REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
31-12-2007

2. REPORT TYPE
Technical

3. DATES COVERED *(From - To)*
Feb 2006-Dec 2007

4. TITLE AND SUBTITLE
Strategic Mobility 21
Collaborative Regional Web Portal Design, Development and Documentation

5a. CONTRACT NUMBER
N00014-06-C-0060

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Mallon, Dr. Lawrence G.
Carson, Dr. Steve

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
California State University, Long Beach Foundation
6300 State University Drive, Suite 220
Long Beach, CA 90815

8. PERFORMING ORGANIZATION REPORT NUMBER
Contractor Report 0013

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Office of Naval Research
875 North Randolph Street, Room 273
Arlington, VA 22203-1995

10. SPONSOR/MONITOR'S ACRONYM(S)
ONR

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
CLIN 0013

12. DISTRIBUTION/AVAILABILITY STATEMENT
DTIC Distribution Statement A: Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
This report documents the research & initial development of a Web Portal by the Strategic Mobility 21 (SM21) program, including defining requirements for an SM21 Web Portal and reviewing current literature and technology associated with Web Portals supporting the transportation and distribution sectors. This document provides an example of a specific service interface that enables collaboration between military & transportation planners and military ship load planners . This paper also describes how the SM 21 program is using Web 2.0 collaboration technologies including Wikis, Blogs; and Modeling, Simulation and Analysis tools to address a key program area identified as having significant capability gaps: a regional planning interface that makes data, models, and analyses available to all stakeholders in an interactive and configurable manner. An underlying theme of this report is the merging of Web 2.0 and knowledge management technologies with Service Oriented Architecture.

15. SUBJECT TERMS
Southern California Logistics Airport (SCLA), Joint Deployment and Distribution Support Platform (JDDSP), Inland Port Multi-Modal Terminal Operation System (IP-MTOPS), Service-Oriented Architecture; Web Portals; Simulation & Analysis Tools.

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
U	U	U		74	Dr. Lawrence G. Mallon
					19b. TELEPHONE NUMBER *(Include area code)* 1-562-985-7392

Reset

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

Strategic Mobility 21

Collaborative Regional Web Portal Design, Development and Documentation

Contractor Report 0013

Prepared for:

Office of Naval Research
875 North Randolph Street, Room 273
Arlington, VA 22203-1995

Dr. Paul Rispin, Program Manager, ONR Code 331
703.696.0339 rispinp@onr.navy.mil

In fulfillment of the requirements for:

FY 2005 Contract No. N00014-06-C-0060
Strategic Mobility 21 – CLIN 0013

Prepared and Submitted by:

Dr. Lawrence G. Mallon, Program Manager
California State University, Long Beach Foundation
6300 State University Drive, Suite 220, Long Beach, CA 90815 562.985.7392

December 31, 2007

Acknowledgement of Support and Disclaimer: This materiel is based upon work supported by the Office of Naval Research under Contract No. N00014-06-C-0060. Any opinions, findings and conclusions or recommendations expressed in this materiel are those of the author(s) and do not necessarily reflect the views of the Office of Naval Research.

TABLE OF CONTENTS

LIST OF FIGURES

APPENDIX A

APPENDIX B

ABSTRACT

This report documents the research and initial development of a Web Portal by the Strategic Mobility 21 (SM21) program. The initial development effort was focused on defining the requirements for an SM21 Web Portal and reviewing current literature and technology associated with Web Portals supporting the transportation and distribution sectors. Overall the focus of this initial year of Web Portal development was on:

- Identifying and filling capability gaps in commercial and government systems designed to support multimodal terminals, regional planning, and distribution management.
- Creating a framework for the continued definition, design, and development of the SM21 Inland Port-Multi-modal Terminal Operating System (IP-MTOPS) capabilities.

The services required to close identified capability gaps will be made accessible through the Web Portal to support the Joint Deployment and Distribution Support Platform (JDDSP) prototype at the Southern California Logistics Airport (SCLA). This document provides an example of a specific service interface that enables collaboration between military and transportation planners and military ship load planners that was selected for initial development, testing, and demonstration. This paper also describes how the SM 21 program is using Web 2.0 collaboration technologies including Wikis, Blogs; and Modeling, Simulation and Analysis tools to address a key program area identified as having significant capability gaps: a regional planning interface that makes data, models, and analyses available to all stakeholders in an interactive and configurable manner. A goal of both the collaborative regional planning interface and the JDDSP services access is to make significant improvements in both how information is shared and how the consequences of different courses of action are explored. An underlying theme of this report is the merging of Web 2.0 and knowledge management technologies with Service Oriented Architecture.

1.0 INTRODUCTION

The Strategic Mobility 21 (SM21) Web Portal is being designed to support the complex planning nature of the SM21 Program and the functional requirements associated with the Joint Deployment and Distribution Support Platform (JDDSP) operating within a regional distribution context. In this complex environment, operational planning and execution must be supported by appropriate and timely data, collaborative processes, and analytical tools to ensure that the JDDSP and the region maintain alignment with the ever changing distribution patterns.

This report documents the results of the Web Portal research, analysis, prototype development, and demonstrations completed to date. The report describes the Web Portal requirement definition and technical approach along with the identification of the users, their roles, two required interfaces, and the conceptual and detailed design of the two interfaces. These two initial interfaces will be used to pattern the future development of other required service interfaces needed to fill the functional requirements of the Inland Port-Multi-modal Terminal Operating System (IP-MTOPS).

The basic report concludes with an overview of the working prototype portal. Appendixes A through D provide additional web portal development information as follows:

- Appendix A contains the regional planning web portal system storyboard
- Appendix B provides the Surge Deployment storyboard.
- Appendix C includes the project Statement of Work for reference.
- Appendix D contains the published Web Portal report, “Collaboration in Regional and Military Transportation Planning” that compliments the basic report. This published report was presented at the International Command and Control Research and Technology Symposium (ICCRTS): Adapting C2 to the 21st Century and provides additional Web Portal development detail.
- Appendix E contains a description of the Web portal IP-MTOPS services and commercial off the shelf software deployment process

It should be noted that the figures in Appendixes A and B are high resolution screen captures; however, they cannot be displayed in the report format of limited dimensions without some loss of perceived (visual) quality[1].

2.0 TECHNICAL APPROACH

The Web Portal development technical approach is centered on interfaces that enable collaboration and the exploitation of unstructured data by techniques such as data mining. It is these interfaces that are lacking in the present commercial environment. Note that commercial off-the-shelf software such as the terminal operating systems (e.g. NAVIS) used at the ports and at intermodal and multimodal facilities already provide the capabilities to produce status interfaces and to manage the workflow at those facilities. They do not however, provide a collaborative environment for all the modalities (air, ocean, rail, and truck), terminal operators, and shippers to plan and execute synchronized shipment flows that have predictable results. In

[1] If a figure is copied and pasted from this MS Word document into an image editor, it can be viewed at full, original size. The figures have been rotated 90 degrees from normal placement to enable better viewing within the report.

like manner the existing commercial systems are not designed to allow terminal and regional planners to maximize shipment throughput capacity and define the surface transportation infrastructure required. Therefore, it is not of research interest to duplicate the interfaces found in existing commercial products. Instead, our continuing development of the Web Portal will focus on identifying and filling shipment management capability gaps. Our initial focus, which continues into the following program year will be:

- Military force deployments
- Modeling, simulation, and analysis (MS&A) capabilities to demonstrate the net regional effects of individual actions
- Experimentation associated with containerized cargo tracking visibility and management for Dole Food Company, Inc. using commercially available systems supplied by TransCore to determine additional value-added services required to be integrated with the Web Portal to fill capability gaps that are generally not available in commercial applications

There are no commercial products that currently enable collaboration in regional planning. Collaboration and regional planning today takes place over long time frames and is based upon stakeholders reviewing reports that each take a year to 18 months to produce. The underlying data and assumptions in these reports are almost never made public, hindering the ability of others to understand the results and how they were derived. There is an urgent need to change the situation by establishing a collaborative environment where all data, models, and simulations are publicly available for scrutiny along with the results derived from such information, and may be reused in a collaborative environment. Readers and collaborators need the ability to modify input data and model assumptions and to rerun any underlying simulations or analyses and compare the results with previous runs.

2.1 Basic Elements and Tenants of the Technical Approach

The basic elements of our technical approach are:

1. Use blogs to express points of view and share information;
2. Use wikis to build consensus in various areas by providing persistence that can evolve over time;
3. Accept and incorporate data in all sorts of natural formats such as text files, spreadsheets, etc., and tag it according to various ontologies/schemas to allow it to be mined; and
4. Plan for the integration of modeling, simulation, and visualization as part of the wikis.

The basic tenants of this approach are:

1. Centralized databases and the systems built on them, such as ERP systems, are bad;
2. All models/schemas/ontologies are local, have limited scope, and will evolve; in fact competing models/schemas/ontologies are good, not bad;
3. Centralized and/or standardized data dictionaries are bad;
4. Achieving shared knowledge by human participants over some limited “universe of discourse” at a point in time is a goal - and this process is repeated many times as the dialog evolves; collaboration enables the communication that allows shared visions to be developed.

3.0 USERS, ROLES, AND REQUIRED INTERFACES

3.1 Overview

Because the JDDSP, as envisioned by the Strategic Mobility 21 Program, will involve largely the application of commercially available or government furnished software systems, this task focuses on those user interface needs that are not met by existing software systems. Among those interfaces that are expected to be provided by commercially available or government furnished software systems are:

1. Interfaces for planning and managing work at terminals at the ports. These interfaces are provided by the Terminal Operating Systems at each terminal. One of the commercial products widely used for these purposes is the Optimization Alternatives Strategic Intermodal Scheduler (OASIS).
2. Interfaces for planning and managing work at intermodal and multimodal facilities, including any potential facility in Victorville. These interfaces are provided by the Terminal Operating Systems at each facility. One of the commercial products widely used for these purposes is OASIS.
3. Interfaces for planning and managing work at any DOD logistics installation that might be located at Global Access in Victorville. These interfaces will be provided by warehousing and distribution commercial off-the-shelf software to be installed at those facilities (e.g. Global Visibility Platform or TransCore 3sixty).
4. Interfaces for use by military ship stow planning and rail load planning functions. These interfaces are provided by existing legacy systems such as ICODES and TCAIMS II.

Based on a series of interviews we conducted with stakeholders in the Strategic Mobility 21 Program around the Los Angeles area from August 2006 through November 2006, we identified the following needs for the initial Web portal type interfaces that will not be met by existing commercial or military software systems:

1. Interfaces and tools for cooperation in regional planning.
2. An interface for collaboration between military ship stow planners and military rail load planners.

Each of these interfaces is addressed in more detail in the subsequent paragraphs.

3.2 Interfaces for Cooperation in Regional Planning

The Strategic Mobility 21 Program itself needs to make the case for the use of the San Pedro Bay ports on surge deployment and sustainment, as well as the build-out of additional infrastructure within the Southern California area. The major justification for new infrastructure is achieving higher container throughput through the ports, with various secondary justifications such as reduction of the impact of container shipments on the region. Because there are many potential solutions to these problems and the effects of implementing an individual solution, and especially the interactions among the multiple solutions, are very difficult to visualize and understand, there is a need for a collaborative interface to support such a regional planning. In the SM21 project itself, many different integrated product teams are at work on various elements of the project. There is a need to coordinate this work, enabling those on different teams to understand the work of others, to understand how information created by other tasks affects their tasks, and for displaying, visualizing, interacting with, and understanding the results of various modeling and analysis efforts.

In the larger sense within the Southern California region, regional planning is just an expanded version of the efforts within the SM 21 program itself. That is, Metropolitan Planning Organization's (MPO) such as the Southern California Association of Governments (SCAG) also have a need to coordinate activities in many different areas and to enable interdisciplinary understanding of analysis, modeling, and simulation work. Today, most of such work is presented in a static manner in reports that take a long time to produce, have hidden input data and non-specified or ill-specified assumptions, and present only a limited number of the possibilities considered, not allowing the reader to interact with the models and analyses, for example changing certain assumptions, and looking at the resulting differences.
Users of a regional planning interface would be experts in a particular discipline related to regional planning. For example they might be: rail experts, trucking experts, railroads or trucking companies themselves, operators of intermodal or multimodal facilities, trade unions, local citizens' organizations, regional air quality authorities, transportation planners, etc. Additional users would be those responsible for the creation of planning infrastructure including those who create GIS systems, model business processes, or model and/or simulate some aspect of the operation of regional systems.

A long-term goal of interfaces in this area would be to allow various input data, and analyses/models/simulations to be automatically configured into effective systems for understanding some aspect of the region. That is, effective interfaces in this area might resemble the SimCity game in their simplicity of operation. An effective interface would allow many alternative models and sets of input data to be organized, understood, and configured in different manners to create those models and simulations capable of assisting and answering specific regional planning questions.

3.3 Collaborative Interface for Ship Stow and Military Rail Load Planning

The two users of this collaborative interface are:

1. A military ship stow planner, and
2. A military rail load planner

Each of these users may be assumed to be an expert in his own discipline. The need for collaborative work comes about because the rail loads need to be planned in such a manner that they can be delivered to the port and military equipment removed from the rail cars "just-in-time" for stowing onto the ship, thereby reducing the footprint, that is, the number of acres of land needed for temporary marshaling of military cargo at a terminal at a port before it is loaded onto a ship.

During the planning for this interface, we did not have the opportunity to interview representatives from either class of user. However, subsequent to our initial interface design efforts documented in this report we were able to interview and document the plan planning process. This information will be used for continued development of this capability. As we confirmed during the observation of a military force deployment, the key functionality required to fill in an identified gap is the production of an order in which equipment needs to arrive at the port to be stowed onto a ship. Technically this reduces the problem of creating a ship load plan from a ship stow plan. A ship load plan specifies the order that pieces of equipment enter the ship, the ship entry point, the holds or ramps through which each piece enters. The loading plan also specifies how many decks and holds can be loaded concurrently and in what sequence. This ship load plan can then be used to plan the order of the loading of equipment onto rail cars. A further key need in this area is a facility to allow rail plans and stow plans both to be effectively visualized using modern graphical techniques and the process of the delivery of rail cars to the port and movement of equipment onto ships to be visualized and understood in the sense of a mission rehearsal.

4.0 CONCEPTUAL DESIGN OF TWO INTERFACES

4.1 Selection of Two Interfaces

The technical approach is centered on interfaces that enable collaboration and the exploitation of unstructured data because it is these interfaces that are lacking in the present commercial offerings. Note that commercial off-the-shelf software such as the terminal operating system is used at the ports and at intermodal and multimodal facilities already provide the capabilities to produce status interfaces and to manage the workflow at those facilities. Therefore, it is not of research interest to duplicate the interfaces found in these commercial products. On the other hand, there are no successful commercial interfaces that enable collaboration in regional planning.

There is also a recognized gap between ship stow planning and rail car load planning. Ship stow planning is done today by using the Integrated Computerized Deployment System (ICODES) which is currently not interface effectively with the rest of the DOD transportation planning environment. ICODES is based on older generation 2-D display technology and does not have effective user interfaces even for use by ship stow planners.

Rail transportation planning today is often done manually because the facilities provided by systems such as TCAIMS II have not been adopted by users. Planning a surge deployment while minimizing the impact on port operations, leads to a requirement to place military equipment onto rail cars so that it may be delivered to a terminal at a port in the right loading sequence in a “just-in-time” fashion. In particular, this means that the assignment of the equipment to rail cars must be based upon the order in which the equipment is needed at the port for stowing onto a ship. One known gap is that there is no mechanism today to determine the order that equipment will be needed at the port to put it on to a ship to achieve a particular stow plan. This is done manually and in real time today, selecting equipment from the set of equipment available at the port. Today, as normal practice, this means moving the entire set of unit equipment to the port and then loading one piece at a time.

Therefore, there is a need to obtain ship stow plans from ICODES in a system independent manner for sharing with other systems, thereby avoiding the stovepiped usage of that single system. There is also a need to produce rail car load plans more effectively than by using a system such as TCAIMS II (which is its own stovepipe). At this point, further investigation is needed of all of these areas. We were able to gather more information on the required rail loading capabilities during a force deployment. Based on the results of our analysis of the information collected, we will determine an approach to the portion of the Web portal that will deal with ship stow planning, rail car load planning, and the interface between the two. In particular, any additional system capabilities should be and must be developed independently of either the TCAIMS II or the ICODES systems. This is a requirement to ensure that this essential functionality not become embedded into any single stovepiped, legacy system. Instead our design approach for interfaces will employ small, flexible, and independent software modules to fill the gaps. The "gap-filling" services will either be obtained as an existing service or by SM21 development of the service as the way to a future where stovepiped, legacy, and failed systems will be replaced in favor of open systems built from small, interchangeable elements.

For the above reasons, we have selected the following two interfaces for prototyping during the first year of this web portal development effort:

1. A collaborative interface for the use of both ship stow planners and military transportation planners that enables the two disciplines to interact and make decisions concerning the flow of cargo to the port and its loading and stowing onto a ship.
2. A collaborative interface for regional planning, tying together the work at CSULB in the areas of GIS, Optimization, and Economic Analysis. We plan to expand this effort in later years to include stakeholders like SCAG, the terminals, the intermodal centers, the railroads, etc. and will be a living tool that CSULB can use to further its penetration into regional planning.

4.2 Base Technology Selection

To select a base technology, we looked again at a survey of open-source collaboration software that GSC Associates, the lead designer for this project, had done for the DARPA Integrated Battle Command (IBC) Program about 18 months ago. We quickly ruled out the FlexWiki open source project that GSC Associates had used on IBC because the software had a large set of defects (such as allowing two different people to edit the same page at the same time) that had not been corrected. In fact, none of the open source projects we had evaluated then had made any significant advances in the last 18 months.

We next turned to commercial collaboration software and quickly found that important commercial products such as Inquira were abandoning their proprietary code bases and converting to become Microsoft SharePoint 2007 applications. This led us to look more closely at Microsoft SharePoint 2007 as a potential base on which to build the Strategic Mobility 21 Web Portal. What we found was an integrated framework that provided capabilities in the following key areas:

1. Collaboration
2. Portals
3. Enterprise Search
4. Enterprise Content Management
5. Business Process and Forms
6. Business Intelligence

We also discovered that SharePoint 2007 had far better capabilities than any of its competitors. The most important ones included:

1. Provide a simple, familiar, and consistent user experience.
2. Boost employee productivity by simplifying everyday business activities.
3. Help meet regulatory requirements through comprehensive control over content.
4. Effectively manage and repurpose content to gain increased business value.
5. Simplify organization-wide access to both structured and unstructured information across disparate systems.
6. Connect people with information and expertise.
7. Accelerate shared business processes across organizational boundaries.
8. Share business data without divulging sensitive information.
9. Enable people to make better-informed decisions by presenting business-critical information in one central location.
10. Provide a single, integrated platform to manage intranet, extranet, and Internet applications across the enterprise.

Next, we installed Microsoft Office 2007 and SharePoint Server 2007 on a local server and built some trial sites using content authored for the SM21 Web Portal. All features worked as advertised even though using beta test versions of the applications and servers.

The final factor in the selection of SharePoint 2007 was the fact that the project was looking to move its program management web site off the e-Project system, which was proving to not only be expensive but had an unusual user interface that most participants did not like to use. SharePoint 2007 had all the functionality needed to create a replacement project management web site and it is being considered along with Microsoft Project Server to create a new project management web site.

4.3 Conceptual Design of the Two Interfaces

4.3.1 Introduction

The following paragraph gives the use cases for each interface in the context of the applicable system architecture. The next two paragraphs describe each of the two interfaces.

4.3.2 Use Cases

Figure 1 is the condensed use case diagram illustrating those elements of the JDDSP that are being constructed in the first year of the program.

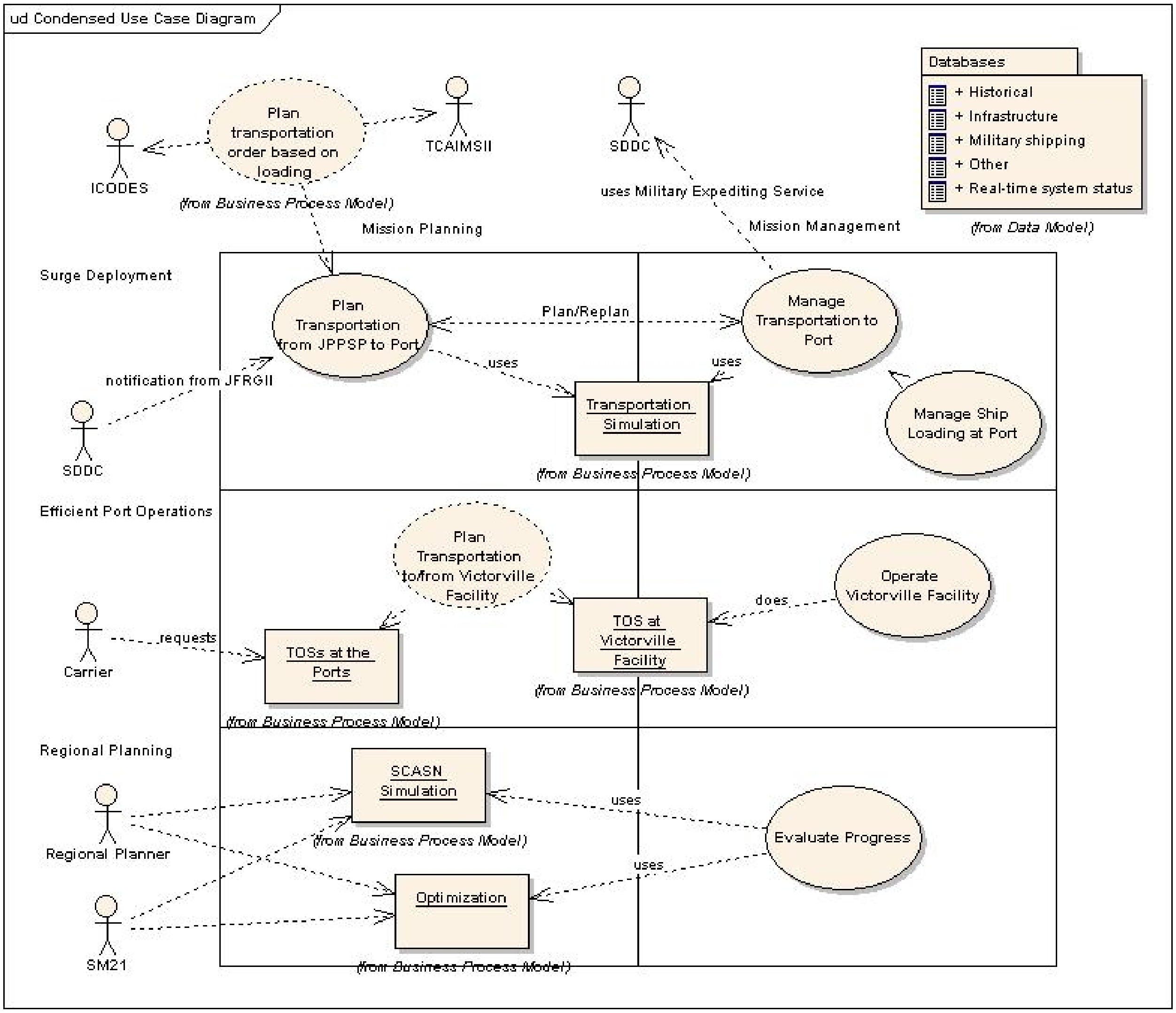

Figure 1: Top Level JDDSP Use Case Diagram

Two more detailed diagrams were developed for the two web portals. Figure 2 shows the Regional Planning Web Portal Use Case while Figure 3 shows the Surge Deployment Web Portal Use Case.

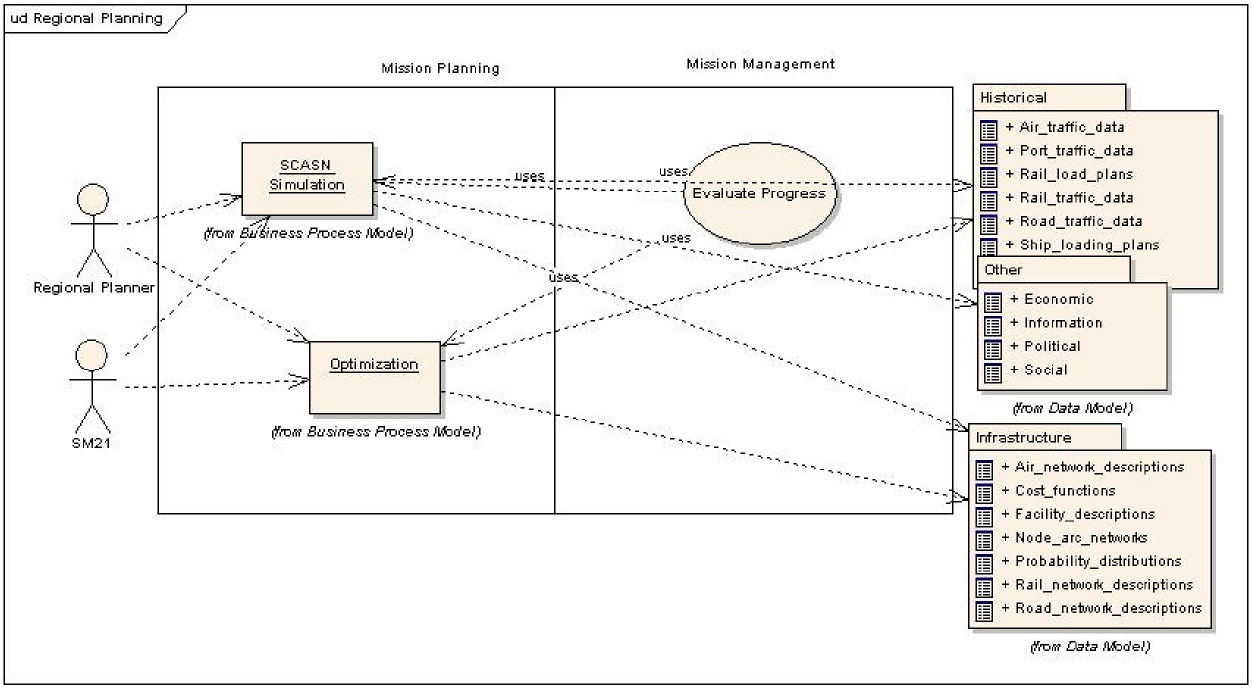

Figure 2: Regional Planning Web Portal Use Case

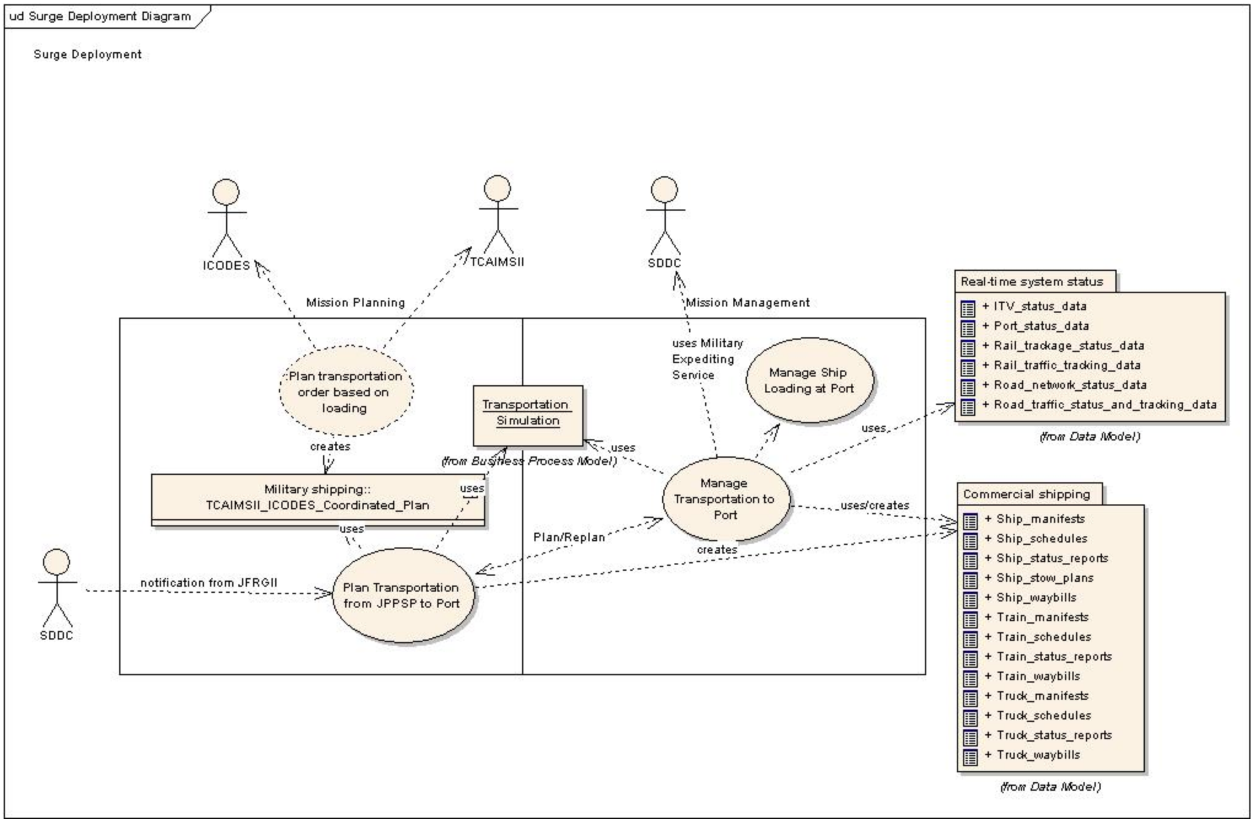

Figure 3: Surge Deployment Web Portal Use Case

4.3.3 Regional Planning Web Portal

The Regional Planning Web Portal will provide a collaborative interface for use by stakeholders during regional planning in Southern California. This section describes the design by storyboarding parts of the interface as a path through the screens (i.e. a scenario) indicating typical use. The screen captures that illustrate this sub-clause are from the GSC Associates development SharePoint site that will be “published” to the SM02 Server at the JDDSP site in Victorville, CA or other designated SM21 Server site.

The functional requirements for this Regional Planning Web Portal as expanded and restated during the functional design are:

1. Provide basic data sets to support regional planning. These will include:
   a. Schedules of ship arrivals.
   b. Rail schedules
   c. PIERS data
2. Provide the ontology of concepts with definitions and relationships for use in describing key issues in regional planning including goods movement. This will be in the context of a wiki that readers can edit so that the content may evolve. UML diagrams will be included as appropriate. The "ontology" is basically the framework around which the wiki entries are organized. Users will be able to search for articles that define or explain concepts.
3. Provide a common user interface that supports developing networks (sets of nodes and arcs) as well as data associated with network elements (such as cost functions, delay characteristics, transit times, etc). This will be the common framework around which Southern California Agile Supply Network (SCASN) simulations are defined and configured as well as the optimization analyses and other functionality that may be added in the future. The intent is to provide a vendor-independent front end that can be used over technologies such as Arena that are too arcane for direct use by non-experts.
4. Provide a common user interface for presenting and comparing the results of analysis, simulation, and model "runs". This will likely use Excel as its basis but with plans for 2D and 3D graphics to be added later. Again, the intent is to provide a vendor-independent front end that can be used over technologies such as Arena that are too arcane for direct use by non-experts.
5. Provides blogs where project personnel can share information. I will start these out with a few of my own, including one about web portal development.
6. Provide wiki's where project personnel (and we hope, especially stakeholders) can carry out discussion of key issues. Longer term we will add functionality that helps to form groups, locate experts to participate, and inform leaders on how to guide discussion, achieve consensus, and publish results.
7. Provide a place for sharing documents with individual security control at the document level for restricting access.
8. Provide search over the whole web site. This will evolve to tag-based search including search over data set contents.

The above list includes some developments that are not likely within the first year.

At the top level, a user first sees the main regional planning web portal page in Figure 4:

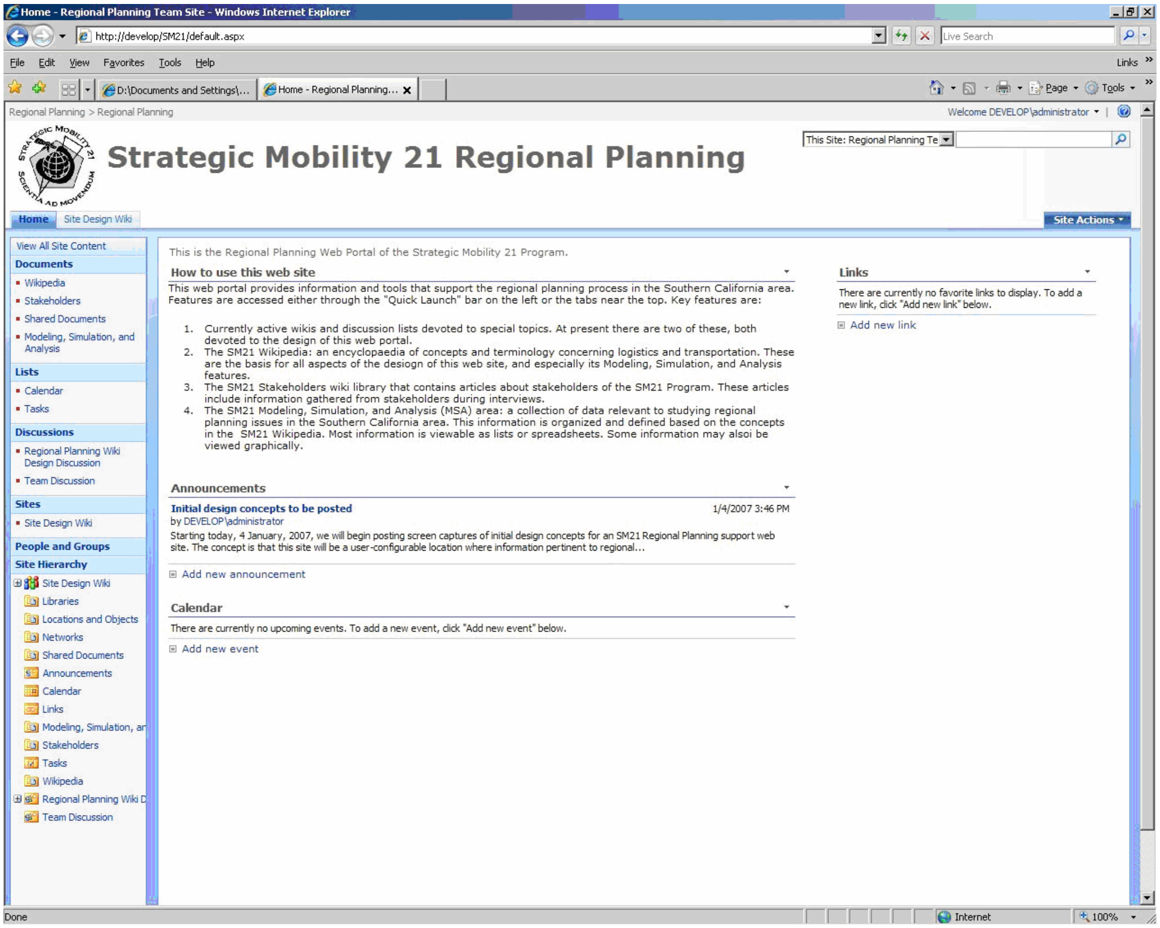

Figure 4: Main Regional Planning Web Portal Page

From this page, the remainder of the Regional Planning Web Portal can be accessed. The Regional Planning Web Portal design completed to date is contained in the form of a screen capture storyboard located at Appendix A.

Below is the top level outline of the Regional Planning Web Portal design and contents:

1. The SM21 Stakeholder Wiki Library (Figure A-2):
2. The SM21 Wikipedia (Figure A-4).
3. The Shared Document Library (Figure A-7)
4. Wiki Discussions (Figure A-8).
5. The Modeling, Simulation, and Analysis (MS&A) pages (Figure A-9)

Each wiki page contains a search box with a link to “Advanced search”. The site uses "SharePoint Server for Search 2007" which has very advanced search capabilities, including customizable search engines and search based on metadata.

4.3.4 Surge Deployment Web Portal

The Surge Deployment (and Surge Sustainment) Web Portal will provide a collaborative interface between a ship load planner (using ICODES) and a military rail load planner (using TC-AIMS II). This sub-clause describes the design by storyboarding parts of the interface as a path through the screens (i.e. a scenario) indicating typical use. The screen captures that illustrate this sub-clause are from the GSC Associates development SharePoint site that will be “published” to the SM02 Server at the JPPSP site in Victorville, CA or other appropriate site as decided in the following program year.

The functional requirements for the Surge Deployment Web Portal as expanded and restarted during the functional design are:

1. Interface with ICODES through a web service interface to be provided by ICODES to receive visualizations (as SVG files) of ship load plans along with associated entity data.
2. Display ICODES stow plans.
3. Provide a link back to ICODES so that a user can use ICODES directly to modify ship stow plans.
4. Display unit equipment lists received from TC-AIMS II.
5. Display preliminary rail plans received from TC-AIMS II.
6. Provide an interface that allows a human user to compare a ship stow plan with rail loading plans to identify discrepancies.

Longer term (likely next program year), additional requirements are:

1. Provide a capability to create a plan of ship loading order ("ship load plan") from an ICODES ship stow plan.
2. Provide a capability to create a rail load plan from a ship load plan. This will plan the rail loads so that the arrival order of unit equipment at the port can be "just in time" for loading onto the ship.
3. Provide a capability to re-plan in response to incremental and partial changes.
4. Provide a capability to re-plan in response to rail conditions, such as rail cars that are left behind due to mechanical problems or trains that arrive out of sequence.
5. Provide a capability to identify mis-matches in rail load and ship stow plans and to suggest rail operations that will correct the problems.

Appendix C contains the design by storyboarding parts of the SM21 Web Portal Surge Deployment collaborative interface as a path through the screens (i.e. a scenario) indicating typical use.

5.0 DETAIL DESIGN OF THE TWO INTERFACES

The technical paper that is the main body of this report describes the detailed design of the two interfaces. Also, the SharePoint 2007 sites are active on the GSC Associates Web Portals Server and the interfaces can be viewed there. Please contact Dr. George S. Carson (+1-303-388-6355; carson@gscassociates.com) to request access to this site.

6.0 WORKING PROTOTYPE OF SOFTWARE

The technical paper located at Appendix C describes the working prototype software.

7.0 THE WAY AHEAD

7.1 Overview

During the follow-on program year, the initial development of the two collaborative interfaces described in this report will be continued to support military force deployment and regional planning demonstrations. In addition to deploying the beta Web Portal for Regional Planning and Surge Deployment, next year's planned design approach includes analysis to identify additional capability gaps for development and demonstration in FY2009.

7.2 Web Portal Architecture Definition (AD) Refinement and Documentation

The first step in the follow-on program year will be to deploy the Web Portal development completed during the current program year to a designated SM21 Web Portal location. After initial review by the SM21 internal stakeholders, the existing system will be made available for external stakeholder review. As the primary military stakeholder and Agile Port System demonstration sponsor, the United States Transportation Command (USTRANSCOM) will be requested to designate the military force deployment stakeholders to review and comment on the current and projected design. The objective of this review is to ensure the program sponsor and their stakeholder[2] force deployment needs and concerns have been captured. Likewise, working with the Southern California Association of Governments (SCAG) and the Southern California Logistics Airport (SCLA) Authority, we will request a review of the regional planning capabilities defined in this document to ensure we have captured the proper regional planning functions.

Once the internal and external military and commercial stakeholder reviews are complete for the initial two Web Portal interfaces, other supporting internal design documents will be reviewed for validity. Both the Integrated Tracking System (ITS) Analysis and Concept Design and the Inland Port - Multi-Modal Terminal Operating System Design Specification developed during the current program year as separate deliverables will be reviewed and evaluated by the designated SM21 Chief Engineer and the design team. Any required revisions to the architecture to meet the stakeholder needs and correct problems found during the review process will be described in an SM21 Web Portal Architectural Description (AD) for the second round of development. A key aspect of the AD will be system security requirements to ensure both commercial and military information security requirements and concerns are satisfied as the system matures through continued development. The AD will consolidate the content of the Web Portal Design, the Integrated Tracking System (ITS) Analysis and Concept Design, and the Inland Port - Multi-Modal Terminal Operating System Design Specification into a single design document.

7.2.1 Surge Deployment Web Portal Continued Development

Following the general plans outlined in paragraph 7.2, the continued development and testing of the Surge Deployment Web Portal is critical to the success of the initial SM21 Service Oriented

[2] USTRANSCOM designated stakeholders will most likely be the Surface Deployment and Distribution Command (SDDC), the Military Sealift Command (MSC), and the Joint Forces Command (JFCOM). The exact stakeholder list will be developed by USTRANSCOM in their role as the force deployment demonstration and capability sponsor.

Architecture capability demonstration. This capability is required as soon as practical after the beginning of the new program year so that testing can begin in advance of the USTRANSCOM sponsored Agile Port System (APS) Force Deployment demonstration.

The first development to take place will be the Web Portal interface with ICODES. This interface will be established through a web service interface to be provided by ICODES. This interface will provide visualizations (as SVG files) of ship load plans along with associated entity data. In addition to the development of the web service interface, the following Surge Deployment functionality is required to be developed for a successful capability demonstration:

- Establish a link back to ICODES so that a user can use ICODES directly to modify ship stow plans.
- The ability to display unit equipment lists received from TC-AIMS II (will require a data interchange arrangement with TC-AIMS II).
- The ability to display preliminary rail plans received from TC-AIMS II.
- An interface that allows a human user to compare a ship stow plan with rail loading plans to identify discrepancies.
- Development and testing of the capability to create a plan of ship loading order ("ship load plan") from an ICODES ship stow plan.
- The capability to create a rail load plan from a ship load plan. This will plan the rail loads for both rail car ordering requirements, and the definition of the arrival order of unit equipment at the port for loading onto the ship.
- The capability to re-plan in response to incremental and partial changes.
- The capability to re-plan in response to rail conditions, such as rail cars that are left behind due to mechanical problems or trains that arrive out of sequence.
- The capability to identify mis-matches in rail load and ship stow plans and to suggest rail operations that will correct the problems.

Current planning requires that this development begin as soon as possible after the beginning of the new program year.

7.2.2 Regional Planning Web Portal Continued Development

Concurrent with the Surge Deployment capability development and following the general plans outlined in paragraph 7.2, there are plans to expand the Regional Planning capability defined in this document. This development will be guided by re-interviewing and reviewing the regional stakeholder requirements. The expanded stakeholder list is likely to include the Southern California Logistics Airport (SCLA) Authority, SCAG, marine terminals, intermodal centers, and the Class I railroads.

The expanded Regional Planning Web Portal design, development, and demonstration for the follow-on program year include:

1. Prototype development and testing of the common user interface that supports developing networks (sets of nodes and arcs) as well as data associated with network elements (such as cost functions, delay characteristics, transit times, etc). This will be the common framework around which SCASN simulations are defined and configured as well as the optimization analyses and other functionality that may be added in the future. The intent

is to provide a vendor-independent front end that can be used over technologies such as Arena that are too arcane for direct use by non-experts.

2. Develop, test, and demonstrate a common user interface for presenting and comparing the results of analysis, simulation, and model "runs". Again, the intent is to provide a vendor-independent front end that can be used over technologies such as Arena and MATLAB etc. that are too arcane for direct use by non-experts.
3. Supporting the SM21 program, SCLA, and SCAG, employ the beta version of the Regional Planning Web Portal for defining the capital investment requirements for the build-out of appropriate additional infrastructure within the Southern California area.

The major justification for new infrastructure is achieving higher container throughput through the ports, with various secondary justifications such as reduction of the environmental and congestion impact of container shipments on the region. The Regional Planning capabilities of the Web Portal will support the evaluation of the many potential solutions to these problems. The effects of implementing an individual solution, and especially the interactions among the multiple solutions, are very difficult to visualize and understand, and therefore there is a need for a collaborative interface to support such regional planning.

7.2.3 Integration of Commercial Services

The integration of commercial services into the Web Portal will be guided by a review of the SCLA stakeholder functional requirements and the identification of gaps between commercial applications supporting the SCLA stakeholders. The design process developed for the initial two interfaces will be employed for the development of the commercial service developed and deployed by SM21. Collectively these commercial and military services become IP-MTOPS.

7.2.4 Commercial Experimentation to Identify Required Services

The identification of the services required at the SCLA prototype JDDSP Web Portal will be identified during the commercial distribution network experimentation process with Dole Foods and potentially Rubbermaid. The experimentation platform to be employed for the experimentation is identified in the Integrated Tracking System (ITS) Analysis and Concept Design. Gaps found between the deployed systems and the commercial shipper's objective requirements will be identified. Services to fill the identified gaps will be considered for development and deployment through the SM21 Web Portal.

7.3 The Way Ahead – A Summary

Continued development of the Web Portal for Military Surge Deployment and Regional Planning support is important to the success of the SM21 program. This document provides a good start point to guide the continued development. While the basic document provides a good overview of what has been developed to date and what needs to be developed during the next program year, the published Web Portal report at Appendix D titled, "Collaboration in Regional and Military Transportation Planning" provides additional insight to the "how and why" the Web Portal should be developed. Feedback received during the presentation of the paper at the International Command and Control Research and Technology Symposium (ICCRTS): Adapting C^2 to the 21st Century indicated that the SM21 Program initial Web Portal design was on track with the leading C^2 systems designers and stakeholders.

APPENDIX A – REGIONAL PLANNING WEB PORTAL STORYBOARD

At the top level, a user sees the **Main Regional Planning Web Portal Page** in Figure A-1 below:

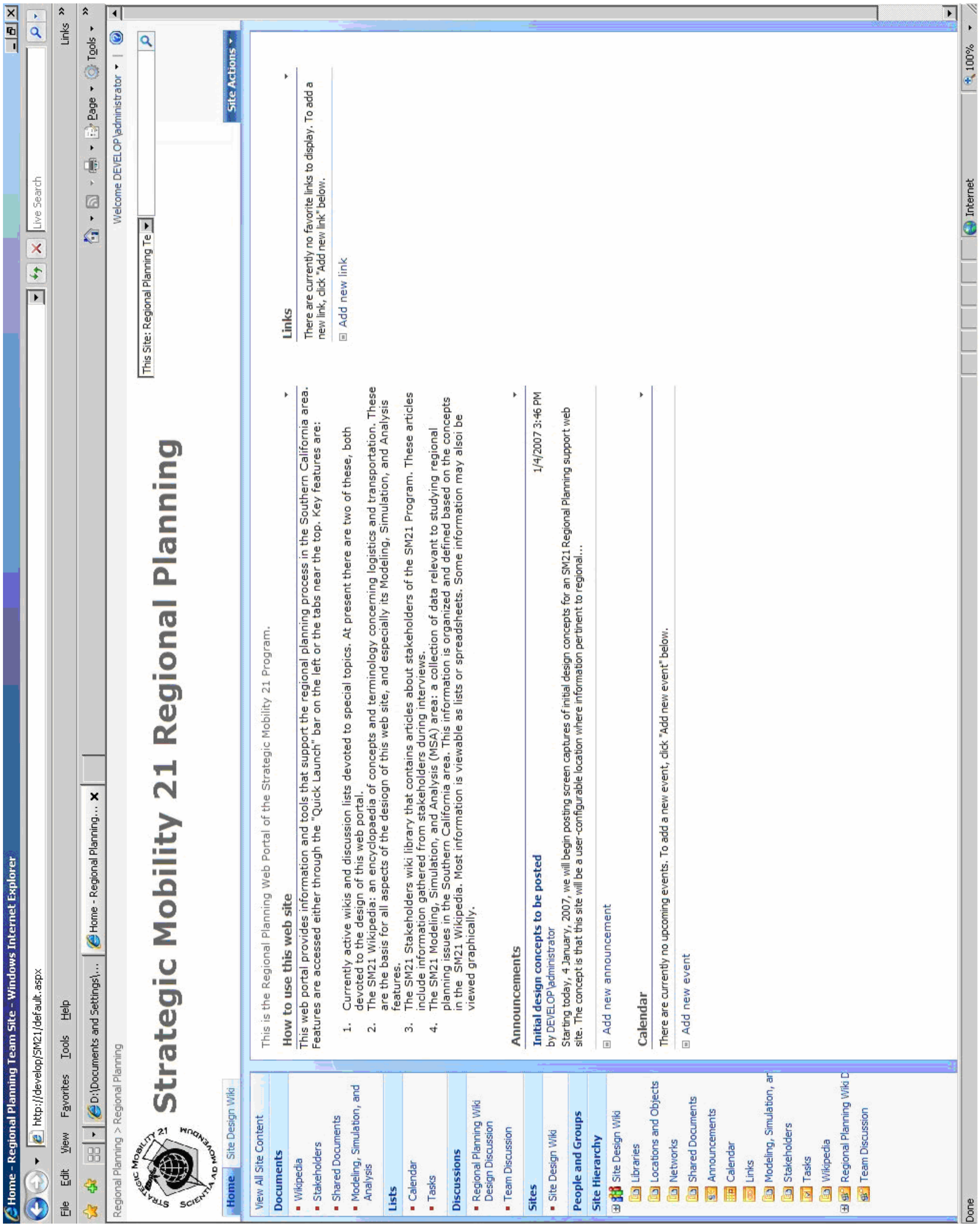

Figure A 1: Main Regional Planning Web Portal Page

From the Main Page (Figure A-1), the following elements of Regional Planning are visible:

- The SM21 **Stakeholder Wiki Library** (Figure A-2): The library pages contain stakeholder interviews along with the data from the interviews. Each library page also contains contact data and links to web sites. The Library will fill in over time.

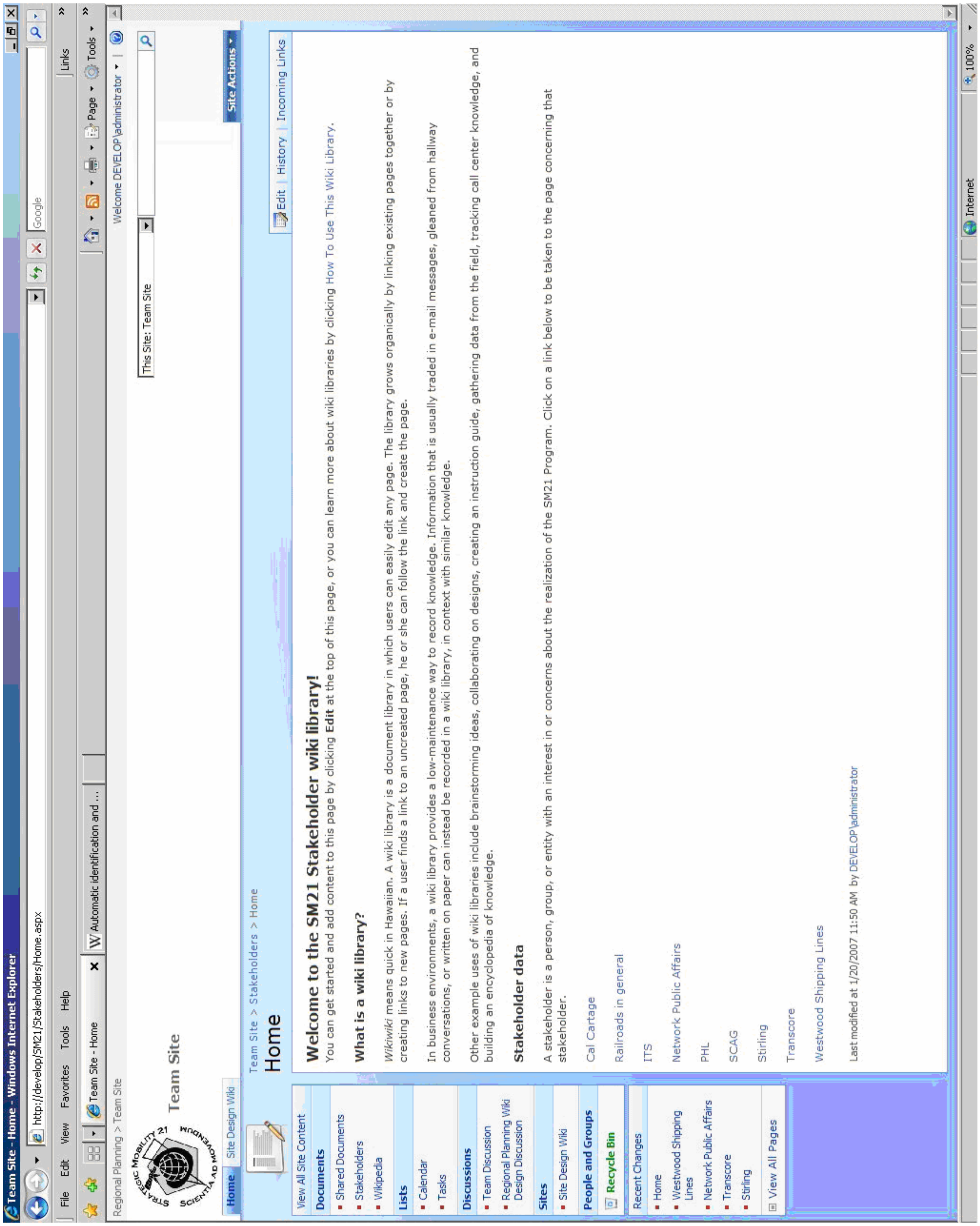

Figure A 2: The SM21 Stakeholder Wiki Library

Figure A-3 below is one example library page from the Network Public Affairs Interview:

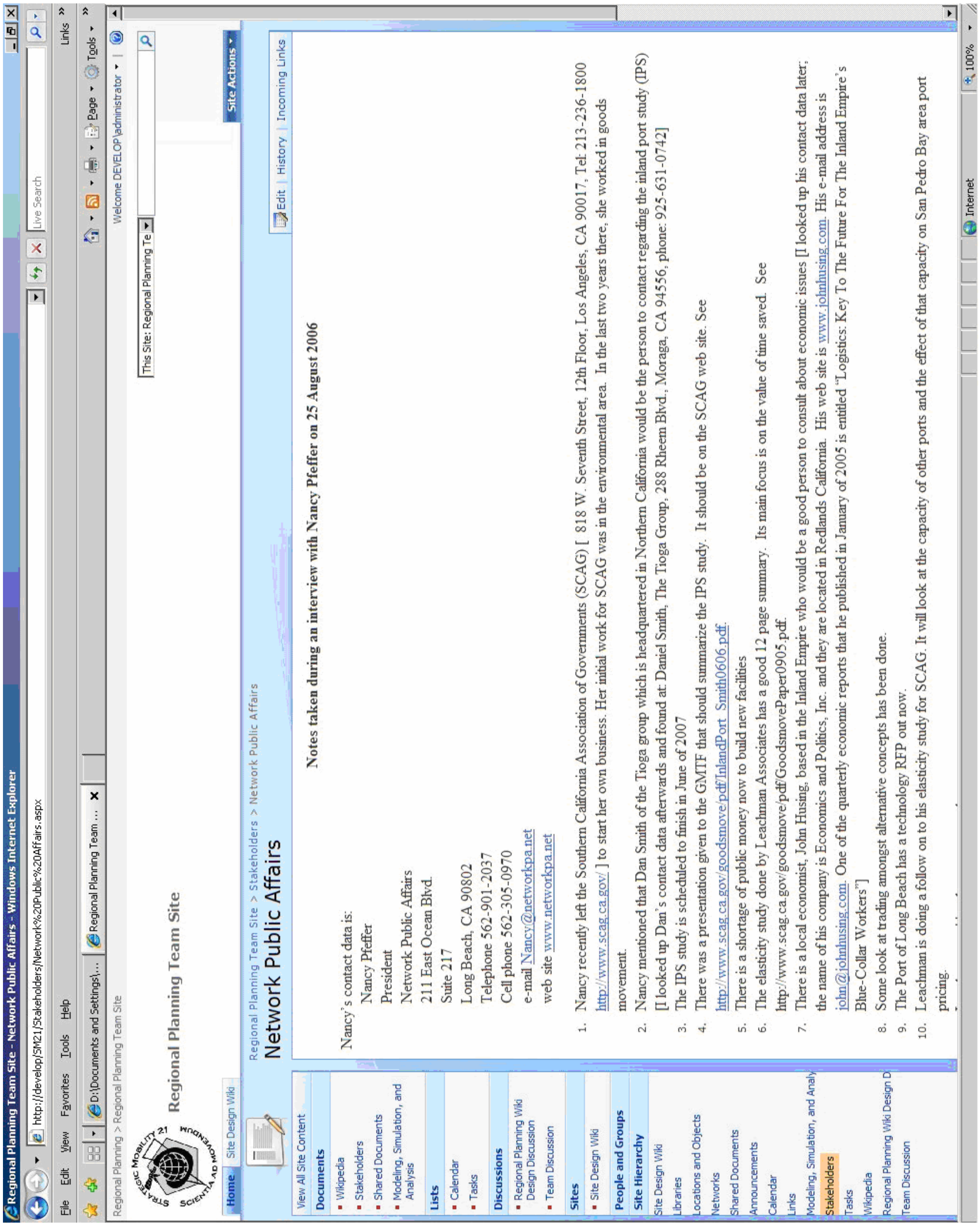

Figure A 3: Network Public Affairs Page (Example Stakeholder Data)

The SM21 Wikipedia is shown in Figure A-4. This Wiki Library is an encyclopedia that contains the "ontology" used throughout both SM21 wikis as well as general information about the specialized language of logistics and transportation. All concepts are defined in the wiki and related concepts are cross-linked. UML is used as the descriptive language where this is needed. Links to important sources of external information are included. These pages will also fill in over time. This page links directly to two indices, one alphabetical and the other topical. The main access to the Wikipedia is by using the search box on any page.

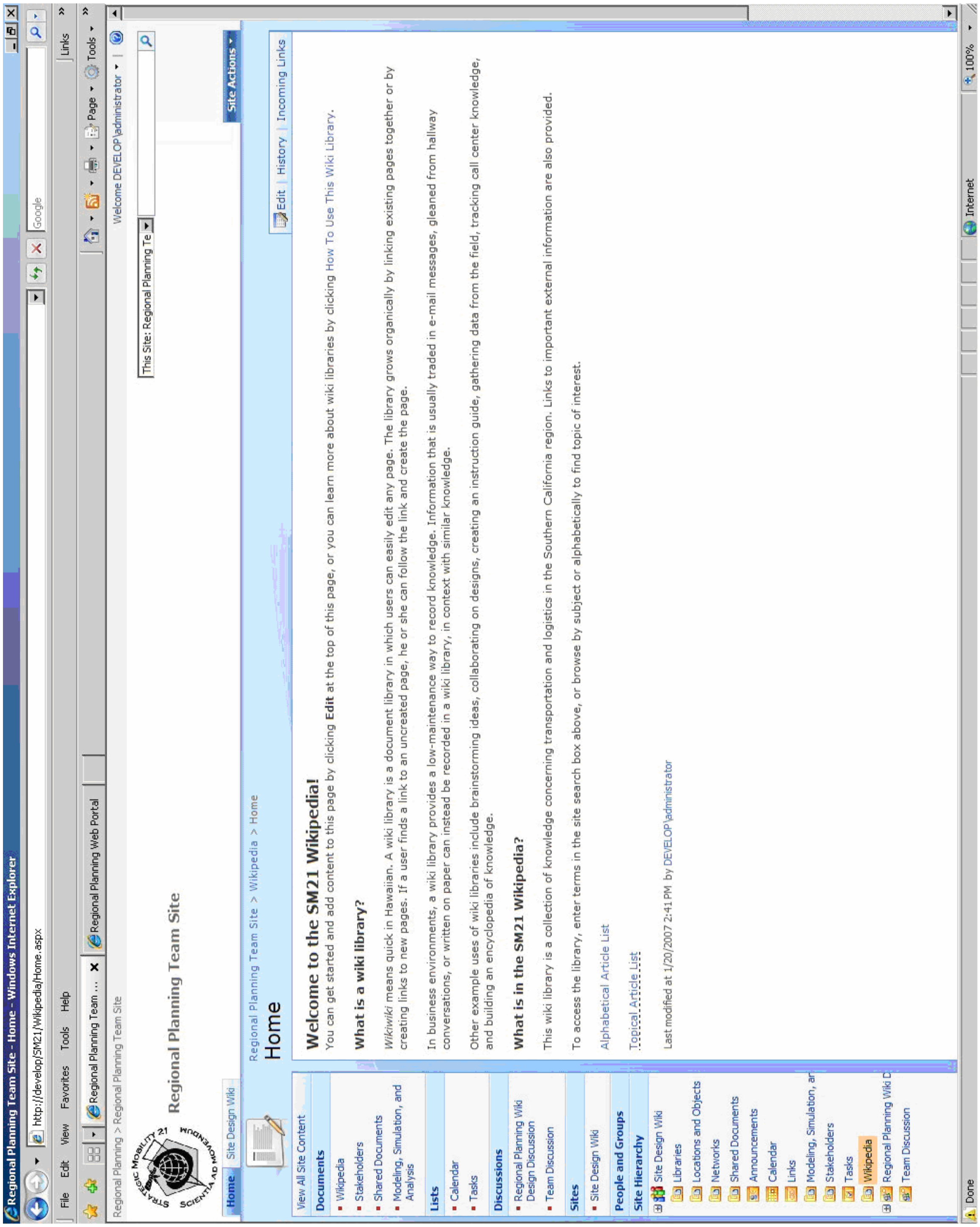

Figure A 4: The SM21 Wikipedia

The main alphabetical index of the SM21 Wikipedia (Figure A-5) provides a link to each wiki library page is listed in alphabetical order.

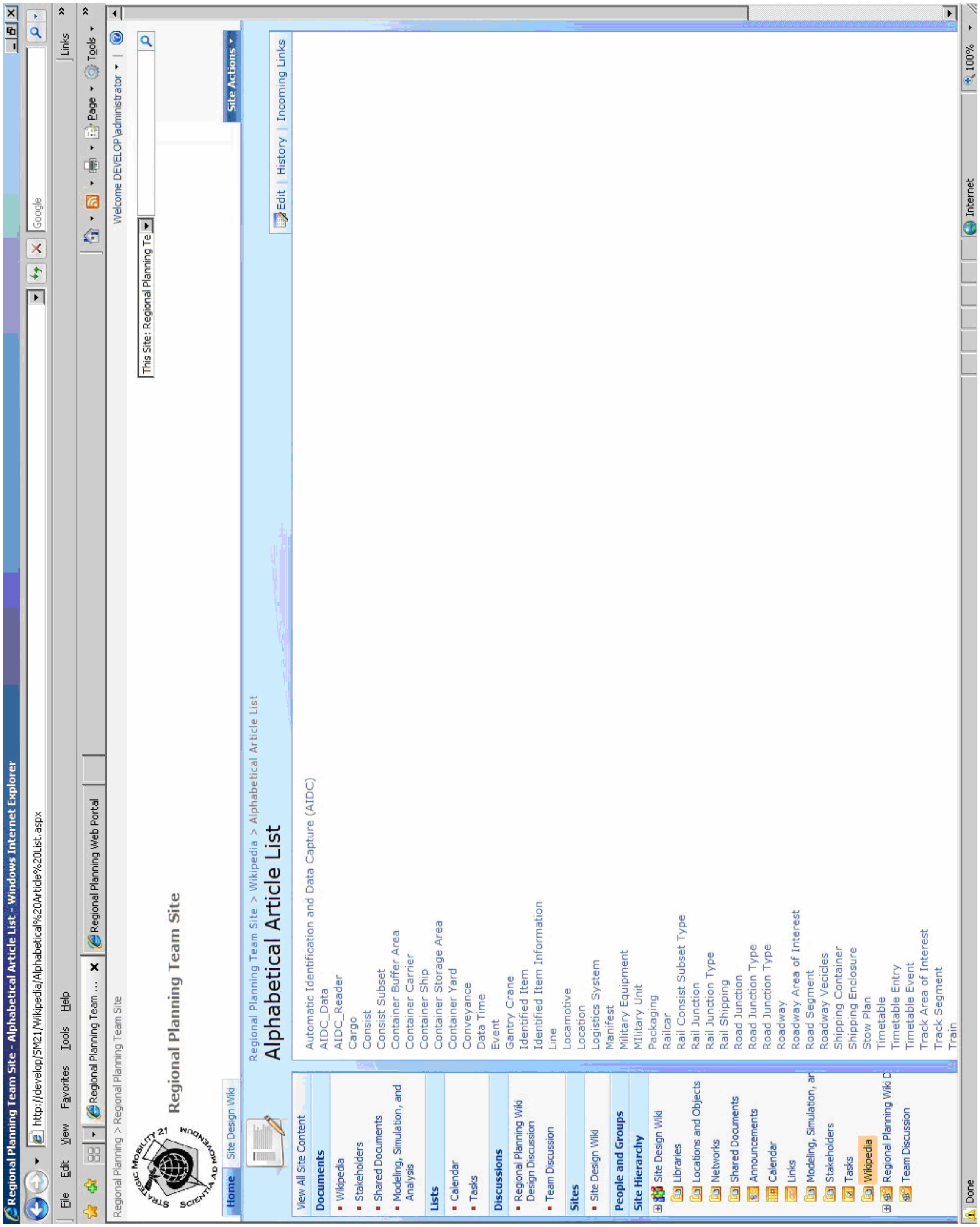

Figure A 5: Alphabetical Index

An example wiki library page is shown in Figure A-6. This page is on the topic of AIDC Readers. Its initial contents are from the project UML models. These pages will also fill in and evolve over time. Any user can edit this content, however all previous versions and complete revision history are maintained, so any undesired changes can be rolled back.

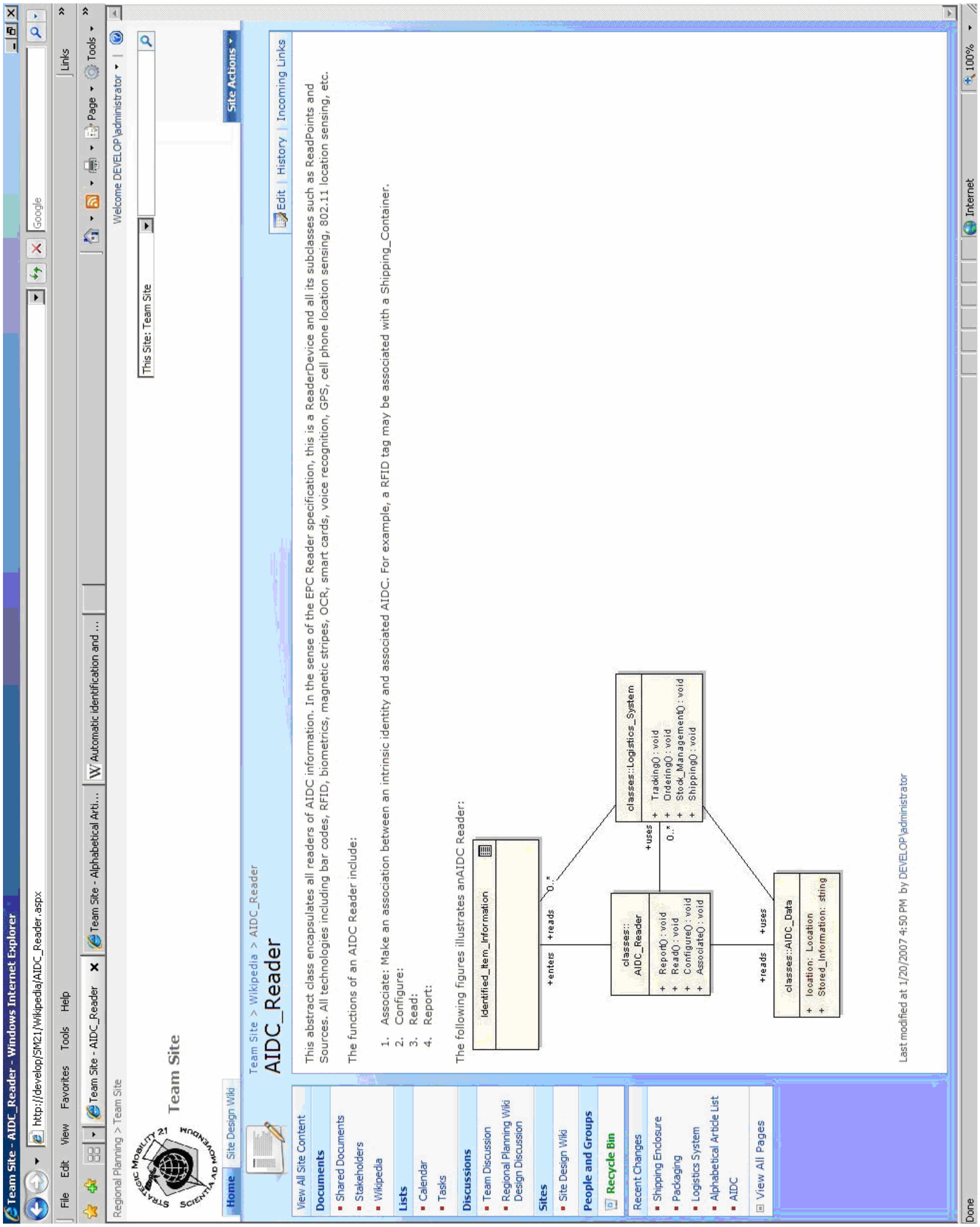

Figure A 6: Example Wiki Library Page

The topical index will list all pages in a taxonomic index. No screen shot is supplied.

The Shared Document Library (Figure A-7 below) is a place to upload and share documents. It is expected that documents will often be converted and merged with other content.

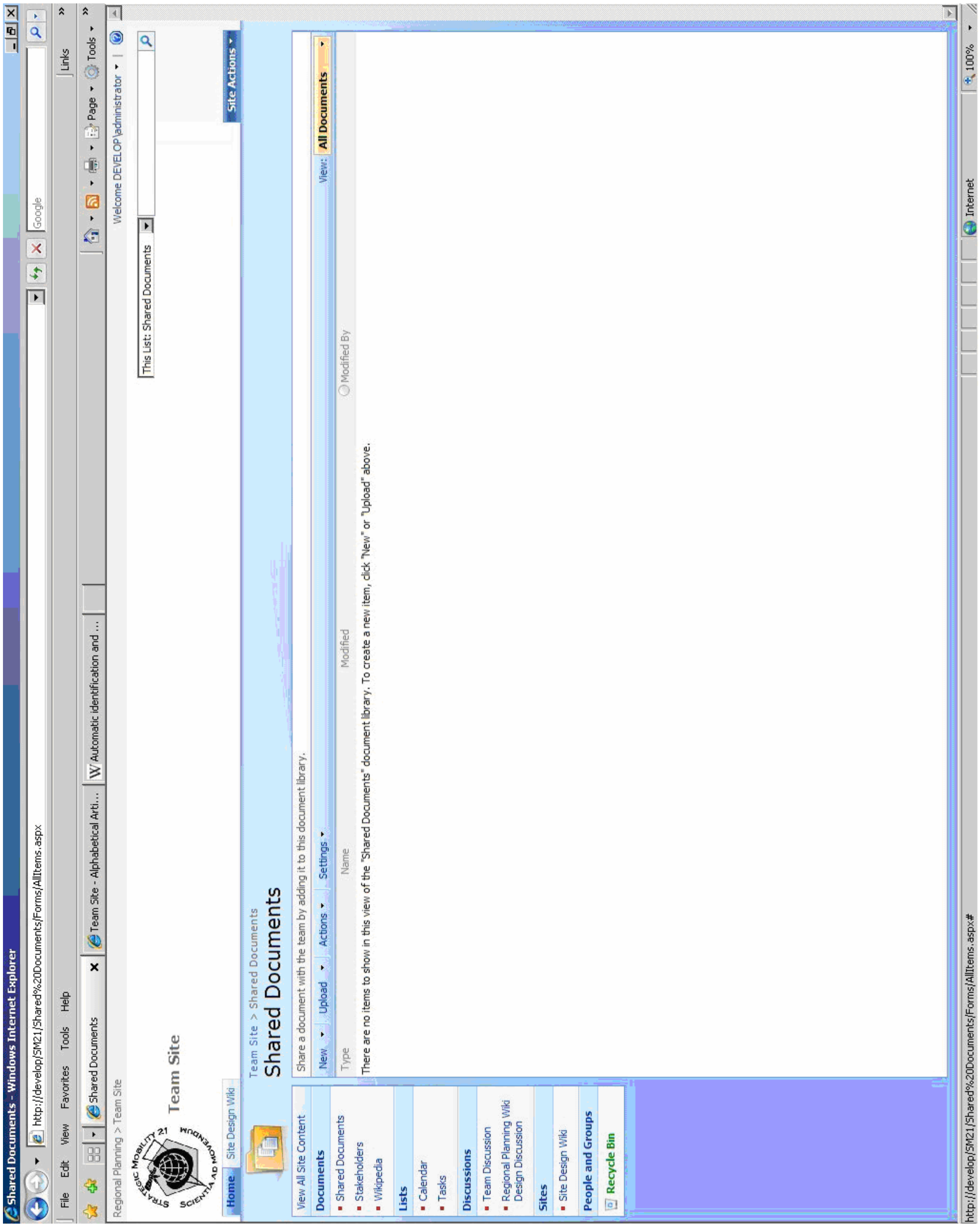

Figure A 7: Shared Document Library

Wiki Discussions is the place where discussions can be held. An example discussion of Regional Planning site design (Figure A-8) has been started.

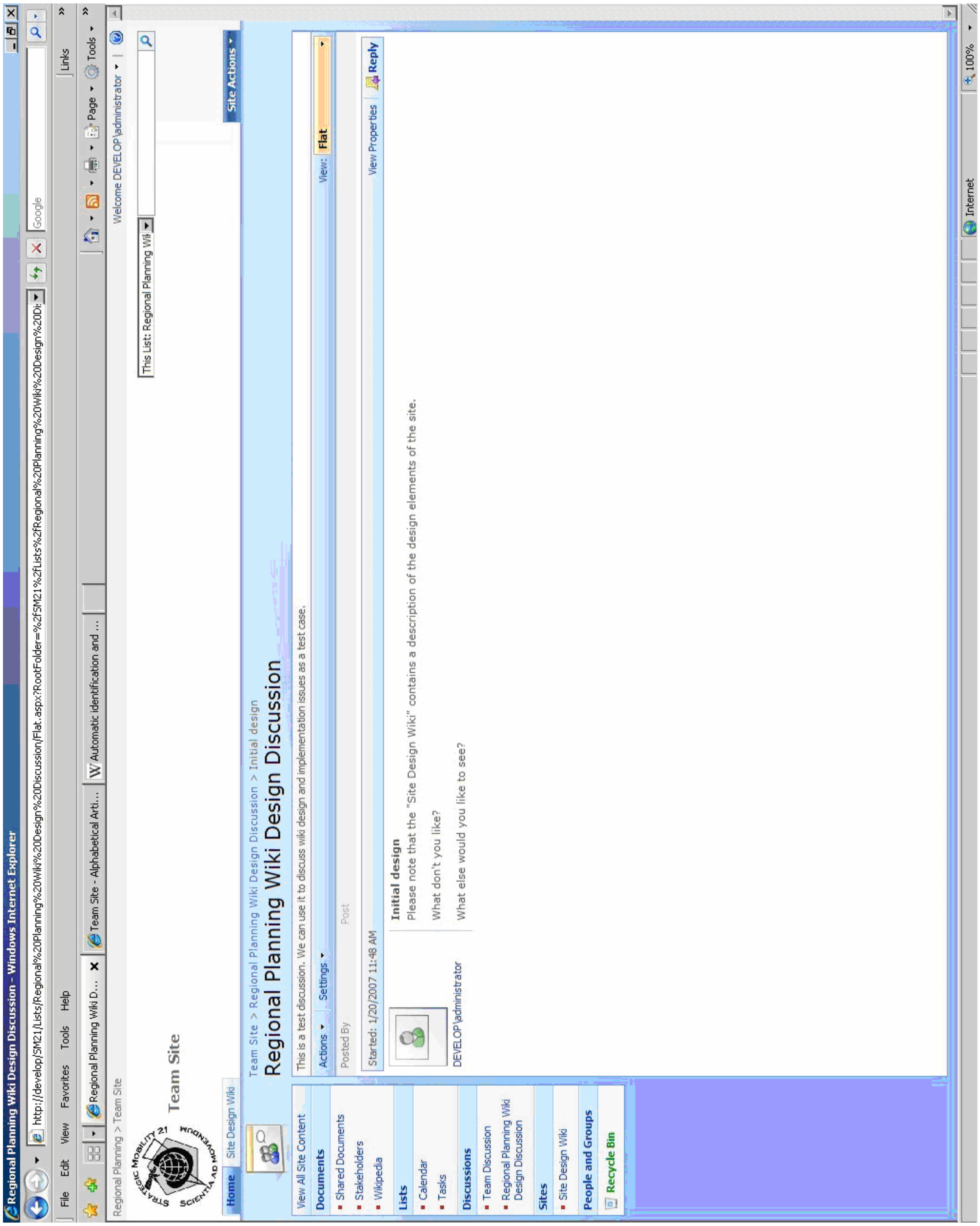

Figure A 8: Example Discussion of Regional Planning Site Design

The **Modeling, Simulation, and Analysis** (MS&A) pages (Figure A-9) is a wiki library page that will introduce how the site organizes MS&A data, how programs may be executed, and how data may be viewed. There is a hidden document library "SMA in SM21" that stores web parts pages. Most MSA data is organized in Excel spreadsheets, although some of it can be visualized in other ways also (for example, using Visio.) There is one web parts page per "document type" used in MS&A. Each web parts page will include a definition of the fields, an explanation of how fields work together to achieve a given function, and a list window listing the files of that type currently on the site. These lists can be sorted and filtered in various ways by a user.

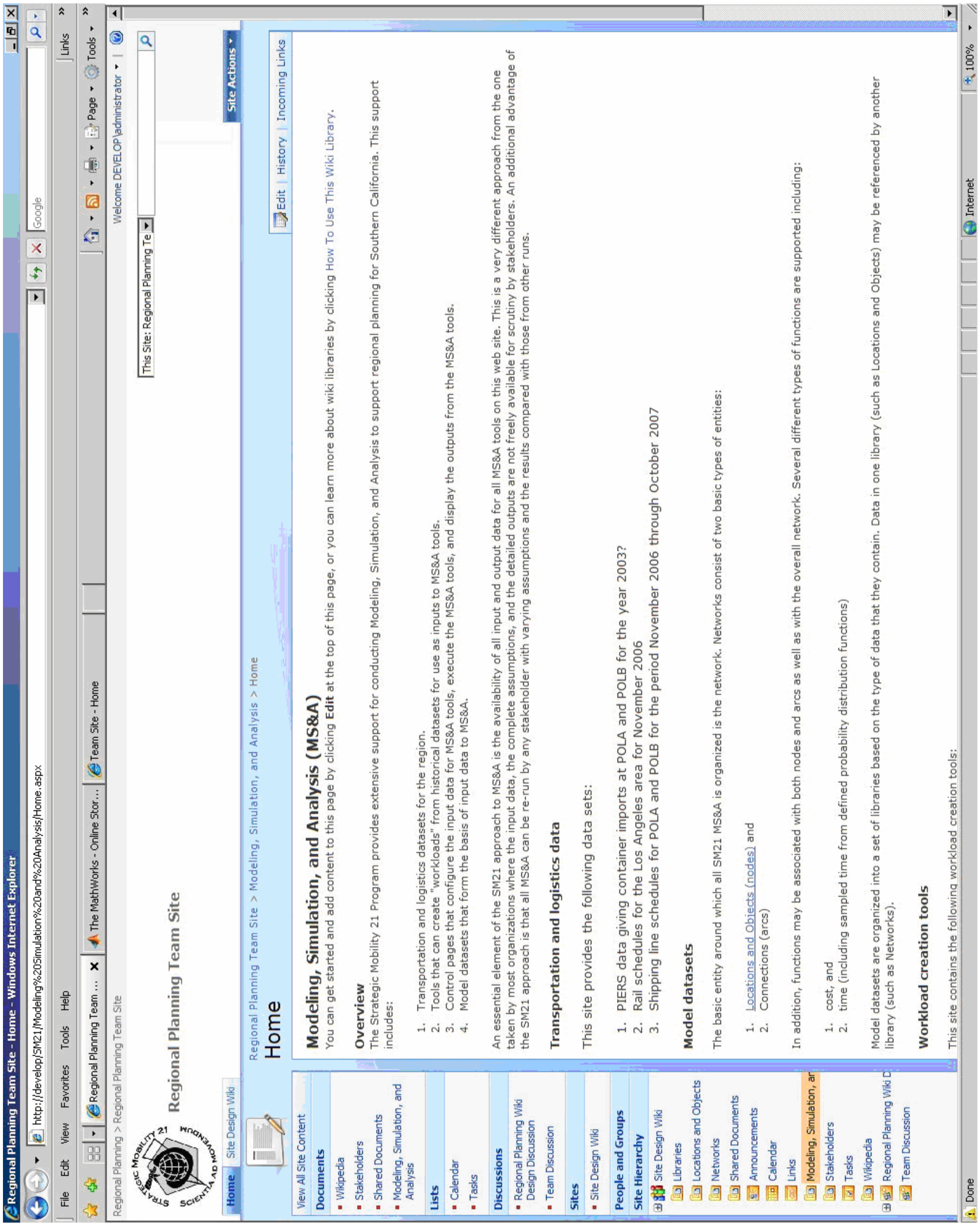

Figure A 9: Modeling, Simulation, and Analysis

The Locations and Objects page (Figure A-10 below) defines and gives access to the Nodes and Locations Document Library. It describes the format of each file in the library and gives a list of the files currently in the library. There will be a similar file for each library type.

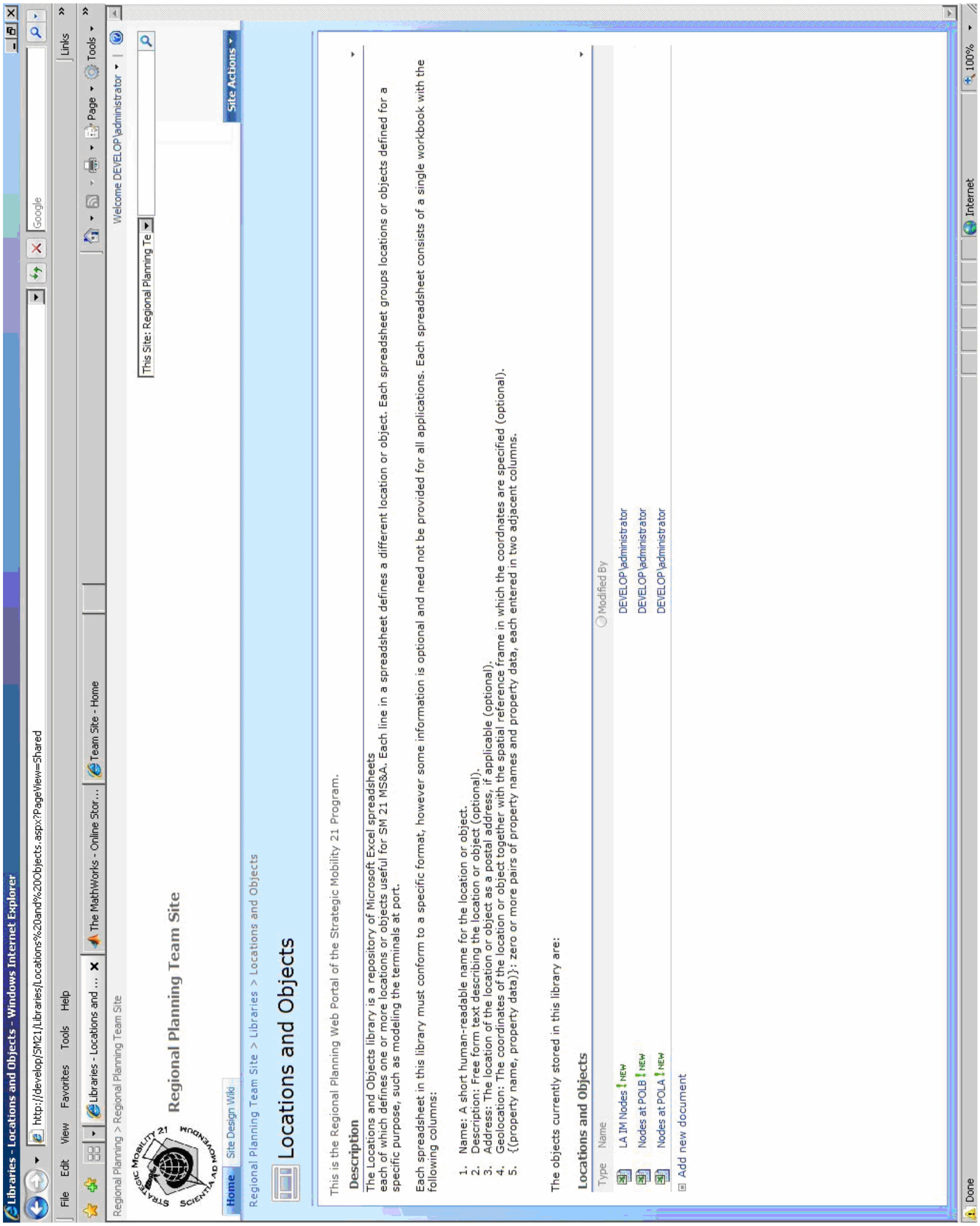

Figure A 10: Locations and Objects

The page “Nodes at POLB” (Figure A-11 below) is an example of an Excel spreadsheet in the Locations and Objects Library.

Name	Description	Address	Geolocation
LBA	POLB - SSA Terminals (LBA)	700 Pier A Plaza, Long Beach, CA 90813, (562) 491-4081, http://www.ssamarine.com	lon=-118.239477, lat=33.774635, datum=WGS84
LBS	POLB - SSA Terminals - Pier C	1521 Pier C St., Long Beach, CA 90813, (562) 495-8657, http://www.ssamarine.com	lon=-118.212054, lat=33.773672, datum=WGS84
LBU	POLB - California United (LBU)	1200 Pier E Street, Long Beach, CA 90802, (562) 435-8235, http://www.shipcut.com	lon=-118.209393, lat=33.765038, datum=WGS84
LBC	POLB - Long Beach Container (LBC)	1171 Pier F Ave., Berth F10, Long Beach, CA 90802, (562) 435-8585, http://www.lbcti.com	lon=-118.195553, lat=33.766162, datum=WGS84
LBJ	POLB - ITS (LBJ)	International Transportation Service (ITS), 1281 Pier J Avenue, Long Beach, CA 90802, (562) 435-7781	lon=-118.195553, lat=33.765877, datum=WGS84
LBP	POLB - Pacific Container (LBP and LBJ)	1521 Pier J Avenue, Long Beach, CA 90802, (562) 983-1001, http://www.ssamarine.com	lon=-118.192527, lat=33.74909, datum=WGS84
LBT	POLB - TTI (LBT)	301 Hanjin Road, Long Beach, CA 90802, (562) 256-2700, http://www.totalterminals.com	lon=-118.239305, lat=33.774599, datum=WGS84

Figure A 11: Nodes at Port of Long Beach

All pages contain a search box with a link to “Advanced search” also. The site uses "SharePoint Server for Search 2007" which has very advanced search capabilities, including customizable search engines and search based on metadata. Figure A-12 below shows the first page of search results page for a search on the term "Container".

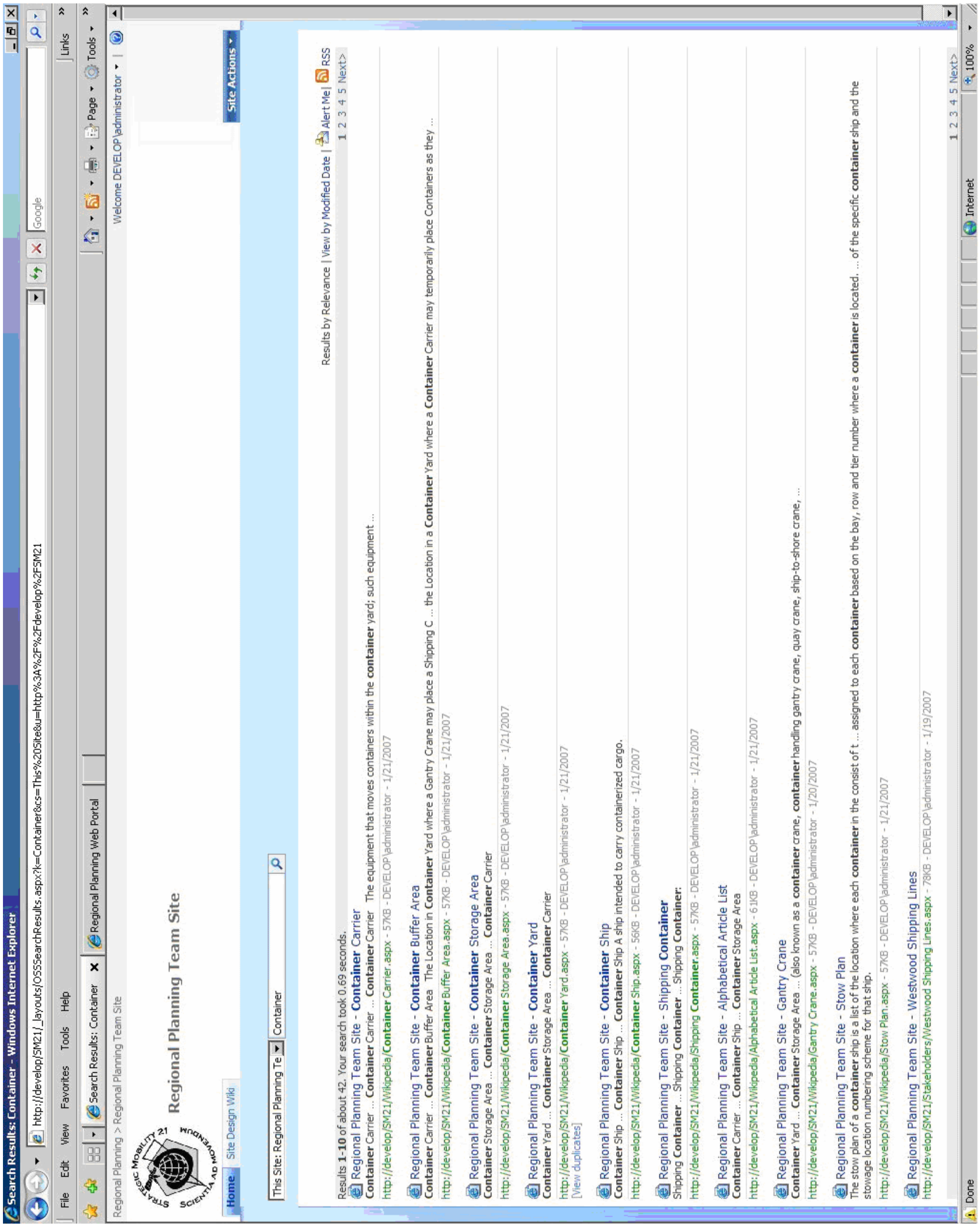

Figure A 12: Search Results for "Container"

APPENDIX B – MILITARY TRANSPORTATION PLANNING STORYBOARD

This appendix contains the design of the SM21 Military Transportation Planning by storyboarding parts of the SM21 Web Portal Surge Deployment collaborative interface as a path through the screens (i.e. a scenario) indicating typical use. The first screen is provided in Figure B-1 shows the main page – with one (example) deployment shown in the link bar across the top.

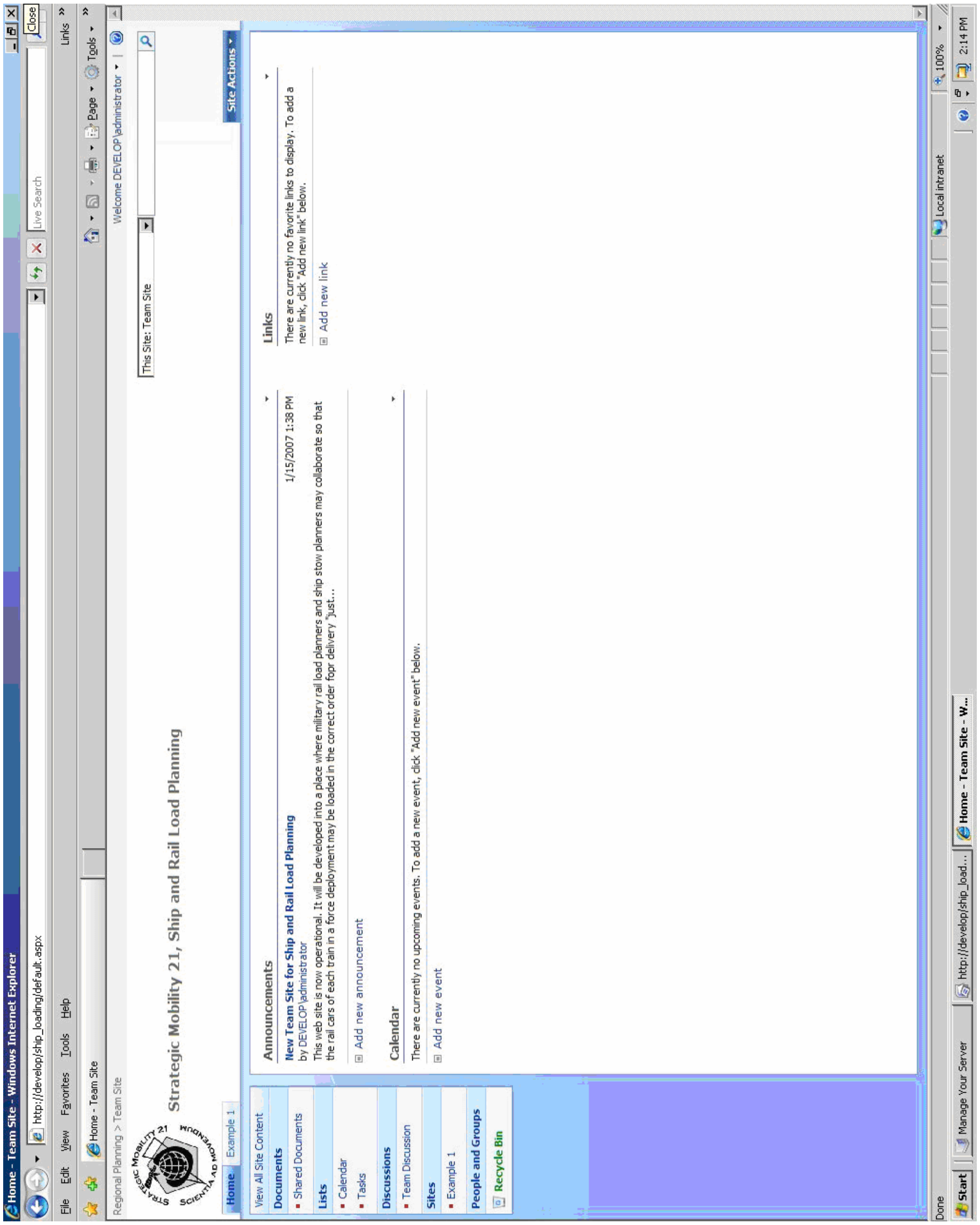

Figure B 1: Surge Deployment Main Page

Figure B-2 depicts the results of choosing the “Example 1” deployment in the top menu bar of the page. Across the top are two bars for the Ship Load Plan and the Rail Load Plan. This is a wiki page. More top menu items will be added in detailed design, including one that will include the functions for creating a rail load from a ship stow plan and one that creates a ship load plan from a ship stow plan.

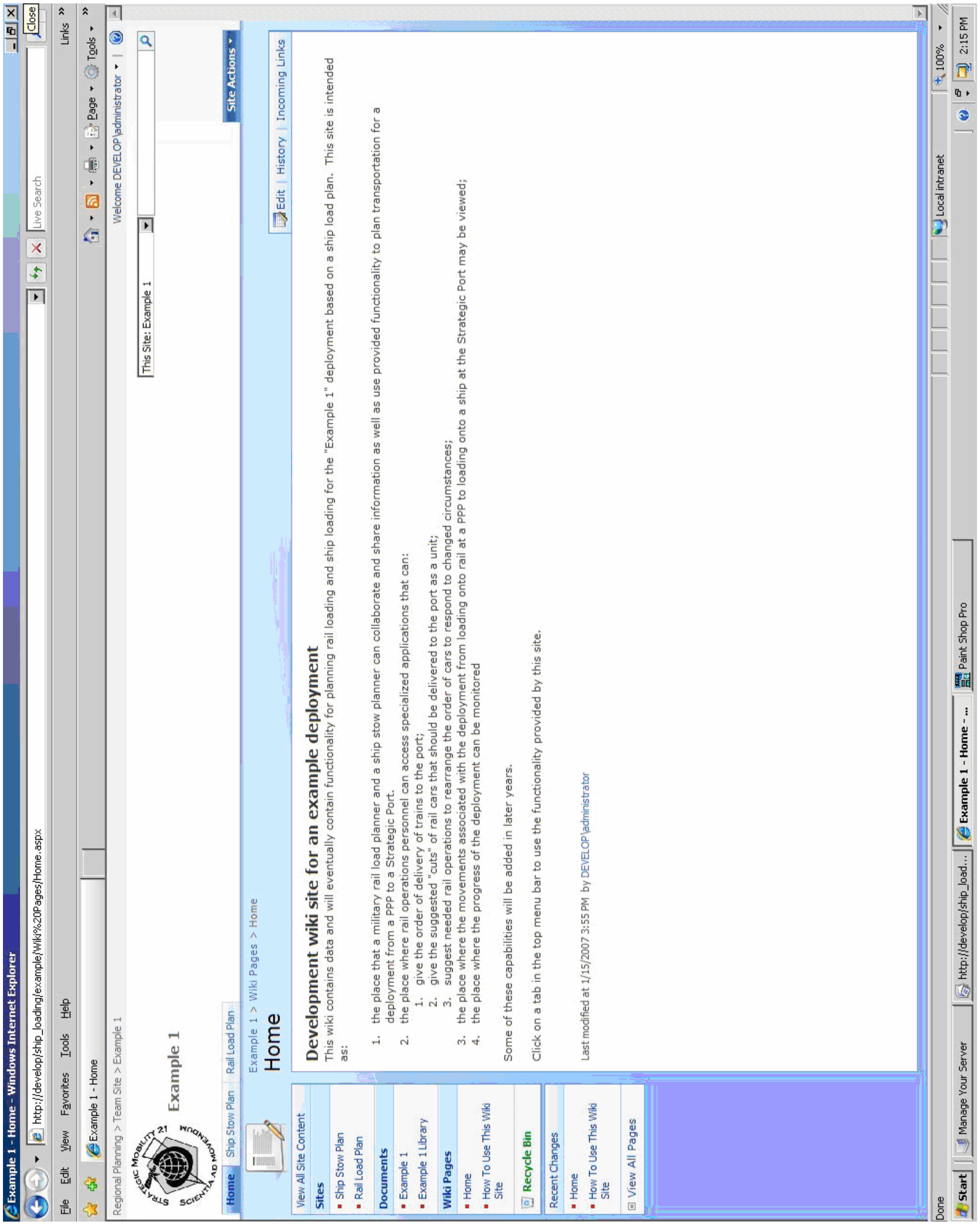

Figure B 2: “Example 1” Deployment

Figure B-3 shows the Ship Stow Plan page for the "Example 1" deployment. Detailed design will add better image controls that allow the Scalable Vector Graphics (SVG) image to be zoomed and panned. Figure B-4 illustrates the rather crude controls provided by the Adobe SVG viewer when you "right mouse" in an SVG image.

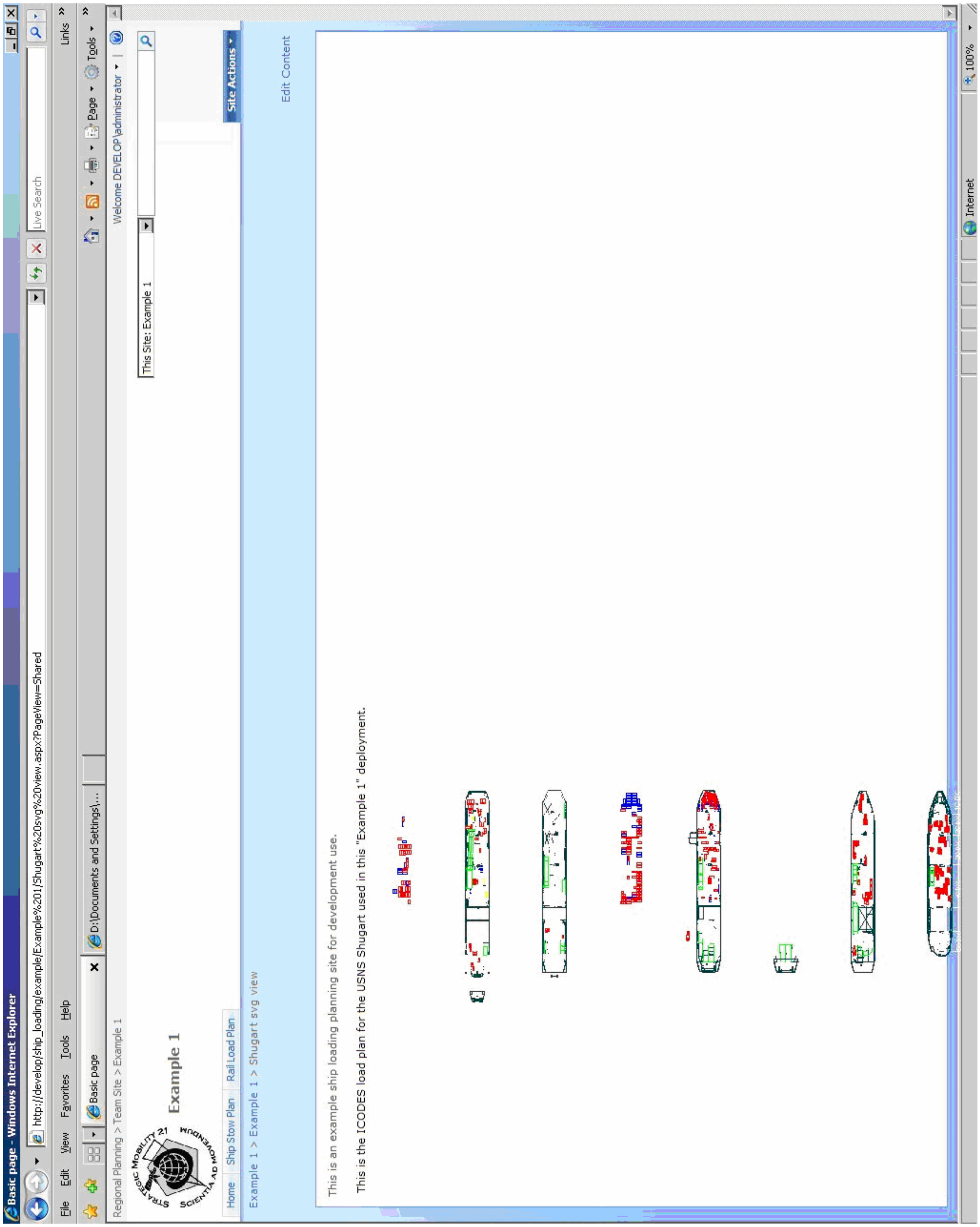

Figure B 3: Display of a Ship Stow Plan from ICODES

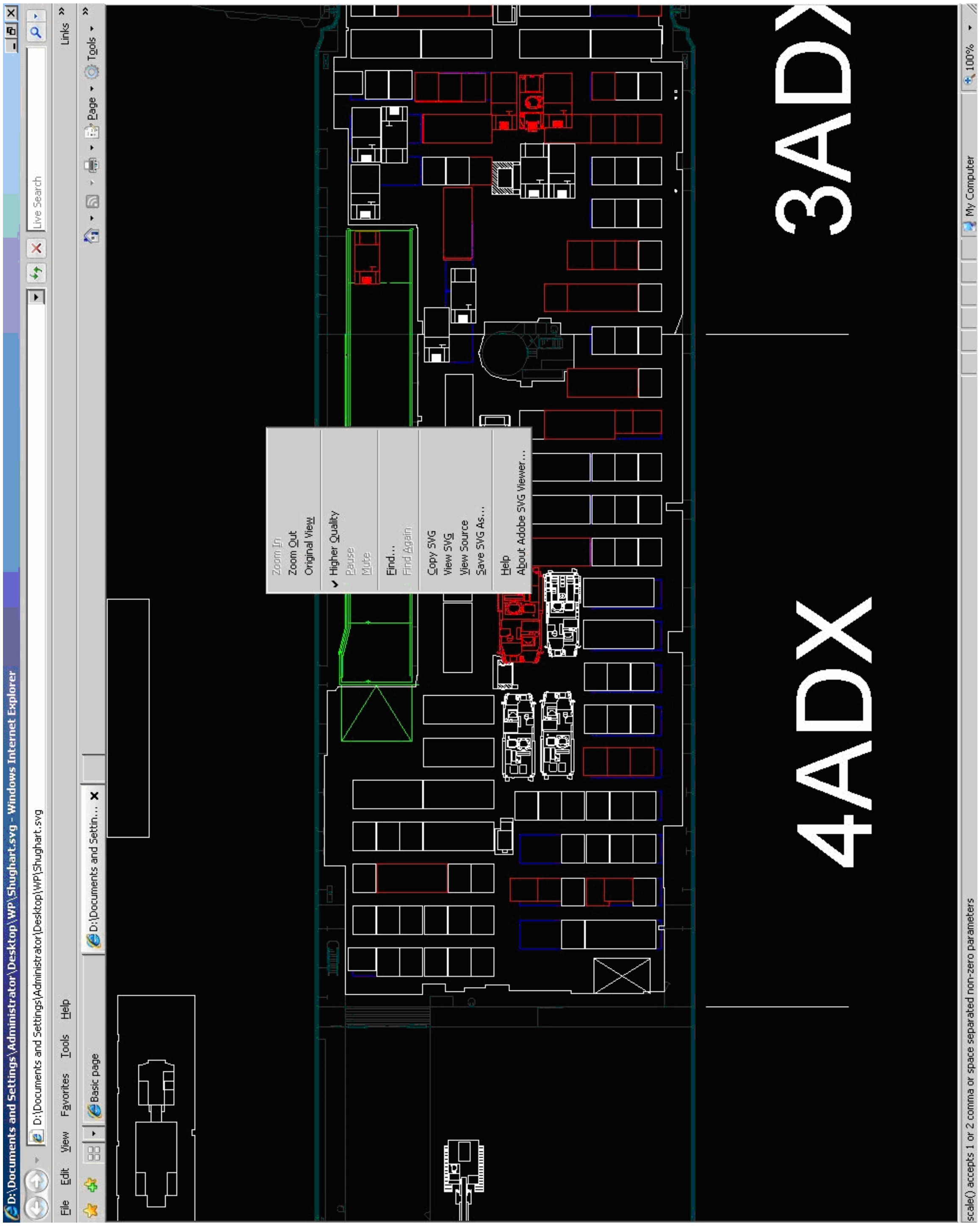

Figure B 4: Zooming in on an ICODES Ship Stow Plan

Figure B-5 is the list of all the equipment the "Example 1" deployment as received from ICODES. This was created automatically by SharePoint by importing an Excel spreadsheet from ICODES to create a SharePoint list object. All the code to edit and display the list in various ways is also created automatically by SharePoint. It takes about 10 minutes to create all this given an .xls file from ICODES as input. The correct column titles will be set during detailed design.

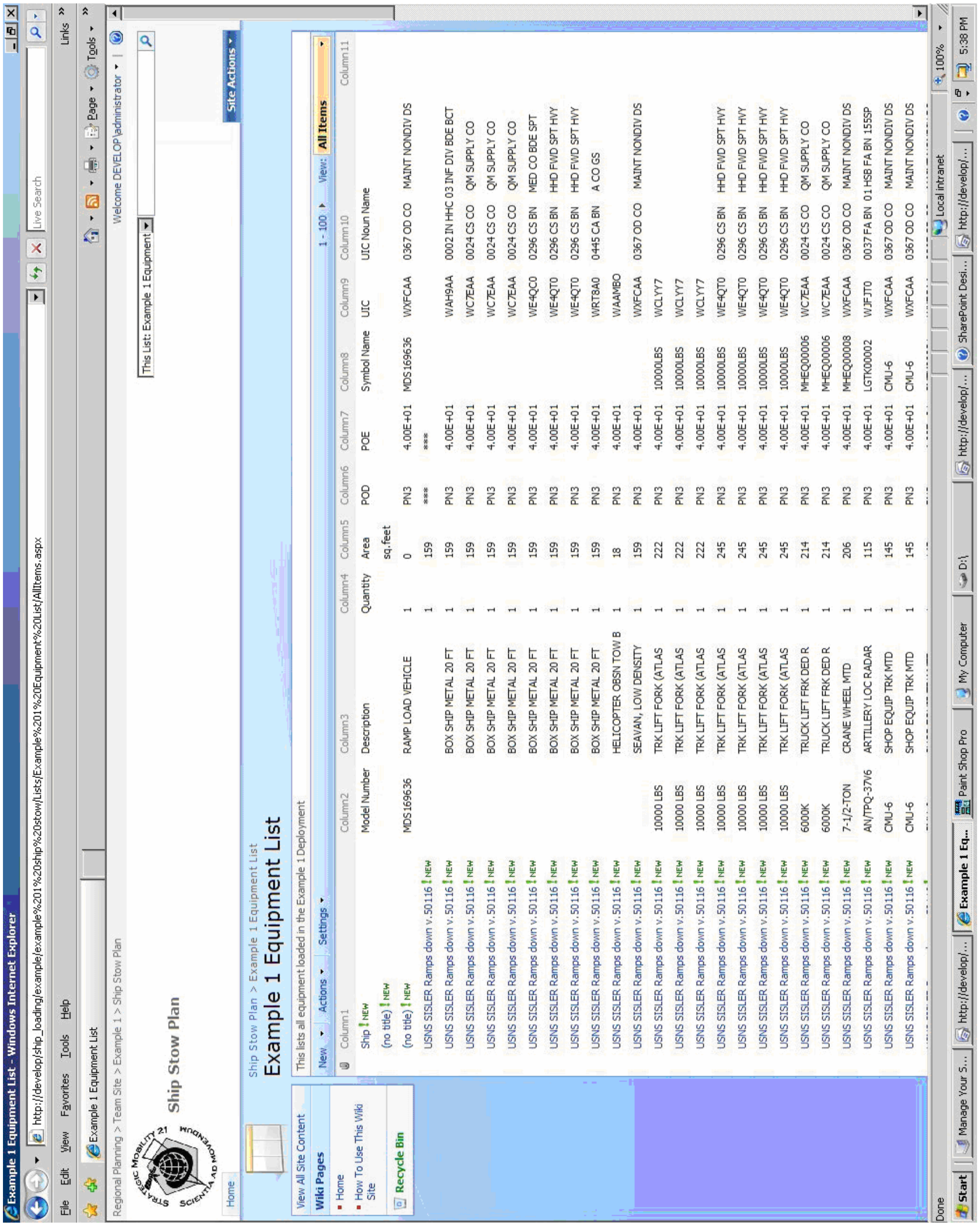

Figure B 5: Display of the "Example 1" Deployment Equipment as a List

Figure B-6 below is the Rail Load Plan page for the "Example 1" deployment. The additional details will be worked out during the next phase (detailed design) since needed data from the TC-AIMS II initial rail load planning module is not yet available to us.

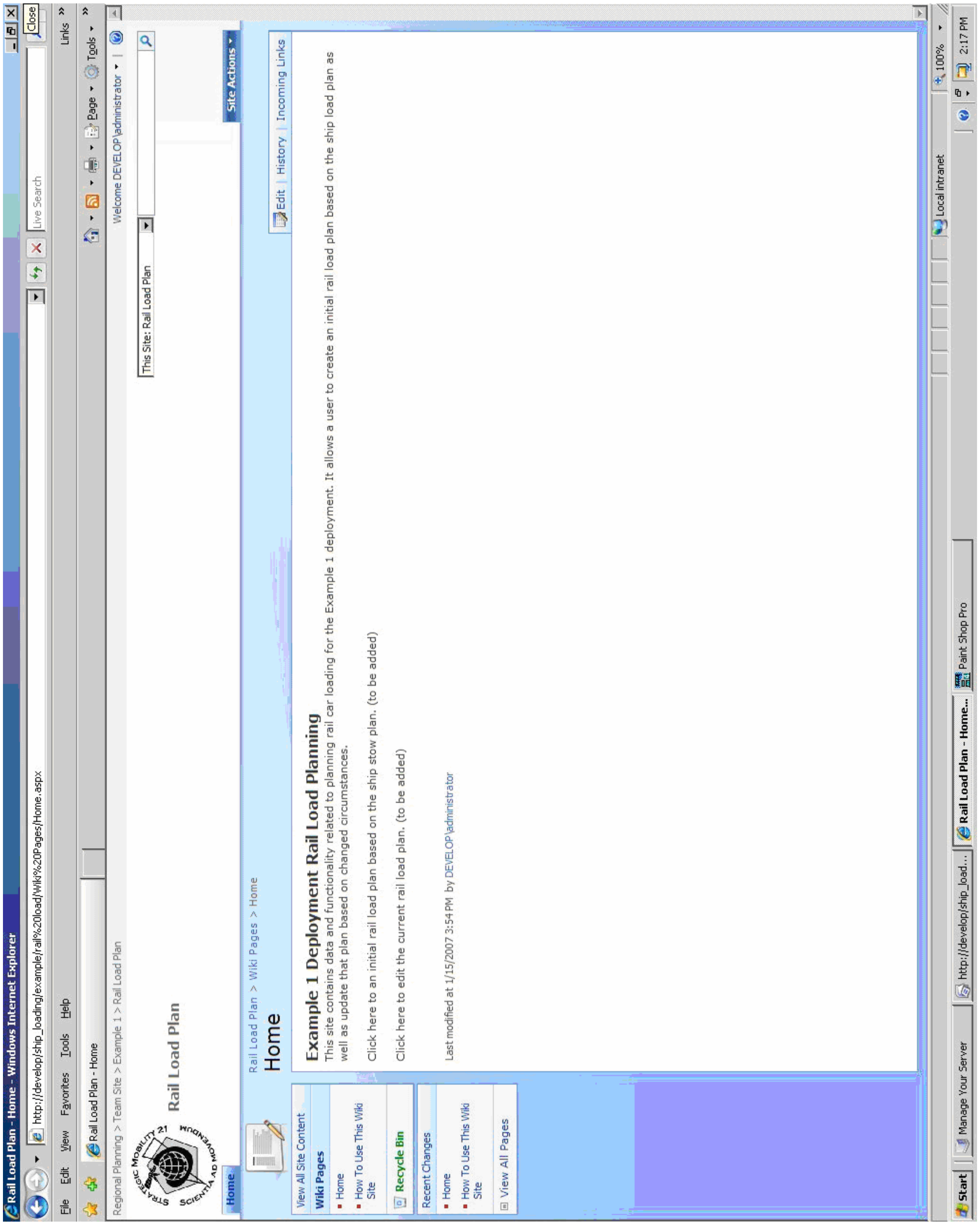

Figure B 6: Rail Load Plan Page

APPENDIX C - PUBLISHED WEB PORTAL PAPER

Note: The remainder of the page intentionally left blank. The published paper begins on the following page.

12TH ICCRTS
"Adapting C2 to the 21st Century"

Collaboration in Regional Civilian and Military Transportation Planning

George S. Carson
GSC Associates
2727 Xanthia Court
Denver, CO 80238
+1-303-388-6355
carson@gscassociates.com

Ed Savacool
Enterprise Management Systems, LLC
8210 Lone Oak Court
Manassas, VA 20111
+1-703-330-7852
esavacool@enterprise-management-systems.com

Collaboration in Regional Civilian and Military Transportation Planning

Abstract

The Strategic Mobility 21 (SM 21) Program[3] is investigating new concepts for improving the utilization of the strategic ports in Southern California for military and civilian purposes. Among project goals are justifying the building of new regional transportation infrastructure to double the present throughput of container shipments through the ports as well as to efficiently support the surge deployment and sustainment of US military combat assets through the ports. This paper describes how the SM 21 program is using web-based collaboration technologies including wikis, blogs; and Modeling, Simulation and Analysis tools to address two key program areas: a regional planning interface that makes data, models, and analyses available to all stakeholders in an interactive and configurable manner and a specific interface that enables collaboration between military land transportation planners and military ship load planners. A goal of both efforts is to make significant improvements in both how information is shared and how the consequences of different courses of action are explored.

[3] Acknowledgement of Support and Disclaimer: This material is based upon work supported by the Office of Naval Research under Contract No. N00014-06-C-0060. Any opinions, findings, and conclusions or recommendations expressed in this materiel are those of the author(s) and do not necessarily reflect the views of the Office of Naval Research.

1 Introduction

Included among the significant challenges in adapting C2 to the 21st Century are:

1. Enabling the re-use of at least portions of legacy systems in new developments. Such legacy systems are often monolithic, "stove-piped" designs not developed to play well with other systems.

2. Enabling effective use of modeling, simulation, and analysis (MSA) tools from domains not always considered in the past in military planning. This includes MSA tools useful for evaluating effects in all of the PMESII dimensions, not just the military dimension.

3. Making collaboration more effective by using rapidly evolving and increasingly effective commercial collaboration technologies such as document libraries, enterprise search, wikis, blogs, and workflow management.

The Strategic Mobility 21 (SM 21) Program is addressing these and other challenges as part of its experimentation with innovative concepts for improving the utilization of the ports in Southern California for both military and civilian purposes. SM21 project goals include:

1. conducting experiments and demonstrations of advanced logistics and transportation concepts, such as net enabled logistics;
2. assuring access to the ports of Los Angeles and Long Beach by the US military for surge deployment and sustainment distribution; and
3. developing a planning infrastructure to study alternative regional transportation concepts that can significantly increase the present throughput of container shipments through Southern California.

Among the concepts being investigated by SM21 is a new type of dual-use (military and civilian) facility called a Joint Power Projection Support Platform (JPPSP). If the concept proves feasible, the first JPPSP would be located at the Global Access facility that includes the Southern California Logistics Airport (SCLA) being built on the site of the former George Air Force Base near Victorville, California (http://www.logisticsairport.com/). This JPPSP would function as an "inland port", playing an important role in both commercial goods movement in the region and the staging and moving of military equipment and supplies to the ports.

The SM21 program believes that significant changes in both business processes and in functional capabilities will be required to achieve project goals and justify the creation of the first JPPSP. Specifically:

1. The ability of all stakeholders to better understand and evaluate alternative transportation and logistics concepts will be enabled by the creation of an effective collaborative environment for regional planning.

2. The impact of military usage at the ports on simultaneous civilian use will be significantly reduced by implementing new processes for loading military equipment onto strategic sealift ships as well as for planning and managing the transportation of that equipment to the ports.

This paper describes the "web portal" developed by the SM21 program to achieve the above objectives.

2 The opportunity

2.1 Regional planning

Today, collaborative regional planning takes place over long periods and is based on stakeholders reviewing “paper” reports produced by contractors. Each report typically takes 12 to 18 months to produce. The underlying data and assumptions in these reports are almost never made public, hindering the ability of others to understand the results and how these results were derived. There is an urgent need to change the situation by establishing a collaborative environment where all data, models, simulations, and analyses are publicly available for scrutiny along with the results derived by them. Interested parties who read the research as well as the collaborators participating in the research require the ability to modify input data and model assumptions and to rerun any underlying simulations or analyses and compare the results with previous runs. Publishing research results only as a static report makes such a capability unavailable.

The SM21 program has realized that today’s technology presents an opportunity to change the nature of the regional planning process. Planning products can now be living documents, created and published on collaborative web portals. The publications can be “live” in the sense that important information needed to create them as well all the modeling, simulation, and analysis tools used in their creation can be made available to stakeholders. In particular, far-reaching exploration of alternative future concepts for goods movement from the ports of Los Angeles and Long Beach into and through the Southern California region can be investigated and better understood. This will lead to an understanding of the benefits that a JPPSP in Victorville as well as other proposed transportation and logistics infrastructure investments would have in the region.

2.2 Military transportation planning

Today, military deployments can have a major impact on the operations of a busy commercial port such as the port of Long Beach. When a unit such as a Stryker Brigade Combat Team (SBCT) is deployed through such a port, all of the unit equipment is moved to the port and stored there before loading operations begin. The result is that between 20 and 30 acres of valuable on-dock space is occupied for many days by military equipment. After all the deploying equipment is staged at the port, ship loading operations are initiated without employing the full loading capability of the ship, a situation that typically adds days or more to the total loading time.

The SM21 program will substantially improve the current situation, once again allowing the US military assured access to important strategic ports. We will accomplish this by:

1. applying today’s technology together with selected process improvements,
2. the development of a small amount of new software,
3. the development of a few new interfaces, and
4. adding a new JPPSP that can serve as a “buffer”.

This opportunity will be created by coordinating ship and rail/convoy planning in such a way that equipment arrives at the port “just in time” and in the correct order to be loaded onto a ship.

As a result, the on-dock acreage required will be reduced to 5 acres or less and the entire ship loading process will be accomplished in less than two days.

2.3 Technology

In the past, tools to support collaboration have been scattered, special-purpose, and not well-integrated [FOUS]. For example, in our previous research [CARS], we used a single tool (a wiki) that we integrated ourselves with Instant Messaging and e-mail to conduct a study of collaboration in a joint forces planning environment. Today, well-integrated and highly functional suites such as Microsoft Office supported by SharePoint Server 2007 can connect people, process, and information together with a seamless set of integrated tools [MICR]. This makes it possible to deploy collaborative environments to support virtual organizations with minimal custom software development. We can now integrate collaboration, portals, search, content management, processes and forms, and intelligence with minimal effort and focus our research on providing value-added integration with legacy COTS and GOTS products.

3 Related research

Effective collaboration among disparate parties in a networked environment is viewed as a critical in the DoD's vision of network centric operations [ALBE1], [ALBE2]. Scott and others [SCOT] have evaluated the effectiveness of traditional commercial collaboration technologies such as email, instant messaging, video and desktop conferencing in a military command and control environment focusing on achieving activity awareness in on-going activities. Our present research differs in that we are looking at longer-term collaborations that take on the order of weeks or months to accomplish and that require access to substantial amounts of supporting data and information as well as to modeling, simulation and analysis tools.

Many papers, notably Fouss and Chang [FOUS] have developed taxonomies and classifications of collaborative tools. Among these tools, both others and we have evaluated wiki technology as a tool to support collaboration. Scott and his collaborators reported "Wiki-style collaborative efforts work within communities of users because they establish systems of trust and reputation" [SCOT]. The well-known Wikipedia project started in 2001 and currently the English edition contains about 1.4 million articles, contributed by volunteers from all over the world [WIKI]. The GSA has developed the wiki-based COLAB [GSA], an open collaborative work environment (CWE) to support networking among communities of practice and demonstrated its effectiveness in several complex collaborative developments. Our own past research [CARS] developed linguistic techniques for evaluating the effectiveness of ongoing collaborations. The present research is distinguished because we incorporate wikis, blogs, discussion lists, and similar types of web-based collaboration and information tools as elements of an integrated approach to support collaborative work.

The UrbanSim work of Alan Borning and others at the University of Washington (http://www.urbansim.org/) uses a custom code base that emphasizes behavioral theory, using an explicit treatment of individual agents such as households, jobs, and locations, and a micro-simulation of the choices that these agents make over time [BORN]. It consists of a set of interacting component models that simulate different actors or processes within the urban environment. This approach is complementary to ours. Our Modeling, Simulation, and Analysis approach concentrates on integrating widely used tools and approaches in time-domain simulation (such as Arena [AREN]), cost based optimization of transportation systems (such as MATLOG used with MATLAB [MATL] and general purpose MILP solvers), and traditional economic cost modeling using business intelligence tools such as Microsoft Excel [EXCE]. Also, the approach taken by UrbanSim "requires exogenous input information derived from: population and employment estimates , regional economic forecasts, transportation system plans, land use plans, and land development policies such as density constraints, environmental constraints, and development impact fees" while our approach focuses on developing information such as this input data by collaborative work.

The Southern California Association of Governments has begun the development of the SCAG Regional Goods Movement Knowledge Base [SCAG]. This knowledge base provides a search engine that currently references about 195 papers and reports, however full text is not available for most of these at the time of this writing. Our research differs because our collaborative environment includes not only reports and papers but also the underlying data and tools required to understand information in the reports. We are working with SCAG to insure that our tools will be complementary to theirs. Ambite and others have studied how data from heterogeneous sources related to the Southern California region might be combined for better freight flow analysis and planning [AMBI], however they have not implemented tools to enable any of their recommendations. Our research considers their approach and aims to realize selected portions of it in practice.

4 The SM 21 approach

4.1 Developing requirements

The starting point for the SM 21 program was previous research and experimentation on the concept of an agile port [MONG]. As originally defined in 1997 [APS], an *Agile Port* (AP) is a marine terminal capable of accommodating military surge and sustainment cargoes while minimizing disruption of commercial operations within the terminal. This concept has expanded since its initial definition and today includes within its scope making the operations of existing intermodal marine terminals more efficient while simultaneously permitting military use of these marine terminals.

Previous research and experimentation on agile port concepts has addressed only business process improvements without specifically addressing the several key areas that are essential to the deployment of the concept commercially:

1. identifying and filling specific gaps in military transportation and ship load planning required to implement an agile port;
2. development of MSA tools that show the benefits of agile ports and efficient marine terminals to stakeholders, including the local community; and
3. building consensus within a region regarding the quantifiable benefits of agile port and efficient marine terminal concepts.

The starting point for defining requirements for filling gaps in military systems was conducting interviews with selected CONUS Transportation Battalions from the Surface Deployment and Distribution Command (SDDC). These battalions are responsible for transportation planning and military operations at ports within their respective areas of operations. In addition, we already knew from our past experience that two DoD systems were key elements in the process of moving military equipment to ports and loading it onto ships: the Integrated Computerized Deployment System (ICODES) [ICOD] and the Transportation Coordinator's Automated Information for Movements System II (TCAIMS-II) [TCAI]. Therefore, meetings were held with the developer of ICODES and with the Program Office for TCAIMS-II to explore how each system was employed today, what planned improvements were scheduled, and what was their view of gaps in functionality or processes. From these meetings a list of specific gaps and the functional requirements to fill each were identified. These gaps were all within the scope of the effort of the SM21 program to fill as described further in 4.4.

The starting point for defining requirements for better use of MSA tools and for building regional consensus was a series of interviews and meetings that the SM21 project held with project stakeholders in 2006. In addition, the latest reports and plans produced by the Metropolitan Planning Organization responsible for the Los Angeles area (the Southern California Association of Governments (SCAG)), the port authorities responsible for the ports of Los Angeles and Long Beach, local transportation agencies, and others were reviewed to establish the current state of knowledge and information/tool sharing in the region. These efforts established a list of key challenges that were within the scope of the SM 21 program to address. These are described further in 4.3.

In all cases, the requirements that the SM 21 program chose to address were scoped by the size of the funded SM 21 effort as well as certain key principles:

1. maximize the use of commercially available software and the use of commercial best practices;
2. use the principles of Service Oriented Architecture to develop small, independent, and re-usable components that could be integrated in multiple ways into existing systems; and
3. within other constraints, maximize the benefits of SM 21 development work to the local region, especially the city of Victorville, CA.

4.2 Top level system use case diagram

Figure 1 is a top-level use case diagram describing key elements of a JPPSP. Of importance to the present paper are these aspects of a JPPSP:

1. Unit movements, including deployments through strategic ports, are planned using TCAIMS-II.
2. Ship stow plans are created using ICODES, a knowledge-based ship stow planning software application that utilizes artificial-intelligence principles and techniques to assist embarkation specialists in the rapid development of cargo stow plans (http://www.cdmtech.com/web/guest/pages/products/ICODES).
3. Main elements of the JPPSP itself are operated by a COTS Terminal Operating System that can manage the arrival of goods and equipment by air, truck or rail, transfers between modes of transportation, short-term storage within the multi-modal and intermodal yards, and the onward movement of goods and equipment.
4. JPPSP models and data support the regional planning process.
5. Efficient port operations are based on concepts investigated and proven by SM21 efforts.

The next two subsections describe JPPSP facilities that support regional planning and surge deployments in more detail.

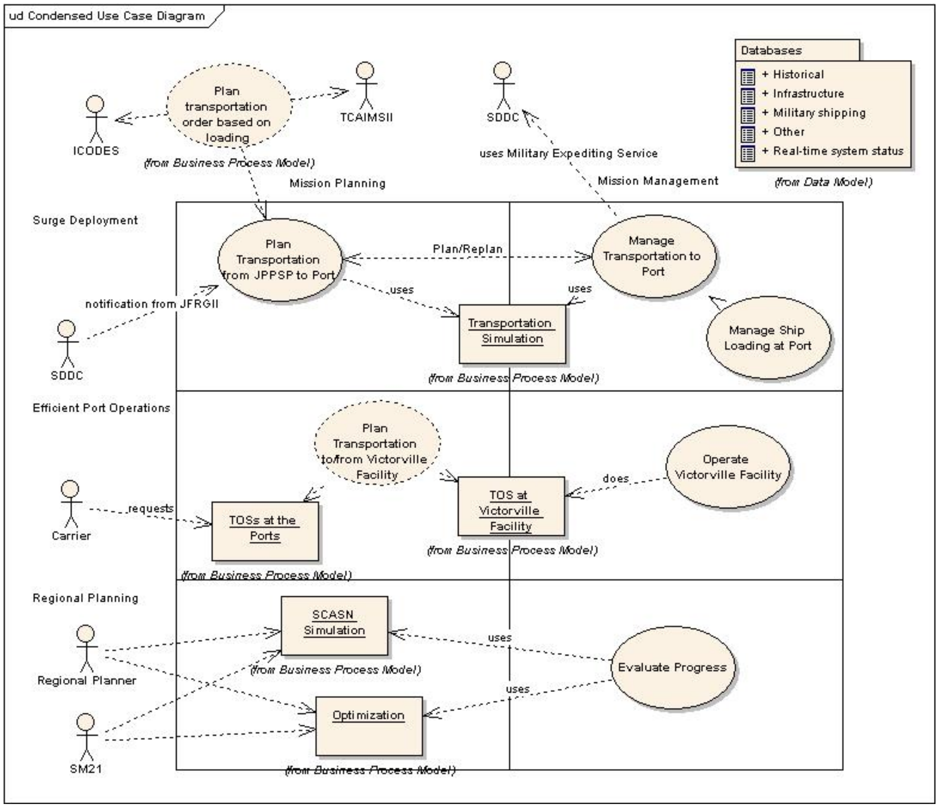

Figure 1. Summary use case diagram

4.3 Regional planning

In its early stages, the SM 21 Program realized that the program itself needed to make the case for the use of the ports of Los Angeles and Long Beach for surge deployment and sustainment. In addition, the program needs to make the case for the build-out of additional transportation and logistics infrastructure within the Southern California area, notably in the Victorville area as well as between the ports and Victorville. The most convincing justification for building new infrastructure is achieving higher container throughput through the ports. Secondary justifications include the reduction of the impact of container shipments on the region. Providing the US military assured access to the ports would not by itself justify the construction of a JPPSP in Victorville or any of the infrastructures needed to support commercial uses.

There are many potential solutions to regional problems. The effects of choices for individual aspects of solution often are confounded and are challenging to visualize and understand. We concluded that better collaborative tools should support such regional planning. In fact, within the SM21 project itself, many different integrated product teams were at work on various elements of the project. This led to a similar need to coordinate this work, enabling those on different teams to understand the work of others, to understand how information created by other tasks affects their tasks, and for displaying, visualizing, interacting with, and understanding the results of various simulation, modeling, and analysis efforts.

As we investigated alternatives, we realized that Metropolitan Planning Organizations such as the Southern California Association of Governments (SCAG) also needed to coordinate activities in many different areas and enable interdisciplinary understanding of analysis, modeling, and simulation work. Today, most of such work is presented in a static manner in reports that take a long time to produce and have hidden input data and non-specified or ill-specified assumptions. These reports present only a limited number of the possibilities considered in their tables and graphs, not allowing the reader to interact with the models and analyses, for example, by changing certain assumptions, and looking at the resulting differences.

The approach that we developed called for replacing static analyses with living, collaborative web portals where input data as well as analyses, models, and simulations could be automatically configured into effective systems for understanding various aspects of transportation and logistics in the region. Our goal was to allow many alternative models and sets of input data to be organized, understood, and configured in different manners to create those models and simulations capable of answering specific regional planning questions.

The functional requirements (see 4.1) we developed for our Regional Planning Web Portal are:

1. Provide basic data sets to support regional planning. These include:
    a. schedules of ship arrivals
    b. rail schedules
    c. data on containers shipped through the ports (Port Import Export Reporting Service (PIERS) data, see http://www.piers.com)
2. Provide an ontology of concepts with definitions and relationships for use in describing key issues in regional planning including goods movement. This will be implemented in the context of a wiki that readers can edit so that the content may evolve. UML diagrams will be included as appropriate. The "ontology" is basically the framework around which the wiki entries are organized. Users will be able to search for articles and supporting documents that define or explain concepts.
3. Provide a common user interface that supports developing networks (sets of nodes and arcs) as well as data associated with network elements (such as cost functions, delay characteristics, transit times, etc). This will be the common framework around which models and simulations are defined and optimization analyses organized. The intent is to provide a vendor-independent front end that can be used over technologies that are too arcane for direct use by non-experts.
4. Provide a common user interface for presenting and comparing the results of analysis, simulation, and model "runs". This will use Excel as its basis but with 2D and 3D graphics to be added later. Again, the intent is to provide a vendor-independent back end that can be used over technologies that are too arcane for direct use by non-experts.
5. Provides blogs where project personnel can share information.
6. Provide wiki's where project personnel and stakeholders can carry out discussions of key issues. Functionality will be added later to help form groups, locate experts, and advise leaders on how to guide discussion, achieve consensus, and publish results.
7. Provide a place for sharing documents with individual security control at the document level for restricting access.

8. Provide search over the whole web portal, including tag-based search over data set contents.
9. Provide tools that extrapolate historical data to create input data to drive simulations and analyses.

Our technical approach to meeting the above requirements is based on:

1. using blogs to express points of view and share information;
2. using wikis to build consensus in various areas by providing persistence that can evolve over time;
3. accept and incorporate data natural formats such as text files, spreadsheets, etc., and tag it according to various ontologies/schemas to allow it to be searched and mined; and
4. integrate modeling, simulation, and analyses along with visualization as part of the wikis.

Additional elements of our approach are:

1. centralized databases and the systems built on them are not a suitable direct basis for our work (however "hidden databases" used by tools such as a shared search provider will be present);
2. all models/schemas/ontologies are local, have limited scope, and will evolve; competing models/schemas/ontologies are good, not bad; these express alternative points of view;
3. centralized and/or standardized data dictionaries are not appropriate; and
4. achieving shared knowledge by human participants over some limited "universe of discourse" at a point in time is a goal - and this process is repeated many times as the dialog evolves; collaboration enables the communication that allows shared visions to be developed.

Figure 2 shows the top-level user interface of the Regional Planning Web Portal that we have developed. Key aspects of the operation of the portal are:

1. The SM21 Stakeholder wiki library contains data about project stakeholders. Each library page contains contact data, links to web sites, and other important information. Examples of stakeholders are: SCAG, terminal at the ports, the Class I railroads, and the City of Victorville. These pages will evolve over time as stakeholders supplement and correct them.

2. The SM21 Wikipedia is an encyclopedia that contains the "ontology" used throughout all SM21 wikis. The wiki defines all concepts; related concepts are cross-linked. UML describes concepts where appropriate. Links to important sources of external information are included. These pages will evolve over time as stakeholders supplement and correct them. The initial page links directly to two indices, one alphabetical and one topical. Access to the wikipedia is typically by using the search box on any page.

3. Shared Document Library: This is a place to upload and share documents. It is expected that documents will be converted and merged with other content elsewhere in the wiki. Documents are organized in folders based on common topics.

4. Wiki discussions: This is the place where discussions may be held.

5. Modeling, Simulation, and Analysis (MS&A): This is a wiki library page that introduces how the site organizes MS&A data, how programs may be executed, and how data may be viewed. A hidden document library stores web parts pages. Excel spreadsheets organize most MS&A data, although some of it may be visualized in other ways also (such as Visio diagrams.) There is one page per "document type" used in MS&A. Each page will includes a definition of the fields, an explanation of how fields work together to achieve a given function, and a list of the files of that type currently on the site. The user can sort and filter rhese lists in various ways.

6. Locations and Objects: This page defines and gives access to the Nodes and Locations Document Library. It describes the format of each file in the library and gives a list of the files currently in the library. There will be a similar page for each library type. One example file is: Nodes at POLB (the Port of Long Beach) that lists the terminal at the port along with their characteristics.

7. All pages contain a search box with a link to "Advanced search" also. The site uses "Sharepoint Server for Search 2007" which has very advanced search capabilities, including customizable search engines and search based on metadata.

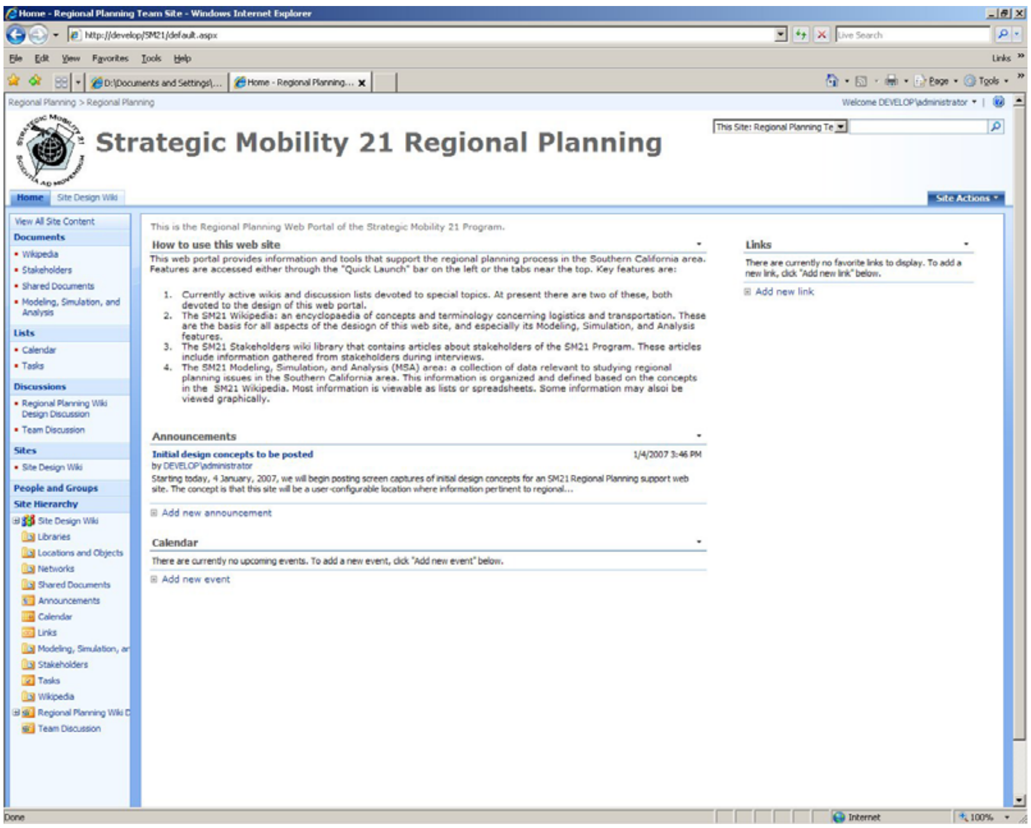

Figure 2. Top level regional planning interface

A key aspect of the Regional Planning Web Portal is the integration of disparate modeling, simulation, and analysis tools into a common framework. The three tools that are initially integrated are:

1. the Arena [AREN] business process modeling and time domain simulation program,
2. the MATLAB [MATL] environment for computationally intensive tasks, and
3. the lpsolve [LPSO] mixed integer and linear program (MILP) solver (initially solving least cost path optimizations).

These tools are all arcane and difficult to use by non experts. Each has its own unique input language, user interface, and output. The Regional Planning Web Portal provides common input languages (Excel spreadsheets and node-arc network visualizations) for all three tools. The code behind the web portal translates the information that the user enters into the input data required by the tool, executes the tool, and then translates the tool output back into common output languages (Excel spreadsheets and geo-spatial visualizations) allowing the data to be viewed and analyzed using a host of common business intelligence tools.

As an example, we consider the solution of a least cost path optimization problem using lp_solve. The first step is either selecting pre-defined sets of nodes from the Locations and Objects library and arcs from the Connections Library within the web portal or creating custom sets (based on predefined sets) for the problem to be solved. Figure 3 presents one of the sets of nodes.

	A	B	C	D	E	F	G	H	I	
1	**Name**	**Property name**	**Property data**	**Property name**	**Property data**	**Property name**	**Property data**	**Property name**	**Property data**	**Propert**
2	Port	Node cost	0	Supply/Demand	160	Node capacity UB	200	Node Capacity LB	0	Geoloca
3	Hobart	Node cost	0	Supply/Demand	0	Node capacity UB	200	Node Capacity LB	0	Geoloca
4	Palmdate	Node cost	0	Supply/Demand	-120	Node capacity UB	200	Node Capacity LB	0	Geoloca
5	Yucca Valley	Node cost	0	Supply/Demand	-40	Node capacity UB	200	Node Capacity LB	0	Geoloca
6	Victorville	Node cost	0	Supply/Demand	0	Node capacity UB	200	Node Capacity LB	0	Geoloca

Figure 3. Locations and Objects library example

The Locations and Objects library is a repository of Microsoft Excel spreadsheets each of which defines one or more locations or objects useful for modeling, simulation, and analysis. Each line in a spreadsheet defines a different location or object. Each spreadsheet groups locations or objects defined for a specific purpose, such as modeling the terminals at a port.

Each spreadsheet in this library must conform to a specific format; however, some information is optional and need not be provided for all applications. Each spreadsheet consists of a single workbook with the following columns:

1. Name: a short human-readable name for the location or object;
2. Description: a free form text describing the location or object (optional);
3. Address: the location of the location or object as a postal address, if applicable (optional);
4. Geo-location: the coordinates of the location or object together with the spatial reference frame in which the coordinates are specified (optional); and
5. {(property name, property data)}: zero or more pairs of property names and property data, each entered in two adjacent columns.

Supported properties (of relevance to least cost path analysis - there are others that are not listed here) include:

1. Node Cost: The cost in dollars to move a single entity through the node.
2. Node Capacity UB: The largest number of entities that the node can process in a single unit of time.

3. Node Capacity LB: The smallest number of entities that the node can process in a single unit of time. This is normally zero (0).
4. Supply/Demand: The number of entities sourced from (positive integers) of sinked into (negative numbers) that node in a single unit of time.

Wherever possible, all data entered in the web portal is automatically annotated with links to appropriate geo-spatial visualizations. For example, each of the geo-location properties in the nodes file in Figure 3 is linked to a hybrid map that shows the node location and allows a user to interact with that visualization in 2D or 3D. These visualizations are created by the Microsoft Visual Earth web service. Figure 4 shows two different visualizations of the Hobart node (a Los Angeles area intermodal center), one a 2D hybrid map and the other a 3D aerial image.

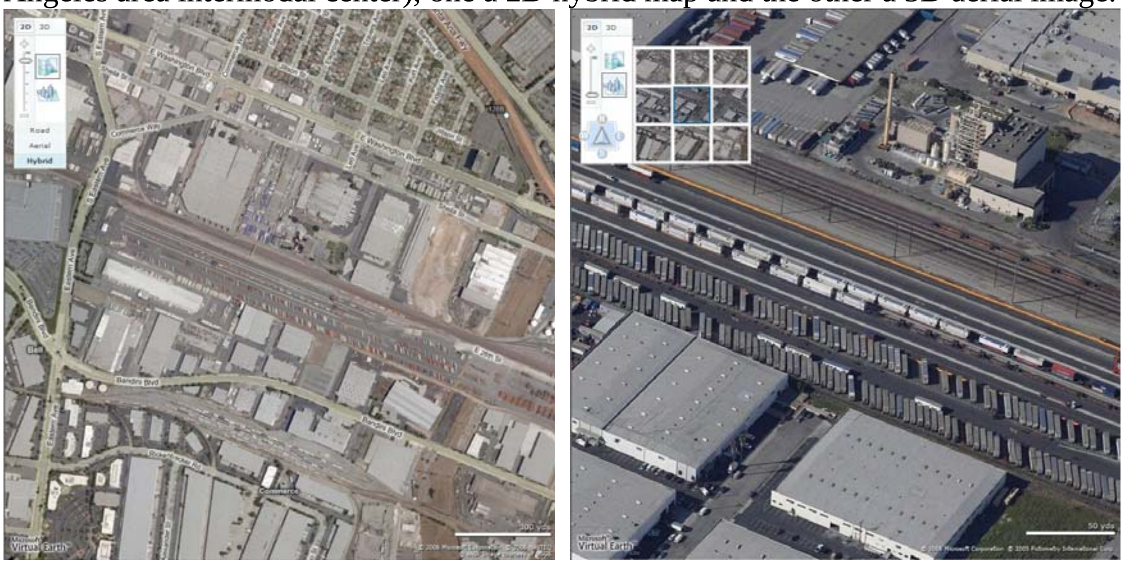

Figure 4. Geospatial visualization in the web portal

The second element of the common user interface in the web portal is a library of Connections. This library contains files that define connections among sets of Locations and Objects defined in the Locations and Objects library. Figure 5 shows a set of arcs defined using the nodes from Figure 3.

	C	D	E	F	G	H	I	J
1	**Start**	**End**	**Property name**	**Property data**	**Property name**	**Property data**	**Property name**	**Property data**
2	Port	Hobart	Cost	1	Capacity UB	150	Capacity LB	0
3	Port	Palmdate	Cost	9	Capacity UB	100	Capacity LB	0
4	Hobart	Yucca Valley	Cost	8	Capacity UB	60	Capacity LB	0
5	Hobart	Victorville	Cost	9	Capacity UB	100	Capacity LB	0
6	Victorville	Palmdate	Cost	3	Capacity UB	100	Capacity LB	0
7	Victorville	Yucca Valley	Cost	5	Capacity UB	60	Capacity LB	0

Figure 5. Connections Library example

Each Connections Library files is based on some or all of the Locations and Objects defined in a single file in the Locations and Objects library. Each connection is modeled as a directed arc in a graph over the nodes in the Locations and Objects library file. Not all nodes from the base file need be included in the set of Connections. Multiple arcs (Connections) between two nodes are allowed.

Each Excel spreadsheet in this library must conform to a specific format; however some information is optional and need not be provided for all applications. Each spreadsheet consists of a single worksheet with the following columns (of relevance to least cost path analysis - there are others that are not listed here):

1. Link name: An optional name for the link.
2. L and O File name: The name of the file in the Locations and Objects Library that defines the nodes used in these connections.
3. Start: The name of the starting node as specified in the column in the Locations and Objects Library file.
4. End: The name of the starting node as specified in the "Name" column in the Locations and Objects Library file.
5. Cost: The cost in dollars to transport a single entity on this Connection.
6. Link capacity UB: The maximum capacity of this Connection per unit time.
7. Link capacity LB: The minimum capacity of this Connection per unit time. This is normally zero(0).

An Economics Data Library (see the example in Figure 6) provides cost figures that populate the Cost properties in both the Locations and Objects Library and the Connections Library. Cost elements (including time) may be assigned to both nodes and arcs and all costs may have values that are single values, a range, or a sample from a specified probability distribution.

	A	B	C	D	E	F	G	H	I	J
1	Property name	Property value	Property units	Property name	Property value	Property name	Property value	Property name	Property value	
2	Cost per container	(90, 100)	US$	Location type	Node	Location	LA-APL	Comment	On-dock lift: This cost in	
3	Cost per container	31	US$	Location type	Arc	Location	AC	Comment	Alameda corridor fee: $1	
4	Cost per container	70	US$	Location type	Arc	Location	LA-APL_SCLA	Comment	Operating cost per mile:	
5	Cost per container	(6.5, 10)	US$	Location type	Arc	Location	LA-APL_SCLA	Comment	Cost of locomotive: $6.5(	
6	Cost per container	4.8	US$	Location type	Arc	Location	LA-APL_SCLA	Comment	Cost of rail cars: $4.80.	
7	Cost per container	80	US$	Location type	Node	Location	SCLA	Comment	Lift at cost of $40 at Vict	

Figure 6. Example economics data

Other libraries within the web portal that are not described in detail here provide a basis for the creation of other properties within both the Locations and Objects Library and the Connections Library. These include:

1. a Historical Data Library that contains summary information on goods movement into, through, and out of the local area’
2. a Shipping Schedule Library that contains past and future information on ship arrivals and departures at the ports;
3. a Rail Schedule Library that contains past and future information on scheduled intermodal rail arrivals and departures in the region’ and
4. a Workload Library whose members may be created based datasets in the Historical Data Library, Shipping Schedule Library, or Rail Schedule Library. Built in tools allow historical data to be extrapolated into the future.

Finally, a user may aggregate a set of nodes and arcs as a single node within another Connections Library file, thereby allowing models to be hierarchical.

The web portal provides a separate page for setting up and executing each modeling, simulation, and analysis tool. Input and output file names may be selected and the input and output data may be visualized. Figure 7 shows the geo-spatial visualization of the input and output data for the example problem while Figure 8 shows a subset of the output in spreadsheet format. On the right, the input nodes and arcs are visualized while on the left the analysis output is visualized by adjusting the thickness of an arc to represent to volume of flow on that arc in the optimal solution. The web portal uses the Microsoft MapPoint web mapping service to produce these geospatial visualizations over large regions.

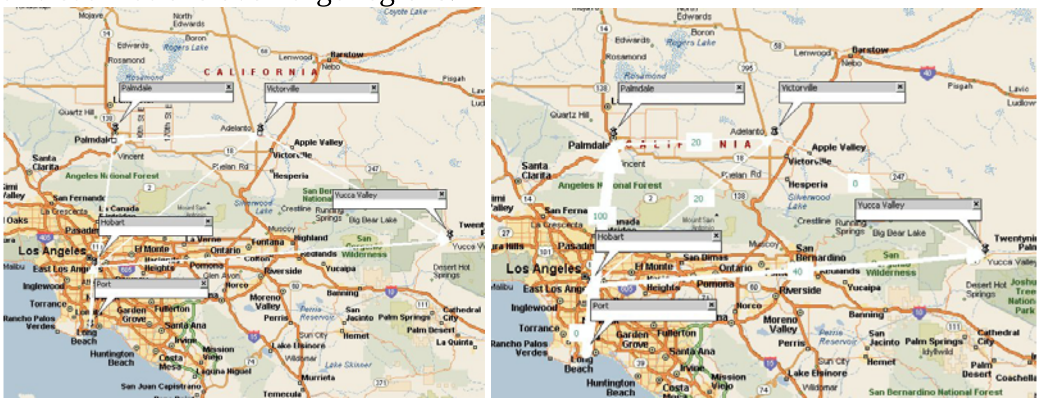

Figure 7. Least cost path visualizations

Name	L and O File name	Start	End	Property name	Property data
1	Opt_Test_Nodes.xlsx	Port	Hobart	Flow	0
2	Opt_Test_Nodes.xlsx	Port	Palmdate	Flow	100
3	Opt_Test_Nodes.xlsx	Hobart	Yucca Valley	Flow	40
4	Opt_Test_Nodes.xlsx	Hobart	Victorville	Flow	20
5	Opt_Test_Nodes.xlsx	Victorville	Palmdate	Flow	20
6	Opt_Test_Nodes.xlsx	Victorville	Yucca Valley	Flow	0

Figure 8. Example spreadsheet least cost path output

4.4 Military transportation planning

To reduce the major impact that military deployments can have on the operations of a busy commercial port, such as the port of Long Beach, the SM21 program developed an approach based on:

1. applying today's collaboration, planning, and algorithm technologies;
2. implementing some process improvements in the manner in which ships are loaded at the port;
3. continuing to use the functionality of legacy systems such as ICODES and TCAIMS-II by adapting key elements of those systems into a Service-Oriented Architecture usable by a web portal;
4. development of a small amount of new algorithms and software to fill key gaps;
5. using the functionality of a JPPSP in Victorville to serve as a "buffer" for incoming equipment as well as a location where equipment can be re-ordered on rail cars or in convoys to respond to unexpected circumstances.

We identified key gaps that our JPPSP needed to fill:

1. ICODES develops effective ship stow plans, yet it provides no functionality to create a ship-loading plan from such a ship stow plan. Such a plan would specify the hatches and ramps from which a ship is to be loaded as well as the time-sequenced order in which equipment is to be loaded onto the ship.

2. TCAIMS II can produce an initial rail-loading plan for a unit movement that can be used to order transportation for the move. TCAIMS II can also produce unit equipment lists for such a movement, although such lists often require refinement by the other systems that use them, such as ICODES. However, TCAIMS II has no capability to produce a detailed, final rail car loading plan nor can it track that actual equipment that is loaded onto a rail car.

3. There is no system that can translate a ship loading plan into a corresponding rail loading plan in such a manner that the loaded rail cars can be delivered to the port "just in time" for unloading and transfer onto a ship. Considering that a SBCT deployment requires 5-6 unit trains each about 5,000 feet long, and that there are many constraints the manner in which equipment must be loaded, delivered on dock, and unloaded, this is not a simple process.

4. There is no system that can monitor and manage rail transportation to the port to achieve efficient port operations with minimal disruption to commercial operations.

Two key individuals who must collaborate to achieve the above are the military ship stow planner and the military rail load planner. Each of these users is an expert in his own discipline. The need for collaborative work comes about because the rail loads need to be planned in such a manner that they can be delivered to the port and military equipment removed from the rail cars "just-in-time" for stowing onto the ship. The Surge Deployment Web Portal provides a collaborative interface between a ship load planner (using ICODES) and a military rail load planner (using TCAIMS II).

The functional requirements (see 4.1) developed for our Surge Deployment Web Portal are:

1. Interface with ICODES through a web service interface to be provided by ICODES to receive visualizations (as SVG files) of ship load plans along with associated entity data.
2. Display ICODES stow plans.
3. Provide a link back to ICODES so that a user can use ICODES directly to modify ship stow plans.
4. Display unit equipment lists received from TCAIMS II.
5. Display preliminary rail plans received from TCAIMS II.
6. Allows a human user to compare a ship stow plan with rail loading plan to identify discrepancies.
7. Create a plan of ship loading order ("ship load plan") from an ICODES ship stow plan.
8. Create a rail load plan from a ship load plan. This will plan the rail loads so that the arrival order of unit equipment at the port can be in the correct sequence and "just in time" for loading onto the ship.
9. Re-plan in response to incremental and partial changes.
10. Re-plan in response to rail conditions, such as rail cars that are left behind due to mechanical problems or trains that arrive out of sequence.
11. Identify mis-matches in rail load and ship stow plans and to suggest rail operations at the JPPSP that will correct the problems.

Figure 9 shows the second-level user interface of the Surge Deployment Web Portal, giving access to functions that support a given deployment (named “Example 1” in this case). Key aspects of the operation of the portal are:

1. Active deployments appear as tabs on the top bar of the top-level page.
2. On the second level page there are tabs to access pages for the ship stow plan, the ship load plan, and the rail load plan. Each of these displays their respective plan in various formats including tabular and graphical.
3. The ship stow plan page includes access to the function that creates a ship load plan from a ship stow plan
4. The rail load plan page includes access to the function that creates a rail load plan from a ship load plan.

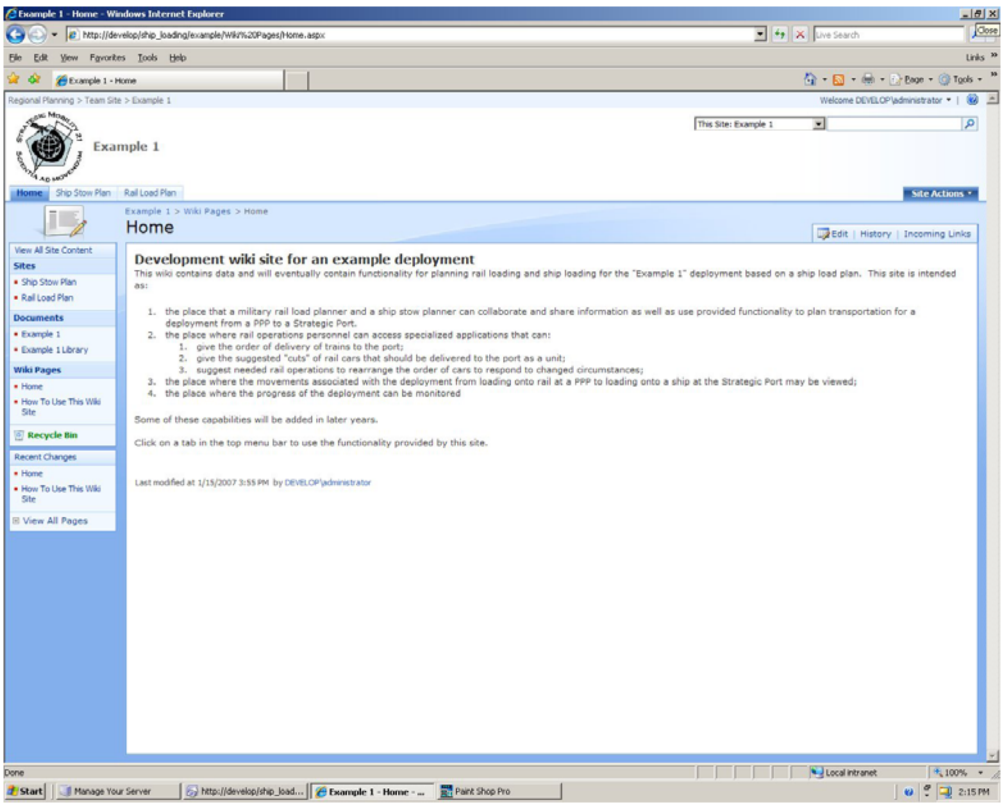

Figure 9. First page of the Surge Deployment Web Portal

Space limitations in this paper prevent a complete description of how the web portal implements all aspects of load planning; however, the capabilities and how they are implemented are summarized below.

1. The web portal contains Military Load Planning Library containing a complete set of reference documents for military load and transportation planning. Web portal search can readily find the documents of interest to a particular deployment plan. These documents include the Transportation Engineering Agency’s (TEA) publications applicable to ship loading and ship stow planning ([55-19], [700-4], [700-5], [700-6]).

2. key data from the TEA publications into spreadsheet form for use by algorithms. Cargo flow path information is among the data extracted from [700-6]. It defines the order in which the holds on a ship are loaded as well as which ramps are used in the path to each hold. The web portal also extracts key figures in graphical form and links to them from key pages for each deployment based on rail and ship equipment types. Figure 10 shows a portion of a diagram of the holds on the USNS Shugart from page 190 of [700-4] needed to understand the ICODES stow plan shown in Figure 11.

3. The web portal extracts key data from the port planning for use by web portal algorithms in spreadsheet form. This data includes the specific terminals used for military deployments at each port along with the characteristics of each terminal, such as the amount and configuration of on-dock and near dock rail track.

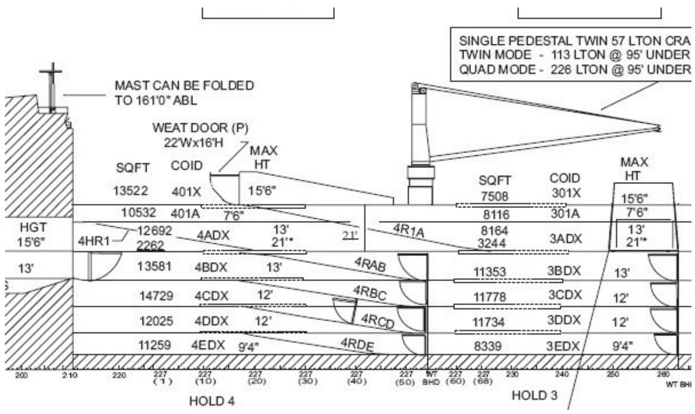

Figure 10. Portion of a depiction of the holds on USNS Shugart

4. For each active deployment, the web portal periodically retrieves ship stow plans from the ICODES system. These plans change frequently as planning progresses, so iterative re-planning is the norm. The web portal allows users to visualize plans both as spreadsheets and graphically. Figure 11 shows a portion of a stow plan received from ICODES presented graphically while Figure 12 shows a portion of the same stow plan presented as a spreadsheet.

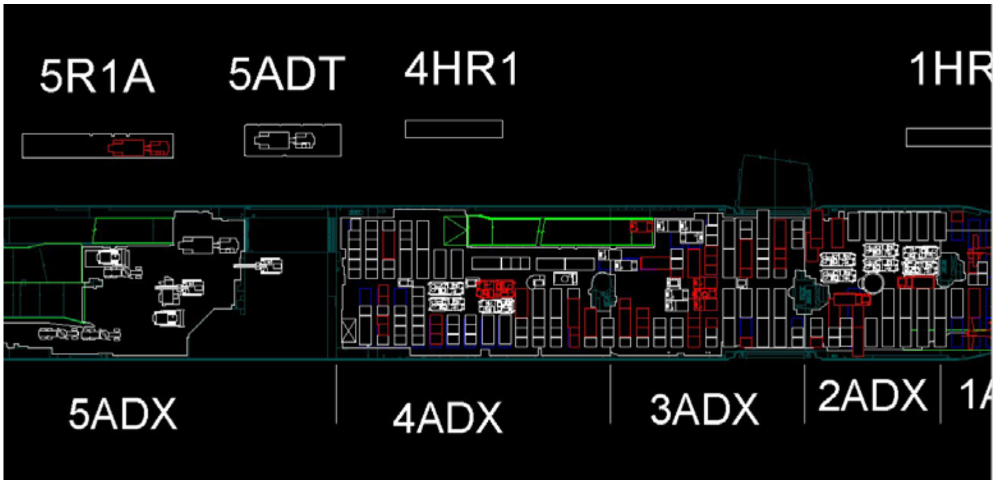

Figure 11. ICODES stow plan presented graphically

Shughart.xls

	A	B	C	D	E	F
1	Ship	Stow Area	Model Number	Description	Bumper Number	TCN
298	USNS SHUGHART v.2006074	2BDX	M1129E	MORTAR CARR/STRYKER	HHC93	AWH9ST0$0D00610XX
299	USNS SHUGHART v.2006074	2BDX	M1130	COMMAND VEH/STRYKER	HQ28	AWJHST0$0D00140XX
300	USNS SHUGHART v.2006074	2BDX	M1130	COMMAND VEH/STRYKER	HQ63	AWH9ST0$0D00180XX
301	USNS SHUGHART v.2006074	2BDX	M1131	FIRE SUPT	B71	AWH9QB0$0D00710XX
302	USNS SHUGHART v.2006074	2BDX	M1133	MED EVAC VEH/STRYKER	HQ79	AWASMT0$0D00110XX
303	USNS SHUGHART v.2006074	2BDX	XM1126	INF CARR VEH/STRYKER	NBN	AWH9SA0$0D04240XX
304	USNS SHUGHART v.2006074	2BDX	XM1126	INF CARR VEH/STRYKER	B75 (2-1	AWH9SA0$0D04300XX
305	USNS SHUGHART v.2006074	2BDX	XM1126	INF CARR VEH/STRYKER	NBN	AWH9SA0$0D04320XX
306	USNS SHUGHART v.2006074	2BDX	XM1130	COMMAND VEH/STRYKER	HQ88 (BD	AWD8XAA$0D04270XX
307	USNS SHUGHART v.2006074	2BDX	XM1132	ENG SQD VEH/STRYKER	EN 213	AWD77AA$0D04250XX
308	USNS SHUGHART v.2006074	2BDX	XM1133	MED EVAC VEH/STRYKER	HQ73(1-1	AWH9QT0$0D04280XX

Figure 12. ICODES stow plan presented as a spreadsheet

5. The ship load planning algorithm implemented in the code behind the web portal incorporates a heuristic algorithm (see [BLUM]) that uses the hold and stow position data from ICODES together with the cargo flow path from [700-6] to produce a ship loading plan. This plan divides cargo into load classes based on how the cargo enters the ship. A separate load class represents each crane and each ramp because cargo is divided into separate groups based on this criterion. The algorithm next determines a load order for each item within each class. The algorithm output is in spreadsheet form with one worksheet for each load class. The load order is a column within each class.

6. The rail load planning algorithm implemented in the code behind the web portal uses a heuristic algorithm that uses the ship loading plan produced in Step 5 above together with the equipment characteristics and the rail car loading data in [55-19] to produce a rail loading plan. This plan is designed so that equipment in each class may be scheduled to arrive at the terminal at the port in the order that it is needed to load the ship. It suggests the best type of rail car for each item and the sequence of rail cars needed at the rail loading point. The algorithm output is in spreadsheet form with one worksheet for each train. The rail car order and cut number (i.e., contiguous subsets of a train) is a column in the sheet for each train. Rail car cuts are planned based on the number and length of on-dock rail tracks available at the terminal (see Step 3 above.) [Note: A military unit train is typically between 5,000 and 6,000 feet in length. Most on dock rail spurs are shorter than that, typically only 2,000 to 3,000 feet in length. This requires dividing each military unit train into subsets (cuts) at a near dock rail facility, with each cut of rail cars delivered independently to the on-dock rail facility.]

5 Conclusions and future work

This paper has described a web portal that provides collaborative interfaces to enable cost-effective solutions to key problems. The regional planning web portal has successfully demonstrated that:

1. reference information can be collected in a set of shared libraries where it can be accessed and searched using robust and configurable enterprise search tools;

2. tagging data sets with XML tags that can be understood by search engines enables data sets to be effectively searched and values returned in search results;

3. wikis provide an effective technique to deploying descriptive information in a manner that it can not only be easily accessed and searched but it can also be edited directly by community members;

4. blogs are an effective technique for sharing individual points of view as well as dissemination of information on specific topics with team members; and
5. disparate modeling, simulation, and analysis programs used in regional planning can be integrated in a web portal where a common user interface and common input and output data formats support data sharing and insulates the user from the different input and output formats of those programs.

The military transportation planning web portal has successfully demonstrated that:

1. needed information can be acquired by a web portal using web service interfaces;
2. a ship stow plan can be used as the basis for creating a ship loading plan;
3. a ship loading plan can be used as the basis for creating a rail load plan;
4. a collaborative web portal using industry-standard formats is an effective user interface between ship stow planners and military transportation planners.

The SM21 program is funded for two additional years. In these future years, the base functionality developed in the first year is expected to be expanded by:

1. adding additional data sets,
2. enhancing the knowledge base in the wikis and blogs,
3. incorporating models to support additional simulations and analyses,
4. conducting experiments in conjunction with unit deployments to demonstrate the functionality,
5. working real regional planning tasks collaboratively with regional stakeholders using the features of the web portal,
6. implementing web service interfaces with key military systems such as ICODES and TCAIMS-II, and
7. expanding the portal's command and control capabilities to support a regional common operating picture for goods movement.

Some additional web portal pages, visualizations, and algorithms planned for future development include:

1. interact with the Military Expediting Service to monitor the progress of rail movements to the JPPSP;
2. verify that all cars of each train involved in the movement are in the correct order based on the analysis of Car Location Messages from the military unit trains;
3. plan rail operations at classification yards or other rail switching facilities to reorder cars on trains as required to meet changed circumstances;
4. visualize the movement of trains to near port rail yards and then of the movements of cuts of rail cars to the terminal at the port;
5. predict rail car cut unloading time to staging areas and ship loading time from staging areas based on equipment characteristics and cargo flow path;
6. visualize ship loading based on ship loading plans; and
7. plan the order of convoys to a port along with the equipment required to transport unit equipment that cannot be driven over roadways under its own power.

References

[55-19] Pamphlet 55-19, Tiedown Handbook for Rail Movements, Transportation Engineering Agency, September 2003

[700-4] Pamphlet 700-4, Vessel Characteristics for Shiploading, Military Traffic Management Command, Transportation Engineering Agency, August 2001

[700-5] Pamphlet 700-5
Deployment Planning Guide - Transportation Assets Required for Deployment
Military Traffic Management Command, Transportation Engineering Agency, May 2001

[700-6] Pamphlet 700-6
Large, Medium Speed, Roll-On/Roll-Off Ships Users' Manual, Military Traffic Management Command, Transportation Engineering Agency, September 2002

[ALBE1] Alberts, D. S., J. I. Garstka, and F. P. Stein, (2000). *Network-centric warfare: Developing and leveraging information superiority*. Command & Control Research Program. Washington, DC

[ALBE2] Alberts, D. S. and R. E. Hayes, (2003). *Power to the edge: Command control in the information age.* Command & Control Research Program. Washington, DC

[AMBI] Ambite, Jose Luis, Genevieve Giuliano, Peter Gordon, Qisheng Pan, and Sandipan Bhattacharjee *Integrating heterogeneous data sources for better freight flow analysis and planning*, Proceedings of the 2002 Annual National Conference on Digital Government Research, May 2002

[APS] *The Global Definition of Port Agility*, Center for the Commercial Deployment of Transportation Technologies, 1997,
http://www.ccdott.org/Deliverables/1997/VZM123/VZM123%202.pdf

[AREN] Arena Simulation Software, Rockwell Automation, Milwaukee, Wisconsin,
http://www.arenasimulation.com/

[BLUM] Blum, C. and Roli, A. 2003. *Metaheuristics in combinatorial optimization: Overview and conceptual comparison*. ACM Comput. Surv. 35, 3 (Sep. 2003), 268-308. DOI=
http://doi.acm.org/10.1145/937503.937505

[BORN] Borning, Alan and Paul Waddell, *Integrated land use, transportation, and environmental simulation: UrbanSim project highlights*, Proceedings of the 2002 Annual National Conference on Digital Government Research, Seattle, WA, pp 1-2. See also
http://www.urbansim.org/

[CARS] Carson, George S. and Peter Bono, *A Measurement and Monitoring System for Tracking and Visualizing Collaboration Metrics in Real-time and for Later Analysis*, 10th International Command and Control Research and Technology Symposium, McLean, Virginia, June 2005

[EVAN] Evans, Phillip, *The Wiki Factor*, BizEd, Jan-Feb 2006, p 28.

[EXCE] Microsoft Excel, http://office.microsoft.com/en-us/excel/FX100487621033.aspx

[FOUS] Fouss, Jonathan D. and Kai H. Chang. *Classifying groupware*, ACM Southeast Regional Conference, 2000, pp. 117-124

[GSA] *COLAB: An Open Collaborative Work Environment (CWE) to Support Networking Among Communities of Practice*, http://colab.cim3.net/cgi-bin/wiki.pl/

[ICOD] The Integrated Computerized Deployment System (ICODES), http://www.cdmtech.com/web/guest/pages/products/ICODES

[LPSO] lpsolve, http://sourceforge.net/projects/lpsolve

[MATL] MATLAB, The MathWorks, Natick, MA, http://www.mathworks.com/

[MICR] Microsoft Office SharePoint Server 2007, http://office.microsoft.com/en-us/sharepointserver/FX100492001033.aspx

[MONG] Mongelluzzo, Bill, *The agile port*, The Journal of Commerce, Vol 7, Issue 50, 11 Dec 2006, pp 14-18.

[SCAG] SCAG Regional Goods Movement Knowledge Base, http://www.scag.ca.gov/goodsmove/knowledgebase/knowledgebase.asp

[SCOT] Scott, S.D., Cummings, M.L., Graeber, D.A., Nelson, W.T., Bolia, R.S. (2006). *Collaboration Technology in Military Team Operations: Lessons Learned from the Corporate Domain.* CCRTS 2006: the Command and Control Research and Technology Symposium, June 20–22, 2006, San Diego, CA, USA.

[TCAI] Transportation Coordinator's Automated Information for Movements System II, https://www.tis.army.mil/

[WIKI] *Wikipedia*, http://www.wikipedia.org/

APPENDIX D: DEPLOYMENT OF WEB SERVICES

1.0 BACKGROUND

This Appendix defines the proposed initial operating capabilities (IOC) for the Southern California Logistics Airport (SCLA) - Joint Deployment and Distribution Support Platform (JDDSP) Inland Port-Multi-modal Terminal Operating System (IP-MTOPS[1]), which will be accessible through the Web Portal. While IP-MTOPS will follow a Service Oriented Architecture (SOA), the initial functional capabilities will be provided by TransCore commercial off the shelf (COTS) systems. These systems will support early experimentation and testing and will be used as the basis for future service design and integration within the Web portal supported IP-MTOPS[2].

2.0 INLAND PORT MULTI-MODAL TERMINAL OPERATING SYSTEM

The primary IP-MTOPS function will be to provide timely, actionable data needed by decision makers to manage terminal and inland port operations associated with the JDDSP and SCLA. IP-MTOPS will be deployed using a network service oriented architecture designed to share information worldwide via Internet or private virtual networks. The SOA will support the stepwise employment of XML and Web Service technologies designed to specifically support the SCLA-JDDSP Business Community of users.

The IP-MTOPS will support SCLA security and operational flow of transportation assets, cargo and personnel. The IP-MTOPS must be capable of supporting the requirements of both military and commercial shippers. The system will not only support the throughput of shipments via a single mode but must also support modal diversions and shipment trans-loading operations for both import and export shipments.

3.0 THE WEB SERVICES DEVELOPMENT APPROACH AND TEAM MEMBERS

SM21 will employ a stepwise development approach for IP-MTOPS web services. In order to enable this incremental development process, we have established an initial list of stakeholders and team members to collaborate with on the discovery, development and deployment of the Web portal services initial operating capability. The initial collaboration will occur between SCLA and SM21 to establish the basic services required to manage security and the dual-use facilities, which includes the military support functionality required by the JDDSP.

---

[1] The Inland Port Management Information System (IP-MTOPS) will be developed by the Strategic Mobility 21 program to support the Southern California Logistics Airport (SCLA) and the Joint Deployment and Distribution Support Platform (JDDSP) as defined in three documents: Inland Port - Multi-Modal Terminal Operating System Design Specification, Contractor Report 0008; Integrated Tracking System Analysis and Concept Design, Consolidated Contractor Report 0010-0012; and Collaborative Regional Web Portal Design, Development and Documentation, Contractor Report 0013.

[2] However, as described in paragraph 4.3.4 of the base document, the collaborative planning process between military ship stow planners and military rail load planners will be developed by SM21 as an initial IP-MTOPS Web service.

In addition to the SM21 and SCLA Team Members, government, academic, and industry partners will collaborate on the overall IP-MTOPS development, testing, and demonstration. Several major importers and exporters through Southern California have agreed to support the discovery and analysis associated with the identification and validation of commercial shipment requirements and will, as practical, participate in technology and process experimentation. Dole Foods, the fifth largest importer through Southern California, will provide the initial shipper related functional requirements and testing support for the Web portal services. The process will begin with the integration of the Dole U.S. Customs and Border Protection, Automated Manifest System (AMS) data with an incidence of the TransCore developed Trade Corridor Operating System (TCOS).

In addition to Dole Foods, Newell Rubbermaid, which currently operates a distribution center at the SCLA, will participate in experimentation more focused on distribution through SCLA. However, like Dole, Newell Rubbermaid will also participate in experimentation related to closing the information gaps that exist within their Southern California regional supply chain visibility and management systems.

The initial comprehensive federal test and demonstration of the IP-MTOPS capabilities is designed to demonstrate the use of the Web portal in a military force deployment scenario, potentially outside of Southern California. This test is tentatively planned with the US Transportation Command and the Port of Tacoma in the Pacific Northwest during a major military force deployment. The Web portal initial operating capability will also support the joint SM21 and MARAD project designed to define and, as appropriate, develop and demonstrate an in-gate/out-gate appointment system. The approach for the MARAD sponsored project is to define the system architecture and the associated business practices and then deploy the system for limited testing within Southern California.

4.0 REFERENCE MODELS

The IP-MTOPS Web services development will follow several reference models to structure the internal system-of-systems architecture:

- As a component in the overarching SM21 EA systems-of-systems architecture, the IP-MTOPS Web portal services will reference the Federal Enterprise Architecture. A detailed description of the FEA can be found at the E-Gov Web page: http://www.whitehouse.gov/omb/egov/a-2-EAModelsNEW2.html.
- The physical reference model, as previously described, is the CCDoTT Agile Port System. The reference documentation is available on the CCDoTT Project Results Website within several files related to the Pacific Northwest Agile Port Analysis and Demonstration: http://www.ccdott.org/content/DS_fr.html.
- The IP-MTOPS system development will be guided by the OASIS SOA Reference Model. For additional background and model information, please refer to the complete reference model documentation, which is available at the SM21 PMIS or at http://www.oasis-open.org/committees/tc_home.php?wg_abbrev=soa-rm.
- The deployment experience of a SOA in the business community of the Port of Genoa, Italy will be referenced as a design pattern for IP-MTOPS

The SM21 program goal for using reference models is to define the central concepts of service oriented architecture, and establish a vocabulary and a common understanding of SOA for all program stakeholders both internal and external. It will provide a “normative reference” that will remain relevant throughout the SM21 SOA stepwise development and implementation, irrespective of the many future technology evolutions that will influence SOA deployment.

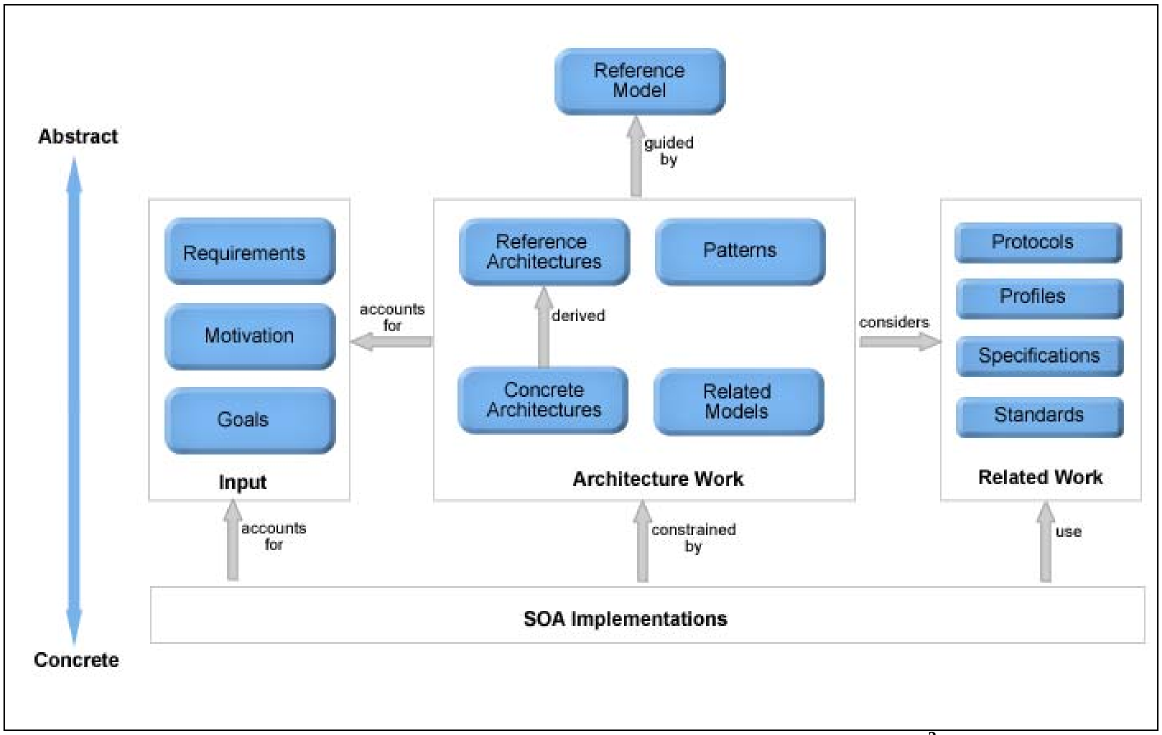

Figure 5: Relationship of the Reference Model to Other Work[3]

The concrete IP-MTOPS architecture will be developed using the requirements identified by the process identified in this Appendix. The SM21 supported IP-MTOPS Architecture development will not be done in isolation but will account for the goals, motivation, and requirements that define the actual problems or gaps being addressed in both the commercial, regional, and military sectors.

5.0 INITIAL IP-MTOPS WEB SERVICES DEPLOYMENT AND TESTING

In open source documents, a significant number of experienced SOA developers have the following words of advice: Start small by talking a little, modeling a little, and learning a lot. This is the intent of working with Dole Foods. Incremental change and gradual improvements will be employed rather than developing the objective system without first developing and deploying small focused capabilities that improve the Dole Foods distribution process. In the case of IP-MTOPS, the first deployment will integrate business and IT strategies to provide Dole with basic tracking services that leverage existing TransCore systems. To achieve success, the

[3] Oasis Reference Model for Service Oriented Architecture 1.0, 10 February 2006; Figure 1, page 5

IP-MTOPS development will start with the TCOS system deployment and the integration of the Dole Foods provided AMS data.

Throughout the first year of capability deployment, the Web services development project will be tightly focused on continuing to improve the Dole supply chain distribution services. After the deployment of TCOS, the focus will be the deployment of the TransCore Global Visibility Platform (GVP) and 3sixty applications[4], a complete shipment and asset management operating system, which is capable of supporting military and commercial shipments through Southern California. Using 3sixty as the basic operating system, SM21will have the required backbone for the development and execution of a comprehensive experimentation program during the follow-on program effort starting in 2008.

Using 3sixty and the CDM developed Integrated Computerized Deployment System (ICODES) described in the basic document for the support backbone; SM21 will complete two experimentation programs: the USTRANSCOM supported military force deployment demonstration with the Agile Port System project, as well as the Dole Foods commercial container shipment optimization studies.

The 3sixty suite of products and services selected for deployment will provide a variety of operations management tools that will be employed. These tools include:

- TCOS – Trade Corridor Operating System – the initial ITS application to be deployed
- Global Visibility Platform – multi modal asset and shipment tracking, to include a yard management system
- An integrated service application composed of six (6) core services:
  - Freight Match Services
  - Fleet Management
  - Operations Management
  - Compliance Services
  - Financial Services
  - Rail-Intermodal Services (including track and trace).

In addition to the applications outlined above, a variety of technical solutions to support experimentation associated with the Dole Foods distribution optimization study will be employed. The selected technology for experimentation includes AEI tags and readers for the rail and intermodal network, RFID tags for trucks, trailers and containers, and GPS units for ubiquitous visibility.

The following sections provide more detailed information on the IP-MTOPS initial system architecture components.

[4] The Global Visibility and 3sixty capabilities are described in paragraph 4.1.2 of this Appendix.

5.1 Trade Corridor Operating System

This section of the document provides a description of the fundamental characteristics of Trade Corridor Operations System (TCOS) and its applicability to IP-MTOPS.

5.1.1 Background and Applicability to IP-MTOPS-Agile Port System Demonstration

TCOS is a system of hardware and software that was developed by TransCore originally for the Washington State Department of Transportation (WSDOT) to implement the Northwest International Trade Corridor and Border Crossing System (NWITC). The NWITC is an operational secure freight management pilot program managed by the WSDOT Intelligent Transportation Systems (ITS) office. The ports of Seattle (American President Lines (APL)) and Tacoma (Maersk-Sealand) are integrated into the system along with the Washington State Commercial Vehicle Information Systems and Networks (CVISN) weigh stations and commercial vehicle database. These sites are outfitted with roadside Automatic Vehicle Identification (AVI) sensors (to read CVISN Radio Frequency Identification (RFID) vehicle tags) and other RFID sensors for reading electronic container seals (e-seals) and Free And Secure Trade (FAST) compatible vehicle sticker tags and driver/crew ID cards. The US Department of Homeland Security bureau of Customs and Border Protection (DHS CBP) commercial vehicle processing facility at Blaine (at the Washington border with Canada) is also instrumented with AVI, e-seal and FAST RFID sensors. This integrated secure freight management system monitors the movement of freight transactions moving north and south along Interstate 5, between Seattle/Tacoma and Vancouver, BC, Canada.

The Pacific Northwest TCOS deployment will significantly reduce the risk of the SM21 support to the PNW Agile Port System (APS) force deployment demonstration. While the initial IP-MTOPS commercial testing with Dole Foods will be completed in Southern California, the first near full military operating capability test in an actual deployment might occur in the PNW. A phased demonstration build-up process will be established as part of the APS demonstration plan to further mitigate risk.

5.1.2 TCOS Functional Design – Web Service

TCOS includes both site sensor controller hardware and software, and regional data center hardware and software. The site controllers all share a common set of software that is uniquely configured for each site. The site controllers are responsible for interfacing with sensor hardware, buffering sensor hardware status and RFID read events, and reporting to the TCOS data center (via a secure Internet connection). The data center receives reports from all of the site controllers in near real time. The reported status and events are processed and stored in a database. The TCOS web server provides real time access to this information to authorized users on the Internet via a secure website (www.transcorridor.com). TCOS also receives and distributes event reports from other sources such as the seaports and weigh stations via their respective information management systems (IMS). Near real time interfaces supported by TCOS include: email and cellular phone paging alerts to stakeholders and enforcement agents; TCP/IP Socket, FTP, SOAP, eForward, and other Internet-based interfaces with stakeholder IMS; and direct interfaces to the CBP Automated Manifest System (AMS).

5.1.2 TCOS Deployability

Although developed originally for NWITC, TCOS is a flexible baseline freight management system that can be adapted by SM21 to other regions. TransCore, and SM21 by extension, has been granted permission by WSDOT to utilize TCOS for such projects. TCOS has been successfully adapted for three trade lanes (two with BVSG/TransCore and one with SAIC/Savi) in the Operation Safe Commerce (OSC) project, and it is being extended to cover US Department of Agriculture (USDA) Agricultural Inspection Policy and Programs (AIPP) trade lanes. TCOS will be configured by the SM21 team to include new sensor sites using the existing TCOS data center at TransCore in San Diego, California. If necessary (for security or other reasons), the TCOS data center software can be cloned and modified to support other trade lanes and/or other freight management projects on other server hardware and/or at other physical locations for DoD. The TCOS-IP-MTOPS application will include commercial vehicle trucks along with marine and rail transportation elements. The software architecture of the SM21 IP-MTOPS TCOS deployment (in the data center and the site controller components) will enable rapid development and integration of software drivers for interfaces to new sensor types and new communication protocols for interfaces to other systems for testing, experimentation and deployment.

5.1.3 TCOS Adaptability Considerations

The TCOS software configuration within the SM21 IP-MTOPS will enable the adaptation of the SM21 products to a variety of dual-use freight management system projects. The fundamental architecture provides a core of common code that will enable SM21 to provide both basic and industry-specific features consistently for all SM21 IP-MTOPS application modules. This core includes everything form high-resolution event timing to various forms of communication to diagnostic logging to event correlation. Basic higher-level TCOS application modules provide coordinated event logging, homogenized external device connections, sensor and output device drivers, and generic site controllers and data center functions.

The SM21-IP-MTOPS TCOS supported application modules communicate using a common messaging interface via TCP/IP (the low-level protocol of computer networks - including the Internet). This TCOS language (a simplified and more flexible derivative of XML) will allow SM21 IP-MTOPS modules to be distributed in a variety of ways using simple configuration file settings. Multiple modules will be run on the same computer, on different computers across a local area network, across the world via the Internet, or any combination without changing any code. The SM21 IP-MTOPS TCOS application will employ dynamic programming languages to enable modules to run on different computer operating systems without code changes. The TCOS language is human readable and it can be extended to message passing via slower interfaces such as email, website forms, and interactive human text messaging sessions.

The TCP/IP connection protocols in the SM21 IP-MTOPS-TCOS application modules will be made more flexible by having each module a multiple simultaneous user server as well as a potential client to multiple other TCOS modules. A primary design feature will enable fast configuration of complex networks that will also allow human users to monitor the activities of any SM21 IP-MTOPS-TCOS application module without disrupting its normal operation (accelerating development, configuration, testing, diagnostics, and maintenance).

The extensive use of dynamic languages will enable SM21 to rapidly develop new features and entire new modules for the SM21 IP-MTOPS-TCOS as needed to implement the requirements of the IP-MTOPS in other regions and deployment scenarios such as an advanced base supporting sea based logistics. The standardization of module-to-module communications means that such features do not need to be reengineered, and new connections between modules are very straightforward (very little redesigning required to accommodate new modules in the SM21 IP-MTOPS-TCOS network).

The TCOS communication language is defined using object-oriented configuration files that serve to efficiently implement a great deal of the TCOS applications, as well as simultaneously implementing the system interface documentation (built in to the client interfaces as online interactive text, and also accessible via a web browser for dynamic interactive navigation). This arrangement means that the system interface documentation is never out of synch with the actual products because both come from exactly the same source.

5.1.4 SM21 IP-MTOPS-TCOS Capabilities

TCOS implements five (5) major functions that are all applicable to multiple IP-MTOPS supported projects. These are significant functions that are not easily developed from scratch. The SM21 IP-MTOPS-TCOS will be deployable stand-alone as the information management system (IMS) data center for a project, or the design will enable the interface with a higher-level IMS. Higher-level IMS do not typically support the lower-level TCOS functions, so TCOS bridges the gap between site sensors and other IMS and analysis tools. Frequently the higher-level systems and tools require access to proprietary and Security Sensitive Information (SSI) that needs to be protected. The SM21 IP-MTOPS-TCOS deployments will be able to serve securely, and with low risk in such environments, as a gateway - by using index values for data. Highly secured IMS can use the index values reported by the SM21 IP-MTOPS-TCOS to reference the protected information. Using TCOS rather than developing lower-level interfaces for other IMS leverages the maturity already invested in TCOS. TCOS first went operational for NWITC in 1999 and has been continuously maintained, updated, and improved. The current architecture of TCOS has been running continuously in the NWITC since June of 2002 - processing hundreds of transactions per day. Enhanced TCOS software has been tested and will be deployed with the SM21 IP-MTOPS-TCOS service.

5.1.5 Major Functions SM21 IP-MTOPS-TCOS

1 - Data Acquisition:
The sensor site controller components of the SM21 IP-MTOPS-TCOS will interface with various RFID readers and other sensors and/or output devices (such as driver signals, active barriers and variable message signs) to monitor hardware status and to acquire events (such as tag reads). These status and event records will be time and date stamped, correlated with each other, associated with the site, and buffered. Event records will be reported in real time or in batch (on a periodic/timed schedule). The site controller will also be configured as a server so a data center or application can actively retrieve buffered data from the site instead of having the site actively send data to an application or data center. The default will be for the sites to actively connect to the SM21 IP-MTOPS-TCOS customer applications or central data center and send event data

and hardware status changes in real time (as soon as it is detected). A separate configuration option will have the site report its current status periodically - so the service customer will know that the site is still functioning - even if it has nothing new to report. For data redundancy and system diagnostics, site controllers will also be configured to log events, status, and other site activity to local hard drives.

2 - Data Collection
The first function of a SM21 IP-MTOPS-TCOS service will be to collect the status and event reports from all of the sensor site controllers and record them in a central database. The application will collect this kind of data from other external sources (such as other IMS some of which are described in this Appendix) when the sensors are not integral components of TCOS. This data can be received in real time or in batch. The site controllers will feature buffering, to allow the SM21 IP-MTOPS-TCOS data center to go down for extended periods of time without losing status and event data. Since all the site controllers will time and date stamp all records, batch reports will still be put into the database correctly. The SM21 IP-MTOPS-TCOS will receive data from handheld readers when docked to an Internet-connected computer, or event data will be entered manually into the SM21 IP-MTOPS-TCOS via either email or a website form.

3 – Regional Data Sources
Extensive research was conducted on the sources of regional tracking data outside of customer and transportation mode and terminal operators. The regional tracking area is defined by the geographic area of responsibility for the Southern California Association of Governments (SCAG). Throughout the region significant investment in ITS technologies has been and continues to be used to help increase the efficient management of the transportation networks. ITS applications provide the region with key management tools that help the operational efficiency of the transportation network and contribute to security and safety. The greatest challenges and perhaps the greatest benefits lie in integrating major systems across the entire region. IP-MTOPS will help to overcome some of the challenges and provide the region with additional value add for its investment in sensor and ITS technology. The recently documented Southern California Regional ITS Architecture document is a primary reference for the sources of ITS event data within the region.[5] The ITS field elements outlined below and depicted in Figure 5 are connected to the Regional Caltrans Transportation Management Centers (TMCs):

- Vehicle Detection Stations (VDS),
- Closed-Circuit Television (CCTV) cameras,
- Changeable Message Signs (CMS),
- Ramp Meter Stations (RMS),
- Highway Advisory Radio (HAR), and
- Environmental Sensor Stations (also known as road weather information systems (RWIS)

[5] Southern California Regional ITS Architecture, NET, Final Version 6.0, April 2005

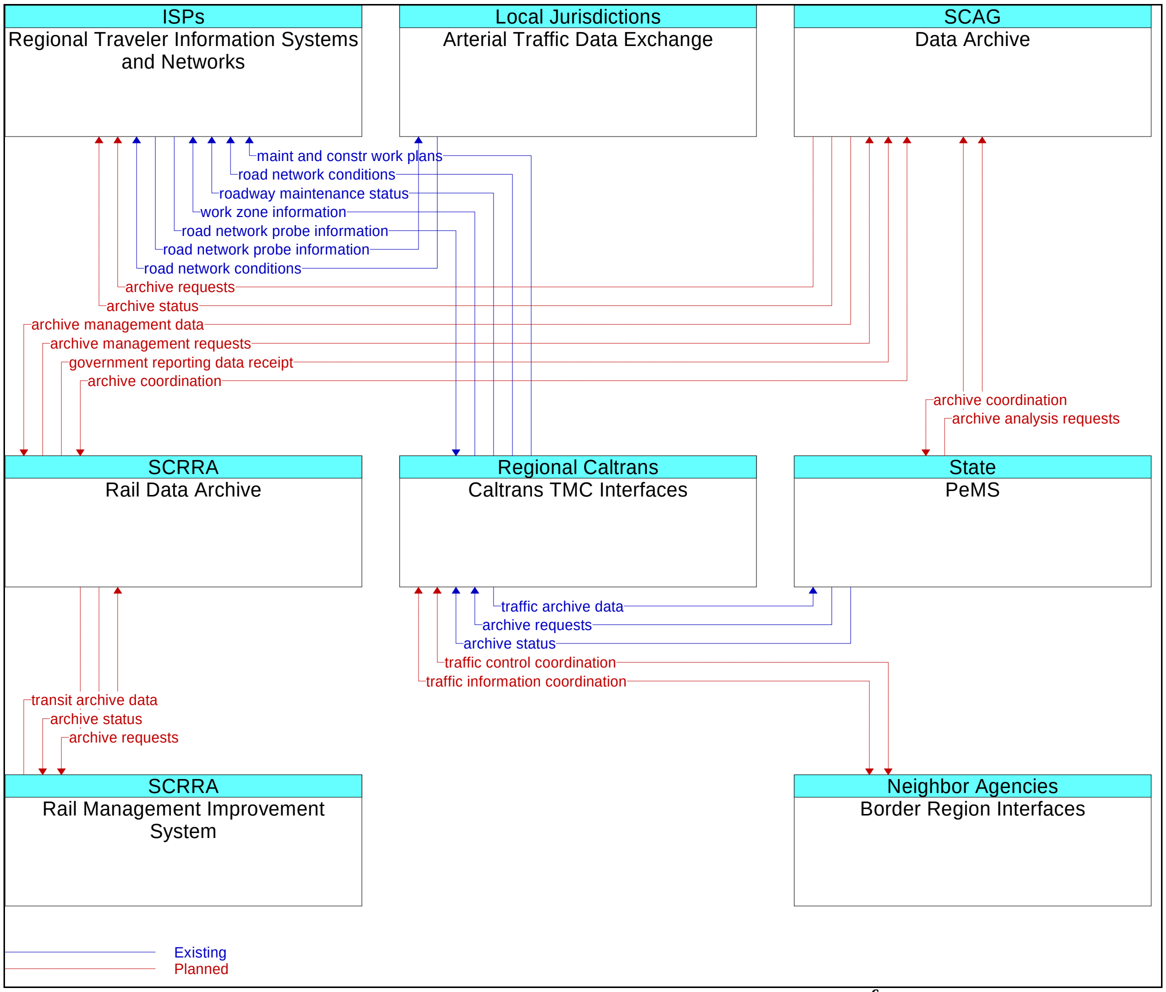

Figure 6: Caltrans TMC Interfaces ITS Data Flows[6]

The Freeway Performance Measurement System (PeMS) included in Figure 5 is a consolidated database of information collected via Caltrans loop detectors and provided as a Web Service by Caltrans through the University of California, Berkley. The intent is to work with SCAG and Caltrans to integrate selected ITS data flows defined in Figure 5 with the SM21 ITS.

4 - Data Processing

The SM21 IP-MTOPS-TCOS will be able to both store raw site status and event records and apply logical processing to the data. The system will be capable of automatically evaluating status and event reports to check for security status, route compliance, travel time compliance, geographical boundary compliance (geo-fencing), authorized transaction component correlation consistency, credentials, and membership in targeting lists.

When events are reported from multiple sensors at the same site, those records are often related to each other and will need to be combined into a singe composite event. This correlation can be done in the site controller, but the SM21 IP-MTOPS-TCOS will the correlation to be completed

[6] Southern California Regional ITS Architecture, NET, Final Version 6.0, April 2005

in the SM21 IP-MTOPS-TCOS data center so that the code can be managed in a single place. When events reported by different sites and/or other IMS require correlation, the correlation function will be performed by the SM21 IP-MTOPS-TCOS data center.

Another form of correlation that the SM21 IP-MTOPS-TCOS will perform is the evaluation of event data relative to prior detections of the same transaction item. This will include measuring travel time between sites and comparing that to allowable tolerances. This also involves monitoring where transaction components change associations (seal-to-container, container-to vehicle, driver-to-vehicle, etc.), and/or security status (sealed or tampered). Travel time checks between gateways in a trade lane rout are a critical component in building a secure freight management system.

The SM21 IP-MTOPS-TCOS will also check event data against credential criteria and targeting lists (specified by authorized agents) to generate alerts. Another data collection capability of the SM21 IP-MTOPS-TCOS will be the retrieval and/or receipt from other IMS: enrolments, registrations, credentials, filings, and other such information that may be needed to make these data processing decisions.

6.0 DATA DISTRIBUTION

The SM21 IP-MTOPS-TCOS will distribute its database information in various forms to multiple authorized recipients. Authorized human users will access real time system status and event data tailored for them using the SM21 IP-MTOPS-TCOS web portal. Targeting will be set to generate alert reports via email to other IMS or to authorized human agents (via email or cellular phone text paging/messaging) when certain types of events occur. Other Internet-based protocols can be used to exchange data with other IMS. As required, non Internet-based communication channels will be used (such as the TCOS to DHS CBP AMS interface). New protocols will be adapted to the SM211 ITS-TCOS to interface with new IMS, or a standard protocol that TCOS already supports can be selected (such as EDI or XML).

7.0 SYSTEM MAINTENANCE

An SM21 IP-MTOPS-TCOS priority will be system maintenance functions. First, all sensor sites will report their hardware status to the data center whenever their status changes -and periodically. Therefore, the data center database will maintain a log of the history as well as the current status of all sensor site hardware. This information will be available on the SM21 IP-MTOPS-TCOS website to all authorized users. The system database will also monitor when it has not heard from a site in its expected reporting period and will mark the site as reporting late (a probable sign of trouble). The SM21 IP-MTOPS-TCOS database will also mark all other data sources (such as external IMS) if they do not communicate within a configurable time period.

Monitoring site status is not sufficient to support maintenance and the SM21 required level of service for government services, especially when the sensor sites are far away from service technicians. The SM21 IP-MTOPS-TCOS sensor site controllers will all support optional dial-in auto-answer telephone modems for direct secure access to the operating systems (telnet and ftp). In addition, the SM21 IP-MTOPS-TCOS site to data center connection through the Internet will support a protocol that will allow a maintenance user to access the site system via a mutual connection to the data center (secure tunneling).

The SM21 IP-MTOPS-TCOS applications will all be designed to allow direct monitoring by maintenance users. This means that a technician or programmer will be able to log on to any software component of TCOS and observe what is going on inside without disturbing its normal operation. This feature will flow as far down as the serial port interface level, to enable a maintenance person to diagnose problems down to the raw device interface. All of this will be done remotely from anywhere in the world via the Internet or direct-dial connection. This makes the basic assumption that either the Internet or the modem connection is available and working. However, the inherent maintenance features of the SM21 IP-MTOPS-TCOS will save time and travel in most cases. In other cases, the SM21 IP-MTOPS-TCOS remote maintenance capabilities will allow an engineer to guide a local technician to fix problems using a voice telephone and an Internet and/or direct dial-up connection.

8.0 SM21 GLOBAL VISIBILITY PLATFORM DEPLOYMENT

To enable Dole Food experimentation through the use of IP-MTOPS-TCOS data, a wide array of COTS software tools will be deployed. This includes the IntelliTrans' developed ***Global Visibility Platform***, or ***GVP***, which will be deployed as modules during the follow-on program year. These systems will be accessed directly or through SM21 Web portal links using a Web browser. The following modules have been identified for deployment and SM21 experimentation support:

- ***Multi-Modal In-Transit Visibility, and Intervention Services:*** These services include a collection of software tools built around a Multi-Modal Tracking System (MMTS) module for tracking and tracing shipments regardless of mode. The MMTS tracking modules will include:
    - Rail.
    - Truck.
    - Ocean Vessel.
    - Intermodal.
    - Barge.
- ***Rail/Intermodal RFID Solutions:*** This includes RFID solutions to the bulk distribution network, including reads from railcar AEI tags, and the integration of other RFID tags.
- ***Telematics:*** The system will be capable of providing telematics services through the appropriate deployment of the TransCore *GlobalWave*® and other appropriate solutions. This type of deployment will tie GPS and sensor data transmission into a single point of contact for hardware, software and services, enabling improved visibility including:
    - Load/empty detection.
    - Detection of valve, hatch, or dome conditions (open or closed).

    - Measurement of pressure, temperature, or other continuous parameters in real time and the generation of alarms.

- ***Rail Yard Management with RFID Solutions:*** The yard management module will provide a complete solution that is capable of providing visibility and command and control to multiple rail yards on a global basis. By integrating a combination of fixed and handheld AEI Tag Readers as well as human input, SM21 will be able to create an efficient yard management solution to support the workflow of rail yards. An initial deployment could be used for testing and support associated with unit equipment deployment to the National Training Center at Fort Irwin, CA.

  Some of the system functions will include the generation of:

    - Event Reports.
    - Switch Lists.
    - Digital Interactive Maps.
    - Detention with user defined rules.
    - Track Lists.
    - Yard Summary Report.
    - Tank Car Loader with Outage Tables.
    - Complex back end logic to control user actions based on circumstances.
    - Audit capability.

- ***Fleet Management Module*** for administering the maintenance, lease and contractual aspects of potential SM21 supported railcar fleets. This module will provide users date-range based search capabilities on rail assets including:

    - HM201 tests.
    - Tank tests.
    - Air brake tests.
    - Coil tests.
    - Rule 88b tests.
    - Out of service.
    - Requiring repairs.

- ***Empty Car Management Module:*** The Empty Car Management module will provide an empty & loaded railcar visibility tool coupled with a diversion decision support system and a railcar demand forecast system specifically designed to allocate railcars and will be designed to promote network optimization.

- ***Global Vendor Managed Inventory ("GVMI") Module*** for enabling optimal mode selection and will be designed to reduce working capital. The GVMI module will employ sensor and telemetry equipment to obtain and broadcast fixed-asset inventory levels. SM21 will work with RFID suppliers to provide Vendor Managed Inventory (VMI) capability on packaged goods, such as totes, cylinders and pallets.

- ***BEAM™ Metrics & Key Performance Indicator ("KPI") Module*** for will be deployed by SM21 to analyze distribution chain performance and will be capable of creating dashboards for monitoring distribution chain performance. The application will support the build of pivot tables and graphical metrics to support the improvement of service level and cost reduction. The KPI module will be linked to an email engine the will "push" KPIs to users on a scheduled basis.
- ***A Bill of Lading (BOL) Generator Module*** will be integrated into the shipment management platform and connected via EDI to all major railroads providing a common BOL platform regardless of carrier. Users will be able to build BOL templates based upon consignee, carrier, commodity, and equipment type allowing for custom formats in an efficient, automated environment.
- ***Detention & Demurrage Management Module:*** This module will enable the management of all aspects of the railcar detention and demurrage process to reduce costs, and verify the accuracy of demurrage invoices and determine the potential dollars that might be anticipated as detention revenue based on both current and historical shipment information.
- ***Rateables and Payables Module:*** The SM21 GVP deployed platform will offer users the ability to store rate and route information for all modes. A freight payables module will be built on top the SM21 database and will match the rate data to shipments and will have the capability to authorize and track payment information.
- ***Switch Performance Reporting:*** The Switch Performance Module will monitor railroad performance and ensure railroads are fulfilling their switch obligations at specific locations.
- ***Materials Management System ("M2S")***: This module will enable the management of operations controlling bulk inventory transload facilities.

SM21 will also employ a combined suite of transportation management services and solutions under the umbrella of the TransCore ***3sixty*** Transportation Management Services, which includes the Global Visibility Platform (GVP) overviewed above. In addition to the services listed above, the SM21 **3sixty** deployment will also include:

- ***Freight Matching Services:*** This service will enable users to ensure their loads are covered by extending connectivity to the 18,000 brokers and carriers that utilize this service.
- ***Fleet Compliance Services:*** This will include the management of fuel tax reporting, titling and equipment compliance, and tools to help users stay current on the latest U.S. Customs and Border Protection Regulations, including the Automated Commercial Environment (ACE).
- ***Wireless Fleet Management Services:*** The deployment of this capability will range from RFID-based systems for freight terminal gate access control to state-of-the-art GPS communications enabling better oversight of equipment location and status.
- ***Operations Management Services:*** The deployment will combine the services of two modules providing brokerage management solutions, including order management, accounts

receivable, accounts payable, analysis reports, general ledger interfacing, and EDI data transmission with rating, tendering, scheduling, and in-transit visibility of shipments.

- ***Financial Management Services:*** This module includes fuel cost management, factoring, credit reporting, rate indexing, and assurance services.

9.0 FUTURE SERVICE INTEGRATION WITH IP-MTOPS

The COTS deployed systems identified above will be undergo SM21 testing, to determine if the systems provide the appropriate service levels required by the SM21-SCLA team. The systems can be either redesigned or replaced as appropriate by more effective modules or services to support the designed stepwise (incrementally) deployment of IP-MTOPS SOA. The IP-MTOPS requirements are documented in an SM21 developed specification[7]. As noted in the specification, no one single commercial software system will meet all the technical and functional requirements defined in the specification. Some or all of the systems tested as part of the IOC testing of the IP-MTOPS will be retained as services within the IP-MTOPS environment. Other systems and services will be procured and implemented by the individual tenants such as air cargo and intermodal rail terminal operators. However, as required, SM21 will also support the selection, or limited development, of systems capable of filling identified military and commercial support gaps and to:

- Enable efficient terminal operations in support of commercial and military shipments by *optimizing* logistics flows,
- Help maintain desired individual terminal and collective inland port *productivity*
- Maintain high customer service *quality*,
- Strengthen customer relationships through up to the minute *visibility* of shipments and quick shipment processing times.

[7] Inland Port - Multi-Modal Terminal Operating System Design Specification, Contractor Report 0008

GLOSSARY

Terminology	Definition
Blog	A blog is a website where entries are written in chronological order and commonly displayed in reverse chronological order.
Business Intelligence	Refers to technologies, applications, and practices for the collection, integration, analysis, and presentation of business information and also sometimes to the information itself.
Collaboration	A structured, recursive process where two or more people work together toward a common goal—typically an intellectual endeavor that is creative in nature by sharing knowledge, learning and building consensus.
Data Mining	The principle of sorting through large amounts of data and picking out relevant information.
Enterprise Content Management (ECM)	Any of the strategies and technologies employed in the information technology industry for managing the capture, storage, security, revision control, retrieval, distribution, preservation and destruction of documents and content.
Enterprise Search	The practice of identifying and enabling specific content across the enterprise to be indexed, searched, and displayed to authorized users.
FlexWiki	An open source wiki engine. The engine is licensed under IBM's Common Public License. FlexWiki uses .NET technology and has an integrated, scripting language called WikiTalk.
Geographic Information System (GIS)	A system for capturing, storing, analyzing and managing data and associated attributes which are spatially referenced to the Earth.
Integrated Battle Command program (IBC)	A Defense Advanced Research Projects Agency (DARPA) program designed to support the military commander's intuition, judgment, and creativity using flexible, intelligent decision aids.
Integrated Computerized Deployment System (ICODES)	The Ship Stow planning system used by the Department of Defense.
Knowledge Management	Comprises a range of practices used by organizations to identify, create, represent, and distribute knowledge for reuse, awareness and learning.
Metropolitan Planning Organization (MPO)	A transportation policy-making organization made up of representatives from local government and transportation authorities.
OASIS	Optimization Alternatives Strategic Intermodal Scheduler (OASIS). OASIS is a comprehensive decision support system that provides intelligent automation of intermodal terminal operations.
Ontology	A data model that represents the relationships of a set of concepts within a domain
Unified Modeling Language (UML)	An object modeling and specification language used in software engineering

Scalable Vector Graphics (SVG)	An XML specification and file format for describing two-dimensional vector graphics, both static and animated. It is an open standard created by the World Wide Web Consortium's SVG Working Group.
Schema	A schema in general is a specific, well-documented, and consistent plan.
SimCity	A simulation and city-building personal computer game first released in 1989 and designed by Will Wright.
Southern California Association of Governments	The Metropolitan Planning Organization for six counties in Southern California: Los Angeles, Orange, San Bernardino, Riverside, Ventura and Imperial.
Transportation Coordinators'-Automated Information for Movements System II (TC-AIMS II)	A DoD deployment and transportation system that provides transportation agents and deploying units a joint capability to automate the processes of planning, organizing, coordinating and controlling deployment, redeployment and sustainment activities worldwide, in peacetime, war, and actions other than war.
Web Portal	A site that functions as a point of access to information on the World Wide Web.
Wiki	A type of computer software that allows users to easily create, edit and link web pages.

REFERENCES

Alberts, D. S., J. I. Garstka, and F. P. Stein, (2000). *Network-centric warfare: Developing and leveraging information superiority*. Command & Control Research Program. Washington, DC

Alberts, D. S. and R. E. Hayes, (2003). *Power to the edge: Command control in the information age.* Command & Control Research Program. Washington, DC

Ambite, Jose Luis, Genevieve Giuliano, Peter Gordon, Qisheng Pan, and Sandipan Bhattacharjee *Integrating heterogeneous data sources for better freight flow analysis and planning,* Proceedings of the 2002 Annual National Conference on Digital Government Research, May 2002

Arena Simulation Software, Rockwell Automation, Milwaukee, Wisconsin, http://www.arenasimulation.com/

Blum, C. and Roli, A. 2003. *Metaheuristics in combinatorial optimization: Overview and conceptual comparison*. ACM Comput. Surv. 35, 3 (Sep. 2003), 268-308. DOI= http://doi.acm.org/10.1145/937503.937505

Borning, Alan and Paul Waddell, *Integrated land use, transportation, and environmental simulation: UrbanSim project highlights*, Proceedings of the 2002 Annual National Conference on Digital Government Research, Seattle, WA, pp 1-2. See also http://www.urbansim.org/

Carson, George S. and Peter Bono, *A Measurement and Monitoring System for Tracking and Visualizing Collaboration Metrics in Real-time and for Later Analysis*, 10th International Command and Control Research and Technology Symposium, McLean, Virginia, June 2005.

COLAB: An Open Collaborative Work Environment (CWE) to Support Networking Among Communities of Practice, http://colab.cim3.net/cgi-bin/wiki.pl/

Evans, Phillip, *The Wiki Factor*, BizEd, Jan-Feb 2006, p 28.

Fouss, Jonathan D. and Kai H. Chang. *Classifying groupware,* ACM Southeast Regional Conference, 2000, pp. 117-124

IntelliTrans LLC, *Global Visibility Platform (GVP); Material Management System (M2S),* www.intellitrans.com

lpsolve, http://sourceforge.net/projects/lpsolve

MATLAB, The MathWorks, Natick, MA, http://www.mathworks.com/

Microsoft Excel, http://office.microsoft.com/en-us/excel/FX100487621033.aspx

Microsoft Office SharePoint Server 2007, http://office.microsoft.com/en-us/sharepointserver/FX100492001033.aspx

Mongelluzzo, Bill, *The agile port*, The Journal of Commerce, Vol 7, Issue 50, 11 Dec 2006, pp 14-18.

Oasis Reference Model for Service Oriented Architecture 1.0, Public Review Draft 1.0, 10 February 2006

Pamphlet 55-19, Tiedown Handbook for Rail Movements, Transportation Engineering Agency, September 2003

Pamphlet 700-4, Vessel Characteristics for Shiploading, Military Traffic Management Command, Transportation Engineering Agency, August 2001

Pamphlet 700-5, Deployment Planning Guide - Transportation Assets Required for Deployment Military Traffic Management Command, Transportation Engineering Agency, May 2001

Pamphlet 700-6, Large, Medium Speed, Roll-On/Roll-Off Ships Users' Manual, Military Traffic Management Command, Transportation Engineering Agency, September 2002

SCAG Regional Goods Movement Knowledge Base, http://www.scag.ca.gov/goodsmove/knowledgebase/knowledgebase.asp

Scott, S.D., Cummings, M.L., Graeber, D.A., Nelson, W.T., Bolia, R.S. (2006). *Collaboration Technology in Military Team Operations: Lessons Learned from the Corporate Domain.* CCRTS 2006: the Command and Control Research and Technology Symposium, June 20–22, 2006, San Diego, CA, USA.

Tapscott, Don and Anthony D. Williams, Wikinomics: How Mass Collaboration Changes Everything, Penguin Group, 2006

The Global Definition of Port Agility, Center for the Commercial Deployment of Transportation Technologies, 1997, http://www.ccdott.org/Deliverables/1997/VZM123/VZM123%202.pdf

The Integrated Computerized Deployment System (ICODES), http://www.cdmtech.com/web/guest/pages/products/ICODES

TransCore 3sity Global Visibility Platform Design Overview Documentation

Transportation Coordinator's Automated Information for Movements System II, https://www.tis.army.mil/

Wikipedia, http://www.wikipedia.org/