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1 Executive Summary

This document contains specifications of methods for evaluating services developed within the STM BALT SAFE project. The specifications were derived in close cooperation with the service developers and end-users to guarantee that the evaluation methods capture the possible effects of the solution and are feasible. Furthermore, the specifications are here defined ahead of the development of the services to be objective towards the services and to guarantee that data necessary for the some of the evaluations are captured in good time.

These specifications will be used in Activity 6.2 for analysing and evaluating the BaltSafe services.
2 Introduction

STM BALT SAFE (BaltSafe) is an Interreg project lead by the Swedish Maritime Administration with participants all around the Baltic Sea. The main objective of the project is to improve the safety and efficiency of tanker shipping and marine traffic through Sea Traffic Management, STM, solutions.

Three work packages within the BaltSafe project will develop new solutions based on the existing STM infrastructure: Work Package 3, on-board solutions; Work Package 4, VTS solutions, and Work Package 5, ship reporting solutions. Each of the solutions developed by the work packages will be independently and objectively analyzed, verified and evaluated by Work Package 6.

Verification, validation, and evaluation are commonly understood differently by different actors. For clarity, the following definitions will be used henceforward:

- **Verification** – determine whether the system meets the specified functional and safety requirements. Simply expressed: determine if the system is built right according to the specification.

- **Evaluation** – determine whether the use of the system results on the desired effects. Simply expressed: determine if the right system is built.

- **Validation** – same as evaluation.

This document contains specifications of methods for analysing and evaluating the to-be-developed services. The specifications were derived by describing and analysing a use-case for each of the services. Section 3 presents a description of the use-case analysis as technique for eliciting requirements and effects. Section 4 presents the evaluation method specifications for each of the use cases or solutions. The actual analyses and evaluations of the services will be performed in Activity 6.2.
3 Use-case analysis

A use-case is a description of how a solution is used to achieve a goal for a user. Use cases clarify what the solution will and will not do and illustrate the value the solution provides to the user. By analyzing the use-case of solution, one can elicit the functional and safety requirements necessary to build or develop the solution, as well as the value of the solution in terms of observable effects. The elicited requirements and effects can then be used to for verifying and validating the solution respectively.

3.1 Implementation in STM BALT SAFE

The service developers were prompted to define the use-cases with the following fields and documented individually:

- Background
- Testbed
- Ships
- Services
- Assumptions
- Frequency
- Actors
- Triggers
- Pre-conditions
- Post-conditions
- Normal flow
- Alternate flows
- Summary

As the use-case documents are not finalised and will be continuously developed as the solutions are developed; there are some uncertainties related to the evaluation. However, the background and the expected effects of the solution on tanker shipping and marine traffic in the Baltic Sea are believed not to change.
4 Evaluation method specifications

A use-case was defined for each of the services to-be-developed within the STM BALT SAFE project. From the use-cases effects that the solutions are expected to have on tanker shipping and marine traffic in the Baltic were elicited. Overall, four general methods were identified as suitable for analyzing the effect of the solutions:

- **Adoption and usage analysis** – For some of the solutions it can be argued that just using the solution correctly has a positive effect on safety and efficiency. Therefore, for those solutions, an adoption and usage analysis aimed at determining whether the solutions are used and used correctly is a suitable evaluation method.

- **Traffic analysis** – Some of the solutions are expected to have clearly observable effects on marine traffic. Therefore, for those solutions, a traffic analysis based on historical AIS data to detect those effects is considered a suitable evaluation method.

- **Questionnaires and Human Performance analysis** – All of the solutions are expected to have an effect on the end users, such as reducing the mental workload or improving the situational awareness. For those solutions questionnaires regarding the expected effects of the solution and general impressions of it, as well as human performance analyses are considered suitable evaluation methods.

- **Hazard Identification (HAZID)** – Nearly all the solutions are expected to have an effect on navigation safety. Positive effects on hazards can be seen as risk reducing measures while negative effects on safety could be the result of hazards introduced by the solutions. Ideally, the safety requirements elicited from the use-cases should lead to the implementation of hazard controls in the solutions. However, to objectively evaluate the safety of the solutions a HAZID will be performed on the final solutions.

The following subsections present the evaluation method specifications for each of the use cases. The specifications include more detailed descriptions of the evaluation methods.

4.1 WP3 UC1 Ship-to-ship route exchange via AIS

4.1.1 Problem background

A ship-to-ship collision is an unacceptable event in marine traffic as its occurrence is a threat to life, property, and the environment. Bridge teams use a wide range of information from several sources to predict the future traffic situation and prevent close quarter situations. Ideally, the information should be easily accessible, up-to-date, clear, and sufficiently detailed to enable timely and correct predictions. In the past couple of decades, the overall quality of the information available to the bridge team has improved dramatically thanks to the adoption of electronic navigational charts and AIS. The former has improved the determination of the current and future position of a ship, while the latter has improved the awareness of the presence of other ships and their current movements. Nevertheless, neither of these systems, nor radar, complements or replaces VHF radio as the sole source of direct information for the future movements of a ship; bridge teams must call said ship through VHF radio and
ask about their planned route or intentions. Unfortunately, future movements or intentions communicated through VHF radio are not easily accessible, clear, easy to communicate, or detailed.

4.1.2 STM BALT SAFE Solution

Ship to Ship Route Exchange (S2SREX) is a technical solution for broadcasting a ship’s route to other ships in its vicinity through AIS. This technical solution was developed in the STM Validation project with the purpose of facilitating the avoidance of close quarter. When used properly, it provides easily accessible, up-to-date, clear, and detailed information about the future movements of a ship. As part of the STM Validation project, a group of vessels were equipped with S2SREX and its functionality tested in the project’s testbed.

The STM BALT SAFE continues the testing of the S2SREX functionality. The project’s testbed spans the entire Baltic Sea region (i.e. from the waters east of Denmark to the Gulf of Finland and the bay of Bothnia) and increases the number of S2SREX-equipped vessels. The STM BALT SAFE project focus specially on tankers and their traffic between Finland and Estonia.

4.1.3 Possible effects of the solution

Safety

- Reduced number of Close Quarter Situations (CQS) avoidance manoeuvres between STM ships using S2SREX – due to accessible, clear, and detailed information of the ships’ future movements.

- Increased or decreased distance between STM ships when sailing – due to accessible, clear, and detailed information of the ships’ future movements.

- Increased or decreased traffic misinformation – depending on the percentage of STM ships that share their routes and how well they follow them.

- Decreased VHF radio communication between STM ships using S2SREX – due to access to each other’s route.

4.1.4 Evaluation methods

4.1.4.1 Adoption and usage analysis

This quantitative evaluation consists of an analysis of the adoption and usage of the S2SREX solution. The data for the analysis will be ship tracks and broadcasted routes of a random sample of STM ships within a period of 3 months. From the data, the following indicators will be calculated:

- Ship usage: the percentage of the total sailing time in which an STM ship broadcasts its route.

- Ship congruence: the percentage of an STM ship’s tracks that are within an area defined by its broadcasted routes and a cross-track error.
- Total usage: the percentage of the total sailing time of all STM ships in which they broadcast their routes.

- Total congruence: the percentage of the sum of all the STM ship tracks that are within areas defined by the ships’ broadcasted routes and a cross-track error.

Ship usage and congruence will be used to find trends in adoption and usage of the S2SREX solution. Total usage and total congruence will be used to draw conclusions about the effect of the S2SREX solution on traffic misinformation as shown in Table 4-1. The threshold values of 75% and 25% may be adjusted depending on the result of the interviews described in section Fel! Hittar inte referenskälla.

Table 4-1 Interpretation of the total usage and total congruence indicators

<table>
<thead>
<tr>
<th>Total congruence</th>
<th>Above 75%</th>
<th>Below 75%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Neutral</td>
<td>Decreased traffic misinformation</td>
</tr>
<tr>
<td></td>
<td>Increased traffic misinformation</td>
<td>Increased traffic misinformation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Below 25%</th>
<th>Above 25%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total usage</td>
<td></td>
</tr>
</tbody>
</table>

4.1.4.2 Traffic analysis

This quantitative evaluation method consists of an analysis of the behavior of STM ships when meeting other ships. The data for the analysis will be ship tracks of STM ships when navigating at less than 20 nautical miles from another ship and within a defined geographical region with crossing traffic. The data will be sorted into one of two scenarios taking care to not double count:

- Null scenario: None of the ships within 20 nautical miles of the STM ship are STM ships.

- STM scenario: At least one of the ships within 20 nautical miles of the STM ship is an STM ship.

The following indicators will be calculated for each scenario:

- Percentage of tracks with CQS avoidance maneuvers: determined by identifying the percentage of tracks in the scenario where the STM ship performs a maneuver that is not a turn.

- CPA mode statistic: calculated from the set of the minimum CPAs between the analyzed STM ships and all other ships every minute throughout each track in the scenario.
Table 4-2 and Table 4-3 present synthetic results for the indicators. The indicators will be interpreted as follows:

- If the STM scenario has a smaller percentage of tracks with CQS avoidance maneuvers the result will be interpreted as an indication of a reduction on the number of CQS avoidance manoeuvres between STM ships using S2SREX.

- If the STM scenario has a smaller CPA mode statistic the result will be interpreted as an indication of a decrease in the distance between STM ships when sailing.

Table 4-2 Synthetic results for the number of tracks in each scenario containing or not a CQS avoidance manoeuvre and the percentages.

<table>
<thead>
<tr>
<th>CQS avoidance maneuver</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Null scenario</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of tracks</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with CQS avoidance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>manoeuvres</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3/(3+4)*100% = 42.8%</td>
<td>1/(1+2)*100% = 33.3%</td>
</tr>
</tbody>
</table>

Table 4-3 Synthetic results for the CPA mode statistic indicator.

<table>
<thead>
<tr>
<th>CPA mode statistic</th>
<th>Null scenario</th>
<th>STM scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 nm</td>
<td>1 nm</td>
</tr>
</tbody>
</table>

4.1.4.3 Questionnaires and human performance

One of objectives of the questionnaire will be establishing if the crew considers that the S2SREX leads to decreased VHF radio communication between STM ships using S2SREX.

4.1.4.4 HAZID – Hazard Identification

A HAZID will be carried out for this solution.
4.2 WP3 UC2 BIMCO STM clause for voyage charter parties

4.2.1 Problem background

Currently, voyage-chartered vessels are contractually obligated to arrive without unreasonable delay to a stipulated arrival location within the confines of a port. This contractual obligation leads to “run and wait” operations: chartered vessels sail as fast as possible just to wait on-turn for a berth at the port if none is immediately available even though the congestion at the berth was known apriori.

In some charter voyages, anchoring is the “waiting” part of the “run and wait” practice. Mainly, anchoring implies that the ship could have sailed at slower speed to save fuel, avoided emissions and arrived later when a berth at the port is available. Overall, anchoring outside a port is undesirable as it may lead or contribute to some of the following:

- Loss of profit for the shipowner or charterer due to delay or off-hire time.
- Release of emissions and pollutants close to shore.
- Collision while maneuvering to/from anchorage.
- Grounding.
- Reduction of the aesthetic value of the coastal vista.
- Minor effects are e.g. Loss or damage of anchor and anchor windlass, disruption and/or damage of the seabed due to anchor drop and chain drag, reduction marine species from their habitat, introduction of marine pests, exploding anchor windlass, piracy attack on anchor.

4.2.2 STM BALT SAFE Solution

To reduce the costs, emissions, and anchoring time associated with “run and wait” operations, shipowners and charterers developed the virtual arrival concept. In this concept, a vessel is given a reserved time slot for loading and/or unloading by a port. The virtual arrival concept received support from BIMCO in form of the Virtual Arrival Clause. BIMCO's Virtual Arrival Clause allows the adjustment of the speed of a chartered vessel to arrive at a loading or discharging point at Requested Time of Arrival (RTA). BIMCO’s STM Clause is distinct from, and does not supersede, or replace BIMCO's Virtual Arrival Clause. BIMCO’s STM Clause is a virtual arrival clause with features that make information received through STM services contractually binding.

4.2.3 Possible effects of the solution

Safety

- Reduced exposure to anchoring related incidents – due to reduction or elimination of anchoring.
**Efficiency**

- Increased or reduced profits – due to reduction of waiting time.
- Increased or reduced fuel consumption – due to slow steaming.
- Reduced communication time – due to the use STM messages to communicate RTA.
- Increased workload for agents to coordinate just-in-time arrivals

**Environment**

- Reduced environmental impact related to anchoring – due to reduction or elimination of anchoring.
- Increased or reduced air emissions – due to slow steaming.

4.2.4 Evaluation methods

4.2.4.1 Traffic analysis

This quantitative evaluation method consists of a comparison of the anchoring times between two scenarios for one or several ports during a period of 3 months:

- **Null scenario** – Voyage chartered STM ships visit the port before it enables virtual arrival (with berth occupied at arrival as pre-condition).

- **STM scenario** – Voyage chartered STM ships visit the port after it has enabled virtual arrival and have BIMCO’s Virtual Arrival clause or BIMCO’s STM clause in their charter parties.

The anchoring times for each of the ships will be calculated from AIS ship tracks and used to generate a distribution of the anchoring times for each scenario. From each distribution the median anchoring time will be determined and interpreted as follows:

- If the STM scenario has a smaller median for the anchoring time the result will be interpreted as an indication of a *reduction of environmental impact related to anchoring* and *a reduction of exposure to anchoring related incidents*.

4.2.4.2 Questionnaires and human performance

Central objectives of the questionnaire will be establishing if the ship owners consider that BIMCO’s Virtual Arrival clause or STM clause:

- Increased or reduced profits.
- Increased or reduced fuel consumption and the associated air emissions.

4.2.4.3 HAZID

A HAZID will be carried out for this solution.
4.3 WP3 UC3 Estonian icebreaker service

4.3.1 Problem background

The Estonian Maritime Administration ensures that all ship traffic bound from and to Estonian ports is served by icebreakers in the event of ice-covered waterways. Currently, icebreaking assistance is requested by the ships’ agents through an online portal, where the icebreaking service coordinator approves or denies the request. If approved, depending on the ice situation, the ships requesting assistance receive either a location to meet with the icebreaker (aka. meeting point or rendezvous point), waypoints to follow (aka. dirways), or a route through the ice-covered waterway (aka. ice-route). These types of ice navigation information are created by the Estonian icebreakers and communicated to the ships in one of two possible flows (see Figure 4-1). Most commonly, the communication is done by email through the icebreaking service coordinator and the ship’s agent, but occasionally, it is done through the VTS operator by radio or a combination of radio and email to save time.

From an operational perspective, information should be concise and up to date, as well as communicated easily, without errors, and confirmed. Whether or not this is the case depends on the source of the information and the communication flow from the source to the recipient. Communication flows with intermediaries, difficult or time-consuming methods, or both, are likely to influence how often is updated information communicated, how timely does the recipient receives it, and how accurate it is. Both current communication flows of the Estonian icebreaking service contain intermediaries and time-consuming methods.

Communication through the icebreaker coordinator relies solely on email and has two intermediaries. Email is a method for communicating written messages and digital files through the internet. The messages (i.e. emails) are free of transmission errors and typically reach the recipients in seconds. These characteristics are very convenient; however, one does not generally receive confirmation that the recipient has received or read the message. To receive such confirmations, the sender and the receiver must both have email systems that allow such functionality and the sender must enable the request when composing the message. Furthermore, because email is such an intensively used communication method, emails can be easily overlooked or forgotten. Every intermediary is a potential source of error or delay.

Communication through the VTS operator relies on radio or an email and radio combination and has one intermediary. Radio is a method of communicating voice messages in real time through a common radio channel. The voice messages can easily be difficult to understand or misunderstood due to background noise or accent, and therefore, closed loop communication is usually the norm. Nevertheless, transmission errors do occur. Furthermore, radio is time consuming method for communicating ice navigation information as it requires the reading and confirmation of several long sequences of numbers. As with email, every intermediary is a potential source of error or delay.

Overall, both communication flows would benefit of removing intermediaries and substituting the communication methods for one that is easy, near immediate, without errors, provides confirmation, and is suitable for communicating ice navigation information.
Current Information Flow

4.3.2 STM BALT SAFE Solution

As part of STM BALT SAFE (Work Package 3,) the Estonian VTS software and two Estonian icebreakers (Botnica and Eva-136) will be made STM compatible, enabling them to communicate ice navigation information through the STM tools: route exchange and STM messages. Regarding the communication of ice navigation information, the key advantages of STM tools are:

- Easier, faster, and transmission error free communication – The STM tools transmit text and RTZ files over the internet and do not involve exporting and attaching RTZ files or dictating several number sequences over the radio.
- Confirmation feedback – The STM tools automatically confirm the delivery of the message.

Figure 4-2 presents the future information flows that the STM compatibility will enable. First, the icebreaker will communicate with the VTS operator and the icebreaking service coordinator through STM tools. This change will reduce the overall time, errors, and work necessary to communicate ice navigation information from the icebreaker to any ship. Potentially, because the STM tools make communication easier, the icebreaker may update the information it communicates more often and in higher detail (i.e. better and more up-to-date information). An example of this would be communicating to a ship not only the meeting point, but also the ice-route to be followed.
Second, the STM tools will be an additional method of communication between STM compatible ships and the VTS operator or icebreaking service coordinator. When used, this method will further reduce the overall time, errors, and work necessary to communicate ice navigation information from the icebreaker to an STM ship.

**Future information Flow**

![Diagram showing information flow between STM Icebreaker, VTS operator, Icebreaking service coordinator, STM Ship, Ship, Agent, and STM.

Figure 4-2 Future information flows for the communication of ice navigation information enabled by STM compatibility. Double arrow lines indicate confirmation of message delivery.]

### 4.3.3 Possible effects of the solution

**Safety**

- Reduced possibility miscommunication – by relying more in STM tools and less on radio and email.

- Improved situational awareness / shared picture – by increasing the communication of detailed ice navigation information.

**Efficiency**

- Reduced workload – by relying more in STM tools and less on radio and email.
4.3.4 Evaluation methods

4.3.4.1 Adoption and usage analysis

This quantitative evaluation consists of an analysis of the adoption and usage of the STM communication solutions. The before and after instances are the winter of 2019/20 and 2020/21 respectively, and the indicators are the following:

- The percentages of ice-routes, dirways, and meeting points communicated by the icebreakers in one icebreaking season.

- The percentage of ice navigation information communicated by radio, email, and STM tools to ships in one icebreaking season.

Table 4-4 and Table 4-5 present synthetic results and Table 4-6 a synthetic example of the captured data. The indicators will be interpreted as follows:

- An increase in the percentage of detailed ice navigation information (i.e. dirways and ice-routes) will be interpreted as indicator of improved situational awareness.

- A decrease in the percentage of ice navigation information communicated by radio or email will be interpreted an indicator of reduced possibility of miscommunication and an indicator of reduced workload.

Table 4-4 Synthetic results for the percentages of ice-routes, dirways, and meeting points communicated to ships before and after the intervention.

<table>
<thead>
<tr>
<th></th>
<th>Meeting points</th>
<th>Ice-routes</th>
<th>Dirways</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>80.00%</td>
<td>4.00%</td>
<td>16.00%</td>
</tr>
<tr>
<td>2020</td>
<td>71.60%</td>
<td>8.40%</td>
<td>20.00%</td>
</tr>
</tbody>
</table>

Table 4-5 Synthetic results for the percentages of ice navigation information communicated by radio, email, and STM tools to ships before and after the intervention.

<table>
<thead>
<tr>
<th>Information type</th>
<th>Channel</th>
<th>2019</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meeting points</td>
<td>Radio</td>
<td>21.50%</td>
<td>12.85%</td>
</tr>
<tr>
<td></td>
<td>Email</td>
<td>78.50%</td>
<td>65.36%</td>
</tr>
<tr>
<td></td>
<td>STM</td>
<td>0.00%</td>
<td>21.79%</td>
</tr>
<tr>
<td>Ice-routes</td>
<td>Radio</td>
<td>30.00%</td>
<td>4.76%</td>
</tr>
<tr>
<td></td>
<td>Email</td>
<td>70.00%</td>
<td>90.48%</td>
</tr>
<tr>
<td></td>
<td>STM</td>
<td>0.00%</td>
<td>4.76%</td>
</tr>
<tr>
<td>Dirways</td>
<td>Radio</td>
<td>12.50%</td>
<td>6.00%</td>
</tr>
<tr>
<td></td>
<td>Email</td>
<td>87.50%</td>
<td>72.00%</td>
</tr>
<tr>
<td></td>
<td>STM</td>
<td>0.00%</td>
<td>22.00%</td>
</tr>
</tbody>
</table>
### Table 4-6 Synthetic example of captured data. (MP: meeting point, DW: dirways, IR: ice-route)

<table>
<thead>
<tr>
<th>ID</th>
<th>Ship MMSI</th>
<th>datetime</th>
<th>method</th>
<th>type</th>
<th>stm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2322234</td>
<td>30/11/2019 03:00</td>
<td>Route</td>
<td>MP</td>
<td>FALSE</td>
</tr>
<tr>
<td>1</td>
<td>7723234</td>
<td>30/11/2019 07:00</td>
<td>STM</td>
<td>IR</td>
<td>True</td>
</tr>
<tr>
<td>2</td>
<td>102344</td>
<td>01/12/2019 02:00</td>
<td>Email</td>
<td>DW</td>
<td>FALSE</td>
</tr>
</tbody>
</table>

#### 4.3.4.2 Questionnaires and human performance

Questionnaires regarding the effects of the STM BALT SAFE Solutions will be sent to the icebreaking service providers (i.e. icebreaker crew, icebreaking service coordinator, VTS operators) and service receivers (i.e. crews on STM and non-STM ships). Central objectives of the questionnaires will be to determine if the recipients consider that the STM communication solutions:

- Reduced possibility for miscommunication
- Improved situational awareness / shared picture
- Reduced workload

#### 4.3.4.3 HAZID

A HAZID will be carried out for this solution.

### 4.4 WP4 UC1 Close quarter situation predictor

#### 4.4.1 Problem background

While not all Close Quarter Situations (CQS) between ships result in a collision, all collisions start as a close quarter situation. Therefore, CQS are undesirable from a safety perspective. Unfortunately, collisions are difficult to predict due to the inherent lack of knowledge regarding the future movements or intentions of ships.

#### 4.4.2 STM BALT SAFE Solution

As part of the STM BALT SAFE project, a CQS monitoring function based on STM’s VIS will be implemented on VTS software. The function will predict CQS between STM ships by inspecting their shared voyage plans against a set of CQS definitions. The set of CQS definitions will enable the VTS operator to define CQS differently considering the size of the ships and their location (e.g. open water, fairway).

#### 4.4.3 Possible effects of the solution

**Safety**

- Improved prediction and monitoring of possible CQS.
- Decreased time predicting and monitor CQS.
4.4.4 Evaluation methods

4.4.4.1 Questionnaires and human performance

Questionnaires regarding the effects of the STM BALT SAFE Solutions will be given to the VTS operators. Central objectives of the questionnaires will be establishing if the VTS operators consider that the CQS predictor:

- Improved their prediction and monitoring of possible CQS.
- Decreased the time predicting and monitoring possible CQS.

4.4.4.2 HAZID

A HAZID will be carried out for this solution.

4.5 WP4 UC2 Cross-track error alarm

4.5.1 Problem background

A ship’s deviation from its route can be voluntary or involuntary. Involuntary deviations may occur due to a variety of reasons, such as tiredness or substance abuse, and are always undesirable. Currently, it is difficult for VTS operators to identify involuntary deviations. To do so, the operator must first identify the event as a suspicious behaviour, and that can only happen when the vessel grossly deviates from what the operator considers a normal route.

4.5.2 STM BALT SAFE Solution

As part of the STM BALT SAFE project, a cross-track error alarm function based on STM’s VIS will be implemented on VTS software. The function will raise an alarm when the cross-track error of an STM ship against its shared voyage plan exceeds the cross-track error in the route or a value determined by the VTS operator.

4.5.3 Possible effects of the solution

Safety

- Improvement in the detection or time to detection of involuntary deviations from the planned route.

4.5.4 Evaluation methods

4.5.4.1 Questionnaires and human performance

Questionnaires regarding the effects of the STM BALT SAFE Solutions will be given to the VTS operators. One central objective of the questionnaires will be establishing if the VTS operators consider that the cross-track error alarm improves the detection of involuntary deviations from the planned route.

4.5.4.2 HAZID

A HAZID will be carried out for this solution.
4.6 WP4 UC3 Route proposals

4.6.1 Problem background

Occasionally, VTS provide informal navigational assistance, where the VTS operator clarifies to a ship how it should navigate in the fairway by, for example, pointing out buoys. This type of assistance is done through radio and therefore, time consuming, prone to errors, and occasionally demanding due to language and tiredness.

4.6.2 STM BALT SAFE Solution

As part of the STM BALT SAFE project, a function for sending route proposals will be implemented in the VTS software. VTS operators will be able to send complete voyage plans to STM ships, as well as to suggest modifications to the voyage plans shared by STM ships.

4.6.3 Possible effects of the solution

Safety
- Improved navigational assistance – by providing clear and detailed navigational assistance through a STM route proposal instead of through VHF radio.

Efficiency
- Reduced workload – by providing less navigational assistance through radio and more as a STM route proposal.

4.6.4 Evaluation methods

4.6.4.1 Questionnaires and human performance

Questionnaires regarding the effects of the STM BALT SAFE Solution will be given to the VTS operators. One central objective of the questionnaires will be establishing if the VTS operators consider that the route proposals solution improves navigational assistance.

4.6.4.2 HAZID

A HAZID will be carried out for this solution.

4.7 WP4 UC4 Forbidden meetings

4.7.1 Problem background

Preventing traffic congestion or meetings at areas deemed unsafe is an effective way of preventing grounding and CQS. Currently, predicting the future presence of two or more ships in an unsafe area is done by the VTS operator with or without the aid of a traffic prediction system. In both cases, the prediction takes time and attention from the VTS operator.

4.7.2 STM BALT SAFE Solution

As part of the STM BALT SAFE project, a function for predicting forbidden (inappropriate) meetings of two or more STM ships in an unsafe area will be
implemented in the VTS software. The function will be based on STM’s VIS and will perform the prediction automatically. The goal of this solution is to improve the detection and facilitate the prevention of meetings or congestion in predefined areas.

4.7.3 Possible effects of the solution

Safety

• Improved prediction and monitoring of forbidden meetings.
• Decreased time predicting and monitoring forbidden meetings.

4.7.4 Evaluation methods

4.7.4.1 Questionnaires and human performance

Questionnaires regarding the effects of the STM BALT SAFE Solutions will be given to the VTS operators. Central objectives of the questionnaires will be establishing if the VTS operators consider that the forbidden meetings predictor:

• Improved prediction and monitoring of forbidden meetings.
• Decreased time predicting and monitoring forbidden meetings.

4.7.4.2 HAZID

A HAZID will be carried out for this solution.

4.8 WP4 UC5 Automated route cross-check

4.8.1 Problem background

Preventing grounding and risky situations can be accomplished by checking the planned route of a vessel considering the vessel’s dimensions and draft, as well as the depth and contours of the fairway. Currently, VTS services do not have the capacity to cross-check a ships route.

4.8.2 STM BALT SAFE Solution

As part of the STM BALT SAFE project, STM’s VIS will be implemented in VTS software and coupled to an algorithm for crosschecking the vessel’s route considering the vessel’s dimensions and draft, as well as the depth and contours of the fairway. By doing automatically, the vessel receives positive feedback about its route without direct communication with the VTS operator.

4.8.3 Possible effects of the solution

Safety

• Improved navigation information – by providing clear and detailed feedback about the voyage plan though STM’s VIS.
4.8.4 Evaluation methods

4.8.4.1 Adoption and usage analysis

This quantitative evaluation consists of an analysis of the adoption and usage of the automated route cross-check. The data for the analysis will be the route feedback sent by the VTS to the STM ships within a period of 3 months. From the data, the following indicators will be calculated:

- **Corrections percentage**: the percentage of the total cross-checked routes that are not approved by the VTS and for which hazards are sent.

Corrections percentage will be used to draw conclusions about the effect of the automated route cross-check solution on improved navigation information. High percentages combined with positive feedback from the questionnaires will be interpreted as an indication of improved navigation information.

4.8.4.2 Questionnaires and human performance

Questionnaires regarding the effects of the STM BALT SAFE Solutions will be given to the VTS operators. Central objectives of the questionnaires will be establishing if the VTS operators consider that the automated route cross-check function is a better source of navigation information from the VTS.

4.8.4.3 HAZID

A HAZID will be carried out for this solution.
4.9 WP5 UC1-3 Automated ship reporting

4.9.1 Problem background

A ship’s master has the obligation of reporting to national and international authorities under certain conditions. Complying with this obligation is commonly referred to as *ship reporting*. Traditional ship reporting is commonly considered to be taxing, cumbersome, and error prone, as it requires a great deal of time and attention from the ship master due to the large number of unharmonized paperwork. To remedy this and other situations regarding information, IMO introduced the e-navigation Strategy Implementation Plan. The plan describes five solutions, out of which “Means for standardized and automated ship reporting” is directly connected to ship reporting.

4.9.2 STM BALT SAFE Solution

As part of the STM BALT SAFE project, automated ship reporting tools will be implemented through STM maritime connectivity platform. The solution will determine automatically the reporting obligations based on the ship’s voyage plan and the necessary information, prompt the user to supply only missing or necessary information, and finally for request approval of the reports.

4.9.3 Possible effects of the solution

*Efficiency*

- Reduction of the workload or effort necessary for ship reporting.
- Reduction on administrative burden of ship reporting.

4.9.4 Evaluation methods

4.9.4.1 Questionnaires and human performance

Questionnaires regarding the effects of the STM BALT SAFE Solutions will be given to the VTS operators. Central objectives of the questionnaires will be establishing if the VTS operators consider that the automated ship reporting function:

- Reduces the effort or workload of ship reporting.
- Reduces the administrative burden of ship reporting.

4.9.4.2 HAZID

A HAZID will be carried out for this solution.
5 References

The use case evaluation methods are based on the following documents:

Document No: draft Title: Rout exchange Ship – Ship via AIS Use Case No: 1 WP3 Date: 24/09/2019

Document No: draft, WP 3 Estonian icebreaker service Use Case No: 2 WP 3 Date: 13/11/2019

Document No: draft No2 Title: BIMCO STM-clause for voyage Charterparties Use Case No.: 3.WP3 Date: 25/10/2019

Document No: BS_WP4.1 Title: Report on the operational concept of STM compatible VTS services Date: 15.01.2019

Document No: BS_WP4. Title: User Stories WP4 Date: 28.10.2019

Presentations: Usecase CloseQuarters, Usecases as of September 2019

Document No: draft Work package 5, Ship Reporting Services Title: OUTPUT 5.1 Use case, processes and data formats for automated ship reporting Date:xx/xx/2019

Document No: 1.0 Work package 5, Ship Reporting Services Title: OUTPUT 5.2 Automatic Ship Reporting -pre-study and concepts document including Use Cases Date: 01/11/2020
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