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*California State University, Long Beach*

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Subject: Deliverable Number 0005, Southern California Agile Supply Network  
Report

Reference: Strategic Mobility 21 Contract N00014-06-C-0060

Dear Paul,

In accordance with the requirements of referenced contract, we are pleased to submit this Southern California Agile Supply Network Report for your review.

Your comments on this document are welcomed.

Regards,

A handwritten signature in black ink, appearing to read 'Lawrence G. Mallon', is written in a cursive style.

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Strategic Mobility 21 Program Manager

cc: Administrative Contracting Officer (Transmittal Letter only)  
Director, Naval Research Lab (Hardcopy via U.S. Mail)  
Defense Technical Information Center  
Stan Wheatley



**Strategic Mobility 21**  
**Southern California Agile Supply Network**  
**Simulation Model Architecture Report**  
**Contractor Report 0005**

**Prepared for:**

**Office of Naval Research**  
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**In fulfillment of the requirements for:**

**FY 2005 Contract No. N00014-06-C-0060**  
***Strategic Mobility 21 – CLIN 0005***

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**September 29, 2006**

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**TABLE OF CONTENTS**

**TABLE OF CONTENTS ..... ii**

**LIST OF FIGURES ..... iv**

**LIST OF TABLES ..... v**

**ABSTRACT..... vi**

**1.0 SOUTHERN CALIFORNIA AGILE SUPPORT NETWORK OVERVIEW ..... 1**

**1.1 Strategic Mobility 21 Project Background ..... 1**

**1.2 Southern California Agile Supply Network Simulation Model Overview ..... 1**

**1.3 Modeling Objectives ..... 2**

**1.4 General Terminology and Assumptions ..... 2**

**2.0 SUMMARY OF MODELING APPROACH ..... 4**

**2.1 Model Architecture ..... 5**

**3.0 SCASN MODEL ELEMENTS ..... 7**

**3.1 SCASN Physical Elements ..... 7**

**4.0 SCASN LOGICAL ELEMENTS ..... 10**

**5.0 SCASN FREIGHT FLOW REPRESENTATION..... 11**

**5.1 Scope of Freight Flows..... 12**

**5.1.1 Commercial Freight Flows..... 12**

**5.1.1.1 Primary Commercial Freight Flows ..... 12**

**5.1.2 Military Freight Flows..... 13**

**5.1.2.1 Primary Military Freight Flows ..... 13**

**5.1.3 Scenarios ..... 13**

**5.2 Run Period..... 14**

**6.0 SCASN IMPLEMENTATION ..... 15**

**6.1 System Requirements ..... 17**

**7.0 MODEL ARCHITECTURE BENEFITS ..... 18**

**8.0 SCASN SIMULATION MODEL ..... 19**

**8.1 Facility Element Capacity Parameters ..... 19**

**8.2 Transportation Lane Capacity Parameters..... 21**

**9.0 DATA COLLECTION PLAN ..... 23**

**10.0 INTRODUCTION TO DATA DEFINITION AND DATABASE DESIGN ..... 25**

**10.1 Listing of EDI Sets and Other Data Sets ..... 25**

**10.2 Information Center For SCASN Model..... 26**

**11.0 MODEL PERFORMANCE MEASURES..... 28**

**APPENDIX A: ACRONYMS ..... 29**  
**APPENDIX B: REFERENCES ..... 31**

**LIST OF FIGURES**

**Figure 1. SCASN Master Control Panel ..... 4**  
**Figure 2. SCASN Freight Flows to Support a Military Deployment Scenario ..... 6**  
**Figure 3. SCASN Freight Flowchart..... 11**  
**Figure 4. SCASN Three-Layer Architecture..... 16**  
**Figure 5. Integration Lab of JPPSP The Strategic Mobility 21 Network System ..... 27**

**LIST OF TABLES**

**Table 1. Mapping of SCASN Network..... 8**  
**Table 2. Cargo Transfer Between Facilities ..... 19**  
**Table 3. Transportation Lane Parameters ..... 21**  
**Table 4. Intermodal EDI Matrix ..... 26**



## ABSTRACT

The Southern California Agile Supply Network (SCASN) simulation model support is being developed to assist in demonstrating the viability of one or more Joint Power Projection Platforms (JPPSP)<sup>1</sup>. The SCASN simulation model described in this document provides the capability to create a “regional freight flow representation” to support “what if” freight movement strategies to be tested, analyzed, and communicated. The model will be used to prove how changes in infrastructure capacity, operating strategy, and level of information coordination can be used to more efficiently move current and projected freight volumes and relieve congestion through the region. The SCASN model is supported by two complementary models that provide input data. The Rail Dispatch Simulation Model developed by Leachman & Associates LLC, will provide the SCASN model with rail network capacity and average transit times for both commercial and surge military deployments. The SM21 Multi-modal Terminal Operating System Model simulates the JPPSP multi-modal terminal component and can be used to represent other terminal nodes within the regional network. The terminal modal is capable of modeling all modes of transportation including truck, rail, air, and intermodal. The Multi-modal terminal model will be used to develop transportation node input data to support the SCASN regional freight flow analysis. The SCASN simulation is developed using a flexible and extendible model framework that allows for a variety of freight flow strategies to be configured and tested. The model architecture will be multi-layered to provide dynamic simulation capabilities, a user interface, and internal database. This modeling “system” is known as the “Modeling Studio” in that it provides a “one stop” master control interface to conduct all modeling activities such as freight flow configuration, data storage, managing scenarios, and executing the simulation and animation runs.

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<sup>1</sup> The JPPSP is a dual-use (commercial and military) inland port designed to support rapid joint military deployment and sustainment requirements and the increasing volume of container imports through the San Pedro Bay, California ports. Additionally, the JPPSP is designed to mitigate the environmental, congestion, and other quality of life challenges associate with increased freight flow.

## **1.0 SOUTHERN CALIFORNIA AGILE SUPPORT NETWORK OVERVIEW**

### **1.1 Strategic Mobility 21 Project Background**

Southern California with its large port facilities in Los Angeles and Long Beach serves as a major US gateway for importing intermodal containers. With the continual growth of import containers, these port facilities are becoming saturated and strategies must be developed to move containers more efficiently from the Port to their regional or Continental US (CONUS) destinations. With current transportation technology, import containers must be primarily moved from the port via highway (truck) or rail (train). The various highway links within this corridor are already impacted with heavy passenger and truck traffic and there is strong interest in removing the trucks from the region's highways. The existing rail links in Southern California to the continental US also pose challenges in that they must move trains across geographical areas that have significant elevation and at-grade crossing causing traffic slowdowns.

To maintain Southern California as a significant gateway for intermodal transportation, new system strategies must be developed to support the projected traffic volumes. Concepts such as the Strategic Mobility 21 (SM21), Southern California Agile Support Network (SCASN) are being developed to provide a regional freight movement system that supports the efficient movement of containers from the ports to their destination.

SM21 presents a formal concept of a prototype Joint Power Projection Support Platform (JPPSP), which is planned for the former George Air Force Base near Victorville, California. SM21 is an operational level concept that merges planning and execution of both commercial freight operations and the deployment and sustainment of joint military forces within a single construct of the JPPSP. The JPPSP, as a single node in Southern California supply chain network, will be able to seamlessly integrate with, and support the end-to-end distribution network. The JPPSP is designed as a major regional inland facility that provides significant intermodal support by providing rail, highway, and air freight access to and from the region. The JPPSP was initiated as a dual-use concept designed to support military deployments and their unique supply and consolidation requirements and commercial movements. The JPPSP concept relies on the region as a “system” in that it synchronizes activities across multiple facilities such as regional military nodes, marine terminals, intermodal container transfer facilities, and others.

### **1.2 Southern California Agile Supply Network Simulation Model Overview**

To assist in demonstrating the viability of one or more networked JPPSPs supporting regional freight flows, a simulation model can provide the ability to quantify and communicate the capacity of the regional freight movement system. The SCASN simulation model that is described in this document provides the capability to create a “regional freight flow representation” that allows for different “what if” freight movement strategies to be tested, analyzed, and communicated.

The SCASN simulation model is also supplemented by another SM21 multi-modal terminal operating system model. This model was developed to simulate the JPPSP multi-modal operations including terminal control, gate operation, and container yard allocation. The

terminal operating system is capable of modeling all modes of transportation including truck, rail, air and intermodal. The multi-modal terminal operating system will provide data input to the SCASN model. Likewise, the SCASN simulation model will provide flow rate inputs to the multi-modal terminal operating system.

### 1.3 Modeling Objectives

The objective of SCASN is to create a regionally based supply network freight flow representation within a simulation model that can be used to:

*“Prove how changes in infrastructure capacity, operating strategy, and level of information coordination can be used to more efficiently move current and projected freight volumes and relieve congestion through the region of Southern California”*

In other words, the model and networks of this project are designed, so they can be efficiently connected together to explore the impact of local, regional, and transcontinental freight movement demands upon port terminal operations. Furthermore, the SCASN model will be able to support inland terminal activities with transportation corridor connections between the ports of LA/LB and the inland hub of Victorville. Where possible, the SCASN model will leverage and supplement capacity modeling efforts including the Rail Dispatch Simulation Model developed by Leachman & Associates LLC and the SM21 Multi-modal Terminal Operating System Model.

### 1.4 General Terminology and Assumptions

The following brief dictionary is provided to clarify some of the terms used in this document:

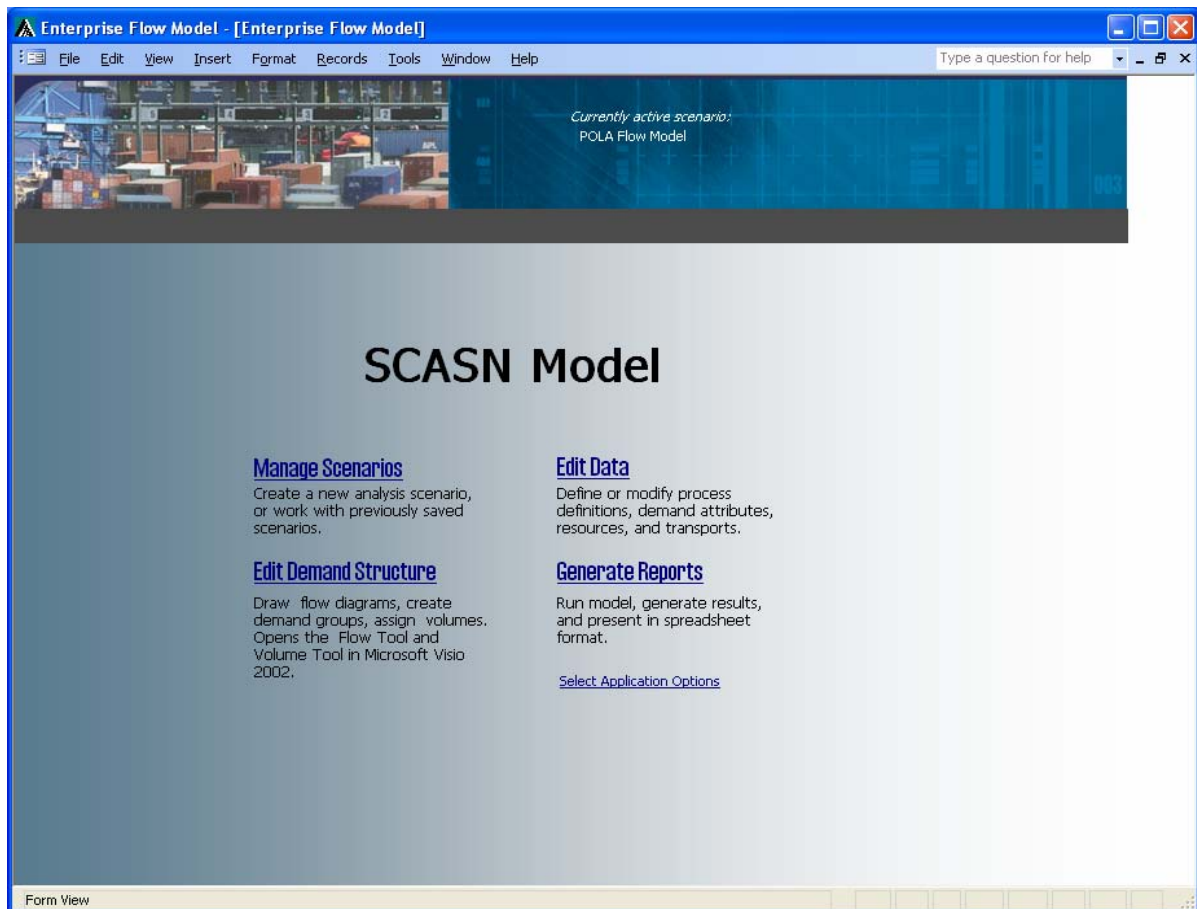
- **Inbound Movement:** An import container that arrives by vessel and is destined for local, regional, or transcontinental destinations.
- **Outbound Movement:** A container that leaves by vessel that originates from local, regional, or transcontinental sources.
- **Short Haul:** Short haul implies traversing distances of 400 miles or less from start to destination.
- **Long Haul:** Long haul refers to distances over 400 miles to reach final destination. Long haul implies traversing a state or a country.
- **Efficient On-dock Rail:** An operating concept that uses one or more on-dock rail magazine pairs to enable direct vessel-to-rail or rail-to-vessel loading. Simultaneous vessel loading and discharge is performed where possible with rapid vessel turn around times.
- **Conventional Rail:** A more traditional operating concept that uses on-dock terminal rail, but requires for all vessel discharges to occur prior to vessel loading. Also, all moves to/from a vessel require some terminal yard storage—direct vessel to rail moves is not possible.

- Inland Terminal: A facility that is remote from the Port and is designed to perform many of the container sorting, storage, and rail support activities to maintain efficient port terminal operations.
- Port Buffer Storage Area: A common port maintained facility that is designed to support terminal activities such as consolidating rail cars into train trips for transport via the corridor, etc.
- Destinations: A generalized view of container destinations that includes:
  1. Local: Those containers that are shipped to very close destinations (within twenty miles of the terminal) or those that leave the terminal very quickly due to expedited conditions, etc.
  2. Regional: Those containers that are destined for one of a handful of general Southern California “zones”.
  3. Transcontinental or Continental US: Those containers that are destined for other areas other than the Southern California region. These containers are assumed to be processed at a remote, inland terminal prior to being moved to various US destinations.

## 2.0 SUMMARY OF MODELING APPROACH

To support the model objectives, a flexible and extensible model framework has been designed to support the configuration and testing of a variety of freight flow strategies. To accomplish this, the architecture will be multi-layered providing dynamic simulation capabilities along with a user interface and an internal database. This modeling “system” called the Modeling Studio provides a “one stop” master control interface for all modeling activities such as freight flow configuration, data storage, managing scenarios, and running the simulation model and animation.

The modeling tool used by the SCASN is called the ‘Transportation Modeling Studio’ (TMS) toolkit. This toolkit provides a dynamic framework to represent inbound/outbound movements along rail corridors, and track the number of “conflicts”, or move to sidings that occur for trains traveling in opposite directions along the corridor. Using the TMS toolkit, individual segments can be defined that comprise lengths of rail along each route, including timeframe restrictions for each segment, to ensure the accuracy of the simulated travel time between locations. The TMS will also provide a schematic 2-D animation of rail movements. Figure 1 shows the control panel of the SCASN model - TMS. The input edit function is built upon the Microsoft Excel spreadsheet. The modeling networks are configured using the Rockwell Arena Simulation Tool.



**Figure 1: SCASN Master Control Panel**

This modeling approach has been developed as a result of creating modeling systems for a variety of industrial and transportation applications. From developing modeling systems, such as this where a variety of scenarios need to be configured, the ability to interact with the model via the user interface is just as critical as developing the simulation model itself. This approach allows for the integration of a user interface with a modeling engine to support analysis activities. A primary input for this modeling studio is a flowchart type of application where the definition of freight flows and volumes will be synchronized with regional facility definitions and data.

A simulation model will be developed to represent all of the physical facilities within this model including terminals and transportation links such as rail and highway connections between them. The emphasis of the simulation model will be to provide a “system level” representation such that impact of different freight flow strategies and volumes may be analyzed as they move from their sources (vessels, inland nodes) through the various facilities needed to move out of the region or to their destinations.

To accomplish this, the level of details to represent the transportation links and facilities in the model will be at a “high level”, in that explicit representation of all the timing and interaction details (rail link signal control, roadway intersection control, etc.) that actually occur within the regional infrastructure are not needed. The model will include the timing aspect of traffic volumes as they move through the region using facility throughput rates, transportation link level of service data tables, and generalized capacity parameters.

## **2.1 Model Architecture**

The SCASN model architecture will allow for a large variety of regional freight flows to be represented. The architecture is organized using a supply network modeling orientation where various network elements can be defined and linked together to define a freight flow representation (arc). These elements serve as regional “building blocks” such that a wide variety of strategies and infrastructure configurations may be represented. For example, to represent the potential range of military freight flows, the following diagram depicts the outbound range and types of flows and the various facilities that may be envisioned to support a deployment plan. In a similar fashion, the major commercial flows could be depicted in both directions using these same elements. Figure 2 shows the SCASN freight flows to support a military deployment scenario.

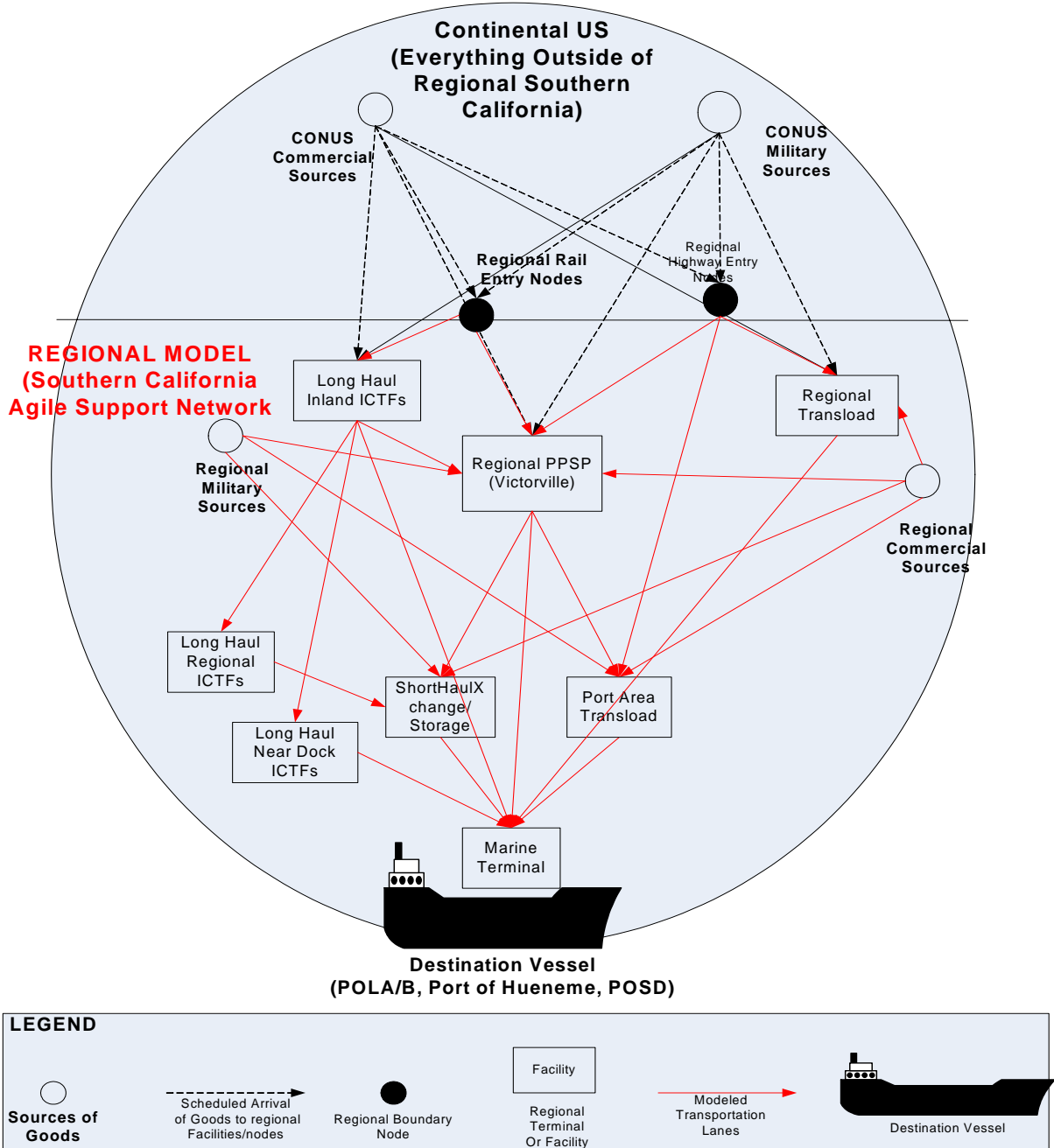


Figure 2. SCASN Freight Flows To Support A Military Deployment Scenario

### **3.0 SCASN MODEL ELEMENTS**

The SCASN model elements to support regional freight flow definitions, has both “physical” and “logical” element categories. Physical elements are mostly those that imply infrastructure availability and capacity. Logical elements can be thought of as strategies, plans, or schedules that are imposed on the physical elements to move freight. The organization of the network’s physical and logical elements serves to create a regional “Freight Flow Representation”. This Freight Flow Representation is the basis for the dynamic simulation, which will be used to define the flow of cargo “entities” and trips through the network.

#### **3.1 SCASN Physical Elements**

##### **I. Sources**

1. CONUS Military
2. CONUS Commercial
3. Regional Military
4. Regional Commercial
5. Port Terminal

##### **II. Facilities**

1. JPPSP
2. Marine Terminal
3. ICTF
4. Transloading/Warehouse
5. Others (security, customs or other facility in network )

##### **III. Regional Nodes**

1. Regional Facilities
2. Entry Nodes
3. Regional Sources

##### **IV. Transportation Lanes**

1. Road
2. Rail
3. Others

##### **V. Destinations**

1. CONUS Military
2. CONUS Commercial
3. Regional Military
4. Regional Commercial
5. Port Terminal

The level of representation of each of these physical elements will be different. The “Facilities and Transportation Lanes” elements will all have some degrees of input differences as follows:



- Capacity volume
- Level of service
- Throughput representation

The regional nodes will most likely be the physical geographical locations that are used to create boundaries and conditions for transportation lanes or as entry/exit points within the region and will not have capacity details associated with them. Many physical elements, such as facilities, are also regional nodes (because they have capacity and physical geographical locations).

The current scope of the SCASN network includes numerous sources, nodes and facilities. The SCASN model will be focusing on those facilities associated with intermodal containerized freight (especially for the commercial flows). The mapping of the SCASN network into the physical elements is outlined in the following table 1:

**Table 1. Mapping of SCASN Network**

<b>Physical Element</b>	<b>Type</b>	<b>SCASN Mapping</b>
Source	Regional Military	Ft. Irwin NTC
Source	Regional Military	29 Palms MAGTF
Source	Regional Military	Concord NWS
Source	Regional Military	NEBO/Yermo (DLA retrograde)
Source	Regional Military	DLA San Joaquin
Source	Regional Military	Camp Pendleton
Source	CONUS Military	Ft. Lewis
Destination	Port	Port of Los Angeles
Destination	Port	Port of Long Beach
Destination	Port	Port of Hueneme
Destination	Port	Port of San Diego
Facility	JPPSP	Former George AFB (SCLA)
Facility	PPSP	Norton AFB San Bernardino
Facility	PPSP	March AF Reserve Base Riverside
Facility	ICTF	UP Inland
Facility	ICTF	BNSF Near Dock POLA
Facility	ICTF	BNSF Hobart Regional
Facility	ICTF	BNSF San Bernardino Inland
Facility	ICTF	BNSF Barstow Inland
Facility	ICTF	UP East LA Regional
Facility	ICTF	UP City of Industry Regional
Facility	ICTF	UP LATC Near Dock
Facility	ICTF	UP Commerce Regional
Facility	ICTF	UP Colton Inland
Facility	ICTF	UP Daggett Inland

<b>Physical Element</b>	<b>Type</b>	<b>SCASN Mapping</b>
Facility	Transload/Warehouse	DC Near Dock
Facility	Transload/Warehouse	DC Downtown LA
Facility	Transload/Warehouse	DC Ontario/Colton
Facility	Transload/Warehouse	DC OC
Facility	Marine Terminal	ITS K line
Facility	Marine Terminal	POSD Tenth Avenue
Facility	Marine Terminal	National City
Transportation Lane	Road	I-710
Transportation Lane	Road	I-110
Transportation Lane	Road	I-10
Transportation Lane	Road	I-15
Transportation Lane	Road	I-5
Transportation Lane	Road	I-405
Transportation Lane	Road	I-605
Transportation Lane	Road	I-210
Transportation Lane	Road	I-215
Transportation Lane	Road	I-40
Transportation Lane	Road	SR395
Transportation Lane	Road	SR18
Transportation Lane	Rail	Alameda Corridor
Transportation Lane	Rail	PHL Switch/Short line
Transportation Lane	Rail	BNSF Main Line
Transportation Lane	Rail	BNSF San Diego
Transportation Lane	Rail	UP Alhambra
Transportation Lane	Rail	UP San Gabriel
Transportation Lane	Rail	UP Palmdale
Transportation Lane	Rail	UP Port Hueneme
Transportation Lane	Rail	Metrolink
Transportation Lane	Rail	UP Central Valley
Transportation Lane	Rail	BNSF Central Valley
Transportation Lane	Rail	UP Yuma
Transportation Lane	Rail	BNSF Mojave
Transportation Lane	Rail	BNSF Needles
Transportation Lane	Rail	UP Las Vegas

## 4.0 SCASN LOGICAL ELEMENTS

The logical elements represent the strategy, rules, and policy that are used to move freight through the region. To accomplish this, most logical elements will need to reference or use the SCASN physical elements. The following logical elements are a part of the SCASN modeling system:

1. **Sourcing Strategy:**

This includes schedule and location (regional or CONUS) where freight volumes arrive in the region. For commercial flows, the primary sources of freight will be vessels at marine terminals for eastbound moves and regional nodes for westbound moves, both of them will be represented by a volume and schedule/ time. For military flows, the primary sources will be military facilities inside or outside the region. If CONUS arrivals to the region, the SCASN model will not explicitly represent the physical elements (infrastructure) outside the region — it is assumed that this freight arrives to a regional node without constraint at the scheduled time.

2. **Transportation Strategy:**

This is the set of facilities and transportation lanes that are used to move cargo through the region, which includes the entire “path” that the cargo takes from source to destination and all the physical elements in between. It is envisioned that there may be a primary and alternate path for a freight flow that is a part of the transportation strategy. This can be used to prefer the rail to the road, or to show alternate paths if there is a disruption scenario, or others.

3. **Inventory Policy:**

To support military scenarios (or commercial ones as necessary), there is a possibility that there may be inventory policies in effect where target stock levels of certain materials may be maintained at one or more regional facilities. This could represent vendor managed inventory scenarios, terminal operator contracts/preference or others.

## 5.0 SCASN FREIGHT FLOW REPRESENTATION

The SCASN physical and logical elements will be organized to create a Freight Flow Representation and will serve as the basic structure for the simulation model. The simulation model will use this information to perform all calculations and timing events of freight movement through the region. The Freight Flow Representation can be thought of as a type of “flowchart” where the physical elements are where “processes” occur and the connections in the flowchart can be thought of as the transportation lanes that are collectively created to form a transportation network.

An example of what this might look like is depicted in the following flowchart. The rectangular boxes are facilities in the region and the lines are transportation lanes connecting them. The transportation lanes may actually represent multiple options (like using BNSF or UP for a particular rail connection, etc.)

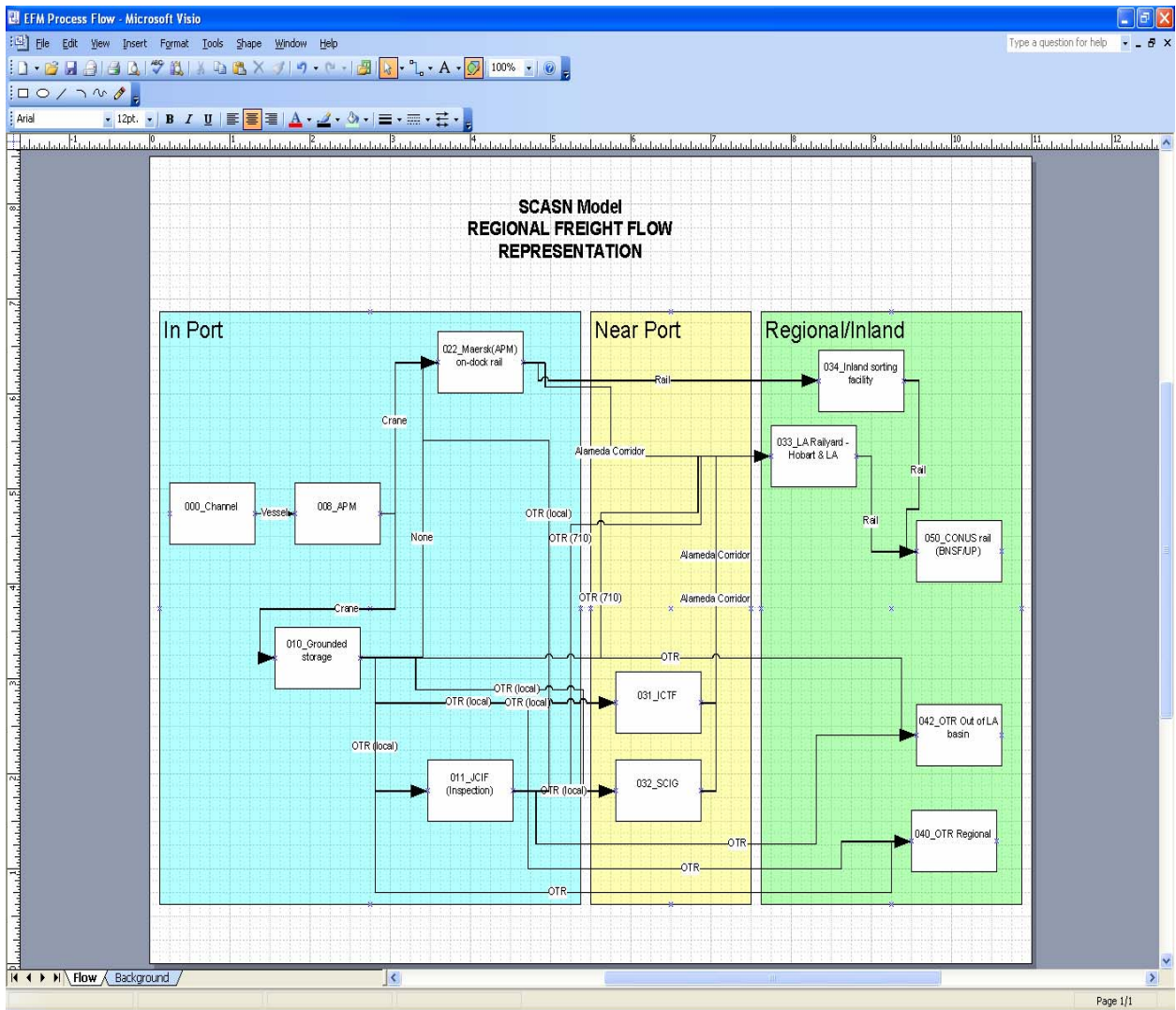


Figure 3. SCASN Freight Flowchart

Also, in association with this flowchart, but not visible here, is an internal database that provides the additional information and detail not displayed on the flowchart. This includes facility parameters, transportation lane data and other information.

## 5.1 Scope of Freight Flows

Generally, cargo will flow to/from or through three different geographic areas. Local areas are the areas directly surrounding the marine terminals served by truck only. The regional area is everything included in this modeling effort and transcontinental or CONUS is the area outside the region that feed or receives cargo at the external nodes.

### 5.1.1 Commercial Freight Flows

The type of freight flows envisioned for the commercial volumes include both inbound (imports) and outbound (exports and empties) between regional ports and either regional or CONUS destinations. The freight will enter and exit the model at either a regional facility (regional traffic) or node or at a regional boundary node (CONUS traffic). The primary modes of transportation in the region to be modeled are rail and road (OTR); other modes (air) can be included as needed. The SCASN model scope will focus on intermodal freight flows for this project. The following type of commercial freight flows are envisioned for this project—others can be added as necessary. For illustrative purposes, commercial flows are shown in one direction (eastbound). The model will flow commercial cargo in both directions. Military cargo will only be modeled in the westbound direction. During the prototyping and later phases of this project, the primary or necessary flows will be identified and included as needed.

#### 5.1.1.1 Primary Commercial Freight Flows

##### 1. Port to Local Destinations

- a. Marine Terminal → OTR → Destination
- b. Marine Terminal → OTR → Transload → OTR → Destination

##### 2. Port to Regional Destinations

- a. Marine Terminal → OTR → Transload → OTR → Destination
- b. Marine Terminal → OTR → ICTF → Transload → OTR → Destination
- c. Marine Terminal → Rail → JPPSP → Transload → OTR → Destination

##### 3. Port to Transcontinental/CONUS Destinations

- a. Marine Terminal → OTR → ICTF → Rail → Exit Region
- b. Marine Terminal → OTR → ICTF → Rail → ICTF → Rail → Exit Region
- c. Marine Terminal → OTR → ICTF → Rail → ICTF → OTR → Transload → OTR → Exit Region
- d. Marine Terminal → OTR → ICTF → Rail → JPPSP → Rail → Exit Region
- e. Marine Terminal → OTR → ICTF → Rail → JPPSP → OTR → Exit Region
- f. Marine Terminal → OTR → ICTF → Rail → JPPSP → OTR → Transload → OTR → Exit Region
- g. Marine Terminal → OTR → Transload → OTR → Exit Region

- h. Marine Terminal → OTR → Transload → OTR → ICTF → Rail → Exit Region
- i. Marine Terminal → OTR → Transload → OTR → PPSP → Rail → Exit Region
- j. Marine Terminal → Rail → ICTF → Rail → Exit Region
- k. Marine Terminal → Rail → ICTF → OTR → Exit Region
- l. Marine Terminal → Rail → ICTF → OTR → Transload → OTR → Exit Region
- m. Marine Terminal → Rail → ICTF → Rail → PPSP → Rail → Exit Region
- n. Marine Terminal → Rail → ICTF → Rail → PPSP → OTR → Exit Region
- o. Marine Terminal → Rail → JPPSP → Rail → Exit Region
- p. Marine Terminal → Rail → JPPSP → OTR → Exit Region
- q. Marine Terminal → Rail → JPPSP → OTR → Transload → OTR → Exit Region

### 5.1.2 Military Freight Flows

The type of freight flows envisioned for the military volumes are mostly outbound from regional or CONUS sources to port vessels.

#### 5.1.2.1 Primary Military Freight Flows

##### 1. Local Origin to Port

- a. N/A

##### 2. Regional Origin to Port

- a. Regional Military Node → OTR → Marine Terminal
- b. Regional Military Node → OTR → JPPSP → OTR → Marine Terminal
- c. Regional Military Node → OTR → JPPSP → Rail → Marine Terminal
- d. Regional Military Node → Rail → JPPSP → OTR → Marine Terminal
- e. Regional Military Node → Rail → JPPSP → Rail → Marine Terminal

##### 3. CONUS Origin to Port

- a. CONUS Military Node → OTR → JPPSP → OTR → Marine Terminal
- b. CONUS Military Node → OTR → JPPSP → Rail → Marine Terminal
- c. CONUS Military Node → Rail → JPPSP → OTR → Marine Terminal
- d. CONUS Military Node → Rail → JPPSP → Rail → Marine Terminal

### 5.1.3 Scenarios

The model will support both military and commercial freight flows. A scenario will most likely consist of both flows concurrently within the region, but a scenario could be created that includes only commercial or military flows as needed. The freight flows will be tagged within the model as type commercial or military such that separate output reports can be attained. The following preliminary scenarios are envisioned to support this project (for model de-bugging):

#### Scenario 1: Baseline

- Existing Regional Network without JPPSP Node in Victorville

#### Scenario 2: JPPSP

- Regional Network with Inland JPPSP Node in Victorville

Scenario 3: JPPSP + Usage of Other Regional Facilities

- Regional Network with Inland JPPSP Node in Victorville
- Usage of regional ICTF facilities or other Regional Overflow Facilities

The baseline model is to simulate existing SOCAL transportation networks without any improvements. This simulation system can generate multiple performance throughput results which will be used to compare with the next Scenario 2 results. In Scenario 2, the JPPSP node in Victorville, CA is of particular interest. It is envisioned that JPPSP could serve as a facility that provides ICTF capabilities to supplement the existing already impacted regional facilities that are run by BNSF and UP. Each scenario can be tested with different freight movement volumes; this will enable sensitivity analysis and the ability to increase volumes to determine maximum system capability. This is the original set of scenarios envisioned; these can be modified or new ones created with the SCASN model as needed.

## **5.2 Run Period**

The simulation model will be created such that it is possible to define the time interval in which to create and represent freight flows. It is envisioned that a run period on the order of one or multiple weeks will be needed to support the analysis

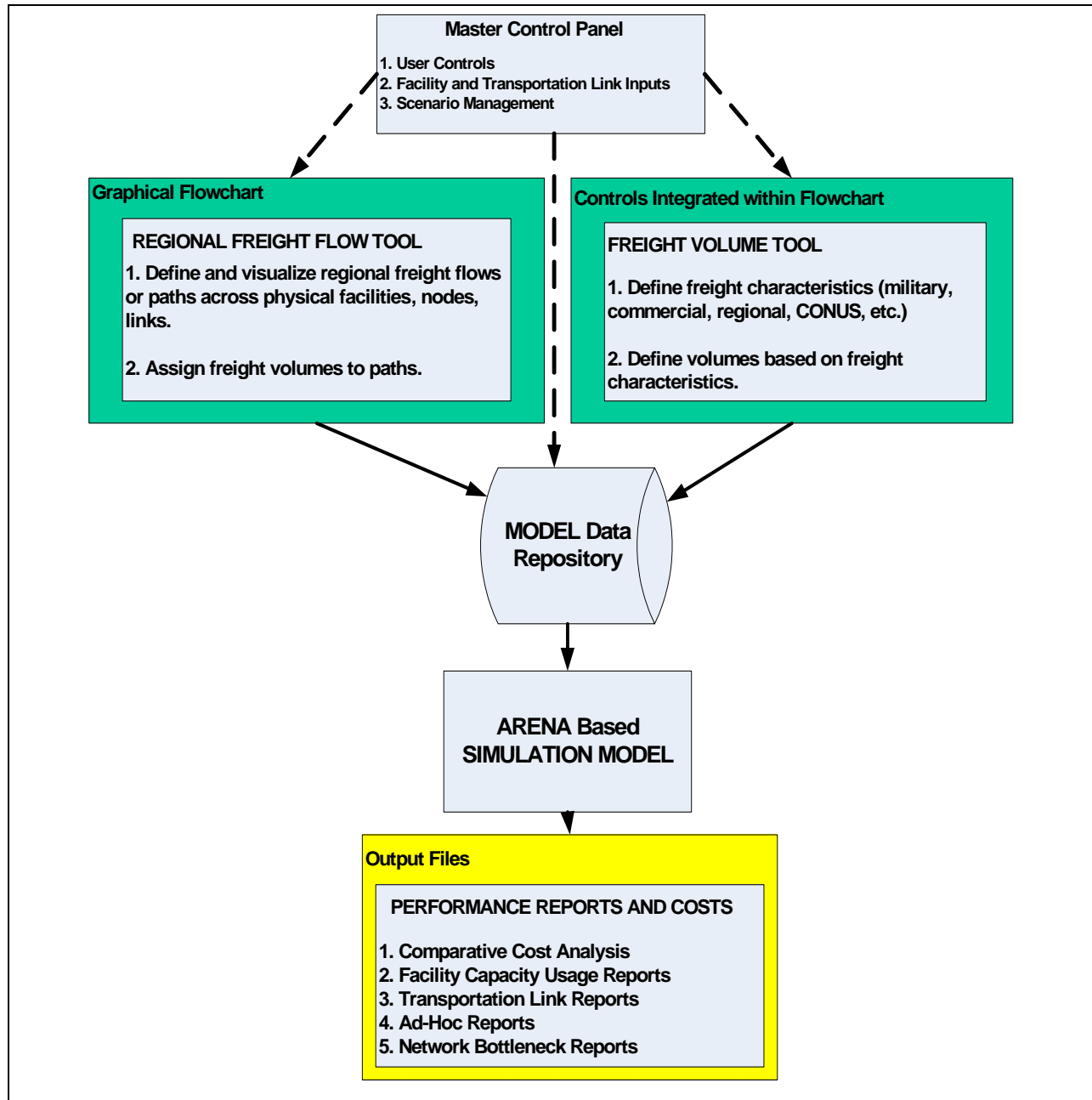
## 6.0 SCASN IMPLEMENTATION

The SCASN model will be constructed using a multi-layer architecture—it is a modeling system that is designed with 3 layers:

1. Presentation Layer: User Interface
  - a. Freight Flow Representation Tool: Tools to define how freight volumes flow through the region.
  - b. Freight Volume Tool: Tools to define freight volumes by type and priority.
  - c. Facility and Transportation Link Database: Definition of inputs to match model parameters.
  
2. Business Layer: ARENA based model
  - a. Logic will represent regional throughput and capacity impacts of:
    - 1) Facilities
    - 2) Transportation Lanes
  - b. Operating and Business Constraints
    - 1) Peak/Off Peak hourly operating practices.
    - 2) Cut off times
  - c. Freight Volumes/Arrival Patterns
    - 1) Port Volume/Vessel Arrival Profile
    - 2) CONUS Train Arrival Schedules
    - 3) Truck Arrival Patterns
  
3. Data Layer: Local data storage
  - 1) Manage model scenario data (inputs and outputs)
  - 2) Synchronize model inputs from input flowcharts and data entry forms.
  - 3) Translate data for ARENA simulation model

A diagram of how this 3 layered architecture is organized for this project is depicted in the following Figure 4:





**Figure 4: SCASN Three-Layer Architecture**

This layered approach allows for the different model functional elements to be separated. This creates an environment that enables extension of modeling capabilities as needed in the future as well as providing a way to separate the complexities of the model logic from the user interface. Some of the benefits of this approach are outlined as follows:

1. User Interface Benefits
  - a. Provides a way to communicate and present SCASN scenarios to stakeholders.

- b. Provides tools such as flowcharts to easily represent regional “freight flow representation” for model scenarios.
  - Reduces need for static tables or spreadsheets that make it difficult to communicate or modify scenario flows and details.
- 2. ARENA Based Model Capabilities:
  - a. Designed to generically represent primary SCASN Model Physical Elements
    - Facilities
    - Transportation Links
  - b. Ability to generate freight flows that require physical elements to move into and out of the region.
    - Vessel, Rail, and OTR arrival schedules.

## **6.1 System Requirements**

For the current project, the SCASN simulation model will be developed as a stand-alone, single user, single server application. It can be installed on most desktop PC configurations that have Microsoft Windows XP Professional (or better) and Microsoft Office. To run the model and animation, a “run-only” version of ARENA is needed at a minimum.

## 7.0 MODEL ARCHITECTURE BENEFITS

The overall SCASN model architecture offers numerous benefits for this project and beyond. Among them are:

1. A Commercial off the shelf (COTS) simulation tool (ARENA) is used and this software is preferred by USTRANSCOM.
2. The model and simulation systems require “Generic Implementation” and function “Extensibility”. Outline of physical and logical elements can be reconfigured to represent more enhanced regional infrastructure.
3. Provides a flexible, high-level network-oriented view that can be used for existing and future infrastructure improvements.
4. The model design is generic such that it is possible to use this architecture for other regions of the United States.
5. Any combination of facilities and transportation connections can be explored.
6. The approach allows you to look at the entire region and its relationship to sourcing and shipments between nodes outside of the region (CONUS).
7. Provides the ability to create a “Regional Network Flow Representation” that synchronizes:
  - a. Regional Infrastructure: Facilities, Transportation Links, etc.
  - b. Transportation Strategies (freight volume flows through the infrastructure).
  - c. Freight Volume Demands: Vessel, Rail, OTR, other arrivals.

## 8.0 SCASN SIMULATION MODEL

The simulation model within the SCASN system will include a high-level representation of the physical elements. A set of parameters will be used to define the characteristics of all defined physical elements such as facilities and transportation lanes. The model will use this information to process cargo over time and move them through the various physical elements defined by their transportation strategy. The model will use a time-slice or other time advancement approach (discrete event) to determine when cargo is available to be moved to the next step.

Physical elements such as regional nodes do not have capacity, they are physical locations for facilities and define end-points for transportation lanes and do not require additional definition.

### 8.1 Facility Element Capacity Parameters

The model will allow for intermodal transfers to occur between water, road, rail, and air. The following Table 2 of cargo transfer between facilities is likely to occur at each of the facility types:

**Table 2. Cargo Transfer Between Facilities**

	Water to Road	Water to Rail	Road to Water	Rail to Water	Road to Road	Road to Rail	Rail to Road	Rail to Rail	Rail to Air	Road to Air	Air to Rail	Air to Road
<b>Marine Terminal</b>	X	X	X	X								
<b>ICTF</b>						X	X					
<b>Transload</b>			X		X							
<b>JPPSP</b>			X	X	X	X	X	X	X	X	X	X

The simulation will include a generic facility that can potentially accommodate all of the mode transfers as noted in the above table. There will not likely be a single facility type capable of accommodating all mode transfers; however, the model will contain inputs to designate which types of mode transfers are applicable.

Each facility will be represented in the model with “gray box” level of detail. There will be parameters to define the throughput and the general capacity of the facility. These parameters are designed to reflect the business operating practices (operating hours), schedule, and physical capabilities of each facility.

Each facility will have the following inputs to characterize its capabilities. Not all inputs will be necessary to define it, but they are available if necessary.

#### I. Inbound Processing:

Each facility has an arrival schedule that can range from vessel arrivals, truck gate arrivals, train arrivals, rail shuttles, and others. Note that there could be multiple modes arriving to a single facility. For example, a marine terminal can receive vessels, trucks, and trains. For each mode at a facility, a separate set of inbound parameters are available

and unique information can be specified.

1. Inbound Arrivals-

This can be specified as a constant rate (containers per hour) or using a time profile (percentage of volume by time of day, etc.) Alternatively, the arrivals to a facility can be specified by a schedule where a given quantity of containers arrives at a particular frequency or at a specific time.

2. Inbound Processing Rate-

Once cargo arrives to the facility there may be a process (wharf crane, lift equipment, etc.) in which cargo actually enters the facility after it arrives.

**II. Internal Facility Processing:**

Each facility will have some internal capacity and storage to process cargo until they are transferred out. For example, in an ICTF, trucks come in to deliver containers and then the containers must wait until they are transferred out via a train schedule. While they are in the facility they must be stored until they are transferred via their outbound schedule. For each mode at a facility a separate set of parameters are available for internal processing if needed.

1. Facility Storage-

This is the capacity of the facility to internally store cargo after it arrives and while it waits to be internally processed and/or for it to be removed for outbound departure.

2. Facility Processing Rate or Dwell Time-

There may be some time, regardless of schedule or outbound processing rate, where cargo must remain in facilities. This parameter could be used to represent the facility dwell time or internal processing rate. For example, often in an ICTF, containers are delivered via truck at a time upstream of actual departure. This parameter could be used to represent the average dwell time that containers remain in an ICTF prior to their outbound departure.

3. Cost-

This is the cost per container to process a container within a facility. This includes labor and equipment only to ensure an apples-to-apples comparison.

**III. Outbound Processing:**

Each facility has an outbound schedule that can range from train departures, vessel departures, or truck gate operating hours. There could be multiple modes departing a facility, such that separate outbound parameters may be defined as needed.

Outbound Departures-

Similar to inbound arrivals, this can be specified as a constant rate (containers per hour) or using a time profile (percentage of volume by time of day, etc.) Alternatively, the departures from a facility can be

specified by a schedule where containers depart at a particular frequency and quantity, or at a specific time.

## 8.2 Transportation Lane Capacity Parameters

Transportation lanes are physical elements in the SCASN model that serve to transport cargo between regional nodes. As noted previously, regional nodes can be associated with a variety of physical elements such as sources and facilities. A transportation lane is actually a set of transportation links and can be defined as the entire group of ways that cargo could be transported. A link is a specific way (mode, service provider, etc.) that cargo can be transported between nodes. For example, both BNSF and UP may offer rail service between two nodes. This may or may not be the same physical rail, but they are separate transportation links in the model.

A data structure will be used to define the various transportation lanes and links within the SCASN simulation model. The following fields are envisioned in this Table 3:

### Input Database:

The following attribute fields (others can be added as necessary) can be used to describe each regional transportation link:

**Table 3. Transportation Lane Parameters**

Link ID	From	To	Service Provider	Mode	Quality	Time Interval	Level of Traffic	LOS Average	LOS Variation	Max Capacity	Cost	Availability	Preference Ranking

### Field Descriptions:

1. Link ID: Unique ID to reference that transportation link.
2. From: A selection from the list of all regional nodes and facilities that have been defined.
3. To: A selection from the list of all regional nodes and facilities that have been defined.
4. Service Provider: The commercial service provider that operates that link (BNSF, UP, PHL, etc.).
5. Mode: Road, rail, air, etc.

6. Quality: The ability of the lane to service a military type of movement (All, no High-Wide, not usable, etc.), or potentially to service certain groups of commercial freight (HAZMAT, etc.)
7. Time Interval: The time of day interval in which the Level of Service (LOS) applies. A day can be broken down into time segments as necessary to highlight LOS differences (All Day, Day, Evening, etc.)
8. Level of Traffic: The level of service parameters can potentially be specified in terms of what the expected times might be at different levels of traffic in the system. This parameter is provided if it is desired to segment expected level of service at different traffic levels.
9. LOS Average: This is the average level of service (time to transport on link from start to end node).
10. LOS Variation: This is the variability of service times that may be expected on this link.
11. Cost: Average cost to transport a container across the link.
12. Availability: This field might be used to designate if a link is available for moving freight, such as a rerouting due to a disruption or other event.
13. Max Capacity: This is the maximum number of cargo units (i.e. containers, military units, etc...) or trips per mode that can be transported on this link at one time. Once this maximum is attained, another transportation link option (if available) must be used.
14. Preference Ranking: A user defined preference (scalar value) that can be used to rank lanes based on other criteria other than best LOS, etc. This would include things like preferential access due to contractual agreements between carriers, shippers, military, etc...)

The above information will be used by SCASN to represent how each container can be moved through its transportation link. The level of representation of transportation links within the simulation model is at a high level and the LOS parameters are the primary determinant used to assess time to travel across it. To create a model that is sensitive to increase volume scenarios, the LOS parameters potentially can be further segmented by level of traffic on link. For rail links, this information may be available from sources such as Leachman & Associates LLC Rail Dispatch Simulation model or from other sources such as Southern California Association of Governments (SCAG), etc.

Additionally, it is envisioned that the model will use the above information to “rank” transportation link choices. The model can prefer links by minimum level of service, availability, quality, and the preference ranking as needed.

## 9.0 DATA COLLECTION PLAN

The SCASN modeling system will contain a centralized database and numerous entry forms. These can provide parametrical information to define facilities and transportation links.

The following outline provides a description of the categories of data needed to support this model and will be enhanced as the model is constructed:

### I. Scenario General Definition

- A. The specifications of the scenarios need to be identified and will include:
  - 1. Scenario Year for freight volumes, facility information, transportation link parameters
  - 2. Length of time to run simulation
  - 3. Military deployment plans
  
- B. Potential Data Sources:
  - 1. The likely source for the data will include PIERS (2004 data) that spans the period between Sept 2002 and August 2003. This will likely influence the scenario year time frames.
  - 2. The length of time will likely span about 2 - 4 weeks (plus any time for warm-up). This will capture the recurring regional cycle time where commercial vessels call during certain days of the week and inland rail facilities experience peaks at a time lag after vessel arrival. The ship sailing cycle will be verified by interviewing with ITS and others. The military scenarios occur across a period of 160 days, but there are military vessel schedules that have 6 ships calling every 12 to 13 days.
  - 3. The military deployment plans to be used are obtained from the Surface Deployment and Distribution Command, Transportation Engineering Agency (SDDC-TEA).

### II. Scenario Freight Flow Volumes and Routing

#### A. Commercial:

This is the type of feasible or desirable cargo flows to include in each scenario. This includes identifying cargo volumes such as regional, CONUS, etc and how they can or need to be routed through the region through facilities and transportation links. This can also include alternative routing options.

#### Potential Data Sources:

- 1. PIERS Data will be providing commercial inbound flows and “ship to” locations.
- 2. Verification of actual destination (local, regional, CONUS) will be obtained via transloading facility historical data/interviews. This also includes breakdown of modes: rail vs. piggy back vs. trucked direct.
- 3. Will try to break out major shippers (such as Kmart and others) and identify via interviews how shipments are made (rail, truck, etc.). Smaller shippers will be aggregated into a profile with generally representative modal splits.



#### B. Military:

This is the deployment plan that will be used by the military to move cargo from sources to port facilities. Similar to the commercial flows, the steps that the various military cargo volumes need to take through the regional facilities will be provided. Also, this can include alternate routing options.

#### Potential Data Sources:

Military volumes and routing including sources of cargo movements, ports of debarkation (strategic throughput ports) will be included in the deployment plans provided by SDDC-TEA.

### III. Facility Parameters

The various facilities in the scenarios need to have specific values for the defined input parameters provided. See **Section 8.1 Facility Element Capacity Parameters** for an outline of the information needed.

#### Potential Data Sources:

1. The SM21 multi model facility model will be used to establish multi-modal throughput data.
2. Marine Terminal discharge rates will be verified via
  - ITS,
  - Previous studies performed by the Center for the Commercial Deployment of Transportation Technologies (CCDoTT) at the California State University, Long Beach, and
  - From wharf crane equipment providers such as Knoell, Bromma, etc.

### IV. Transportation Link Parameters

The various transportation links within the region need to be defined for the specific values for the defined input parameters. See **Section 8.2 Transportation Lane Capacity Parameters** for a description of requirements. In particular, the Level of Service information is of critical value for model representation.

#### Potential Data Sources:

1. Rail data: Inland Empire Railroad Mainline Study (schedules, capacity, freight traffic levels)
2. Rail carriers: Actual rail car movements, schedules, rates
3. Various SCAG studies: Highway data.
4. TransCORE (a transportation software house): Traffic flow rates, rail-tracking data along routes, and container tracking study data.

## **10.0 INTRODUCTION TO DATA DEFINITION AND DATABASE DESIGN**

The container movement data of the SCASN model can be divided into inbound and outbound shipments. Input data to the model include the rail network, routing highways, nodes, shipment schedules, and level of service. To house all these data, a centralized relational database will be designed and implemented in the Integration Lab of the Victorville hub. This database will be functioning as the inputs and outputs of SCASN simulation system and all other SM21 tasks.

Since 1983, the transportation industry in the United States has been using the American National Standards Institute (ANSI) accredited Standards Committee X12 Electronic Data Interchange (EDI) format (Muller, 1999). The purpose of EDI data transmission is to allow transaction sets of different types to be transmitted from one party to another in the same structure. Most of SCASN required data could be extracted from designated EDI sources and translated into appropriate input formats.

### **10.1 Listing of EDI Sets and Other Data Sets**

For the SCASN model the required EDI transaction sets, the following data sets will provide inbound and outbound processes. Among the EDI data files, the 200 level of EDI transaction sets provide motor carrier information; the 300 level of EDI transaction sets provide vessel shipment information; and the 400 level of transaction sets provide rail carrier information as outlined below:

1. 204 Motor Carrier Load Tender
2. 214 Transportation Carrier Shipment Status Message
3. 304 Shipping Instructions
4. 309 Customs Manifest
5. 315 Status Details (Ocean)
6. 322 Terminal Operations and Intermodal Ramp Activity
7. 404 Rail Carrier Shipment Information
8. 418 Rail Advance Interchange Consist
9. 856 Ship Notice/Manifest (Generally used for commercial Shipments)
10. 858 Shipment Information (Mainly used for Government Shipments)

The EDI transaction sets will be organized to follow relational database requirements. One EDI transaction set consists of numerous segments whereby one segment contains numerous elements. The scope of most data elements in this SCASN database can be collected from all the segments of the required EDI transaction sets. The construction of EDI data requirements

matrices for the applicable database provides simplified direction for mapping. Table 4 displays three breakdown examples of EDI sets 309, 322, and 418. A data file of a transaction set includes numerous records with various record layouts. A segment ID is the identification for each record layout. An element ID is the identification for each field in the record layout.

**Table 4. Intermodal EDI Matrix**

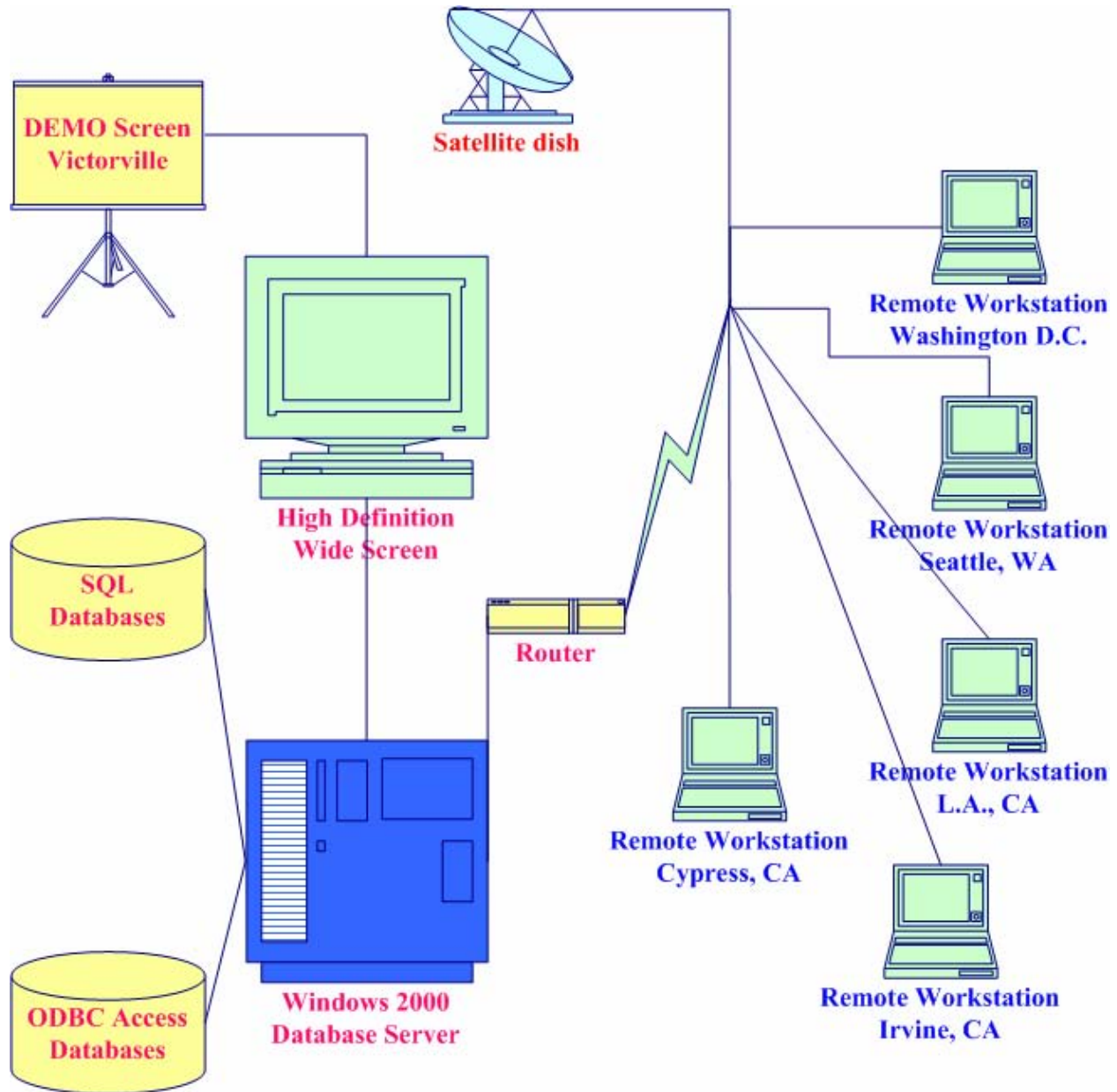
	Vessel		Marine Terminal		On Dock Rail Yard		Railroad	
EDI Set	Segment ID's	Element ID's	Segment ID	Element ID's	Segment ID	Element ID's	Segment ID	Element ID's
309	ST M10 P4 R4 VID	140, 91, 26, 182, 55 310, 373 309, 310, 314, 174 40, 206, 207, 24, 322						
322			ST Q5 W2 R4 DTM	157, 19, 156, 206, 207, 40, 578, 373 309, 310, 114, 174, 156 374, 373	ST Q5 W2 R4 DTM	157, 19, 156, 206, 207, 40, 578, 373 309, 310, 114, 174, 156 374, 373	ST Q5 W2 R4 DTM	157, 19, 156, 206, 207, 40, 578, 373 309, 310, 114, 174, 156 374, 373
418					ST BAX W1 W2 W3	579, 374, 373, 41 42 206, 207, 40, 373, 301 19, 156	ST BAX W1 W2 W3	579, 374, 373, 41 42 206, 207, 40, 373, 301 19, 156
		1. Container Number 2. Date/time Transaction 3. Transaction Location 4. Status ( full or empty) 5. Origin/Destination		1. Container Number 2. Date/time Transaction 3. Transaction Location 4. Status ( full or empty) 5. Origin/Destination		1. Container Number 2. Date/time Transaction 3. Transaction Location 4. Status ( full or empty) 5. Origin/Destination		1. Container Number 2. Date/time Transaction 3. Transaction Location 4. Status ( full or empty) 5. Destination

**10.2 Information Center for SCASN Model**

The architecture of the SCASN database is built upon a multi-tier client/server configuration. The physical implementation site resides in the JPPSP at Victorville, California. Four power edge Dell servers serve more than 30 remote workstations nationwide. A secured VPN/router has been implemented to enable a secure system. A SQL server database provides substantial data warehousing functions for all end users at numerous locations from coast to coast. Another log shipment replicated database is also created to synchronize the data and image from the major SQL server database using ODBC links.

Figure 5 depicts a complete picture of the IT architecture. Therefore, with these intelligent client/server systems, an end user can remotely retrieve information from the Integration Lab server and manipulate it locally to run and view the SCASN simulation system. The intent is to offer an interactive capability for interested parties who can retrieve data warehousing queries as well simulation outputs and summary information online. This configuration optimizes the

processing of the information, and allows each end user and workstation to work independently in a manner best suited for moving locations. The server focuses on the database processes, and the end user focuses on the retrieval of the useful information [Morneau and Batistick, 2001].



**Figure 5. JPPSP Integration Lab  
The Strategic Mobility 21 Network System**

## **11.0 MODEL PERFORMANCE MEASURES**

The SCASN simulation model will provide numerous output reports. These reports will be designed such that it is possible to quantify and analyze sensitivity of the regional infrastructure to respond to different transportation strategies and cargo volumes. Separate reports will highlight commercial and military cargo performance.

A general outline of the model performance measures is provided below and will be enhanced as the model is constructed.

### **I. Regional Summary Report**

1. Total cargo processed through region by mode
2. Regional Level of Service: Time cargo takes to move through region by mode (min, average, maximum or percentile breakdown)
3. Hours of delay by mode: Time cargo is in region not being processed or transported - time waiting in storage or waiting to be processed
4. Backlog levels of cargo waiting to enter region by mode (average, maximum)
5. Total regional cargo flow costs by mode
6. Total regional cargo costs by mode
7. Total regional transportation costs by mode

### **II. Facility Detail Report**

1. Total cargo processed through each facility by type (container, military unit, etc...) and mode
2. Facility level of service by mode: time cargo spent within each facility.
3. Facility delay by mode: Hours of delay for cargo being stored or waiting to be processed
4. Facility utilization (average, maximum)
5. Storage levels within facility (average, maximum)
6. Facility processing costs
7. Backlog levels of containers waiting to enter

### **III. Transportation Lane Detail Report**

1. Total cargo traveling through each lane by mode
2. Total trips through each lane
3. Total cargo traveling through each link
4. Total trips through each link
5. Time for cargo to move through a lane (min, average, max)
6. Time for containers to move through a link (min, average, max)
7. Transportation costs by lane
8. Transportation costs by link

**APPENDIX A: ACRONYMS**

<b>ACRONYM</b>	<b>DEFINITION</b>
AEI	Automatic Equipment Identification
BNSF	Burlington Northern Santa Fe
CONUS	Continental US
COTS	Commercial Of-The-Shelf
CTC	Centralized Traffic Control
DC	Distribution Center
DHS	Department of Homeland Security
DLA	Defense Logistics Agency
DoD	Department of Defense
ICTF	Intermodal Container Transfer Facility
ITS	International Transport Solutions, Inc.
JPPSP	Joint Power Projection Support Platform
LOS	Level of Service
MAGTF	Marine Air-Ground Task Force
NMFD	Notional Military Force Deployment
NTC	National Training Center
NWS	Northwest
OC	Orange County
OTR	Over-the-Road
PHL	Pacific Harbor Line
POLA	Port of Los Angeles
POLB	Port of Long Beach
POSD	Port of San Diego
PPSP	Power Projection Support Platform
SCAG	Southern California Association of Government
SCIG	Southern California Intermodal Gateway
SCLA	Southern California Logistics Airport
SCRRA	Southern California Regional Rail Authority
SM 21	Strategic Mobility 21
SOCAL	Southern California

<b>ACRONYM</b>	<b>DEFINITION</b>
TEU	Twenty Foot Equivalent Container Unit
UP	Union Pacific
UPRR	Union Pacific Railroad
USTRANSCOM	US Transportation Command

## APPENDIX B: REFERENCES

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