U.S. Waterborne Cargo Data System: Phase II

Final Report

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Introduction

In previous research projects, Vanderbilt University created and enhanced a U.S. Foreign Waterborne Cargo Data System to support the analysis of cargo flows between U.S. and foreign ports. The U.S. Army Corps of Engineers (USACE) Waterborne Commerce Statistics Center (WCSC) collects, maintains and disseminates maritime cargo flow data for the United States. All of these datasets are tabular in nature, but may be visualized geographically. Additionally, by manipulating the information for display in an Internet geographic information system (GIS), data retrieval is much easier for end users that may not be savvy enough nor have the need to process large amounts of data to get the specific information they require for their analyses.

The first release of this system was 2002 when the web-based tool was released. The most recent release of the system was completed in 2009. These previous releases included only U.S. to foreign movements and data; domestic shipping movements and those along the inland waterways were largely left out. The main focus of this 2013 release was to modify the system architecture, add new datasets, make the Internet GIS the portal for retrieving all information, and include information on domestic cargo movements.

Potential system users include government agencies, businesses, port authorities, shippers, carriers and trade associations. These and other stakeholders will be able to rapidly understand cargo movement statistics and trends relevant to their port, region or business in terms of historical data. This document is the final report for this project and describes the architecture, data, system interface design and demonstrates how information is retrieved.

System Architecture

Previous releases of this system made use of a Microsoft Access database and direct connections using database connectivity drivers on the server. This release upgraded the back-end database to Oracle 11g, an enterprise-class relational database. Additionally, stored procedures are used to standardize the queries that are run against the database and ensure that only the minimum user permissions are required. Additionally, the system runs on XML web-based services, which allows for any system or human user, not just the system being described here, to access the data through a standard TCP port of 80. At the moment, the web services are not documented for public consumption, but they will be in the future, and the data will continue to be updated as new annual data is published by the Corps of Engineers. The web pages can reside anywhere as long as they can access the XML web services, which are stored on the server with the database at Vanderbilt University.

This combination of new technology provides a dramatic upgrade in security, scalability and response time. The Oracle database platform is much more capable of handling the load imposed on the database by such a system in terms of concurrent user sessions and the large amount of data present in the database. The stored procedures and database views will automatically display new data as it becomes available (most data is through 2010 at the time of this writing). For example, when 2011 data is
released, once it is loaded in the database, it will be visible through the system without requiring any modification to the system code. The next section will discuss the data that is available in the system.

**Data**

As discussed previously, the data contained in the system originates from the U.S. Army Corps of Engineers. This data is disseminated by the Waterborne Commerce Statistics Center (WCSC), part of the Navigation Data Center (NDC). Vanderbilt University has archived these datasets since the late 1990’s and received some datasets via special request to the Corps. The datasets are all publicly available on the NDC website at: [http://www.ndc.iwr.usace.army.mil/data/data1.htm](http://www.ndc.iwr.usace.army.mil/data/data1.htm).

The following types of data are available:

- **Vessel entrances and clearances**\(^1\) – this data originates from the U.S. Customs and Border Protection (USCBP) agency. The raw data dates back to 1997 and includes the vessel name, date, net and gross tonnages, ship type, flag of registry, draft and destination port (clearance) or previous port (entrance) for all U.S. ports. The data is available in the system by port and the number of entrances (vessel calls) are tabulated by year and ship type.

- **National Waterway Network (NWN) link tonnages**\(^2\) – The national waterway network (NWN) is a geographic information system (GIS) line layer that represents navigable waterways in the U.S. For each link, information such as depth, river name, segment name, milepost ranges, among other administrative information is available. This network is used to analyze waterborne commerce and this dataset is the publicly available version. Commodity movements are expressed in short tons moving upbound and downbound on most NWN links. The categories for each movement type are aggregated into coal, petroleum, chemicals, crude materials, manufactured goods, farm products, machinery, waste, unknown and a total for each link. High-level categories are used to protect the confidential nature of the shipments (for both shippers and carriers).

- **Import and export data (port to port and port to country)**\(^3\) – The USACE publishes foreign cargo data at the foreign port level (Schedule K code). The same dataset is used by both the port to port and port to country analyses. The system aggregates data for the foreign country level, as that is one of the most commonly requested data products. The type of movement (import, export and in-transit) may be queried, as well as commodity codes and the U.S. port or waterway on which the movement took place.

- **Trips and drafts data** – This dataset was requested and received directly from the Corps of Engineers. The Corps reports the data in their annual Waterborne Commerce of the United States (WCUS) publications.\(^4\) The data had to be requested directly, because the WCUS

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publication is an Adobe PDF file, and not easily imported into a relational database. The attributes include traffic type, traffic direction, vessel type, vessel draft, and number of trips. This is reported by waterway code, which is a larger aggregated unit than a single waterway link.

- **Containers/TEUs (twenty foot equivalent unit)** – This data contains annual containerized activity observed at U.S. ports. Container movements are reported by the number of inbound, outbound, loaded and empty containers handled, including foreign and domestic, by year and port.

- **Manuscript cargo commodity flows** – This dataset contains domestic waterway tonnages by commodity, direction (upbound, downbound), and type of traffic (import/export, coastwise, lakewise, internal, local), reported by waterway code.

- **Public domain commodity flows (state to state and region to region)** – This dataset contains annual state to state and region to region waterborne cargo tonnages for 14 major commodity groupings. The 26 regions are aggregated by coastal district (e.g., North Atlantic, California Coast, Gulf Coast) and waterway system (e.g., Upper Mississippi, Tennessee River, Illinois Waterway). These datasets are the only ones not available through the map interface. Rather, these datasets may be queried directly using a form interface from the front page.

Discussion of the database design is beyond the scope of this report. However, it should be noted that there was no pre-processing required of the aforementioned datasets. This makes updating the system as easy as possible. The next section will discuss in broad terms how the system handles requests and returns data to the user.

**System Interface Design**

As mentioned previously, the tabular data published by the Corps of Engineers is not geographic in nature, but can easily be visualized by relating it to geographic layers maintained by the Corps. Namely, these layers are the National Waterway Network and the Principal Ports datasets. The Principal Ports and NWN layers can be seen in Figure 1 and 2, respectively. These are screenshots from the system’s web interface.

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The Principal Ports layer has port codes that are linked to most of the datasets discussed in the previous section. These include imports and exports (foreign cargo), port to port/country, containers/TEUs, trips and drafts and vessel entrances. The information window that appears upon clicking a port is shown in Figure 3, and contains links to these datasets. Figure 3 is the information window for the Port of New Orleans, LA (port code 2251).

Clicking on the “Imports” by country link brings up a new window with each country that has exported product to the U.S. in the Port of New Orleans. This screenshot is shown in Figure 4.
Figure 4. Screenshot of U.S. Imports by Country via New Orleans, LA.

Similarly, the NWN information window contains links to view link tonnages, waterway commodities and trip data as shown in Figure 5.
Clicking on the “View Trips by Vessel Type” link will open a new browser tab showing trip data for waterway code 6034, “Mississippi River, Mouth of Ohio River to Baton Rouge.” The green dots along the river banks in Figure 5 are water terminals.

Conclusions and Recommendations for Future Research

This research project has resulted in an upgrade to a U.S. Maritime Cargo Data System. The upgrade resulted in a new design, featuring Internet GIS as the main portal through which comprehensive maritime cargo data can be retrieved. Internet GIS has become much easier to manage and customize over the past several years. Use of JavaScript makes the system readable using a wide variety of devices, including tablets and mobile phones. Additionally, the response time, portability and scalability have been improved. This was accomplished using an enterprise-level relational database (Oracle 11g), XML web services and a design that makes updating the database as simple as loading data (which does not need any pre-processing). To display the new data, there is no code modification required. Moreover, the supporting XML web services may be used by other information systems once the services are documented in terms of required parameters, etc.
Despite these upgrades, there are additional enhancements that can be made in the future. Among these are:

- Inclusion of ton-miles between U.S. and foreign port origin/destination combinations. The International Waterway Network (IWN) needs to be updated with multiple origins and destinations run to determine the actual shipping lane distance between all U.S. and all foreign ports. This will be included in the next release of this system.

- Real-time visualization of the actual shipping route using the International Waterway Network (IWN). Rather than the straight line distances (“as the crow flies”) that were included in the 2009 release, displaying the actual shipping route can be accomplished by routing through the IWN in real-time (using ESRI ArcGIS Server and the Network Analyst extension) between the U.S. and foreign ports of interest.

- There are additional datasets, perhaps not collected and published by USACE, that could be included in such a portal. Such datasets might include safety data (USCG marine safety data maintained by the USCG), port authority links for each port or even freight data from truck and rail modes of freight transportation. Internet GIS has been demonstrated by this project and other efforts to be a great means of managing information for easy retrieval and visualization.

The final system is located at: http://transp40.vuse.vanderbilt.edu/westhemmaritime

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