Colorado State University

ENGR 695-**Independent Study**

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Architecting an Enterprise (System of Systems) for a Managed Service Provider to Develop, Deploy, and Support Cloud-Based Solutions Using Systems Engineering and MBSE

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Written By

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As a candidate for the Colorado State University Systems Engineering Master of Science Program (Plan B), I am producing this document as the fulfillment of the requirement to graduate as set by the Systems Engineer Department (1) and the SYSE 695 Independent Study course.

The project for this course is to be evaluated by:

- Dr. Daniel Herber (Advisor)
- Dr. Steven Simske (Committee Member)
- Dr. Subhas (Karan) Venayagamoorthy (Committee Member)

Project Abstract

Model-Based Systems Engineering (MBSE) has been developed over the past two decades to meet an overwhelming need across a wide range of industries to manage and communicate effectively for complex systems. Likewise, the System Modeling Language (SysML) has been developed to specifically target complex system modeling by providing the relevant and organization of concepts for a comprehensive system model. The use cases of MBSE and SysML stretch from aerospace to energy systems, with a common denominator of truly complex systems or systems of systems. In this project, the proposed system of systems or enterprise system is comprised of various aspects that make up a cloud-solution managed service provider (MSP). The Solution-Technology Engineering, Architecture, and Management (STEAM) group has been tasked with architecting the products and capabilities of a highly skilled and diversified MSP. The product categories of the STEAM model have been organized into Subject Matter Expert (SME) groups including Business Productivity Suites, Communication Infrastructure, and Unified Endpoint Management. The overall capabilities of the STEAM model will consist of provided services including Development, Deployment, Support, and Lifecycle Management. The focus of this project is to apply MBSE using SysML to model the STEAM enterprise, products, and capabilities to answer both business and engineering-related questions to meet the various levels of requirements as set by Systems Engineering and MBSE. The model itself is created, managed, and shared from the MBSE tool CAMEO Systems Modeler.

Table of Contents

Table of Figures

1 Introduction

1.1 Solutions as a Service (SaaS) Background

Information technology (IT) and computer systems have been traditionally left to the end-user or business to determine the cost-benefit analysis of whether it makes tactical and economic sense to keep IT resources on-premises or move to the cloud. Thanks in large to competition and innovation to reduce the cost of cloud-based solutions, modern information technology and computing resources are moving from on-premises infrastructure to fully cloud-based solutions at an alarming rate. End-users and businesses alike are also realizing the value of forgoing high-cost in-house IT overhead and alternatively moving to a contract or subscription basis of solutions. Where the average organization might have been able to keep up with these integrations and interfaces utilizing their own internal IT department a mere ten years ago, the progress of cloud solutions and computing has proven to be more than they can handle. Along with some of the great aspects of cloud solutions also come the many opportunities for integrations and, more than likely, the many headaches that come with the endless use cases and customizations. The main driver for this has been the increase in the number of application programming interfaces (APIs) which allow for different applications to provide information to and from one another without requiring massive overhauls of the software infrastructures. Iterations and improvements made to cloud-based solutions and computing have allowed many industry titans to continue to lead the charge into fully cloud-based enterprise software development, including Microsoft, Google, Oracle, IBM, Cisco, ServiceNow, SAP, Ivanti, and VMWare. As a result of the cloud computing revolution, today's Enterprise Software Solutions have incredibly sophisticated and sometimes convoluted integrations and interfaces with a multitude of other software and hardware systems. The enterprise systems being deployed on average involve everything from Business Productivity Suites and Voice Over IP to Telecommunications and Collaboration tools.

There are two primary considerations for moving away from the traditional IT model of in-house specialists or consultants and to Solution as a Service (SaaS). The first consideration is the overhead cost of the personnel and capital expenditure (CAPEX) required to maintain and accommodate the software and hardware associated with these complex systems. The average costs associated with existing systems do not incorporate the upgrades developed by vendors and require a large investment to do so. Rather they are simply focused on keeping the lights on for the existing system. The second consideration is the innovation and agility cloud-based solutions

inherently provide. Combining scalability with the availability of resources, updates, and new features in cloud-based solutions, it has many advantages over the on-prem alternative.

1.2 STEAM Context

The Solution Technology Engineering, Architecture, and Management (STEAM) group resides within a large corporation. The overall corporation is traditionally focused on telecommunications and data transmission; however, the focus from brick and mortar to subscription-based revenue has driven the corporate strategy to focus on the overall business customer experience rather than one aspect or another. As such, STEAM has been created to bridge the gap between the core communications teams and the cloud solutions teams to provide value in the form of a full-scale managed service provider (MSP). As an MSP, STEAM would be charged with not only learning, deploying, and supporting each system or solution, but also mastering advanced capabilities that go beyond the standard reseller of each product. These advanced activities include what is called enablement, which is all-encompassing for complex integration and customized solution requests for both internal and external groups. Within STEAM, there are two main units, Management and MSP. Within the Management unit, there are operations and responsibilities that allow STEAM to interface, communicate, and effectively get along with other corporate and external persons or groups. The MSP unit will solely focus on the systems being deployed, supported, or enabled, and will be responsible for the success of the systems and the customer experience as the "boots on the ground" for STEAM. Collectively, STEAM will be looking to complete the proposed project to develop an enterprise system capable of operating as an MSP and taking on new products in what is called "burn-in" operations.

1.3 Project Proposal for STEAM

The proposed enterprise system will be focused on the collective capabilities to develop, deploy, support, and manage various cloud-based solutions as part of larger system architecture. The STEAM group will serve as the organizational body responsible for developing each level of decomposition for the system. As such, the team has various resources at its disposal to evaluate the proposed customers' needs and provide a comprehensive solution for each application. The information and considerations outlined above provide the context for defining and qualifying the proposed enterprise system as a system worthy of utilizing Systems Engineering processes and standards. It is the intention of this project to evaluate the effectiveness of the Systems Engineering

approach to model such an enterprise system to evaluate the value and viability of the STEAM group. The specific aspects of Systems Engineering that are to be used in this project will be covered in the next section.

The proposed SaaS Enterprise System will be focused on building an inventory of solutions to provide such services to a diverse range of customers. Included in the SaaS portfolio will be one product from each of the following categories: Business and Productivity, Communications Network, and Unified Endpoint Management. Within these tools, there are thousands of integrations and interfaces with internal and cloud-based software applications that must be accounted for, as well as hundreds of cloud computing, mobile, and on-premises devices. The customer and the designated groups and/or departments within the organization have expressed interest in having a visual representation of the proposed solution's architecture for the communication of various iterations to be completed during the development of the solutions as a service. Included within the architecture will be the project proposal, system requirements, preliminary design, the SysML Model, project risk analysis, and project results and conclusions.

The phases of traditional Systems Engineering, as outlined by the International Council of Systems Engineering (2), include the various phases and stages within each of these checkpoints will also be included and outlined by Systems Engineer processes and guidelines. Each milestone will be included in a visual representation for the customer's consideration and approval before moving on to the next phase and or stage. The use of Model-Based Systems Engineering, or MBSE, (3) and more specifically System Modeling Language v1.6, or SysML 1.6, (4) will assist with the effective organization and communication of the system and the decomposition of the enterprise system down to the subsystem level. The breakdown of customer needs to eventual requirements will also be included in the project scope in accordance with the MBSE and SysML best practices.

The contents of this document serve as the final project submission, which includes the documentation, artifacts, and modeling necessary to satisfy the objectives of the project and of the proposed customer. The project deliverables throughout the semester included review meetings at least once per week, and several iterations of the model and document based on collaboration between the author and Dr. Herber (the project advisor). Each iteration of the model and document included documented feedback which ultimately led to the successful completion of the research, documentation, and complete model for the proposed STEAM Enterprise.

1.4 Traditional Systems Engineering and MBSE

One of the main focuses of this project is to format the research and results in a format consistent with MBSE while incorporating aspects of traditional Systems Engineering. The aspects of traditional Systems Engineering to be addressed by MBSE include Conceptual Design, Advanced Development/Preliminary Design, and Engineering Risk Management. The format to address these aspects represents a slightly altered version of the already augmented MBSE framework developed in *Towards a Model-Based Implementation in Technology/Platform Life-Cycle Development Processes Applied to a Thrust Reverser Actuation System (TRAS) Concept* (5). Included in this format are four major levels of decomposition:

1. Enterprise – Operational
2. System – Conceptual
3. Subsystem – Logical/Functional
4. Component – Physical

The project scope focuses entirely on the Enterprise, System, and Subsystem levels and will address the Component level in outline form to provide a roadmap for future research or progress in the subject matter.

Included within each of these three levels of decomposition will be the corresponding elements of SysML, including requirements, structure/data, use cases, behavior, parameters, and verification/validation. It was determined in addition to the established framework of decomposition, it is reasonable to add a section for risk within each level for the corresponding level of system or subsystem. The parameters and verification/validation elements will only be addressed if time permits for them to be properly delivered.

1.5 Project Expectations

As part of the application of the SE and MBSE architectural frameworks, there are specific questions that need to be answered to register the project's success. The questions below will be either included as part of the Needs, Requirements, or Risk, or they will be addressed separately from the STEAM Model in this project document.

1. Can an enterprise-managed service provider for cloud-based solutions be architected using SE and MBSE/SysML principles?

2. How will the scope of the project be defined and communicated for continued research in the future?
3. What aspects of an enterprise system can be modeled using MBSE?
4. Which aspects of systems engineering risk management can be applied to validate the enterprise system architecture?
5. Can each level of decomposition account for the management of existing products and development of new products?
6. Are the individual cloud-based solutions accounted for as MBSE artifacts within the SysML model?
    a. Business Productivity (MS 365, G Suite)
    b. VoIP (Dialpad, MS Teams)
    c. Communications (Wireline/Fiber/Coax, Telecom/LTE/5G)
    d. UEM/MDM (VMware, Ivanti, MS Intune)
7. Does SysML provide the necessary information to model for the roadmap for developing and handing off new products?

2 STEAM Architecture Organization

As stated previously, the model has been developed and refined using SysML and the corresponding artifacts to define aspects of the system. The *STEAM Model* (6) was architected using the software program *CAMEO Systems Modeler* (7) but was done so in a way that is agnostic to the software program to satisfy the overarching objective of the project to utilize SysML and MBSE for the enterprise architecture. The artifacts generated by CAMEO will then be inserted and organized based on the reference architecture as stated above. Each level of decomposition will carry with it unique diagrams that describe the corresponding SE and SysML principles within each section beginning with the STEAM Enterprise Level.

The project has utilized the organizational characteristics as set by *3DS CATIA and the CAMEO Systems Modeler Software* (8) with specific artifacts utilized from the *SysML Plugin* (9) for CAMEO. While there are some UML artifacts to be included, the main SysML artifacts to be included in the model are Requirement Diagrams, Block Definition Diagrams, Package Diagrams, Sequence Diagrams, Activity Diagrams, Use Case Diagrams, Matrices, Relationship Map Diagrams, and Requirement Tables.

2.1 STEAM Enterprise (Operational) Level

The content for this level of the model includes the breakdown of STEAM and Non-STEAM objects and interactions with other groups within the larger corporation that STEAM is under. The Enterprise or system-of-systems level serves as the overall architecture prior to making it to the system level. The STEAM Model artifacts to be utilized in the STEAM Enterprise Package in the model are organized based on the corresponding level of decomposition, which includes Stakeholders, Needs, Requirements, Structure, Use Cases, Behavior, and Risk. These aspects of decomposition and MBSE architecture were chosen due to the relatable characteristics between the STEAM Model and the organization of the reference architecture in the *TRAS System Model* (5). The main consideration is that each level of decomposition carries with it unique artifacts relevant to that viewpoint. For example, the TRAS System Model architecture provides Requirements, Structure, and Behavior for each level of decomposition allowing for the viewpoints and decomposition to be organized at the same time. The STEAM Model requires a flexible organizational structure due to the nature of Systems-of-Systems and the stereotypes that are applied to artifacts. The requirement of this type of architecture allows the STEAM Model to achieve

the overarching principle of MSBE and SysML, which is to remove ambiguity and provide the correct amount of context for the viewer of the model to logically connect artifacts that would be otherwise entirely too complex. The Relationship Map Diagram shown in *Figure 1* below illustrates the organization of the STEAM Model utilizing the reference architecture.

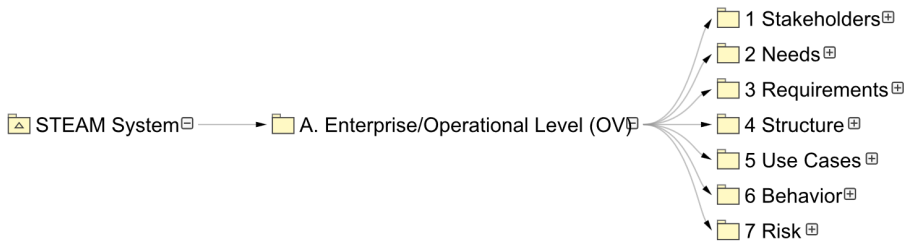

Figure 1 - STEAM Enterprise Relationship Map Diagram

2.2 STEAM Systems and Subsystems (Logical) Level

The content for this level of the model will include the structure of the classification for the domains of products and services to be provided for specific types of applications or customers. The last level of decomposition for this project will include the individual services and products to be included in each system's domain. The information included in this section will not delve into the component level of detail and will avoid the Physical Level altogether due to the large allocation of additional time this level of decomposition requires. Instead, the Component Level or Physical View will be accounted for in the Discussion section of this project document for future research and development.

The STEAM Model artifacts utilized in the STEAM Systems Packages in the model are consistent with the organization stated previously in this document. The MBSE elements that are represented as Packages for the corresponding included in this level of decomposition include Requirements, Structure, Behavior, and Risk. The Relationship Map Diagram shown in *Figure 2* below illustrates the organization of these artifacts.

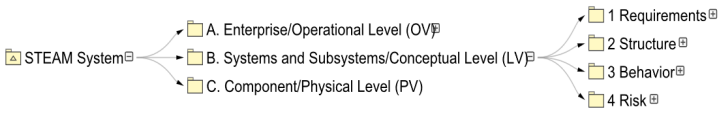

Figure 2 - Systems and Subsystems Relationship Map Diagram

3 Applying MBSE Architecture to STEAM Project

3.1 STEAM Enterprise (System-of-Systems)

The STEAM Enterprise level includes stakeholders, needs analysis, operational requirements, enterprise operational structure, and the enterprise operational context within the model.

3.1.1 Stakeholders

The artifacts for representing stakeholders in MBSE and SysML are labeled as Actors; however, within the CAMEO System Modeler tool, it provides an option to specify the Actor as a stakeholder, which was applied for all diagrams in the STEAM Model. The stakeholders for the project were established by dividing the enterprise into two main categories, internal and external. The stereotypes STEAM and Non-STEAM were also created with similar intent to allow for different views to be filtered depending on the specific information that is wanted. By sorting stakeholders into either internal and external or STEAM or Non-STEAM, it allows the stakeholder needs to be traced to the individual stakeholder. The stakeholders were added initially based on their title rather than by department or classification to allow for different stereotypes to be added for filtered views. The stakeholders are shown as the corresponding associations and stereotypes in *Figure 3*. The organization is based on both STEAM and corporate practices which set a Director as the highest level for operational involvement. Since the STEAM group is entirely operational in nature, the corporate leadership above the Director was not included. The Senior Manager is provided with responsibilities to position the personnel and resources in the most effective method possible to drive both sustainable growth of new products and the personnel within the STEAM group. The Personnel Managers, Cloud Engineers, and SME Leads are on the same authority level but have various levels of operational responsibilities. The remaining Solution Engineers and Specialists are under the Personnel Manager. The Internal vs. External stereotypes were established to help define the tangible and intangible boundaries of the STEAM Group and its responsibilities. The Internal stereotype is set for any artifact that is within the scope of STEAM and is owned by the corresponding stakeholder within the group. The External stereotype is set for anyone outside of the STEAM group, including corporate stakeholders or vendor stakeholders. The key focus for the External stereotype is to define interfaces vs. integrations later in the development of the enterprise, especially where there are problems that arise and certain systems, subsystems, or components need to be taken into the scope of STEAM.

#	Name	Owner	Associations	Applied Stereotype
1	STEAM - 1.0 Director	1 Stakeholders	Management Add value to company for shareholders New Product Initialization	Stakeholder [Classifier] Internal [Element]
2	STEAM - 2.0 Senior Manager	1 Stakeholders	Management Add value to company for shareholders Business/Econ Analysis New Product Initialization Give system, solution, and application options for corporate and custom Quantitatively record, monitor, and improve customer retention Generate, record, and maintain organized team performance data Assign Deployment Create STEAM Product Interface	Stakeholder [Classifier] Internal [Element]
3	STEAM - 2.1 Cloud Engineers	1 Stakeholders	New Product Hand-Off to External Team Create process for developing new products and then adding them to o Create STEAM Solution Architecture Give system, solution, and application options for corporate and custom Create STEAM Product Interface Gain and maintain expert skills with all core solutions SaaS MSP Burn-In Management Test Solution Architecture/GAP Analysis	Stakeholder [Classifier] Internal [Element]
4	STEAM - 2.2 SME Leads	1 Stakeholders	Test Solution Architecture/GAP Analysis Create process for developing new products and then adding them to o Management Create STEAM Solution Architecture Gain and maintain expert skills with all core solutions Plan & Design Solution Document Customer System SaaS MSP Build Solution New Product Hand-Off to External Team Create STEAM Product Interface Data Management	Stakeholder [Classifier] Internal [Element]
5	STEAM - 3.0 Personnel Managers	1 Stakeholders	Management Quantitatively record, monitor, and improve customer retention Generate, record, and maintain organized team performance data SaaS MSP	Stakeholder [Classifier] Internal [Element]
6	STEAM - 3.1 Solution Engineers	1 Stakeholders	Coordinate Transition to STEAM or External Handoff to STEAM or External Support Verify Solution Conduct Closeout New Product Hand-Off to External Team Conduct Plan and Design Maintain and expand MSP capabilities including pre-sale, deploy, suppo Management Build Solution Conduct Review Perform Communications Conduct Verification Conduct Setup & Training Coordinate Deployment Meetings Create STEAM Solution Architecture Gain and maintain expert skills with all core solutions	Stakeholder [Classifier] Internal [Element]
7	STEAM - 3.2 Engineering Specialists	1 Stakeholders	Maintain and expand MSP capabilities including pre-sale, deploy, suppo Gain and maintain expert skills with all core solutions Conduct Network Assessment SaaS MSP	Stakeholder [Classifier] Internal [Element]
8	Non-STEAM - Corporate - Product Manager	1 Stakeholders	Add value to company for shareholders Management New Product Hand-Off to External Team Give system, solution, and application options for corporate and custom Create STEAM Product Interface Generate, record, and maintain organized team performance data	Stakeholder [Classifier] External [Element] Non-STEAM [Element]
9	Non-STEAM - Customer - Business Decisior	1 Stakeholders	SaaS MSP Give system, solution, and application options for corporate and custom	Stakeholder [Classifier] External [Element] Non-STEAM [Element]
10	Non-STEAM - Customer - End User	1 Stakeholders	Quantitatively record, monitor, and improve customer retention Train Customer or Admin SaaS MSP	Stakeholder [Classifier] External [Element] Non-STEAM [Element]
11	Non-STEAM - Customer - System Admin	1 Stakeholders	Gain and maintain expert skills with all core solutions Conduct Setup & Training Conduct Communications Handoff to STEAM or External Support Quantitatively record, monitor, and improve customer retention SaaS MSP Train Customer or Admin	Stakeholder [Classifier] External [Element] Non-STEAM [Element]
12	Non-STEAM - Customer - Technical Decisio	1 Stakeholders	SaaS MSP Give system, solution, and application options for corporate and custom	Stakeholder [Classifier] External [Element] Non-STEAM [Element]
13	Non-STEAM - Vendor - Partner Support	1 Stakeholders	Create STEAM Product Interface Management Create process for developing new products and then adding them to o Gain and maintain expert skills with all core solutions	Stakeholder [Classifier] External [Element] Non-STEAM [Element]
14	Non-STEAM - Vendor - Product Manager	1 Stakeholders	Management New Product Initialization Give system, solution, and application options for corporate and custom New Product Hand-Off to External Team Generate, record, and maintain organized team performance data	Stakeholder [Classifier] External [Element] Non-STEAM [Element]
15	Non-STEAM - Corporate - Individual Contri	1 Stakeholders	Conduct Verification Management Submit Solution Order Coordinate Deployment Meetings Perform Communications Create process for developing new products and then adding them to o Conduct Closeout	External [Element] Non-STEAM [Element] Stakeholder [Classifier]
16	Non-STEAM - Corporate - Manager/Directo	1 Stakeholders	New Product Initialization Management Create STEAM Product Interface Add value to company for shareholders	External [Element] Non-STEAM [Element] Stakeholder [Classifier]

Figure 3 - All Stakeholders Table

3.1.2 Needs

Once all stakeholders were added to the model, the stakeholder needs were established and traced from each stakeholder as a contribution. As shown in *Figure 4* below, the stakeholder needs are denoted by *SN* as well as a numerical designation (i.e., 1, 1.1, 1.1.1) to allow for hierarchy to be represented in the displayed table and in multiple other ways depending on the chosen method. The hierarchy and naming convention in this table allow for easy organization and assignment of additional stereotypes for filtered views. These needs were accounted for in the matrix shown in *Figure 5* by the *trace* relationships, which ultimately ensured the needs were then ready to be converted into mission objectives.

#	△ Id	Name	Text
1	SN1	SN1 STEAM Needs	
2	SN1.1	SN1.1 Management Needs	
3	SN1.1.1	SN1.1.1 Revenue	Adequate revenue to justify overhead of STEAM.
4	SN1.1.2	SN1.1.2 Multiple Solution Vendors	SME Group options to provide options for customers.
5	SN1.1.3	SN1.1.3 Risk	Account for and mitigate risk.
6	SN1.1.4	SN1.1.4 Reporting	A system to compile metric data to provide summaries and reports to Director and Corporate levels.
7	SN1.1.5	SN1.1.5 Burn In	The ability to take on new products from Corporate, develop them and then either add them to core STEAM products or hand them off to teams with lower overhead.
8	SN1.1.6	SN1.1.6 Analytical Data	Management and MSP data tracking to provide details of how the STEAM group operates on a high or detailed level.
9	SN1.1.7	SN1.1.7 Relationships	The relationships between product vendors, product managers, and the STEAM group.
10	SN1.1.8	SN1.1.8 Escalation Paths	Defined processes and expectations for escalating issues and resolutions both internal and external to STEAM.
11	SN1.1.9	SN1.1.9 Overhead	Path and process to manage the personnel and resources for the team, and to request/add new personnel and resources.
12	SN1.1.10	SN1.1.10 Security Compliance	A means to either comply with corporate security standards, apply corporate security strategies, or implement unique security measures that exceed corporate security.
13	SN1.2	SN1.2 Solution Engineering Needs	
14	SN1.2.1	SN1.2.1 Communications	Communications tools.
15	SN1.2.2	SN1.2.2 Documentation	Ticketing system to document communications and other media.
16	SN1.2.3	SN1.2.3 Training	Enough training to keep or grow certification level(s).
17	SN1.2.4	SN1.2.4 Network Options	Public and private networks to test and deploy solutions as well as LAN and WAN connections for various testing and support.
18	SN1.2.5	SN1.2.5 DEMO Lab	The demo or lab environments in each solution or instance of a system to test aspects of the system in deployment, support, or enablement situations.
19	SN1.2.6	SN1.2.6 Knowledge Base	A system to track internal only and customer facing documentation; possibly provide direct access to customers via URL.
20	SN1.2.7	SN1.2.7 INT Licenses	Product licensing to test integrations across multiple subsystems or apps/solutions;
21	SN2	SN2 Non-STEAM Needs	
22	SN2.1	SN2.1 Corporate Needs	
23	SN2.1.1	SN2.1.1 Reporting	Adequate real-time reporting on important metrics for STEAM group per product.
24	SN2.1.2	SN2.1.2 Interfaces	The necessary web or application interfaces to get communication or data for each product or SME group.
25	SN2.1.3	SN2.1.3 Customer Retention	Verifiable proof of increased customer retention.
26	SN2.2	SN2.2 Vendor Needs	
27	SN2.2.1	SN2.2.1 Application Info	Information for deployment, support, or enablement scenarios to provide technical feedback and or assistance with specific applications and planning.
28	SN2.2.4	SN2.2.4 Security Info	Means to verify STEAM credentials AND customer account info/credentials.
29	SN2.2.5	SN2.2.5 Deploy and Support MSP	A group capable of deploying and supporting the vendor's product as an MSP; financially beneficial for SW companies to focus on SW instead of deploy/support/enable; MSP's are necessary to fill the gap for these SW companies.
30	SN2.3	SN2.3 Customer Needs	
31	SN2.3.1	SN2.3.1 Communications	Means to contact STEAM for deployment, support, or enablement requests.
32	SN2.3.2	SN2.3.2 Documentation/Training	Documents and training material specific to each individual product.
33	SN3.2.1	SN3.2.1 Solution Bundle	The ability to get all cloud solutions from one provider.
34	SN3.2.2	SN3.2.2 MSP Over IT	The ability to use/scale support for their business needs instead of employing a full IT team.

Figure 4 - Stakeholder Needs Table

Legend: Trace	1 Stakeholders																
	Non-STEAM - Corporate - Individu	Non-STEAM - Corporate - Manage	Non-STEAM - Corporate - Product	Non-STEAM - Customer - Busines	Non-STEAM - Customer - End Use	Non-STEAM - Customer - System	Non-STEAM - Customer - Technic	Non-STEAM - Vendor - Partner Su	Non-STEAM - Vendor - Product M	STEAM - 1.0 Director	STEAM - 2.0 Senior Manager	STEAM - 2.1 Cloud Engineers	STEAM - 2.2 SME Leads	STEAM - 3.0 Personnel Managers	STEAM - 3.1 Solution Engineers	STEAM - 3.2 Engineering Speciali
SN1 STEAM Needs																	
SN1.1 Management Needs																	
SN1.1.1 Revenue	2									↙	↙						
SN1.1.2 Multiple Solution Vendors	3										↙	↙	↙				
SN1.1.3 Risk	1									↙							
SN1.1.4 Reporting	3									↙	↙			↙			
SN1.1.5 Burn In	2									↙	↙						
SN1.1.6 Analytical Data	2									↙	↙						
SN1.1.7 Relationships	2										↙		↙				
SN1.1.8 Escalation Paths	3									↙	↙			↙			
SN1.1.9 Overhead	2									↙	↙						
SN1.1.10 Security Compliance	4									↙	↙	↙	↙				
SN1.2 Solution Engineering Needs											3	7	7	3	6	5	
SN2 Non-STEAM Needs																	
SN2.1 Corporate Needs		1	3	2													
SN2.2 Vendor Needs									3	3							
SN2.3 Customer Needs					3	2	4	3									

Figure 5 - Stakeholder Needs Matrix

These objectives were then organized into diagram form before moving to the establishment of operational requirements. While showing slightly different relationships, *Figure 6* and *Figure 7* both show the relationships from the Enterprise Objective to the refined objectives. The Enterprise Objective is stated in both diagrams to show that it has no single relationship, but rather has a cascading relationship to all stakeholders. The diagram shown below in Figure 6 illustrates how different stereotypes can allow for different views to be accounted for in each statement. In the diagram, the stereotype <<Objective>> is utilized so that the associated objective can be utilized for association and satisfaction of customer needs during iterations of the needs analysis if needed in the future. Although this is not intended as a true requirement diagram, the presets within CAMEO provide a beneficial representation and correct translation of needs to objectives to requirements.

As such, the denotation for the objectives is *EO* with a numerical denotation following (i.e., 1.1). *Figure 7* provides a different display of the objectives by displaying the association from stakeholder to objective. These relationships represent the origination of the objective and who contributes to the need and potential to satisfy the derived requirement. Once the requirements are derived, it is possible to have a different representation or diagram of the original needs translated to objectives and derived to requirements.

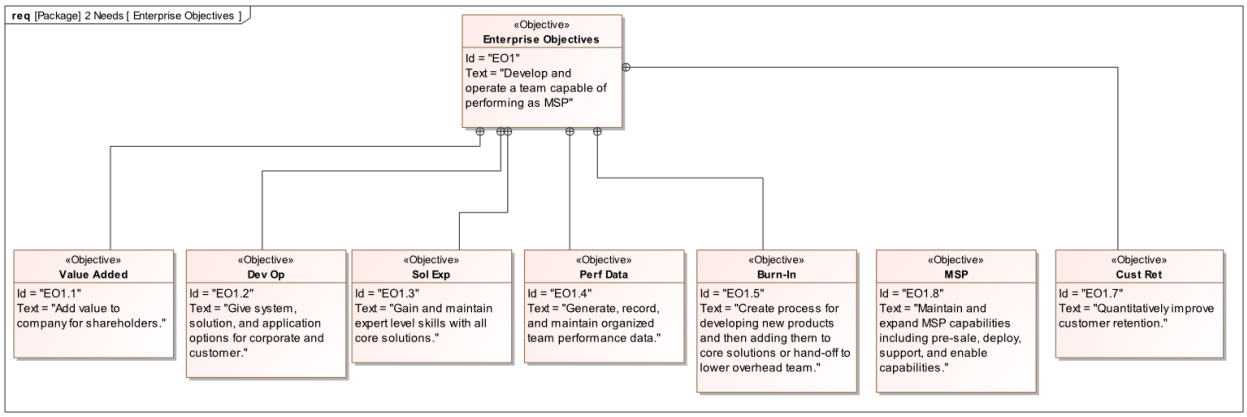

Figure 6 - Enterprise Objectives as Requirements Diagram

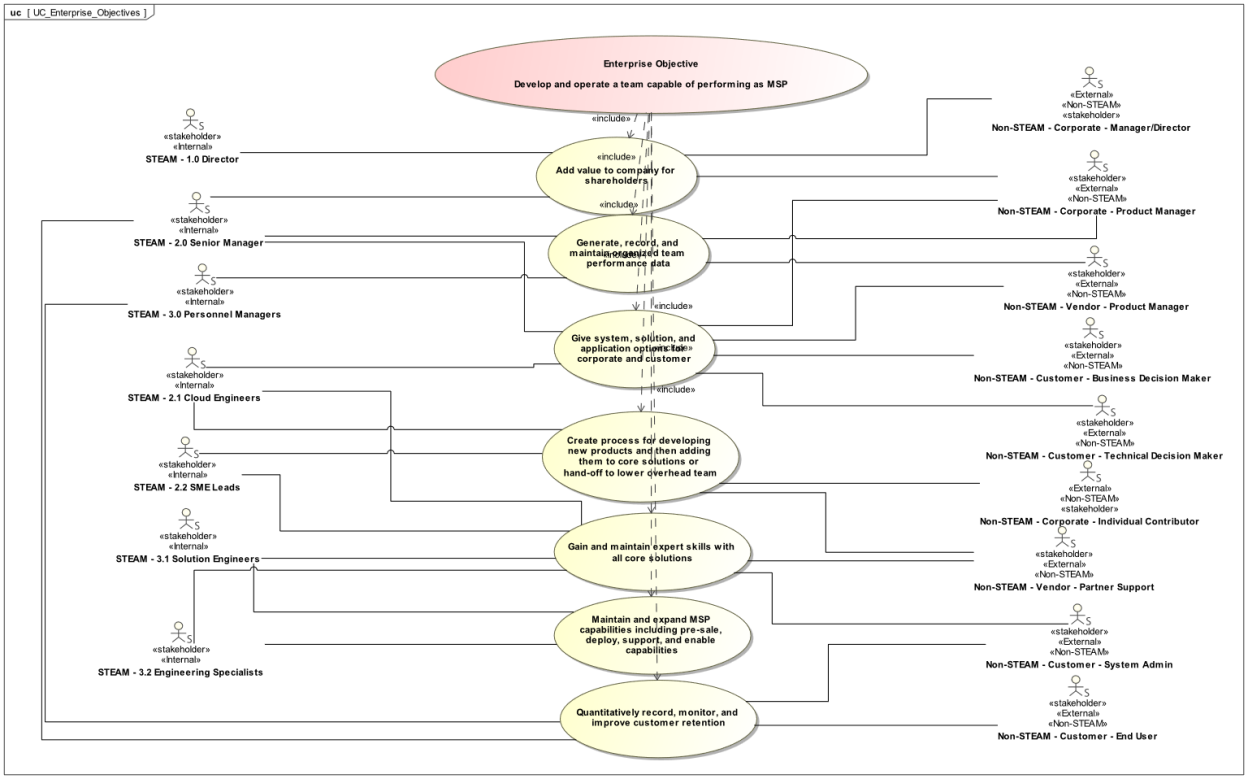

Figure 7 - Enterprise Objectives as Use Case Diagram

3.1.3 Requirements

The completion of the needs analysis is represented by the output of Enterprise Requirements which is shown in *Figure 8*. The organization of these requirements utilizes SE naming, including functional and non-functional. The functional requirements also have extended requirements to allow for a naming convention specific to the STEAM Enterprise. The non-functional requirements include business, useability, and interface requirements for organization logic. The inclusion of these new non-functional requirement artifacts were preconfigured but allow for a different filtered view to be included in the model as well. The ID organization provides a numerical hierarchy and association in the table; however, stereotypes could also be applied to organize depending on the view. The functional requirements are most likely to be derived from systems and subsystems that include vendor-based applications and solutions. The non-functional requirements will most likely be made up of STEAM-controlled elements. The decomposition to the Logical Level is where more detail will be included and refine existing requirements or add new requirements.

#	Id	Name	Text
1		STEAM Enterprise Requirements	
2	1	1 Non-Functional Requirements	
3	1.1	1.1 Usability Requirements	
4	1.1.1	1.1.1 Human Resources	STEAM will have minimum personnel qualification requirements including: a BS degree in CS, CIS, or Engineering; min 2 years professional experience/no new-grads.
5	1.1.2	1.1.2 Location/Access	STEAM will provide facilities/location accessible by all team members +/- 1 hour commute from residence; system access to on-prem or cloud-based subsystems to be remotely accessed in the exception a STEAM member is unavailable.
6	1.2	1.2 Interface Requirements	
7	1.2.1	1.2.1 Corporate Facing Data/Report	STEAM will provide the interface necessary for Corporate personnel to access reporting and or data to the level or detail or access determined by STEAM Management.
8	1.2.2	1.2.2 Customer Facing Data/Report	STEAM will provide the interface necessary for Customer personnel to access their solution information and or data to the level of access or detail determined by STEAM Management.
9	1.2.3	1.2.3 Vendor Facing Data/Report	STEAM will provide the interface necessary for Vendor personnel to access subsystem specific information and or analytics to the level or access or detail determined by STEAM Management.
10	1.2.4	1.2.4 Vendor Support	STEAM will work with solution vendors to ensure system has proper access to Vendor support and documentation for each product/solution.
11	1.3	1.3 Business Requirements	
12	1.3.1	1.3.1 Net Revenue	STEAM will maintain a net revenue positive status at the end of every fiscal year. (ie. Will generate or be responsible for more revenue generation than the total overhead of the STEAM group.)
13	1.3.2	1.3.2 Maintain MSP	STEAM will maintain MSP status for core products.
14	2	2 Functional Requirements	
15	2.1	2.1 MSP Ops	
16	2.1.3	2.1.3 Enablement Ops	STEAM will maintain at least 1 Cloud Engineer for each SME Group capable of advanced integration or enablement projects as designated by management.
17	2.1.2	2.1.2 Deployment Ops	STEAM will maintain enough capacity to handle a minimum of 10 deployment tickets per solution engineer; deployment operations will meet or exceed expectations as set by solution SLOs and vendor SLAs.
18	2.1.1	2.1.1 Support Ops	STEAM will maintain enough capacity to support customer issues classified as Severity 3 or 4.
19	2.2	2.2 Burn-In Ops	
20	2.2.2	2.2.2 New Product STEAM Scale	A developed product moved to by scaled by STEAM will be prioritized based on STEAM Management guidelines; depending on priority level, the new product will be scaled to full capabilities within STEAM within 3 to 6 additional months;
21	2.2.1	2.2.1 New Product Hand-Off	Once a product has been developed, STEAM will produce documentation necessary to admin and train the Non-STEAM Corporate team to take over the Support and Deployment of the product; Enablement will remain with STEAM for as long as the product/solution remains under the Corporate portfolio; movement to the Non-STEAM Corporate team will be completed within 6 additional months.
22	2.2.3	2.2.3 New Product Development	STEAM will have the capability to burn-in at least 2 solutions at any given time; solutions will be moved to either STEAM Scale or Hand-Off within 6 months of initialization.
23	2.3	2.3 SME Group	
24	2.3.2	2.3.2 Solution Integration Compatability	All systems and subsystems will have the capability to be integrated with at least two ecosystems; one native ecosystem and one non-native ecosystem.
25	2.3.1	2.3.1 Solution Options	The enterprise system will have no fewer than 2 solution options for each system and subsystem.

Figure 8 - Enterprise Requirements Table

The requirements allocations were also carried out via CAMEO using a requirements matrix shown in *Figure 9* below. Each need is allocated to a requirement to verify and account for all inputs into the needs analysis process. The format of the matrix provides the same naming denotation as used previously, with the addition of numerical totals for each need and requirement in the corresponding cell for the row or column, respectively. The focus of this matrix is to first verify that at least one need is allocated to a requirement. The next aspect would be the distribution of the allocations and identifying any requirements that may have far fewer allocations than others. There are justifications that can be made one way or the other; however, it is important to take them into consideration regardless. It is worth noting that in the diagram legend, the allocation arrow is pointing in an arbitrary direction. However, the arrows in the cells within the matrix designate the allocation direction by pointing where the allocation is being made toward. All the arrows are pointing in the same direction, which is the allocation "column to row" or Need to Requirement. Additionally, the table shown in *Figure 10* provides verification that all of the defined Enterprise Objectives are accounted for by cross-referencing each of the objectives with a requirement. The

Refine symbol provides the verification from the column (Objective) to the row (Requirement) and the number of occurrences for the intersecting cell within the table.

Legend: Allocate	EO1 Enterprise Objectives	SN1.1.1 Revenue	SN1.1.2 Multiple Solution Vendors	SN1.1.3 Risk	SN1.1.4 Reporting	SN1.1.5 Burn In	SN1.1.6 Analytical Data	SN1.1.7 Relationships	SN1.1.8 Escalation Paths	SN1.1.9 Overhead	SN1.1.10 Security Compliance	SN1.2.1 Communications	SN1.2.2 Documentation	SN1.2.3 Training	SN1.2.4 Network Options	SN1.2.5 DEMO Lab	SN1.2.6 Knowledge Base	SN1.2.7 INT Licenses	SN2.1.1 Reporting	SN2.1.2 Interfaces	SN2.1.3 Customer Retention	SN2.2.1 Application Info	SN2.2.4 Security Info	SN2.2.5 Deploy and Support MSP	SN2.3.1 Communications	SN2.3.2 Documentation/Training	SN3.2.1 Solution Bundle	SN3.2.2 MSP Over IT
2 Needs																												
SN1 STEAM Needs																												
SN1.1 Management Needs																												
SN2 Non-STEAM Needs																												
SN1.2 Solution Engineering Needs																												
SN2.1 Corporate Needs																												
SN2.2 Vendor Needs																												
SN2.3 Customer Needs																												
3 Requirements		6	5	16	4	4	6	8	5	5	5	6	10	5	4	5	8	6	5	4	6	8	8	7	3	9	7	6
STEAM Enterprise Requirements																												
1 Non-Functional Requirements																												
1.1 Usability Requirements																												
1.1.1 Human Resources	9	↙		↙			↙	↙		↙									↙		↙		↙	↙				
1.1.2 Location/Access	5			↙						↙	↙				↙								↙					
1.2 Interface Requirements	1																											
1.2.1 Corporate Facing Data/Report	11	↙		↙	↙	↙		↙	↙		↙		↙				↙		↙	↙								
1.2.2 Customer Facing Data/Report	10			↙	↙			↙	↙				↙				↙		↙	↙					↙			↙
1.2.3 Vendor Facing Data/Report	13		↙	↙	↙	↙		↙	↙				↙				↙		↙	↙		↙	↙			↙		
1.2.4 Vendor Support	14			↙	↙	↙	↙	↙	↙					↙				↙		↙	↙	↙	↙			↙	↙	
1.3 Business Requirements	3	1	1	2			1			2			1	1		1		1	1					1			1	1
2 Functional Requirements																												
2.1 MSP Ops	4								↙		↙				↙													
2.1.1 Support Ops	11			↙								↙	↙								↙	↙	↙	↙	↙	↙	↙	↙
2.1.2 Deployment Ops	13			↙				↙				↙	↙	↙		↙					↙	↙	↙	↙	↙	↙	↙	
2.1.3 Enablement Ops	12			↙								↙	↙	↙		↙		↙			↙	↙	↙			↙	↙	↙
2.2 Burn-In Ops	3		↙												↙													
2.2.1 New Product Hand-Off	4			↙				↙					↙				↙											
2.2.2 New Product STEAM Scale	9	↙		↙				↙		↙			↙				↙	↙						↙		↙		
2.2.3 New Product Development	12	↙		↙		↙	↙				↙	↙	↙			↙	↙	↙				↙				↙		
2.3 SME Group	1	1	2	2			2				1	2		1	1	1	2	1			1	2	1	2		2	2	2

Figure 9 - Enterprise Requirements Allocation Matrix

Legend: Refine	UC_Ent_Objectives							
	Add value to company for sharehold	Create process for developing new p	Develop and operate a team capable	Gain and maintain expert skills with	Generate, record, and maintain orga	Give system, solution, and applicatio	Maintain and expand MSP capabilitie	Quantitatively record, monitor, and i
R STEAM Enterprise Requirements								
R 1 Non-Functional Requirements								
U 1.1 Usability Requirements								
U 1.1.1 Human Resources	↙			↙			↙	
U 1.1.2 Location/Access	↙			↙				
I 1.2 Interface Requirements					4	1		4
B 1.3 Business Requirements				1			1	
R 2 Functional Requirements								
E 2.1 MSP Ops				2		3	1	1
E 2.2 Burn-In Ops			3	1		1	1	
E 2.3 SME Group			2	2		2	2	

Figure 10 - Table of Enterprise Objectives Refined to Requirements

3.1.4 Structure

The information stated previously as to how the STEAM group is organized within the corporate hierarchy allows for the decomposition of the Enterprise while following the SE guidelines of viewpoints. The diagram shown below in *Figure 11* represents the system structure as well as the stakeholders associated with each of the main systems of the organization. The diagram also provides additional context as to where the relationship of the stakeholder relates to specific stereotypes that were applied earlier during the Enterprise stakeholder analysis. The consolidation of the *parts* within both the Management and SaaS MSP blocks is strictly for display purposes to format in an effective way for this document. When these *parts* are expanded, they are shown with relationship connections similarly to the connections shown from each block to the Enterprise.

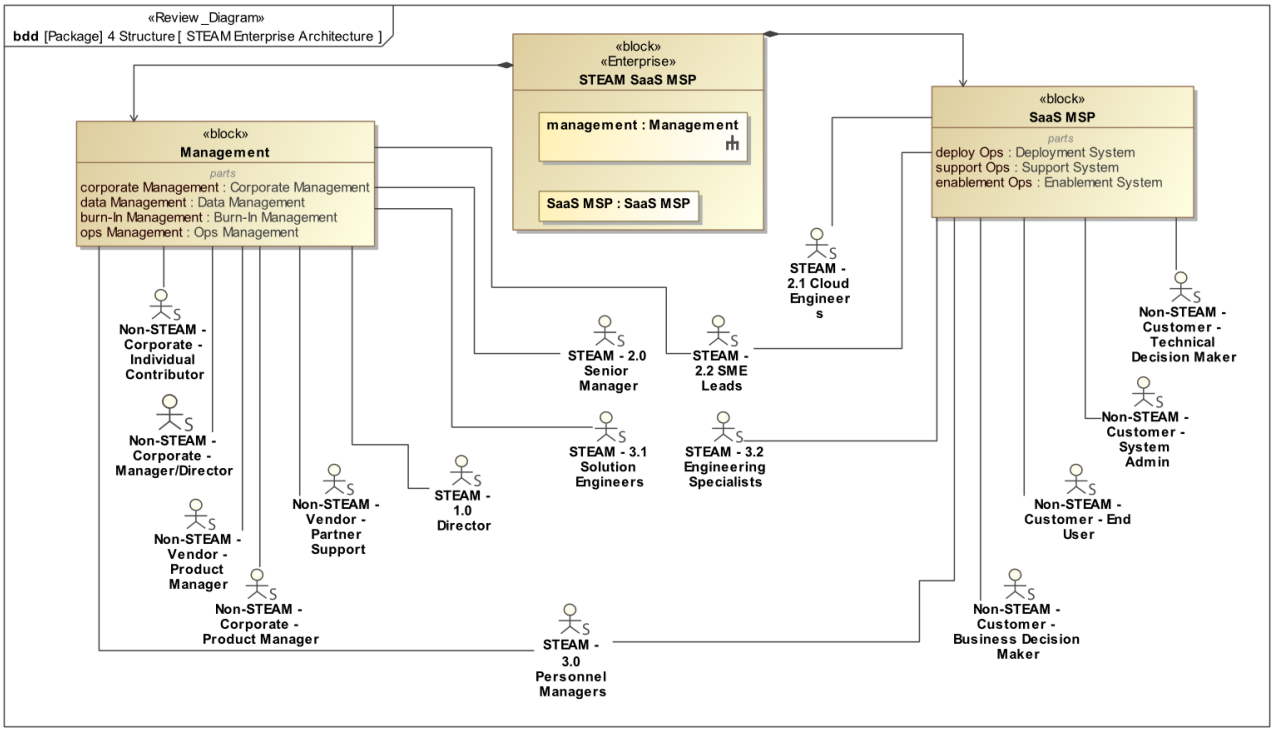

Figure 11 - Block Definition Diagram of the STEAM Enterprise Architecture

3.1.5 Use Cases

While there are different terms to describe the focus of other sections within the reference architecture, the Use Cases section focuses entirely on the same artifact and diagram within the MBSE and SysML context. The Use Cases within the Use Case diagrams in this section are aimed at revealing the relationships between stakeholders and specific events or actions to provide the correct context between artifacts within the model. The Use Case diagrams shown in *Figure 12* and *Figure 13* below illustrate the Full MSP Deployment and New Product Enterprise threads, respectively. The Full MSP Deployment thread illustrates the priority events that must take place to properly deploy a system or solution for a customer. The stakeholders included in the diagram show the level of association they hold for a given event. The main consideration for this diagram is the illustration of the STEAM vs. Non-STEAM stakeholders and corresponding responsibilities. The New Product thread shows the key events that must take place within the STEAM Enterprise to successfully develop and implement a new solution or product within the STEAM and corporate portfolio.

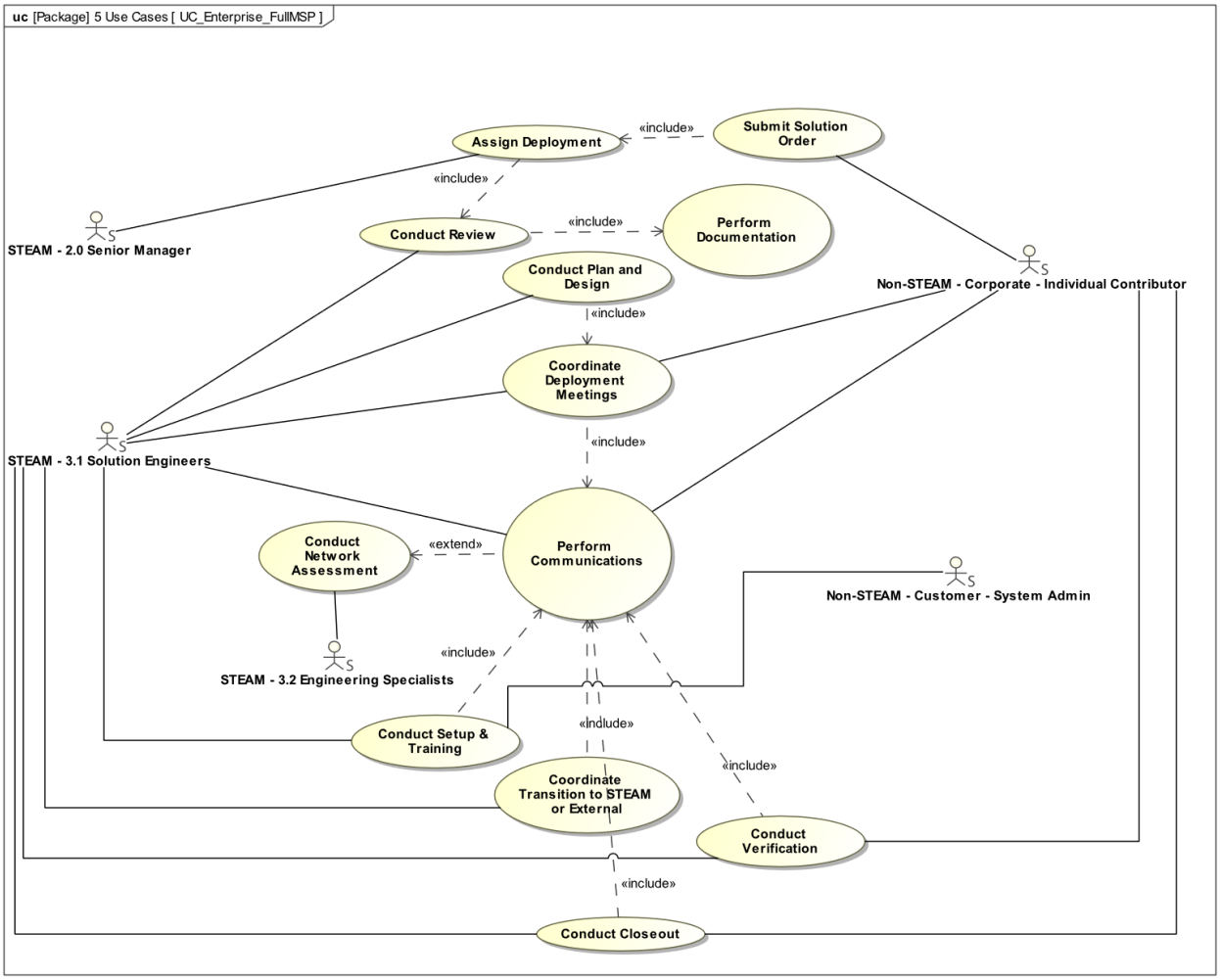

Figure 12 - Use Case Diagram of the Full MSP Deployment Enterprise Thread

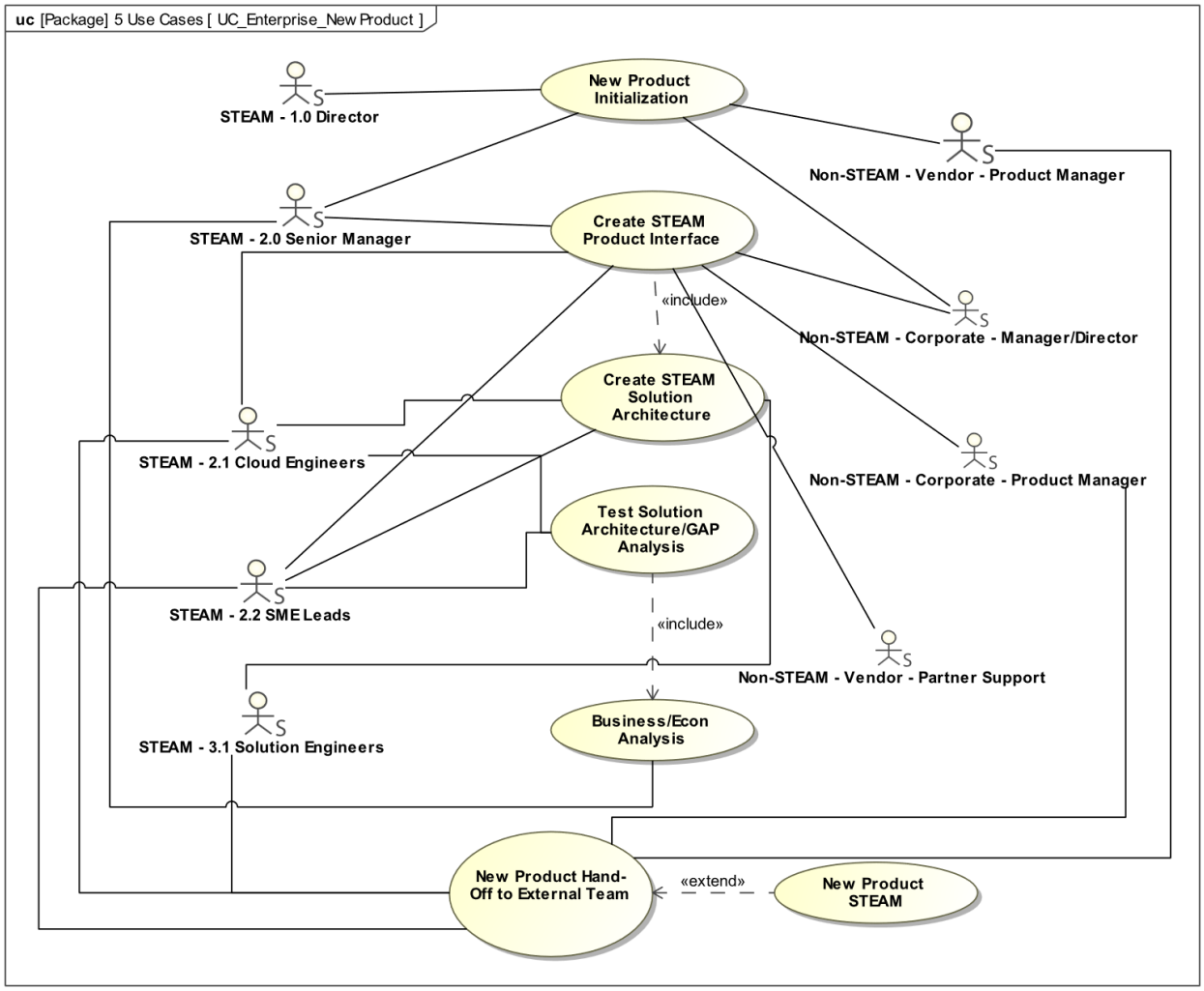

Figure 13 - Use Case Diagram of the New Product Enterprise Thread

3.1.6 Behavior

The focus of this section is to describe the associated behavioral connections between various aspects and artifacts within the model up to this point in the decomposition process. While the Use Case section may illustrate the events that take place to properly execute an Enterprise thread, the Behavior section is focused on providing the context for the interactions between both systems, subsystems, and stakeholders. Activity Diagrams are added to the model in this section to meet the need for this kind of display of the interaction. The illustration shown below in *Figure 14* and *Figure 15* display the transmission and communication of both actions and objects that are required to complete one of the corresponding activities. The Full MSP Deploy diagram in *Figure 14*

shows both actions and objects need to complete the thread of the activity for solution deployment. It was purposefully left as subsystem or solution agnostic to provide the detail needed without adding redundancy to this project document. All the included subsystems and solutions could apply this diagram for deployment operations. The New Product diagram shown in Figure 15 displays the actions and objects needed to complete the thread for the activity, but also include detail related to the <<Internal>> vs. <<External>> stereotypes that were mentioned earlier. This is just another example of how these stereotypes can be applied for different views and focuses within a diagram.

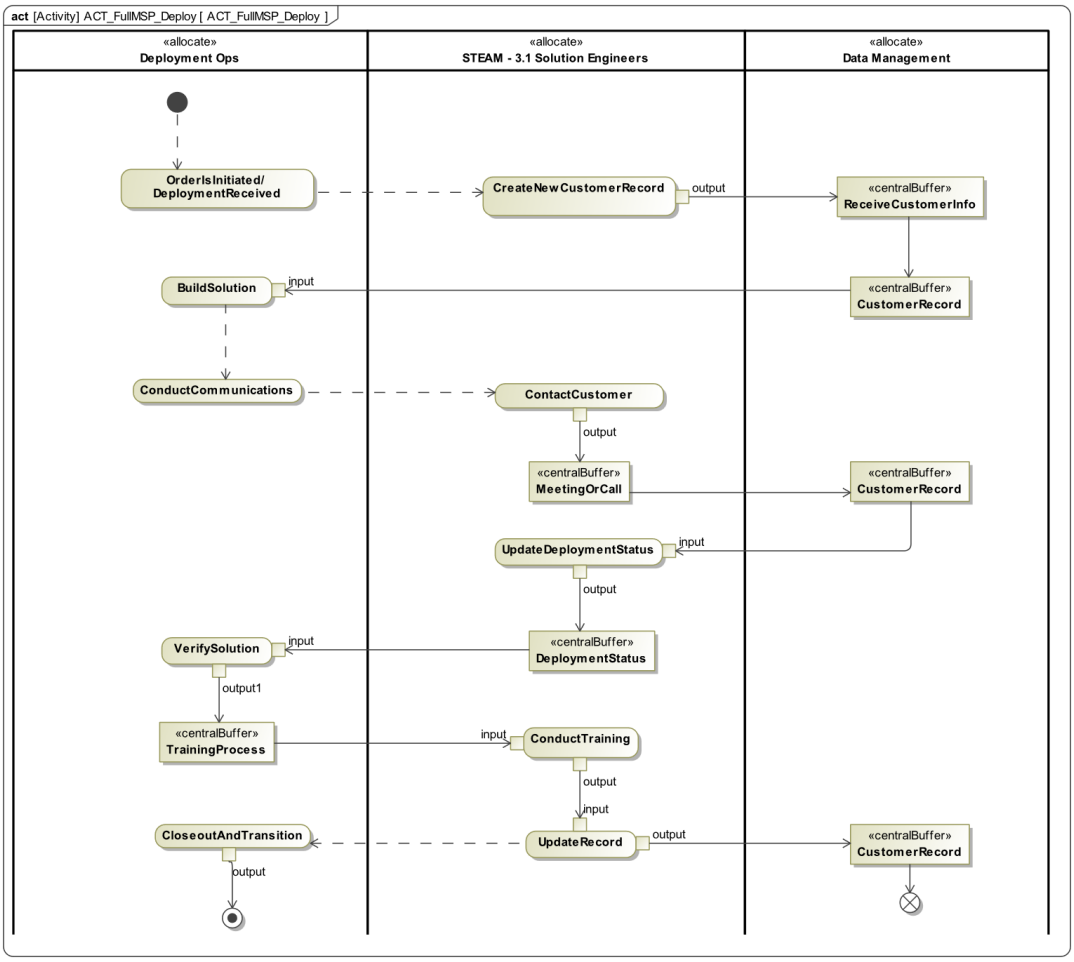

Figure 14 - Activity Diagram for the Full MSP Deploy Thread

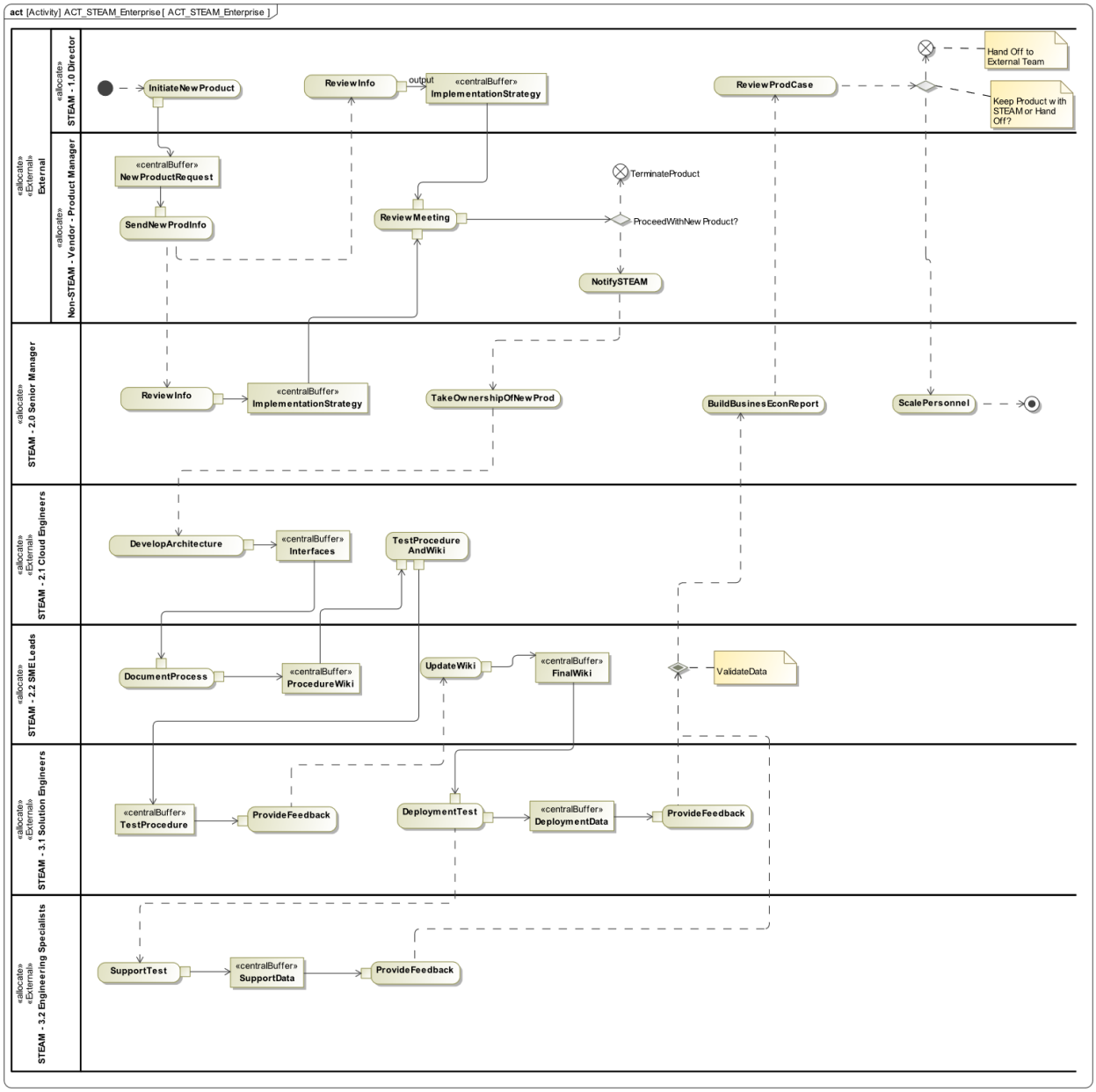

Figure 15 - Activity Diagram for the New Product Thread

3.1.7 Risk

While it is not expressly defined within the reference architecture how to state the risk associated with each System, Subsystem, or Component within the model, the most logical way to represent this risk for the STEAM model is to consolidate these descriptions in the Requirement Diagram shown in Figure 16. The risk categories are defined within the CAMEO Systems Modeler

software and were applied based on the level of negative impact to the Enterprise (i.e., low impact is “Low”, medium impact is “Medium”, and high impact is “High”). In addition to a standard risk profile, the somewhat rudimentary Failure Modes, and Effects Analysis (FMEA) table shown below in *Figure 17* was included as another subsystem-agnostic representation of any of the operations that would be regularly conducted within the STEAM framework. The table created for this project was developed outside of the CAMEO STEAM Model but can be replicated and adapted to other applications utilizing the guidelines provided by NASA (10). Within the context of the STEAM Model, the Process Inputs are generally included in the Deploy, Support, and Enable subsystems, as well as other Management subsystems. The main output of the FMEA is a quantitative value to show the importance or Risk Priority Number (RPN) to assist with the prioritization of the most heavily impacting risks. The inclusion of the FMEA is also crucial to the principles of MBSE and SysML by removing ambiguity that may be left over from a generic risk profile.

#	△ Id	Name	Risk
1	1	R Non-Functional Requirements	
2	1.1	U Usability Requirements	
3	1.1.1	U Human Resources	High
4	1.1.2	U Location/Access	Medium
5	1.2	I Interface Requirements	
6	1.2.1	I Corporate Facing Data/Report	High
7	1.2.2	I Customer Facing Data/Report	Low
8	1.2.3	I Vendor Facing Data/Report	Medium
9	1.2.4	I Vendor Support	High
10	1.3	B Business Requirements	
11	1.3.1	B Net Revenue	High
12	1.3.2	B Maintain MSP	Low
13	2	R Functional Requirements	
14	2.1	E MSP Ops	
15	2.1.1	E Support Ops	Low
16	2.1.2	E Deployment Ops	High
17	2.1.3	E Enablement Ops	Medium
18	2.2	E Burn-In Ops	
19	2.2.1	E New Product Hand-Off	High
20	2.2.2	E New Product STEAM Scale	Medium
21	2.2.3	E New Product Development	Medium
22	2.3	E SME Group	
23	2.3.1	E Solution Options	Low
24	2.3.2	E Solution Integration Compatability	Medium

Figure 16 - Table of Enterprise Requirements and Associated Risk Rating

FMEA Form

Process/Product Name: Process FMEA - MSP Deploy, Support, Enable Process

Prepared By: Dalton Fox

Responsible:

FMEA Date (Orig.): Thursday, July 14, 2022 (Rev.): 7/25/2022

Process Step/Input	Potential Failure Mode	Potential Failure Effects	SEVERITY (1 - 10)	Potential Causes	OCCURRENCE (1 - 10)	Current Controls	DETECTION (1 - 10)	RPN	Action Recommended	Resp.	Actions Taken	SEVERITY (1 - 10)	OCCURRENCE (1 - 10)	DETECTION (1 - 10)	RPN
What is the process step, change or feature under investigation?	In what ways could the step, change or feature go wrong?	What is the impact on the customer if this failure is not prevented or corrected?		What causes the step, change or feature to go wrong? (how could it occur?)		What controls exist that either prevent or detect the failure?			What are the recommended actions for reducing the occurrence of the cause or improving detection?	Who is responsible for making sure the actions are completed?	What actions were completed (and when) with respect to the RPN?				
Account Authenticaion for Financially Impacting Changes or Account Migrations	Person could correctly verify admin info, but be fraudulent or maliceous	Account could be altered outside of customer approval or data could be compromised	9	End user or maliceous actor calls or emails in asking for a change, or end user goes around authority to request a change	3	Email and phone number verification	6	162	Implement one-time-password or unique support code generator	SETC Management will audit and enforce, but Deployment Managers and Solution Engineers will be responsible for implementing on a daily basis	Support code generator implemented - 02/15	9	3	2	54
Information Documentation/Notes for Deployments	The Deployment Manager provides inaccurate or incomplete information as to the operations and details taking place on a deployment	Customer requests for financial compensation or reimbursement do not have adequate information to defend/deny claims	5	Lack of time for deployment manager to provide notes on the deployment and or lack of organization in process to account for detailed notes	5	Quickbase noting system, Outlook email records, call records, meeting records	2	50	Implement clear process Plan of Record (PoR) or guidelines for deployment notes; regular note audits for deployments	SETC Management will audit and provide coaching for deployment managers	PoR and Audits Implemented 11/04/2021	5	5	1	25
Issue Escalation	The engineers and deployment managers improperly identify and or classify issues and miss opportunities to escalate issues to proper management channels	Customers are left waiting on issue resolution; SETC misses SLAs for specifed issues	7	Lack of understanding on how to ID issues and classify them correctly based on severity and or type	4	Word of mouth and tribal knowledge	4	112	Implement daily standup meetings; provide channels for team to reach management throughout the day to ask questions	SETC will have daily standup meetings between 8am and 9am mst (slowest time of day) to communicate questions or issues to be addressed by management	Daily standup meetings started 09/19/2021	7	1	2	14

Figure 17 - Table Display of the FMEA and the Corresponding RPN Value

3.2 STEAM Systems

The STEAM Systems level includes the derivation of the Enterprise requirements into System requirements, system structure, and the system context within the model. While the reference architecture provides separate sections for systems and subsystems, the section was consolidated to avoid redundancy in language and diagrams within the model and this project document.

3.2.1 Requirements

The Enterprise level requirements established earlier in the project were organized based on Functional and Non-Functional classifications; however, for the purposes of relating the SE guidelines to the structure and content of the STEAM group and model, the System level requirements were organized differently. The System requirements focused on the detailed derivatives of the Enterprise requirements as they relate to Performance, Lifecycle, Business, and Integration. The table shown in *Figure 18* displays a similar naming convention; however, the ID was changed to reflect System Requirements, or SR, with the numerical label following. It is also worth noting that the Risk associated with each System Requirement is displayed in this table to remove a redundant table to be referenced in the Risk section of this document.

The final step for the needs and requirements as they relate to this project is to account for the derived requirements at the system level to show the relationship to the original enterprise requirements. The table shown in *Figure 19* provides the artifact relationships between the system and enterprise requirements with the arrow symbol showing the system requirements (rows) are derivatives of the enterprise requirements (column). The rows and columns that only show a number instead of the *DeriveReqt* arrow symbol are reflective of the number of occurrences for the corresponding intersection.

The key consideration for this section, as stated above, is the consolidation of the systems and subsystems into a single section of requirements. The consolidation in this section allows the artifacts and actions generated in the Logical View to satisfy both enterprise and system-level requirements.

#	Id	△ Name	Risk
1	SR	⊟ R SR System Requirements	
2	SR.1	⊟ R SR.1 Performance	
3	SR.1.1	E SR.1.1 Time to deploy	High
4	SR.1.2	E SR.1.2 SLO	Medium
5	SR.1.3	E SR.1.3 SLA	Medium
6	SR.1.4	E SR.1.4 Escalation	Low
7	SR.1.5	E SR.1.5 Time to resolution	Low
8	SR.1.6	E SR.1.6 Personnel count	Medium
9	SR.1.7	E SR.1.7 Personnel Skill	Medium
10	SR.1.8	E SR.1.8 Access to Internal Resources	Low
11	SR.1.9	E SR.1.9 Access to External Resources	Low
12	SR.1.10	E SR.1.10 Website Internal	Low
13	SR.1.11	E SR.1.11 Website External	Low
14	SR.1.12	E SR.1.12 Productivity	Low
15	SR.1.13	E SR.1.13 Repository	Low
16	SR.1.14	E SR.1.14 Sys Security	High
17	SR.1.15	E SR.1.15 Voice Comms	Low
18	SR.1.16	E SR.1.16 Text/Fax Comms	Low
19	SR.1.17	E SR.1.17 MDM Security	High
20	SR.1.18	E SR.1.18 UEM Security	High
21	SR.1.19	E SR.1.19 Total Solutions	Medium
22	SR.1.20	E SR.1.20 Time to Launch	High
23	SR.2	⊞ R SR.2 Lifecycle	
30	SR.3	⊞ R SR.3 Business	
36	SR.4	⊞ R SR.4 Integration	

Figure 18 - Table of System Level Requirements and Associated Risk

Legend: DeriveReqt	STEAM Enterprise Requirements																						
	1 Non-Functional Requirements													2 Functional Requirements									
	1.1 Usability Requirements			1.2 Interface Requirements						1.3 Business Requirements				2.1 MSP Ops			2.2 Burn-In Ops			2.3 SME Group			
	1.1.1 Human Resources	1.1.2 Location/Access		1.2.1 Corporate Facing Data/Report	1.2.2 Customer Facing Data/Report	1.2.3 Vendor Facing Data/Report	1.2.4 Vendor Support		1.3.1 Net Revenue	1.3.2 Maintain MSP			2.1.1 Support Ops	2.1.2 Deployment Ops	2.1.3 Enablement Ops		2.2.1 New Product Hand-Off	2.2.2 New Product STEAM Scale	2.2.3 New Product Development		2.3.1 Solution Options	2.3.2 Solution Integration Compatat
SR System Requirements																							
SR.1 Performance	2	7		5	5	4	6			3			8	1	12		7	7	16		2	4
SR.2 Lifecycle																							
SR.2.1 Churn Rate					↗					↗			↗						↗			
SR.2.2 Lifecycle ops					↗								↗		↗				↗			
SR.2.3 Lifecycle feedback					↗					↗			↗						↗			
SR.2.4 Personnel Redundancy	↗									↗									↗			
SR.2.5 Internal Mainenance							↗						↗						↗			
SR.2.6 External Maintenance							↗						↗		↗							
SR.3 Business																						
SR.3.1 Net Revenue	↗								↗					↗			↗		↗			↗
SR.3.2 Net Corporate Add	↗								↗					↗	↗		↗		↗			↗
SR.3.3 Corporate Usage	↗			↗					↗				↗	↗	↗		↗		↗			↗
SR.3.4 Partnership	↗			↗			↗		↗	↗			↗	↗	↗		↗		↗			↗
SR.3.5 Market Share							↗		↗						↗		↗		↗			
SR.4 Integration		3												8	5						8	8

Figure 19 - Table of Enterprise Requirements Derived into System Requirements

3.2.2 Structure

The structure of the STEAM Enterprise was decomposed into the two primary systems, Management and SaaS MSP. The diagrams shown in *Figure 20* and *Figure 21* include the corresponding Block Definition Diagram to illustrate the various parts that are to be included as the subsystem level for each classification. The Management system has slightly fewer subsystems at this time, mostly due to the needed development of internal subsystems that would need to be defined with parameters and industry specifications prior to naming specific custom in-house or vendor-built solutions. The SaaS MSP system has the designated vendor solutions that correspond with each SME Group (i.e., Productivity and Microsoft 365) to provide additional context for subsystem allocation. In each of the diagrams, the denotation for the subsystems is set in the *parts* section of each block. The

vendor solutions as subsystems within each of the blocks are the established options and not reflective of the "burn-in" process or capability. The Burn-In Management would need its own set of parameters as well as test and validation procedures. The most likely option for testing and validation of the Burn-In Management system would be to do a beta-run of a new product.

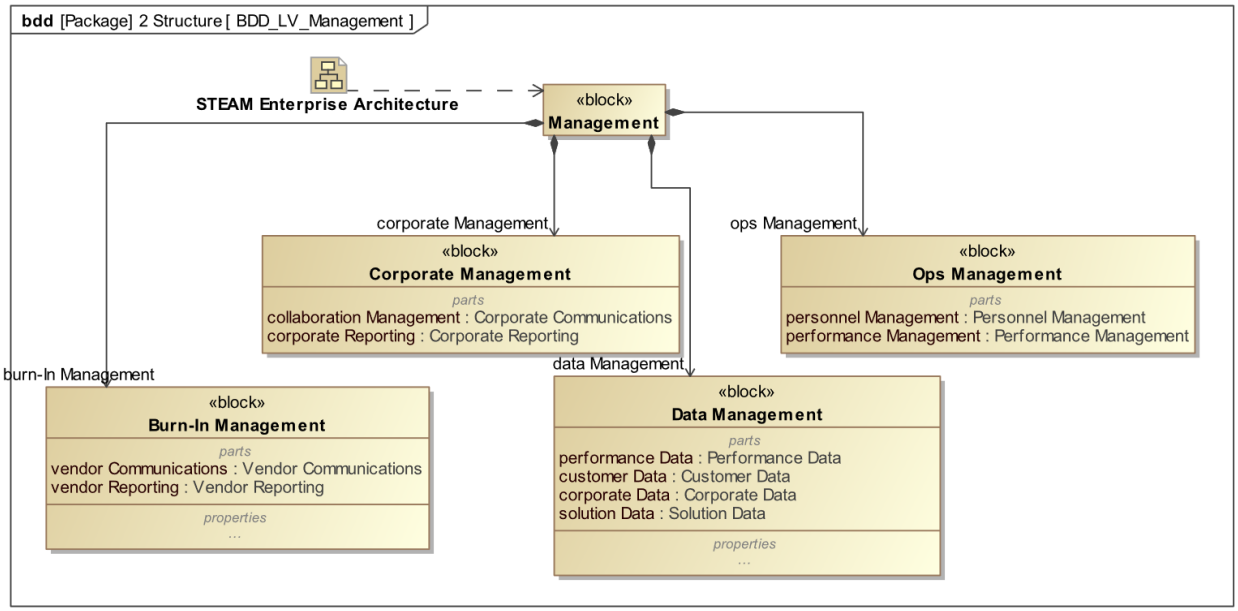

Figure 20 – Block Definition Diagram of the Management System

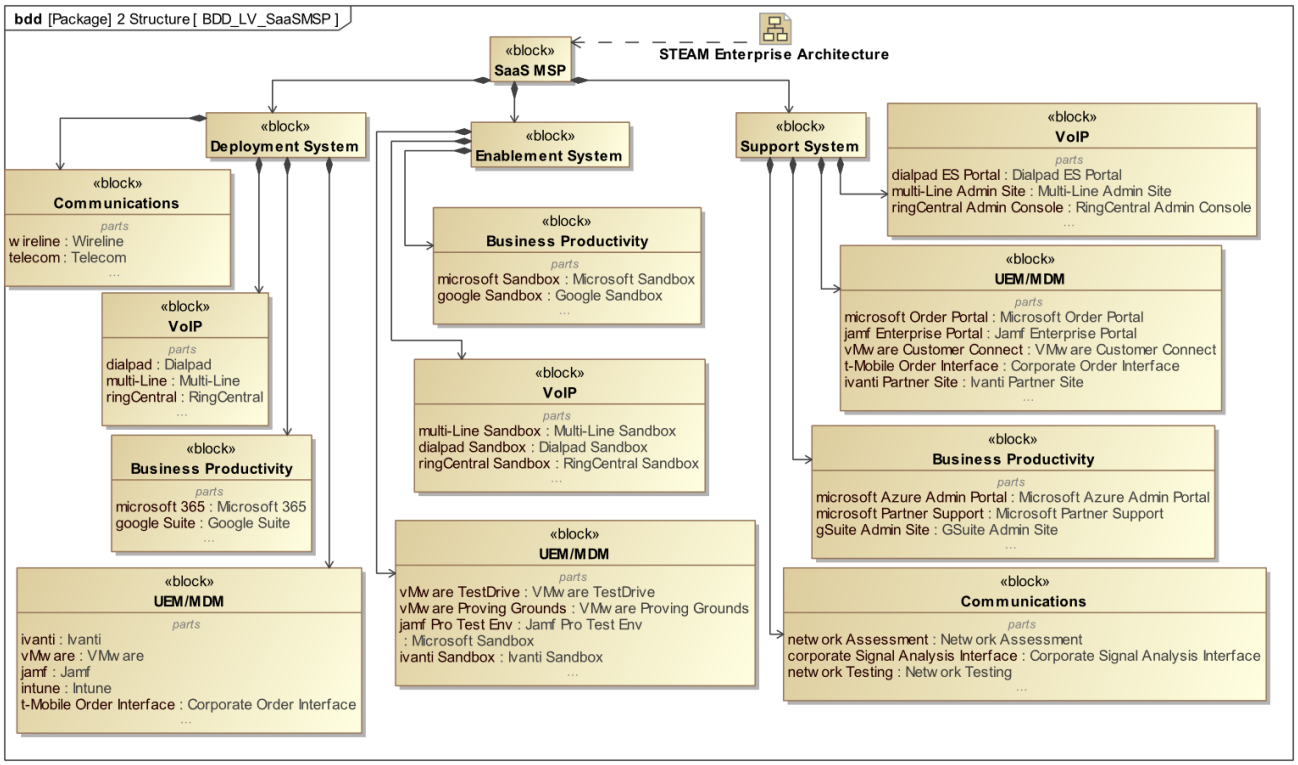

Figure 21 – Block Definition Diagram of the SaaS MSP System

3.2.3 Behavior

While there are several behavioral diagrams and artifacts that could be inserted into this section to illustrate the system and subsystem events, the best system-agnostic example is shown in *Figure 22* below for the Enablement System. The events represented in this diagram could also be represented on the SaaS MSP side of the Enterprise and provides an additional level of flexibility when the Use Cases were created. The other consideration is the involvement of the individual contributors from both STEAM and Non-STEAM stakeholders. The association relationship shown in this diagram illustrates that even though these stakeholders have associations with other systems, they are directly associated with events and actions that are both internal and external to the STEAM Enterprise.

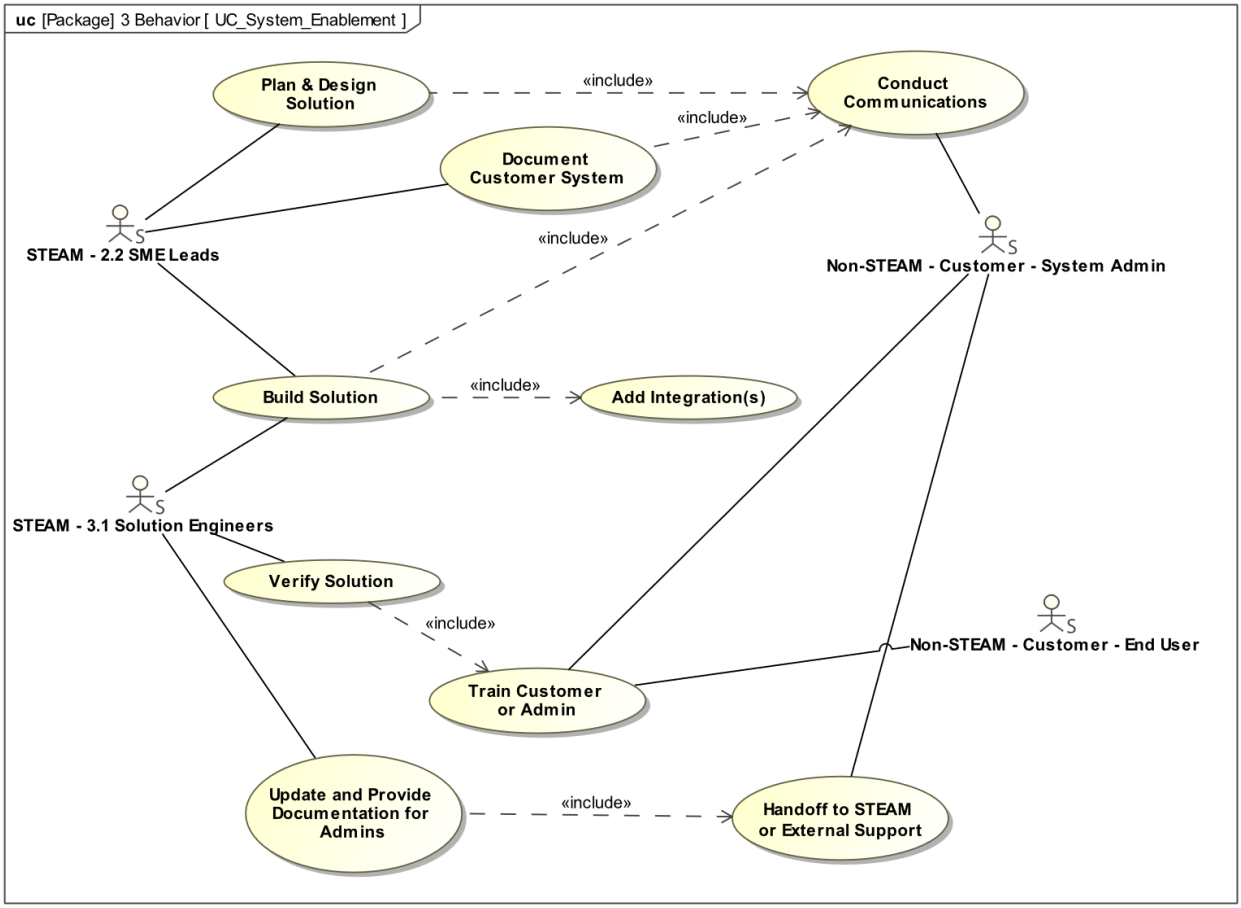

Figure 22 - Use Case Diagram for the Enablement System

3.2.4 Risk

The risk profile generated and displayed previously in Figure 18 reflects the importance of each of the requirements but does not provide the quantitative evaluation that is ultimately needed for the system level of decomposition. The main reason the quantitative assessment was not conducted is that the specification down to the component level (Physical View, PV) is needed to provide the correct specifications, governing codes, or regulations corresponding with each process to be evaluated, similarly to how the FMEA was conducted in *Figure 17*. The detailed development of this level should be included in future research both at the system level (LV) and the component level (PV).

4 Discussion

While this project certainly proved the main objectives as achievable within the scope of the original purpose, time did not permit the depth of development needed for the full evaluation of the proposed enterprise system. The project development has utilized two main productivity tools for collaboration and publishing the model and documentation. Microsoft OneDrive served as the main iterative library for all related files to the project and model; however, the project has also been published through a GitHub repository (6) to allow for future research in a publicly accessible fashion.

The expectation for this section is to outline the items that would be beneficial for said future research and development of the model as it applies to MBSE/SysML or the further application of these tools to develop the STEAM Management and SaaS MSP platform.

4.1 STEAM Enterprise Discussion

While the primary focus of the project was aimed to answer specific questions regarding the application of SE, MBSE, and SysML to the STEAM architecture, it is also acknowledged that this project would serve as one of the iterations necessary to revise and manage the requirements of the enterprise. The main aspect of future development work and/or research at the Enterprise level would include iterations of the enterprise, systems, and subsystems, as well as the representative model architecture. The traditional use of the SE V-Model would require at least one full cycle of this process to be completed before it could be fully validated. As such, it is our recommendation that a full cycle of the V-Model should be completed prior to multiple iterations of the system-of-systems.

The additional aspects of the Enterprise level that should be expanded in future research are the diagrams and artifacts used to satisfy the business requirements. There are advanced economic analysis tools that could be utilized; however, there are several aspects in both agnostic MBSE tools as well as CAMEO Systems Modeler that could be utilized. The economic analysis tools would include items such as Rate-of-Return calculators, Return-on-Investment tables, amortization tables, interest comparisons, and asset valuation tables.

4.2 STEAM Systems and Subsystems Discussion

The details that were included in the Systems section above were deemed as conclusive for the purposes of this project, to establish a clear architectural framework for the development of MSP and Management systems within the STEAM group. However, there are additional layers of detail that should be included for the full completion of the V-Model approach. In these details would be the parameters and corresponding functional and non-functional requirements associated with each. Also, there would need to be further development regarding the testing and evaluation phases of the systems and subsystems to satisfy the enterprise-level requirements. It is our recommendation that any future work includes a specific method to test these requirements for each of the two primary systems, Management, and SaaS MSP. The inputs of these could include a test run of a new product/solution, as well as the STEAM personnel and resources needed internally and externally to execute a trial run.

4.3 STEAM Components Discussion

The limited scope and focus of this project allowed for the attention to be kept on the structural architecture of the development of the STEAM group and capabilities. The Components that would eventually need to be allocated to specified subsystems include the various software, middleware, and hardware parts that are involved with STEAM, Corporate, and Vendor infrastructure to develop, maintain, and support ongoing cloud-based systems. Additionally, there are several different industry specifications that would need to be considered to make certain requests or requirements to the vendor when in-house components are not an option. It is our recommendation that future research on the component level (PV) begin with the industry standards for each of the main SME Groups, including productivity, VoIP, communications, and MDM/UEM. Once these standards are verified and included in the request for proposal (RFP) to each vendor, the performance can be evaluated against business considerations such as cost, maintainability, and end-of-life estimates.

5 Conclusions

The project as outlined previously was able to successfully answer all the questions to the satisfaction of the development of the STEAM group's capabilities to maintain and expand capabilities as an MSP and facilitate the "burn-in" capacity for new product development. The STEAM Enterprise composed of Management and SaaS MSP systems was successfully architected using traditional Systems Engineering and Model-Based Systems Engineering methods. While there are still considerable steps that could be taken in future research, there are clear paths provided for further research as it pertains to both the STEAM Enterprise and MBSE/SysML. It is the conclusion of this project that all aspects of the STEAM Enterprise could be modeled, however there were several diagrams and artifacts that were outside the scope of the project at this time. The future research and development of the model has the full capability to complete all aspects of the model within either the CAMEO Systems Modeler tool or any other MBSE tool (11). While there are various engineering risk management tools that can be applied to computer, software, and information systems in general, the relevant tools were utilized in a general risk profile and FMEA. The levels of decomposition in this project were adequate for the architectural definitions needed for the STEAM Enterprise, however there are still additional steps to fully decompose the enterprise to the level(s) needed for proper Systems Engineering. The completion and future research, as stated previously in the previous sections, is outlined for each level of additional decomposition and detail. The artifacts available within the MBSE/SysML format allow for each of the SME Groups within the STEAM Enterprise and Systems to be accounted for including Business Productivity, VoIP, Communications, and UEM/MDM. Since each of these items has been addressed by at least one artifact within the STEAM Model, it is considered to be successful.

There were several aspects of the tool, CAMEO, that are noteworthy for future development not only for this research area, but for all enterprise systems. First, the ability to utilize packages and smart-packages within the model's containment (12) allowed for quick organization in the early steps of development. Once the packages were established it was straightforward how to contribute artifacts for the corresponding level of decomposition. Second, the use of <<Stereotypes>> provided the ability to flag and sort different artifacts based on the desired view of the system or individual artifacts (13). The stereotypes within the STEAM Model were added during each level of decomposition which allowed for dynamic adjustments to be made throughout the system development process. Third, the ability to produce each diagram in a .SVG format (Scalable Vector Graphic) allowed for the diagrams to be easily transferred from the CAMEO

Systems Modeler software to any document of choice, but specifically into Microsoft Word in a high-resolution form. The resolution of each graphic allowed for the graphics to be scaled without depreciation to the original quality of the diagram, and for any text within the image to be easily legible. Overall, the use of any MBSE tool or software could be used to replicate the work done for this project, however the exceptional experience with CAMEO Systems Modeler would make for a great tool to be used for any future development in this subject area.

Glossary

The glossary was compiled as a supplemental artifact in the CAMEO model based on word or acronym usage within other diagrams or artifacts throughout the project. The table shown below can also be referenced within the model as *Figure 23.*

#	△ Term	Description
1	admin	The permission and designation level for a corresponding system, solution, or application. STEAM has both internal and external admins for various scenarios. EX. STEAM provides two internal persons with admin level permissions for databases, communications applications, and repositories.
2	corporate	Corporate is the established US based company with several facets but is broken down into two main categories, Business and Consumer. All references to STEAM are under the Business division of corporate, as well as all other stakeholders and designations.
3	customer	A STEAM customer is anyone outside of STEAM or corporate who is inquiring about or already entered into an agreement for solutions purchased through the corporate umbrella.
4	deploy	The physical and or virtual installation or implementation of a system and its applications for a new or existing customer.
5	Deployment	An instance of deploy operations or the artifact related to deploying.
6	enablement	STEAM enablement begins where the support ends; it involves anything that was not included in the original scope of the solution sold and deployed to the customer; may or may not incur an additional cost to the customer from STEAM to complete; includes any hardware, middleware, software or cross-system applications where advanced knowledge is required to complete an installation or integration.
7	enterprise	The highest level of the model/system; all decomposition derives from the enterprise or STEAM in this case.
8	external	Identifies any artifact that should reside outside of the bounds of the STEAM group. Scope definition term for anything that resides outside of the STEAM personnel, tangible, or virtual resources.
9	INCOSE	International Council of Systems Engineering
10	internal	Identifies any artifact that should reside inside of the bounds of the STEAM group. Scope definition term for anything that resides inside of the STEAM personnel, tangible, or virtual resources.
11	LV	Logical View
12	MBSE	Model-Based Systems Engineering
13	objective	In the context of systems engineering, an objective is the output of the initial step of the needs analysis, which intakes customer needs to align with overarching goals of the system-of-systems or system.
14	OV	Operational View
15	RFP	Request for Proposal
16	SE	Systems Engineering
17	SME	Subject Matter Expert; can be a person when referenced by itself, or a group when referenced as "SME Group".
18	STEAM	Solution Technology Engineering Architecture and Management STEAM is housed under the Corporate Business division, and operates with only business related vendors, and customers.
19	subsystem	The third level of decomposition; one level below the system level; incorporates the cloud solutions for a given SME group; the SME group would be productivity, and the subsystem would be Microsoft 365.
20	support	In the context of STEAM, this is the capability of assisting a customer or any party with issues and requests for their solution; system changes, permission changes, technical break-fix, maintenance issues, etc.
21	SysML	System Modeling Language
22	system	The level of decomposition below the enterprise level.
23	trace	CAMEO relationship as defined by 3DS, A 'Trace' relationship is a dependency between a requirement anc an arbitrary model element traced by this requirement."
24	vendor	A cloud-based system, solution, or application developer who originally created or manufactured the item. Ex. Microsoft, VMware, Ivanti, Google, Jamf, Dialpad, RingCentral, etc.

Figure 23 - Glossary of Terms from the STEAM CAMEO Model

References

1. **Colorado State University.** Systems Engineering - Master of Science (M.S.). *Systems Engineering Department.* [Online] Colorado State University, Walter Scott, Jr. College of Engineering, 2022. https://www.engr.colostate.edu/se/ms/.

2. **International Council for Systems Engineering.** *Systems Engineering Handbook, Fourth Edition.* San Diego : John Wiley & Sons, Inc., 2015. 9781118999400.

3. **Bradley, John M. Borky and Thomas H.** *Effective Model-Based Systems Engineering.* s.l. : Springer International Publishing AG, 2019. 978-3-319-95668-8.

4. **OMG.** About the OMG System Modeling Language Specification Version 1.6. *OMG.org.* [Online] Object Management Group, OMG, 2022. https://www.omg.org/spec/SysML/1.6/.

5. **Narsinghani, Jayesh B.** *Towards a Model-Based Implementation in Technology/Platform Life-Cycle Development Processes Applied to a Thrust Reverser Actuation System (TRAS) Concept.* Fort Collins : Colorado State University, 2021.

6. **Fox, Dalton.** DaltonFox_SysML_MBSE_SaaS-MSP. *Github.com.* [Online] July 2022. [Cited: August 4, 2022.] https://github.com/ColoradoFox/DaltonFox_SysML_MBSE_SaaS-MSP/.

7. **3DS Catia, Dassault Systemes.** CAMEO SYSTEMS MODELER. *3ds.com.* [Online] Dassault Systemes, 2022. https://www.3ds.com/products-services/catia/products/no-magic/cameo-systems-modeler/.

8. **3DS CATIA - No Magic.** SysML 19.0 Diagram Descriptions. *3DS CATIA - No Magic.* [Online] Dassault Systemes, November 21, 2019. https://docs.nomagic.com/display/SYSMLP190SP3/Diagram+descriptions.

9. **Dassault Systemes.** SysML Plugin Documentation. *NoMagic.com.* [Online] January 2022. https://docs.nomagic.com/display/SYSMLP2022x/SysML+Plugin+Documentation.

10. **NASA.** Rapid III Documents, MAR Reference. *NASA Documents.* [Online] [Cited: July 21, 2022.] https://rsdo.gsfc.nasa.gov/documents/Rapid-III-Documents/MAR-Reference/GSFC-FAP-322-208-FMEA-Draft.pdf.

11. **Pivot Point Technology Corp.** Commerical, Free, and Open Source SysML Tools for MBSE. *sysmlforum.com.* [Online] 2021. https://sysmlforum.com/sysml-tools/.

12. **3DS Catia, Dassault Systemes.** MagicDraw 19.0 LTR Documentation, Smart Packages. *NoMagic Documentation.* [Online] 2019. https://docs.nomagic.com/display/MD190/Smart+Package.

13. **3DS Catia, Dassault Systemes.** MagicDraw 19.0 LTR Documentation, Stereotype. *NoMagic Documentation.* [Online] 2019. https://docs.nomagic.com/display/MD190/Stereotype.

14. **OMG.** SysML FAQ: What is SysML? Who created SysML? ... *SysML.org.* [Online] 2021. https://sysml.org/sysml-faq/.

15. **Blanchard, Benjamin S and Fabrycky, Wolter J.** *Systems Engineering and Analysis, Fifth Edition.* Upper Saddle River : Pearson Education, Inc. publishing as Prentice Hall, 2010. 978-0132217354.