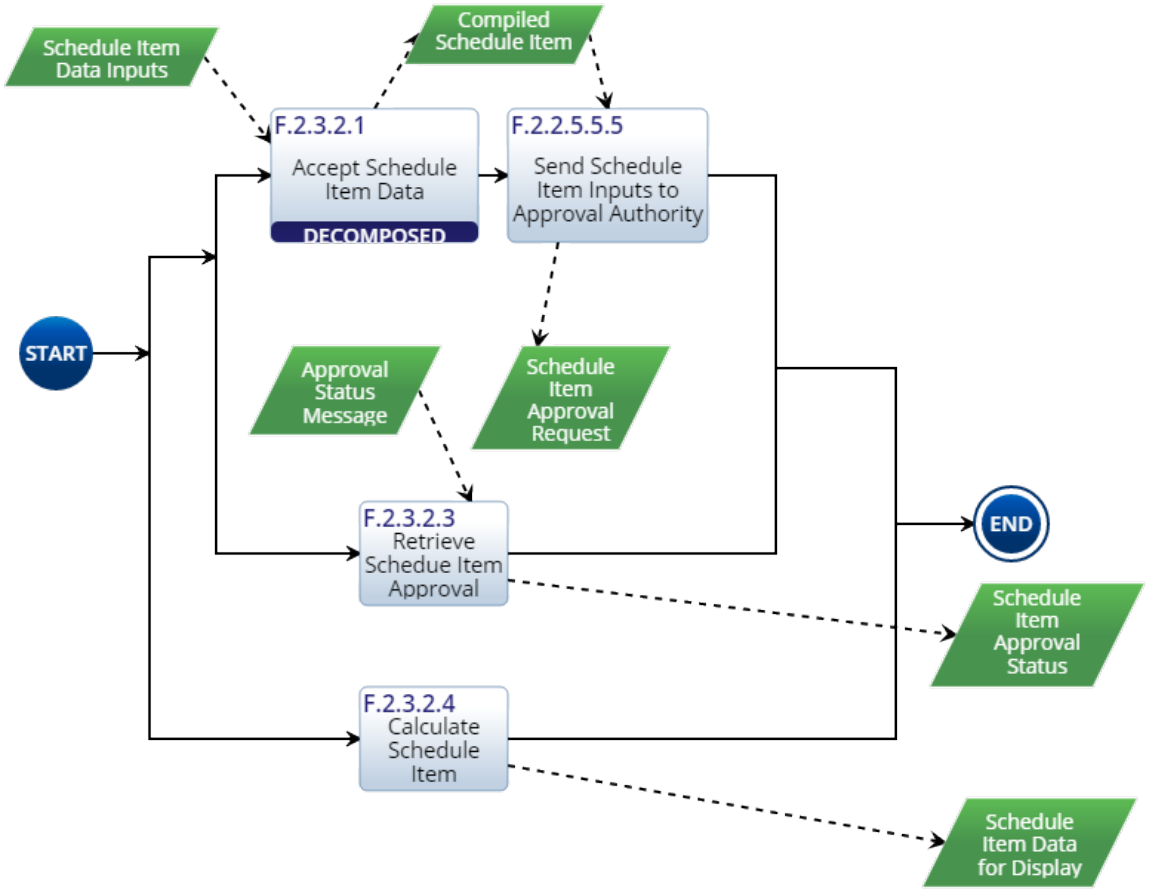

Figure I-18. F.2.3.2Action Diagram

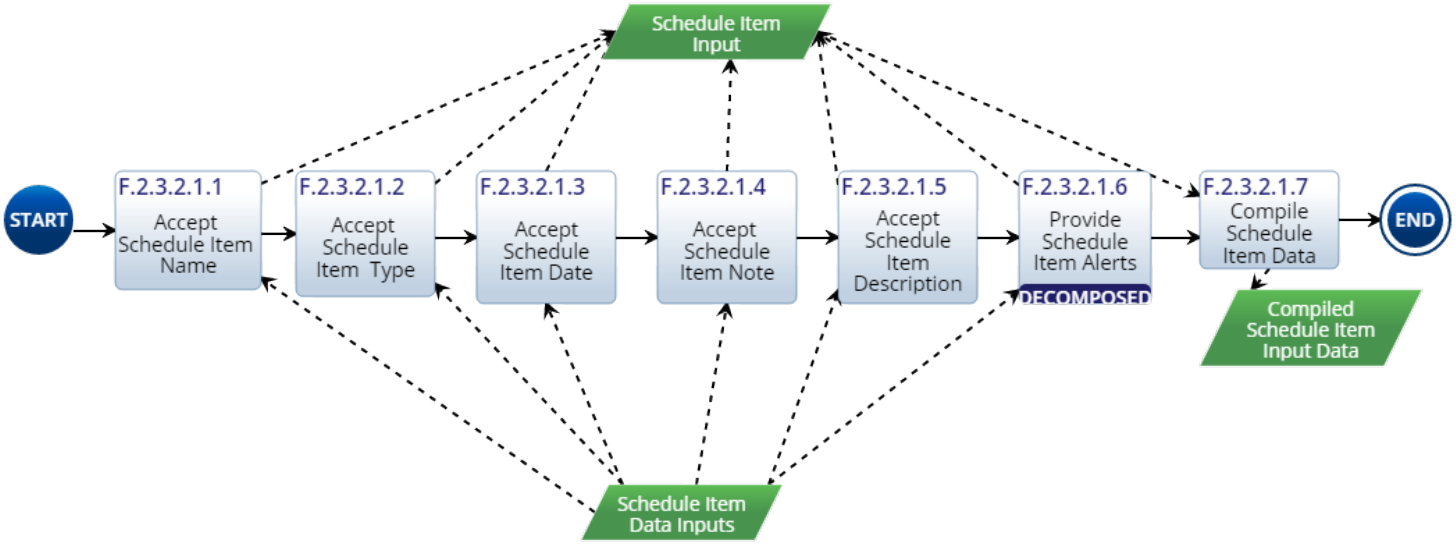

Figure I-19. F.2.3.2.1 Action Diagram

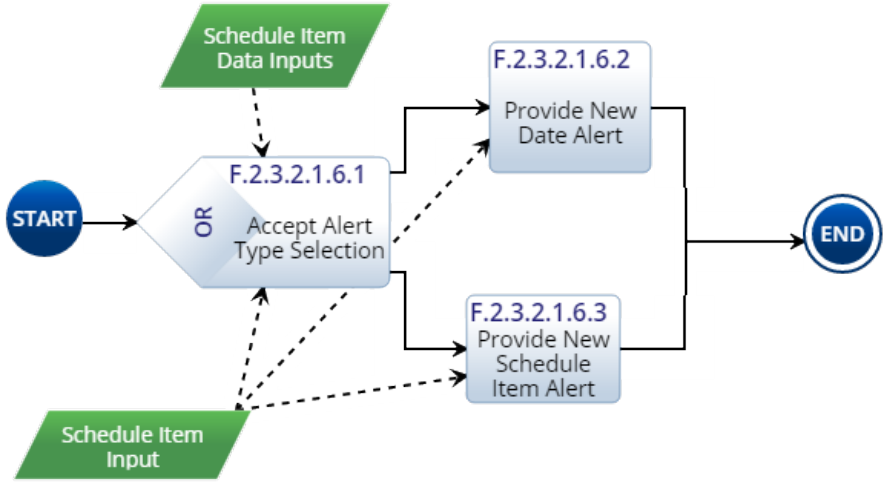

Figure I-20. F.2.3.2.1.6 Action Diagram

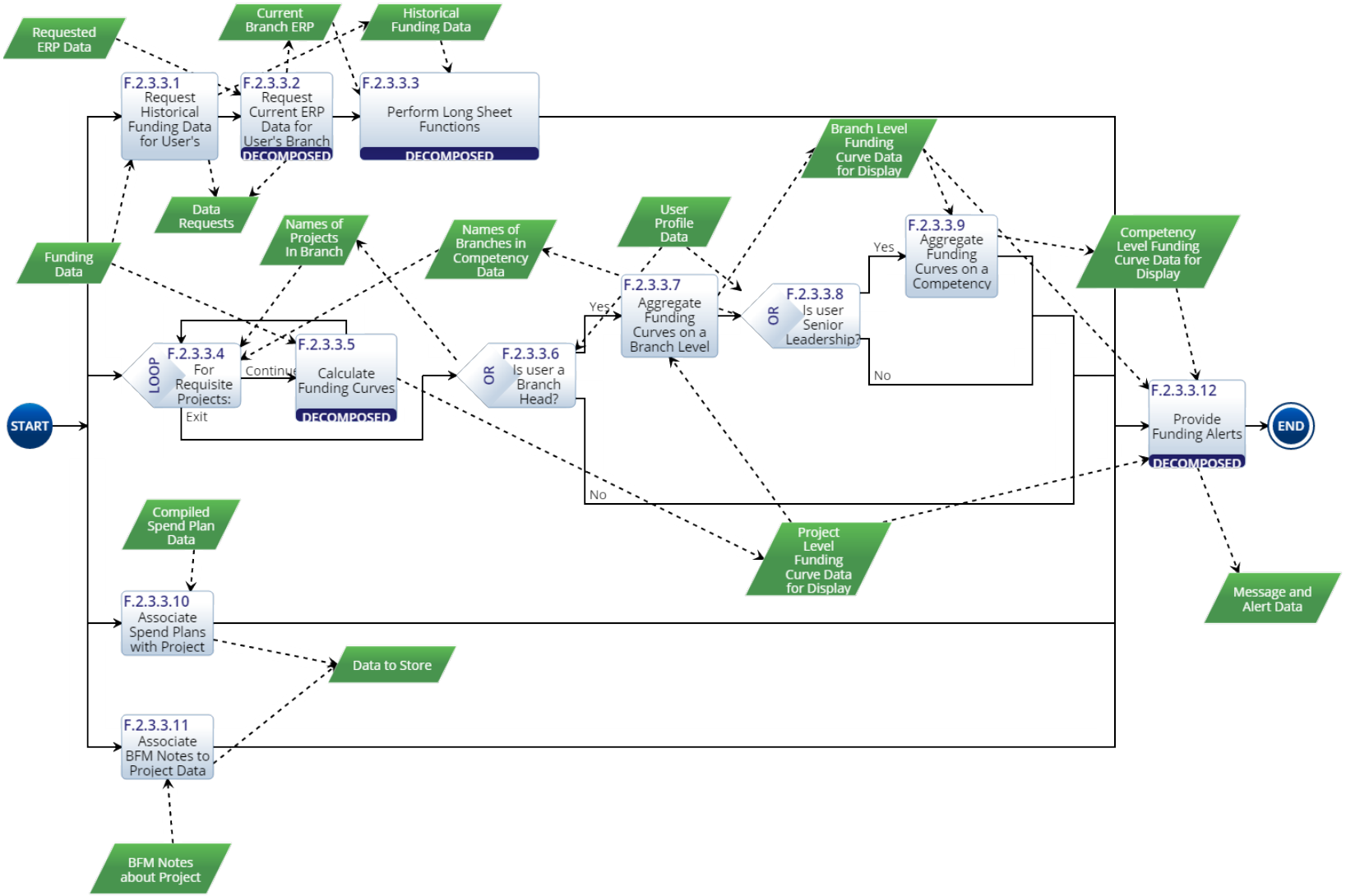

Figure I-21. F.2.3.3 Action Diagram

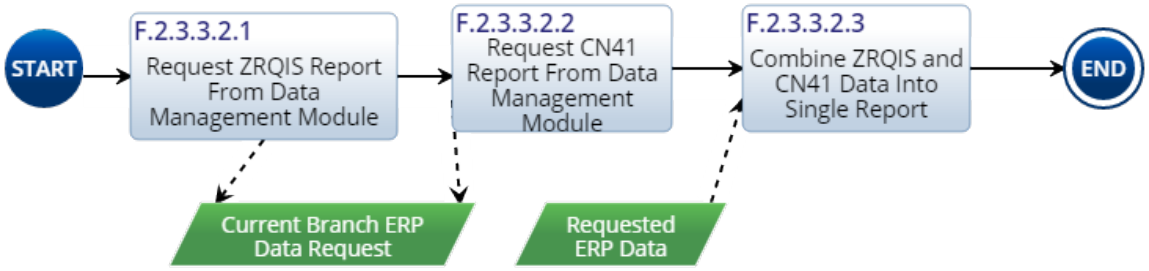

Figure I-22. F.2.3.3.2 Action Diagram

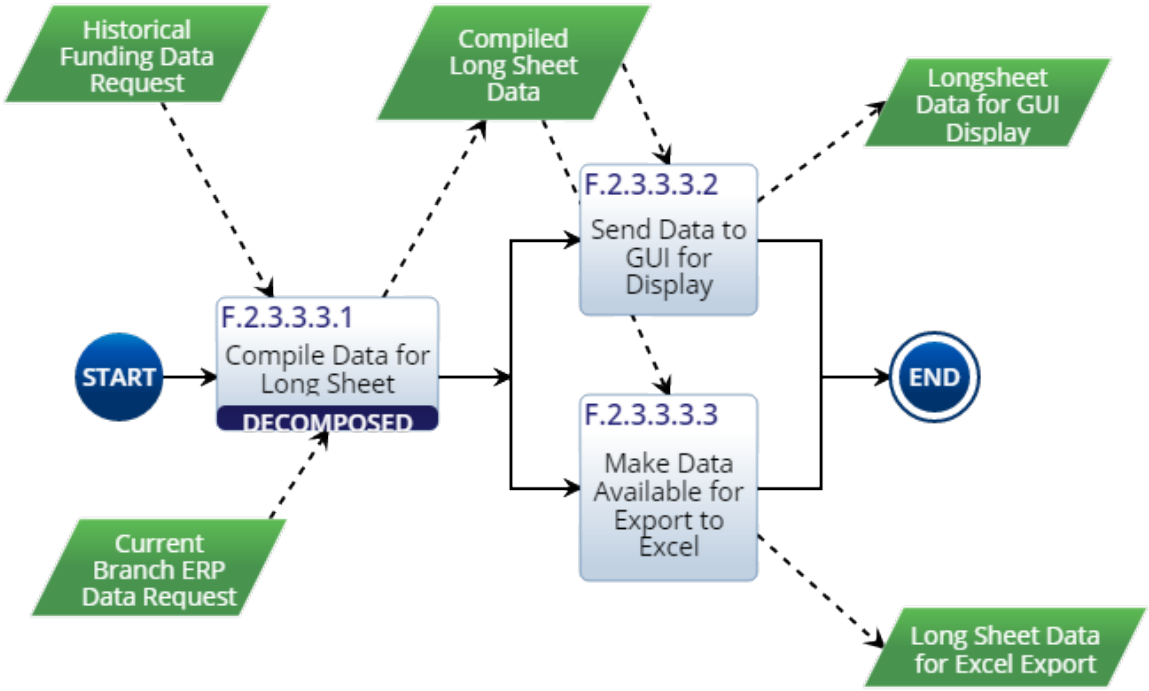

Figure I-23. F.2.3.3.3 Action Diagram

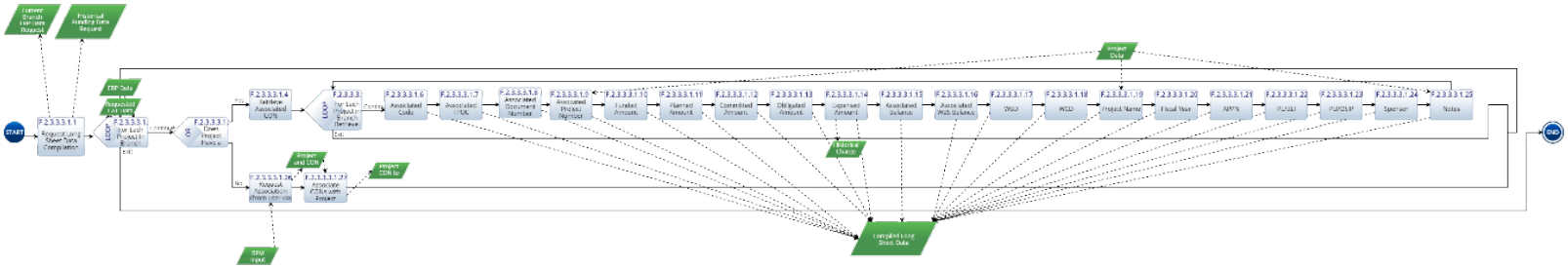

Figure I-24. F.2.3.3.3.1 Action Diagram

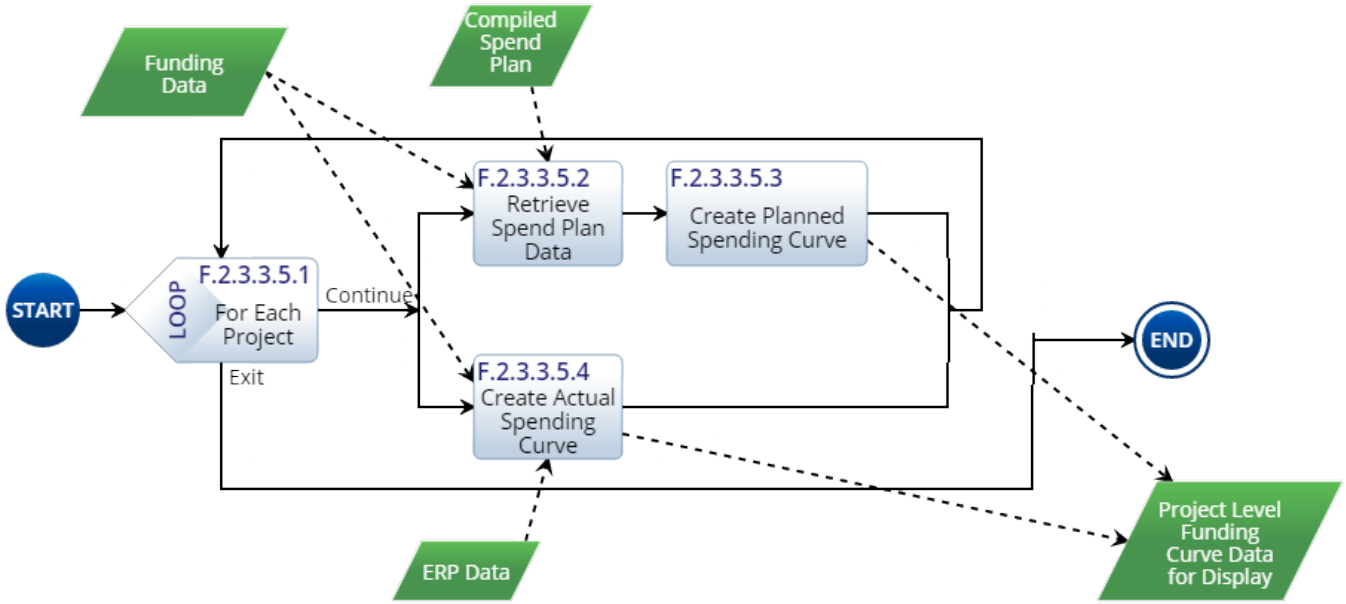

Figure I-25. F.2.3.3.5 Action Diagram

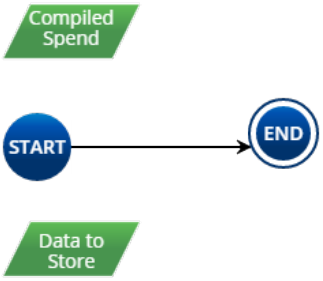

Figure I-26. F.2.3.3.10 Action Diagram

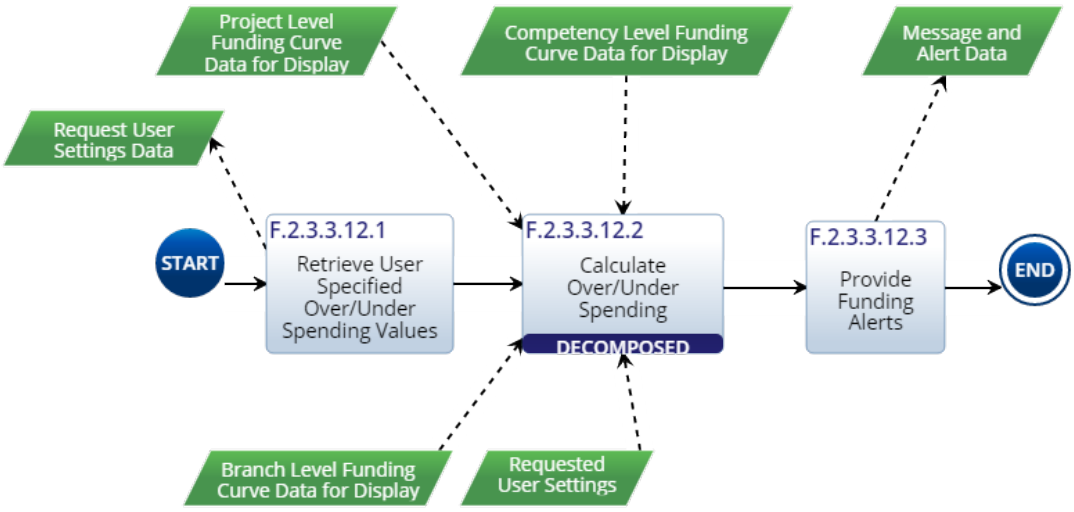

Figure I-27. F.2.3.3.12 Action Diagram

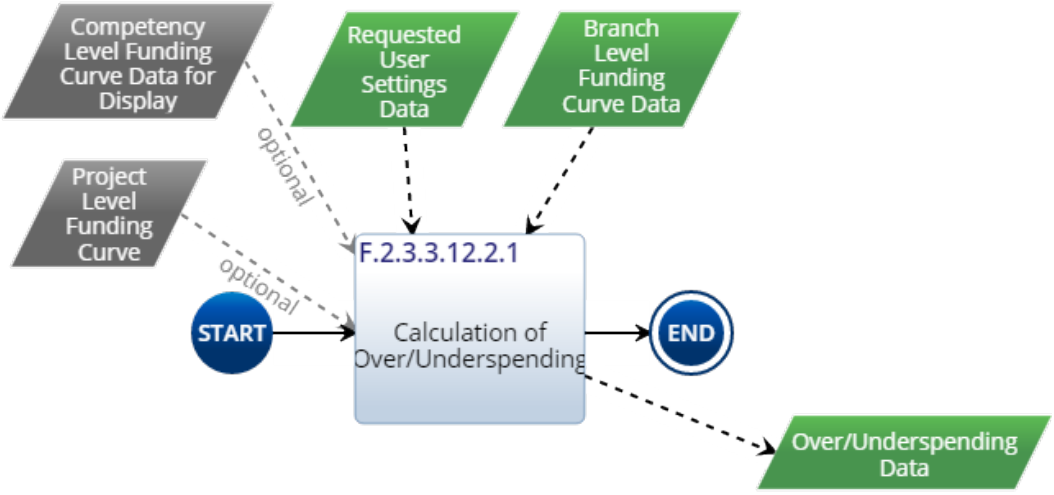

Figure I-1. F.2.3.3.12.2 Action Diagram

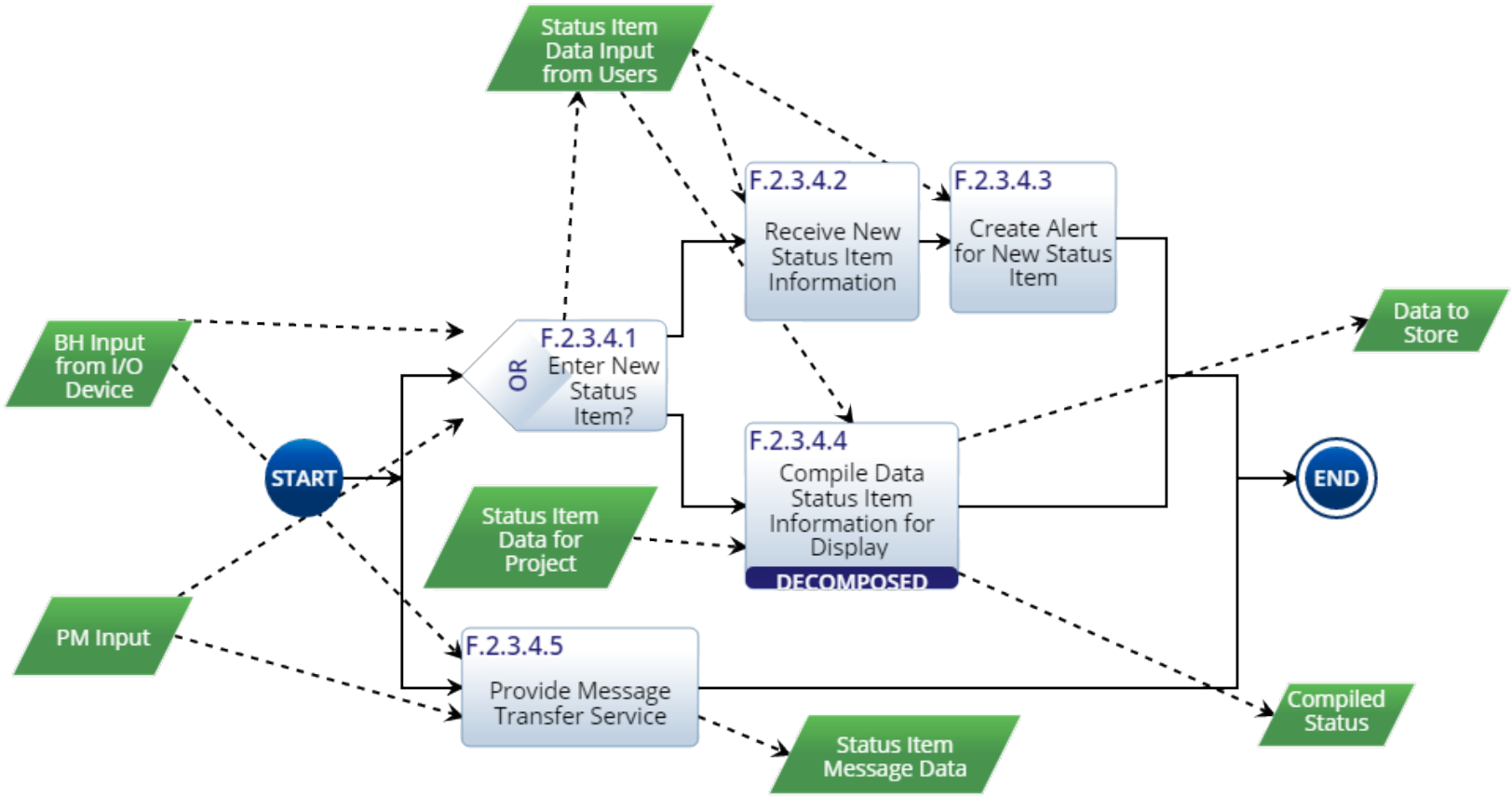

Figure I-2. F.2.3.4 Action Diagram

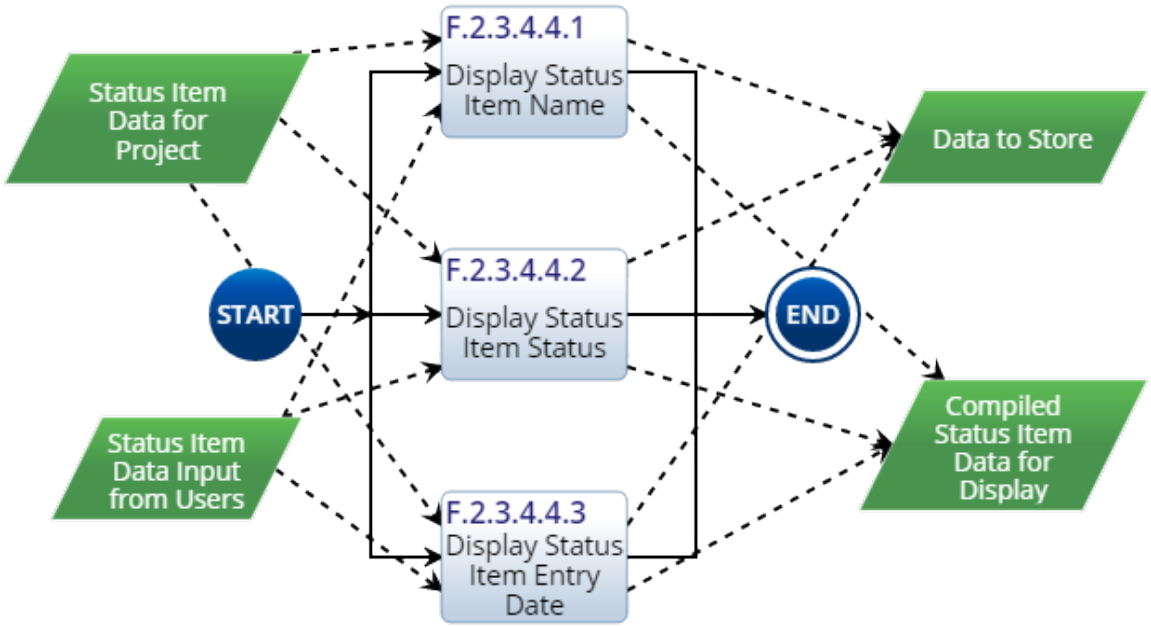

Figure I-3. F.2.3.4.4 Action Diagram

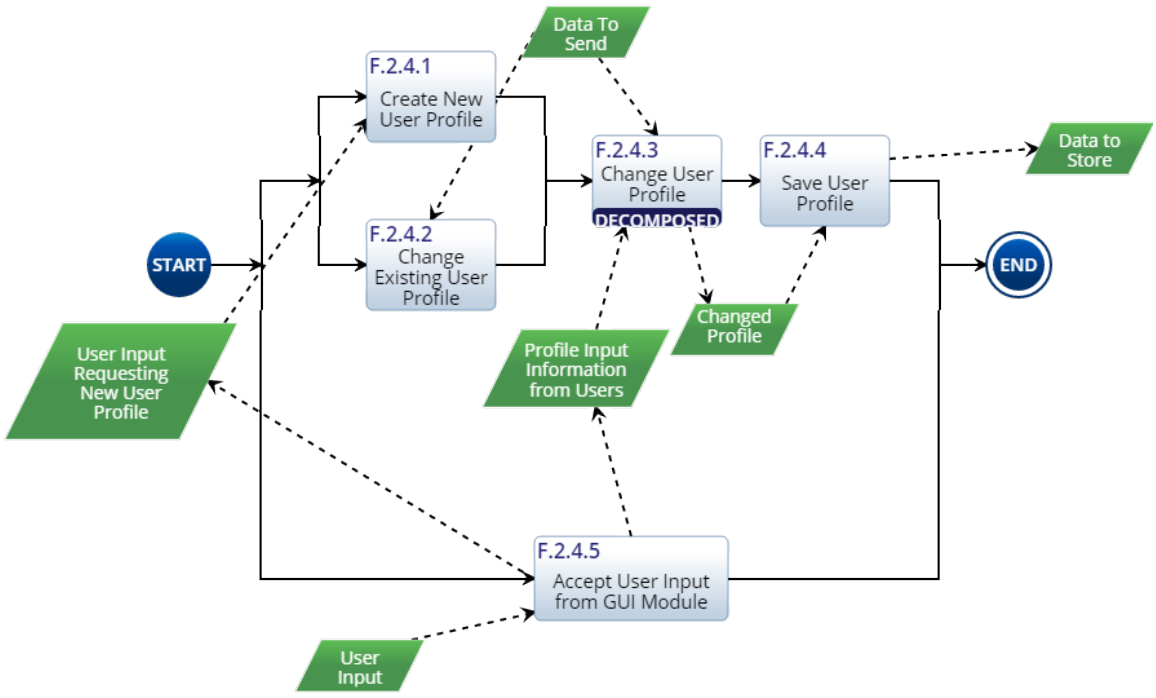

Figure I-4. F.2.4 Action Diagram

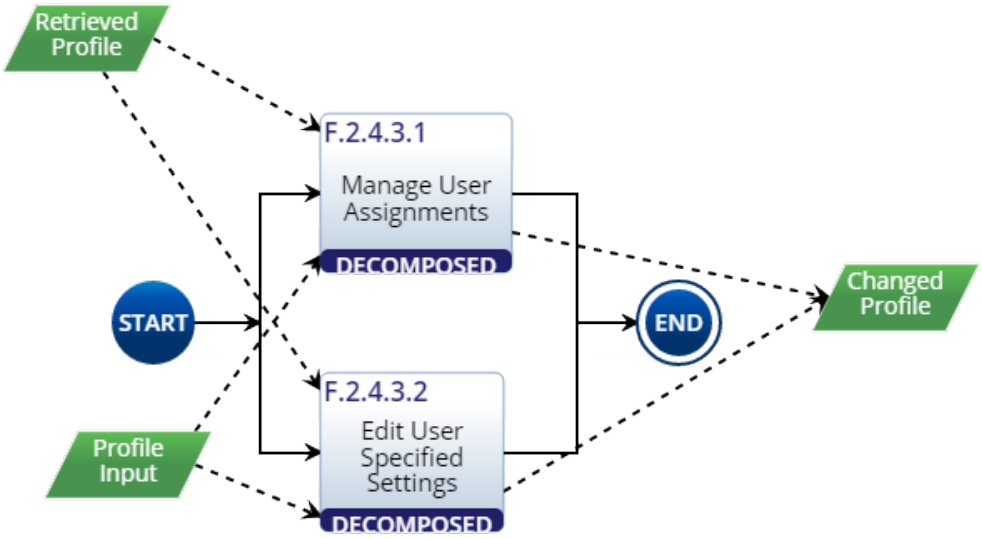

Figure I-5. F.2.4.3 Action Diagram

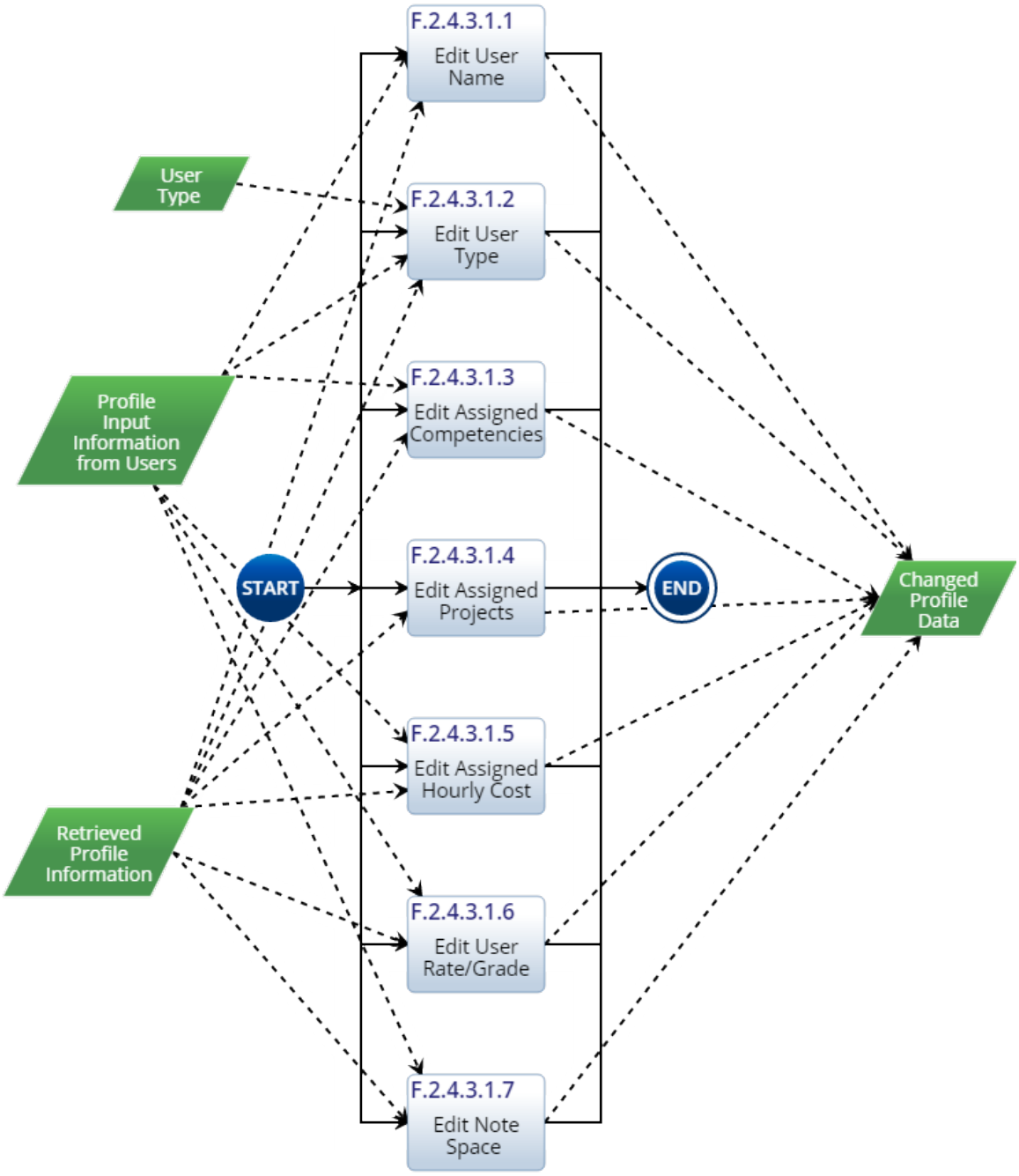

Figure I-6. F.2.4.3.1 Action Diagram

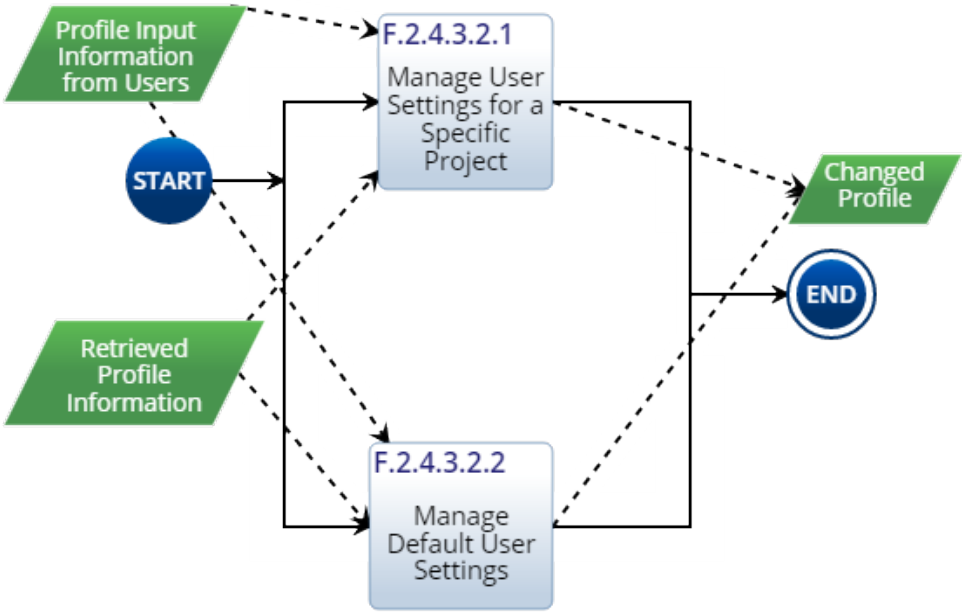

Figure I-7. F.2.4.3.2 Action Diagrams

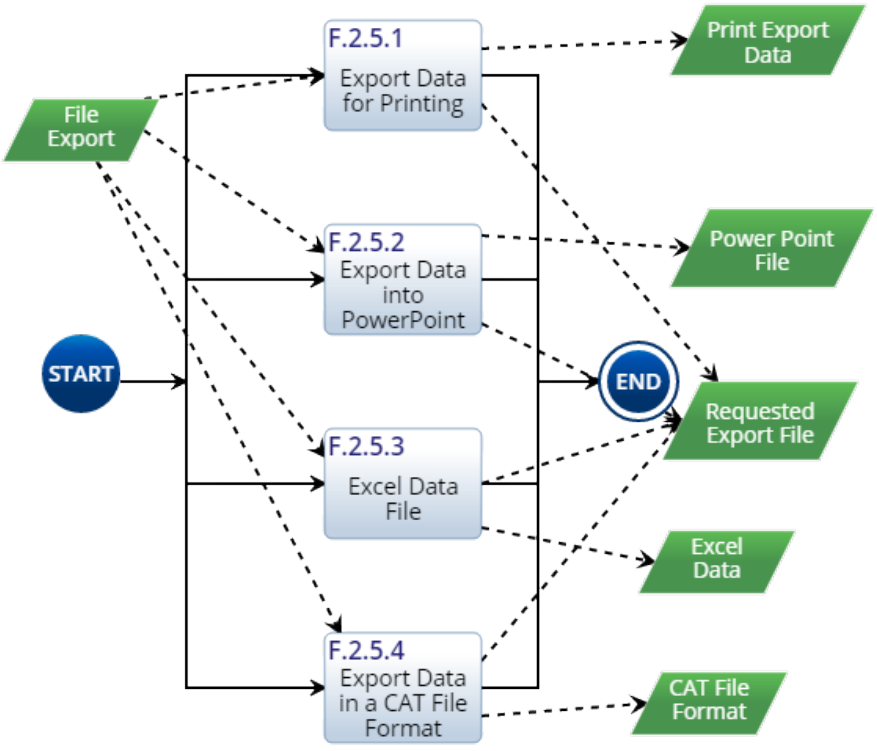

Figure I-8. F.2.5 Action Diagram

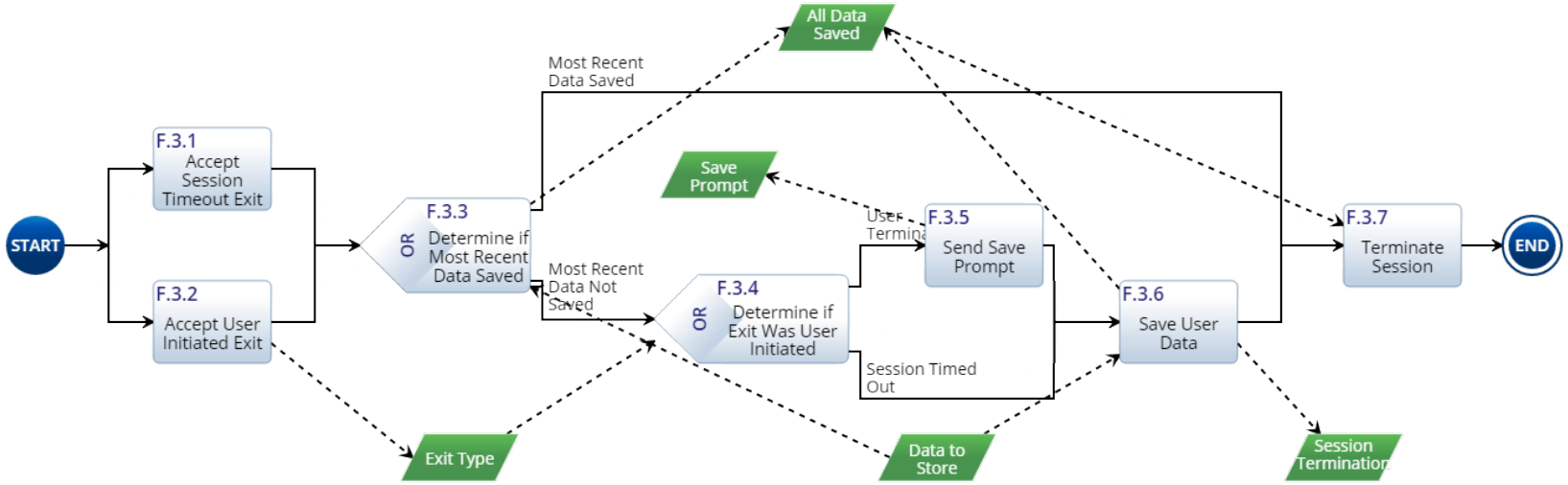

Figure I-9. F.3 Action Diagram

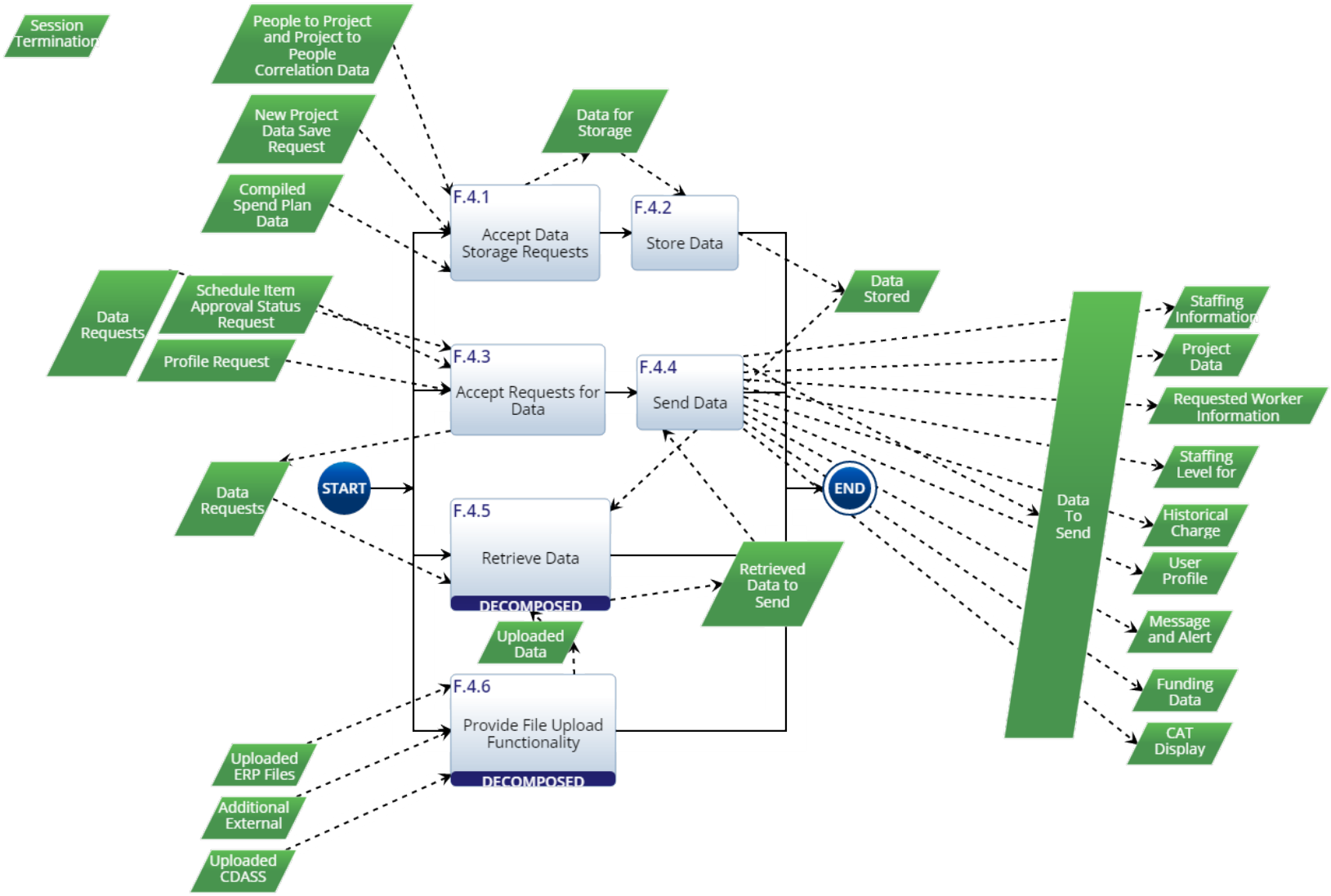

Figure I-10. F.4 Action Diagram

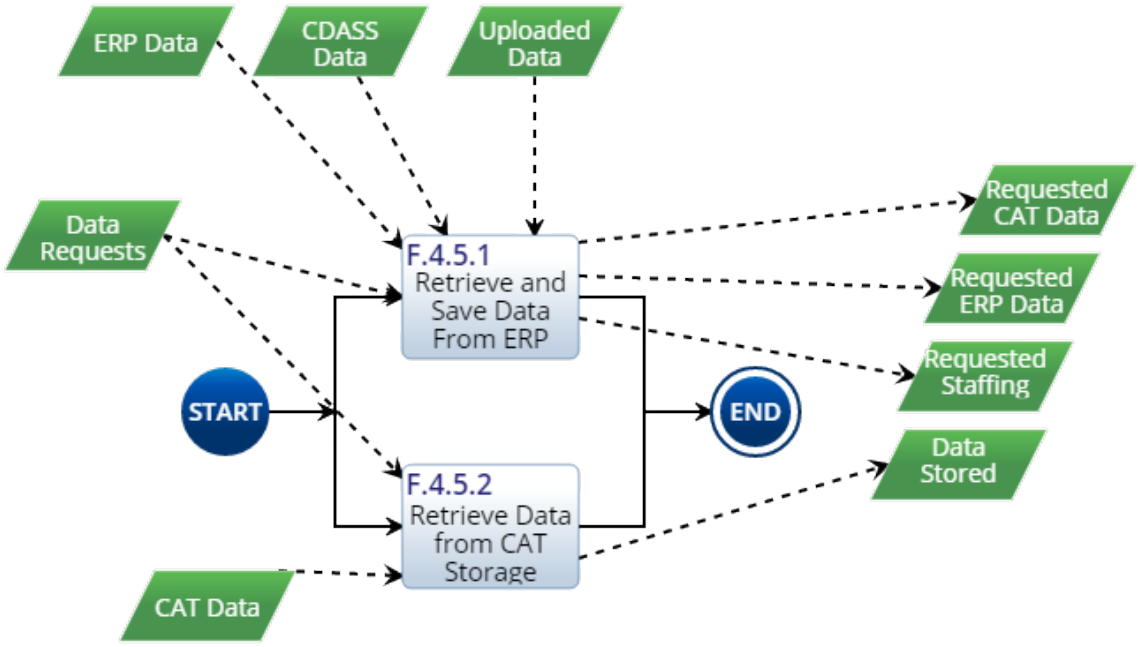

Figure I-11. F.4.5 Action Diagram

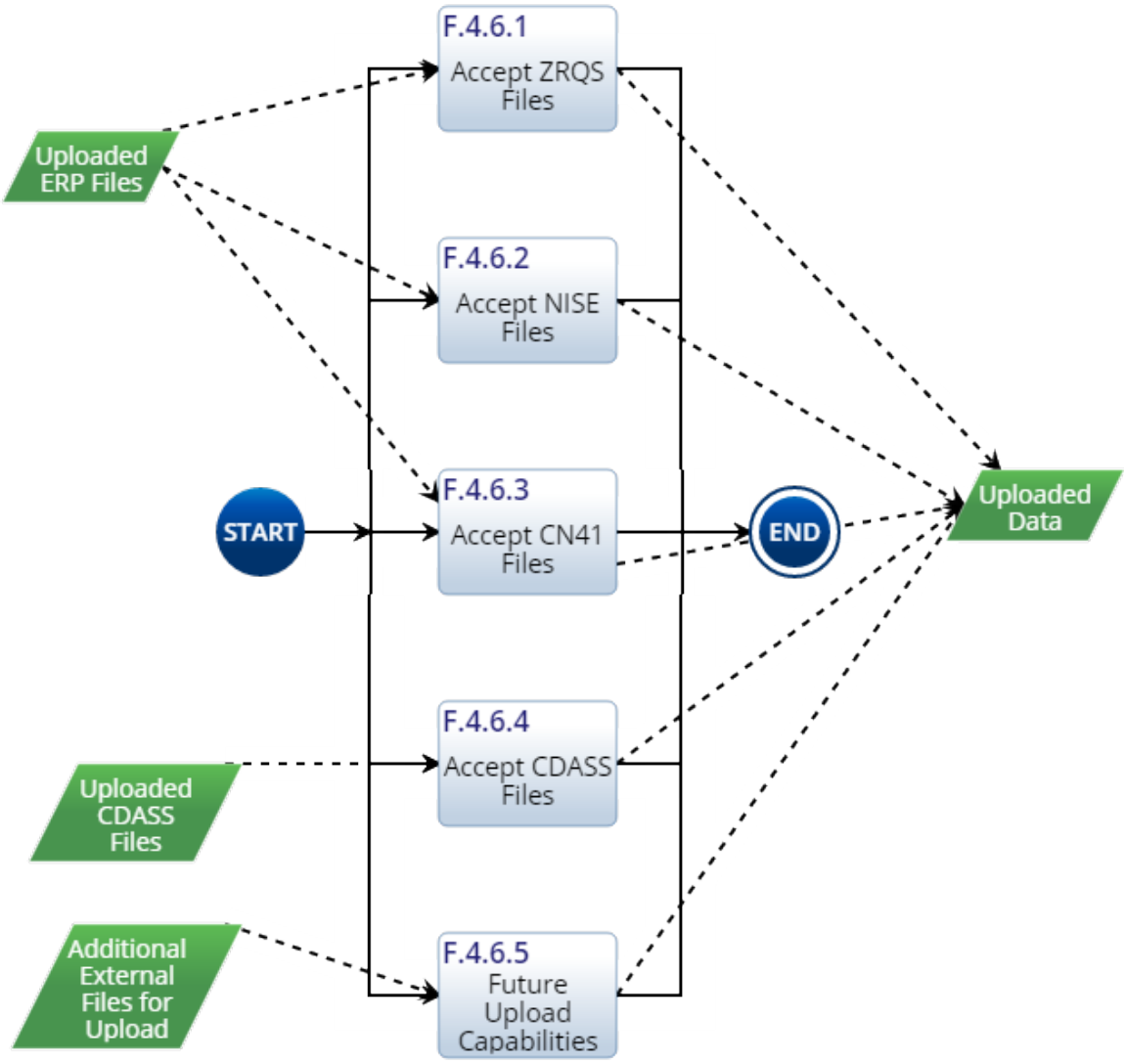

Figure I-12. F.4.6 Action Diagram

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APPENDIX J. SCREENSHOTS OF SPREADSHEET MODELING FOR EXAMPLE PERSONNEL ALLOCATION AND FUNDING CALCULATIONS

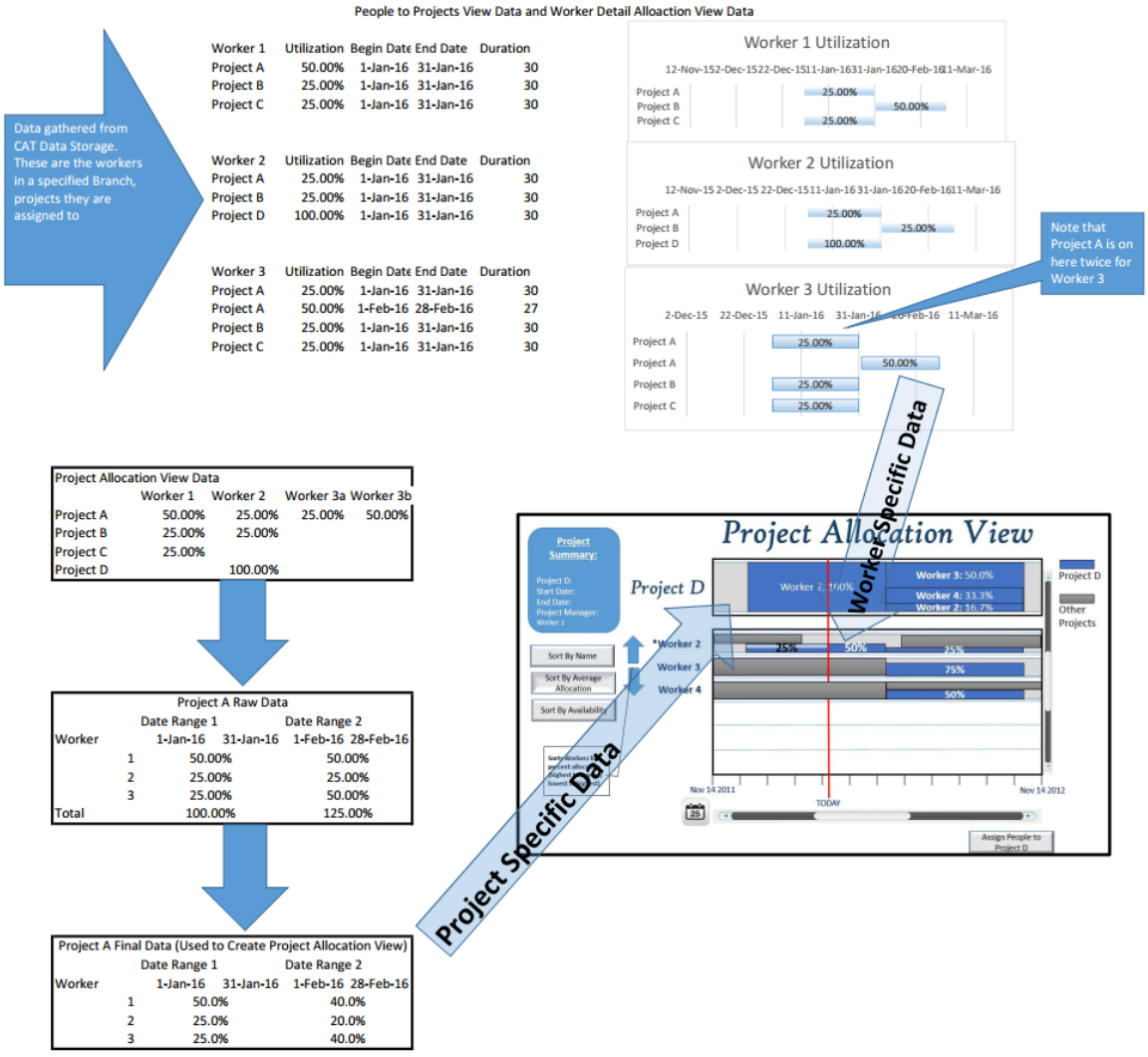
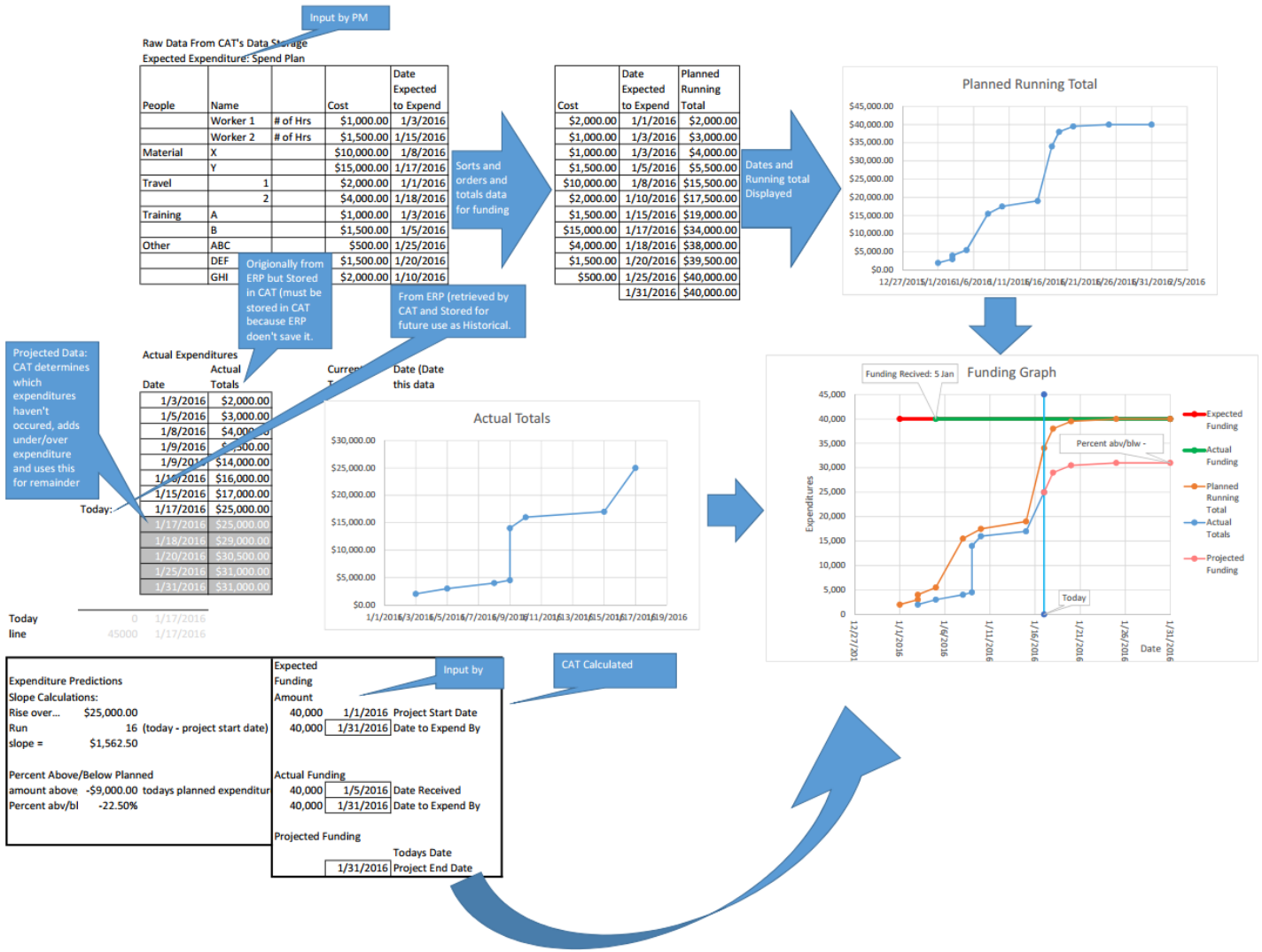


Figure J-1. People to Project Calculations



People	Name		Cost	Date Expected to Expend
	Worker 1	# of Hrs	$1,000.00	1/3/2016
	Worker 2	# of Hrs	$1,500.00	1/15/2016
Material	X		$10,000.00	1/8/2016
	Y		$15,000.00	1/17/2016
Travel	1		$2,000.00	1/1/2016
	2		$4,000.00	1/18/2016
Training	A		$1,000.00	1/3/2016
	B		$1,500.00	1/5/2016
Other	ABC		$500.00	1/25/2016
	DEF		$1,500.00	1/20/2016
	GHI		$2,000.00	1/10/2016

Cost	Date Expected to Expend	Planned Running Total
$2,000.00	1/1/2016	$2,000.00
$1,000.00	1/3/2016	$3,000.00
$1,000.00	1/3/2016	$4,000.00
$1,500.00	1/5/2016	$5,500.00
$10,000.00	1/8/2016	$15,500.00
$2,000.00	1/10/2016	$17,500.00
$1,500.00	1/15/2016	$19,000.00
$15,000.00	1/17/2016	$34,000.00
$4,000.00	1/18/2016	$38,000.00
$1,500.00	1/20/2016	$39,500.00
$500.00	1/25/2016	$40,000.00
	1/31/2016	$40,000.00

Date	Actual Totals
1/3/2016	$2,000.00
1/5/2016	$3,000.00
1/8/2016	$4,000.00
1/9/2016	$5,500.00
1/9/2016	$14,000.00
1/15/2016	$16,000.00
1/15/2016	$17,000.00
1/17/2016	$25,000.00
1/17/2016	$25,000.00
1/18/2016	$29,000.00
1/20/2016	$30,500.00
1/25/2016	$31,000.00
1/31/2016	$31,000.00

Today	0	1/17/2016
line	45000	1/17/2016

Figure J-2. Funding Graph Calculations

APPENDIX K. GUI SCREENSHOTS

The following figures illustrate the final dashboard configurations for each user role in CAT. Dashboards are described in more detail in Chapter V, Section C.

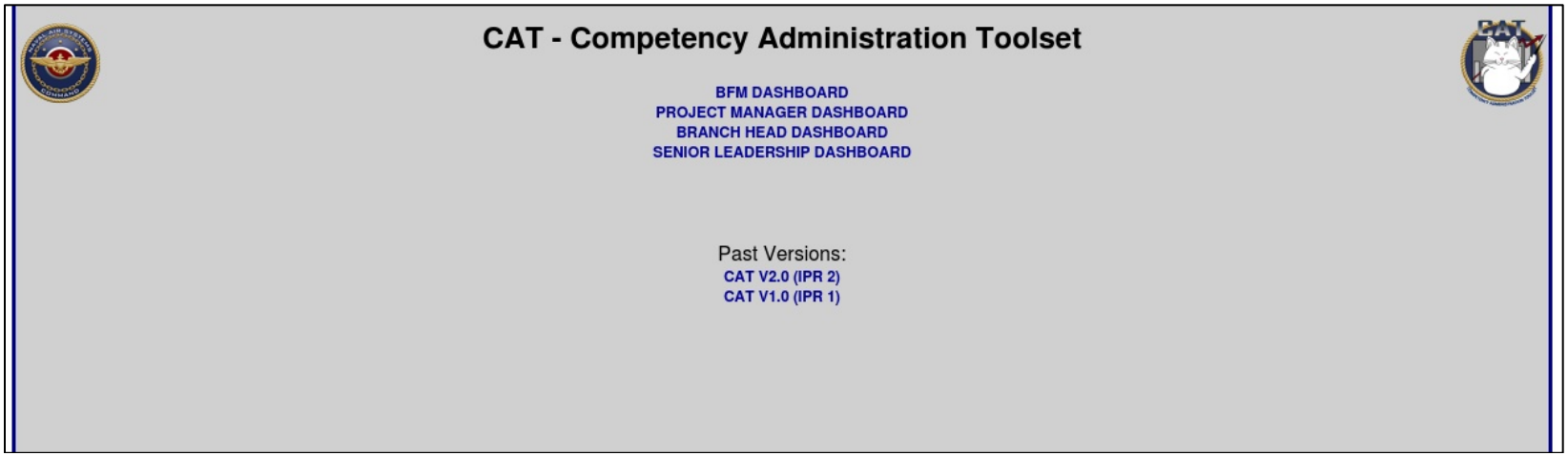


Figure K-1. Homepage Screenshot from Prototype GUI

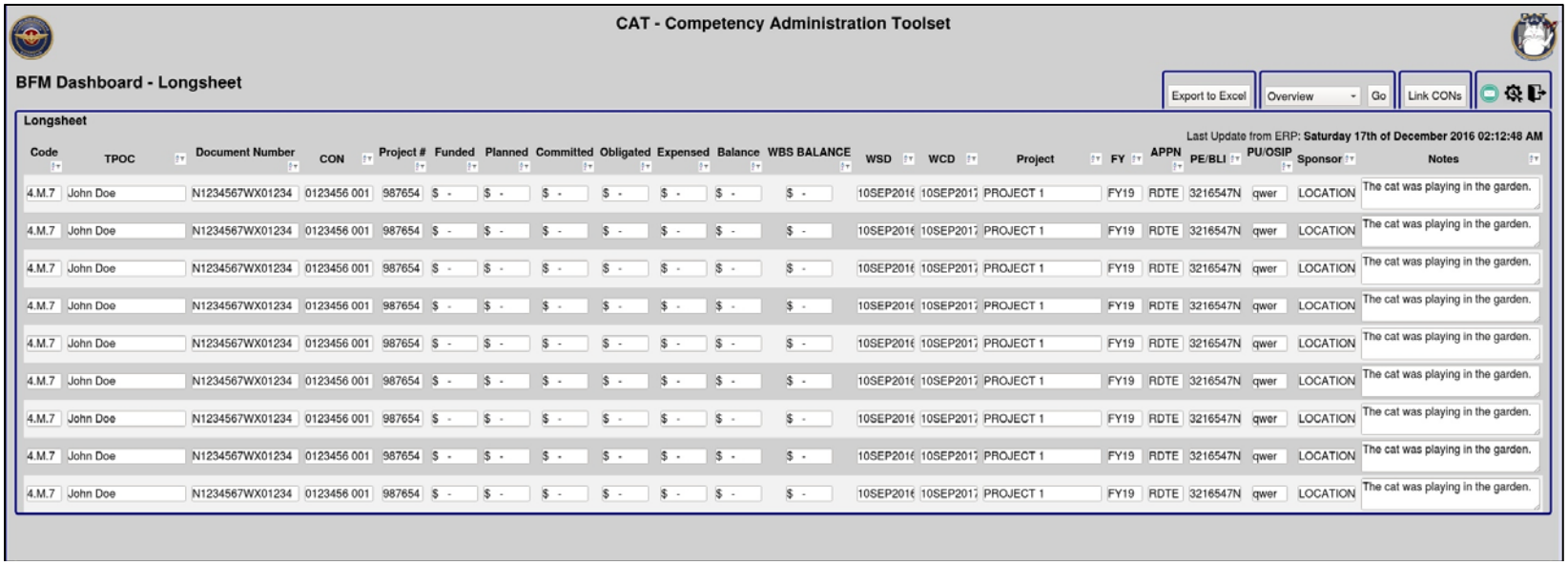


Figure K-2. BFM Dashboard Screenshot

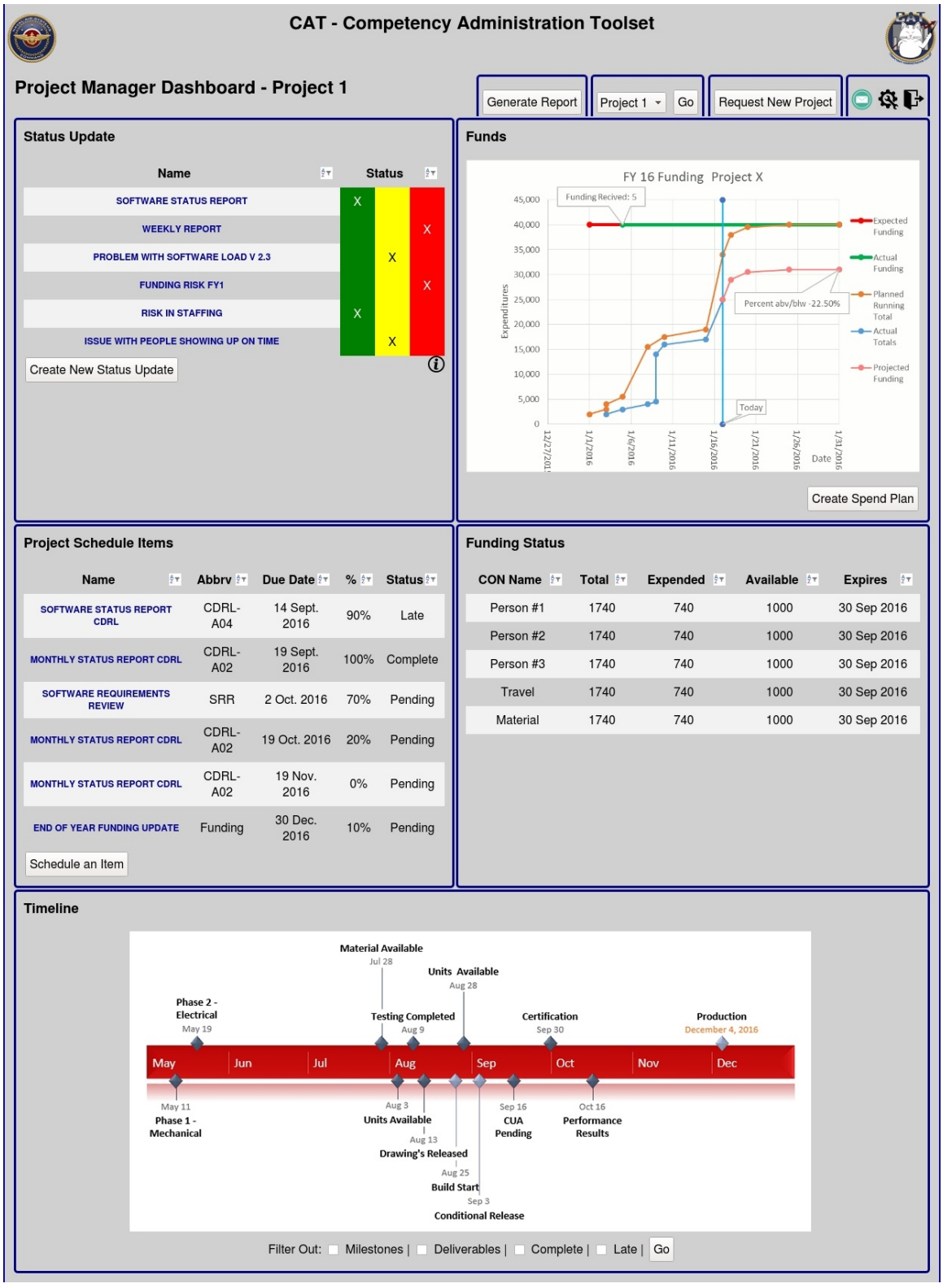


Figure K-3. Project Manager Dashboard Screenshot

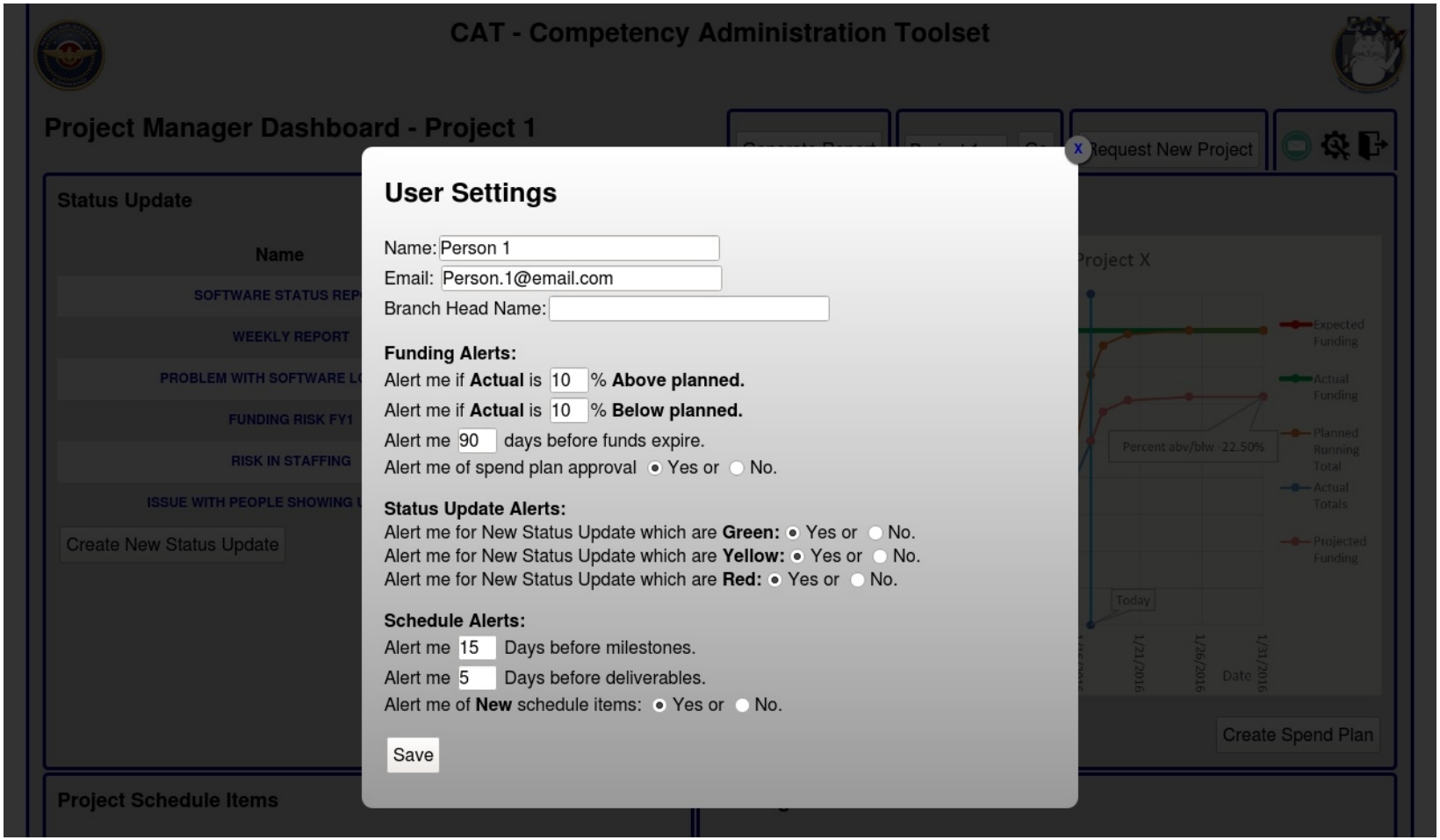


Figure K-4. Project Manager Dashboard Screenshot – User Settings Window

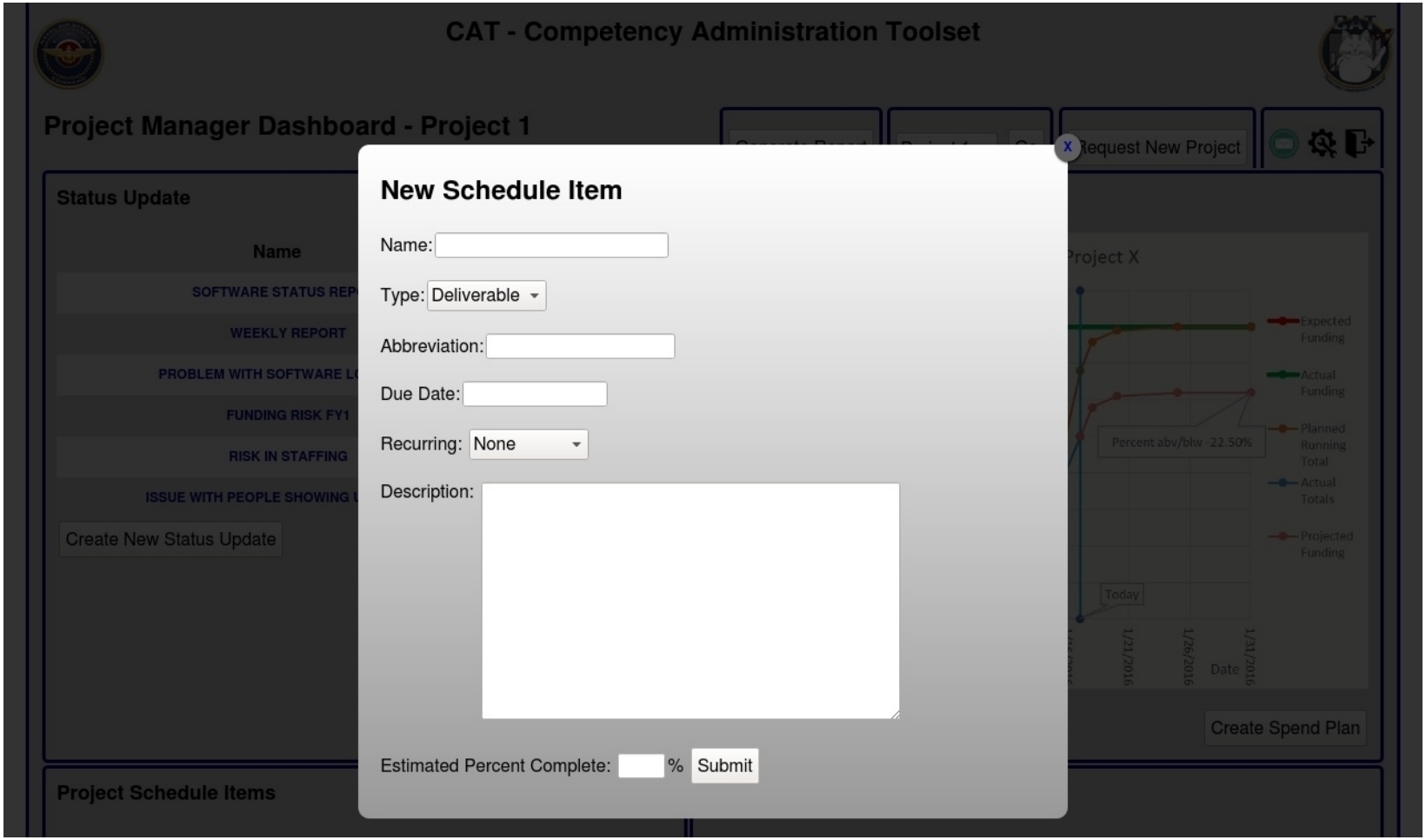


Figure K-5. Project Manager Dashboard Screenshot – New Schedule Item Window

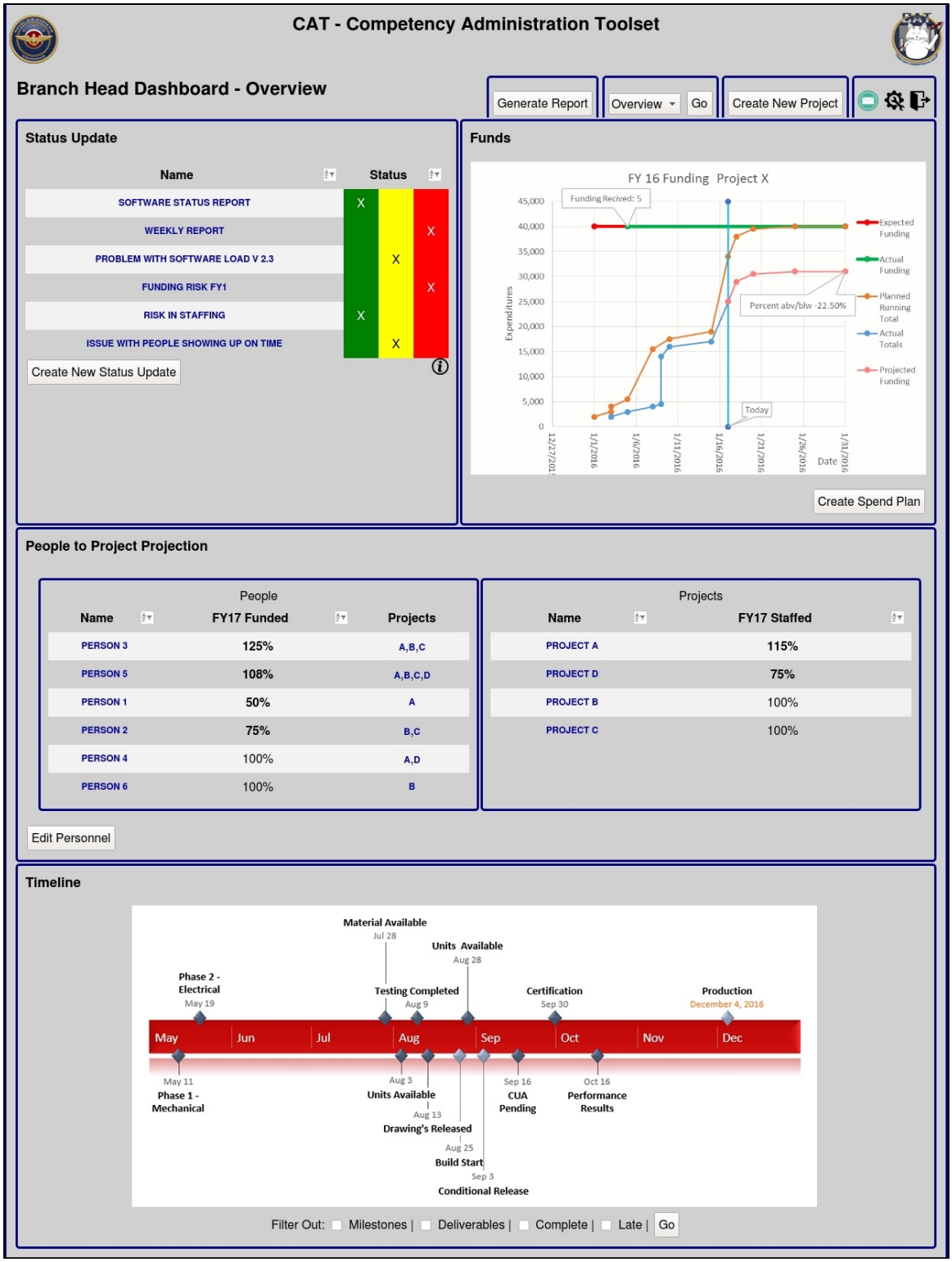


Figure K-6. Branch Head Dashboard Screenshot

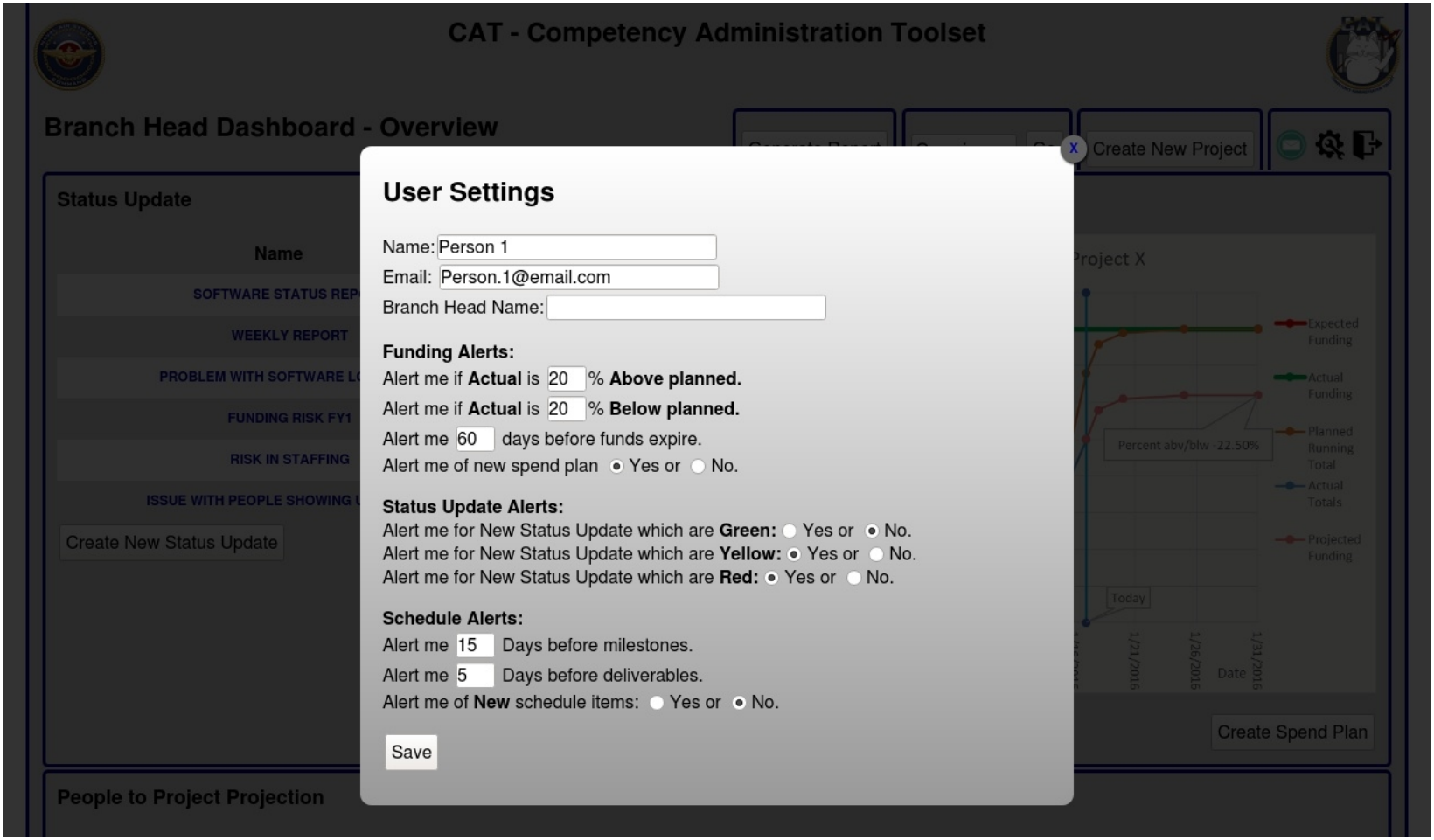


Figure K-7. Branch Head Dashboard Screenshot – User Settings Window

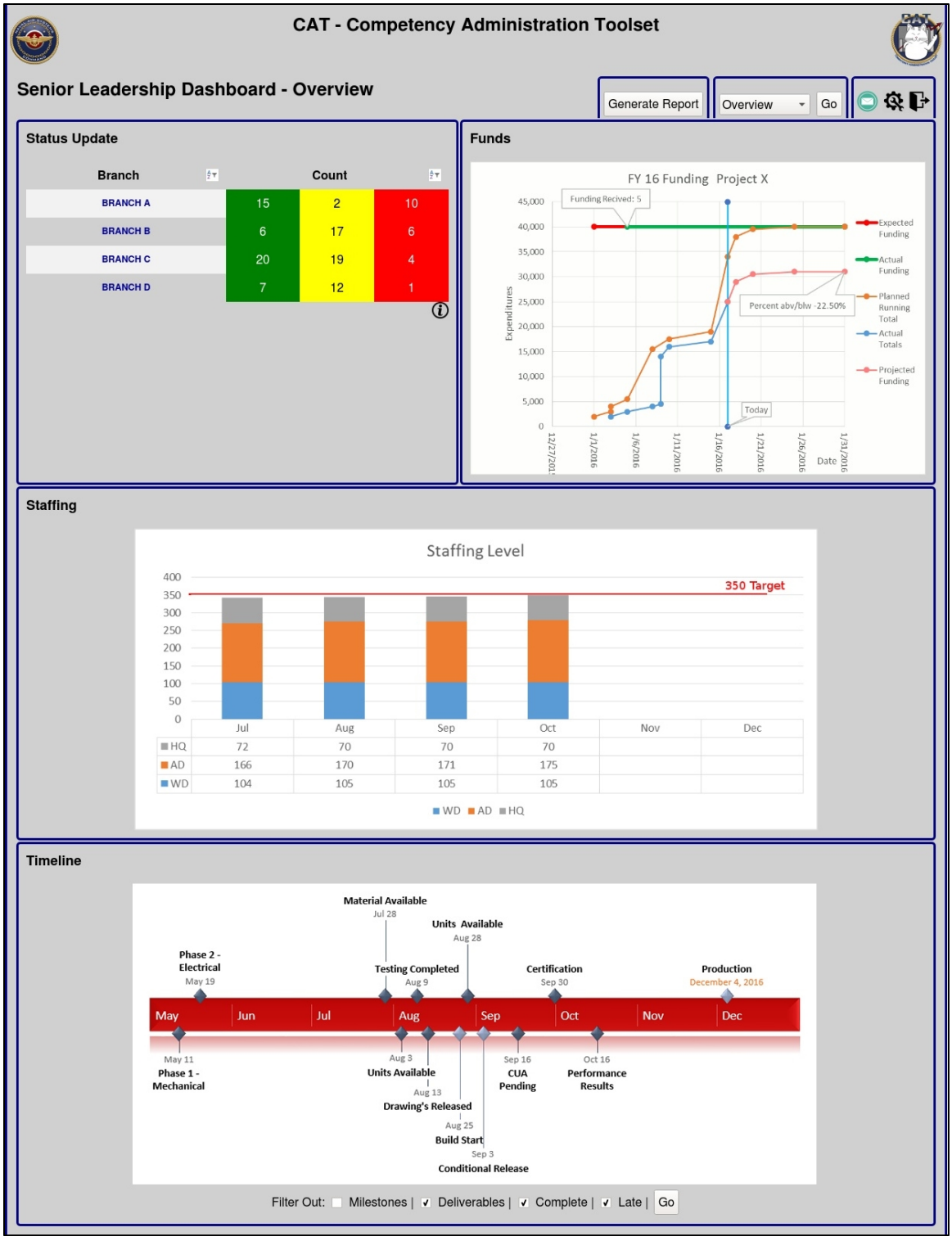


Figure K-8. Senior Leadership Dashboard Screenshot

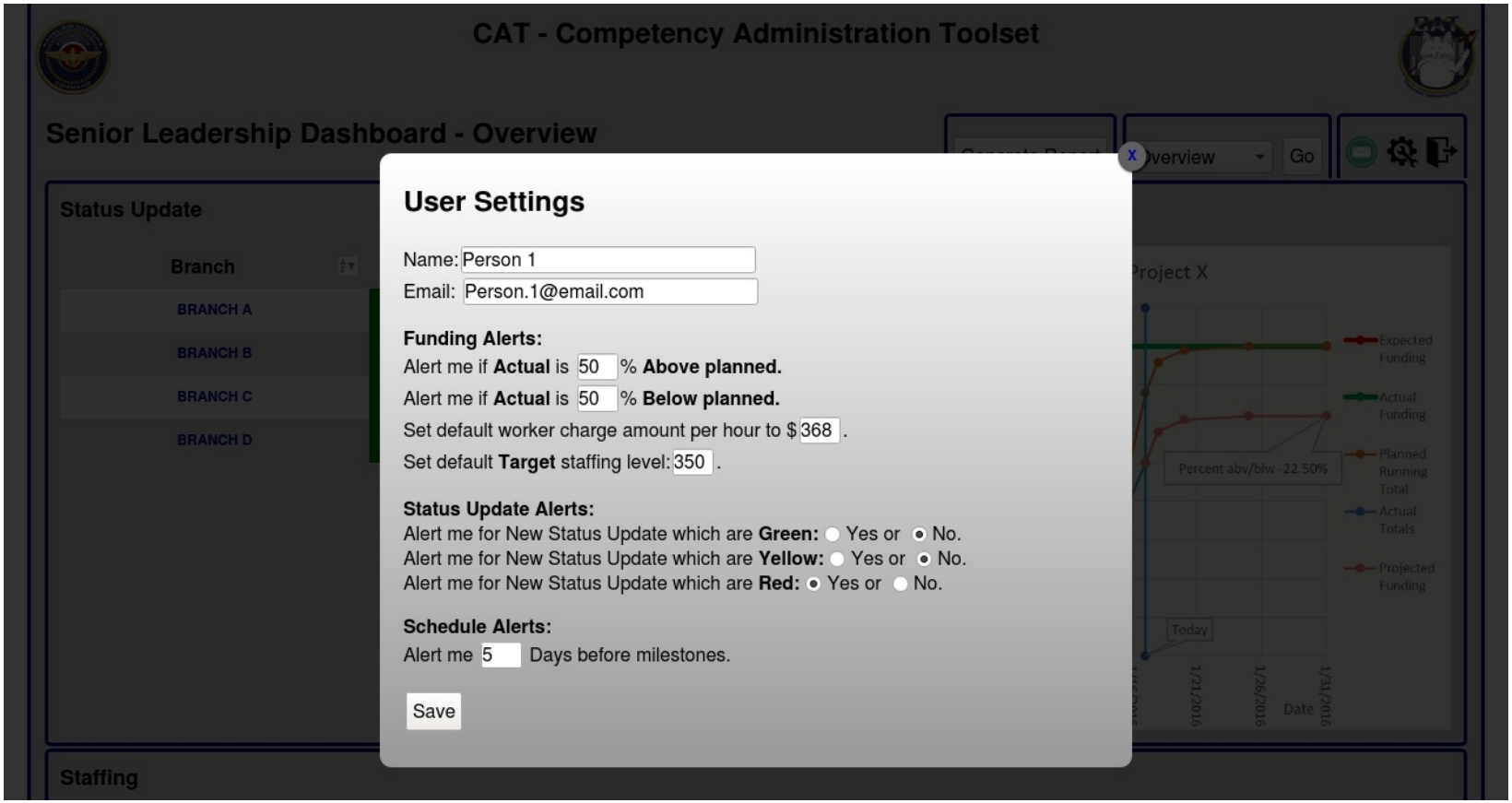


Figure K-9. Senior Leadership Dashboard Screenshot – User Settings

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