Digital Mariners' Routeing Guide

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Table of Contents

Executive summary

This report summarizes work on a prototype digital mariners' routing guide for the North Sea.

The digital mariners' routing guide project consists of a presentation of datasets compiled from nautical publications in an online application that provides information necessary to preparing for a voyage between selected ports in the North Sea. This information includes ships routing measures, marine services, reporting requirements, areas where special regulations apply, etc. The datasets are designed to conform to the new standards for marine information being developed by the International Hydrographic Organization and other international bodies.

Activity in an earlier phase of the BLAST project converted selections from unstructured textual information from nautical publications into structured data conforming to a new data model under development by IHO working groups , and used the results to prepare XML datasets for three North Sea ports. This report describes a subsequent phase which demonstrates that disparate nautical publications information conforming to the common data model can be used in novel applications and presentations built with commonly available technology, thereby improving its availability and utility to data vendors, application developers, and end users.

BLAST is an INTERREG IVB North Sea project involving 16 partners from 6 countries, including government organizations, universities and private companies. BLAST will demonstrate improvements in maritime safety, economy, and environmental management that can result from trans-national harmonization of land and sea data. There are 6 Work Packages in all. For more detail on BLAST, please refer to http://www.blast-project.eu/. The work described in this document is a part of Work Package 4 of the BLAST project.

1. Preface

1.1. The BLAST (Bringing Land and Sea Together) project

BLAST is an Interreg IVB North Sea project promoting maritime safety in the North Sea region. It involves 16 partners from 6 countries, including government organizations, universities and private companies. The BLAST partners are collaborating to demonstrate the potential for improvements in maritime safety, economy, and environmental management that can result from trans-national harmonization and integration of land and sea data. BLAST is divided into 6 Work Packages and a variety of projects from late 2009 through 2012. The BLAST Website summarizes BLAST and gives detail on its work packages - http://www.blast-project.eu/.

1.2. BLAST Work Package 4: Navigating the North Sea

The projects in WP 4, conducted by Jeppesen GmbH and partners, examine the collection, processing, and publishing of nautical information. The Jeppesen projects started with primary research to identify the current state of the art in Denmark, Germany, and Norway. This enabled the partners to identify what works well today and where there trans-nationally harmonized data could make it easier for the North Sea community to maintain a clear, current view of maritime conditions. The fourth project, a digital routing guide web demonstrator, is the focus of this paper.

1.2.1.   Project 1: Survey Current State of the Art

The report summarized research into the current state of the art in nautical information management systems in three North Sea ports. The research is related to three projects in BLAST Work Package 4 conducted by Jeppesen GmbH, Mälardalen University, the Hydrographic Offices of Norway, Denmark, and Germany, and the Coastal and Port Authorities in the three subject ports: Hirtshals, DK, Stavanger, NO, and Wilhelmshaven, DE.

1.2.2.   Project 2: Maritime Data Collection System Web Demonstrator

The Maritime Data Collection System (MDCS) project demonstrated a web-based solution prototype of trans-nationally harmonized maritime data collection, validation, and publications. MDCS requirements definition started in Phase 1.

1.2.3.   Project 3: Harmonization of Nautical Information

The Harmonization of Nautical Information project demonstrated conversion of selected nautical information for the three test ports into XML datasets conforming to a common data model. The information consists of extracts from publications produced by the Hydrographic Offices and Coastal Authorities in Norway, Germany, and Denmark. The common data model conforms to the new IHO S-100 standard for hydrographic information. North Sea Hydrographic Offices have a central role in the definition of the standard. This project is a practical test of applying the IHO work to nautical publications information.

1.2.4. Project 4: Digital Mariners Routing Guide Web Demonstrator

The Digital Mariners Routing Guide project demonstrates the potential benefits of using trans-nationally harmonized data in new information software applications for improved maritime efficiency and safety. It uses the datasets produced in earlier phases. Thus the North Sea DMRG builds upon what was learned in the prior projects.

2. Introduction

2.1. Background

In addition to charts and nautical publications, mariners use recent or real-time information including weather, navigational warnings, etc. This information may be obtained by one form or another through radio communications, and more recently over the Internet.

Obviously the Internet can be used for disseminating many types of information, including recent or (near) real-time information, digital charts, publications, and updates to them, and it is in fact being so used by various producers including hydrographic offices, coastal authorities, ports, government agencies, and private sources. Traditionally, nautical publications were distributed in printed form. Digital formats have been introduced relatively recently for charts (ENCs) and are being increasingly used. Digital formats for nautical publications have generally been limited to digitized forms (e.g., PDF files or HTML Web pages) of the corresponding paper documents or database-backed web presentations (e.g., lists of chart corrections or inoperable navigation aids).

A data model for hydrographic data was introduced by the IHO in the 1990's in the S-57 standard [S57], and is currently used for ENCs. The IHO has since developed a newer framework standard "S-100: Universal Hydrographic Data Model" [S100], which is intended to support other types of navigation information and other data products in addition to ENCs. S-100 is a framework standard from which standards for different data types and data products are derived. Examples of such derived standards are the S-101 and S-102 Product Specifications, both currently under development, which describe data models for ENC and high-density bathymetry data respectively.

Chart data and bathymetry are well-structured data which can easily be expressed using object-attribute data models, but information in nautical publications, being textual, narrative, unstructured and expressed in natural language, is difficult to express in object/attribute form. The IHO Standardisation of Nautical Publications Working Group (SNPWG) is working on a data model for nautical publications which is based on S-100. The Harmonisation Phase converted unstructured textual information from nautical publications pertaining to one port each from Denmark, Germany, and Norway into structured data conforming to the IHO SNPWG data model, and produced XML datasets for the three ports. The project used the information requirements of a hypothetical digital mariner's routing guide to drive the selection of data from nautical publications. This phase of the project demonstrates that nautical publications information for the 3 participating North Sea nations and for ports of different size can be harmonised by means of conversion into a single data model.

Mariner's routeing guides are a mixture of textual, graphic, and geographic information about traffic separation, recommended routes, ship reporting systems, regulations for navigation and environmental protection, and other information. They provide an overview of the information needed by navigation officers for planning voyages. Their presentation to end-users combines different types of information, including geographic features from nautical charts and text extracts from publications, in a largely graphical product.

The prototype Digital Mariner's Routing Guide (DMRG) described in this paper is a web-based system demonstration that will allow mariners to view information from different North Sea ports that has been converted to the new IHO S-100 data framework. DMRG features include:

- a user-controlled graphical display of land and sea areas, traffic separation, ship reporting, restricted areas, nature preserves, and similar information of use in voyage planning;
- auxiliary displays of specific information on navigation, rules and regulations, environmental protection, and other topics;
- different types of information access functionality, including geographic searches, intended to provide users with efficient access to information.

2.2. Acronyms and Abbreviations

BSH	Bundesamt für Seeschifffahrt und Hydrographie
DaMSA	Danish Maritime Safety Administration (see also FRV)
DMRG	Digital Mariners' Routeing Guide
ENC	Electronic Navigation Chart
FRV	Farvandsvæsenet (see also DaMSA)
IHO	International Hydrographic Organisation
IMO	International Maritime Organisation
KMS	Kort & Matrikelstyrelsen (National Survey and Cadastre)
MDCS	Maritime Data Collection System
NCA	Norwegian Coastal Administration (Kystverket)
NHS	Norwegian Hydrographic Service (Statens Kartverk Sjø)
SNPWG	Standardisation of Nautical Publications Working Group (IHO)
TSMAD	Transfer Standard Maintenance and Development Working Group (IHO)
VTS	Vessel Traffic Service
WSA	Water and Shipping Agency (Wasser- und Schifffahrtsamt)
WSD	Waterway and Shipping Directorate (Wasser- und Schifffahrtsdirektion)
WSV	Wasser- und Schifffahrtsverwaltung des Bundes

2.3. References

[BLAST1] State of the art report: Nautical information management. BLAST Deliverable D_WP4_1, 2010. URL: http://www.blast-project.eu/media.php?file=283

[BLAST2] Harmonisation of nautical information. BLAST Deliverable D_WP4_3, 2011. URL: http://blast-project.eu/media.php?file=553

[DRGPS] BLAST Digital Routing Guide Product Specification.

[S49]   Standardization of Mariner's Routeing Guides. Special Publication No. S-49, Edition 2.0. April 2010. International Hydrographic Bureau, Monaco.

[S57]   International Hydrographic Organization. S-57: IHO Transfer Standard for Digital Hydrographic Data, ed. 3.1. November 2000. (latest supplement June 2009)

[S100]   International Hydrographic Organization. S-100: Universal Hydrographic Data Model, Edition 1.0.0. International Hydrographic Bureau, Monaco, 2010.

[SW]   Wiki maintained by Capt. Schröder-Fürstenberg for Standardization of Nautical Publications Working Group discussions, URL: http://www.fuerstenberg-dhg.de/mediawki/index.php

[WG2011] IHO S-100: The universal Hydrographic data Model. R. Ward and B. Greenslade, International Hydrographic Organisation. IHO Information paper, 2011. URL: http://www.iho-ohi.net/iho_pubs/standard/S-100/S-100_Info.htm

3. Content

3.1. Sources

Data for the DMRG consists of geographic features from ENCs combined with extracts from text official nautical publications of hydrographic offices and other sources, converted to an XML format compatible with both S-100 and GML (Geography Markup Language). The current implementation contains only information on selected ports in Norway, Denmark, and Germany. Data was prepared with the participation of the Norwegian Hydrographic Service (NHS), Bundesamt für Seeschifffahrt und Hydrographie (BSH), and Kort & Matrikelstyrelsen (KMS) in converting data from their publications to the new information model. The report for the "Harmonisation of nautical information" phase [BLAST2] contains a list of publications from which content was extracted. The structure and volume of the source texts varied greatly but all source material was mapped to the common data model being constructed by the IHO Standardisation of Nautical Publications working group.

3.2. Data Model and Format

The "Universal Hydrographic Data Model" described in S-100 is a framework intended to support data modelling for a variety of data sources, products, and applications. The model is based on ISO/TC211 standards for geographic information. The main characteristics of the framework described in the S-100 standard are abstractions of objects, attributes, and their relationships. The S-100 framework standard defines an abstract General Feature Model (GFM) upon which data models for application domains (e.g., nautical charts, nautical publications, bathymetry, etc.) are built. The GFM does not define entities or attributes corresponding to tangible geographic features or chunks of information – these are supposed to be defined in a feature concept dictionary, and their attributes and relationships in the context of an application domain are supposed to be specified in a feature catalogue for each application domain. The S-100 framework is described in an earlier report [BLAST2] and IHO publications [S100, WG2011].

The IHO working group on Standardization of Nautical Publications (SNPWG) has developed an broad-based domain model for nautical publications information (the "SNPWG model") based on the S-100 framework. The scope of the SNPWG model is limited to the type of information found in textual nautical publications (as opposed to nautical charts). The geographic objects range from radio stations to port security areas. The information objects range from regulations to address/contact information, ship reports, hours of work, and specification of classes of vessels to which a rule applies. This model is currently documented online at the SNPWG Wiki [SW]. The corresponding product specification for ENC information (the "S-101" product specification) is being developed by the IHO TSMAD working group.

The data model used by the DMRG combines the SNPWG data model with the current data model for hydrographic data known as the S-57 standard and specified by the IHO [S57]. (The "S-101" model mentioned above was not mature enough at the time the DMRG model was built.) The scope of the SNPWG data model is larger than digital mariners routing guides, and a subset of features and attributes was included in the DMRG data model. For similar reasons, a subset of ENC objects and attributes from the S-57 model was selected for the DMRG.

The data model used for the DMRG is documented in the DMRG Product Specification [DMRGPS]. This documents the features, attributes, their relationships, metadata, data format, encoding guidelines, and other specifications for DMRG data sets. It includes the DMRG feature catalogue, which specifies feature and information types, their attributes, and the data types and allowed ranges for attribute values. Features and attributes were selected for inclusion in the feature catalogue based on the guidelines for mariners' routing guides provided by the IHO publication "Standardization of Mariner's Routeing Guides" [S49], augmented by additional feature and information types defined the SNPWG model.

The S-100 standard allows definition of different data formats ("encodings") for tangible representations of information. The encoding for the DMRG content was defined using an XML application schema derived from GML 3.2.1. The encoding is capable of coding geographic features, information objects, simple and complex attributes, feature associations, information associations. The format is described in more detail in the report for the Harmonisation activity and the product specification [BLAST2, DRGPS].

3.3. Data Conversion

The information mapping work for this project was performed by project participants at BSH, NHS, and KMS, and reviewed by Jeppesen. The three hydrographic offices selected material, from both nautical publications as well as selected data from ENCs, for the routing guide. Coordinates for geographic features were determined from the text if available; if not, the coordinates were obtained from the appropriate ENC or created in an ENC editing tool. The selected information was converted into XML data sets, which were in turn converted into formats required by the implementation technology of the DMRG. Our report for the previous activity [BLAST2] contains more information about the process and lessons learned.

4. Functionality

Mariner's routing guides are intended to be used for planning a voyage rather than voyage monitoring. The consequence for the routeing guide is that detail used for ship navigation, such as accurate information about the locations of geographic features and details about navigation aids and marks is not included. Instead the routeing guide presents information on services, reporting requirements, restrictions, environmentally sensitive areas, rules and regulations, etc. Since much of this information is in fact attached to specific locations or applies to specified areas, a geographic component is still a must. In addition, the information which is in text form varies in content from brief fragments to paragraphs, though an effort was made to condense it for the on-screen display. The content and user interaction functionality reflects these constraints and the above intended use of the information.

The DMRG presents a single screen comprised of a graphic representation of land and sea areas, accompanied by panels with interaction controls. The graphic display can be overlaid under user control with the geographic features contained in the DMRG datasets described in Section 3. The textual presentations are produced by menus in the control panels on the right, and appear as pop-ups over the graphic display.

4.1. Geographic Browsing

The lower control panel allows a user to select which types of locations should be displayed and highlighted on the graphic display. The various layers in the panel correspond to vector objects such as Vessel Traffic Service (VTS) areas and associated calling-in points, major navigational aids, pilot services, etc. Selecting a group or item in the *Layers and Features* panel displays and highlights the relevant feature(s). Clicking a displayed feature in the graphic window brings up a popup with information about the feature. Figure 1 shows this functionality in action.
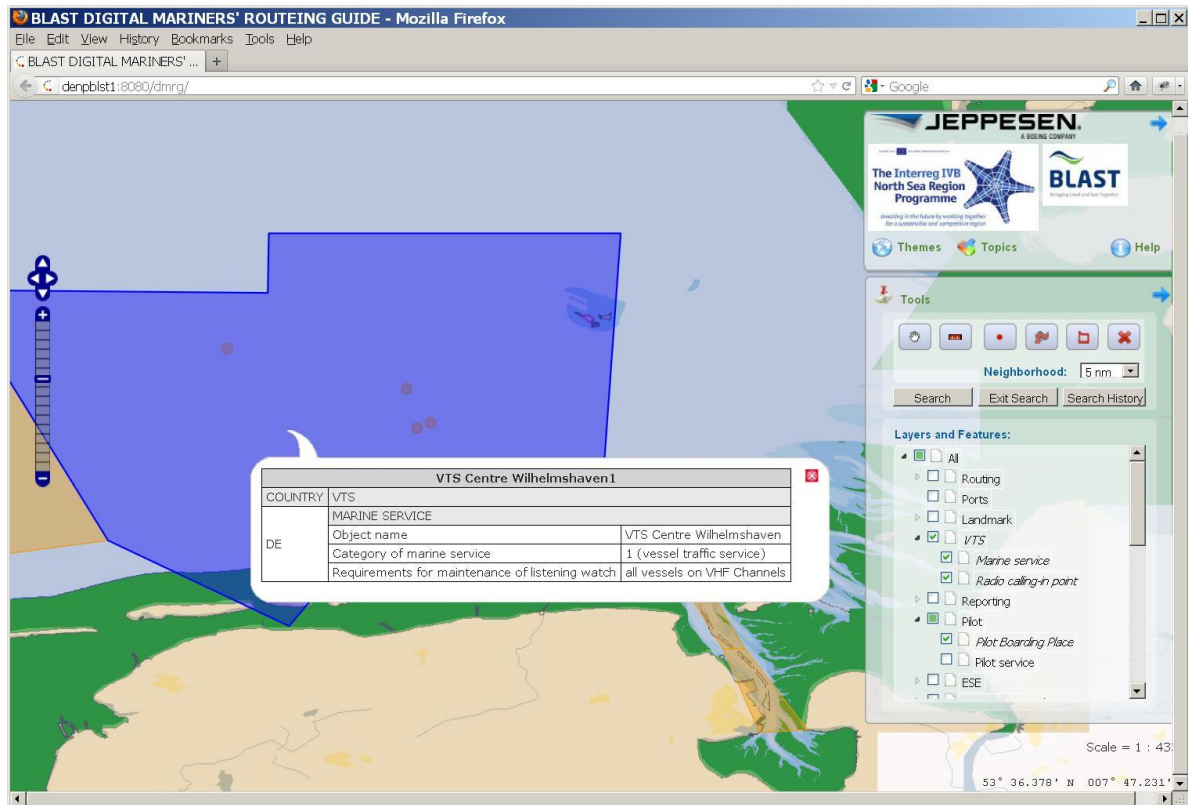
Figure 1: Graphical browsing for VTS areas showing information popup for user-selected feature (blue) and other VTS features (orange).

4.2. Structured Presentations of Text

The system provides a menu-based interface which allows the user to obtain results about a single feature class, a group of feature classes (topics), or a broad subject (themes menu). The choices available for the two are shown in the figures below.
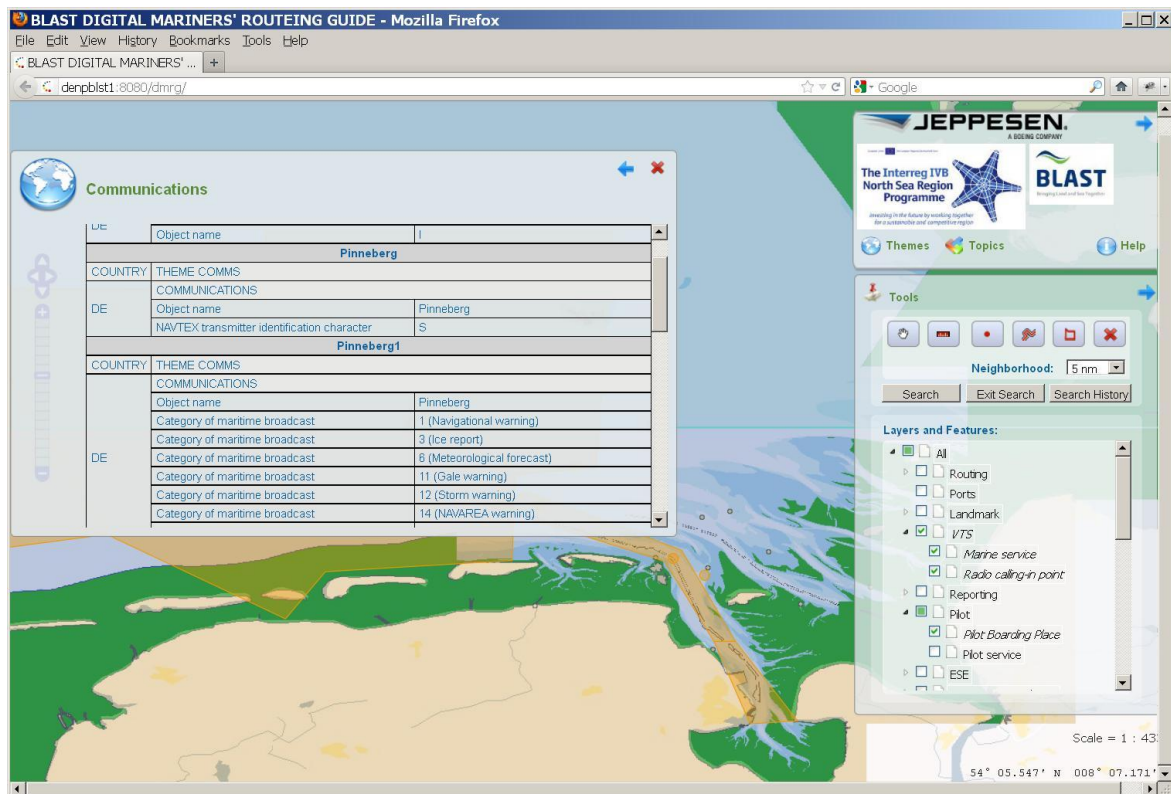

Figure 2. Choices for Topics menu

Figure 3. Choices for Themes menu

Figure 4 shows an example of the results obtained by clicking a theme or topic item, which is a third panel displaying all available information pertaining to the selected theme or topic in tabulated form, depending on what data is available.

Figure 4: Tabular presentation of communications information. This displays all the available information about the selected topic, organized by country and type of information.

4.3. Geographic Queries

The DMRG permits users to find information by means of user-specified geographic queries. Users specify the search by drawing the search geometry on the graphic display with the mouse. Four types of query geometry can be specified.

1. Point query allows searching for information around a selected point in the chart display, selected by clicking at the desired location.
2. Polygonal area query allows users to search by drawing a polygon in the chart display using the mouse.
3. Radial query allows users to search for information within a specified radius of a central point. Users select the point on the graphic around which they want to search and draw a circle giving the search radius.
4. Line/route query allows the user to obtain information intersecting, or in the neighbourhood of a route specified by the user. The route is specified by placing consecutive waypoints with the mouse.
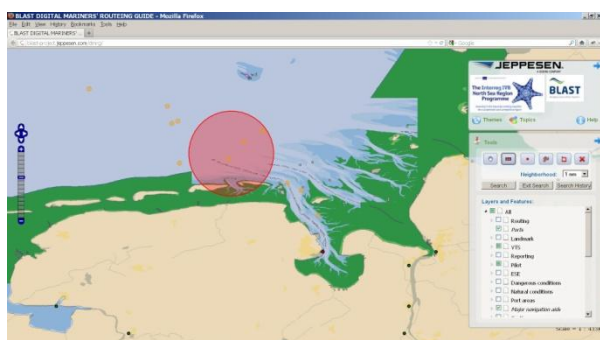
The search geometry is shown in red while it is being drawn and black after drawing is complete. Screens showing the four queries are shown in Figures 5–8 below.
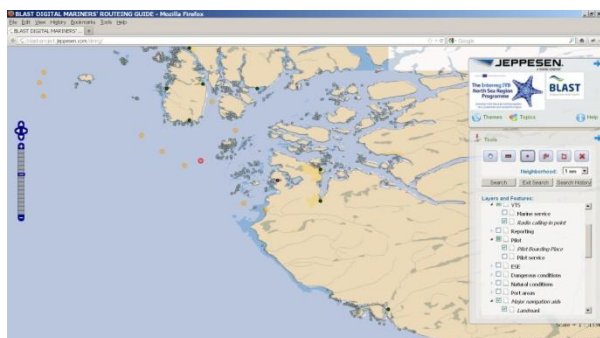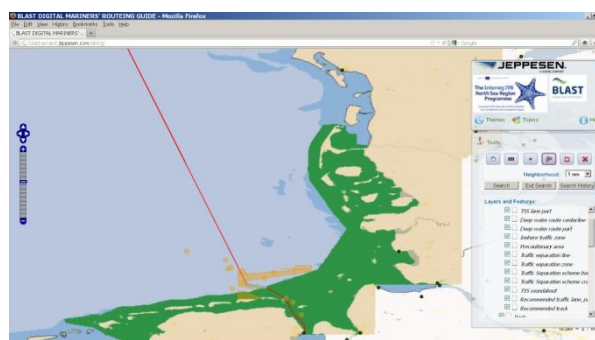
Figure 5. Point query
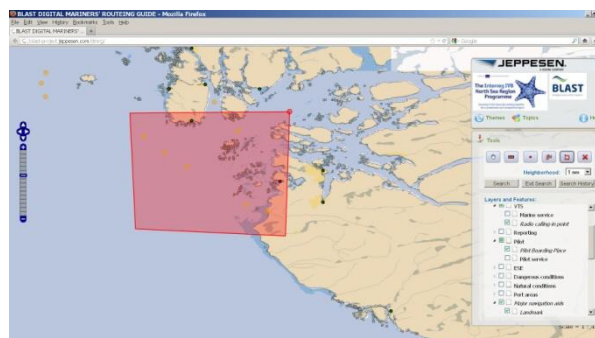
Figure 6. Polygonal area query

Figure 7. Radial query

Figure 8. Line/route query

The system also retains search history for the current session. Users can display the results of previous searches executed during the current session. This fucntionality is activated only after at least one search has been executed. It displays a tree in the layers and Features panel for each available search. Users can select which searches to show or hide and also pick classes of features or individual features in the Layers and Features panel, which in this mode replaces the initial display of feature classes with a hierarchical list of previous searches and their results. Figure 9 shows the use of the search history functionality to revisit the results of a previous radial query. The large dark circle in the figure shows the original radial query, and the orange dots the results of that query. The blue highlighted dot is the consequence of the user clicking the orange dot at that location to find out details about that pilot boarding place.
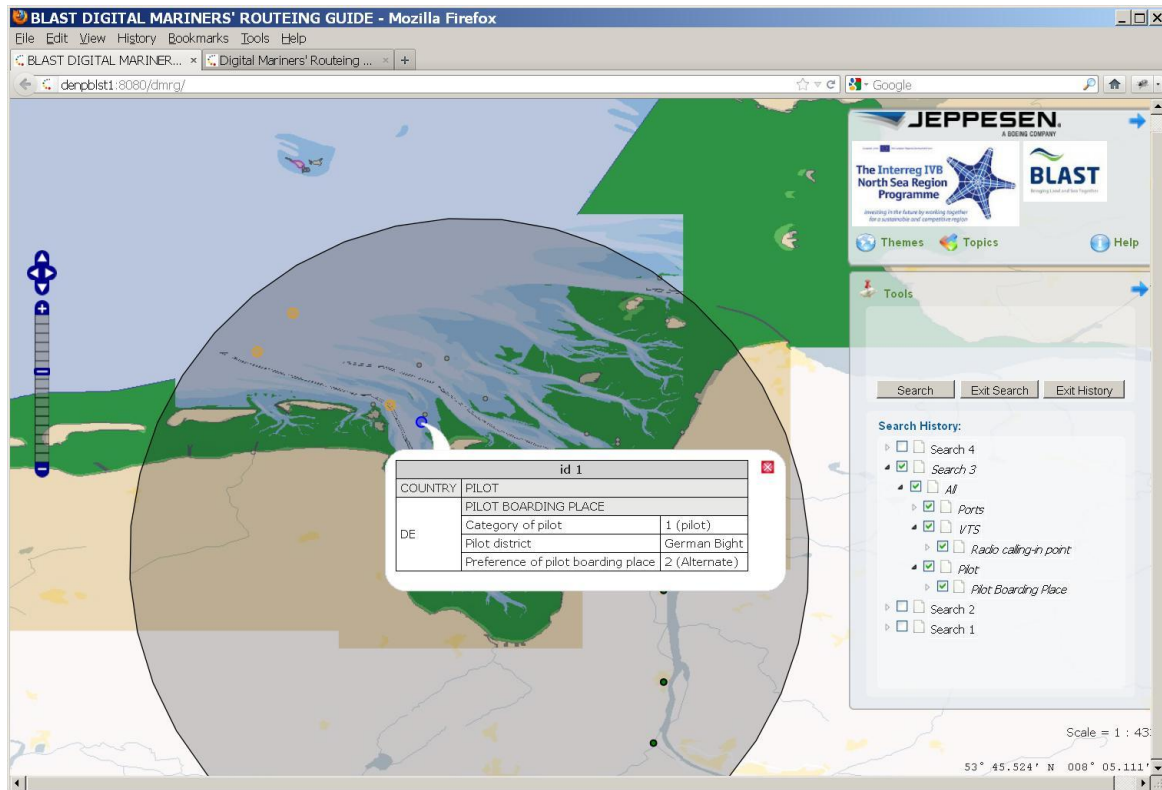
Figure 9. Search history, showing a previous radial search and its results

5. Conclusion

Recent maritime information standards, in particular the "S-100" family of standards, are based on the following significant concepts:

- Modelling maritime information in conformance with ISO standards for geographic data, specifically the ISO 191xx family of standards.
- Expanding and improving the use of marine information, integrating information from ENC and other sources, making it compatible with GIS and off-the-shelf technology.
- Improving capabilities and compatibility for data streams – more flexible collection, distribution, analysis, and processing of data.
- Simplifying maintenance and change management for data, applications, and information models.

The key ideas demonstrated by this exercise are the use of the new IHO data model to (a) represent information not usually encoded as data, (b) harmonize this information across different hydrographic offices with different content styles and different levels of detail, and (c) disseminate the harmonised information to users using commonly-available technology.

The DMRG project demonstrates that standardized information models can be used for very different types of information, specifically text-based as well as vector data. It demonstrates the application of harmonised information modelling from different European nations, by making an information model and datasets derived from different countries, structured in different ways, and containing very different types of data (vector data and text-based information). It also

demonstrates the integrated use of marine information, specifically vector data used in ENCs with text-based information form nautical publications, and its presentation to end-users in an integrated fashion – chart objects (ENC data) are presented seamlessly with text-based information from nautical publications.

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