ENES489P Mid Year Report

Automated Container Shipping System Team

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Problem Statement

Current manual shipping methods often involve many workers, who perform repetitive tasks as part of a larger shipping system. These tasks are often not very complicated, but require attention to detail in order to ensure that the shipping system overall functions efficiently. Automated shipping systems offer a cost effective solution to companies who aim to maintain or improve their shipping system efficiency. These system eliminate the need for the manual performance of the repetitive aspects of the shipping system, and can help to maximize efficiency through the automation of simple and repetitive tasks. Additionally, workers can be better utilized to handle other aspects of the shipping process, consequently improving multiple areas of a shipping system concurrently.

The Automated Container Shipping System is needed to ensure that container unloading is handled in an expedient and efficient manner. The system will be capable of loading, unloading, and storing containers that arrive at or are in the facility, while also logging data regarding the identity of the containers that have arrived, and their position within the facility. This is to ensure that all imported products are accounted for and easily locatable. The customers of this service could utilize the system to expedite the waypoint processing and sorting of containers en route to their final destination. The goal of this system in summary, is to unload and load containers or store them for processing, while also scanning and recording data about inbound and outbound containers. The principal conceptual elements that the system comprises of are the Database element, Maintenance element, Control element, Stacker Vehicle element, and the Gantry Crane element. The system environment is composed of the Area of Operation, External environment, Fuel, and Power. The system users include manufacturers, who provide the imported containers and utilize the service the ACSS system provides, and include ACSS Operators and Maintainers, who aid in system function and upkeep.

Solution Domain Definition

In designing the ACSS, it is important to establish certain measures and metrics to provide an indication of when the system is succeeding or failing in meeting its goals. There are four of these key performance indicators (KPIs), or measures of effectiveness (MOE) for the Automated Container Shipping System.

KPP/MOE 1: Import Rate

The ACSS must maintain a steady import rate as this is the first part of the systems progression towards its goal of importing and exporting containers expediently. Importing containers at a steady, and relatively high rate ensures that the automated

facets of the system are being utilized thoroughly as they are capable of this increased speed.

KPP/MOE 2: Storage Rate

The storage rate is an important measure of the effectiveness of the automated and data processing components of the ACSS. The systems ability to log container information, and quickly assign containers to open storage locations is a key improvement goal over current manual shipping system methods.

KPP/MOE 3: Retrieval Rate

The retrieval rate is equally important as the storage rate as a measure of effectiveness as it is essentially the same process as the storing of containers, but in reverse. The storage and retrieval rates utilize the same automated components, and a drastic difference in these rates could be indicative of a data processing or stacker vehicle issue.

KPP/MOE 4: Export Rate

The export rate is an indication of the efficiency of the final components of the ACSS, as it elucidates how fast containers are able to be loaded for transportation to their next or final destination. The import and export rate are dependent on similar automated components of the ACSS.

Requirement Engineering

Overview

The high-level operational capabilities of the system, the system's Measurements of Effectiveness (MOEs) and Key Performance Parameters (KPPs), were built to serve the requirements of the system's stakeholders. The purpose of the proposed system is to advance the automation technology in shipping docks by building a automated container shipping system, which would make shipping services much cheaper. After setting up our stakeholder requirements and verifying them with our MOEs, we constructed our use case diagrams and use case narratives to reflect our innovative automated system. Finally we mapped our stakeholder requirements to system requirements.

Top-Level Stakeholder Requirements Diagram

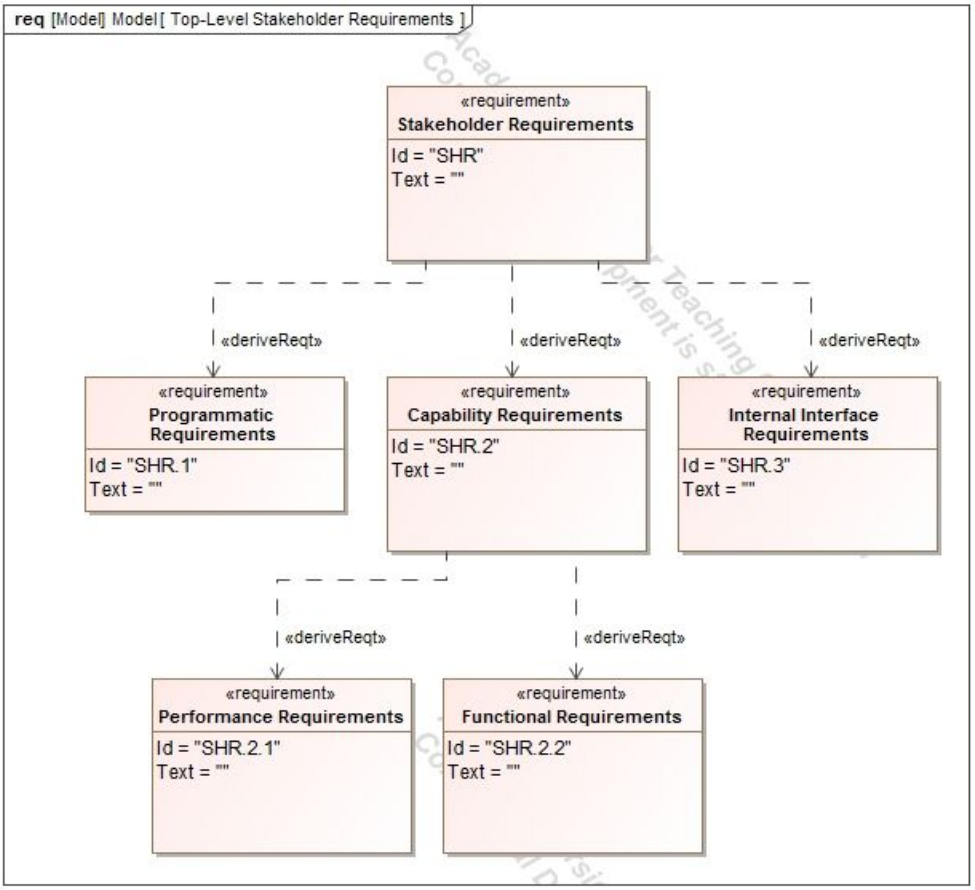


Figure 1. Top-Level Stakeholder Requirements

Programmatic Requirements Diagram

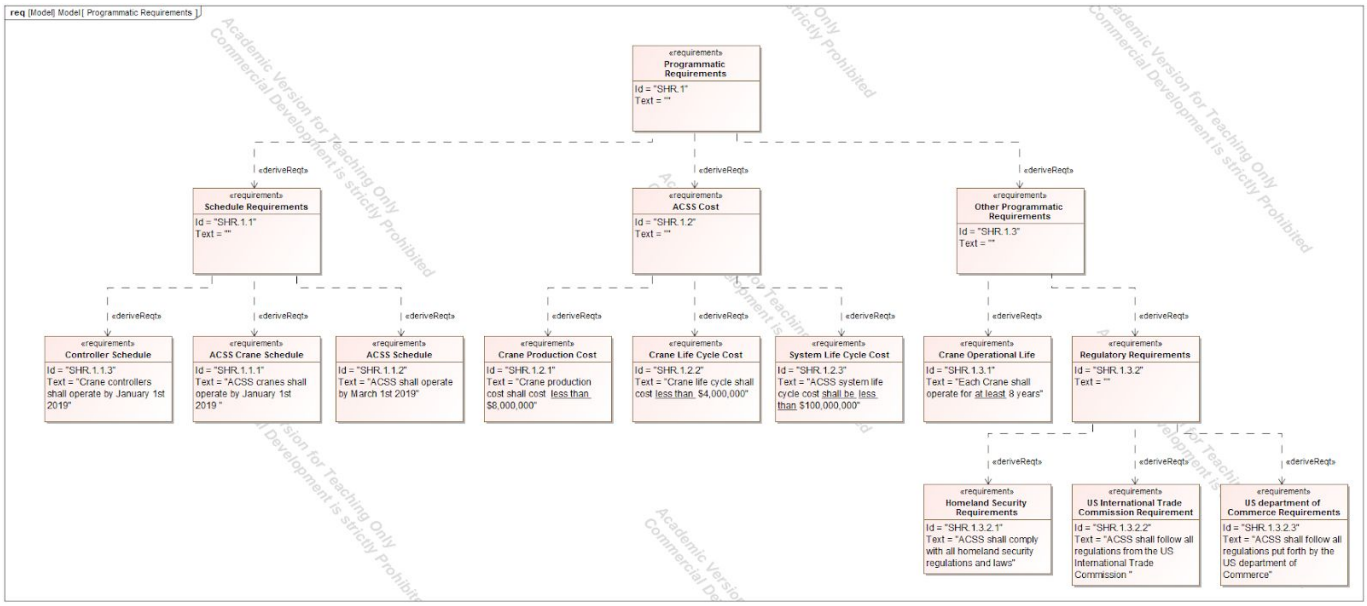


Figure 2. Programmatic Requirements Diagram

Capability Requirements: Performance Requirements Diagram

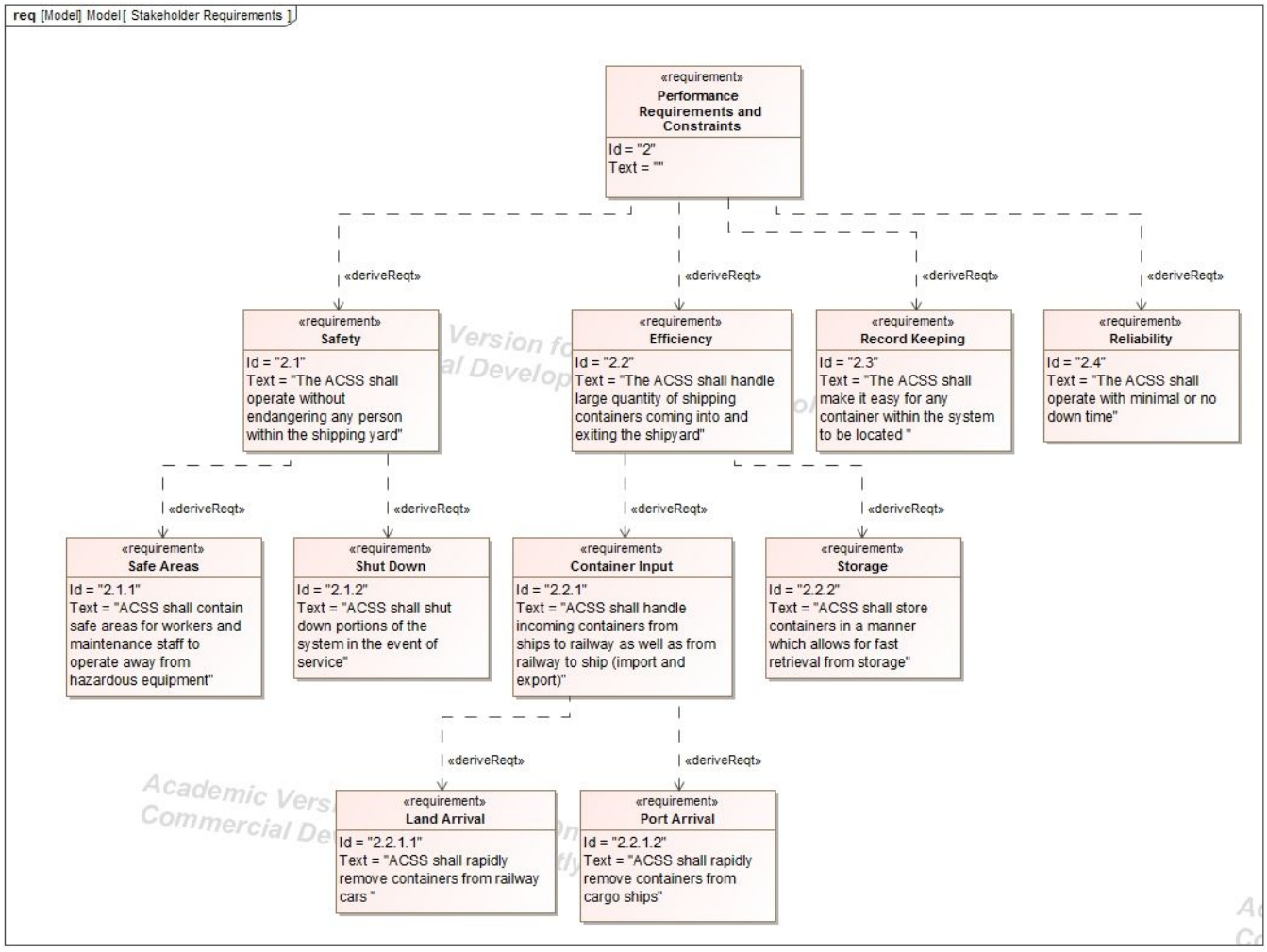


Figure 3. Performance Requirements Diagram

Capability Requirements: Functional Requirements Diagram

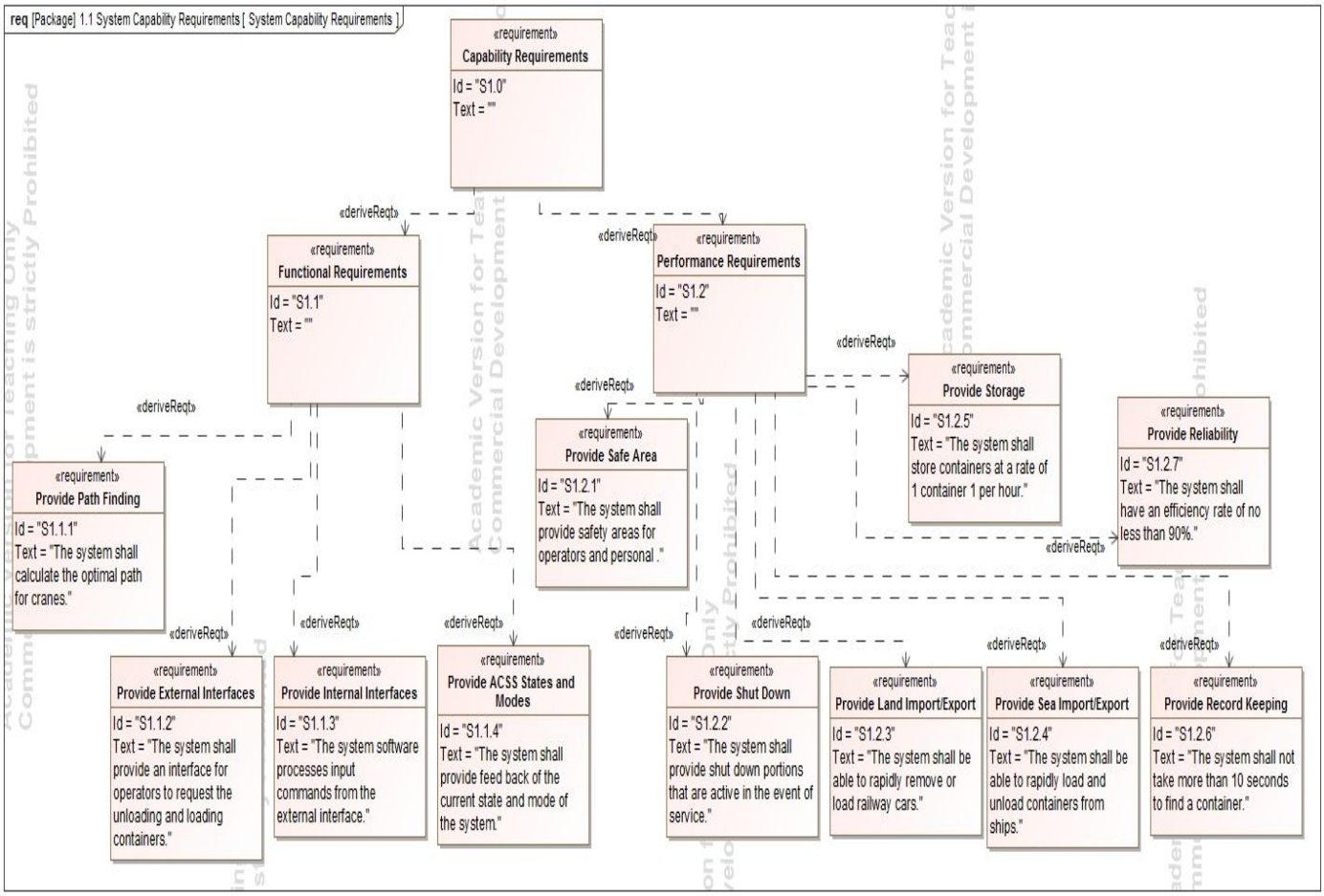


Figure 4. Functional Requirements Diagram

Interface Requirements Diagram

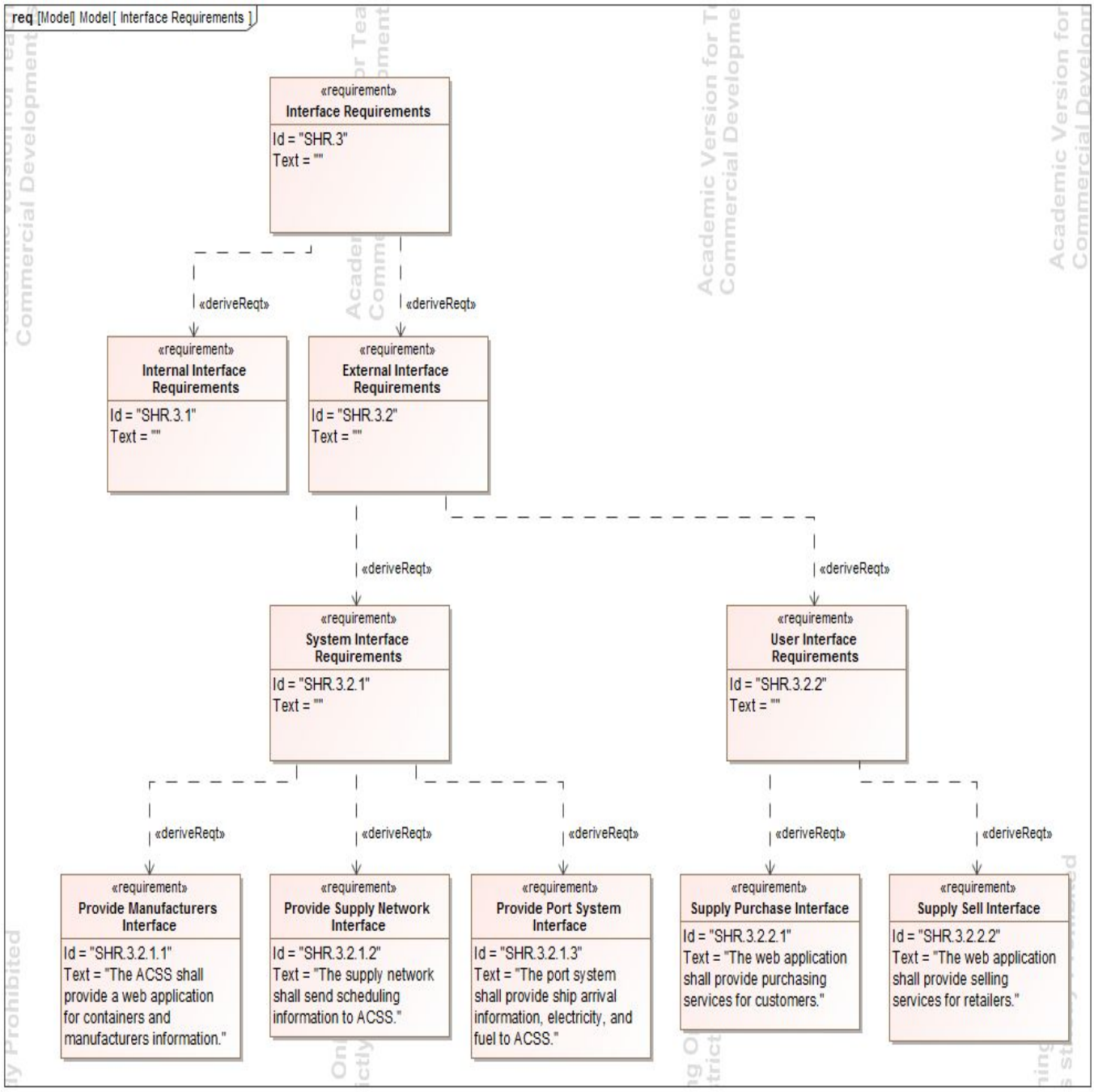


Figure 5. Interface Requirements Diagram

Stakeholder Requirements Table with all Stakeholder Requirements

#	Name	Text
1	SHR.1.1.1 ACSS Crane Schedule	ACSS cranes shall operate by January 1st 2019
2	SHR.1.1.2 ACSS Schedule	ACSS shall operate by March 1st 2019
3	SHR.1.1.3 Controller Schedule	Crane controllers shall operate by January 1st 2019
4	SHR.1.1 Schedule Requirements	
5	SHR.1.2.1 Crane Production Cost	Crane production cost shall cost less than $8,000,000
6	SHR.1.2.2 Crane Life Cycle Cost	Crane life cycle shall cost less than $4,000,000
7	SHR.1.2.3 System Life Cycle Cost	ACSS system life cycle cost shall be less than $100,000,000
8	SHR.1.2 ACSS Cost	
9	SHR.1.3.1 Crane Operational Life	Each Crane shall operate for at least 8 years
10	SHR.1.3.2.1 Homeland Security Requirements	ACSS shall comply with all homeland security regulations and laws
11	SHR.1.3.2.2 US International Trade Commission Requirement	ACSS shall follow all regulations from the US International Trade Commission
12	SHR.1.3.2.3 US department of Commerce Requirements	ACSS shall follow all regulations put forth by the US department of Commerce
13	SHR.1.3.2 Regulatory Requirements	
14	SHR.1.3 Other Programmatic Requirements	
15	SHR.1 Programmatic Requirements	
16	SHR.2.1 Performance Requirements	
17	SHR.2.2.1 Unloading Containers	System software receives unload request
18	SHR.2.2.2.1	Operator shall request loading of container
19	SHR.2.2.2.2	System software receives load request
20	SHR.2.2.2.3	Crane shall load one container
21	SHR.2.2.2 Loading Containers	
22	SHR.2.2.3.2	System software shall receice scan request
23	SHR.2.2.3.3	System software shall record data received from crane scan
24	SHR.2.2.3 Handling Containers	
25	SHR.2.2.4 Storing Containers	
26	SHR.2.2 Functional Requirements	
27	SHR.2 Capability Requirements	
28	SHR.3.1 Internal Interface Requirements	
29	SHR.3.2.1.1 Provide Manufacturers Interface	The ACSS shall provide a web application for containers and manufacturers information.
30	SHR.3.2.1.2 Provide Supply Network Interface	The supply network shall send scheduling information to ACSS.
31	SHR.3.2.1.3 Provide Port System Interface	The port system shall provide ship arrival information, electricity, and fuel to ACSS.
32	SHR.3.2.1 System Interface Requirements	
33	SHR.3.2.2.1 Supply Purchase Interface	The web application shall provide purchasing services for customers.
34	SHR.3.2.2.2 Supply Sell Interface	The web application shall provide selling services for retailers.
35	SHR.3.2.2 User Interface Requirements	
36	SHR.3.2 External Interface Requirements	
37	SHR.3 Interface Requirements	
38	SHR Stakeholder Requirements	
39	SHW.2.2.5.1	Operator shall request scanning of container by system

Figure 6. Stakeholder Requirements Table

Use Case Diagram

The primary actors are the ACSS Operator and ACSS Maintainer. The ACSS will automate the entire shipping process in a dock.

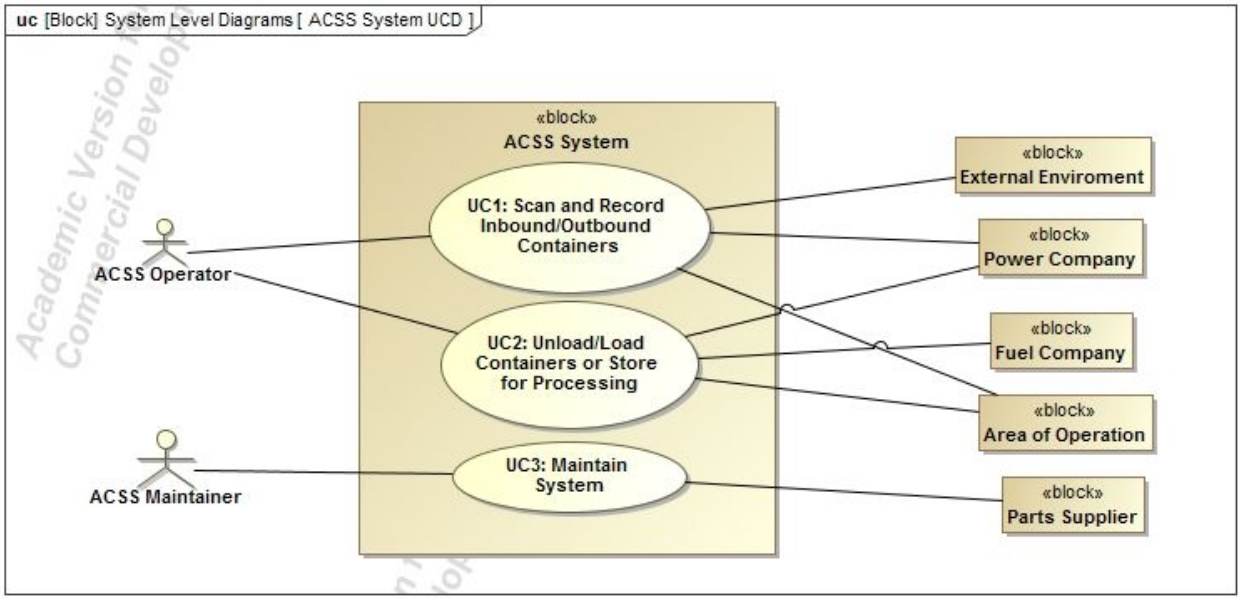


Figure 6: Use Case Diagram

Use Case Narratives

A use case narrative describes the interaction between actors and the system to achieve an end goal. It describes main success scenarios of use cases. This is where the system achieves its end goal. Use cases are started with a trigger. Situations where there are interruptions are called extensions.

Use Case Narrative: UC 2.1 Load Containers
Introductory Information

Use Case ID: UC 2.1
Use Case Name: Load Containers
Configuration Control Information: Version:1.1
Date: 3/24/18
Team Name: ACSS Group
Author: Rodrigo Pimenta
Approval Date: 10/1/17
Approver: Sri Saikrishna
Level: System/Element Level
Primary Actor(s):

ACSS Operator
ACSS Maintainer

Supporting Actor(s):

Supply Network
Transit Area

Precondition(s): Manufacturer wants to move container from storage to warehouse.ACSS system is operational. The storage area is open and ACSS Operator and ACSS Maintainer are there.

Post-condition(s):

Minimum Condition(s):

System Hardware is functioning

Success Condition(s):

ACSS completes task
ACSS updates database.

Trigger: When ACSS operator requests load of container.

Main Success Scenario (MSS):

1. The ACSS Operator (User) requests load of container in storage to warehouse.
2. The ACSS System Software locates specific container in storage area.
3. The ACSS System Hardware (Automated machines) retrieves container from its location in storage.
4. The ACSS System Hardware signals System Software container has been found.
5. The ACSS System Hardware (Automated machines) transports container to the warehouse requested by the ACSS Operator (User).
6. The ACSS Operator (User) signals System Software the container has been received and uploads information to the database.
7. End

Extensions:

Extension 1: E1a The ACSS System Hardware is at capacity and there are no Automated machines to load container.
Extension Trigger: The ACSS operator requests the load of container.
1a.1) Container load request is placed in a queue of System Software.
1a.2) Automated machines are sent to storage area when container is top priority in queue.

1a.3) Return to step 2 of MSS.

Extension 2: E2a System Hardware Critical Failure during processing of containers.
Extension Trigger: Automated machines assigned by System Software experiences a critical failure.

2a.1) ACSS System Software reports critical failure to ACSS maintainer.
2a.2) If other Automated Machines are available for use, they will be assigned to the container. If not, the ACSS operator will request manual load of container.
2a.3) Return to step 1 of the MSS.

Use Case Narrative: UC 2.2 Unload Containers
Introductory Information

Use Case ID: UC 2.1
Use Case Name: Load Containers
Configuration Control Information: Version:1.1
Date: 3/24/18
Team Name: ACSS Group
Author: Rodrigo Pimenta
Approval Date: 10/1/17
Approver: Sri Saikrishna
Level: System/Element Level
Primary Actor(s):

ACSS Operator
ACSS Maintainer

Supporting Actor(s):

Supply Network
Transit Area

Precondition(s): Operator wants to move container from port to storage. ACSS system is operational. The storage area is open and ACSS Operator and ACSS Maintainer are there.

Post-condition(s):

Minimum Condition(s):

System Hardware is functioning

Success Condition(s):

ACSS completes task
ACSS updates database.

Trigger: ACSS Operator (User) request to unload container from port to storage.

Main Success Scenario (MSS):

1. ACSS Operator requests unload from system software.
2. System Software requests system hardware (Automated machines) to scan container in port.
3. ACSS System Hardware returns its scan to system software.
4. ACSS System Software requests System Hardware (Automated machines) to move container to storage.
5. System Hardware (Automated machines) signals System Software Container has been moved.
6. End

Extensions:

Extension 1: E1a The ACSS System Hardware is at capacity and there are no Automated machines to load container.
Extension Trigger: The ACSS operator requests the unload of container.
1a.1) Container unload request is placed in a queue of System Software.
1a.2) Automated machines are sent to port area when container is top priority in queue.
1a.3) Return to step 2 of MSS.

Extension 2: E2a System Hardware Critical Failure during processing of containers.
Extension Trigger: Automated machines assigned by System Software experiences a critical failure.

2a.1) ACSS System Software reports critical failure to ACSS maintainer.
2a.2) If other Automated Machines are available for use, they will be assigned to the container. If not, the ACSS operator will request manual load of container.
2a.3) Return to step 1 of the MSS.

Top-Level System Requirements

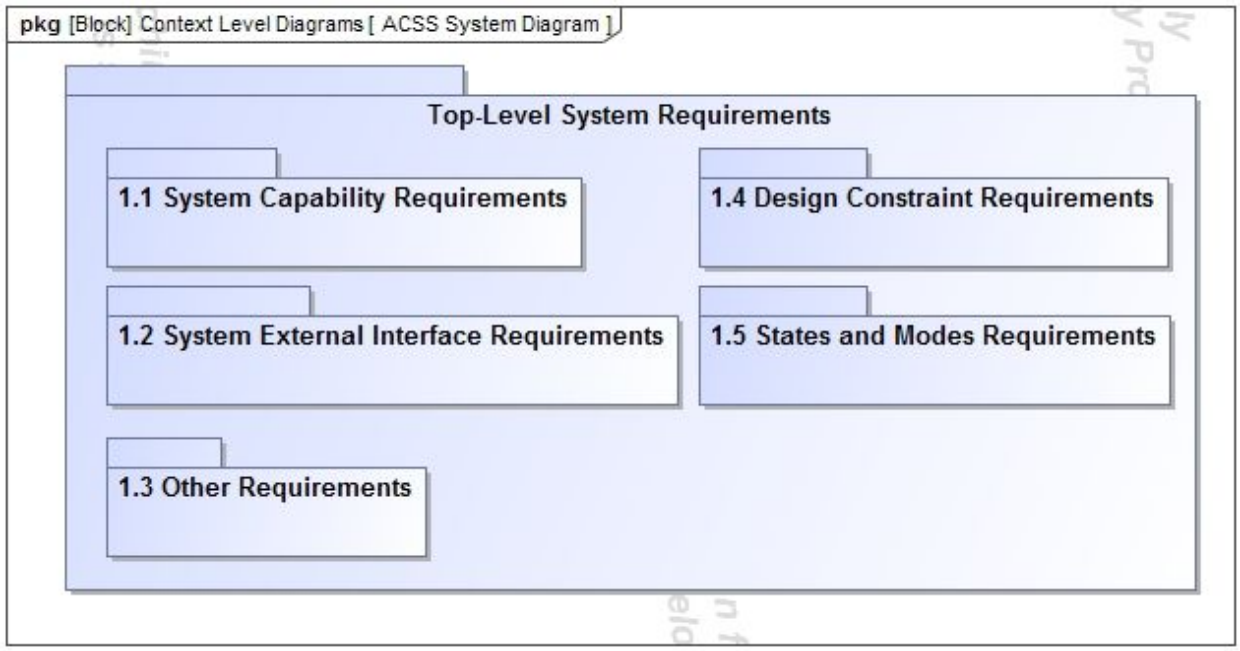


Figure 7. ACSS Package Diagram

System Capability Requirements

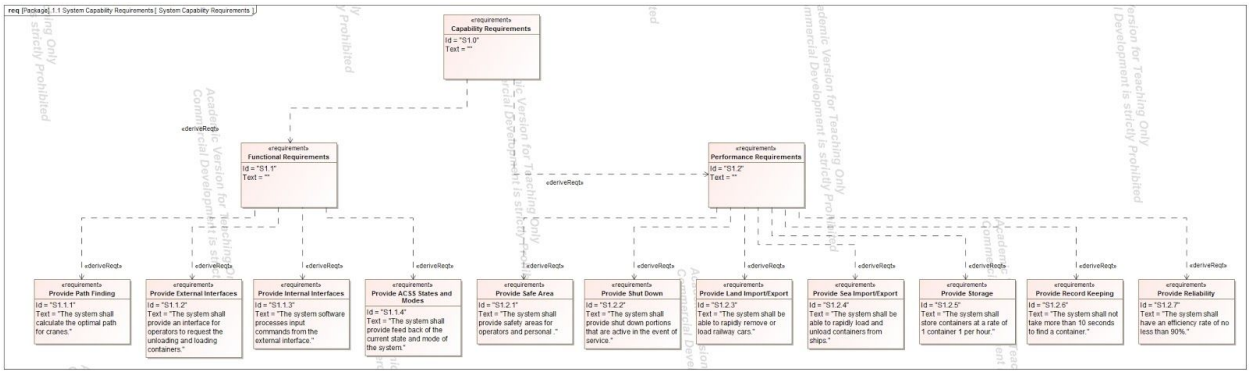


Figure 8. System Capability Requirements

System External Interface Requirements

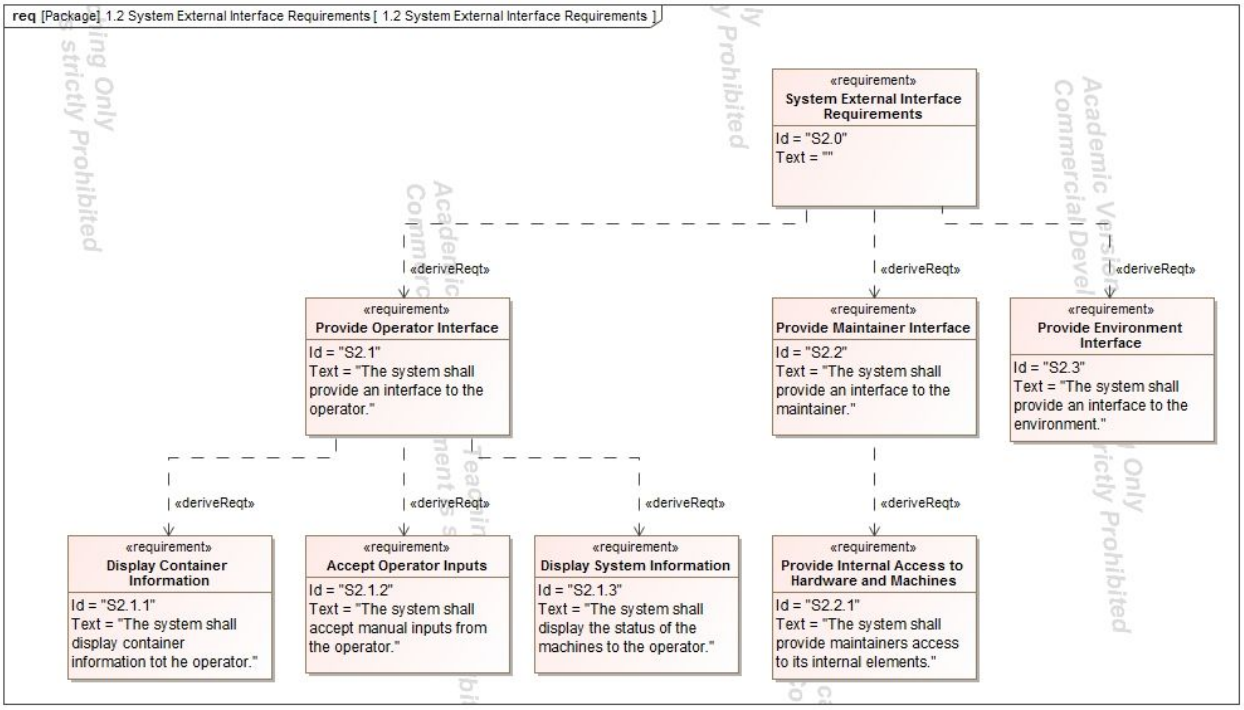


Figure 9. System External Interface Requirements

System Requirements Table with all System Requirements

System Requirements Table

#	Name	Text
1	S1.0 Capability Requirements	
2	S1.1.1 Provide Path Finding	The system shall calculate the optimal path for cranes.
3	S1.1.2 Provide External Interfaces	The system shall provide an interface for operators to request the unloading and loading containers.
4	S1.1.3 Provide Internal Interfaces	The system software processes input commands from the external interface.
5	S1.1.4 Provide ACSS States and Modes	The system shall provide feed back of the current state and mode of the system.
6	S1.1 Functional Requirements	

7	S1.2.1 Provide Safe Area	The system shall provide safety areas for operators and personal .
8	S1.2.2 Provide Shut Down	The system shall provide shut down portions that are active in the event of service.
9	S1.2.3 Provide Land Import/Export	The system shall be able to rapidly remove or load railway cars.
10	S1.2.4 Provide Sea Import/Export	The system shall be able to rapidly load and unload containers from ships.
11	S1.2.5 Provide Storage	The system shall store containers at a rate of 1 container 1 per hour.
12	S1.2.6 Provide Record Keeping	The system shall not take more than 10 seconds to find a container.

13	S1.2.7 Provide Reliability	The system shall have an efficiency rate of no less than 90%.
14	S1.2 Performance Requirements	
15	S2.0 System External Interface Requirements	
16	S2.1.1 Display Container Information	The system shall display container information tot he operator.
17	S2.1.2 Accept Operator Inputs	The system shall accept manual inputs from the operator.
18	S2.1.3 Display System Information	The system shall display the status of the machines to the operator.
19	S2.1 Provide Operator Interface	The system shall provide an interface to the operator.
20	S2.2.1 Provide Internal Access to Hardware and Machines	The system shall provide maintainers access to its internal elements.
21	S2.2 Provide Maintainer Interface	The system shall provide an interface to the maintainer.
22	S2.3 Provide Environment Interface	The system shall provide an interface to the environment.

Figure 10. System Requirements Table

System Structure

Overview

The primary users of the system are the ACSS Operators and ACSS Maintainers. They are external to the system.

The environment is comprised of the Area of Operation, the External Environment, the Fuel, and the Power(Electricity). The Area of Operation includes all the components that make up the system. The External Environment includes the variety of weather conditions that can affect the systems performance (for instance heavy snow). The Fuel includes forms of gasoline delivered to the system in order to power the automated mechanical parts. Finally, the Power(Electricity) includes the power lines that deliver electricity to the system, helping to power the electrical components.

Block Definition Diagram

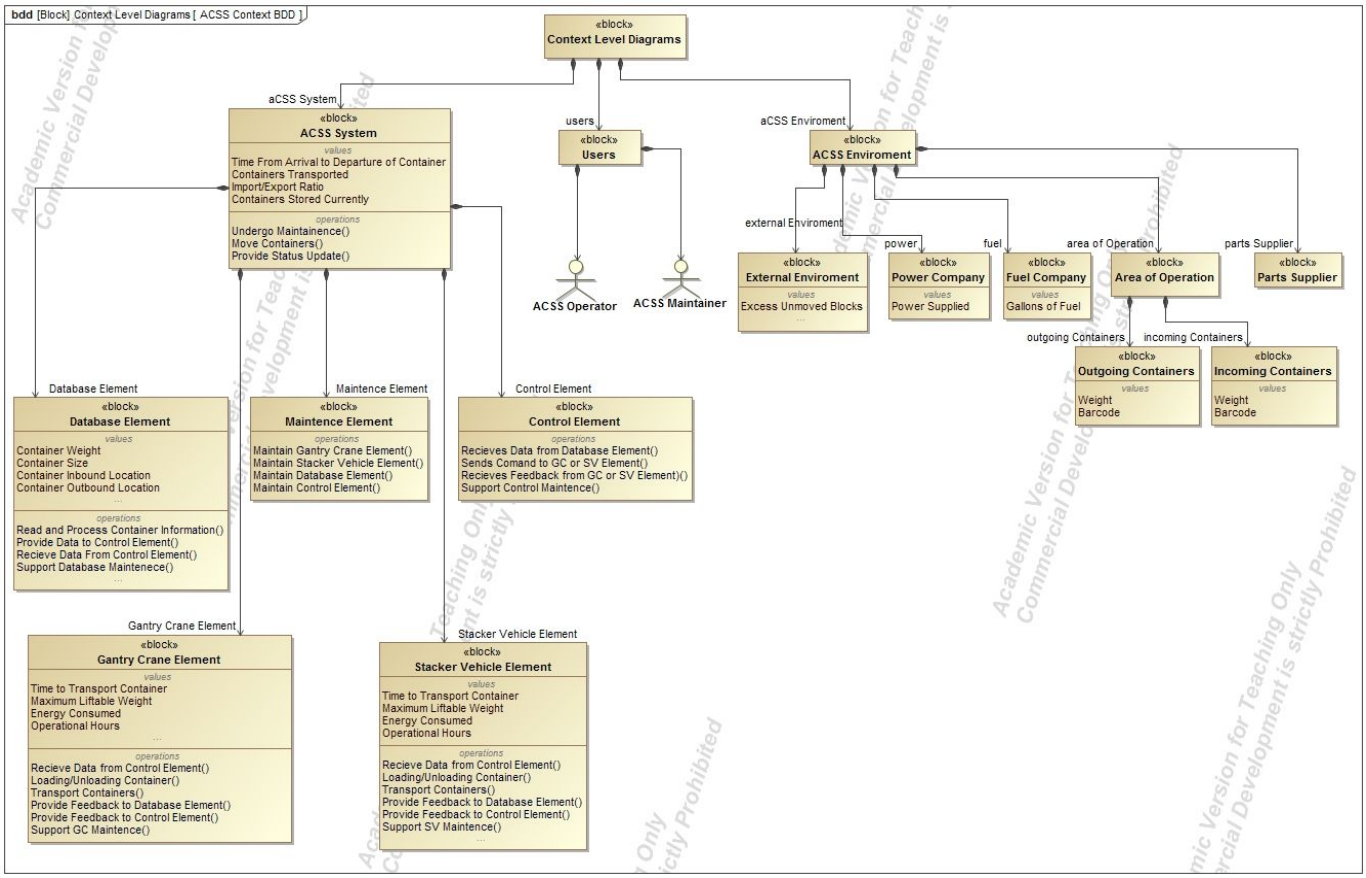


Figure 11. ACSS Domain BDD

Internal Block Definition Diagram

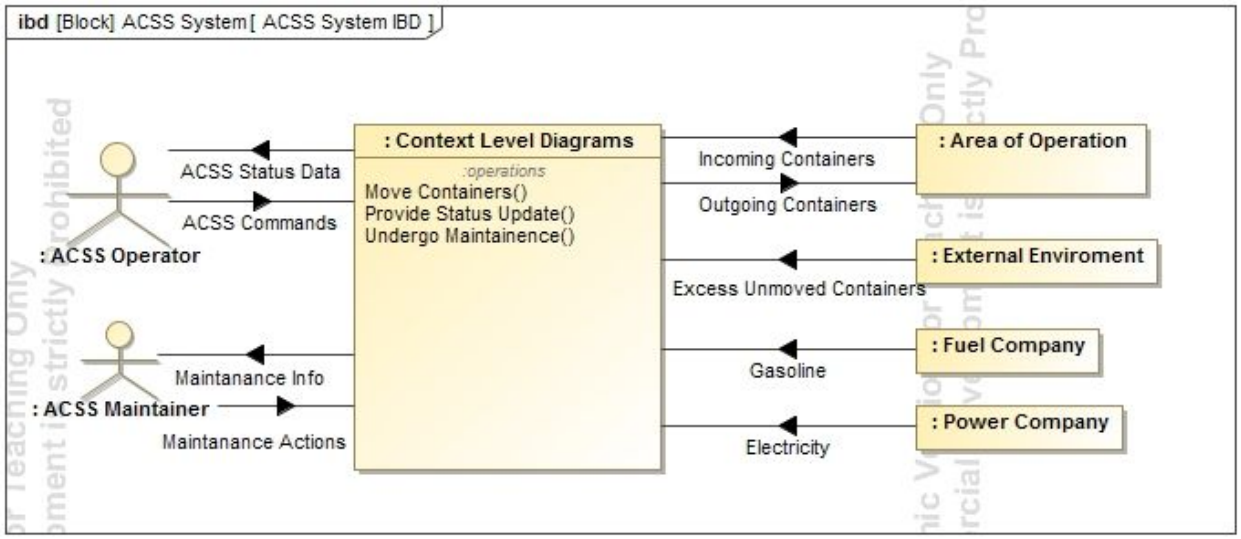


Figure 12. Internal Block Definition Diagram

Interface Flow Block Definition Diagram

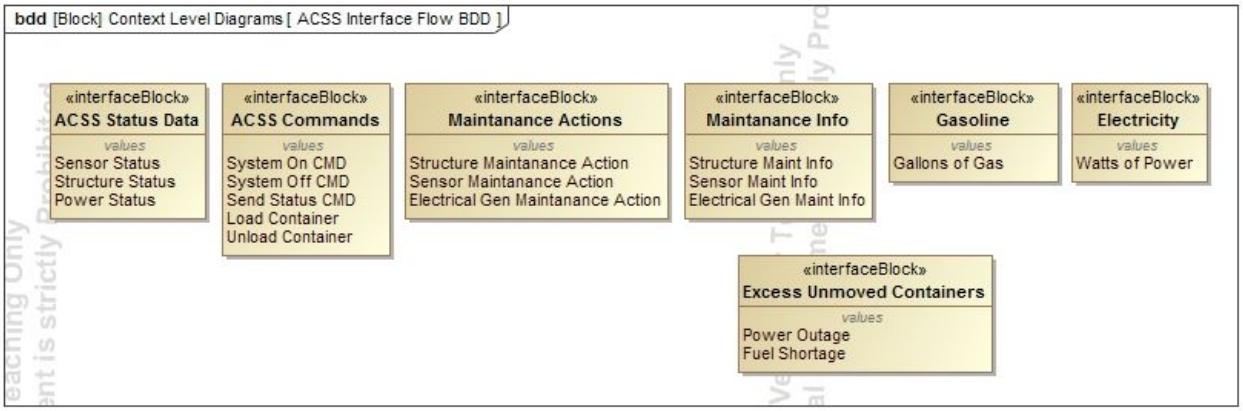


Figure 13. Interface Flow BDD

System Behavior

Sequence Diagram

Brief Description of the purpose of a Sequence Diagram

The purpose of the sequence diagrams is to show how the different blocks of the system communicate and interact. Every system has different major parts that have to interact in order

to function properly. This diagram shows how a block can input a command and another block processes and performs the task.

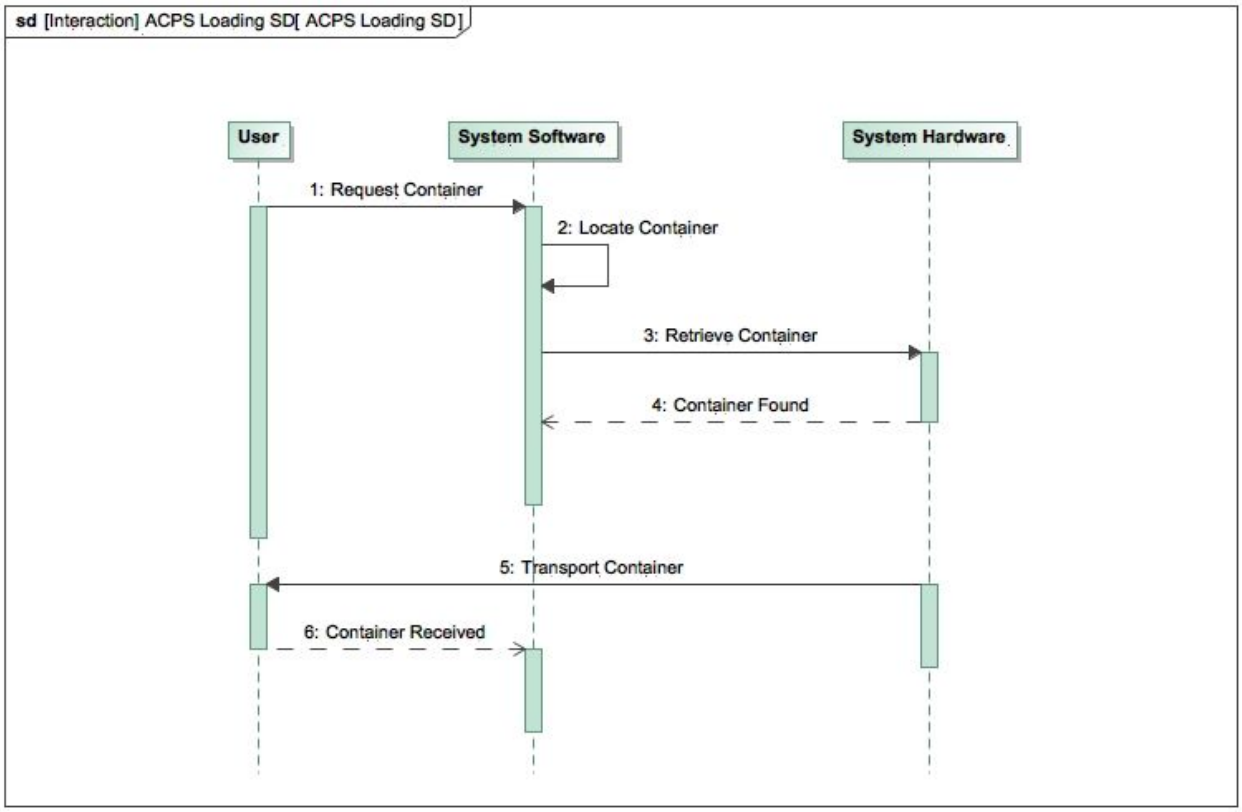


Figure 14. ACPS Loading SD

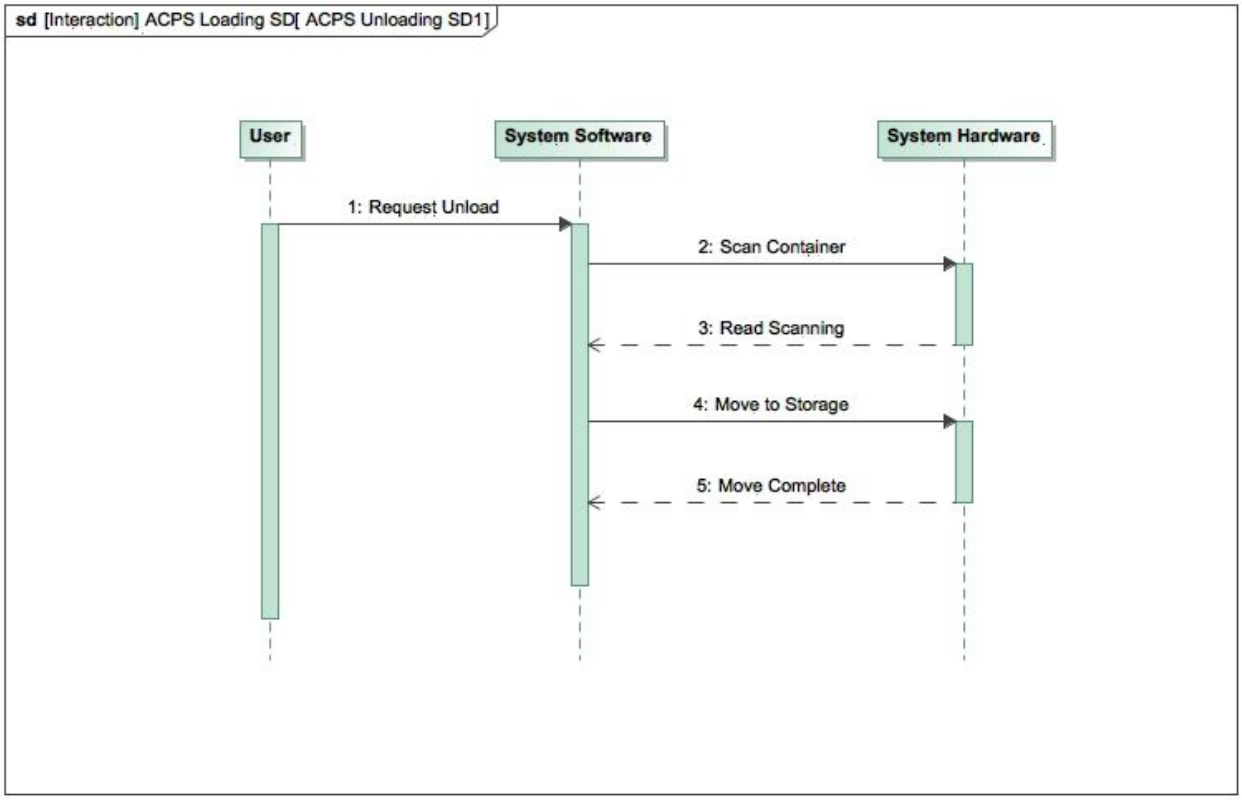


Figure 15. ACPS Unloading SD

Activity Diagram

Brief Description of the purpose of a Activity Diagram

The purpose of this activity diagram is to show the flow of actions through commands given to the system. Each command or input will result in an action that the system will complete. The activity diagram shows all the possible sequences of commands that the system can take, whether it is completing the task or failing to complete the task thus requesting maintenance.

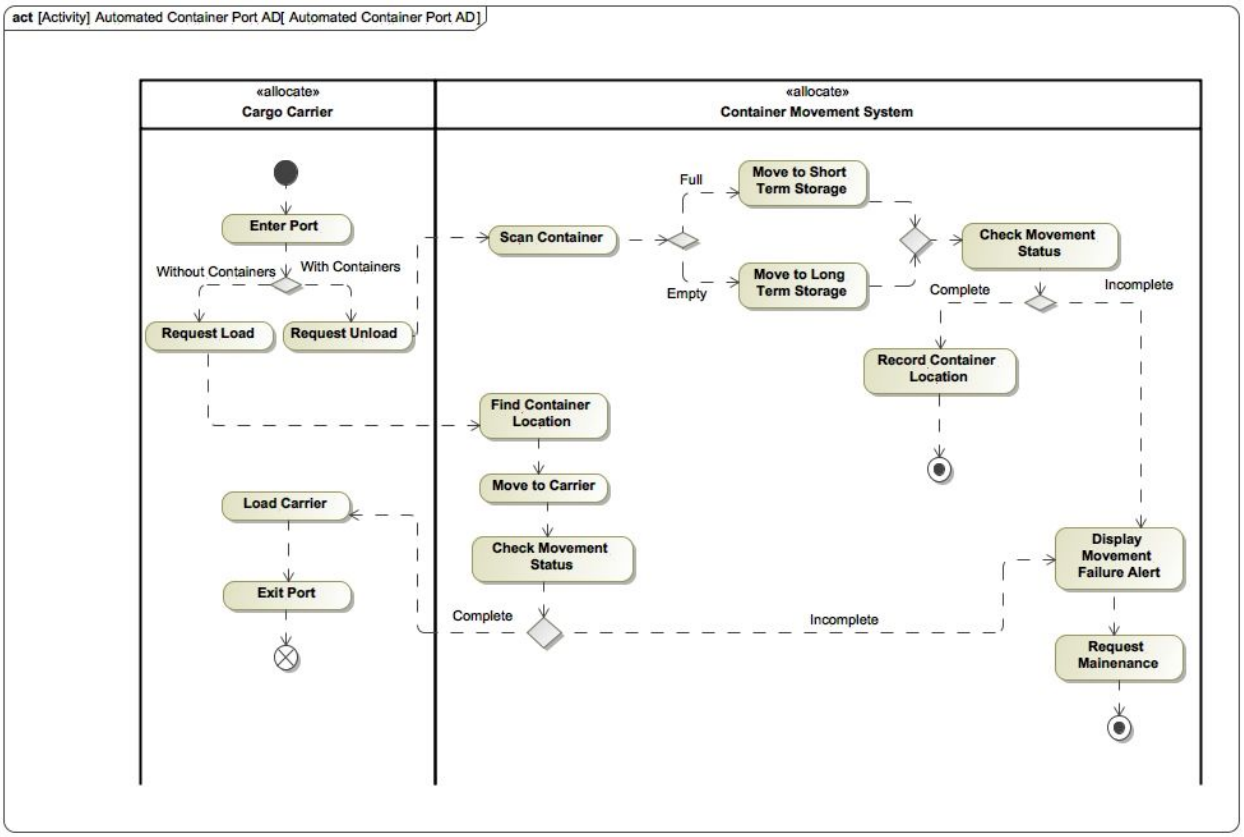


Figure 16. ACSS Automated Container Port Activity Diagram

Parametric Diagrams

Overview

The purpose of the parametric diagram below is to illustrate how the constraints placed on the values of the system interact and depend on one another.

Parametric Diagram

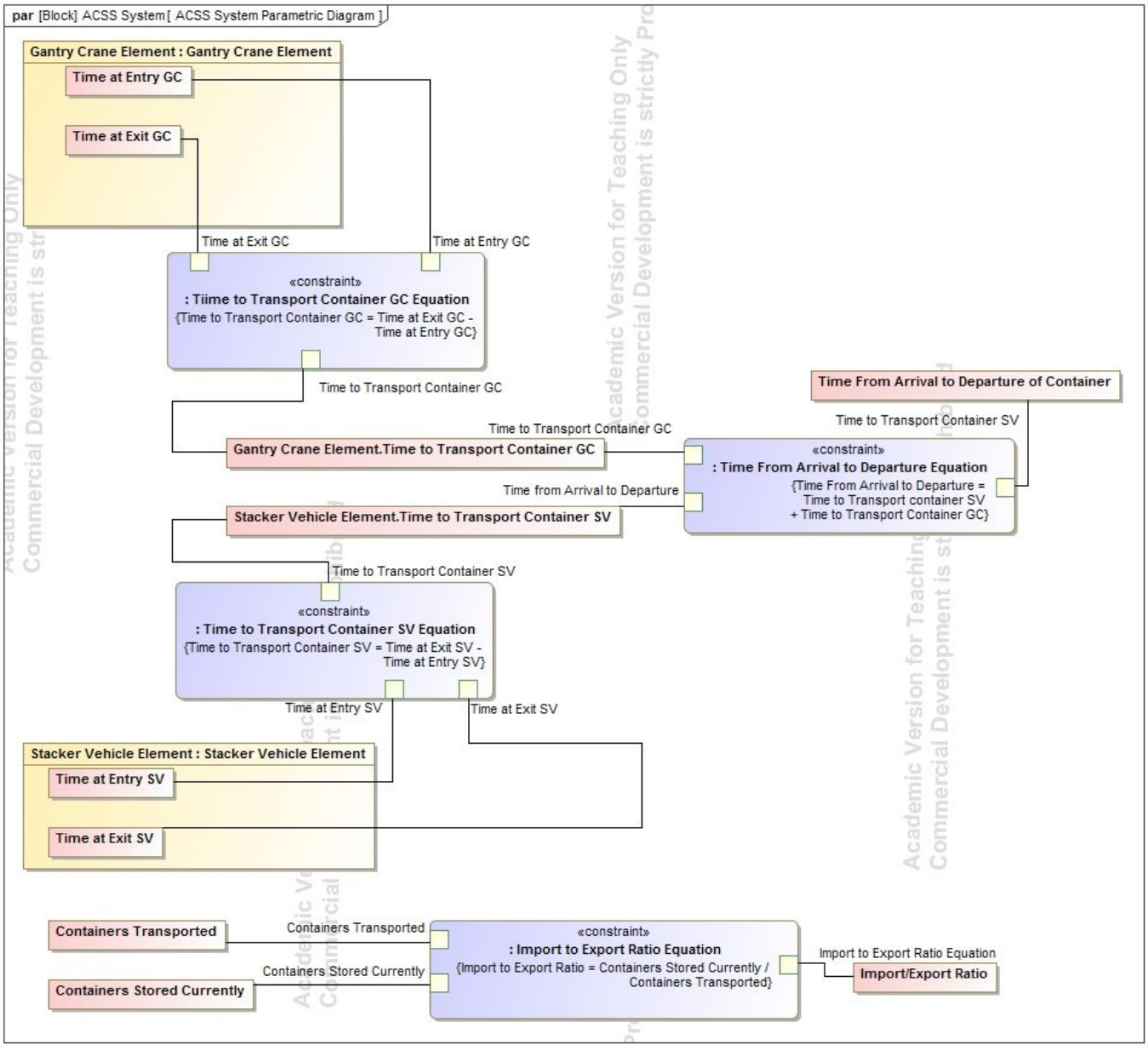


Figure 17. ACSS Parametric Diagram

Project Breakdown and Contributions

Green indicates the specified team member is responsible for the part indicated by the column header

Accountability Chart

Team Member	Problem Definition	Solution Domain Definition	Use Cases	System Requirements	Structure	Behavior	Parametric	Stakeholder Requirements
Sri								
Rodrigo								
Albert								
Alex								
Michael								
Mike								

Figure 18. Accountability Chart

References

[1] ENES489P HW5 System Concept Description and Architecture Template, John McCarthy, 2018

[2] ENES489P HW5 Example, John McCarthy, 2018

[3] INCOSE Systems Engineering Handbook

[4] "4 Cost-Saving Benefits of an Automated Shipping System." Conveyco, 28 Feb. 2018, www.conveyco.com/4-cost-saving-benefits-automated-shipping-system/.

Appendices

Appendix A: System Concept Tables

ID	Stakeholder	Role(s)
SH1	Logicure	Owner, Operator, Maintainer
SH2	Manufacturers	User

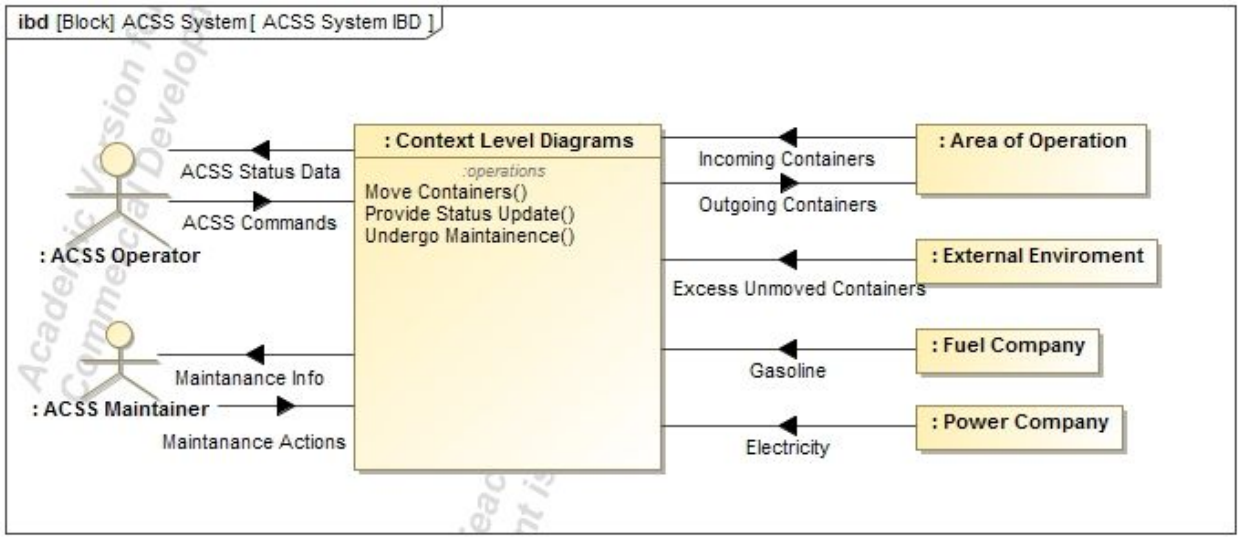
SH3	Consumers	User

Priority	Capability	Rationale
1	Unload containers upon operator request	Defines “unloading”
1	Log data regarding container identity	Defines “logging”
2	Transport containers to open storage location	Defines “storage”
1	Log data regarding container position within storage	Defines “logging”
2	Retrieve containers from storage location	Defines “storage”
1	Update data log to reflect newly open storage location	Defines “logging”
1	Load containers upon operator request	Defines “loading”
2	Notify manufacturer of location of container	Defines “notifying”

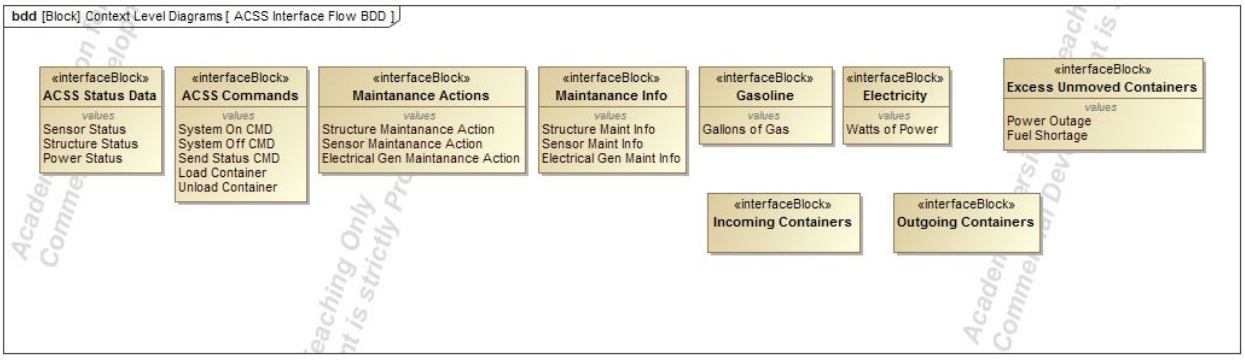
Attribute	Metric	Type	Definition	Threshold Value (w. units)	Rationale
Import rate	Import Rate (IR)	MOE	Containers unloaded per hour	~80 containers / hour	Assumption 1*
Storage rate	Storage Rate (SR)	MOE	Containers stored per hour	~20 containers / hour	Assumption 2*
Retrieval rate	Retrieval Rate (RR)	MOE	Containers retrieved from storage per hour	~20 containers / hour	Assumption 2*

Export rate	Export Rate (ER)	MOE	Containers loaded per hour	~80 containers / hour	Assumption 1*

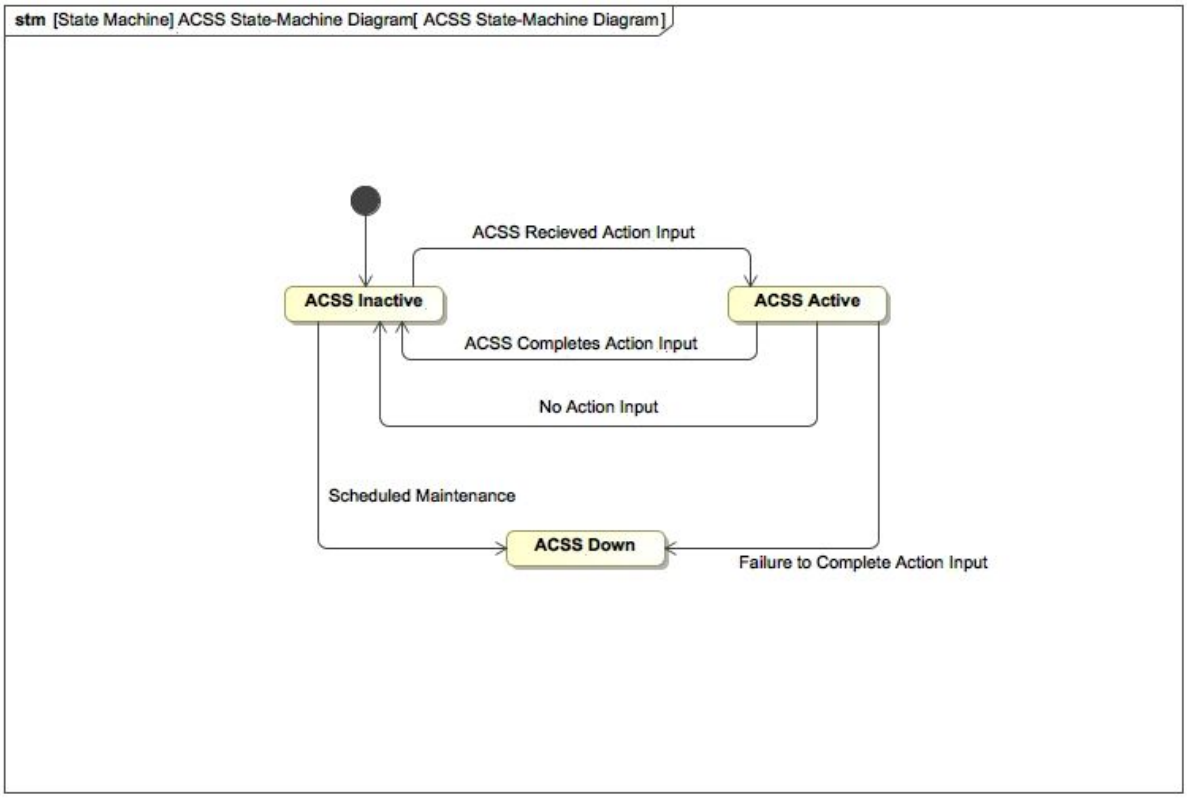
Appendix B: ACSS System Context Diagram IBD



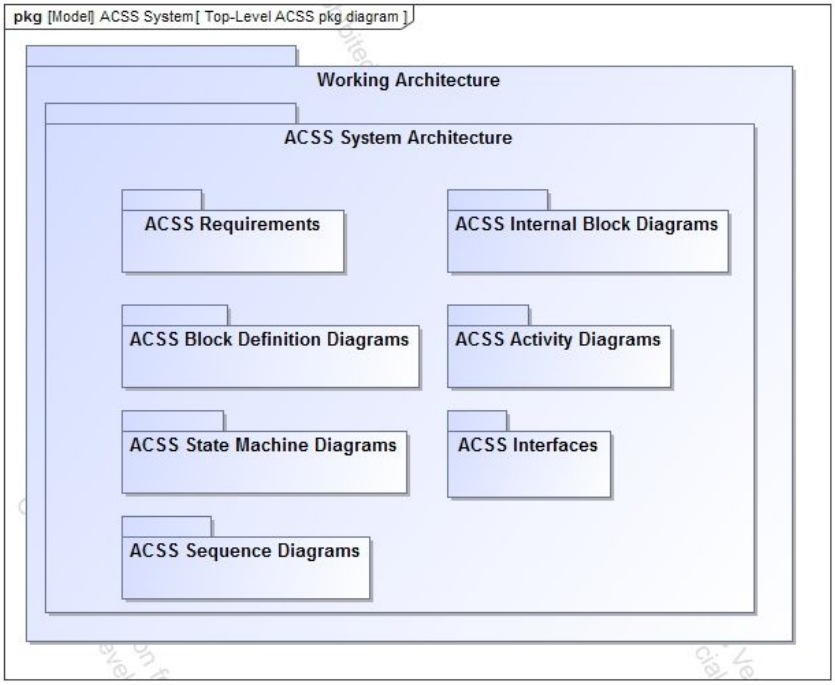
Appendix C: Interface Flow BDD for the ACSS Context Diagram IBD



Appendix D: ACSS State-Machine Diagram



Appendix E: Project System Architecture Framework



Appendix F: System Level Automated Container Shipping System BDD