# *Service Description: Tactical Route Suggestion*

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| Lead Author | Reviewer | Approved for Release |
|---|---|---|
| **Name:** Mads Bentzen Billesø | **Name:** Transnational Project Co-ordination Group | **Name:** Project Steering Committee |
| **Job Title:** WP6 Contributor | **Job Title:** N/A | **Job Title:** N/A |
| **Partner:** DMA | **Partner:** All | **Partner:** All |
| **Signature:** pp Alwyn I. Williams | **Signature:** pp Alwyn I. Williams | **Signature:** pp Alwyn I. Williams |

## *Executive Summary*

Route exchange plays a central role in the effort of the maritime community to integrate e-navigation tools in an all-embracing system that will contribute to enhanced navigational safety and reduce the burden on the navigator.

The *Tactical Route Suggestion Service,* developed and tested in the ACCSEAS project, is intended as a tool for VTS operators to effectively communicate route suggestions to vessels as a response to developing traffic situations or as navigation assistance (hence the term "tactical", as opposed to planning-based *strategic route service*). Also, the service may be used by pilots, communicating their pilot plan to the vessel before boarding, and in Search and Rescue Operations.

The service is a supplement to traditional VHF voice communication, which is prone to misunderstandings due to language problems, lacking situation awareness, wrong interpretation of surroundings and human error.

The Tactical Route Suggestion Service has been implemented using the *e-Navigation Prototype Display* (EPD), and field tests involving ships and shore-side VTS centres have been conducted with promising results.

Other route exchange concepts, such as intended route broadcasting and dedicated search and rescue tools, have also been investigated in the ACCSEAS project. A strategic route suggestion service, which focus on the planning of routes, has been explored in the MONALISA-2 project.
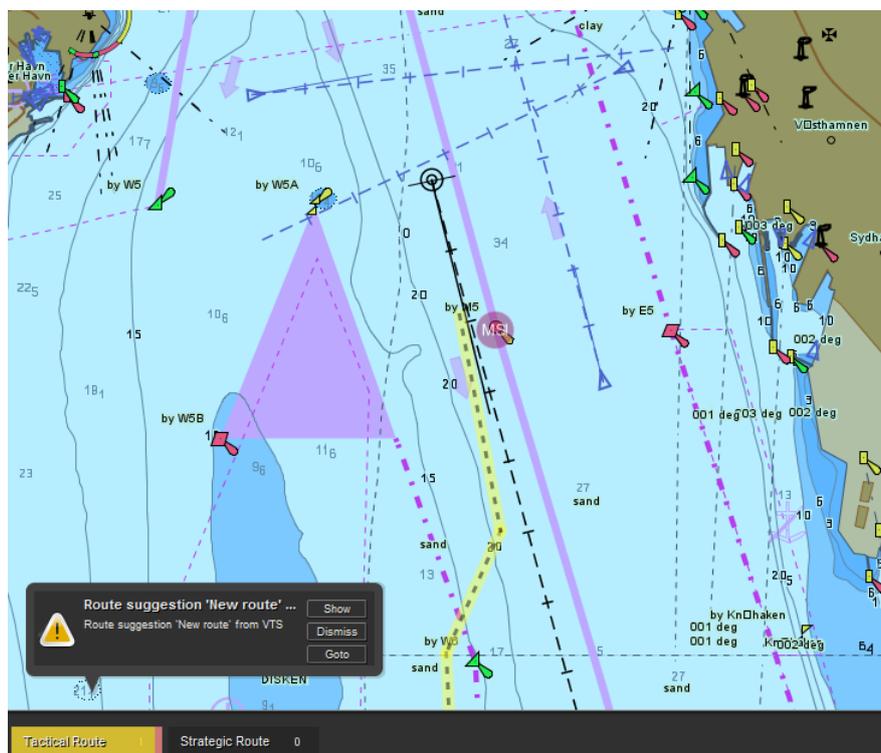


**Figure 1: Vessel receiving Tactical Route Suggestion**

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| Lead Author's Contact Information | Søfartsstyrelsen / Danish Maritime Authority |
| | Maritime Analysis, Technology and Business Development (MAF), e-Navigation |
| | Telephone: +45 9137 6329 |
| | E-mail: MCB@dma.dk |
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# 1 Introduction

## 1.1 Background

About 33 000 to 35 000 ships over 300 GT pass the Sound between Sweden and Denmark every year (not counting the many ferries going back and forward across the Sound). In later years, there have been between 50 and 70 incidents annually where VTS operators have been forced to take action, mostly to warn ships with too deep draughts or that were heading for shallows (Garbebring, 2011).

This illustrates the need for VTS centers to be able to respond to developing traffic situations based on the traffic image they maintain, and to have efficient solutions and tools to facilitate their Information Service (INS) and Traffic Organization Service (TOS).

## 1.2 Tactical Route Suggestion Service

The *Tactical Route Suggestion Service* is an e-navigation tool that may be used by VTS operators to effectively communicate route suggestions to vessels as a response to developing traffic situations (hence the term "tactical", as opposed to planning-based *strategic route service*). On the targeted vessels, the route suggestions are automatically received and presented on the navigation display together with explanatory text.

The service is intended to supplement traditional VHF voice communication, which is prone to misunderstandings due to language problems, lacking situation awareness, wrong interpretation of surroundings and human error.

The service is closely linked to one of the five prioritized e-navigation solutions identified in the IMO e-navigation strategy implementation plan, S9: Improved communication of VTS Service Portfolio, supported by the FSA Risk Control Option 6 (RCO6), Improved Shore-based Services.

A Tactical Route Suggestion Service was originally explored in the EfficienSea project. The solution was implemented using the *e-Navigation Prototype Display* (EPD) for shore and ship-side ECDIS-like functionality, and by adopting AIS as the protocol for exchanging route suggestions.

As part of the ACCSEAS project, it was decided to improve and develop the concepts further. Using AIS as the means of route exchange has substantial advantages, however, in practice it has turned out to be too fragile, due to the limitations in the protocol and poor robustness of delivery. In the ACCSEAS project, all services have been migrated to use the Maritime Cloud MMS as the means of communication.

To improve the user experience, the Tactical Route Suggestion services, along with other maritime services such as MSI, messaging, and general notifications, have been integrated into a unified *Notification Centre* with a standardized way for presenting and handling notifications of varying severity (notices, warnings and alerts).

The implemented solution has subsequently been tested extensively in simulators and in the field with participation of vessels and VTS operators.

## 2   Description of Developed Service

### 2.1   Use Case

The scenario for this type of service might look like this:

1. The VTS center monitors the ships passing through their area. In addition to positional information provided by radar and AIS, this may include the intended routes for the ships (see Tactical Exchange of Intended Route, another ACCSEAS project).
2. If e.g. a ship is seen to be heading towards shallow waters, the VTS operator selects a standard route from her list, and sends it to the ship along with an explanatory text.
3. The suggested route pops up on the ECDIS of the targeted ship. The OOW/navigator gets a choice of either accepting or rejecting the new route. He accepts the route and makes it his active, monitored route.
4. At the VTS center, the navigational display shows that the suggested route has been accepted and adopted as the ships intended route.

The functionality and presentation of the Route Suggestion Service, developed and tested in the ACCSEAS project, is described in the subsequent sections.

### 2.1   Creating and Modifying Routes

The VTS centre, i.e. the shore-side EPD, needs the ability to maintain a library of standard routes as well as the ability to create *ad hoc* routes to cater with specific situations.

Routes are added via the *New Route* ( ) toolbar button. Consecutive waypoints are inserted by clicking on the chart area, and the route is completed by selecting *End* Route from the right-click menu.



**Figure 2: A route spanning The Sound**

Existing routes can be modified *in situ* by dragging waypoints around, or by adding and deleting waypoints from the context sensitive route menu.

Routes can also be edited in detail via the *Route Properties* dialog. All route data, such as name, waypoint positions, XTD, SOG, etc., can be adjusted. In addition, there are various functions for re-computing speed based on ETA and vice versa.
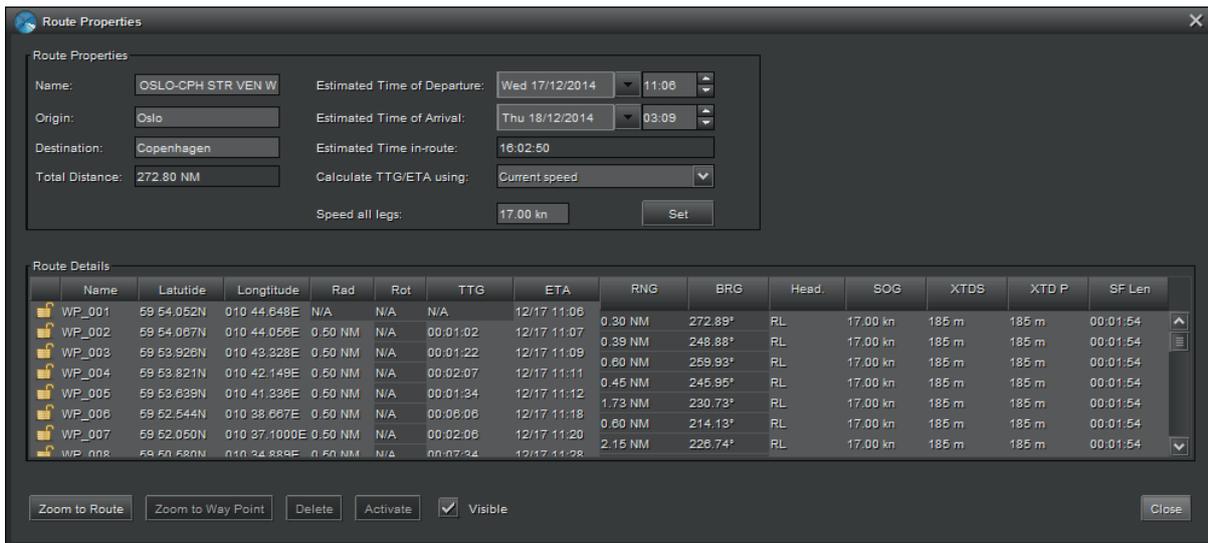
**Figure 3: The Route Properties Dialog**

A more common (and faster) place for a VTS operator to adjust the ETA/ETD and speed of a route is in the *Tactical Route Exchange Dialog*, detailed in a later section.

## 2.2   Route Manager

The full library of routes is available in the *Route Manager Dialog*, which also provides functions for editing routes, exporting and importing routes in commonly used formats.
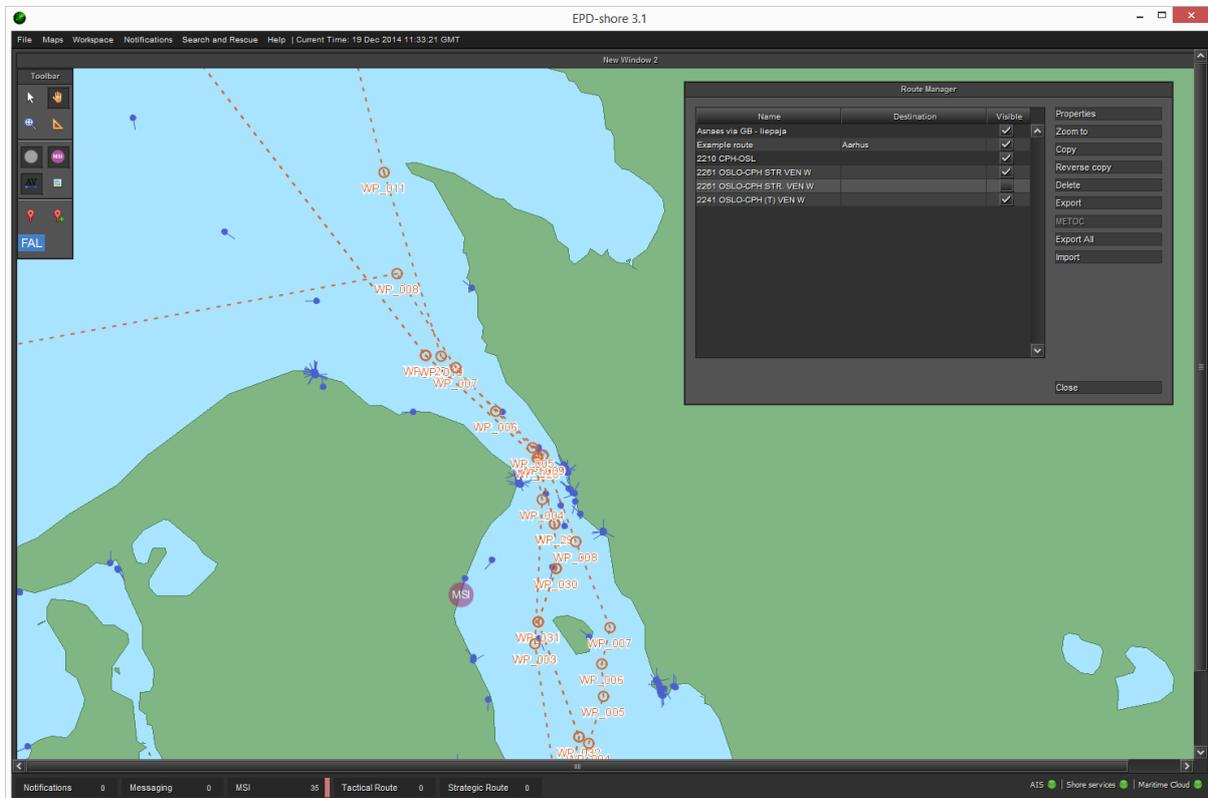


**Figure 4: The Route Manager Dialog**

## 2.3   Intended Routes

Intended routes are not directly part of the Tactical Route Suggestion Service. However, as explored in the ACCESEAS *Intended Route Exchange* sub-project, they are expected to become an important tool, helping VTS centres monitor and manage the traffic in their area. Based on the intended route of a vessel, the VTS operator may send an alternative route suggestion via the Tactical Route Suggestion Service.

A ship may designate a route *the active route,* i.e. the route that the vessel is currently following. The active route will periodically be broadcast to other vessels and VTS centres as the *intended route* of the vessel.
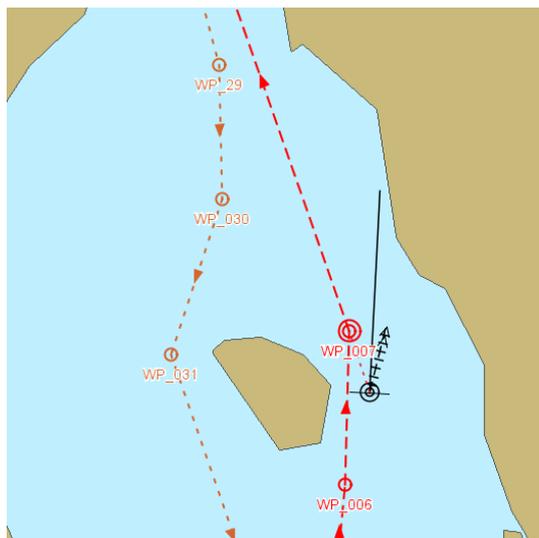
**Figure 5: Active route, as displayed on a ship-side navigational display**

The intended routes are displayed in a separate layer of the VTS centre navigational display (EPD), which can be turned on and off. Furthermore, the visibility of the individual intended route can be toggled, and indeed, to avoid clutter on the navigational display, all intended routes are initially hidden. The VTS operator can toggle the intended route of all or specific nearby vessels via the vessel target context menu.

By default, the intended routes are depicted in green, using a slightly lighter appearance than the operator's own routes. The active waypoint is flagged with a double-circle, and past route segments are grey:
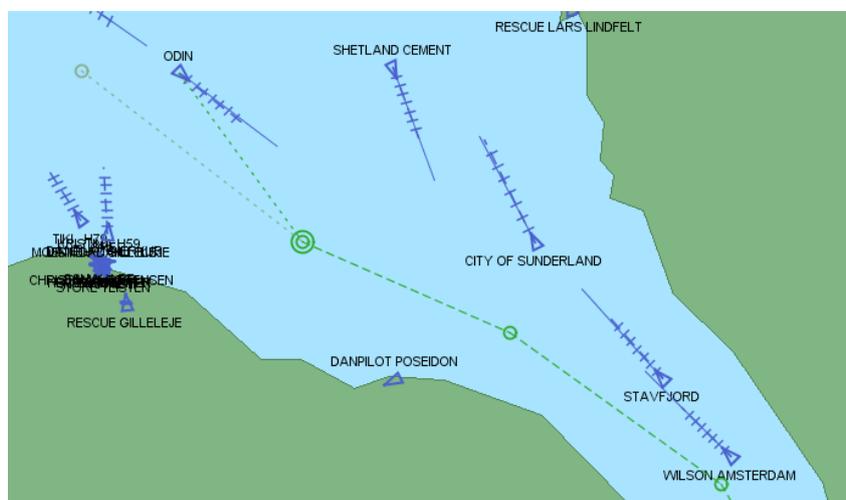
**Figure 6: Intended Route Portrayal**

Between the vessels current position and the active waypoint, a finely dotted line segment is added and dynamically updated whenever the vessel position changes.

If the VTS operator hovers the mouse over the route, a tooltip window will be displayed stating the computed ETA at that particular position.

The validity of an intended route depends on when it was last updated via an intended route broadcast - a quality measure that is being reflected in the route portrayal. When a new broadcast is received, the route will be completely opaque, and henceforth it will gradually become more and more transparent until, after a configurable number of minutes, it becomes completely invisible.

## 2.4  Sending Tactical Route Suggestion

When the VTS operator detects a dangerous developing traffic situation, such as a ship heading towards shallow waters or an intended route of a ship that spells danger, she will want to suggest a new route to the ship.

The operator can either choose "Send route to vessel…" from the vessel context-sensitive menu, or "Send route…" from the route context-sensitive menu. Either way, the *Tactical Route Exchange Dialog* will be opened:
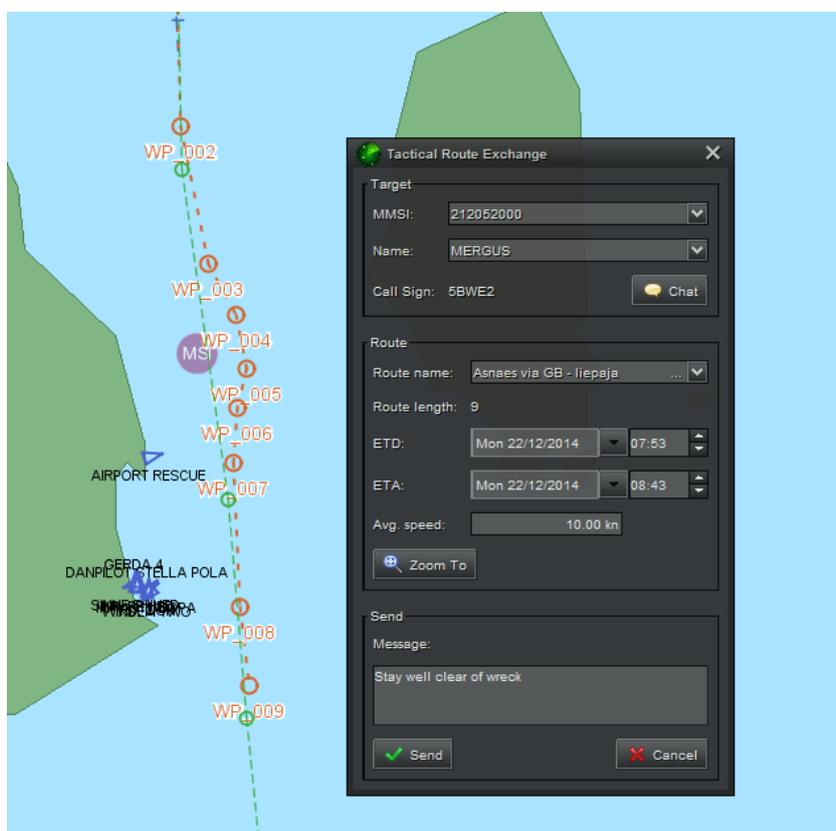


**Figure 7: Tactical Route Exchange Dialog**

The dialog allows the operator to choose the route to send, and the vessel to send it to (depending on which way the dialog was opened, the choice of route or vessel will be pre-populated).

Since standard sailing routes will be re-used continually, the dialog also contains shortcut fields for overriding ETD, ETA and average speed of the route being sent. Lastly, the dialog contains a message field, which the VTS operator may use for an explanation.

Once the route suggestion has been sent, the status of the interchange can be monitored by the VTS operator in the *Tactical Route* section of the *Notification Center.* Initially the status will be "Pending":
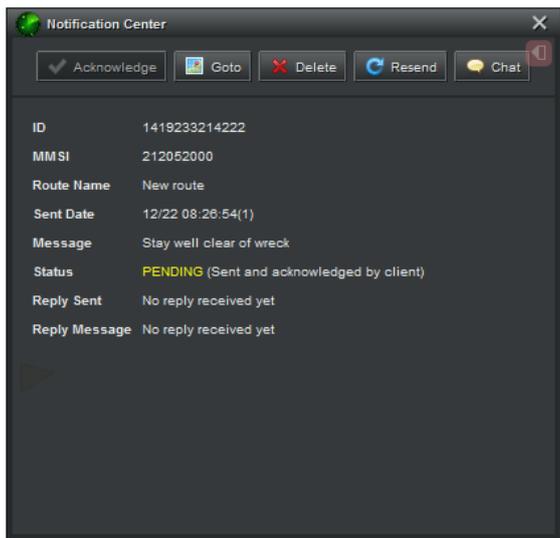
**Figure 8: Tactical Route Suggestion with status "Pending"**

Next to the operational status of the route suggestion, there will also be an indication of the current Maritime Cloud transmission status of the message. That will be one of:

- *Not sent* - If the VTS center is not properly connected to the Maritime Cloud.
- *Sent* - When the message has been submitted to the Maritime Cloud.
- *Failed to send message* – when an error has occurred while transmitting the message.
- *Sent and received by cloud* - when the message has been successfully sent to – and received by – the Maritime Cloud.
- *Sent and received by client* – when the message has been received by the target vessel.
- *Sent and acknowledged by client* – when the message has been received and acknowledged by the target vessel.

## 2.5  Receiving Tactical Route suggestion

When the ship receives a tactical route suggestion from the VTS center, they will be alerted by a pop-up window in the EPD:
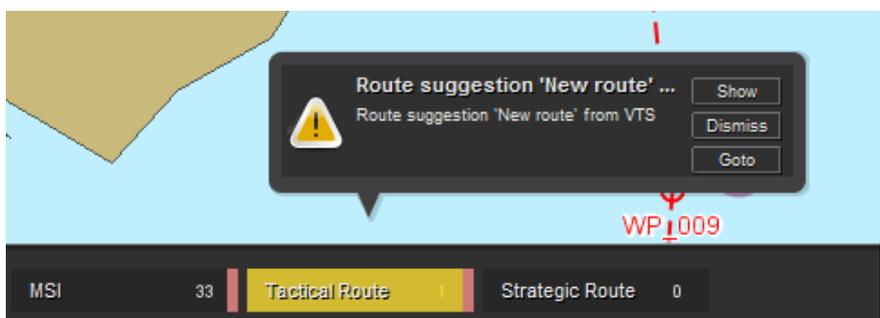
**Figure 9: Tactical Route Suggestion Notification**

### 2.5.1   Notification Centre

This is standard Notification Center behavior whenever a new notification is received. The notifications are categorized as either MSI, tactical route suggestions, strategic route suggestions, chat messages or general notifications, and depending on the severity of the notification (message, warning or alert), the pop-up window will fade out after a couple of seconds. The notification may also be accompanied by alerting beeps or audio warnings.

The actual Notification Center Dialog is opened by clicking the bottom notification bar, or the "Show…" button of the notification pop-up window.

If the former approach is used, the full Notification Center is opened in *expanded mode*, displaying all categories and notification lists:
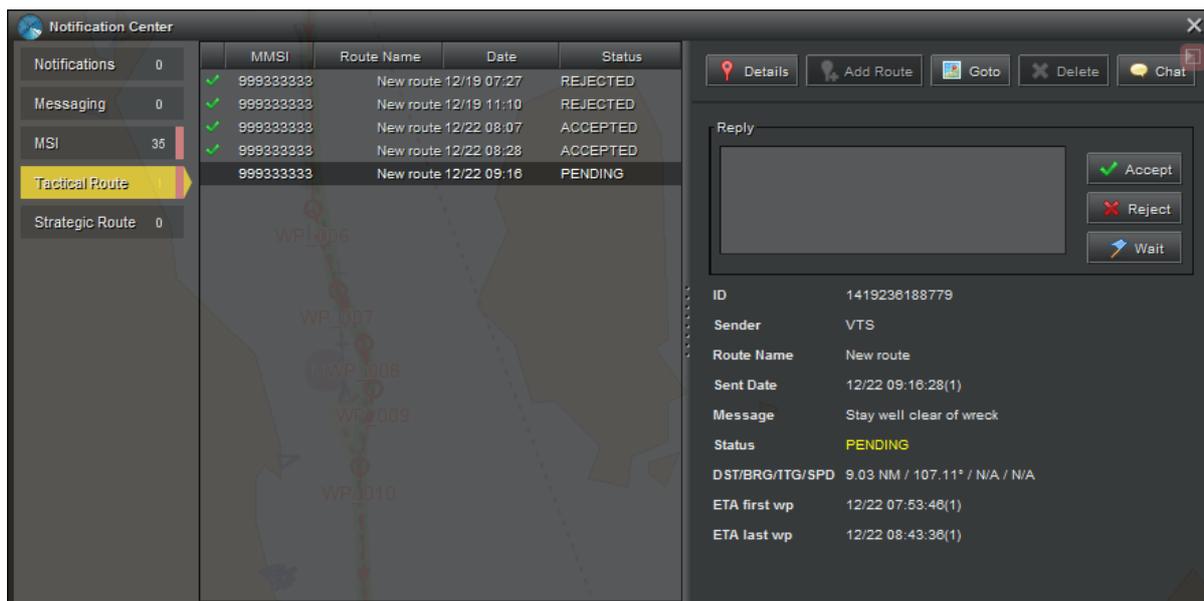


**Figure 10: Notification Centre opened in expanded mode**

If the latter approach is used, i.e. a specific notification is shown, the Notification Center will be opened in a *collapsed mode*, where only the associated notification is visible (see next screenshot). This mode will prevent clutter of the navigational display. The display mode of the Notification Center is toggled using the red top-right button.

### 2.5.2   Handling a Route Suggestion

When the Tactical Route Suggestion is opened via the Notification Center on the ship-side EPD, the navigator will be presented with an overview of the route suggestion and functions for responding to it.

Furthermore, the actual route being suggested is displayed in the chart area with yellow (i.e. pending) route portrayal.
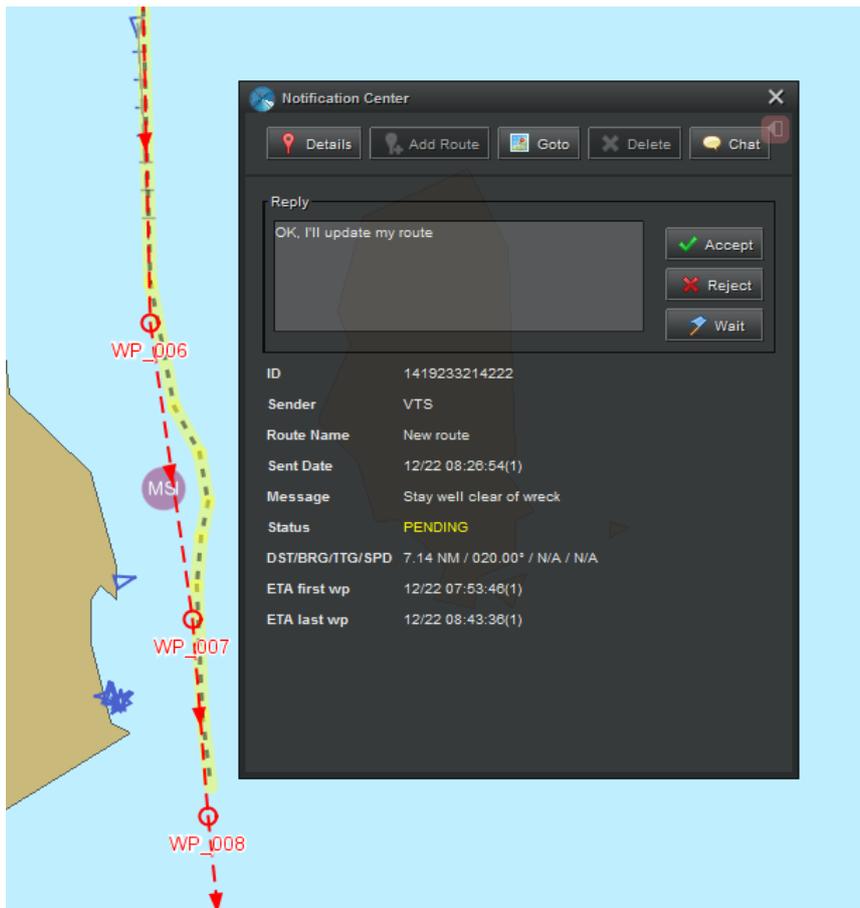
**Figure 11: Responding to a Tactical Route Suggestion**

Topmost, the dialog contains buttons for displaying the details of the route in the Route Properties Dialog, for adding an accepted route, for zooming in on the suggested route, deleting an accepted route, and for chatting over the Maritime Cloud with the sender (the VTS center).

The "Reply" area of the dialog contains the options for responding to the route suggestion, and a field for a message to send along. The response options are:

- *Accept*: Will accept the route suggestion and send a reply to the VTS center. The actual suggested route in the chart area will change from yellow to green (indicating acceptance). Subsequently, the ship navigator can amend his existing active route according to the suggestion, or simply add the suggested route to the system and the make it the active route.
- *Reject*: Will reject the route suggestion and send a reply to the VTS center. The route suggestion graphics is also removed from the chart area.
- *Wait*: Will send a text message to the VTS center, stating that the route suggestion will be handled later.

As described for the VTS center, the route suggestion notification panel will display a status flag for the message, which will change from "Pending" to either "Accepted" or "Rejected" depending on the response. The Maritime Cloud transmission status of the response will also be displayed.

## 2.6   Receiving Tactical Route Reply

When the targeted ship has responded to a tactical route suggestion, the originating VTS centre will receive the reply via the Notification Center:
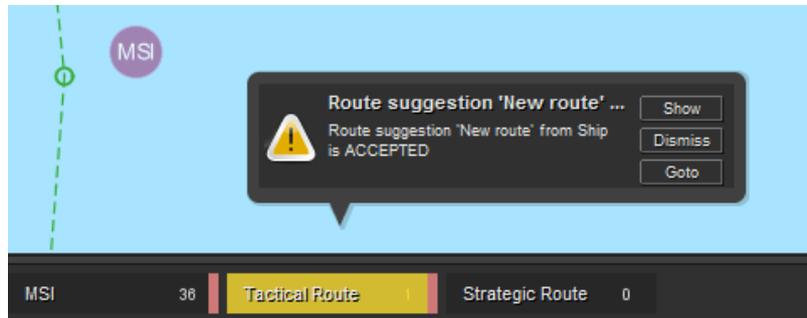


**Figure 12: Receiving a Tactical Route Reply**

The status of the route suggestion will be updated in the tactical route details panel of the Notification Center. The VTS operator also has the option to re-send a tactical route suggestion, delete it, or chat over the Maritime Cloud with the Vessel navigator.
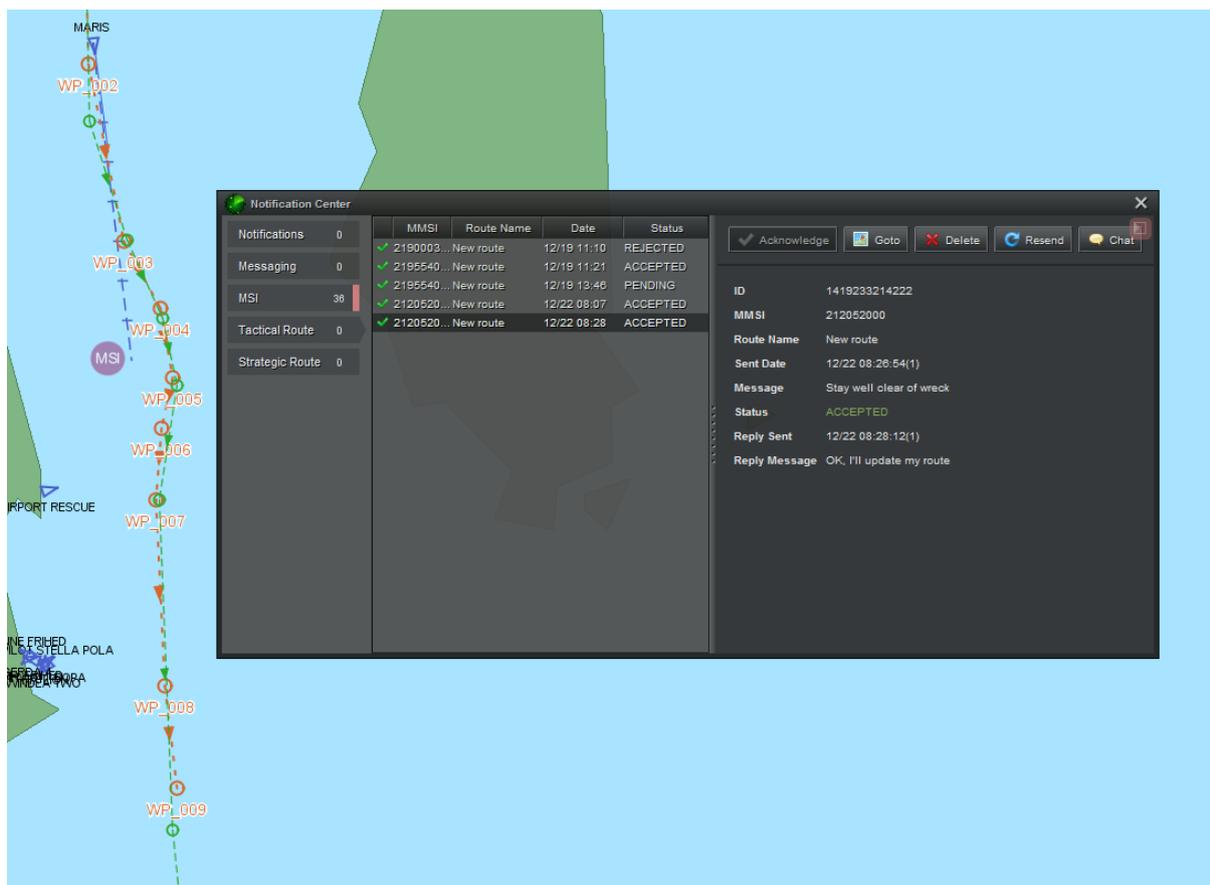


**Figure 13: Tactical Route Notification Centre – Expanded**

# 3   Technical implementation

This chapter outlines the technical implementation of the Tactical Route Suggestion Service, focusing specifically on the communication protocol.

The EPD client (ship and shore) and the Maritime Cloud have been used in the reference implementation of the Tactical Route Suggestion Service. Furthermore, the system has served as a test bench for the user tests.

## 3.1   EPD

The *e-Navigation Prototype Display* (EPD) comes in two flavours, EPDShip and EPDShore, used for testing ECDIS-like functionality on a vessel, respectively in a VTS centre.

The EPD client is open source, and the project is available on GitHub:
https://github.com/dma-enav/EPD

## 3.2   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, which is also open source, please refer to http://maritimecloud.net.

EPD uses the *Maritime Cloud Messaging Service* (MMS) for services such as intended route exchange, route suggestions, MSI-NM and text messaging. A VTS centre can send a route suggestion to a vessel if the vessel has registered with the Maritime Cloud as a *TacticalRouteEndPoint*. The vessel operator may then process the suggestion and send a reply to the VTS centre, which must have registered with the Maritime Cloud as a *TacticalRouteReplyEndpoint*.
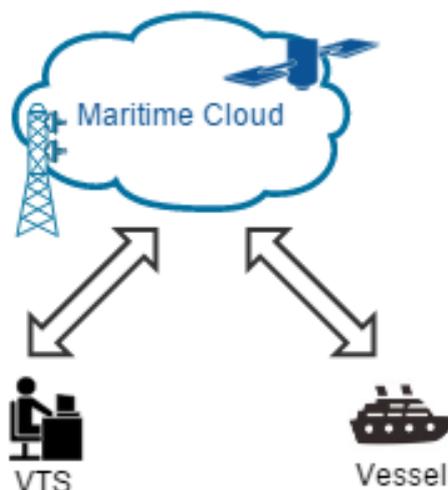


**Figure 14: Communicating via the Maritime Cloud**

## 3.3   Tactical Route Endpoint

Ships that wish to receive tactical route suggestions must register as clients to the *TacticalRouteEndpoint* MMS service. The UML for the service can be seen below:

**Figure 15: Tactical Route Endpoint**

The Tactical Route Endpoint service and models have been implemented in the *Maritime Cloud Description Language* (MSDL) format. The MSDL files are maintained at:

https://github.com/MaritimeCloud/Services/tree/master/mc-services/src/main/msdl/dma/route

- The files are reproduced in Appendix A.

## 3.4   Tactical Route Reply Endpoint

In order to receive a reply to a tactical route suggestion, the VTS centre must register as a client to the *TacticalRouteReplyEndpoint* MMS service. The UML for the service can be seen below:
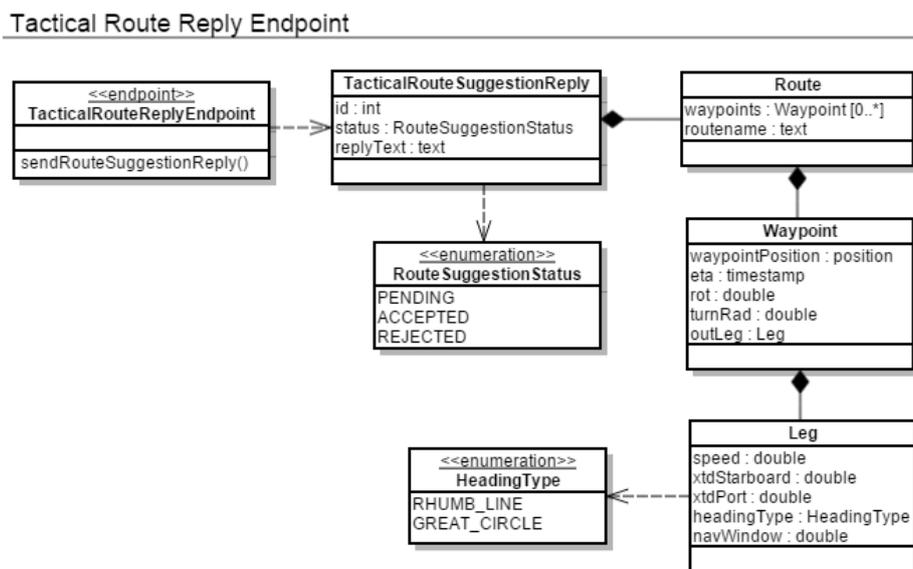


**Figure 16: Tactical Route Reply Endpoint**

The *id* attribute of the TacticalRouteSuggestionReply should be identical to the id send along in the initiating tactical route suggestion, as it is used to tie suggestion and reply together.

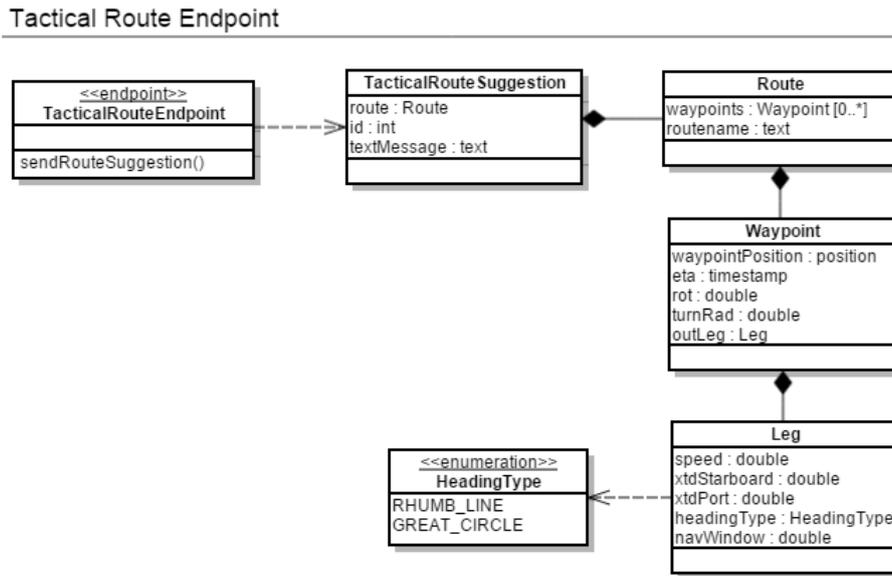The Tactical Route Reply Endpoint service and models have been implemented in the *Maritime Cloud Description Language* (MSDL) format. The MSDL files are maintained at:

https://github.com/MaritimeCloud/Services/tree/master/mc-services/src/main/msdl/dma/route

- The files are reproduced in Appendix A.

# 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

Both ship and shore participants agreed that the Suggested routes service was good. No one was against. "Absolutely, from a VTS perspective, it is very useful." (00170; 15.48)

One participant said: "If the VTS tells you to go the Sunk Dredge Channel, they might as well send out a route showing me where that is if I do not know." But the captain is the one who will have the last word. (00192; 04.44) Off course if you have a pilot onboard who immediately knows which way to take then it might not be so important with Suggested routes. (00192; 07.03) But another participant said that sending out the rout might be valuable in any case because it would give the captain a better understanding of what the suggestion was about, and he is the one who has the final word. (00192; 07.45)

The importance of data being correct was also discussed with respect to the Suggested route service. "The risk is that the VTS sends out a rout that is not deep enough for the ship." It is important that AIS draught information is correct, and that no human error is committed in the VTS. A suggested route always has to be checked onboard. (00192; 05.14)

One caution brought up was that a route suggestion might arrive onboard in a stressed situation when on one of the bridge can deal with it. "It must not be sent in the last minute". (00192; 05.45). A comment in this respect was also made regarding a useful procedure from the VTS to first call a ship and talk to them and tell them that they will send a Suggested route, That way you will get the best of both worlds: you will talk to the ship and get a feeling of the situation onboard, and you will save a lot of explaining by sending out the route.

One participants described a situation where in the Sound between Denmark and Sweden ships are asked by the VTS to pass east or west of "Ven" (an island in the sound) but it would sometimes take the VTS 5-10 minutes to explain what "Ven" was and which route they want the vessel to take. Sending off a Suggested route will save a lot of talking on the VHF which in turn is blocking the channel for other calls (00170; 16.16)

Voyage planning was discussed. Although the IMO demands a "birth-to-birth" voyage plan a vessel from Gothenburg to Immingham will only make a voyage plan from Gothenburg to the pilot station or to Spurn Head because "we do not know which way the pilot will take for the final part." (00191; 03.45) This was also acknowledged by the Humber pilots who said that 90 % of the cargo ship would have their last waypoint at the pilot station, the situation was better for the tanker fleet because they were heavily vetted and therefore mort compliant to regulations. (00168; 03.30) But several of the participants agreed it would be a good thing if the pilot organizations would publish their recommended routes so that they could be downloaded from the Internet (as is already done in some places of the world). A discussion followed of how tankers dealt with the situation when they had an approved voyage plan all the way to birth and the pilot decided to go another route that was not panned maybe to

avoid meeting another ship in a narrow. They would then violate the regulation if they could not quickly come up with a new voyage plan. (00191; 04.55)

One of the pilots mentioned that in times when there are many ships coming in, the pilot could create a "path" so that the ships would approach in an orderly fashion one at a time to the pilot pick-up station. This would facilitate for the boat setting the pilots onboard. (00192; 10.39)

Most often the suggested route was a result of a VHF dialogue where either the ship asked the VTS for a route suggestion, or the VTS offered to send a route to clear out a misunderstanding.

### 4.1.2   Procedural level

It seemed to be an understanding that receiving a suggested route would lessened the workload when they were asked to go another channel. (00170; 26.50)

The question was asked if it was a risk that some information that today was publicly agreed on the VHF now instead becomes a private agreement between the VTS and a ship receiving a Suggested route, and in that way caused the common situation awareness to decrease. Some participants agreed that that was a risk, but said that it happened already today with information that was available on the AIS and therefore did not have to be asked on a public channel. A VTS operator said that the procedure would probably be that the VTS agreed verbally on a Suggested route over the VHF, but the route was then only seen by the vessel in question. (00170; 17.34). Of course once the vessel agreed and changed its route accordingly, this new Intended route would be seen by everybody.

Route suggestions are a shore-to-ship service (or Coast Guard-to-ship) because the ship-to-shore communication is taken care of by the Intended route service.

The Suggested route service will not change the work-load at the VTS. You still have to do the same job, possibly it will lessen the work load because you may not need to explain things may times over. (00170; 20.22) And it lessens radio traffic. (00170; 20.43)

In one of the discussions with half of the participants there was an agreement that it was important that the VTS gave a reason for why the ship should go a particular route. (00192; 09.58).

### 4.1.3   Functional level

The procedure for agreeing on a suggested route in the present prototype was as follows:

1. The suggested route highlighted in yellow pops up in the EPD screen with a Warning notice saying "Route suggestion from VTS: Show/Dismiss/GoTo"
2. If the ship agrees to the route the operator has to drag the waypoints from the present route on top of the waypoints of the suggested route. This creates a copy of the active voyage plan. It is this copy that is altered.
3. Once the copy aligns with the suggested route the navigator deletes the suggested route and activates the new voyage plan.
4. The new activated route is now visible as a new intended route at the VTS as a confirmation that the route has been accepted.

Some of the captains had problems with parts of this procedure. When trying to click and drag the waypoints of the copy they could miss the waypoint and moved the chart instead. They felt it was a time consuming and cumbersome procedure that could lead to the navigator giving up on changing his voyage plan and just follow the yellow suggested route. But this would mean that the VTS would lack a confirmation and the new intentions would not be broadcasted. (00191:01.41) However, another of the captains said that with practice this will be a more natural process (00191; 02.39)

This discussion was continued by saying that a ship in regular line traffic would probably already have routs for the available fairways in an area like the Humber River. A question would then be how fast and easy they could pick one of them from a library and apply it. (00191; 03.16

The Suggested route should be automatically checked for UKC on arrival. It should use the proper depths depending on the tidal situation from the NoGo area service so that when it is visible on the screen it is also checked and approved. (00192; 13.34) The Suggested rout arriving could contain a message saying that "this route suggestion is based on your stated draught of 11.8 meters". That way it would be easier to spot a mistake, and maybe by changing the draught and click "Check UKC" a new check would be performed. (00192; 14.26) Another participant commented that is important that all this is very simple because in a stressed situation it is easy to overlook something and then the accident could be a fact. (00192; 15.20)

### 4.1.4   HMI level

It is difficult to delete the suggested route once you have moved you own rout on top of the suggested route, because it is hidden underneath.   A suggestion is that the original Suggested route could be deleted (or hidden) in the message dialogue. (00170; 22.18)

It was discussed whether it should be possible to automatically merge the Suggested route into the vessels route plan. There were two opinions on this. One that it was only unnecessary to onboard copying what the VTS had already done. The other that it, from a legal point of view was important that the ship "planned" its own route and it also makes the bridge team more confident in the new route. (00170; 23.16) In that case it must be very clear that they have then accepted the Suggested route as a part of the ships voyage plan. (00170; 25.09)

There could also be other semi-automatic methods for merging the current voyage plan with the new suggested route, e.g. by click one or two points where the current rout should be split and the suggested route inserted. (00170; 28.32)

Yellow is a good underlay colour for the Suggested route. (00192; 17.47)

### 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 Suggested routes concept**? All 9 answering participants answered Good or Very good. No-one answered I don't know. Nobody answered Bad or Very Bad.

**2. Do you think a similar Suggested routes 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 3.8, close to "Very acceptable".

### 4.1.6   Discussion

VTS operators often stress the need to have voice communication with vessels in order to assess their competence and alert level. It is referred to as a question of trust. Moving away from voice communication to a text or graphical interface would endanger this risk mitigation method. However what was found in this test was that VTS used both methods. Both voice communication over VTS to prepare the vessel for the route suggestion coming up, and the

graphical interface to send the route in an unambiguous format. By that unnecessary VHF traffic was avoided freeing up channel space at the same time as misunderstandings was avoided.

In the case of ships approaching port with pilot onboard, the Suggested route service facilitates bringing the ships master into the loop as it will be more obvious to him what suggestions from the VTS to the ship means. VTS communicating with the pilot suggesting to use "Sunk Dredged Channel" might mean nothing to a master new to the area, and the pilot might be too occupied with navigating to give the captain a full update on what the change in plans might mean.

The importance of the ship being in control and the master having the final word was also stressed for the Suggested route service. A suggested route received from the VTS must always be checked for UKC before a voyage plan is changed. Probably this should be an automatic feature of the ECDIS which always should warn if the UKC is too small.

The legal implications of a suggested route was brought up several times and needs to be clear; if the VTS sends out a suggested route that leads to an accident, who is then responsible? There was some discussion where it was argued that there was no difference from today: if a route is suggested graphically by a path send to the ECDIS or verbally by VHF, it is still the captain on the ship that has to take the final decision. And a graphical representation is less bound to cause misconceptions.

### 4.1.7   Conclusions

The Suggested routes concept was considered a valuable concept. Voice VHF communication together with graphical depiction directly on the chart system would be a way of mitigating misunderstandings and reducing unnecessary VHF use.

## 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 as described above.

During the demonstrations with Pride of Hull and Humber VTS the Tactical Route Suggestion service was used via the Maritime Cloud. Route suggestions were sent from VTS Centre to vessel via the Maritime Cloud without any problems. Even on a very slow connection (see below).
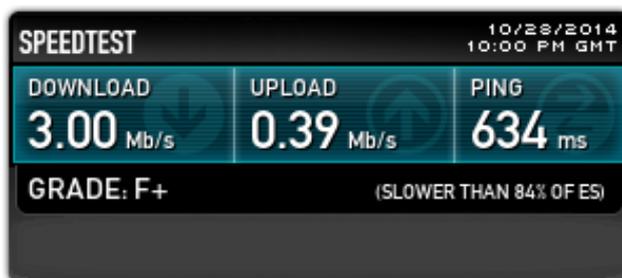


**Figure 17: The general throughput of the internet connection used during the demonstrations was tested. Note the download/upload, response time and that the service gets a poor grade. The download speed is decent, but shared across the entire ship. The upload speed is ~10 times slower.**

# Annex A     Tactical Route Suggestion MSDL

The Tactical Route Suggestion service is defined by three MSDL files:

### ROUTE.MSDL

```
namespace dma.route;

/** The heading of each leg. */
enum HeadingType {
    RHUMB_LINE = 1;
    GREAT_CIRCLE = 2;
}

/** A route leg. */
message Leg {
    /** The speed over ground in knots. */
    1: double speed;

    /** Cross track starboard distance in meters. */
    2: double xtdStarboard;

    /** Cross track port distance in meters. */
    3: double xtdPort;

    /** The heading of the leg. */
    4: HeadingType headingType;

    /** The length of the navigational window in meters. */
    5: double navWindow;
}

/** A waypoint in a route. */
message Waypoint {

    /** The position. */
    1: position waypointPosition;

    /** The planned or estimated time of arrival at the waypoint position. */
    2: timestamp eta;

    /** The rate of turn of the waypoint. In degrees */
    3: double rot;

    /** The turn radius of the vessel. In nautical miles. */
    4: double turnRad;

    /** The waypoints outleg, will be null for the final waypoint. */
    5: Leg outLeg;
}

/** Route. */
message Route {
    /** A list of waypoints on the route . */
    1: list<Waypoint> waypoints;
    2: text routename;
}
```

## TACTICALROUTEENDPOINT.MSDL

```
namespace dma.route;

message TacticalRouteSuggestion{
        /** The route segment*/
        1: Route route;
        /** The transaction ID */
        2: int64 id;
        /** Text message included */
        3: text textMessage;
};

endpoint TacticalRouteEndpoint {

        void sendRouteSuggestion(
         1: TacticalRouteSuggestion suggestion
     );
}
```

## TACTICALROUTEREPLYENDPOINT.MSDL

```
namespace dma.route;

/** Status of the Route Segment Suggestion. */
enum RouteSegmentSuggestionStatus {
    PENDING = 1;
    ACCEPTED = 2;
    REJECTED = 3;
}

message TacticalRouteSuggestionReply{
        /** The transaction ID */
        1: int64 id;
        /** The answer status*/
        2: RouteSegmentSuggestionStatus status;
        /** Reply Text Message*/
        3: text replyText;
};


endpoint TacticalRouteReplyEndpoint {
        void sendRouteSuggestionReply(
         1: TacticalRouteSuggestionReply reply
     );
}
```