

12TH ICCRTS
“Adapting C2 to the 21st Century”

Collaboration in Regional Civilian and Military Transportation Planning

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Abstract

The Strategic Mobility 21 (SM 21) Program¹ 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.

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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 as 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.

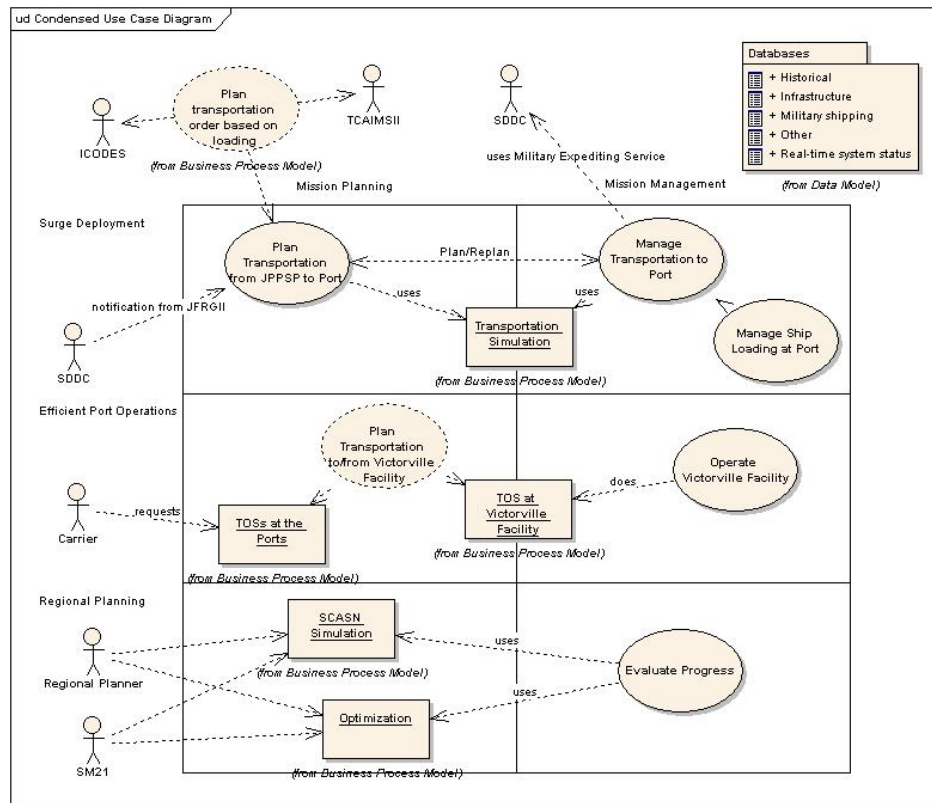


Figure 1. Summary use case diagram

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 include 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 these 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.

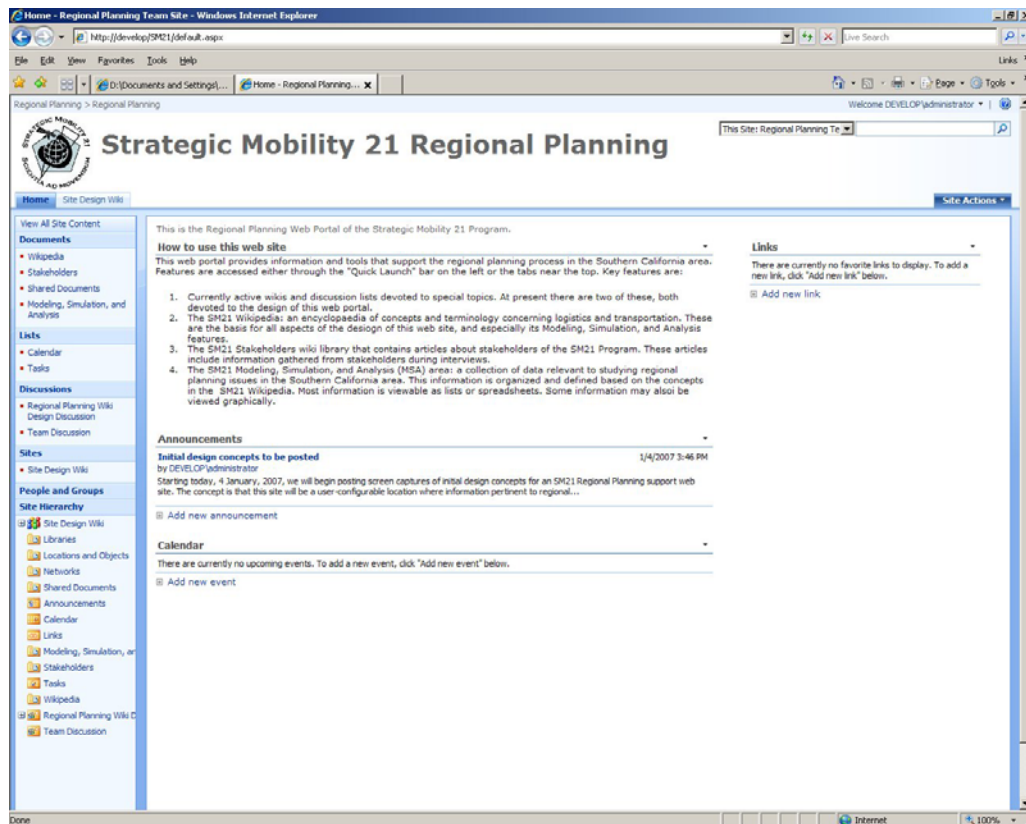


Figure 2. Top level regional planning interface

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 Ipsolve [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 Ip_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	J
1	Name	Property name	Property data	Property name	Property data	Property name	Property data	Property name	Property data	Property name
2	Port	Node cost	0	Supply/Demand	160	Node capacity UB	200	Node Capacity LB	0	Geolocat
3	Hobart	Node cost	0	Supply/Demand	0	Node capacity UB	200	Node Capacity LB	0	Geolocat
4	Palmdale	Node cost	0	Supply/Demand	-120	Node capacity UB	200	Node Capacity LB	0	Geolocat
5	Yucca Valley	Node cost	0	Supply/Demand	-40	Node capacity UB	200	Node Capacity LB	0	Geolocat
6	Victorville	Node cost	0	Supply/Demand	0	Node capacity UB	200	Node Capacity LB	0	Geolocat

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) or 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.

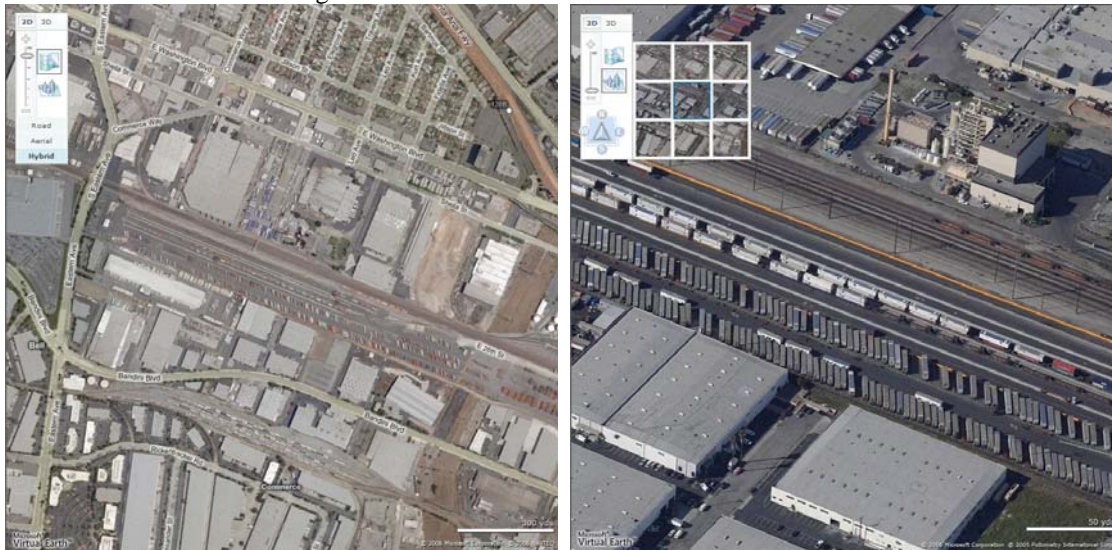


Figure 4. Geospatial visualization in the web portal

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 file 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: \$6.51	
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.

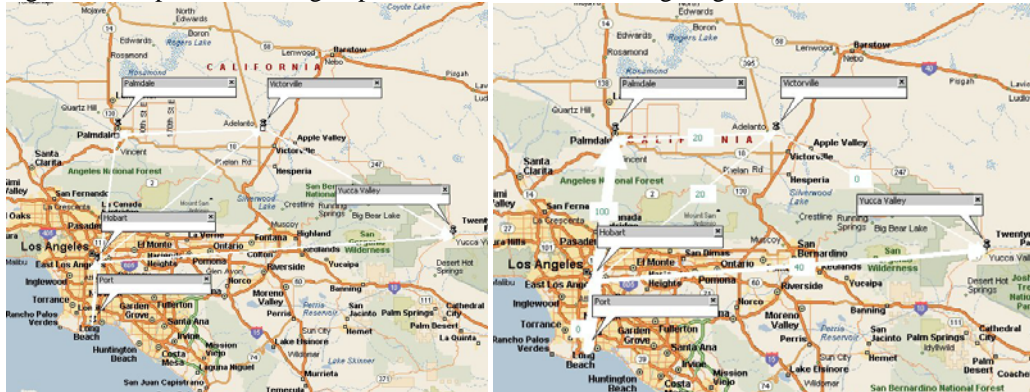


Figure 7. Least cost path visualizations

	A	B	C	D	E	F
1	Name	L and O File name	Start	End	Property name	Property data
2	1	Opt_Test_Nodes.xlsx	Port	Hobart	Flow	0
3	2	Opt_Test_Nodes.xlsx	Port	Palmdate	Flow	100
4	3	Opt_Test_Nodes.xlsx	Hobart	Yucca Valley	Flow	40
5	4	Opt_Test_Nodes.xlsx	Hobart	Victorville	Flow	20
6	5	Opt_Test_Nodes.xlsx	Victorville	Palmdate	Flow	20
7	6	Opt_Test_Nodes.xlsx	Victorville	Yucca Valley	Flow	0
8						

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.

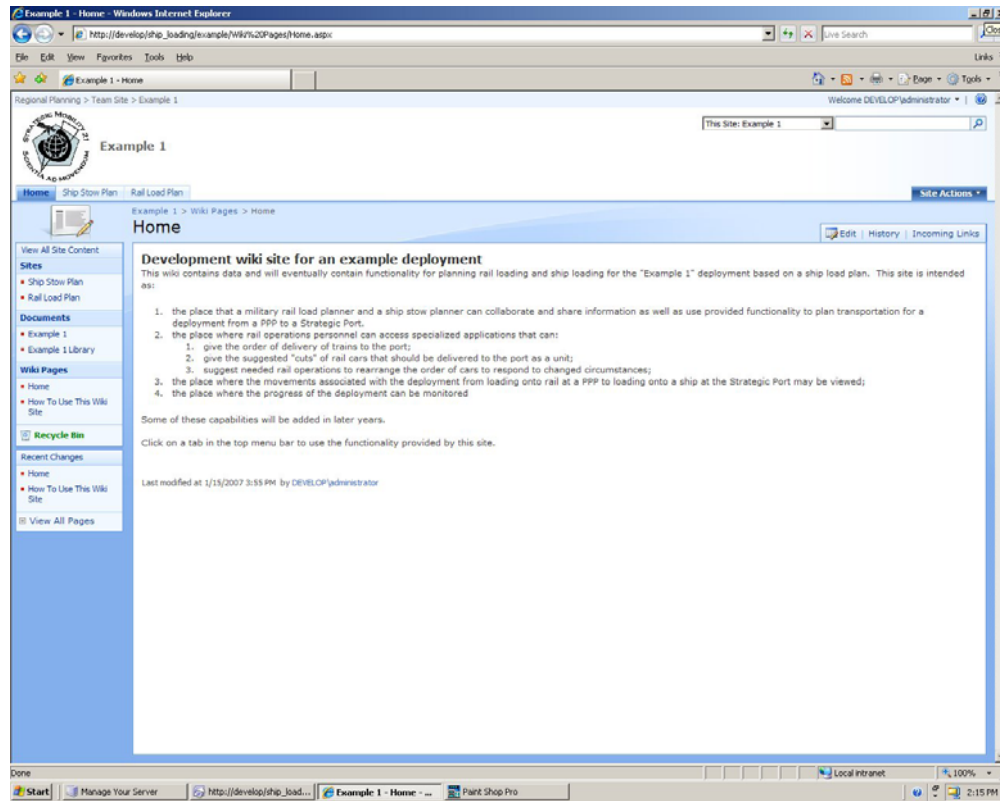
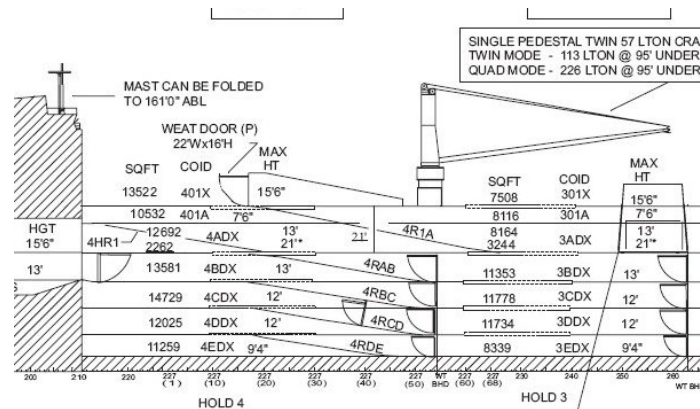


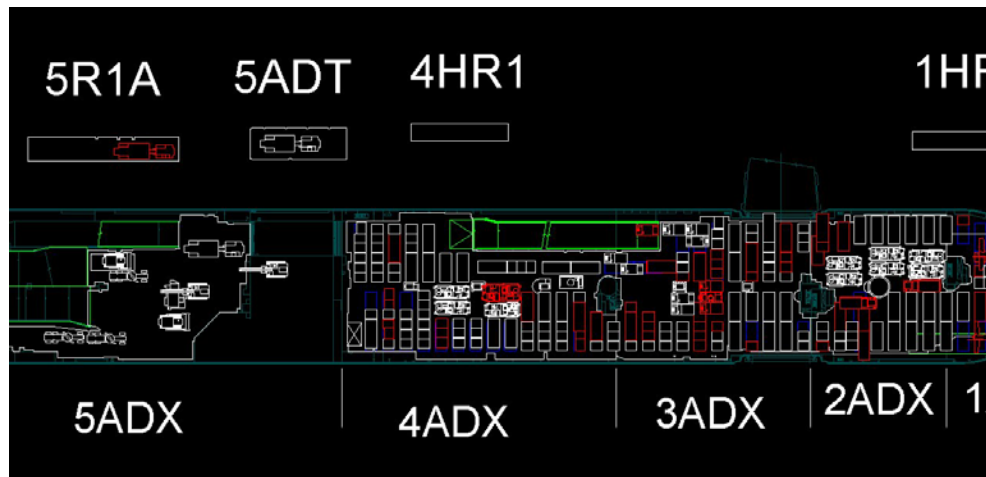
Figure 9. First page of the Surge Deployment Web Portal

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.



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.



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	AWJHS0\$0D00140XX
300	USNS SHUGHART v.2006074	2BDX	M1130	COMMAND VEH/STRYKER	HQ63	AWH9ST0\$0D00180XX
301	USNS SHUGHART v.2006074	2BDX	M1131	FIRE SUPT	B71	AWH9GB0\$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\$0D04200XX
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	AWD8AA0\$0D04270XX
307	USNS SHUGHART v.2006074	2BDX	XM1132	ENG SQD VEH/STRYKER	EN 213	AWD77AA0\$0D04250XX
308	USNS SHUGHART v.2006074	2BDX	XM1133	MED EVAC VEH/STRYKER	HQ731-1	AWH9GT0\$0D04280XX

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.

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