



European Union The European Regional Development Fund

The Interreg IVB North Sea Region Programme



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Service Description: Maritime Safety Information/Notice to Mariners Service

Issue: 1

Issue Status: Approved

Issue Date: 18/05/2015

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Executive Summary

An approach to MSI-handling and promulgation has previously been tested in the EfficienSea project with promising results. As part of the ACCSEAS project WP6, it was decided to develop and test this concept further, and based on analysis and user feedback, to include other important maritime information, specifically temporary and preliminary Notices to Mariners (NM T&P), within an integrated service for authoring, storing and promulgating maritime information.

There are many similarities and few differences between MSI messages and NM T&P. They largely serve the same purpose, with the main differences being down to the speed and methods of promulgation.

This document describes the result of the effort to devise a combined MSI-NM model and interchange format, and an authoring system, which has been developed by DMA and tested with participation of MSI and NM authorities from countries around the North Sea Region (NSR).

The MSI-NM interchange format has been detailed in an S-100 product specification, "ACCSEAS MSI-NM S-100 Product Specification", and **is intended as an input paper for the forthcoming S-124 NW specification.**

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Document Information

Project Title	ACCSEAS
Work Package No.	6
Document Title	Service Description: Maritime Safety Information/Notice to Mariners Service
Description	This document describes the results of the efforts in developing the Maritime Safety Information/Notice to Mariners service.
Date	18/05/2015
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Contributing Author(s)	WP6 Contributors
iManage Location	29916
Circulation	<ol style="list-style-type: none"> 1. Client 2. Project Files (i-manage) 3. Transnational Project Co-ordination Group 4. Project Steering Committee
NSRP Secretariat Approval	Yes-/ No

1 Introduction

The most important information for vessels is safety-related information, including Maritime Safety Information, Notices to Mariners and chart corrections. These three information types, along with nautical charts and position updates, form the basis for safe navigation at sea.

Maritime Safety Information (MSI) is navigational and meteorological warnings, meteorological forecasts and other urgent safety-related messages.

Notices to Mariners (NMs) are promulgated in order to keep paper nautical charts and publications, as far as possible, up to date. Temporary and Preliminary NMs (T) and (P) advise mariners of important matters affecting navigational safety, including new hydrographic information (in advance of new editions or chart updates), changes to routing measures and aids to navigation, and other important categories of data. Not all ENCs include T&P information currently.

Chart corrections are corrections to paper and digital nautical charts which makes it possible for the Mariner to keep the vessel's charts up to date.

Chart corrections and the way they are promulgated have evolved tremendously the past 10 years, and are in many ways very different from traditional MSI and NM T&P today. Chart corrections are georeferenced and portrayable by nature. MSI and NM T&P are often georeferenced but not necessarily portrayable with text and symbols.

The main differences between MSI and NM today are the way of promulgation and speed of handling and thereby quality assurance. The content of the two message types are on the other hand more or less the same and they solve the same user need.

MSI is today promulgated in text or voice via SafetyNET, NAVTEX, coastal radio stations and is in some countries accessible on the Internet. NM T&P's are promulgated on paper weekly, fortnightly or monthly and are often accessible on the internet in pdf format. In addition Hydrographic Offices are encouraged to include as many NM T&P's in their ENC updates as possible. There are obvious benefits in this but also disadvantages and pitfalls.

As part of the ACCSEAS project, a combined model for MSI and NM T&P has been devised and a web application has been developed in order to effectively test the combined model, the portrayal and promulgation of the messages. The MSI-NM System include features such as:

- An editor for MSI and NM T&P messages.
- Multi-language message support and features such as rich-text descriptions, attachments, etc.
- Management of message life cycles and base data such as categories, areas, charts, etc.
- Promulgation via web services, mailing lists, Maritime Cloud Messaging Service (MMS)¹, NAVTEX, Twitter, etc.

¹ The Maritime Cloud is documented at <http://maritimecloud.net>

- Web interface and API's for searching and filtering MSI-NM T&P messages.
- Map-based portrayal of MSI-NM T&P messages.

Furthermore, a navigational display test application, the e-Navigation Prototype Display (EPD)², has been updated to integrate with the MSI-NM System.

² The EPD is available at <http://www.e-navigation.net/index.php?page=software-and-services>

2 Combined MSI-NM Model

The combined MSI-NM model needs to cater for the IHO-IMO-WMO S-53 standard on MSI and the IHO S-4 standard which covers NM T&P.

The overarching idea has been to generalize the constituent parts and fields of MSI and NM T&P messages, and make the format both backwards compatible and future-proof by e.g. adding support for:

- Multi-language support. All messages must be localizable to any number of languages.
- Rich text support. NM's in particular, can contain a rich layout features such as tables, links, embedded pictograms, etc. By supporting HTML descriptions this can be accommodated.
- Support for attachments. Attachments can be binary files, such as a picture or a PDF, and optionally they may be embedded in the rich text descriptions as links or nested images.
- New identifier format. In a system containing both NM and MSI, possibly from several authorities, the existing NM and MSI identifier format is not adequate. A new more complete identifier format is proposed and used in the MSI-NM model.
- Base data. Part of a combined MSI-NM model is to define a relationship between messages and base data such as charts, categories and areas. Previous proposals have opted for rigid solutions with a fixed number of area and category levels, and with enumerated category values.

This approach has been discarded as too inflexible. Rather, categories and areas have been defined as hierarchical base data of named categories and areas respectively, and it is left as an administrative task to fill out the specific data in each implementing system (i.e. for each country).

Additionally, the MSI-NM model needs to be backwards compatible and provide support for promulgations such as NAVTEX, which has many restrictions on the format of the message.

The approach to solving backwards compatibility and promulgation to various existing and future channels, has been to extend the MSI-NM model with *publications*. Example publications are NAVTEX, mailing lists, Twitter, Voice broadcasts and Maritime Cloud Messaging Service.

Whereas the base MSI-NM model is intended to be a common model with a standardized interchange format, the list of publications is extendable and may vary from implementing system to implementing system.

A publication will typically contain a publication-specific description of the message in a particular language, created by aggregating and formatting the core MSI-NM model fields in a particular way.

2.1 MSI-NM Modal Fields

The fields of the combined MSI-NM model, are listed below:

Information	Description
Identifier	To accommodate a system that contains MSI as well as NM messages, the following identifier format has been devised: <ul style="list-style-type: none"> • Format: <i>Type-Authority-Number-Year</i> Where <i>Type</i> is either "MSI" or "NM", <i>Authority</i> is the issuing authority, such as "DK" in Denmark, <i>Year</i> is the calendar year and <i>Number</i> is a sequential number. The number sequence is unique for each combination of type, authority and year.

	<p>Examples:</p> <ul style="list-style-type: none"> • “MSI-DK-001-14”: Danish MSI number 1 in year 2014.
Sub-Type	<p>In addition to the main message type that is part of the message series identifier, messages have a sub-type. For MSI messages, the sub-type is either “Local Warning”, “Coastal Warning”, “Subarea Warning” or “Navarea Warning”. For NM messages, the sub-type is either “Permanent NM”, “Temporary NM”, “Preliminary NM” or “Miscellaneous NM”.</p>
Status	<p>The MSI-NM model defines the following values for the message status: “Draft”, “Published”, “Expired”, “Cancelled”, “Deleted”.</p> <p>It is up to the implementing system to manage the message life cycle, and enforce rules, such as:</p> <ul style="list-style-type: none"> • Messages are created as drafts. • A draft message can be deleted or published. • A published message can be cancelled manually or expired by the system if the valid-to date has passed.
References	<p>Each message can be assigned a list of <i>references</i> that is used to define the relationship to other messages. A reference consists of a series identifier of the referenced message and a reference type. The supported reference types are: “Reference”, “Repetition”, “Cancellation” and “Update”.</p> <p>The MSI-NM system can thus chain related messages together.</p>
Time	<p>Each message has a (possibly open-ended) date interval for which the hazard described by the message is valid.</p> <p>Additionally, messages can be assigned a localized time description, which may be used for a more extensive textual description of the time interval for which the message is valid.</p> <p>Examples of textual time descriptions:</p> <ul style="list-style-type: none"> • 14 June 2014, hours 0800 - 15 June 2014, hours 2000 • Week 22 2015
Area	<p>The existing MSI and NM standards both provide support for specifying multiple area levels (<i>general area</i> and <i>locality</i> for MSI, <i>general region</i>, <i>sub-region</i> and <i>specific location</i> for NMs).</p> <p>This has been generalized in the MSI-NM model. Part of the responsibility of the MSI-NM system is to administratively define a hierarchical area tree (with each area having a localized name). A message must be assigned one of these areas, and by implication, the parent areas of the selected area.</p> <p>Additionally, a message can be assigned a localized textual <i>vicinity</i> description, for detailed location information not defined in the area tree.</p> <p>Example area and vicinity:</p> <ul style="list-style-type: none"> • Area: Denmark -> Great Belt • Vicinity: Taars Ferry Harbour
Locations	<p>Each message can be assigned a list of geographical <i>locations</i>. A location may be either a point, a circle, a polyline or a polygon.</p> <p>Locations, and the individual positions of a location, can all be assigned a localized description.</p>
Charts	<p>A message can be assigned a list of <i>charts</i>. The available charts are defined by administrators in the MSI-NM system with their regional chart numbers and</p>

	<p>international chart numbers.</p> <p>Optionally, the geographical extent and scale can be specified for each chart, allowing the list of charts assigned to a message to be automatically deduced from the message locations and sorted by scale.</p>
AtoN's	<p>Each message can be assigned a list of AtoN's (e.g. lights) to which the message pertains. The AtoN's are identified by local or regional identifiers and possibly a Persistent Unique Identifiers, as proposed by IHO SNPWG to HSSC.</p>
Categories	<p>A message can be assigned a list of <i>categories</i>. The available categories are defined by administrators in the MSI-NM system as a hierarchical category tree (with each category having a localized name).</p> <p>Although the MSI-Model does not mandate any specific category tree, a suggested model will at its top level have categories such as <i>Aids to Navigation</i>, <i>Drifting Objects</i>, <i>Obstruction</i>, etc. The sub-categories will represent the types of hazard relevant to the parent category.</p> <p>Example of category lineages:</p> <ul style="list-style-type: none"> • AtoN -> Floating AtoN -> Buoy -> Buoy Established • AtoN -> Light -> Light Unlit • Obstruction -> Diving Operation <p>The purpose of categories is to better facilitate searching and filtering of messages. Also, the MSI-NM system provides a template system tied to the selected message categories. Templates allow you to easily fill out a new hazard-specific standardized message including publications (e.g. NAVTEX) that adheres to the MSI or NM standards, based on very little information.</p>
Title	<p>A message is assigned a localized <i>title</i> field, which is a generalization of the <i>key subject</i> field of the MSI standard and the <i>subject</i> field of the NM standard. The title should be a short concise message description used in e.g. message lists or on ECDIS displays.</p>
Description	<p>A message is assigned a localized <i>description</i> field, which is a generalization of the <i>amplifying remarks</i> and <i>detailed description</i> of the MSI and NM standards.</p> <p>The type of the description field is mandated to be HTML, and thus allows for fairly advanced layout and typography, and may contain elements such as tables, links, images, etc.</p> <p>Links and images are particularly useful in conjunction with message attachments (see next row), whereby you can insert attached images directly into the message description, or provide a direct link to, say, an attached chart update PDF file.</p>
Attachments	<p>Messages can be assigned a list of <i>attachments</i>, a generalization of NM <i>blocks</i>. An attachment can be any binary file, such as a picture or a PDF.</p> <p>As described above, attachments can furthermore be embedded in the message description as links or nested images.</p>
Miscellaneous	<p>A message can be assigned an additional set of optional and localized fields, such as <i>note</i>, <i>publication</i> and <i>source</i>.</p> <p>Also, a message has a flag to indicate if the message is based on original information or not.</p>
Publications	<p>Each message can also be assigned a list of publications. The available publication types and the format of a specific publication is extendable and not part of the MSI-NM model <i>per se</i>, since it may differ from MSI-NM system to MSI-NM system (i.e. be country specific).</p>

	The MSI-NM system experimentally ships with publication types for Mailing lists, NAVTEX, Navdat, Audio, Twitter and Maritime Cloud Messaging Service.
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3 MSI-NM System

As part of the ACCSEAS project, an MSI-NM System/web application was developed in order to facilitate and test the combined MSI-NM model, the portrayal and the promulgation of the messages.

This chapter will outline the main parts of the MSI-NM System. However, for a full and comprehensive description, please refer to the MSI-NM User Manual.

3.1 Message Viewing

All users can use the MSI-NM system for browsing and searching MSI-NM messages. Messages can be filtered by all sorts of criteria, such as message type, status, category, area, chart, location, date, etc.

The message search results can be presented in several ways, two of which are displayed below.

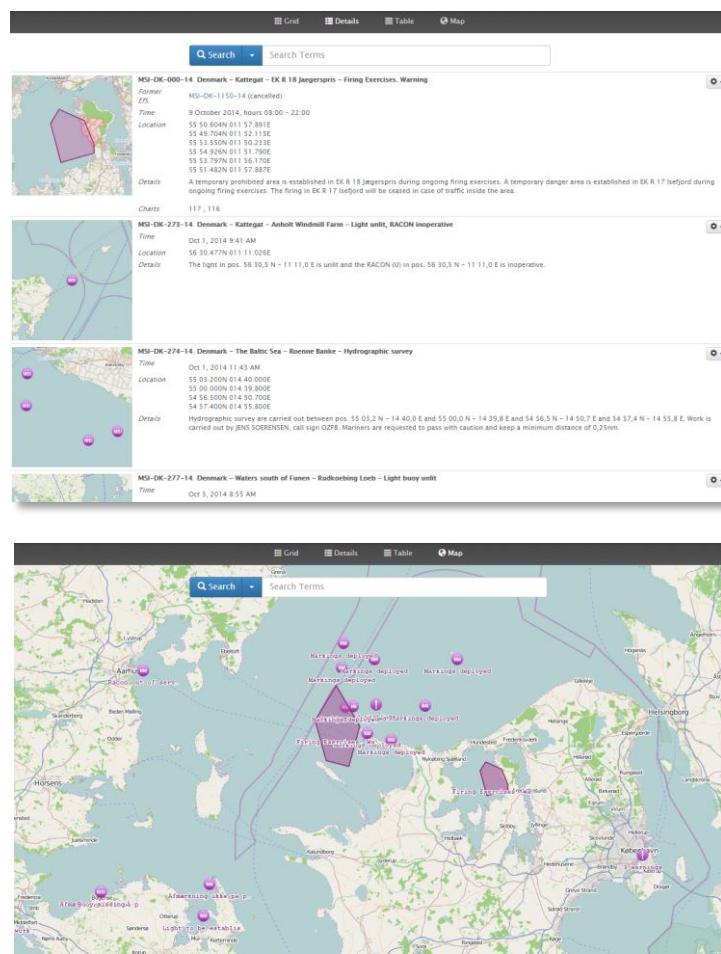


Figure 1: Details view mode and map view mode

Alternatively, the message search result can be exported as a PDF file, thus resembling the NM digests that maritime authorities typically publish on a weekly basis.

Registered users can furthermore bookmark messages and subscribe to mailing lists and receive updates based on arbitrary filtering criteria, i.e. get the messages relevant for their specific voyage or area of interest.

3.1.1 Message Portrayal

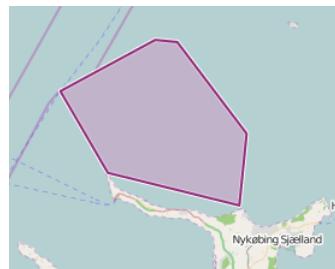
The map-based portrayal of the MSI and NM messages is based on the portrayal devised in the earlier EfficienSea project, where integration of MSI in navigational charts was explored and input made for IEC.

The magenta MSI symbol has been supplemented with an analogous NM symbol. Also, a cluster symbol has been chosen to represent a cluster of MSI and NM messages and may be used in order to avoid clutter in maps:



Symbols for MSI, NM and clustered messages

When the message location is given by a polygon, a polyline or a circle, the actual geographical shape will be used for portraying the message:



3.1.2 Message Details Dialog

Irrespective of the kind of symbol or view mode used to display a message list, clicking a message will always display the details of the message in a Message Details dialog:

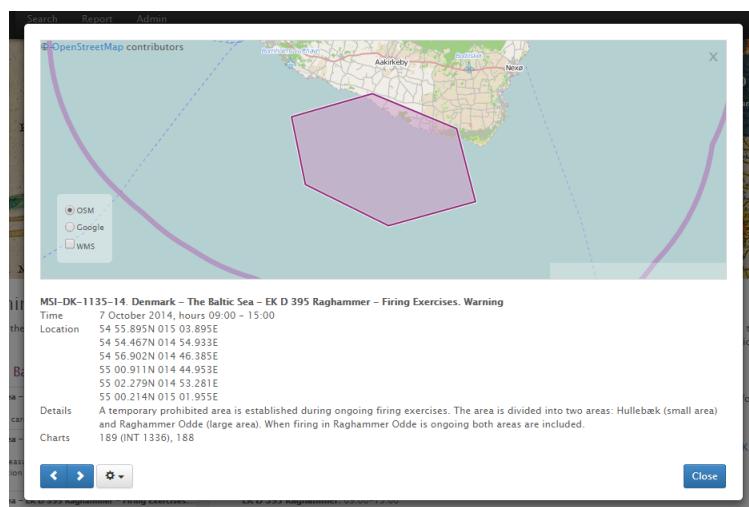


Figure 2: The Message Details Dialog

3.2 Message Editor

The MSI-NM System provides a full-fledged editor that allows qualified users to create and edit MSI and NM messages. All aspects of the MSI-NM model, as detailed in an earlier chapter, can be edited, and hence, the editor page is quite extensive:

Create Draft Message

ID & Type
Select the main type and sub-type of the message.
MSI NM - DK - **Num.** **2014**
 Local Coastal Subarea Nearest

References
List references for this message. Search messages
 Message ID Reference

Time
Please specify the time interval of the message, and optionally a verbal time description.
 04-12-2014 09:45 Valid To
 Time Description Time Description
 Translate

Area
Please specify the general area of the message and optionally the more specific vicinity. Edit areas
 Baltic Copy Locations
 Roenne Banke Rømø Banke

Locations
Specify the locations for the message. Click the icons on the locations or points to update the description.


Charts
Please select the list of charts affected by the message. Also specify any horizontal datum other than WGS-84. Edit charts
 x 189 (INT 136) x 188 Horizontal Datum Compute from Locations

Categories
Please pick the categories of the message and optionally add other categories. Edit categories
 Wreck Execute Template
 Other Categories Other Categories

Title
Please provide the title of the message. The title is e.g. used as ENC text.
 Wreck Vrag

Description
Please provide a full description of the message.

Formats:

A sailing vessel has sunk on pos. 55° 04.047'N 014° 34.231'E. The depth above the seabed is approx. 3m. The vessel is marked with a yellow-black buoy. A group of 2 fish approx. 200m north of the position. Mariners are advised to keep well clear.

Formats:

Et sejlykk er sunket på pos. 55° 04.047'N 014° 34.231'E. Dybden over vraket är ca 3m. Det är markerat med en gul-svart boll. En grupp av 2 fiskar finns ca 200m norr om positionen. Marinerna är rådade att hålla godt klart af positionen.

Attachments
Associated images and PDF documents. Please note, uploading a document takes effect immediately.
 Browse or drop files here

Miscellaneous
Optionally fill out Note, Publication, Source and Original Information below.

<input type="checkbox"/> Note	<input type="checkbox"/> Note
<input type="checkbox"/> Publication	<input type="checkbox"/> Publication
<input type="checkbox"/> Source	<input type="checkbox"/> Source
<input type="checkbox"/> Original Information	

Publications
 Publish via navtex
Transmitter Priority
 BALTICO ROGLAND None Routine Important Vital
Navtex Message
004640 UTC DEC 14
COASTAL WARNING MSI-DK-7-14
BALTIC - ROENNE BANKE
SINKING VESSEL - 55-04.047N 014-34.231E
014-34.231E, DEPTH ABOVE WRECK 3M. WRECK
MARKED WITH YELLOW-BLACK BUOY SHOWING
PFD

Save Message Reload Message Manage Message

Figure 3: The MSI-NM Editor

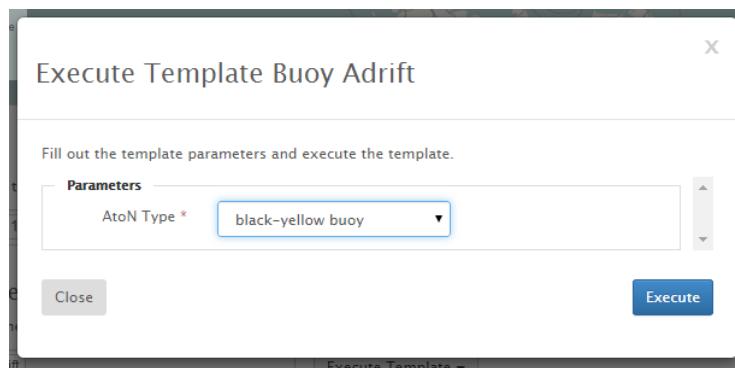
3.2.1 Message Editor Templates

For MSI messages in particular, the vast majority of all messages follow standard templates that are specific to the category/hazard of the message, e.g. light unlit, buoy missing, etc.

The MSI-NM editor sports an extensive template system that makes it very simple to properly fill out the message details in a standardized way.

Once the message type, time, area, location and category has been filled out, a category-specific template can be executed, and based on a few input parameters the template will fill out message details such as title, description, and publications such as NAVTEX, Voice broadcast, Twitter, etc.

As an example, once the “Buoy adrift” category has been assigned to a message, the “Buoy Adrift” template can be called to fill out a standard MSI message detailing that a buoy has been observed adrift. The template will first prompt the user to fill out a few parameters:



Upon executing the template, relevant fields gets populated with standardized texts that will incorporate the parameter values and the area and location already defined for the message. In this example, the template is executed in a Danish MSI-NM System, and will fill out localized versions of message title and description, along with English NAVTEX and Twitter publications and a Danish voice broadcast:

Field	English	Danish
Title	Wreck	Vrag
Description	A black-yellow buoy has been observed adrift in pos. 57° 07.553'N 011° 03.296'E on Dec 10, 2014.	Et sort-gult dagsømærke er observeret drivende på pos. 57° 07,553'N 011° 03,296'E d. 10-12-2014.
NAVTEX publication	100636 UTC DEC 14 COASTAL_WARNING MSI-DK-?-14 KATTEGAT BLACK-YELLOW BUOY OBSERVED ADRIFT 57-07.55N 011-03.30E AT DEC 10, 2014.	N/A
Twitter publication	MSI-DK-?-14: Denmark - Kattegat - Buoy adrift	N/A
Voice broadcast publication	N/A	Et sort-gult dagsømærke er observeret drivende på position 57 grader 7,6 min. nord - 11 grader 3,3 min. øst d. 10-12-2014.

Note that the series identifier contains a ‘?’ for the number part. This will automatically be filled out with a proper sequence number when the message is published. Once a template has been executed, you typically only need to proof read the result and can then save the message.

3.3 Message Management

Qualified users can manage the life cycle of a message. The main states of a message are depicted below:

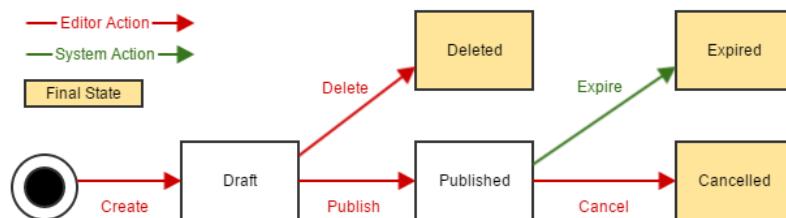


Figure 4: MSI-NM Message States

All state changes, bar expiration, are the result of a manual action by a qualified user (the editor). Expiration happens when the MSI-NM system detects that the valid-to date of a published message has passed. A full revision history is maintained for each messages.

Only draft messages are editable, all other messages are read-only (except for sysadmins). However, the MSI-NM System provides functions for easily copying any message, or for cancelling a published message and create a copy with a cancel-reference to the original message.

When a message gets published, the associated publications will be processed, and the message will be promulgated accordingly, i.e. sent to mailing lists and to the NAVTEX transmitter, published to Twitter, broadcast via the Maritime Cloud Messaging Service, etc.

3.4 MSI-NM System Administration

The MSI-NM System provides an extensive set of admin pages available to qualified administrative users. There are admin pages used for managing users, mailing lists, charts, areas, categories, templates and publishers (plus a few extra pages for system administrators):

Chart Number	Int. Number	Horiz. Datum	Name	Scale	Name
D	WGS84	Danmark med sogrænser	1:850,000		
C	WGS84	Danmark med omgivende farvande	1:850,000		
198	WGS84	Østersøen, Fakse Bugt og Hjelm Bugt	1:75,000		
197	WGS84	Østersøen, Gedser Rev og Kadetrenden	1:75,000		
196	WGS84	Femer Bælt	1:75,000		
195	WGS84	Østersøen, Vestlige del	1:75,000		
190	WGS84	Fakse Bugt	1:50,000		
189	1336	WGS84 Bornholmsgat	1:100,000		

Figure 5: MSI-NM System Administration

For a detailed description of the Administrative functionality, please refer to the MSI-NM User Manual.

4 EPD Integration

The combined MSI-NM T&P model devised in the ACCSEAS project is conceptually an extension of the MSI system explored earlier in the EfficienSea project, where integration of MSI in navigational charts was tested, including portrayal and relevance filtering of MSI messages.

In the EfficienSea project, the EPD (e-Navigation Prototype Display) was used to simulate a navigational display (ECDIS). It was extended to display MSI messages using standardized icons and graphics (see the Message Portrayal section). Furthermore, methods and schemes for relevance filtering was implemented and tested, taking into account various information types such as time and position.

For the ACCSEAS project, the EPD has been extended again with the following features:

- The EPD now fetches MSI and NM T&P messages from a test MSI-NM system via the Maritime Cloud Messaging Service.
- MSI-NM messages have been integrated in the EPD Notification Centre (warnings and alarms).
- MSI messages are portrayed as before, and NM messages are portrayed in an identical manner, except for the use of an NM icon.
- The MSI relevance filtering now also applies to NM messages.

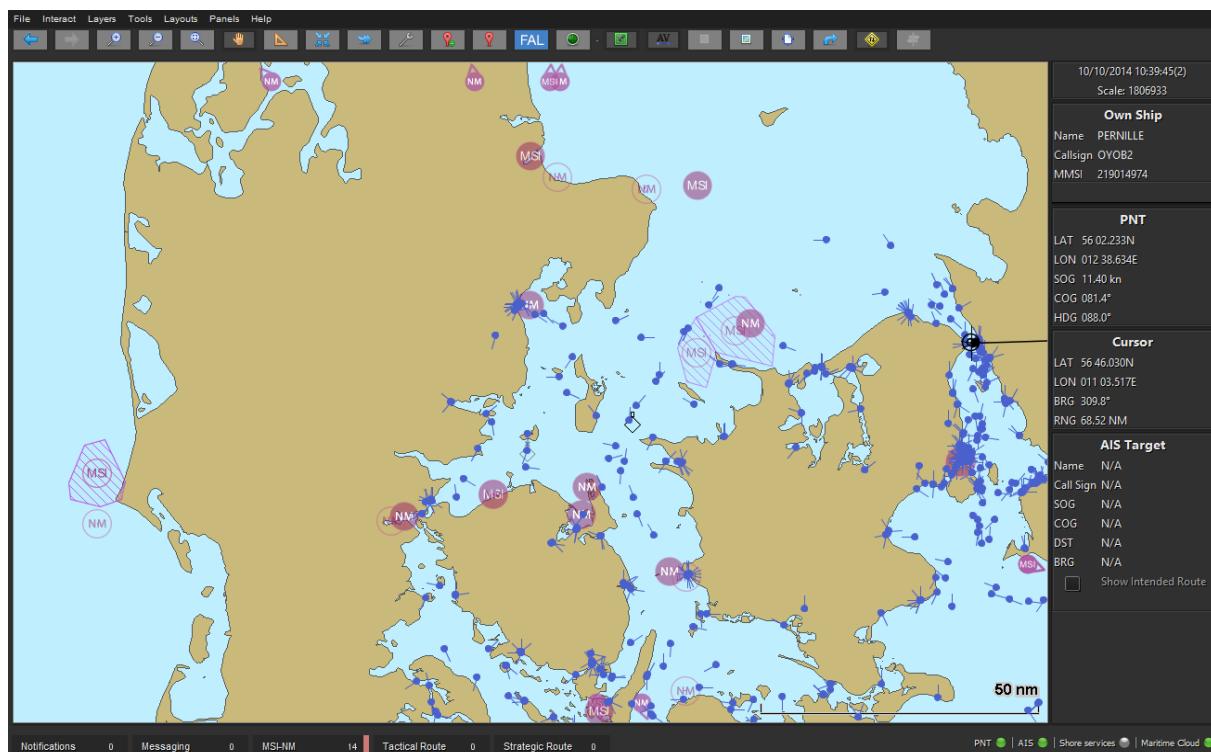


Figure 6: EPD with MSI and NM messages

The MSI-NM Notification Panel displays an MSI or NM message similar to the way message details are displayed on the MSI-NM System website, including linked references, rich-text descriptions and downloadable attachments. Example:

The screenshot shows the 'Notification Center' interface. On the left, a sidebar lists categories: Notifications (0), Messaging (0), MSI-NM (14), Tactical Route (0), and Strategic Route (0). The 'MSI-NM' section is expanded, showing 14 entries. A provider selector dropdown at the top right is set to 'Dev. MSI-NM Service (999000300)'. The main area displays a table of messages with columns: TYPE, ID, Valid From, and Main area. The table contains rows for various MSI-NM messages, including NM-DK-1020-14 through NM-DK-001-14. To the right, a detailed view of a specific message is shown. The message details are: Reference: MSI-DK-1127-14 (cancellation), Time: 09/24 13:23:00(2), Location: 56 34.660N 010 05.434E, Details: A yellow buoy in pos. 56 34,7 N - 10 05,4 E is missing. It includes attachments: 'Bell-Buoy-off-Wood-Island.gif' and 'Chart1041NM5812.pdf'.

Figure 7: MSI displayed in the EPD MSI-NM Notification Panel

All MSI-NM systems, present and future, can register themselves with the Maritime Cloud Service Portfolio Registry as MSI-NM service providers within certain geographical bounds. Vessels can thus seamlessly choose to subscribe to the published MSI-NM messages from a specific provider, depending on their current position.

Support for MSI-NM service provider selection, has been implemented in the EPD by adding a *Provider* selector in the MSI-NM Notification Panel, which displays all the MSI-NM service providers available via the Maritime Cloud Almanac.

The screenshot shows the 'Notification Center' interface with the provider selector dropdown open. The dropdown is set to '999000007' and lists three providers: 'Danish MSI-NM Service (999000301)', 'Dev. MSI-NM Service (999000300)', and 'Great Belt VTS (899333333)'. The main area of the interface is visible below the dropdown.

Figure 8: Provider selector

5 Technical Implementation

This chapter outlines the technology underlying the MSI-NM System, focusing on an MSI-NM interchange format and the API's used for integration and promulgation of messages. For a detailed S-100 product specification of the proposed MSI-NM interchange format, please refer to the "ACCSEAS MSI-NM S-100 Product Specification".

One of the main tenets of the MSI-NM system is that it is open source. The project is available to all on GitHub: <https://github.com/dma-dk/MsiNm>

By design, MSI-NM is highly customizable, and it is exceedingly simple to develop implementations for additional countries, by creating a new sub-project that *overlays* the main *msinm-web* web application and overrides system properties such as the list of supported languages, the authority, base data for administrative users, areas and charts, and as much or as little of the user interface graphics and mail templates as desired.

Furthermore, the MSI-NM system has a plug-in architecture that makes it relatively easy to develop additional country-specific message publications, such as NAVTEX, Twitter, and mailing lists.

5.1 MSI-NM Interchange Format

The MSI-NM model described in an earlier section defines the *system model* used by the MSI-NM System. However, the MSI-NM System also defines an *MSI-NM interchange format*, which is the format that should be adopted by clients of the MSI-NM system. This can be seen as a subset of the full MSI-NM system model, which contains enough information to fully define a message, but does not contain all the base data or the publications of a message.

An important aspect of the MSI-NM interchange format is that it should be compatible with the forthcoming S-124 NW product specification. This can be accommodated by providing a transformation from the MSI-NM model classes to the corresponding S-100 features and model.

The UML model for the interchange format is represented in the figure below.

The interchange format form the basis in interchanges between the MSI-NM system and external clients. The MSI-NM System supports three types of message promulgation, each of which is detailed in a subsequent section:

- REST API: The REST API serves as the main mechanism for fetching and updating message data using a simple and standardized HTTP protocol. Messages are returned in the MSI-NM interchange format.
- MMS: The MSI-NM System integrates with the Maritime Cloud by registering as an MSI-NM service provider. The MMS service also promulgates data in the MSI-NM interchange format.

Publications: An assorted set of protocols is used to promulgate published MSI-NM message publications, such as mailing lists, NAVTEX, Twitter.

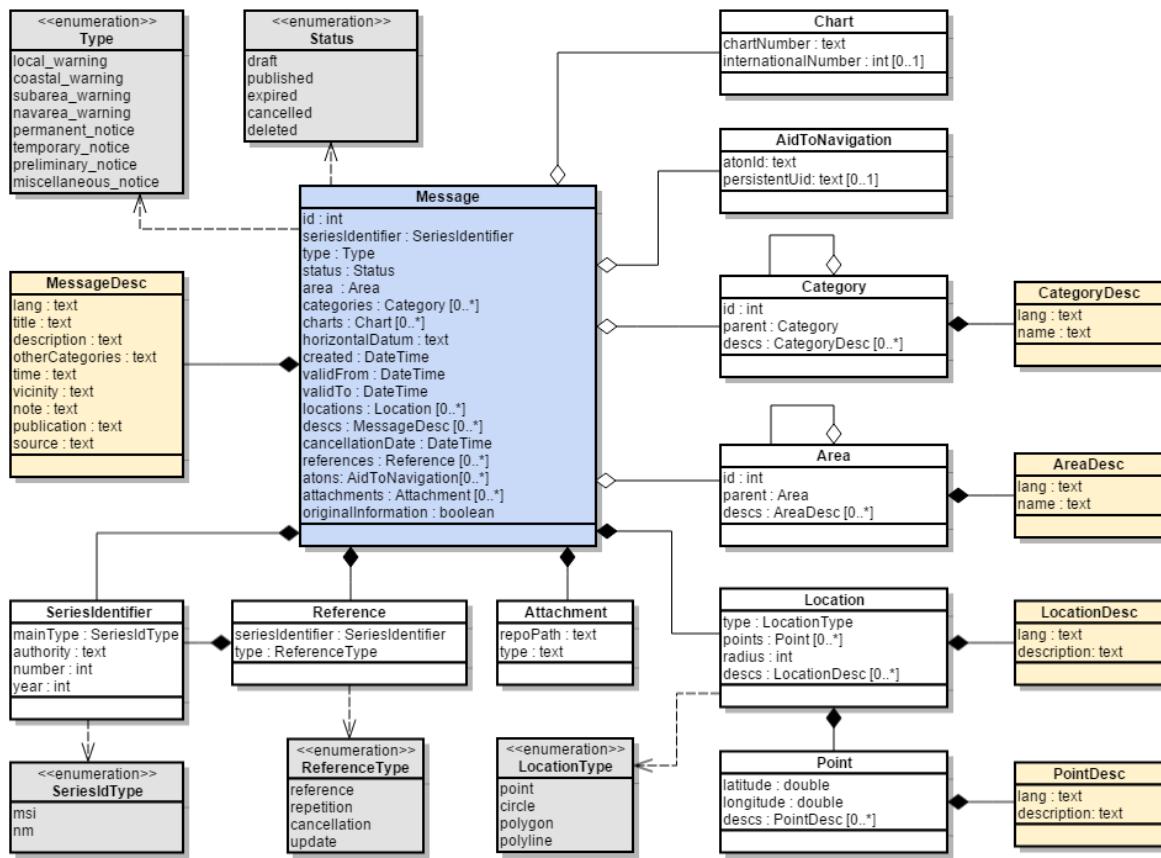


Figure 9: UML model for interchange format

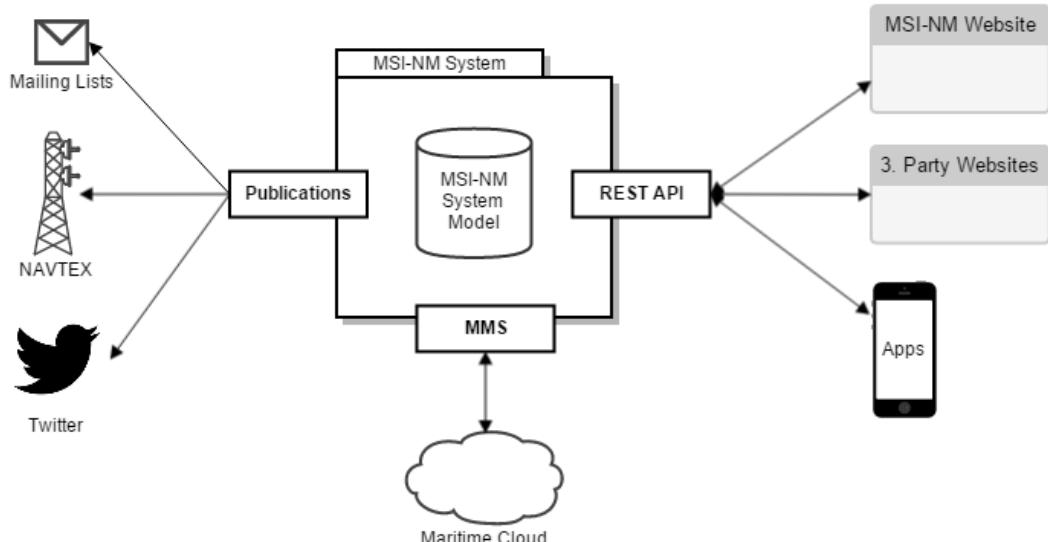


Figure 10: Overview of MSI-NM promulgation

5.2 MSI-NM REST API

REST (REpresentational State Transfer³) is an intrinsically simple protocol, or set of conventions, built on top of standard HTTP. The REST protocol is used to define an API for creating, modifying and fetching messages, and indeed all other types of base data used in MSI-NM, such as users, areas, categories, etc.

Much of the functionality exposed via REST is protected and subject to authorization checks. However, the main functions for, say, searching all MSI-NM messages, are public and may be enacted by any client, such as a website or a smartphone app. Indeed, the most prominent client of all is the MSI-NM web application itself, which uses the very same REST API whenever it needs to access any kind of data.

Messages are returned in the MSI-NM interchange format described in the previous section. More formally, there is a corresponding XML Schema Definition⁴ (XSD) of the message interchange format, which defines the data model in terms of XML and (indirectly) JavaScript Object Notation⁵ (JSON). Initially, all REST API's support the JSON data encoding, and in a future version, XML encoding will be supported as well.

MSI-NM Interchange format XSD: <https://github.com/dma-dk/MsiNm/blob/master/docs/msi-nm-1.0.xsd>

Only the main REST call for searching MSI-NM messages will be documented in this chapter. For the remaining REST API, please refer to the REST endpoints defined in the msinm-web project.

5.2.1 REST Search Function

The REST endpoint for searching messages is: /rest/messages/search

Example URL that returns all published MSI and NM messages in English:

<https://msinm-test.e-navigation.net/rest/messages/search?lang=en&status=PUBLISHED>

Some of the parameters accepted by the search REST function are documented below:

Parameter	Description
lang	The language code for the returned message data. If not defined, all language variants will be returned. Example: "en" will return the messages in English.
q	A general free-text query parameter. The format of the query string is similar to the one used by e.g. Google. All fields of a message are searched for a match, i.e. the message description, title, areas, categories, charts, etc. Examples: <ul style="list-style-type: none"> • "light buoy": Search for messages containing either "light" or "buoy". • "+light -buoy": Search for messages containing "light" but not "buoy". • "'light buoy)": Search for messages containing the specific term "light buoy". • "copenha*": Search for messages containing terms starting with "copenha".

³ REST is described on http://en.wikipedia.org/wiki/Representational_state_transfer

⁴ XSD is described on http://en.wikipedia.org/wiki/XML_Schema_%28W3C%29

⁵ JSON is described in <http://en.wikipedia.org/wiki/JSON>

status	Restrict the search result to messages with a specific status, i.e. PUBLISHED, EXPIRED and CANCELLED. Additionally, authorized users may search for the statuses DRAFT and DELETED.
type	Can be a comma-separated list of matching message types. Either a main type, “MSI” or “NM”, or one of the subtypes, “PERMANENT_NOTICE”, “TEMPORARY_NOTICE”, “PRELIMINARY_NOTICE”, “MISCELLANEOUS_NOTICE”, “COASTAL_WARNING”, “SUBAREA_WARNING”, “NAVAREA_WARNING” or “LOCAL_WARNING”.
maxHits	The maximum number of messages to return, e.g. 100.
startIndex	The index of the first message to return, e.g. 0. Used in conjunction with the “maxHits” parameter to provide support for paged search results.
sortBy	The field to sort the messages by, one of “DATE”, “ID” or “AREA”. Date sorting applies to the creation date, ID sorting sorts the messages by their series identifier and area sorting sorts the messages by their associated area.
sortOrder	Whether to sort in ascending order, “ASC”, or descending order, “DESC”.

Additionally, there are REST parameters to filter by category, area, location, and chart and date interval. Please refer to the `MessageRestService` class of the `msinm-web` project.

5.3 Maritime Cloud API

The MSI-NM System integrates with the *Maritime Cloud*. The Maritime Cloud is a digital Information Technology framework consisting of standards, infrastructure and governance that facilitates secure interoperable information exchange between stakeholders in the maritime community using the principles of Service Oriented Architectures (SOA). For a detailed description of the Maritime Cloud, please refer to <http://maritimecloud.net>.

When the Maritime Cloud integration is enabled, the MSI-NM System will register itself with the Maritime Cloud *Maritime Messaging Service* (MMS) as an MSI-NM service provider. It supports two types of message promulgation:

- Broadcasting: Every time an MSI-NM message is published, it is broadcast over the Maritime Cloud within a geographical area in order to notify all listeners.
- Published messages service: The MSI-NM System can be called via MMS to return all published messages, thus allowing connected clients, such as an ECDIS, to fetch messages with regular intervals. The API has provisions to reduce the amount of returned data by passing a last-modified date along.

As with the REST API, the Maritime Cloud message data is based on the MSI-NM message interchange format, and defined using MSDL, a data description format native to the Maritime Cloud.

The interchange format MSDL is available at: <https://github.com/dma-dk/MsiNm/blob/master/msinm-publish/src/main/msdl/dma/msinm/msinm-model.msdl>

The MSI-NM message service MSDL is available at: <https://github.com/dma-dk/MsiNm/blob/master/msinm-publish/src/main/msdl/dma/msinm/msinm-service.msdl>

5.4 Publications

As detailed in section 4, messages can be assigned a list of *publications*, such as NAVTEX, mailing lists, Navdat, Twitter and Maritime Cloud broadcasting (the latter type was described in the previous section).

A publication is typically a representation of a message that is based on the combined MSI-NM model, but not part of it.

The publications are typically promulgated using assorted one-way channels, such as e-mail (for mailing lists, NAVTEX and Audio) or proprietary API's such as the one used for submitting a new tweet to Twitter.

6 Observations and Feedback

In order to properly test and evaluate the combined MSI-NM concept, two types of test benches were created and evaluated.

6.1 Legacy MSI-NM Test

A Danish legacy MSI-NM test bench was set up and configured to continually import MSI messages from the Danish legacy MSI production system, and indeed to import production MSI messages from years back in time. The test bench was also extended with a function for importing legacy NM messages by scraping weekly NM PDF digests.

The purpose of this test bench was to test the breadth of a combined MSI-NM model, to verify that the model is backwards compatible and the ability of the MSI-NM System to handle many thousands of messages.

6.1.1 Conclusions from Legacy MSI-NM Test

Whereas the quality of the legacy production MSI import was very high (MSI data was scooped directly from database tables), the quality of the imported NM messages was not so high. Parsing extracted textual descriptions from a PDF into structured data is always an error prone task, and so, imported NM messages needed to be manually post-edited in the MSI-NM Editor to improve their quality.

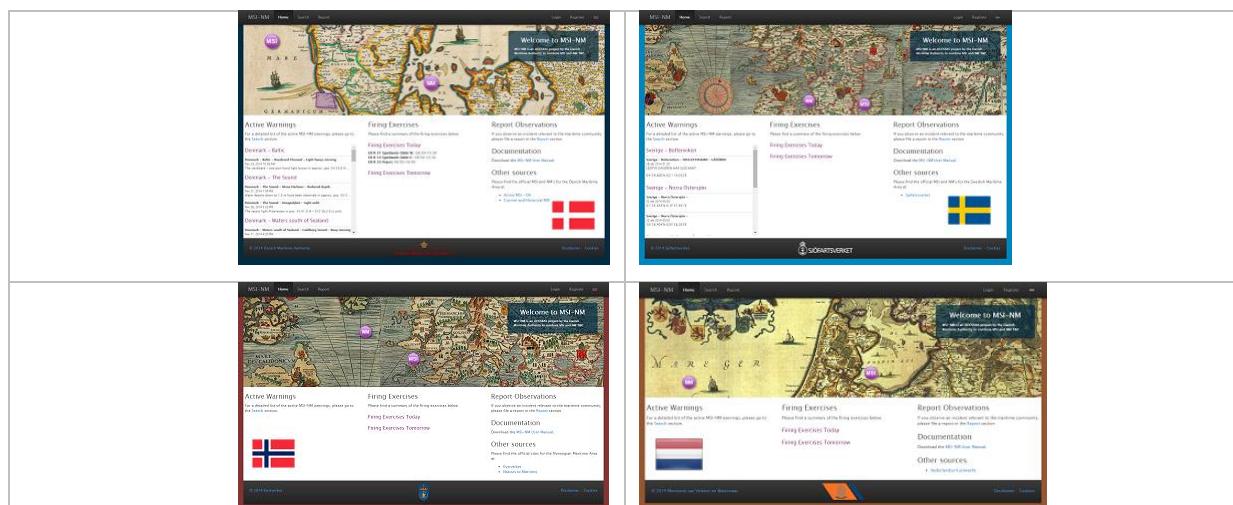
The conclusion after importing many thousand MSI's and hundreds of NM's was that the proposed underlying MSI-NM model is sound. Before using the MSI-NM system operationally, there needs to be an effort to harmonize base data, such as categories and areas, since that has never been a priority or important for the legacy data.

Performance-wise, the MSI-NM system can easily cater with the years' worth of imported messages. The underlying technology is highly optimized for geographical searches in large volumes of messages, and the presentation of message lists adopts techniques such as paging and clustered map symbols.

6.2 MSI-NM User Test

A user test was conducted in the second half of October 2014 with participation of relevant maritime authorities from Denmark, Sweden, Norway and the Netherlands.

An MSI-NM test bench was set up for each country, by creating customized versions of the MSI-NM System tailored to the specific countries in terms of supported languages, authority identifier and base data for administrative users, areas and charts.



Participants were asked to test various aspects of the MSI-NM system, and in particular, to create, edit, publish and manage the life cycle of MSI and NM messages.

The user test was concluded with a workshop at the premises of the Danish Maritime Authority to discuss the feasibility of a combined MSI-NM model and the experiences obtained from using the MSI-NM test bench.

6.2.1 MSI-NM User Test Feedback and conclusions

The following is a categorized list of feedback from the workshop, and from input received from participants during the user test and after the workshop.

General Feedback

- It was concluded that there were indeed clear benefits of a combined MSI-NM model/system to the mariner/end user
- A pending task is to flesh out the work process for editors, such as quality assurance.
- In general, there is a need to harmonize naming conventions between MSI and NM messages, and harmonize base data such as areas and categories.
- There is a clear need for compatibility with existing systems, such as NAVTEX, for the foreseeable future.
- Before using the MSI-NM system operationally, it needs lots of UI tweaks and polishing, plus better robustness and browser compatibility.

Feedback on the combined MSI-NM model

- Participants were generally in favour of the global identifier format and sequence numbering scheme adopted by the MSI-NM system, but it was concluded that more investigation was needed. Will e.g. omitting week numbers from NM's have unforeseen consequences?
- Participants were generally in favour of the time model adopted by the MSI-NM system, but the need for an issue-date field was raised. This would be particularly useful for SafetyNET-promulgated MSI messages, since they must be republished every 42 days. This also calls for an alert mechanism prior to the re-publishing deadline.
- Participants were generally in favour of sharing and harmonising the hierarchical category and area base data between MSI and NM, as adopted by the MSI-NM system.
- As an aside, it was discussed if areas could be left out of the model altogether, since messages are assigned geographical locations. However, the conclusion was that a textual area description is still an important part of a message presentation.
- For NM messages in particular, there may be a need to be able to assign multiple areas to a message.
- It was concluded that a priority (routine, important, vital) should not be part of an MSI-NM message – it is left to the client (ship) to prioritise the messages.
Note, however, that the NAVTEX publication of a message still carries a priority.

Message Viewing

- It was proposed to have the option to show MSI and NM messages in separate layers and to consider making the icons more distinguishable.
- In map view mode, message information should be displayed via mouse-over tooltips.
- It was proposed to facilitate integration with real-time information, e.g. by linking messages to the contractor working on the issue that the message pertains to.

Message editing

- Participants called for better AtoN integration, such as a rich text editor tool for inserting AtoN pictograms in description field.
- It was concluded that there was a massive need for simplifying the creation of MSI messages. The vast majority of MSI messages are written in a completely standardized way that is tied to the category/hazard of the message; this also ensures that the messages adhere to the strict NAVTEX standards and guidelines. After the user test was completed, the MSI-NM System has been extended with an extensive template system to address exactly this point.
- Additional simplifications were requested, such as removing/hiding editor fields not considered relevant to MSI messages when editing such ones?

Message Management:

- It was agreed that, once published, a message should not be editable. If changes are required, the original message must be cancelled and a new one issued.
- There seemed to be a need for a more fine-grained quality control of messages before they are published, e.g. by enforcing a verification and a proof-reading workflow.

EPD integration

- It should be investigated how to present messages with no geographical information on graphical clients such as ECDIS, and ensure that they are read by the OOW.
- It was debated if the OOW should be allowed to delete MSI-NM messages, and how to ensure that the next OOW see all relevant messages. This could possibly be handled by requiring all new OOW's to start their watch by reloading all MSI-NM messages.