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Service Description: Dynamic No-Go Area

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Executive Summary

One of the most important pieces of information to a Mariner is how much water is under the vessels keel (Underkeel Clearance – UKC) and the effective limits of vessels safe navigation. This information is today obtained by a number of more or less manual operations put together from different sources. The No-Go area service provides an automatic real-time and future-time picture of depth contours specific for vessels present draught, minimizing workload and the risk of human errors and thereby potentially improving safety of navigation.

Based on user feedback collected during the EfficienSea project the Dynamic No-Go area service has been developed and tested in the ACCSEAS project. The service has been tested both from a technical and a human factors point of view.

This document describes the results of the efforts in developing and testing the Dynamic No-Go area service.

Contents

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Document Information

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1 Introduction

Of crucial interest to a mariner is how much water he has under his keel (SOLAS Chapter V, regulation 34). The way to consider and mark dangerous shallow areas in paper charts are described in the ICS Bridge Procedures Guide, chapter 2.3.3 The Passage Plan:

> *"At any time during the voyage, the ship may need to leave the planned leg temporarily at short notice. Marking on the chart relatively shallow waters and minimum clearing distances in critical sea areas is one technique which will assist the OOW when having to decide quickly to what extent to deviate without jeopardising safety and the marine environment."*

For reasons of cluttering, depth information on paper charts are limited to a number of representative spot soundings in the form of a depth figure (in metres, feet or fathoms) or in the form of a depth contour, outlining an area within a certain depth interval. Depth contours has specific standardized levels depending on the charts scale, e.g. 10, 20, 30, 50 meters (scale 1:750,000). In the electronic chart system (ECDIS) a mariner can more freely select a safety contour to be highlighted to give prominence to areas of shallow water he does not wish to venture into. However the safety contour can only be selected from the limited selection of depth contour contained in the electronic navigational chart (ENC) database, typically 2, 5, 10, 20, 30, 50, etc. meters. The reason for the ENC not having depth contours for all possible depths is the cluttering issue mentioned above, which in the ECDIS could be solved simply by just showing contours relevant to vessels draught. Other reasons could be tradition and also a need to keep the ENC database to a limited size. There may also be military safety reasons in many countries for not publicizing a full bathymetrical database.

There are a number of human factor issues linked to depth information in charts. The depth information given in charts is related to a chart datum (a standard water level which can be different in different parts of the world. (So for instance, the chart datum in the parts of the NSR with large tidal variation is referred to Lowest Low Water, while in other parts of the NSR – e.g. Skagerrak and Kattegat is referred to Mean Sea Level). To be able to relate the depth figures in the chart to available sea room for own ship the navigator on the bridge need to do some mental arithmetic. For instance if the safety contour on the chart is set to 20 meters and his ship at present draught draws 15 meters he can calculate that 20-15 leaves 5 meters of under keel clearance (UKC), adding to this a low tide of 2.5 meters, leaves only 2.5 meters. Considering that he with present speed has a squat of 1.2 meters, the UKC is reduced to only 1.3 meters, add to that the heave of the present sea state… and we will see that such arithmetic calculation, if needed to be done on the fly, risk to become error prone.

In normal circumstances a voyage is planned with a large UKC and the traditional contours often work well enough as an approximation of navigable water. However in a future situation with limited sea room, available space might need to be more efficiently used, and particularly in a situation where ships need to make unplanned evasive maneuvers, or is drifting due to engine problems and quickly need to know the extent of available water, the mental workload might be considerable and risky.

In planning for a close quarter situation it might sometimes also be valuable to know other ships UKC.

2 Description of Developed Service

In short the No-Go area service will provide the Mariners with tailored depths contours for their ship at preset draught at the present tidal situation.

Input to the calculations is:
Manual by Mariner or VTS operator:

- Vessel draught
- Wanted Underkeel Clearance; taking into account vessels draught, squat, heave, etc.

Automatic:

- Detailed bathymetry (in database; 1 centimeter depth intervals in a 50x50 metre grid is kept in a database
- Tidal information; in 10 minute time slices and 1 centimeter intervals for the closest Standard Port (TotalTide).
- Weather information adjusting astronomic tidal level (not tested during ACCSEAS project).
-

In Figure 1 below the calculation is shown and described.

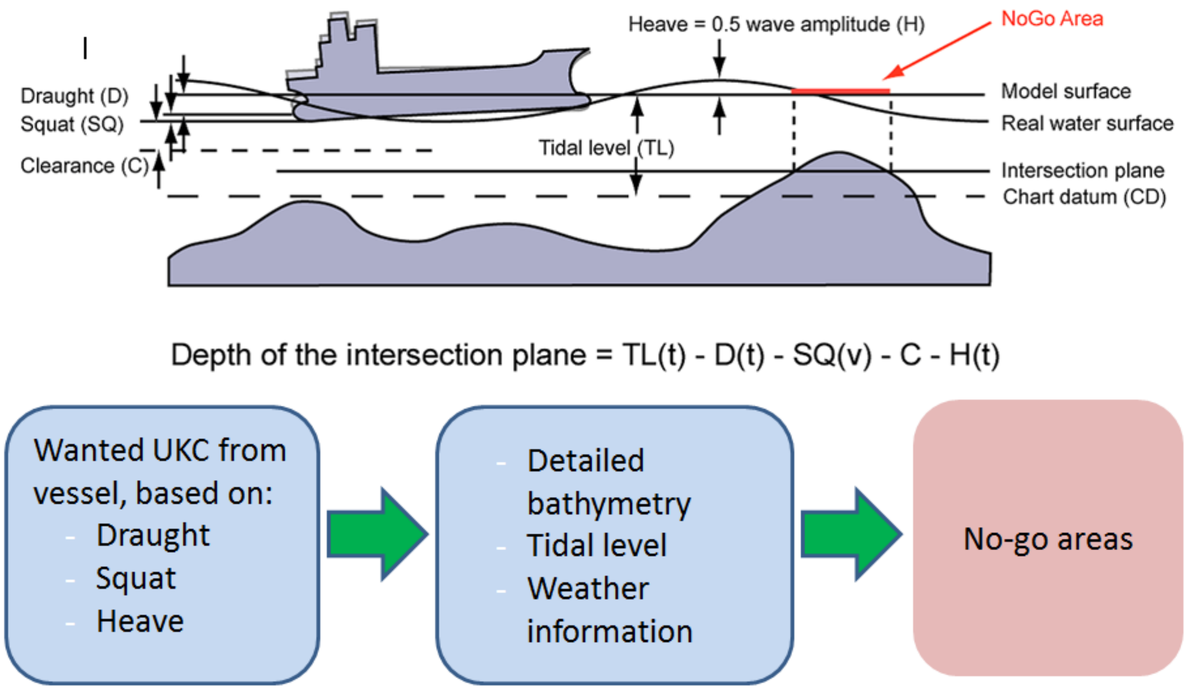

Figure 1: ***The diagram shows parameters needed to calculate the UKC advice. (Source: Porathe, 2006)***

The request for individual UKC in time slices may be used to find best suitable/possible route as they include future tidal states that can be of value to route planning. In any case such a service might lead to cognitive off-loading for the officer on the bridge and thereby reduce the risk of errors leading to groundings or unnecessary close meetings.

For the tests the No-Go area service has been implemented in the e-Navigation Prototype Display (EPD), a chart display with basic ECDIS functionality.

3 Technical Implementation

3.1 Request formulation

A vessel requesting a NoGo area needs to define the following parameters.

An area defined by 4 points in a bounding-box.
A time-slot
OR a time zone (from time A to time B) and a slice interval (how many minutes between each time slice).
In the reference implementation an XML schema is used.

3.2 Reply

A server offering NoGo in the desired area will return a request containing the following information

A polygon or array of polygons for each of the desired slices. Each polygon consists of a series of poly lines going from west to east in the bounding box.

In the reference implementation an XML schema is used.

3.3 Ship side HMI functionality

The ship can via. a right click menu select to form a NoGo request. This opens a dialog in which the user specifies the desired request (area - selected via mouse drag on the main chart, time or timezones - selected via time spinners and timeslices if application - selected via. a drop down menu. The vessels draft is automatically entered from the own ship AIS message. A custom defined UKC is added to the ships draft).

Once the request has been formulated and sent to the server, the map will display a black outline around the selected area. An optional panel can be displayed to show status of request. Once the request has been processed and returned from the server, the selected area will display a transparent polygon with the NoGo area coloured in red (that is, the area the ship should/can't safely enter).

If the request contained a time period a timeslider will be available on the status panel, to allow the user to slide through the various timeslices. Each timeslice will show an aggregated worst-case (lowest values) view of the area for the particular timezone.

The polygons visibility can be toggled on / off.

When user requests a new polygon, any previous requests are automatically removed to avoid overclutter of map.

3.4 Shore side HMI functionality

Shore side functionality is very similar to ship side functionality however the multiple window layout of a VTS display allows multiple requests to be performed and displayed at the same time.

3.5 EPD Integration

The integration is best described by an example.

In below example a vessel with a draught of 8.5 metres is approaching River Humber. The vessel has planned a route via the southern Channel (Bull Channel) with limited depths at low water but shorter and with less traffic.

Figure 2: Vessel approach to River Humber with planned route

The vessel would like depths information for the area and requests information.

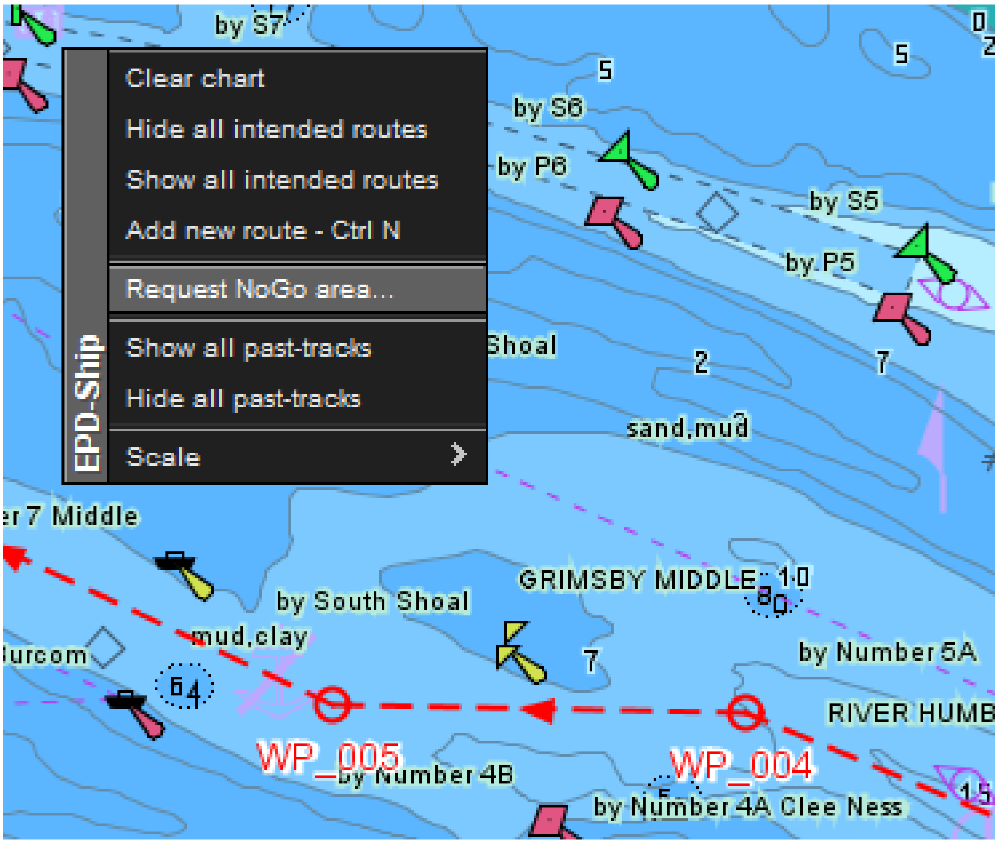

Figure 3: Request No-Go area

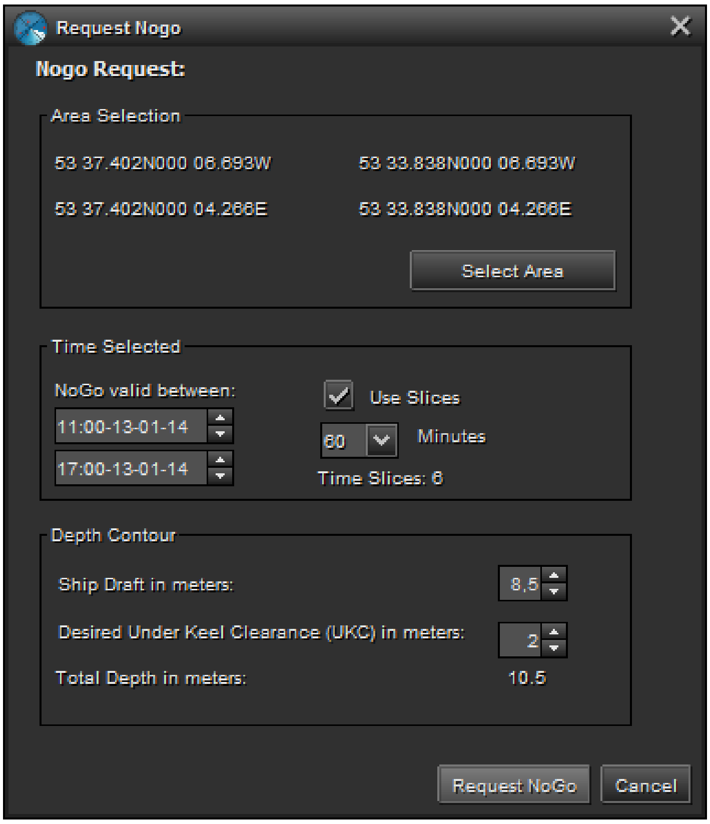

Figure 4: Vessel selects area by drawing corners on chart and input time interval, ships draft and desired UKC. Choose to use time slices for every 60 minutes in interval.

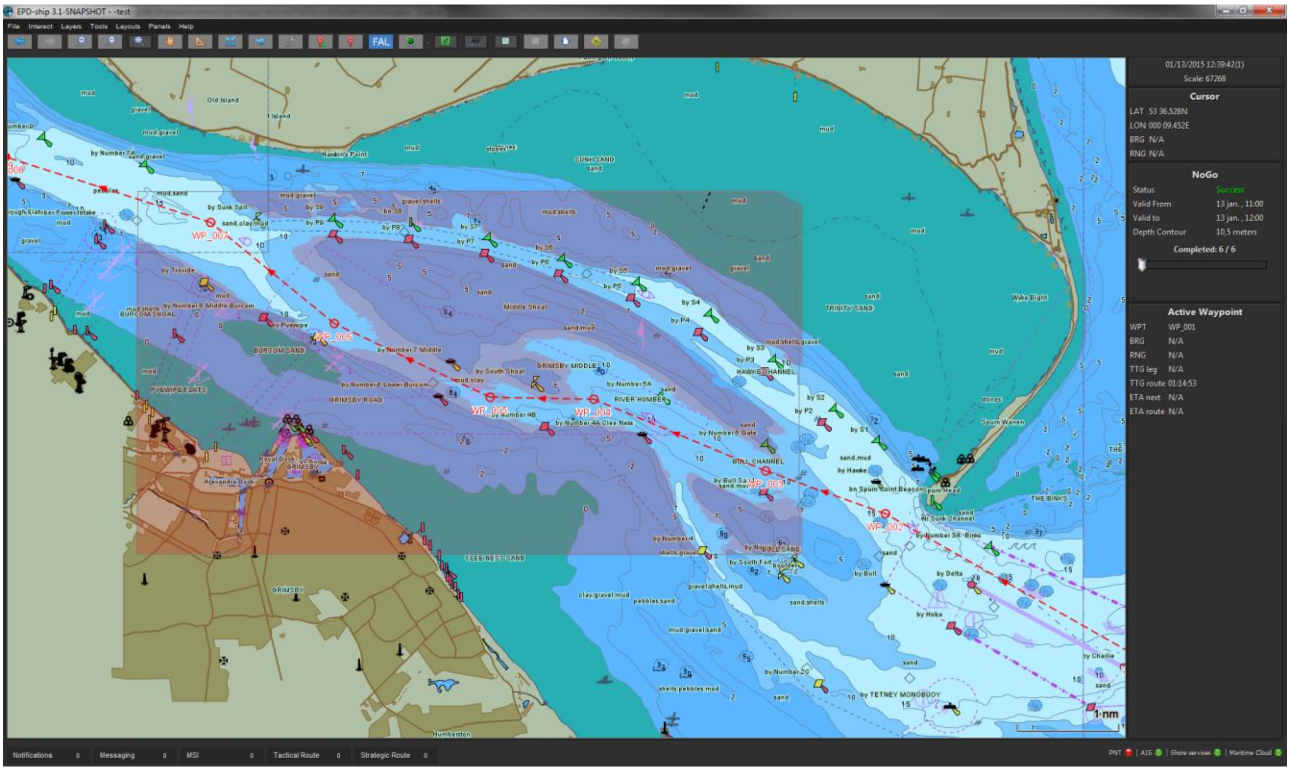

Figure 5: No-Go areas are returned and drawn on chart with purple polygons. Between 11:00 and 12:00 southern channel is closed for vessel due to low water.

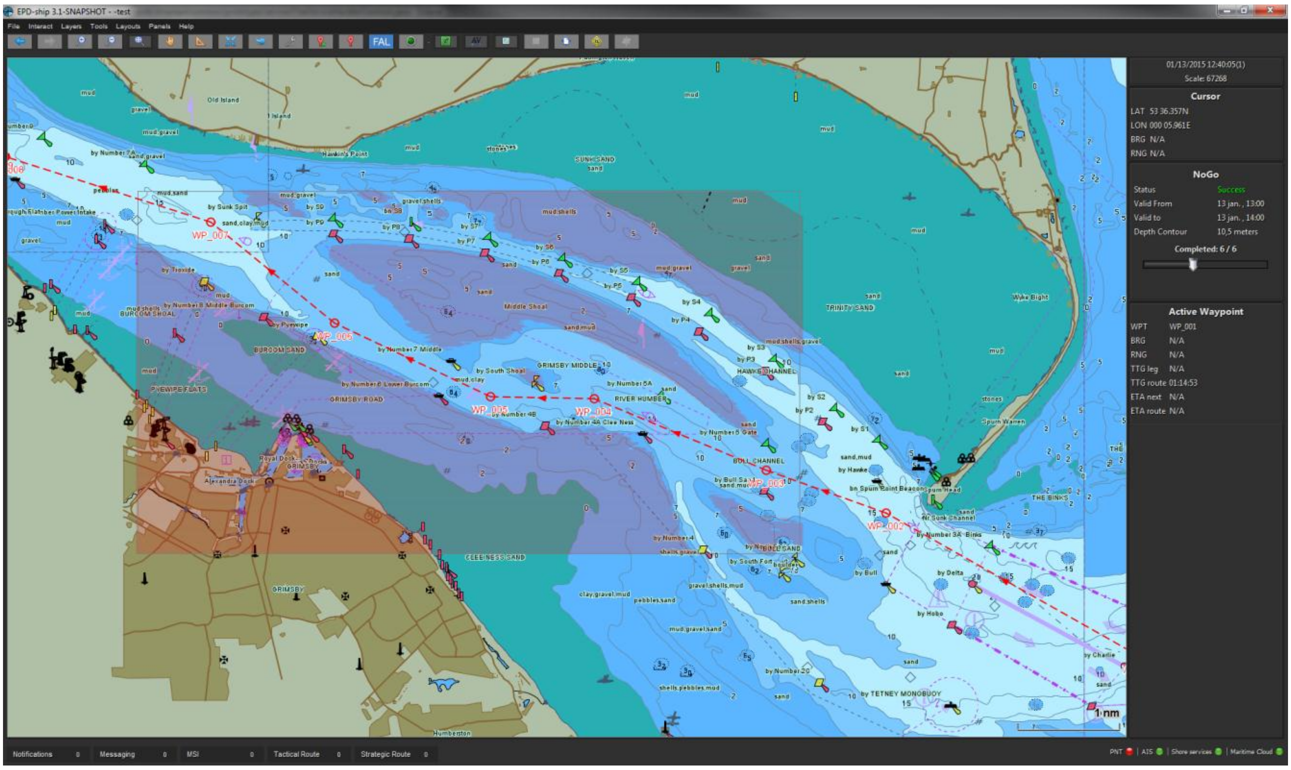

Figure 6: From 13:00 to 14:00 southern channel opens as water rises. With the time slices it is possible to browse through time and easily see the changing water level and when channels or areas are navigable for vessel.

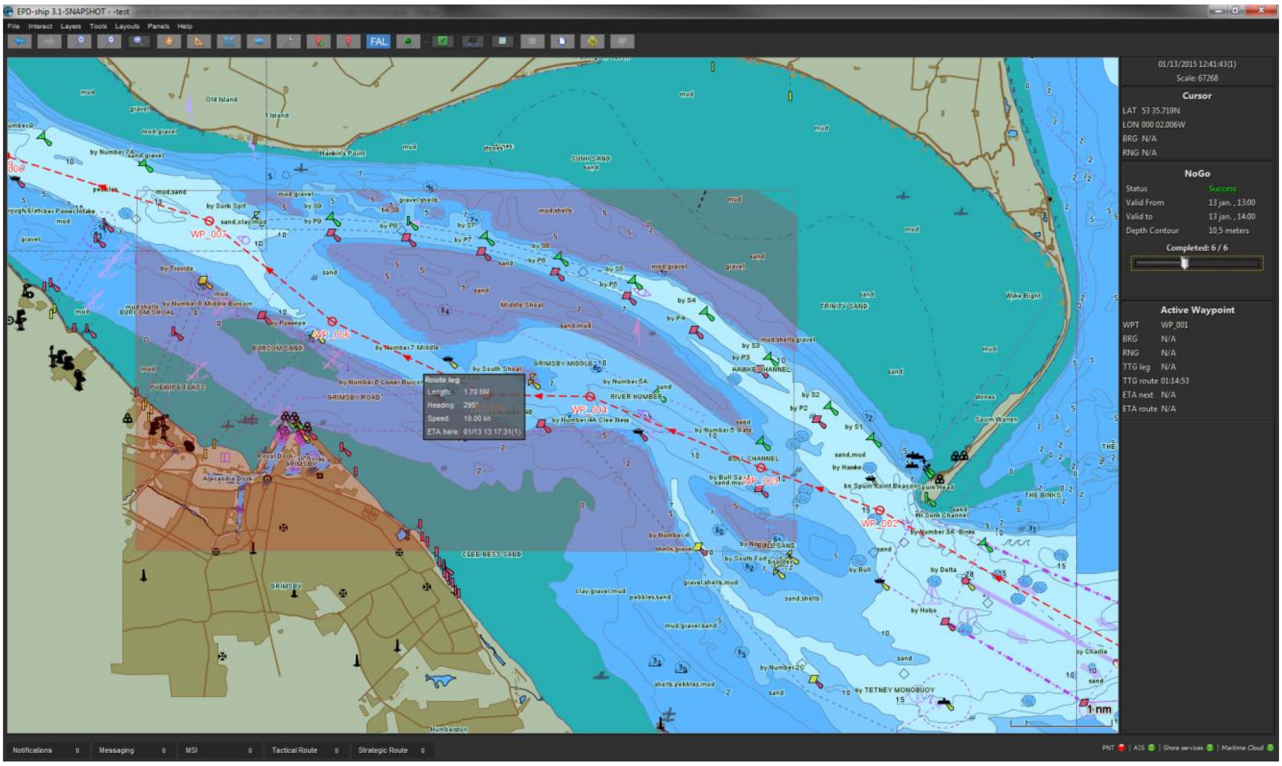

Figure 7: By mouse-over it is possible to see vessel's progress on route / ETA's at position and Waypoints. ETA at the shallow area in southern channel is shown above and can be used in the detailed planning.

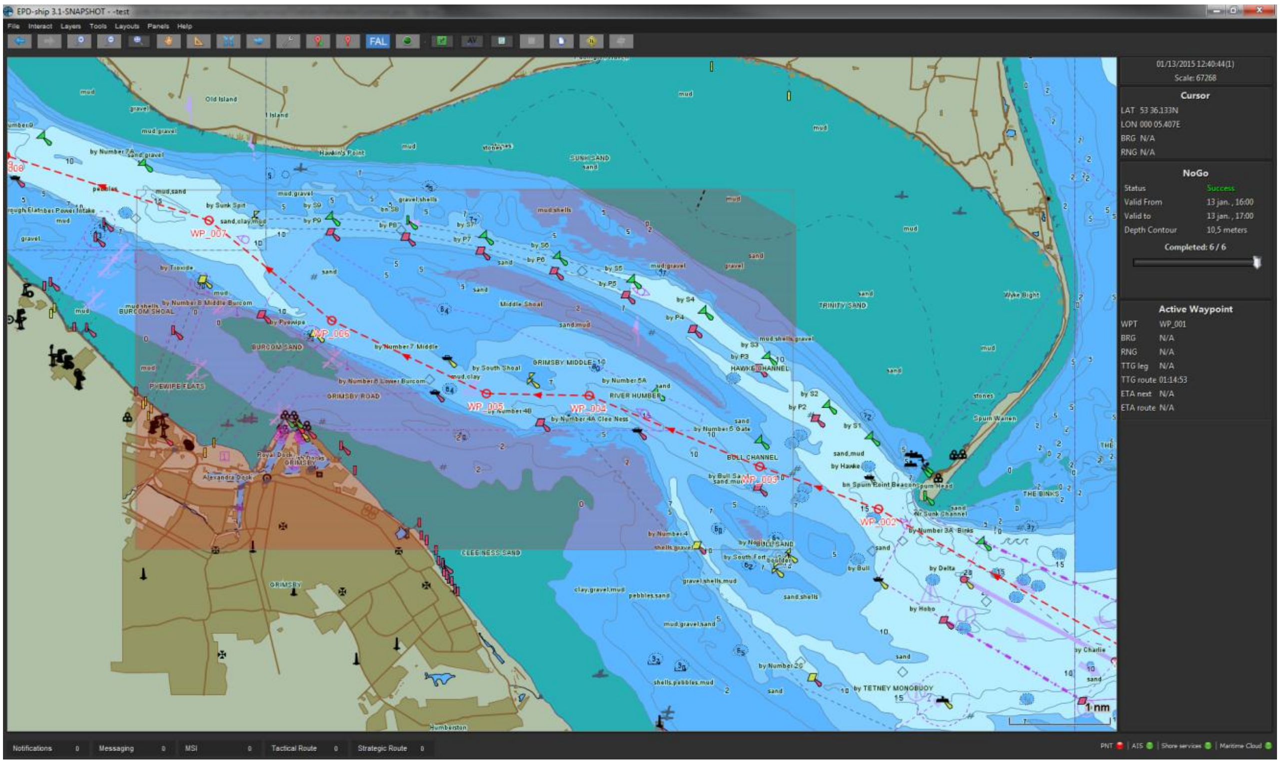

Figure 8: Low water is between 16:00 and 17:00

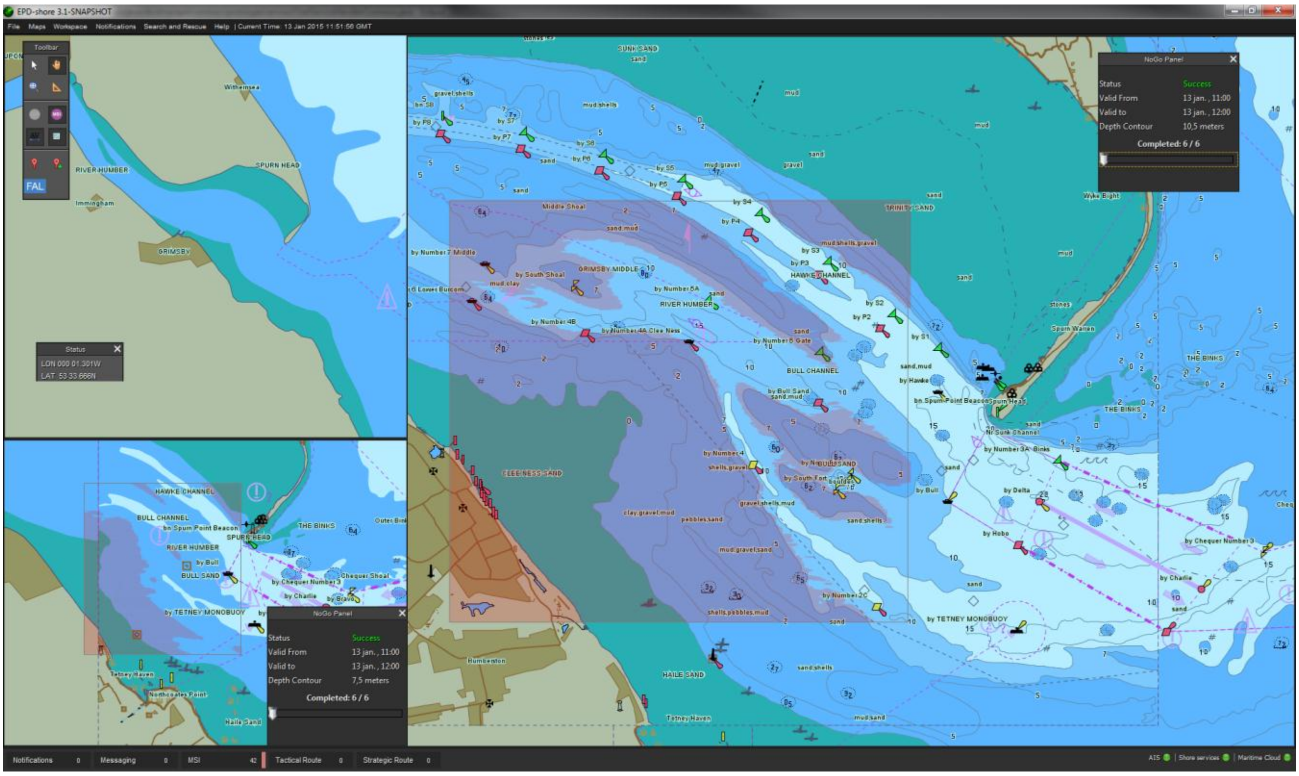

Figure 9: VTS operator may request No-Go for vessels in the area. Possible to have different No-Go depths contours shown in the different windows.

4 Observations and Feedback

4.1 Simulations

The No-go area service was tested during the 29 September to 3 October simulator session at Chalmers University in Gothenburg together with the Intended and Suggested route services. The method used was Usability test. Usability is “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (ISO 9241-11) No efficiency or effectiveness measures were used but qualitative data collected. Special focus was on usability, professional acceptance and unintended consequences of change.

Results are summarized below. References are made to the video data (video number; time code). The results are divided into four levels: conceptual, procedural, functional and HMI level. Then there is a brief discussion with the same structure and a conclusion.

4.1.1 Conceptual level

There was an agreement that this service was beneficial, especially for tidal areas as ECDIS today does not take in tidal information. (00171; 02.44) Even if the pilot would know the area at the particular tidal situation it will supply at-a-glance reassurance for the rest of the bridge team. (00171; 02.54) One of the pilots said that many times I have had captains look over my shoulder pointing at the ECDIS saying, “look my draught is 7 meters, it says 5.5 there” and I have had to say, “don’t worry, captain, we got 3 meters of tide on top of that number”. (00171; 03.17)

Another benefit is that even if you have old ENC cells that have not been updated for a long time, you will get the No-Go areas based on the latest bathymetrical survey data from the area. (00171; 05.52)

For pilots it is an extra confidence. It is a nice-to-have. (00171; 06.17)

But the way the service is working today it is much less beneficial. You must draw out a small area. There are a lot of clicks; you have to type in a time interval. It should be looking ahead automatically the whole time and relating that to where the ship would be at that time. (00171; 03.48)

The service is particularly good for foreign ship not known to the area.

4.1.2 Procedural level

NoGo areas based on the most current surveys and for the correct tidal situation will make it easier for the VTS to show to vessels that they can actually go a certain way and they will not ground. (00171; 06.08)

It might lessen the workload for the VTS because they might not need to answer a lot of questions about the tidal level. (00171; 07.03)

4.1.3 Functional level

NoGo areas should be delivered automatically along the future route of the ship with right times for future positions along the route.

There should be an alarm for track leading into NoGo areas.

4.1.4 HMI level

Several participants agreed that the NoGo area service, in the present stage of development, was too difficult to handle. It was too many steps and too many windows to get it to work and you made it too big you got no result (and no feedback on what you had done wrong). But off course it was because they were new to the system. It felt a lot more comfortable the second day than it did the first. (00191; 26.59)

There was also a comment about the colour the needed to be more noticeable.

4.1.5 Survey

The participants were asked to summarise their impressions about the service in a survey with three questions:

1. What is your opinion about the tested No-Go area concept? Of the 9 answering participants 8 answered Good or Very good. One answered I don't know. Nobody answered Bad or Very Bad.

2. Do you think a similar No-Go area concept will become reality in the future? On this question all 9 participants answered Probably or Most probably. No one answered I don't know or Probably or Most probably not.

3. What is your professional opinion about the system tested? On this question the participants were asked to rank their acceptance on a scale between 0 and 5 where 0 was "Totally unacceptable", 1 was "Not very acceptable", 2 was "Neither for, nor against", 3 was "Acceptable", 4 was "Very acceptable" and 5 was "Extremely acceptable". The mean acceptance score from the 9 answering participants was 3.3, somewhere between "Acceptable" and "Very acceptable".

4.1.6 Discussion

It is interesting that some of the pilots pointing out the No-Go area service function as information sharing. The experienced pilot already have a mental model of the tidal situation in the Humber River. He knows where the vessel can freely move at the present water stand. But the rest of the bridge team can by the No-Go service share the same knowledge.

It was also obvious from the tests that the service is not that far in the developed as the other two services (Intended and Suggests routes). Mainly this was due to the limited bathymetrical database available and the time-consuming computation of the No-Go areas. During the discussions it was clear that the participants wanted the No-Go area to be easier to turn on, maybe only with a click or generated automatically along the route of the ship with a tidal window corresponding to the position of the ship along the track.

The service potentially bypasses the centralised and time consuming process of chart updates. For areas like the Humber River, changes in the bathymetry with shifting sandbanks are real challenge for the national hydrographic authority. Humber Ports is constantly surveying the area and publishing rudimentary sounding charts on the web every fortnight (http://www.humber.com/). The charts are pdf maps showing the track of the particular survey with depth figures along the track (see Figure 9). The data is much more current than the ENC cell in the ECDIS, but as a pdf image on a separate computer screen the usefulness is nil.

But by allowing the No-Go area service to access survey data that has not passed the quality assurance process of the national hydrographic organisation there might be legal issues that needs to be taken into account.

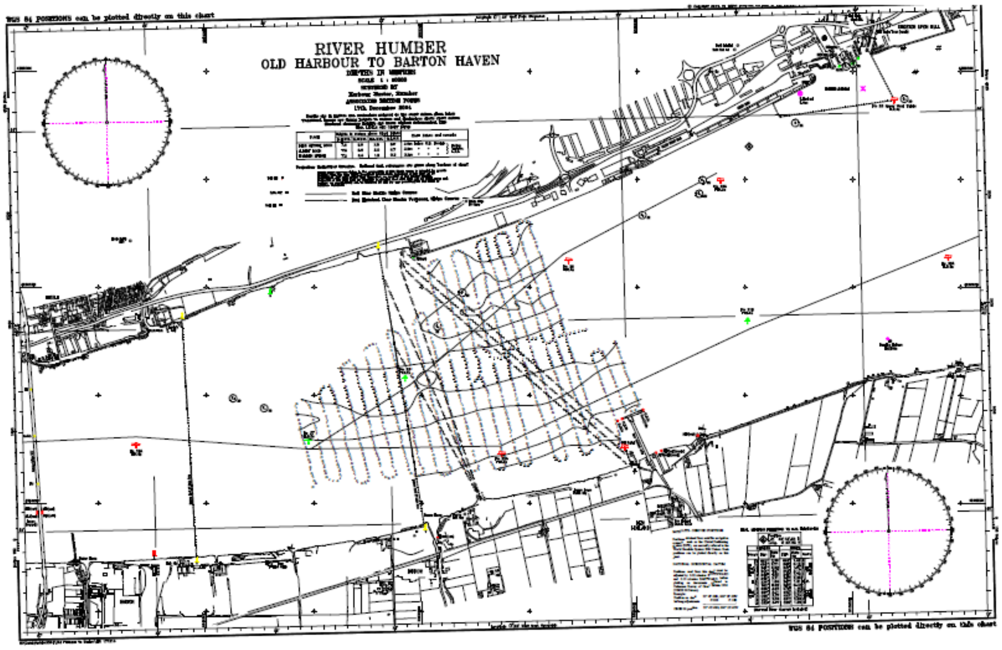

Figure 9: Example of a new survey map from the Humber River. The format is a paper map scanned into a pdf file. The track of the survey vessel can be seen in the middle of the image. The survey track consists of depth figures. (Source www.humber.com)

4.1.7 Conclusion

- The NoGo area service was relevant and useful but lacked usability in its present stage
- The service should be easier to turn on and automatically displayed along the ships track taking time into consideration.

4.2 Live tests/demonstrations Humber

The primary goal of the live tests was to demonstrate the services and solutions working in real life. Feedback on services and usability from the participants in the live tests in Humber was the same as for the participants in the simulations and described above.

During the demonstrations with Pride of Hull and Humber VTS the No-Go area service was used via the Maritime Cloud. No-Go Data was requested and exchanged via the Maritime Cloud without any problems. Even on a very slow connection (see below).

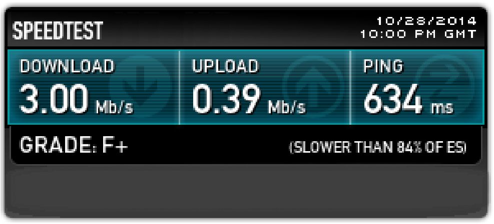

Figure 10: The general throughput of the internet connection used during the demonstrations was tested. Note the download/upload, response time and that the service gets a poor grade. The download speed is decent, but shared across the entire ship. The upload speed is ~10 times slower.

5 Publications

SOLAS Chapter V

ICS Bridge Procedures Guide