TEN-T PROJECT NO: 2014-EU-TM-0206-S

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EXECUTIVE SUMMARY

The mission of Activity (ACT) 5 in the frame of the Sea Traffic Management (STM) Validation project is to facilitate the validation of the proposed STM services. The objective of this document is to summarize the methods and results of Sub-Activity 5.5 M24 STM Operational Aspects. This report closes project’s milestone 24.

The STM concept sets focus upon enabling safe, sustainable and efficient sea transports and having that goal, STM becomes one response to the overall need to increase efficiency in operations within and between ports. The concept takes a holistic approach to operational services, putting the berth-to-berth voyage in focus. Further, it uses “the voyage as a core element for process optimization, actors and stakeholder interaction and information sharing”. (ML2, 2015) One of the overall ideas with the STM concepts is to meet the user’s information needs and by that increase the situational awareness.

In order to structure the operational aspects, the concept is divided into three sub-concepts or strategic concepts, based on different views on a ship’s voyage. The strategic concepts are implemented by a number of operational services. Some of the services exist already today but are enhanced further with an increased exchange of information, whilst some are new. These services need to be considered in the operational environment, changing some of today’s procedures and work. Hence, when introducing the STM concept, some current operational procedures on-board and ashore might need to be updated. These new services also imply a need for additional training.

The overall operational idea with the STM concept is to support the ship’s voyage through all navigation phases with interoperable services. These services are built on an enhanced information exchange between ship and shore and give new possibilities for assistance of ships en-route. The strategic enablers of STM (PortCDM, Strategic Voyage Management, Dynamic Voyage Management, Flow Management and SeaSWIM) were defined to meet the user’s information needs, collaborative needs, and by that to increase the situational awareness. The effective implementation of these strategic concepts is carried out through a number of operational services. These services need to be considered in their real operational environment. Therefore, some operational procedures on-board or ashore might need to be updated, i.e. Bridge Standard Operational Procedures and VTS Operator procedures, based on the operational recommendations from this sub-activity.

The methodology used to perform such impact evaluation has consisted of data collection and discussions coming from those project activities dealing with testbeds i.e. ACT 1 PortCDM testbeds, ACT 2 Voyage Management testbeds and ACT 3 European Maritime Simulator Network testbeds. This approach includes both quantitative data (testbeds results) and qualitative information (interviews, questionnaires, actors’ reflections and stories), and the discussions of those results in the test bed activities. However, this data gives not enough statistical base for any strong conclusions but gives indications. Based on those results, operational aspects are discussed and operational recommendations are given. The outcome of this analysis and its operational implications together with recommendations for a successful future deployment are presented in this report. Below follows a short summary of the findings put forward in this report.

The proposed chat message function might be an efficient way of communication, as written messages may be easier understood than spoken ones and it will improve the traceability of the information flow. However, in contrast to VHF, chat messages would not allow the OOW (Officer of the Watch) to keep a proper look-out, navigate and communicate at the same time and it may be distracting for the navigator when misused. Also, information exchange, using chat messages may exclude other station to receive possibly important information, which would not be the case if VHF is used. The usage should focus on supporting other STM
functions and services, e.g. explaining and giving rationale for a route suggestion from a shore centre.

The ship-to-ship route exchange function would enhance situational awareness by anticipating potential traffic situations at long range. However, it may be difficult to use this function in tactical situation e.g. in dense traffic. It may generate misinterpretation of the monitored vs. followed route. Hence, it is important that its usage is regulated under bridge/safety/company procedures.

The new route suggestion function may reduce misunderstandings and the fact, that it is based on local knowledge/expertise, is highly appreciated by the OOW. Nevertheless, it may be time consuming to receive, check and approve or reject a suggested route.

Regarding the STM navigational warning service, it may allow faster access to the information than NAVTEX and will reduce workload, although it was noted that some usability issues should be improved.

There were generally positive comments about the STM pilot route service and its capacity to create a common operational picture between pilot and bridge team was highlighted, whilst in the case of the route cross check service, there is still room for improvement, related to the understanding of some specific ship’s characteristics, e.g. manoeuvring characteristics.

The enhanced monitoring service, performed by a VTS or other shore centres, enables the prediction of future critical navigation situations. It could increase the workload for the shore centre’s operator, based on the number of alarms received.

The STM winter navigation service was well received by the users with the potential of reducing the workload and enhancement of situational awareness in the context of ice navigation.

The positive aspects of the STM SAR (Search and Rescue) service is the provision of a holistic approach, resulting in a clear picture for ships/units involved, the improvement of cooperation between the RCC (Rescue Coordination Centre) and the VTS. However, additional information is required at the RCC for sending search pattern to vessel of opportunity (e.g. ship characteristics, ship data, etc.). This enhanced SAR service would need updates of SAR procedures and working praxis. It should be noted, that all ships, involved in a rescue operation, might not have STM compliant equipment.

Regarding PortCDM related services, a basis for information exchange among the stakeholders, including ships, has been developed, in the form of S-211 standardised message format. A new mind-set within ports is required to get ports to issue recommendations internally and externally. Port CDM would facilitate and enable this change within shipping and port operations.

The port call synchronisation service, interconnecting the ship with the port domain, may contribute to a reduction of the total turn-around-time through collaboration and data sharing as a driver for the ideal port call process. STM ships could share the voyage plan with different STM compliant ports in the same way through the same functionality.

The port call coordination and port call monitoring services have shown promise for making better estimates for getting access to multiple data sources, using indicators and warnings to ensure coordinated actions and achieving common situational awareness. However, ports should make efforts in the medium-long term to increase their PortCDM maturity, e.g. by adapting the PortCDM maturity model, in order to achieve these promising results.

Finally, it is important to stress, that each service or function implementation as operational procedure, would imply a need for additional training and familiarisation, as appropriate.
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1 INTRODUCTION

1.1 Scope and purpose
The mission of Activity (ACT) 5 in the frame of the Sea Traffic Management (STM) Validation project, hereafter denoted the project, is to facilitate the validation of the proposed STM services. The objective of this document is to summarize the methods and results of Sub-Activity (SA) 5.5 Operational Aspects. The purpose of SA 5.5 is to study an impact of STM on the operational aspects of shipping and port activities. The SA includes the following subtasks:

- Establish validation aspects of the STM concept, based on the vision of STM, the strategic enabling concepts descriptions, KPA, KPO and KPI. This is presented in this document, see chapter 3.
- Identify possible data sources, measurable parameters and observations. This is discussed in this document, see chapter 2.
- Follow the international developments, e.g. IMO, IALA, within with respect to STM and if possible, align the developments between the STM concept - e-navigation initiative. This is reported in SA 5.8 Concept of Operation Report, (STM, 2019)
- Support test bed activities in ACT 1, 2, and 3, with test objectives for operational aspects and parameters. That is not reported in this document.
- Establish validation results based on test bed results. This is reported in this document, see chapter 4, 5, and 6.
- Description of the operational services as a result of this document is summarised in SA 5.8 Concept of Operation Report, (STM, 2019)
- Based on validation results, give recommendations with respect to operational aspects of the operational services, see chapter 7.

The evolution of this report has included four versions illustrating the progress of the project:

- The first version of the document included table of contents, identification of operational parameters, and a first discussion of these parameters.
- The second version included a fully developed method chapter and a draft text regarding the operational parameters.
- The third version, was the first version of the final report, based on results from the testbeds and conducted analyses. That version introduced recommendations on how to develop the operational services from an operational perspective.
- The fourth version is the reviewed and approved final report.

1.2 Background
The STM concept sets focus upon enabling safe, sustainable, and efficient sea transports and having that goal, STM becomes one response to the overall need to increase efficiency in operations within and between ports. The concept takes a holistic approach to operational services by putting the berth-to-berth voyage in focus. Further, it uses “the voyage as a core element for process optimization, actors and stakeholder interaction and information sharing” (ML2, 2015). One of the overall ideas with the STM concepts is to meet the user’s information needs and by that increase the situational awareness.

In order to structure the operational aspects, the concept is divided into three sub-concepts or strategic concepts, based on different views on a ship voyage. The strategic concepts are implemented by a number of operational services. Some of the services already exist today but are enhanced further with an increased exchange of information whilst some are new.
These services need to be considered in the operational environment changing some of today’s procedures and work. Hence, some current operational procedures on-board and ashore might need to be updated when introducing the STM concept. These new services also imply a need for additional training.

The project has tested the STM concept in some large-scale test beds in which the potential benefits have been demonstrated. More specifically, ACT 1 (Port Collaborative Decision Making) and ACT 2 (Voyage Management) within their respective areas: port view and sea voyage view, and ACT 4 (Maritime Service Infrastructure) within the development of the information exchange platform. This together with, ACT 3 (European Maritime Simulator Network), which has been enhancing the European Maritime Simulation Network (EMSN), created in MONALISA 2.0, to make available the use of simulators to model complete situations that in real life cannot be performed in the test beds, facilitating new valuable evidences to complete the analysis.

1.3 Relation to other documents

This current document relates to other documents according to the Figure 1 below:

![Figure 1 Relationship to other documents](image)

This document, “STM Operational Aspects”, is based on the outcome of ACT 2 “STM Definition Phase” in the EU MONALISA 2.0 project. In this project the STM concept is validated and updated according to the test beds results. These are reported in a number of test beds reports from ACT 2, 3 and a Validation report from ACT 1. The operational aspects of the STM concept are discussed and reported in the current document. The SA 5.8 Concept of Operation Report then updates the STM concept of operation description, (STM, 2019).

1.4 Study logic

The SA 5.5 focuses on the operational aspects, which are identified in §3.3. This document makes uses of the discussions and results presented in ACT 1, 2 and 3. Based on those results operational aspects are discussed and operational recommendations are given. This study logic is depicted in Figure 2.
1.5 Structure of the document

To meet the scope and purpose outlined in §1.1, this document is structured as follows:

- **Chapter 1** defines scope and purpose, lists abbreviations and definitions.
- **Chapter 2** describes the methodology used in the data collection and analyses.
- **Chapter 3** discusses and identifies operational parameters and gives an operational description of the STM concept.
- **Chapter 4-6** discusses and summarises the results for the identified operational aspects.
- **Chapter 7** discusses operational recommendations.
- **Chapter 8** lists applicable and reference documents.

1.6 Delimitation

This report details some of the results from the projects test-beds. It should be noted that this is an innovation project meaning that needs of the users and the limits and opportunities of information technology when developing STM, has led to an innovation development in incremental steps. The discussions and analyses presented in this document is based on results and data collection presented in:

- ACT 2 Voyage Management Test Report (STM, 2019b); and
- ACT 3 EMSN Test Reports (STM, 2019c).

1.7 Abbreviations and definitions

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<td>Activity</td>
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<tr>
<td>AIS</td>
<td>Automatic Identification System</td>
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<td>BNWS</td>
<td>Baltic Navigational Warning Service (c.f. NWS)</td>
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<tr>
<td>COLREG</td>
<td>Convention on the International Regulations for Preventing Collisions at Sea</td>
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<td>Dir.Way</td>
<td>Directional Waypoints</td>
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<td>DVM</td>
<td>Dynamic Voyage Management</td>
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<td>EC</td>
<td>European Commission</td>
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<td>ECDIS</td>
<td>Electronic Chart Display and Information System</td>
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<td>EMSN</td>
<td>European Simulator Network</td>
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<td>ETA</td>
<td>Estimated Time of Arrival</td>
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<td>FM</td>
<td>Flow Management</td>
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<td>Acronym</td>
<td>Definition</td>
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<td>FOC</td>
<td>Fleet Operation Center</td>
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<td>HF</td>
<td>Human Factor</td>
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<td>HFO</td>
<td>Human Factor Observers</td>
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<td>IMO</td>
<td>International Maritime Organisation</td>
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<td>JRCC</td>
<td>Joint Rescue Coordination Centre (Air and Maritime RCC in Sweden)</td>
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<td>KPA</td>
<td>Key Performance Area</td>
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<td>KPI</td>
<td>Key Performance Indicator</td>
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<td>Key Performance Objective</td>
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<td>MRCC</td>
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<td>NPRS</td>
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<td>NRS</td>
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<td>NWS</td>
<td>Navigational Warning Service (c.f. BNWS)</td>
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<td>OOW</td>
<td>Officer of the Watch</td>
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<td>PortCDM</td>
<td>Port Collaborative Decision Making</td>
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<td>PRS</td>
<td>Pilot Route Service (c.f. NPRS)</td>
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<td>RCCS</td>
<td>Route Cress Check Service</td>
</tr>
<tr>
<td>RTA</td>
<td>Requested Time of Arrival</td>
</tr>
<tr>
<td>RDV</td>
<td>Rendez-Vous (STM-feature)</td>
</tr>
<tr>
<td>SA</td>
<td>Sub-activity</td>
</tr>
<tr>
<td>SAW</td>
<td>Situational awareness</td>
</tr>
<tr>
<td>SC</td>
<td>Shore Center</td>
</tr>
<tr>
<td>SCO</td>
<td>Shore Center Operator</td>
</tr>
<tr>
<td>SeaSWIM</td>
<td>Sea System Wide Information Management</td>
</tr>
<tr>
<td>SIP</td>
<td>IMO e-navigation, Strategic Implementation Plan</td>
</tr>
<tr>
<td>SRU</td>
<td>Search and Rescue Unit</td>
</tr>
<tr>
<td>STM</td>
<td>Sea Traffic Management</td>
</tr>
<tr>
<td>SVM</td>
<td>Strategic Voyage Management</td>
</tr>
<tr>
<td>S2SREX</td>
<td>Ship to Ship Route Exchange</td>
</tr>
<tr>
<td>TBC</td>
<td>To Be Confirmed</td>
</tr>
<tr>
<td>TBD</td>
<td>To Be Determined</td>
</tr>
<tr>
<td>TXT</td>
<td>Text</td>
</tr>
<tr>
<td>VDES</td>
<td>VHF Data Exchange Service</td>
</tr>
<tr>
<td>VHF</td>
<td>Very High Frequency</td>
</tr>
<tr>
<td>VM</td>
<td>Voyage Management</td>
</tr>
<tr>
<td>VOO</td>
<td>Vessel of Opportunity (SAR)</td>
</tr>
<tr>
<td>VP</td>
<td>Voyage Plan</td>
</tr>
<tr>
<td>VTS</td>
<td>Vessel Traffic Services</td>
</tr>
<tr>
<td>VTSO</td>
<td>VTS Operator</td>
</tr>
</tbody>
</table>
### 1.8 Terms and definitions

Table 1 List of terms and definitions used in this document.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of operation</td>
<td>A geographical area where a certain service can be provided</td>
</tr>
<tr>
<td>Critical area</td>
<td>A high-risk geographical area where ship traffic is allowed, but increased safety measures are taken as stringent safety margins</td>
</tr>
<tr>
<td>Dynamic No Go Area</td>
<td>A dynamic (in time and space) geographical area restricted or partially restricted for ships traffic</td>
</tr>
<tr>
<td>Flowpoint</td>
<td>Key waypoint for which ETA is used in Traffic Coordination</td>
</tr>
<tr>
<td>Function (or STM function)</td>
<td>A tool implemented in an STM compliant equipment that can be used by a user.</td>
</tr>
<tr>
<td>Information service</td>
<td>A technical service implementing exchange of information, fulfilling IALA, technical specification</td>
</tr>
<tr>
<td>Intended routes</td>
<td>A route that has reached status 8 according to the IEC 61174</td>
</tr>
<tr>
<td>Leg</td>
<td>A part between two waypoints in a route, typically consist of course and distance to sail.</td>
</tr>
<tr>
<td>Operational scenario</td>
<td>A set of operational services and functions meeting a common objective.</td>
</tr>
<tr>
<td>Pilot route</td>
<td>A predefined pilot route in a fairway or port approach</td>
</tr>
<tr>
<td>Route</td>
<td>The intended horizontal direction of travel with respect to the earth. The route is described in IEC 61174 by route information, route geometry and route schedule</td>
</tr>
<tr>
<td>Route plan</td>
<td>Detailed plan of the geometrical route together with route schedule.</td>
</tr>
<tr>
<td>Route exchange (ship-to-ship)</td>
<td>Next couple of waypoints along the ships planned route are broadcast by means of AIS/VDES to vessels in line of site</td>
</tr>
<tr>
<td>Ship</td>
<td>A vessel that is regulated by SOLAS</td>
</tr>
<tr>
<td>Shore center</td>
<td>“Vessel traffic service (VTS) - a service implemented by a Competent Authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and to respond to traffic situations developing in the VTS area.” (IMO, Resolution A.857(20)) All others are considered to be shore centers.</td>
</tr>
<tr>
<td>State</td>
<td>The stages of progress for an event divided into location states and service states</td>
</tr>
<tr>
<td>Static No Go Area</td>
<td>A static (over time and in space) geographical area where ship traffic is restricted or partially restricted</td>
</tr>
<tr>
<td>Strategical navigation</td>
<td>This phase covers aspects that affects the overall voyage or a large part of the voyage</td>
</tr>
<tr>
<td>Suggested or recommended route</td>
<td>A proposed change to the agreed geometrical route</td>
</tr>
<tr>
<td><strong>Suggested or recommended schedule</strong></td>
<td>A proposed change to the agreed route schedule</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td><strong>Tactical navigation</strong></td>
<td>This phase covers near-time aspects of the voyage. This can be a time span of several hours down to less than an hour</td>
</tr>
<tr>
<td><strong>Time stamp</strong></td>
<td>The combination of a time type (Actual, Estimated, Targeted, Cancelled, or Recommended) and a state as specified in (PCMF, 2017)</td>
</tr>
<tr>
<td><strong>Vessel</strong></td>
<td>“…includes every description of water craft, including non-displacement craft, WIG craft and seaplanes, used or capable of being used as a means of transportation on water.” (COLREG, 1972, as amended)</td>
</tr>
<tr>
<td><strong>Voyage plan</strong></td>
<td>Route plan together with additional voyage information regarding crew, cargo, environmental and legal aspects.</td>
</tr>
<tr>
<td><strong>Waypoint</strong></td>
<td>Reference point on the route</td>
</tr>
<tr>
<td><strong>VTS</strong></td>
<td>“Vessel traffic service (VTS) - a service implemented by a Competent Authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and to respond to traffic situations developing in the VTS area.” (IMO, 1997)</td>
</tr>
<tr>
<td><strong>VTS area</strong></td>
<td>VTS Area - the delineated, formally declared service area of the VTS. A VTS area may be subdivided in sub-areas or sectors.</td>
</tr>
</tbody>
</table>
2 METHODOLOGY

2.1 Introduction

This section discusses validation and data collection methods for the operational aspects, relevant for the STM concept.

In order to turn the STM concept into operational services the different project ACTs have developed large-scale test beds. In particular; ACT1 (PortCDM) and ACT2 (Voyage Management) within their respective areas: port side and ship side, and ACT4 (Maritime Service Infrastructure) within the development of the information exchange platform. ACT3 (European Maritime Simulator Network) has been enhancing the EMSN established in MONALISA 2.0. The use of ship simulators has made it possible to mimic complete traffic situations that in real life cannot be performed in a live test beds, facilitating new valuable evidences to complete the analysis. Data is collected in three of the STM-Validation projects activities:

- ACT 1 Port Collaborative Decision Making (PortCDM), which results are reported in ACT 2 Validation Report (STM, 2019a);
- Activity 2 Voyage Management (VM), which results are reported in the ACT2 Test report (STM, 2019b); and
- Activity 3 EMSN Network, which results are reported in a number of test reports (STM, 2019c)

while the data from the fourth one, i.e. Activity 4- SeaSWIM, which is a communication infrastructure, has been used only in very limited extent for this analysis.

2.2 Validation model

As argued by Wilson (2010, p.7), research methods are usually connected to two approaches, namely inductive or deductive. Starting with observations of specific instances and seeking the investigated phenomenon to be generalised, thus possibly contributing to start of a new theory, defines the first one, while the latter one “begins with and applies a well known theory”. In other words, “a deductive approach is concerned with developing a hypothesis (or hypotheses) based on existing theory, and then designing a research strategy to test the hypothesis” (Wilson, 2010, p.7).

Taking above mentioned into consideration, the research approach in analysing operational aspects of STM Validation Project can be described as deductive, but with strong reference to inductive approach, drawn from the preceding ML2.0 project, as well as project’s specific findings.

However, the deductive approach is usually associated with quantitative type of research (Wilson, 2010, p.7). The validation of STM concept and analysis of its operational aspects has been performed as both, quantitative and, to some extent, qualitative research, through analysing numerical data, collected in the testbeds, as well as examining narrative data, gained at various stages of tests and simulations, as well as from other sources. Inductive approach has been applied for the development of operational recommendations and proposing appropriate procedures after analysis of qualitative data collected in experiments and tests.

For further insight into the data collection, please refer to § 2.3 in this report.

This applied validation model has been depicted in Figure 3 below.
In the antecedent project MONALISA 2.0 (ML 2.0) the concept of STM has been defined as well as the target concept, with Key Performance Areas (KPA), Key Performance Objectives (KPO), worked out for STM four strategic enabling concepts, see “STM Information Environment Created and Tested” (STM, 2017). For the purpose of this report, consideration has been paid to the safety and efficiency in shipping, while the environmental sustainability has not been considered directly as the operational aspect, thus remains beyond the scope of our analysis.

The following KPA and KPO have been used for the STM operational aspects:

1. **KPA Safety:**
   - KPO at holistic level:
     - Increase situational awareness
   - KPO for PortCDM:
     - Increase situational awareness inside the port
   - KPO for VM:
     - Increase situational awareness in navigation

2. **KPA Efficiency:**
   - KPO at holistic level:
     - Enhance coordination of berth-to-berth sea transport
     - Improve communication among shipping actors
   - KPO for PortCDM:
     - Optimise operational procedures inside the port
     - Reduce administrative burden for port stakeholders
     - Enhance coordination between port actors of berth to berth sea transport
   - KPO for VM:
     - Optimise operational procedures in navigation

![Figure 3](image-url) The applied validation model
Source: (STM 2017, p.37).
3. KPA Environmental sustainability:
   - KPO at holistic level:
     - Reduce the environmental impact of shipping
   - KPO for PortCDM:
     - Reduce the environmental impact of shipping in ports
   - KPO for VM:
     - Reduce the environmental impact of shipping in navigation

The KPOs above are further broken down into validation parameters in §3.2. The SA 5.5 focuses on the operational aspects, which are identified in §3.3. This document makes uses of the discussions and results presented in ACT 1, 2 and 3. Based on those results, operational aspects are discussed, and operational recommendations are given. The appropriate data set for validation of operational aspects of the STM concept has been collected from several sources.

2.3 Data collection

2.3.1 Introduction

A variety of tests has been performed within the project, aiming at collecting data for validating the STM concept within the hypotheses statement. In general, in the project analyses and evaluations, the data has been collected as:

- Quantitative data, e.g. AIS data, routes, time stamps, historical data on traffic situation, obtained by logging into various databases or directly from appropriate source as a primary data, this is denoted data logging;
- Qualitative data, obtained in interviews, questionnaires, actors’ reflections and stories;
- Mixed data, collected from various sources, e.g. the Maritime Safety Index (MSI) or various user case, based on testbeds;
- Other data, collected from e.g. manuals, recommendations, guidelines.

2.3.2 ACT 1 PortCDM

ACT 1 has included all the steps from data collection, pre-analysis, analysis and validation. Figure 4 depicts the general concept of the validation model and data collection sources applied within ACT 1.
The following has been used as a source of data collected for the purpose of this report:

1) Testbeds
   STM Ports:
   - Nordic Testbed – 5 ports included; and
   - Mediterranean Testbed – 4 ports included;
   
   Due to various business models, thus lack of standardised environment, one most representative port for specific testbed, i.e. Gothenburg respectively Valencia, has been chosen for collecting data for analysis of operational aspects.

2) LivingLab principle’s activities:
   A. The Lab;
   B. The evaluation;
   C. Putting (testing) the solution into application.

Methods used, and validation results are presented in detail in ACT1 report (STM, 2019a). The data logging is discussed further in §2.4.

2.3.3 ACT 2 Voyage Management
The ACT2 data collection is based on test beds including:

1) STM Ships:
   - On board abt. 300 STM compliant ships; and
   - Ship-port and port-ship interaction (VM-PortCDM).
2) Shore Centres (SC) equipped with STM- equipment, able to interact with STM-compliant ships:
   - Nordic Testbed – 3 SC locations included; and
   - Mediterranean Testbed – 1 SC included.

Methods used, and results of discussions are presented in detail in (STM, 2019b). The data logging is discussed further in §2.4.

2.3.4 ACT 3 EMSN
The ACT3 data collection is based on test beds including:

1) EMSN simulations:
   - Baseline Scenario simulations;
   - STM-scenario simulations;
   - Controlled experiment scenarios.

2) Other sources, as resulting from research on operational perspectives and/or procedures:
   - Appropriate recommendations;
   - Appropriate guidelines; and
   - Appropriate manuals.

Methods used, and results of discussions are presented in detail in (STM, 2019c). The data logging is discussed further in §2.4.

2.4 Data logging
In order to obtain the data from various sources recognised as applicable for STM, it was decided to collect and pre-select the data from logs into the following testbeds:

A. Real life testbeds:
   a) STM Ports:
      Data has been collected from the PortCDM specific tools and services, e.g. time stamps, port call message;
   b) STM Ships:
      Data has been collected from the European Maritime Routes Database (VESSL) and VIS database with tracked movement and traffic information, concerning STM compliant ships (quantitative data).
      In addition, the attention has been given to the STM-compliant ships in the database, for which the opportunity of interaction with other STM-compliant ships might appear.

The STM compliant ships with higher probability of calling any of the STM port have been approached with special attention, aiming at collecting extended data, focused on ship-port and port-ship interaction (e.g. port call synchronisation). Thus, in turn, some possibility to obtain and collect additional qualitative data, from e.g. §2.6 interviews, has been detected.

B. EMSN simulations
In order to ensure availability of reliable data in the EMSN environment, a set of technical and functional tests has been carried out prior to the EMSN simulations, but description of such tests is beyond the scope of this report.
The following data has been collected in EMSN:

a) Numeric data
   i. Safety Index
      - Collision;
      - Grounding.
   ii. Nautical and ships movement parameters
      - Position;
      - SOG;
      - COG;
      - CPA;
      - TCPA;
      - ROT; and
      - Time-for efficiency measurements.
   iii. Ships tracking (for further analysis of incidents/accidents)
   iv. Deviation from planned/active route

b) HF Data
   i. Passive recording of HCI;
   ii. Passive recording of voice communication;

For further information about numeric data collecting and A&E tools for further processing, please refer to the document “STM Information Environment Created and Tested.” (STM, 2017)

2.5 Observations

A. STM Ports observations
Due to specific attributes of PortCDM tests, this method has not been applied.

B. On board STM ships
Due to the peculiarity of tests performed on board, any observations on board 300 participating ships were not found to be applicable, thus data has not been collected by this mean.

C. EMSN simulations observations
Observations of the behaviour of the test participants on bridges in the EMSN simulators have been carried out and recorded by the Human Factor Observers (HFO).
Prior to taking part in the simulator trials, all test participants had given their Informed Consent. Informed consent means that test participants have had an explanation about what taking part in the project involves.
The Human Factor Observers have been placed in the instructors’ room and depending on the background of the observer, i.e. HFOs without or with limited nautical knowledge were assisted with on-site expertise of the instructors.
Similarly, the HFOs with a recognised nautical background have been placed directly in the VTS/SC working station during the same exercises in the EMSN.
   a) Local observations data
      i. Simulators’ bridges
Human Factors Observers were engaged in recoding the behaviour of the test participants on the bridges they observed. A Human Factors Assessment sheet had been devised which recorded the following categories of behaviours:
      - Situational Awareness;
      - Collision Avoidance;
      - Communication;
      - Errors and Violations.
The HFOs were instructed to record behaviours that they had witnessed and not to complete an assessment for behaviour not observed. However, it was very important to err on the side of over-recording rather than under-recording and to record behaviours for all the significant events during the exercise.

ii. Simulator’s VTS/SC work station

The Human Factor Observer with a recognised nautical background was placed directly at the VTS/SC working station. A specific Event Log had been developed in order to record any communication, scheduled to or from the VTS/SC operator to any of the participating ships. The following categories have been recorded by the HFO:

- Name of ship involved;
- Who initiated (communication event);
- Time record (time stamp in exercise time);
- Type of the message;
- Result of communication event (if missed or not);
- Notes, concerning details of the particular communication.

Results were elaborated jointly by a VTS and a HF specialist in the internal Act.3 reports (STM, 2019c) and made available for the authors’ further analysis of operational aspects.

iii. Simulator’s Rescue Coordination Centre (RCC) under Search and Rescue (SAR) exercises

No HFO have been placed directly at the RCC station. However, an Event Log was developed in order to record any communication, scheduled to or from the VTS / Shore Centre (SC) and RCC operator to any of the participating ships, similar to the log applied in VTS/SC observations.

b) De-briefing the Test Participants

Each test participant was de-briefed and was given opportunity to exchange experience and thoughts in regard to the simulation by itself and the STM concept. De-briefings were carried out at the end of the simulator day, mainly as group event. After completion of exercises, all questionnaires (ref. to §2.7) were collected and the test participants had opportunity to share own experiences and opinions in the open-ended discussions. HFOs were involved during de-briefings, which, to some extent, were linked with observations, made during specific simulation. Besides sharing experiences and opinions by the test participants, one of the main aims for de-briefing was also to gain more knowledge and understanding about certain situations, observed during simulations and the participants’ decision making behind it.

No separate de-briefings sessions were arranged for VTS/SC or RCC test persons, but possibility to share own experiences and opinions was given to these test participants during the commonly held de-briefings.

2.6 Interviews

Interviews, defined by the Cambridge Dictionary online (Cambridge 2018) as “a meeting in which someone answers questions about himself or herself for a newspaper article, television show, etc.” have been arranged within the STM-VP activities, aiming at collecting primary quantitative data.

A. STM Ports

Interviews and users’ stories have been used for collecting qualitative data within ACT1, mainly during the specific events, such as, but not limited to, LivingLabs.

Following the LivingLabs principle, interviews has been carried out at various stages of the process, aiming at collecting appropriate qualitative data for further steps, i.e. finding the specific port solutions within STM Validation Project and PortCDM. During the LivingLabs meetings and other specific activities, the main actors have been interviewed, whilst outcomes
elaborated and pre-analysed during subsequent stages, such as, but not limited to, continuous evaluation and post evaluation processes as well as identification of new steps to take.

B. STM ships
Interviews with the crew as the actors for STM operational aspects have been carried out by the STM staff on board of selected STM compliant ships at the time and place convenient. It should also be noted at this point, that appropriate procedures, aimed at selecting the most adequate ships and the most convenient locations, have been applied, in order to collect the appropriate qualitative data.

C. STM Shore
Similarly, interviews with the SC operators as the actors for STM operational aspects have been carried out by the STM staff in selected Shore Centres (i.e. SC Tarifa, SC Kvitsøy) at the time and place convenient. It should also be noted at this point, that the above-mentioned interviews have been complemented by the data, collected by the authors during continuous dialog and working meetings with the STM staff involved in tests at Gothenburg SC. The data, obtained form above-mentioned means, for the purpose of this report, has been classified as collected in interviews.

D. EMSN simulations
No interviews, in the scope previously defined, have been carried out in association with EMSN simulations. However, to some extent, the process of de-briefing could be seen as deriving from observations and subsequent interviews.

However carefully noted and recorded, this form of data collecting, from the EMSN activity has not been supported by any customary developed or standardised form of interviews.

Nevertheless, debriefings, as described in §2.5.C.b, were carried out to gain more knowledge and understanding about certain situations, observed during simulations and participants' decision making behind it. Debriefing sessions encompassed both ship (bridge work station participants, i.e. OOW, Master) and shore (Shore Centre operator and RCC operators).

Further pre-processing of the collected data has been done by the Human Factors experts in order to make it useful for E&A purpose, thus for this report.

During specific Controlled Experiment Scenario simulations (S2S REX) de-briefing, the test persons were asked by Human Factor expert to answer questions, related to observations, made by HFOs during each run. Further discussion was arranged in order to catch both general and specific opinions of test persons about S2SREX feature.

2.7 Questionnaires

A. STM Ports
The main actors in the STM ports have been identified and appropriate questionnaires produced. However, only the range of selected questionnaires has been considered for purpose of this report, aiming at focusing on operational aspects, listed in Chapter 3 of this report and actors.

B. STM Shore
Collecting data from RCC operators, participating in the life SAR testbeds, has been carried out from appropriate questionnaires produced. However, due to specific attributes of the SAR exercises, thus very restricted number of RCC operators, the weight of such data has been found uncertain thus very limited in use for the purpose of this report.

C. STM EMSC
The test persons answered on questions, specific for each type of simulation runs directly after completion of particulate exercise. Appropriate procedures have been described in specific simulation report (STM, 2019c) and results provided.
3 OPERATIONAL DESCRIPTION

3.1 Introduction
This chapter gives an operational description of the STM concept. In order to structure the description of the concept and services, operational parameters have been identified.

3.2 STM concept
The STM concept takes a holistic approach on operational and information services making the berth-to-berth ship voyage efficient, safe, and environmentally sustainable. Hence, STM puts the ship’s voyage and port approach in focus and uses that as a core element for process optimization, and actors and stakeholder interaction.
Within STM, four enabling strategic sub-concepts have been identified as crucial for reaching the operational target values. These are:

- Port Collaborative Decision Making (PortCDM), in which the process for arrivals and departures is made more efficient through information sharing, common situational awareness and improved processes;
- Strategic Voyage Management (SVM), which deals with route planning, route exchange and route optimisation before the voyage has started;
- Dynamic Voyage Management (DVM) which deals with route planning, route exchange and route optimisation whilst the ship is on its voyage; and
- Flow Management (FM), which includes services that will support both land organisations and ships in optimising overall traffic flow through areas of dense traffic and areas with particular navigational challenges.

These are all enabled by:
- Information sharing by Sea System Wide Information Management (SeaSWIM), which has the intention of being a common framework for information sharing and service distribution for maritime activities.

In the following paragraphs and chapters SVM, DVM and FM have been merged into Voyage Management (VM).

The overall operational idea with the STM concept is to support the ship’s voyage through all navigation phases with interoperable services. These services are built on an enhanced information exchange between ship and shore and gives new possibilities for assistance of ship’s en-route. Note that the SeaSWIM guarantees a seamless transition of information along the ship’s route. The process is depicted in the Figure 5 below and includes:
- optimisation of the voyage plan of a sea voyage before sailing;
- nomination of collaborators and govern access rights to services and information applicable for the voyage;
- continuously adjust the voyage plan in order to run the ship in the most cost efficient, safe and sustainable way; and
- support of an optimal port approach and port operations.

Further, this operational idea builds on the following fundamental principles: (ML2, 2015)

- Ship’s Master is in command;
• UNCLOS/COLREG not contravened;
• Existing systems and initiatives are considered;
• Information ownership is managed by access control and authentication; and
• Cyber security and integrity of the information is considered.

Figure 5 An operational picture showing a generic voyage supported with different interoperable STM services en-route. Source: (STM, 2019b)

The strategic sub-concepts are implemented by a number of operational services as listed in the table below. In the table below, only operational services are listed which are used in the validation of the operational aspects. Some of the services exist already today but are enhanced with an increased exchange of information whilst some are new, see Table 2.

Table 2 Operational services used for the operational validation.

<table>
<thead>
<tr>
<th>Strategic sub-concept</th>
<th>Operational service</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voyage management</td>
<td>Ship-to-ship route exchange</td>
<td>STM function</td>
</tr>
<tr>
<td></td>
<td>Chat messages</td>
<td>STM function</td>
</tr>
<tr>
<td></td>
<td>Route suggestion</td>
<td>STM function</td>
</tr>
<tr>
<td></td>
<td>Route cross check</td>
<td>Operational service</td>
</tr>
<tr>
<td></td>
<td>Pilot Route Service (route catalogue)</td>
<td>Operational service implemented in Swedish waters</td>
</tr>
<tr>
<td></td>
<td>Navigational Warning Service</td>
<td>Operational service implemented in the Baltic</td>
</tr>
<tr>
<td></td>
<td>Enhanced Monitoring</td>
<td>Operational service</td>
</tr>
<tr>
<td></td>
<td>STM Winter navigation service</td>
<td>Operational scenario</td>
</tr>
<tr>
<td></td>
<td>STM SAR Service</td>
<td>Operational scenario</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------</td>
<td>----------------------</td>
</tr>
<tr>
<td><strong>Voyage management</strong></td>
<td>Port Call Synchronization – ship centric</td>
<td>Operational scenario</td>
</tr>
<tr>
<td></td>
<td>Port Call Synchronization – port centric</td>
<td>Operational scenario</td>
</tr>
<tr>
<td><strong>PortCDM</strong></td>
<td>Port call coordination</td>
<td>PortCDM can be considered to be a operational scenario</td>
</tr>
<tr>
<td></td>
<td>Port call monitoring</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Port call improvement</td>
<td></td>
</tr>
<tr>
<td><strong>SeaSWIM</strong></td>
<td>NA</td>
<td>Used in all applications</td>
</tr>
</tbody>
</table>

The VM sub-concept puts the ship’s navigation in focus and provides improved situational awareness through enhanced traffic information by route exchange ship-to-ship, ship-to-shore. This opens for new possibilities for supporting of ship’s en-route. The optimisation creates the prerequisite for “just-in-time” operations arriving and departing from ports. If a ship’s route plan and schedule are exchanged and made available for different actors and stakeholders, VM services can be provided both by authorities or commercial service providers. Below some services and functions are described:

- **Pilot route service**: supporting the ship’s planning process giving the possibility to incorporating the route segments for applicable in pilotage areas, which will be used by the marine pilot.

- **Route optimizing service and ETA calculator**: gives enhanced possibilities for route optimization both in the planning and in the execution phase of the voyage.

- **Navigational Warnings Service**: opens up the possibility of getting current navigation warnings applicable for my voyage and areas of navigation sent directly to the navigation display.

- **Ship-to-ship route exchange**, enhancing the ships situational awareness in the strategic navigation.

VM services are provided by authorities or commercial shore-based service providers depending upon the characteristics of the service.

The port approach and port operation process are covered in the third strategic sub-concept Port CDM. PortCDM provides a basis for collaboration between key actors within a port and its surroundings by relying on continuous interactions exchange of intentions and actual events between the different port actors. Using this information sharing enable port calls to be efficient, safe and having a fast turn-around, continuous interactions between a port’s actors as well as with shipping companies and shipping operators. Hence, PortCDM supports the port call with the objectives to:

- provide a basis for collaboration between key actors within the port and towards its surroundings based on shared situational awareness enabling increased predictability;
- enable just-in-time arrivals of ships, just-in-time operations and further on just-in-time integration with hinterland transportation leading to optimized turn-around processes;
- enable improved resource utilization for all involved port actors and optimized operations.
PortCDM together with VM opens up the possibility for:

- **Port call synchronization**, which optimize a port call by synchronizing relevant actors in the port call process.
- **Port Call Coordination**, where actors become more coordinated in relation to each other on where and when to provide port call services.
- **Port Call Improvement**, where the port call operations are improved based on the performance achieved when serving ships during their conducted port visits.
- **Port Call Monitoring**, where an overarching image of the situation prior, during, and after the port call is achieved.

### 3.3 Operational description

#### 3.3.1 User needs

One of the overall ideas with the STM concepts is to meet the user’s information needs and by that increase the situational awareness. A thorough user need analysis was performed in the process of establishing IMO’s e-Navigation Strategy Implementation Plan (IMO’s SIP, 2010). In the Table 3 below, applicable user need for e-navigation has been cross-referenced to STM operational services.

<table>
<thead>
<tr>
<th>User need</th>
<th>Function or service</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shipboard Annex 2 (SIP,2010)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Mariners expressed a desire to sort and display MSI, such as NAVTEX, SafetyNET more effectively”</td>
<td>STM Navigational warning</td>
<td>Navigational warnings are transmitted directly to the ship’s navigation system using S-124.</td>
</tr>
<tr>
<td>“Mariners have expressed a keen desire to reduce the amount of ship/shore reporting and to adopt the principle of single entry for any information into the system. They have further expressed a desire for globally standardized reporting procedures and forms to avoid repetition of reporting and to reduce workload.”</td>
<td>Ship-to-shore route exchange</td>
<td>Ship to shore route exchange using RTZ format. Ship’s voyage plans (VP) could be part of an autonomous ship reporting function.</td>
</tr>
<tr>
<td>“Mariners would be grateful if e-navigation could facilitate better detection of targets.”</td>
<td>Ship-to-ship route exchange</td>
<td>Ship to ship route exchange. Gives new information in combination to Radar, AIS.</td>
</tr>
<tr>
<td>Mariners expressed a desire to have more effective Guard Zones to notify watchkeepers of hazards pertaining to collisions and groundings.</td>
<td>Ship-to-ship route exchange</td>
<td>Ship to ship route exchange. Gives new information in combination to Radar, AIS.</td>
</tr>
<tr>
<td></td>
<td>Area management</td>
<td>Dynamic no-go-areas can be sent out using the S-124 standard.</td>
</tr>
</tbody>
</table>

Table 3 User needs for IMO e-navigation with cross reference to STM operational services.
“Shore authorities need an enhanced ability to share maritime information amongst authorized shore users to ensure consistency and reduce the reporting burden by ship personnel.”

| Ship-to-shore route exchange | Enhanced monitoring | Ship-to-shore route exchange using RTZ format. Ship’s VP could be part of an autonomous ship reporting function. |

“More effective shore-to-shore information exchange will aid safety, security, the identification of risk, environmental protection and improve logistics management”

| Ship-to-shore route exchange | Enhanced monitoring | Ship-to-shore route exchange using RTZ format. Ships VP could be part of an autonomous ship reporting function. |

The knowledge of a passing ship’s VP in a VTS area makes it possible to perform an enhanced monitoring of that ship.

**SAR Annex 4 (SIP,2010)**

| “SAR should have access to relevant information contained within the e-nav domain” | STM SAR Service | Search pattern and datum send directly to the ship’s navigation display |

| “Effective Communication and information sharing.” | STM SAR Service | Search pattern and datum send directly to the ship’s navigation display |

Further, the STM concept mainly addresses aspects of the four of the e-navigation solutions (S), namely S2, S3, S4 and S5: (IMO e-Navigation SIP-Update 1, 2018)

- **S2** Means for standardized and automated reporting; Single reporting could use the maritime digital infrastructure and SeaSWIM for the exchange of information;

- **S3** Improved reliability, resilience and integrity of bridge equipment and navigation information; integrity of navigational information is achieved by cyber security measures in the maritime digital infrastructure;

- **S4** Integration and presentation of available information in graphical displays received via communication equipment; In STM, services have been directly integrated to ECDIS to allow presentation of e.g. text messages, route proposals and MSI;

- **S5** Improved communication of VTS Service Portfolio (not limited to VTS stations); several of the STM operational services would enhance VTS operations Risk Control Options.

### 3.3.2 Operational parameters

In order to structure discussions and recommendations in chapter 4, 5, 6 and 7, operational parameters for the services are defined. A description of these services should include:

- **Objectives**;
- **Operating nodes**: elements that participates in the service interaction e.g. ship, VTS, etc.
- **Actors**: uses or providers of the service, e.g.:
  - Service provider; and
In this paragraph, we start to structure the operational parameters of the overall STM concept with the starting point of an operational picture and description. An operational picture of port approach is depicted in the Figure 6 below, which can be used to identifying operating nodes, actors, stakeholders and operating elements.

STM uses the following main modes of operations for the efficient transfer of maritime information and data between all appropriate users, which are:

- Ship-to-ship;
- Ship-to-shore;
- Shore-to-ship; and
- Shore-to-shore.

During the execution of the voyage, the ship will pass through a number of ships routeing systems and VTS areas. The ship-to-shore and the shore-to-ship interaction are very important mode of operation for STM. Shore-based organizations can contribute considerably by adding valuable information. E.g., VTS or other types of shore centers can support the ship’s navigation with the objective to improve navigational safety and maritime security achieved by increased situational awareness and correct information at the right time also in order to establish a better ship and shore teamwork.

The term “shore” is here representing different shore-based service providers like; ports, VTS other shore centers or other shore-based service providers. The distinction between shore centre and VTS is provided in IMO RESOLUTION A.857(20) - definition of VTS (IMO, 1997):
“Vessel traffic service (VTS) - a service implemented by a Competent Authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and to respond to traffic situations developing in the VTS area.” All others are considered to be shore centers.

Exchange of route information **Ship-to-shore mode** would be established in order to facilitate, e.g.:

- Enhanced traffic monitoring for improved navigational safety;
- Enhanced traffic surveillance for improved security;
- Shore-based navigational assistance;
- Route optimisation for efficient shipping and low environmental impact, and
- Ashore coordination of ice navigation by dynamic ice routes changes to participating ships;
- Ashore coordination of SAR and pollution response operations by providing search path as route changes to participating ships; and
- Port call synchronisation.

**Ship-to-ship mode:**

Exchange of route information between ships within the horizon, or AIS/VDES range, would be established in order to, e.g.:

- Enhance the on-board situational awareness by combining Radar/ARPA/AIS/Visual observations of other ships; and
- On scene coordination of SAR and oil response operations by providing search pattern as route suggestions to participating ships.

Based on the operational picture, the following operational nodes can be identified:

- **Actors**, which are part of the system. Each actor is in fact a complete system operated by one or several operators. The term actor is in this document interchangeable with **user**.

- **Stakeholders**, which are working outside the system, which are benefiting from the system. Stakeholders are analysed further in SA 5.1.

The following actors have been identified as applicable for this analysis:

- Ships’ crew;
- Pilots;
- Shore center, VTS, RCC operator; and
- Port actors.

The following specific phases of a sea voyage have been identified as areas appropriate for the analysis and evaluation of operational aspects, thus found applicable in this report:

- Ocean phase;
- Coastal phase; and
- Pilotage phase (with proceeding to the anchor/anchoring as well as berthing stages included).

The area of operation parameter defines the geographical area where the operational service can be used. In some case the information exchange is using internet, hence the availability is depending on satellite communication. In one case it is depending on AIS range. A typical range to be expected at sea is 20 to 30 nautical miles depending on antenna height (IMO
The following operational nodes are identified:

- **SC**, if the area of operation is located within a VTS area, then the service is performed by the VTS and its operator.
- **Port**
- **Other service providers**, this can be e.g. providers of route optimisations
- **STM compliant ships**, having the relevant STM equipment and procedures implemented on board, so it can make full use of the STM concept. In practice, meaning the functionality of exchanging a segment of its route and schedule plan with the shore-based operator.
- **STM non-compliant ships**, a ship(s) that is/are not participating in the STM process or does not have the relevant STM compliant equipment. Following vessels can be of this category:
  - Other merchant ships
  - Fishing vessels
  - Leisure craft
  - Governmental ships.

The main operational elements in the STM concept, representing the information transfer, are the ship’s route, port call messages, text messages and dynamic restricted areas. The operational services consist of these information elements. This is detailed below:

- **Voyage Plan in RTZ format**
  The main information exchange is initiated by ship sending its voyage plan (RTZ format) to another actor (ship-shore) such as a shore centre performing enhanced monitoring, or a service provider performing route optimization or a port to synchronize the port call. The core components of the exchanged voyage plan are ship’s identification, route geometry and calculated schedule. Depending on receiver, the voyage plan also contains additional information such as displacement, draught, fixed times, fixed speeds etc. A service can also send a proposal for changed route geography or proposed change of schedule back to the ship using the same format (RTZ). SAR services also uses the route exchange format to send search patterns to ships.

- **AIS Route message**
  Part of the route plan (next 7 WPT) on-board the ship can also be broadcasted as AIS Route. Work is also on-going to define VHF Data Exchange Service (VDES).

- **Navigational Warning in S-124 format**
  Navigational Warnings are sent to the ship using the IHO S-124 format for the areas concerned with the route, in geography and time. SAR services also uses the S-124 to send search areas to ships.

- **STM Text message in TXT format**
  In addition, text messages are also exchanged via the STM Text message format. Text messages are used both as free text by humans and automated response texts from services in addition to the defined formats.

- **Port call message in PCM format**
  Times within a port and between ship and port can also be exchanged with the Port Call Message Format (PCMF). The ship can report its planned and estimated time for arrival, and the port can recommend a new time to the ship for arrival.
### 3.4 Validation aspects

These services need to be considered in the operational environment changing current procedures and work. Hence, some operational procedures on-board or ashore might need to be updated. These new concepts, service implemented as operational procedures also implies a need for additional training. Based on the previous discussion, the following operational parameters have been identified and selected for further analysis. The parameters in bold will be further analysed in this document see chapter 4 to 6, whilst other parameters will be analysed within another SA in ACT5:

- Information needs
- Operating procedures
- Navigational safety (see SA 5.6)
- Risks (see SA 5.6)
- Usability
- Workload
- Training (see also SA 5.7)
- Situational awareness

The relationship and the logic between the parameters above are illustrated in the Figure 7 below. The selected parameters are detailed in section 4 to 6 for the different operational services.

![Figure 7 Relationship between the operational parameters.](image)

One of the research objectives was to find if the bridge team (OOW) had been provided with “the right information” by the STM services tested in EMSN respectively in the life-testbeds. The second objective was to find the answer to if “the right information” was available to the OOW “at the right time”. As the test persons had not been asked the subject questions directly, a further pre-analysis was needed in order to find the answers.

Beside above-mentioned objectives, the risks of over-reliance and misinterpretation of information obtained from STM tools or services have been taken into consideration in this report. Appropriate analysis and discussion have been based on results from short controlled scenario simulation trials, as mentioned in §2.3.4. As far as it was applicable, the influence of use of the STM tools and functionalities on the decision-making process of the bridge team has been analysed.
As the questions regarding information need were not being asked directly, the initial interpretation and pre-analysis of the available data (mainly post scenario questionnaires and end of the day open-ended debriefings) has been accomplished by the authors to their best experience and knowledge after consulting the HF expert, allowing performing further analysis in the subject. In addition, any changes identified in communication, e.g. communication pattern or use of new functionalities, were analysed.

**Operating procedures** are closely connected with the stages of ships passage plan and its execution. According to ICS Bridge Procedures Guide (ICS, 2016, p.30), the four phases of a voyage relate to specific procedures, required for the safe performance of it. The four stages of a safe passage plan are:

1. Appraisal- Collecting and assessing all relevant information required for the intended passage;
2. Planning stage - Developing and approving a passage plan based on the outcome of the appraisal of all relevant information;
3. Execution - Briefing the Bridge Team on the passage plan. Navigating the ship in accordance with the passage plan;
4. Monitoring - Checking progress of the ship against the passage plan.

**Familiarisation** is a part of Standard Operational Procedures (SOP). However, due to rather meagre availability of data about SOP, collected in simulations and mainly other, i.e. more technical and instructional approach to SOP in this report in Chapter 7, it has been decided to strive for analysing familiarisation aspects in close correlation to training in the extent appropriate for operational recommendations.

It has been found, however, that the question, concerning familiarisation, has, in some cases, been understood and answered by test person as related to the familiarisation with the simulator rather, than with specific STM features and tools. However, due consideration has been given even to this approach in order to catch up as broad sight into this operational parameter as possible.

The term **navigational safety** or **safety of navigation** is of very broad meaning. Selected aspects, related to the safety of navigation, were identified by MONALISA 2.0 and presented by that project in appropriate reports.

One of the fundamental documents related to the safety at sea, the SOLAS (Safety of Life at Sea) Convention is published by the IMO (International Maritime Organisation) and Chapter V refers to the Safety of Navigation for all ships at sea. Separate analysis of STM project proposal in relation to SOLAS has been conducted by the legal experts of the project and presented in appropriate report (ref. to STM_M 23 Legal and Liability Report. 2018).

In addition, a separate Formal Safety Assessment, concerning safety of navigation, has been conducted and an appropriate report is expected to be released by SA 5.6 (ref.to STM_D5.6.1 Analysis of Current Formal Safety Assessment. 2019), analysing and evaluating safety of navigation in the STM context.

Defined by ISO 9241-11, **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”. (IDF, 2018)

In the common understanding, usability is defined as the capability of being used. The term “usability” is embodied in the broader meaning of “user experience”, which refers to the ease of access and/or use of a product. The level of usability is determined by design features together with the user's context, i.e. “what the user wants to do with it and the user's environment” (Ibid). Looking at three main outcomes of a useable interface, it should be:
- Easy for the user to become familiar with and competent in, using the users interface the first time;
- Easy for users to achieve their objective through using the tool;
  “Easy to recall the user interface and how to use it on subsequent visit” (IDF, 2018).

In the context of operational aspects, the focus has been kept on the users’ experience in applying the STM-services for obtaining the benefit from these services, thus their assessment in the ability to use the services for a certain purpose in certain situations during the ship's voyage.

However, due to the way how the tests persons were asked and questions formulated, the scope of categories of effectiveness, efficiency and satisfaction were also identified in answers to other questions in different categories. Thus, pre-analysis and pre-qualifying processes have been applied, allowing further categorising of collected qualitative data.
4 SHIP

4.1.1 Introduction

STM Bridge

The appropriate data for this report has been collected during series of simulation runs in the EMSN and in the life-testbeds, as described in Chapter 2.

Operational aspects, covered by this report, have been analysed in cooperation with Human Factors (HF) experts, who were also involved in collecting data from EMSN simulations. Furthermore, the analysis of operational aspects for this report is mainly based on appropriate reports from the specific simulations, submitted by EMSN and HF experts in 2018 and 2019 (STM, 2019c).

For better understanding and interpretation of the collected data, an electronic demographic survey was completed prior to simulations. The appropriate demographic data was available in respective report from EMSN simulations (STM, 2019c).

Worth to note is that the age of participants was between 20 and 69 years. The age context has been assessed as it might have been of importance for the evaluation of services or tools, used by the test persons.

In terms of navigational experience, one of participants had less than 1 year, while the rest of them had between 3 to 31 years of it, with the majority of having 11-20 years of sea-going experience. In regard to participants’ current role, 68 of them were captains, 18 maritime pilots, 29 Chief Officers, 57 Deck Officers, 7 VTS Operators (including these acting as VTS/SC operators), 16 working in educational services, 14 in the maritime field as well as 18 who did not report in the demographic survey.

The test participants were of various nationalities which, however appropriate data available from the EMSN reports (STM, 2019c), was found out of the consideration of this report.

Standardised STM Service Specific Questions were asked during open end-of-the day de-briefings, taking into consideration the following:

- safety of navigation (improvement or decrease);
- efficiency in navigation (improvement or decrease);
- change in today’s way of working/navigation/management procedures;
- training needs (technical/pedagogical) in order to use STM services; and
- possible adoption of the STM services by shipping companies (Yes-Why?, No-Why?)

Answers to above-mentioned categories of questions and data collected in the Post-Scenario Questionnaire (see § 2.7). have been further elaborated and pre-analysed jointly by the HF and EMSN teams in order to be able to discuss and evaluate results in relation to the chosen operational parameters as appropriate. That data was available from the appropriate EMSN reports (STM, 2019c).

Further, the data collected in the so called short S2SREX controlled scenario EMSN runs have been collected, elaborated, analysed and reported (STM 2019c: 3.3.8) by the EMSN and HF team, resulting in availability of additional data, allowing more specific evaluation of S2SREX tool and its impact on decisions and actions taken by the OOW in traffic situations, thus even the risk of misusing or placing over reliance on its functionality. The intention of using S2SREX was thought to provide additional information, which may assist the navigators in their decision making on a longer range and thus not being a substitute of the COLREGS. There were, however, several questions, which needed to be addressed prior to evaluating the possible effect of S2SREX on the OOW’s decisions and behaviour. The answers were taken into consideration and discussed in the report.

Moreover, for some parts of Ch.4 (as well as Ch.5) appropriate qualitative data was extracted from the post-scenario de-briefing notes, provided by ACT3 after simulations, carried out March and June 2018 (STM EMSN, 2018: AM, CJ, CML, CTH, FUAS, WMA).
Furthermore, appropriate report from ACT2 STM live-testbeds (STM 2019b) was produced and made available for further analysis of operational aspects, presented in this report.

**Winter Navigation**
The data was collected by observations of the bridges, debriefing interviews and, to some extent, feedback questionnaires.

Further elaboration and analyses were carried out by the EMSN team, including HF experts, and summarised in the STM report (STM 2019c: 3.3.5).

It was considered by the EMSN team, that the appropriate data could be collected and usability of the winter navigation services best determined and evaluated through observations and debriefings interviews, as the exercises were run only for two days, encompassing a limited number of participants in the exercises on 6 manned bridges. The observers focused on two main areas: the general situational awareness of the bridge team and their communication, both internal and external.

Furthermore, appropriate results from ACT2 STM live testbeds report (STM, 2019b) were, to some extent, taken into consideration in this report.

**Search and Rescue (SAR) operations**
Data for the SAR operations has been collected both in EMSN and life testbeds. For the analytical and evaluation’s purpose, the appropriate source was clearly defined and stated in applicable sub-chapter and its parts. The data has been collected in the process of de-briefing, as well as partly from the questionnaires and presented in appropriate ACT3 report (STM 2019c: 3.3.9).

Further elaboration and pre-analysis were carried out by the EMSN and HF team as well as ACT.2 SAR experts, involved in live-testbeds.

Appropriate results from ACT.2 STM live-testbeds report (STM, 2019b) were, to extent deemed applicable, taken into consideration in this report.

**4.2 Chat message function**

**4.2.1 Information and communication**
Chat message function has been found to be a good complement to a verbal communication via VHF and using it would reduce spoken mistakes and misunderstandings. (3.3.9 p.39) The participants found this service “potentially useful for ship-to-shore communication”. (3.3.6 p.15)

It has been pointed out, however, that written messages are also dependent on the language skills of the message sender. (3.3.5 p.12) (3.3.6 p.15)

Some uncertainties in dynamically developed situations needed however, resolving by discussions over the VHF. (3.3.5 p.11)

The test persons expressed their concerns, that with the current way of communicating via VHF it was possible to have closed loop communication, whilst through the Chat this quality could be lost. (3.3.9 p.37) In consequence, a risk could appear, that the information exchange would only involve two parties (ship-to-ship or shore-to-ship), whilst the remaining ships in the area could have been unaware of on-going traffic situations and agreements made through the chat service instead of the VHF. (3.3.6 p.16) Related to mentioned attribute was the opinion that “group Chat would be desirable” (3.3.6 p.15). This might be a remedy for that undesirable effect, improving the Situational Awareness in the considered area.

The addition of the Chat message function to the available communication channels (i.e. VHF and NAVTEX) was expected to improve the exchange of safety critical information, enable better understanding and, thus, reduce the number of misunderstandings and human error. (3.3.9 pp. 39,40)
It was also pointed out that STM services (as e.g. Chat) would increase information exchange efficiency and improve collaborative operations performance. Introducing STM services may also increase the amount of information exchanged. (3.3.9 p.40)

4.2.2 Situational awareness

During Winter Navigation exercises in EMSN it was observed, that Chat message function could take the attention away from the navigation, causing difficulties in controlling the ship, if the same person was writing an answer and steering the ship. (3.3.5 p.11,12)

The above-mentioned occurrence might have potential impact on situational awareness and safety of navigation.

The opinion was also expressed, that “Chat messages will distract the operator and draw too much attention to the ECDIS screen”. This is a problem already present on the bridges and should not be encouraged. (3.3.6 p.15)

Participants of the EMSN runs pointed out, that the attribute of closed loop in ship-to-ship and ship-to-shore communication might be lost when using the Chat function. (3.3.9 p.37)

Needless to say, it might have potential influence on Situational Awareness and safety of navigation. The functionality of a “group Chat” was proposed and recommended (3.3.6 p.15), which might be seen as a remedy for this undesirable effect, resulting in improving the Situational Awareness in the considered area.

4.2.3 Usability

Opinions were expressed by test persons, that Chat “service could increase efficiency if the usability was improved”. (3.3.6 p.15) The HF observers noted some usability issues, like missing immediate reception of Chat message, whilst at the same time the bridge team paid their main attention to the ECDIS. (3.3.5 p.11)

Usability of Chat message function would benefit from adding a “kind of button”, enabling to confirm receipt of the message. Different colours to highlight the urgency of the message were suggested for further consideration and implementation in the Chat message function. (3.3.5 p.12)

Based on the data available from SAR life testbed exercises, the Chat message function was found of very limited (or even of no) usability on board SRU, given the prevailing operational environment. Here the preferable and more relevant would be the voice communication. (STM, 2019b p.55)

4.2.4 Workload

Traffic situation (i.e. dense or light) will dictate the frequency of usage of the services, like e.g. Chat message function, as they appear to be more useful in lighter traffic situations with time to plan, than in dense, close quarters traffic situations. (3.3.6 p.20)

The overall frequency of communication between the ship and VTS almost doubled in the STM simulations in comparison to the baseline tests (3.3.6 p.20). Introducing STM services may also increase the amount of information exchanged. (3.3.9 p.40) No clear evidence of increased workload due to use of Chat message function was found, however, increased risk for overload of the end user cannot be precluded.

In their general analysis, the project HF experts argued, that increased workload could be expected if using cognitive resources in an exclusive way. For instance, “normal communication via VHF allows simultaneous attention to several other things, whereas when using the chat all attention needs to be directed to that activity” that in turn, might lead to “distraction from navigation” or information overflow (e.g., “too much information during a short period of time”). (3.3.9 p.36)

4.2.5 Training

In general, most participants considered the services useful and, with some training, rather easy to use. (3.3.9 p.42) No specific training requirement was expressed in regard to Chat
message function. However, taking into consideration the statement about the risk that the Chat message function can “take the attention away from the navigation”, the need of proper awareness about limitations and potential risks for end users would be crucial, thus must be taken into consideration during discussing training and on-board familiarisation. Further considerations need to be given to standard operational procedures on board.

4.3 Ship to Ship Route Exchange (S2S REX)

4.3.1 Information and communication

The participants have expressed their trust put on the S2SREX service and the majority stated they would trust the services most of the time. They also believed, the shift towards using the ECDIS (with S2SREX and RDV information) instead of Radar/ARPA/visual means would occur, when ascertaining the risk of collision. (3.3.8, p. 21)

These opinions indicate, in turn, that mentioned services would be able to provide the bridge staff “the right information available at the right time”. Opinions were expressed, that S2SREX function provided useful information about other ships’ routes and waypoints, allowed to identify their intentions and act accordingly. (3.3.9 p.32) (3.3.6 p.14)

During debriefings, the S2SREX function was found informative tool, assisting in planning and decision making (3.3.6 p.14). Opinion was expressed, that visualisation of the route enables sharing and better understanding of information and reduces unnecessary communication over the VHF (3.3.9 p.32, 34) (3.3.6 p.14). That would be achieved by displaying relevant information in a simple manner without any need to be queried. (3.3.9. p.33)

Furthermore, Route Exchange service can reduce language issues/barriers by making routes visible. (3.3.9 p.34)

The most common reason of using the S2SREX service, was “to enhance Situational Awareness”, “to supplement information from other means (ARPA, AIS etc.)” and “to help in assessing if a Close Quarter Situation was developing”. (3.3.8 p.18)

Indeed, it can be concluded at this point, that the S2SREX functionality may provide OOW with additional information.

However, further concerns were made about possible case, that ships not followed own monitored and broadcasted route. Taking for granted, that the information equals reality, imposes a risk for making navigational decision, based on false information. (3.3.6 p.14), (3.3.9 p.36)

The RDV tool of S2SREX was not used often and was considered not helpful or unnecessary in particular situations. With reference to the opinions, that radar and the presentation of intended routes provided enough information, it may be concluded, that RDV functionality might necessarily not to lead to enhanced Situational Awareness nor provide OOW with supplementary information in the assessment of a developing Close Quarters Situations. (3.3.8 p.18)

Mention should also be made, that current way of communicating via VHF makes it possible to have closed loop communication. The use of STM services, like S2SREX and Chat, might lead to loss of that attribute. (3.3.9 p.37) The participants expressed their opinion about importance of sharing the information with all adjacent ships. (3.3.9 p.32) That would be difficult to achieve in case of not STM-compliant ships.

Furthermore, risks of automation bias and over-reliance on technologies (3.3.9 p.37) were pointed out by participants as well as the issue of increased amount of information exchanged. (3.3.9 p.40)
4.3.2 Situational awareness

STM-services and functions, as S2SREX, encourage maintaining high-level of situation awareness and safety during navigation and participants agreed that STM services improved SAW. (3.3.9 pp.32, 41)

The most common reason of using S2SREX, chosen by the participants, was “to enhance Situational Awareness”, “to supplement information from other means (ARPA, AIS etc.)” and “to help in assessing if a Close Quarter Situation was developing”. (3.3.8 p.17) All above-mentioned could be connected with SAW category and its enhancement through use of the S2SREX functionality.

Nearly all of responses acknowledge that S2SREX improve their SAW, while the number of stating the same in case of S2SREX/RDV function was somewhat lower. (3.3.8 p.18)

The perceived influence of S2SREX and RDV on SAW is depicted in Figure 8.

![Figure 8 Perceived influence of S2SREX respectively RDV on Situational Awareness](source: STM (3.3.8 p.19))

Expressed in their subjective opinions during open-ended debriefings, the test participants appreciated the idea of using the S2SREX service to make enable a “collective decision” far in advance. An early planning would be helpful to develop navigators’ Situational Awareness, which, in turn, would support their navigational acting. (3.3.8, pp. 22-3)

4.3.3 Usability

The participants have expressed their trust put on the S2SREX service and RDV tool. (3.3.8, p.21).

As provided by the participants in open-ended debriefings, the potential confusion and thus possible risks were identified as emerging from implicitly made assumptions that the “route” and “intention” to be the same think. This observation, together with the issue of lacking information clarity with too many clustered routes (in more complex traffic situations), were pointed out by the participants as contributing to limited usability of S2SREX. Some responders were of the opinion that the information displayed for S2SREX was confusing and somewhat for the S2SREX with RDV function. (3.3.8 p. 22) More data available in the Act.3 reports (STM, 2019c).

Generally, usability of the S2SREX function was a common complaint among participants. The screen became very much cluttered, when several ships routes were shown, what made it difficult to see which route belonged to which ship. (3.3.6 p.14) Further considerations were made about information overlay on the ECDIS Display, obscuring the chart (3.3.9. p.35)

S2SREX function was not considered to be usable in dense traffic conditions, i.e. with many close quarter situations. (3.3.6 p.14)

In opinions from the life testbeds, although being positive to the function, some concerns were made on display issues. It shows the importance of proper HMI, but also familiarisation with the new tools and getting used to working with them
“(...) there are settings available to filter, which ships routes you want to display based on route CPA and TCPA. As with all electronic aids to navigation, the meaning is not to interfere with proper lookout.” (STM 2019b pp.56-7)

4.3.4 Workload
Potential confusion, emerging from implicitly made assumptions, that the “route” and “intention” to be the same think, as well as the issue of lacking information clarity, when multiple routes tangled together (in more complex traffic situations), were reported as likely being contributing to extra mental workload to the navigators, if they decided to use S2SREX for tactical decision making in close quarter situations. (3.3.8 p.22)
However, it should also be emphasised, that S2SREX allows OOW early planning of manoeuvres and avoiding extra turns and speed change. (3.3.9 p.32)
Needless to say, that reduction of unnecessary communication on VHF (3.3.6 p.14) might contribute to reduced workload on ships.

4.3.5 Training and familiarisation
Almost all participants agreed that training for the STM Services, including S2SREX, could be built into an ECDIS model course or an 8-hour training. It would not require an additional stand-alone course.
Generally, participants also agreed that a simulation/practical aspect to the training should be required where they can practice using the services in an operational environment. (3.3.6 p.17)
Over-reliance on S2SREX function and provided information might be dangerous. (3.3.6 p.14)
From the operational point, it would be essential for navigator to gain a good knowledge about limitations and restrictions in use of this STM-function in order to use it properly. This aspect is further discussed in Ch.7.

4.3.6 Navigational Safety
Approximately two thirds of participants believe that this service will have a positive effect on navigation. However, S2SREX was also found controversial because participants were not convinced it would be used properly. (3.3.6 p.14)
Participants were of opinions, that the function provides useful information about other ship’s routes and their waypoints, allowing planning own ship’s manoeuvres early and avoiding extra turns and speed change. (3.3.9, p.32) This function helps OOW with identification of other ships’ intentions, planning and decision making, thus in consequence, acting accordingly. (3.3.6 p.14)
Participants in the SAR-exercises were of opinion, that STM tools had positive impact on safety of navigation, since there would be fewer collisions or dangerous situations thanks to the exchange of routes between ships (3.3.9. p.32)
On several occasions, the participants considered themselves having failed to maintain a safe CPA and even got surprised by the manoeuvre of other ships. It was both, under baseline, i.e. without STM services, and controlled, i.e. with STM services scenarios. In general terms, the use of STM services i.e. S2SREX and RDV, was considered to improve the likelihood of maintaining safe CPA, however not necessarily decrease the likelihood of getting surprised by the manoeuvres of other vessels. (3.3.8 p.17). The most challenging in the terms of maintaining the CPA were situations with multiple possibilities to avoid close quarter situations in the area adjacent to a TSS, considered as a less constrained. Nevertheless, in situations (scenarios in EMSN simulations) considered as difficult, this service “demonstrated a potential value of the S2SREX service when it comes to maintaining a safe CPA”, according to report from the exercise. (3.3.8 pp.17-18)
Participants were concerned, that ships were not following their broadcasted route, which could be a risk if a navigational decision is made based on false information. (3.3.6 p.14)
The navigational risk was identified, if it would be “taken for granted that the information equals reality”, “The overall picture will be clearer on both ends but only if every participant will follow his route plan”. (3.3.9 p.36)
Over-reliance on this service would be dangerous. (3.3.6 p.14)

The perceived impact of S2SREX service on participants’ decision-making in navigation has been examined and categorised in relation to the safety of navigation.
For further insight into appropriate data, please refer to STM, 2019c: 3.3.8.
The test participants admitted a tendency to be less willing to deviate from their routes, while knowing that the monitored route is broadcasted and exchanged with other STM-compliant ships. (3.3.8 p.20). The tendency to be less willing to deviate from their monitored route has been depicted in the Figure 9 below.

Most of the participants recognised the risk, that the ECDIS with S2SREX and RDV functions would be used instead of RADAR/ARPA or visual means, when determining the risk of collision. (3.3.8 p21) Mentioned tendency in use of ECDIS would have an impact on safety issues of navigation, which was further discussed in the report (see Ch.7).
During de-briefing discussions there was no consensus amongst the participants if they would have done manoeuvring differently with the S2SREX service available (in baseline scenarios) or without it (in experienced controlled scenarios). However, the tool could influence some of their decision-making processes. The recorded video showed that different navigational solutions were applied in avoidance of any close quarters situations in all scenario trials and a kind of “standard” solution has not been identified. (3.3.8 p.21)

Based on the majority of the responses from the participants, there were two major aspects, pointed out by responders, namely that:

i. the tool was perhaps not applicable for tactical manoeuvring (ref. to Ch.1) in collision avoidance. The respondents were of opinion, that close quarter situations involving multiple vessels may be highly complex and constrained as regarding to space and time.

Figure 9 Perceived willingness to deviate from monitored route. Source: STM (3.3.8 p.20)
ii. the tool had been largely recognised as helpful support tool for strategical planning (ref.to Ch.1). The respondents were of opinion, that in case of less temporal and spatial constraints, when the ships are far away from each other, the routes exchanged and visible for OOW allows involved ships to get more understanding as to the plans of other ships. Thus, an early planning or, in some cases, warning for potential possible close quarter situations, was made feasible with S2SREX to undertake steps to avoid it evolving into close quarter situations.

It should be emphasised that using S2SREX did not necessarily make the OOW contravene the COLREGs by following the monitored route. It is, however, "likely to cause potential confusions and risks when the "route" and "intention" were "implicitly assumed to be the same thing, especially if the CPA value is relatively small" (3.3.8 pp. 20-2).

The number of breaches of the COLREGs was significantly higher, when S2SREX was available, although none of the breaches resulted in any collisions. Introducing S2SREX may potentially introduce situations, where OOWs might disregard the COLREGs. (3.3.8 p.26)

However, from the other side, the possibility to early planning would be helpful to develop navigators’ Situational Awareness, which would in turn support their navigational actions that follow the COLREGs.

As expected (with ref. to MonaLisa 2.0 presumptions and reports), the function was considered of no-relevance for tactical manoeuvring for the purposes of collision avoidance. (3.3.8 p.21) This is one of the key-points to note as outcome in the validation process.

This issue is considered in recommendations, Ch.7

The post-scenario questionnaire data shows that some of the responders were of the opinion, that the information displayed for S2SREX, when used in more complex traffic situations, was confusing and this number a little higher for the S2SREX with RDV function.

"In such cases the risks of over-reliance and misinterpretation data obtained from S2SREX and RDV cannot be ignored, which was correlated to the responses in the debriefing questionnaire in terms of "risk level":

Half of the participants evaluated the risks as medium or high." (3.3.8 p.22)

The S2SREX function with RDV was largely recognised as a strategical planning support tool. (3.3.8 p.22), offering helpful visualization of CPA. (3.3.6 p.15) However, Bridge Teams must ensure not to over-rely on the RDV. It is a tool in S2SREX service and it must be used solely as such. (3.3.6 p.15)

Figure 10 depicts the perception of risks of over-reliance and misinterpreting of data.
4.3.7 Operational Procedures

It has been stated, that majority of participants (ref. to Navigational Safety §4.3.6) were aware of the risk that ECDIS with S2SREX and RDV functionalities would be used instead of RADAR/ARPA or visual means, when determining the risk of collision. Some of them were of the opinion, that it would be extremely likely to happen when services are introduced. To cope with this issue would mean a change in operational procedures, further discussed in Ch.7.

Nevertheless, S2SREX was largely recognized as a helpful strategic planning support tool among the test participants, i.e. at a longer range (3.3.8, p. 29), while attempts to use the same for tactical planning purposes resulted in increase of mental workload for navigators and confusion. (3.3.8, p. 22)

Introduction of the S2SREX service also seems to suggest that it is more likely that navigators may change their current approaches and preferences as to the means of communication. In terms of VHF communication, majority of participants believed that with S2SREX it would be change in communication patterns (both more and less option) and thus procedures, while some of them believed it would remain the same. (3.3.8, pp. 21-2)

However, these numbers need to be further examined in comparison to the quantitative data received from appropriate simulation runs, indicating e.g. that the communication patterns between ship and VTS/SC station will be significantly affected with the integration of the STM services (ref. to 3.3.6 p. 20).

4.4 New Route Suggestion (NRS) function

New Route Suggestion service specific cases in SAR operational use and Winter Navigation have been presented in appropriate dedicated subchapters of this report.

4.4.1 Information need

Participants were of opinion that NRS service allows to include local knowledge and up-to-date information into the route planning process. (CML, 2018-03-13)

Here, some additional explanation shall be given about the fact, that in specific situations, the SCO sent NRS proposals to the ships in purpose of checking service’s function rather than due to particular need of ships. (3.3.6 p.16)

Sending of Route suggestions to ship, “must be in conjunctions with information on the reason for the route suggestion.” (FUAS, March 2018) It would be of vital importance to provide ships with such kind of information, giving understanding of Route suggestion proposal and supporting bridge team in each particular case.
It was commonly recognised by the participants that, considering usability of the service of Route Cross Check and Route suggestions, the SCO “should know the ship characteristics and its basic data (draft, length, ROT, company policy on safety parameters, etc.).” (CJ 2018-03-14) Again, this was found to be of high importance for these functionalities. However, acceptance of the new suggested route is always the subject to Master’s approval (ref. to SOLAS, Ch.V, Regulation 34-1).

It was also emphasised, that “S2SREX routes interchange, will (...) reduce misunderstandings” (CJ, 2018-03-13), thus positively influence perception and understanding of information. It is difficult to escape the conclusion, that it would also be the case of ship-shore REX and NRS, both for VTS/SCs’ and ships’ would gain on situational awareness.

According to participants, STM services and tools as Route Exchange and NRS, can reduce language barriers or issues by making the routes visible to both end users. Besides providing necessary information, visualization of the operation enables better understanding and thus reducing the possibility of misunderstanding and human error, improving SA and making e.g. “easier to explain suggested routes or search patterns”. (3.3.9 p 34)

4.4.2 Situational awareness
Sending of Route suggestions to ship, “must be in conjunctions with information on the reason for the route suggestion.” (FUAS, March 2018) It would be of vital importance to provide ships with such kind of information, giving understanding of Route suggestion proposal and supporting bridge team in each particular case.

Another issue, taken into consideration during post-exercise debriefings, was the probable “risk of “over trusting” by vessels”, when using e.g. NRS. The bridge team would be in all cases obliged “to check the route anyway, so why not just create it themselves.” (WMA, 2018-03-14)

Some of participants pointed out, that “Loading, checking, re-planning is time consuming and stands against situational awareness.” (FUAS, March 2018) and “If not doing it yourself (over-relying on Route Cross-Check) you may not be so aware of the hazards etc.” (WMA, 2018-03-15)

4.4.3 Usability
On the other side, some negative opinions, about NRS were expressed “No, standardisation of Routes”, (WMA, 2018-03-16) but even lapidary “No” (WMA, 2018-06-13), when discussed the impact of the service on improvement of safety.

The usability of the service was criticised, as “Route suggestions have too many clicks. It should be simpler, because in a tight situation you might need to leave it undone.” (AM, March 2018)

When changing the route, as proposed, “You probably need proof that you do it. Would be nice if it was automatic” (CTH, 2018-03-14)

4.4.4 Workload
With the STM services (Route Suggestions and S2SREX), the burden on navigators due to execution of navigational task was lowered. The time was not spent on updating the waypoints into the ECDIS. It was also pointed out, that NRS tools were very helpful especially in case of routes with many waypoints. Receiving the new route and waypoints reduced workload of OOW. Moreover, these services released time for other important tasks, especially in safety critical and dynamic situations. (3.3.5 p.10, p.12)

Some participants rightly claimed that “A new suggestion required the captain to do the check again” after NRS received and “that the captain needs to approve changes to the route before it should be taken into use”. (AM, March 2018) “Thus, every change of waypoint or schedule must be communicated which will take a lot of time.” (CML, 2018-03-13) However, as further provided in Ch.7, this is also the issue of consideration in SOP.
4.4.5 Training and familiarisation

No specific training requirements for OOW were noted in regard to use of NRS services. However, bridge participants agreed, that personnel, providing NRS service, “must have the appropriate skills & training in order to be able to conduct Route Checking/Route suggestions etc.” (WMA, 2018-03-13)

Moreover, VTSO/SCO “should know the ship characteristics and its basic data (draft, length, ROT, company policy on safety parameters, etc.).” (CJ, 2018-03-14) and how to use or interpret it.

4.4.6 Navigational safety

In the terms of safety of navigation, participants were of that “If things like “minimum separation” between similar/recommended Routes were to be considered, this would improve safety.” (WMA, 2018-03-14) Some concerns were expressed in regard to the risk of “standardisation of Routes”. (WMA, 2018-03-16) However, it was rightly emphasised during one of the de-briefings in regard to NRS, that “It is an advisory to the Master – he is the final judge.” (CTH, 2018-06-12) (ref. to SOLAS, Chapter V, Regulation 34-1).

4.4.7 Operational procedures

Participants were of opinion, that “It Should not be vessels requesting new route – should be VTS sending out a route. Change course as would for another vessel, visual is better than oral in terms of oil spill”, (CTH, 2018-06-12) or in other circumstances, if further action on a ship would be required.

“Example: once the ship got the NW – some ships changed routes – wasn’t necessary to send a new route. VTS sent to either one that requested or ones that did not alter their route.” (CTH, 2018-06-12) This, in turn, means that clear ship-shore-ship procedures need to be established for NRS service.

Regarding Route exchange and Route suggestion the critical opinion was expressed regarding re-inforce of the “follow the line” philosophy (…), especially regarding Routes being sent from Shore Authorities.” (WMA, 2018-03-14)

Indeed, in case of SC under direct supervision of responsible authority, that risk cannot be ignored.

It should also be emphasised, that captain has to approve new routes “before it should be taken into use.” (AM, March 2018) and appropriate procedure need to be implemented it in the standing orders: “changing the route, requires new approval – BUT this will be taken care of in standing orders.” (CTH, 2018-03-13) (c.f. e.g. §§ 4.4.1, 4.4.6)

Mention should also be made of discussed legal/organizational aspects of NRS: “who will suggest and why”. (FUAS, 2018-03)

However not tested in EMSN-simulations, one of participants liked the “the idea of weather routeing.” which might be provided in specific cases by SC or other service provider. (WMA, 2018-03-14)

4.5 Route Cross-Check Service (RCCS)

4.5.1 Navigation safety and Situational Awareness

“If not doing it yourself (over-relying on Route Cross-Check) you may not be so aware of the hazards etc.” (WMA, 2018-03-15)

REX/Route Cross Check was also discussed from safety and SAW perspective, pointing out possible duplication of work and the risk of “over trusting” by ships. (WMA, 2018-03-14)
4.5.2 Workload

The usability of the Route Cross-Check and NRS service was questioned by some participants, as well as workload was discussed, as ships “have to check the Route anyway, so why not just create it themselves.” (WMA, 2018-03-14) According to one of the VTSO/SCO “sometimes ships changed their Routes at the same time as the Shore Centre was doing it.” (WMA, 2018-03-14)

4.5.3 Training

No any specific need of training for OOW were identified in regard to RCC service, however during de-briefing discussions, some participants pointed out additional requirements towards VTS/SCO, as “Ability to see Routes and monitor them was very useful indeed but personally as a VTSO I would not have the capacity to check and send new updated Routes. Few VTSO will have the experience and skills required.” (WMA, 2018-03-14)

4.6 (Baltic) Navigational Warning Service

The Navigational Warning Service (NWS) was the most appreciated service by the participants of EMSN simulations in regard to safety and efficiency (3.3.6 p.13), where the latter could be perceived, to authors’ best understanding, also as related to workload and performing of duties.

4.6.1 Information need and communication

The message notification, which appeared directly on the ECDIS, was appreciated by the users. It was pointed out, that notification, appearing directly on the ECDIS, would alert BT much sooner. Participants were of the opinion, that this service would allow reducing “noise in communications” on VHF, as navigational warnings promulgated by that means could be superseded by the NWS and graphically depicted on the ECDIS. (3.3.6 p.14)

The life-testbeds end-users pointed out that information was easy to access. (2.12 p.36)

4.6.2 Situational awareness

NW services have been found benefiting the users. However, the Navigational warnings messages have been found somewhat difficult to detect. In one particular case it took 3 minutes before the bridge team noted the new message even though their attention was mainly on the ECDIS. (3.3.5 pp.11-2)

The reception of the message within 3 minutes or even somewhat more, as observed in other EMSN exercises with STM-tool, and “consumption” of it, yet is advantageous in comparison to the contemporary way of distribution of Navigational warning messages. Thus, the NWS function would be unlikely to be hindering improvement of situational awareness.

It was pointed out, that the instant notification, provided by the NW service, would alert the BT much sooner, in comparison to e.g. printed NAVTEX message, which could remain unseen for hours. (3.3.6 p.14)

4.6.3 Usability

Navigational Warnings were found “really good - easy to use and intuitive.” (CML, 2018-06-12)

As mentioned above, it has been noted, that detection of incoming Navigational Warning messages was somewhat difficult to spot and thus delayed, according to the observers. This fact was also taking place in other exercises in EMSN, might be considered as HMInterface and design related issues. (3.3.5 p.11)

Usability of this function would benefit from adding a “kind of button”, enabling to confirm message received. (3.3.5 p.12)

The life-testbeds end-users complained about delay in receiving service response. In that case the response time depends on system settings and the ship’s connectivity. Regrettably, connectivity of ship is still an issue for some of them.
One of STM-ships Bridge Team appreciated the easiness of discovering and clear marking of an alerted area. That was also the case when pointed out the easy access to information by clicking “the grey box” and reading. However, the NW markings cluttered up the picture, what was found annoying navigators. (STM, 2019b pp.35-6)

4.6.4 Workload
It was pointed out during EMSN de-briefings that the automatic plotting of the NW could contribute to reduction of workload for Bridge Team (BT) (3.3.6 p.13). Skipping the need to listen, record and plot the coordinated would result in possibility to use that time to perform other navigational tasks. (3.3.6 pp.13-4)

4.6.5 Navigational Safety
The message notification, which appeared directly on the ECDIS, would alert BT much sooner than a printed NAVTEX message, which participants said could remain unseen for hours. Furthermore, instant notification could provide additional time for the bridge team to react to the message if necessary. (3.3.6 p.14)
Participants were of opinion, that NWS could allow reducing human related errors. (3.3.6 p.14)
In general, the opinion was expressed, that “Navigational Warning: Good, increases safety”. (CTH, 2018-06-12)

4.6.6 Operational Procedures
It was observed during life-testbeds performed broadcast of NWS (Both Baltic Sea testbed and Mediterranean) that a whole Voyage Plan, i.e. a route with ETA at its respective waypoints, of STM-compliant ship need to be transmitted to NWS providers in order to ensure proper functionality of the service. Exchange of geographical data and time-related information is a prerequisite of this service that need to be transmitted from ship.

“Baltic Navigational Warning Services: Vessels trading in the Baltic area are encouraged to share their routes and schedules with BNWS and in return Navigational Warnings are sent to their ECDIS. This service has received a positive reception from the test vessels.” (STM, 2018a)

4.7 (Nordic) Pilot Route Service
“Planning a route passing through previous unvisited areas could be tedious and difficult. Officer of the watch on board might need to consider unknown obstacles such as shallow waters, speed and size of the ship, local regulations etc. and in most cases a pilot is needed. When the pilot boards the ship, a pilot route candidate could be included into the route that is loaded into the ship’s ECDIS system and if the pilot agrees, it can be used for navigation into or out from the port.”

“The Nordic Pilot Route Service (NPRS) is an onshore service that exposes a route catalogue consisting of pilot routes in RTZ format. NPRS service is intended for real time usage during the route-planning phase. End users (ships and shore centers) uses the service either by sending their planned route or by sending a STT Text Message with an area included. For the sent in route NPRS will perform a geographical search for pilot routes based on the waypoint coordinates in the route solely i.e. NPRS is not dependent on UN/LOCODE or any naming objects. For a sent in area, NPRS will return all pilot routes intersecting that area. NPRS is including pilot routes from Sweden, Finland and Norway (restricted to Bay of Oslo). NPRS architecture enables connection to many databases and each request will merge the search for routes among all of these.” (STM, 2019b p.28)
The data for Nordic Pilot Route Service evaluation has been collected in life testbeds and made available for further operational analysis in the STM-VP, Act.2: Voyage management testbed report. (STM, 2019b)

4.7.1 Information and communication
The responsible OOWs appreciated opportunities to get reliable and well-proven routes berth to berth, in particular for a port the ship had not called before. In case of a voyage plan made berth to berth, the pilot routes were used for comparison and found being of great value. In case the ship did not have a route from ECDIS as a layer in radar, the own route would not be considered when navigating with pilot. (STM 2019b, p.32) Indeed, it was opportunity to get the same picture of route with the pilot, available in advance for whole Bridge Team. Resulting from appreciation of the service, it would be desirable to make the NPRS available in all ports throughout the Nordic countries. “Alternatively, there could be an online list available, that states in with which ports the Pilot Route Service is working in.” (STM, 2019b p.32)

4.7.2 Situational awareness
NPRS users appreciated the value of getting the route information earlier, i.e. prior to arriving the port, because “When pilot is boarding it is already a lot of information that is to be exchanged in a short time. Knowing the route on beforehand would give more time to other information.” (STM, 2019b p.32)
Indeed, this NPR Service should be seen as improving SAW for Bridge Team.

4.7.3 Usability
The life-testbeds participants appreciated usability of NPRS and availability of service “by downloading pilot routes from the Swedish Maritime Administration website” when we bound for some Swedish ports with rather complicated approach and long fairways. “This Pilot Route Service is smoother as it goes directly into our ECDIS”
It would be desirable to make the NPRS available in all ports throughout the Nordic countries. “Alternatively, there could be an online list available, that states in with which ports the Pilot Route Service is working in.” (STM, 2019b p.32)

4.7.4 Workload
In case of a call at a new, i.e. not called before, port, the route need to be created by the crew. Use of NPRS saves time and is easy to access. When going to a known, i.e. visited before, port, the received NPR could be compared with own route and possibly adjusted. “Good check for own route”. (STM, 2019b p.32) Thus, again, saving time and resources.

4.7.5 Training and familiarisation
Results from the life-testbeds showed, that it would be important, that the users know how the service is working. (STM, 2019b p.32)

4.7.6 Navigational Safety
“When going to a new port and we don’t know the way of the route it saves time and is easy to access. When going to a known port for example Gothenburg we used it to compare our own route. It was almost the same. Good check for own route.” (STM, 2019b p.32)

4.7.7 Operational Procedures
Standard Operating Procedures would need to be established for use of NPRS, e.g. for a call at “new”, respectively previously visited port.

“We will not use your routes between Pilot-Pilot, but Pilot to berth would be interesting. I have informed navigation officer to start to include “Nordic Pilot Routes”, so when he has
time he will use NPRS. We are always planning berth to berth, which should be done before leaving berth.” (STM, 2019b p.32)

4.8 Enhanced Monitoring Service (EMS)

"Enhanced Monitoring Service is basically what the VTS has been doing since the 1950s. A ship is monitored and surveilled by an operator from shore and if the ship should seem to be running in to a potentially dangerous situation e.g. heading for shallow waters, the operator will alert the ship.

What differ the basic VTS service from Enhanced Monitoring Service (the term is used in conjunction with STM and shore centres, not in VTS) is that the STM shore centre receives the route from the ship, which is to be monitored in advance. It is also important to note that this route, sent from the ship, states the ship’s intentions. This gives the shore centre operator the possibility to review the ship’s planning of their approach to shore. Should the ship deviate from its intended route the shore centre operator will be alerted that the ship, for some reason, no longer is complying with its plan." (STM, 2019b p. 70)

Nevertheless, the authors of this report are of the opinion, that the term Enhanced Monitoring Service is not exclusively applicable to the Shore Centre and its activity. Arguably, the Enhanced Monitoring Service could also be provided by VTS. This issue is further examined in Ch.7.

The appropriate data, concerned Enhanced Monitoring and related to ship, collected in EMSN, was classified as follows:

4.8.1 Information need and communication/Operational Procedures

The notion was made by the participants, that STM Enhanced Monitoring Service and route sharing function, enables that SC operator would be able to communicate with numerous vessels without needing to use VHF. (WMA, 2018-06-14)

4.8.2 Navigational Safety

Enhanced Monitoring Service would allow to monitor from the shore side, if for some reason, monitored ship deviated from her intended route. By means of the STM technology, the VTS Operator will be alerted and ready to contact ship in an alarming situation in case, for some reason, the ship has left her plan. (STM, 2019b p.71) Thus, this service would contribute to enhancement of safety of navigation in covered area.

Concerns were expressed by some of the participants about the risk, that “monitoring might result in increased laziness” (AM, 2018-03), meant probably as the complacency of Bridge Teams.

4.9 Search and Rescue (SAR) operations service

The data for SAR operations has been collected both in EMSN (STM, 2019c: 3.3.9) and life testbeds (STM, 2019b). For the analytical and evaluation’s purpose the appropriate source was clearly defined and stated in applicable sub-chapter and its parts. The data has been collected in the process of de-briefing, as well as partly from the questionnaires. Further elaboration and pre-analysis have been carried out by the EMSN and HF team as well as ACT.2 SAR experts, involved in life testbeds. Appropriate results from ACT.2 STM live testbeds report (STM, 2019b) were, to extent deemed applicable, taken into consideration in this report.
4.9.1 Information and communication

Easy access to SAR operation related information and traffic information is considered critical for planning SAR operations. Sharing of information helps to maintain a higher level of situation awareness and safety during the operations, as pointed out by test persons. (3.3.9 p.40)

Test participants see the introduction of STM services as an improvement in the transfer and exchange of information. STM is an enabler of holistic coordination of all rescue operations and units through the shore side. (3.3.9 p.34)

Similarly, sharing critical information with all involved actors in a clear and effective way, enables better understanding and thus reducing the possibility of misunderstanding and human error, thus contributing to enhancement of safety of navigation during operations. (3.3.9 p.40) Addition of the Chat message service to the available communication channels (i.e. VHF and NAVTEX) is expected to improve this process and safety. (3.3.9 p.39)

However, with the current way of communicating via VHF it is possible to have closed loop communication, while via STM this possibility might be lost. (3.3.9 p.37)

Feedback from the SAR units in the life testbeds indicated positive evaluation of STM functionalities, pointing out that much more data was exchanged, faster, in the clear for all (between MRCC and SAR Units) way and with less mistakes (STM, 2019b p. 54). What more, it wouldn’t be achievable without STM tools. (STM, 2019b p.55). This, in turn, resulted in reduction of time to start research for SRU. (STM, 2019b p. 54)

Faster, clear and with less mistakes and simplified communication in SAR operations (STM, 2019b pp.54-5) contributes to enhancement of safety of navigation.

The addition of the Chat message to the available communication channels (i.e. VHF and NAVTEX) is expected to improve the exchange of safety critical information, enable better understanding and, thus, reduce the number of mis-understandings and human error. It should be mentioned at this point, that the search pattern broadcasts in SAR operations were highly valued by the participants, as both sides (ship and shore) could see the big picture and make sense of it in an efficient and effective way.

This would be possible mostly because of the holistic approach utilized in the STM concept through sharing information with all actors in a clear and effective way, such as the visualization of the operation. (3.3.9 pp. 39,40)

Visualization of the SAR operation enables better understanding and thus reducing the possibility of misunderstanding and human error, making “easier to explain suggested routes or search patterns”. (3.3.9 p 34)

Use of STM services to transmit/exchange information was considered by many test participants on the bridge as more useful and effective, than exchanging the information by traditional VHF and NAVTEX channels.

The majority of participants expect less of traditional communication, because the future use of STM services increase information exchange efficiency, improve collaborative operations performance and save time through e.g., “keeping everyone in the communication loop”. (3.3.9 p.33)

Participants pointed out, however, that with the current way of communicating via VHF it would be possible to have closed loop communication. Via STM you might lose that. (3.3.9 p.37)

STM services will increase information exchange efficiency and improve collaborative operations performance. However, introducing STM services may also increase the amount of information exchanged. (3.3.9 p.40)

It was also pointed out, that the use of the STM services is depending on area and scenario. Generally, it was considered appropriate only for the normal navigation in open waters but limited in congested waters/TSS navigation or scenarios beyond SAR operations. (3.3.9 p.36)
The STM services can reduce language issues/barriers by making the routes visible. Besides providing necessary information, visualization of operation enables better understanding and thus reducing the possibility of misunderstanding and human error the SAR operations. (3.3.9 p.34) This, in turn, means positive impact on situational awareness of bridge team during SAR operations. Mention should also be made, that easy access to SAR operation related information and traffic information is considered critical for planning and performing SAR operations. Sharing information helps to maintain a higher level of situation awareness and safety during the operations. (3.3.9 p.40)

4.9.2 Usability
Some of the usability issues were due to technical, functional or regulatory limitations (e.g. the way the information may be presented on the ECDIS) while others may have been due to the participant’s lack of training and familiarization with the equipment. (3.3.9 p.34, p.43)

Life testbeds participants from the SAR Units (SRU) reported some usability issues connected with sending long names (geographic). (STM, 2019b p.54) This issue was, however, identified as mainly connected to SRU peculiarity (small units) and its activities in extremely hard environment. In such conditions the voice communication might be more appropriate. (STM, 2019b p.55)

One other point was regarding the exchanging text messages between MRCC/SRU as a chat function was found in most cases not possible given the environment on board, i.e. small unit, high see, dark, inexperienced crew, etc. Here the preferable and more relevant would be the voice communication. (STM, 2019b p.55) Resulting from lessening of the voice communication between MRCC and SRU, more “time slots” would be created and available for short message transmissions, e.g. confirmation or acknowledgments from SRU. (STM, 2019b p.55)

4.9.3 Operational procedures
According to the participants, the STM tools simplify operational procedures. (3.3.9 p.32) In their positive evaluation, the participants expressed an appreciation of an emerging holistic approach in coordination of SAR activities so that “operations become safer and more efficient. (…) the overall coordination performance using the STM services is improved mostly because of the holistic approach utilized in the STM concept.” and that “holistic coordination can more effectively control rescue operations”. (3.3.9 p.31) STM makes possible holistic coordination of all rescue operations and units through the shore side, resulting in more efficient processes. (3.3.9 p.34)

STM services in SAR operations will conceivably improve the MRCC’s overview and provide the possibility to direct and monitor SAR-units and vessel of opportunities in search and rescue operations. (3.3.9 p.39) However, stating that,

“all parties involved in a SAR operation need to assume that all other vessels are equipped with these advanced systems, use the services and actually follow their monitored routes, otherwise it will likely become a risk”. (3.3.9 p.36)

It should be considered as a limitation of the STM concept during its implementation and voluntary phase, thus further discussed in Ch.7.

The participants pointed out, that the efficiency of the system would increase by a new distribution of roles in a SAR operation. (3.3.9 p.39), where

“Introducing the STM concept in SAR operations will likely influence the operational and management procedures on both shore and ship sides. The possible changes on the management procedures did not concern ships only but more likely was a part of the emerging synergy, which includes the operational and management practices of all parties involved in the SAR (e.g. ships of
opportunity, dedicated SAR units, other vessels, MRCC or shore-based control centre)." (3.3.9 p.41)

The perspective of such change

“suggests the importance of information coordination via technological means and may have implications on (...) operational practices for regulatory authorities, organizations and shipping companies." (3.3.9 p.41)

Introducing the STM concept in SAR operations will likely influence the operational and management procedures on both shore and ship sides. The possible changes on the procedures did not concern ships only but more likely was a part of the emerging synergy, which includes the operational and management practices of all parties involved in SAR. This system perspective, in turn, suggests the importance of information coordination via technological means and may have implications even on operational practices for regulatory authorities, organizations and shipping companies. (3.3.9 p.41)

Data collected in life testbeds indicated reduction of time to start search by SRU. (STM, 2019b p.54) This was achieved mainly due to simplified and faster communication procedures and data exchange amongst actors involved (MRCC and SRU) in operations. It was pointed out those new operating procedures for SAR operations, based on STM functionalities, need to be established for MRCC, SRU and Vessel of Opportunity (VOO). (STM, 2019b p.55)

The participants’ positive evaluation of STM concept could be summarised as an appreciation of an emerging holistic approach in coordinated SAR activities, resulting in safer performed as well as more efficiently and effectively controlled rescue operations. (3.3.9 p.31)

All parties involved in a SAR operation need to assume that all other vessels are equipped with these advanced systems, use the services and follow their monitored routes, otherwise it will likely become a risk. (3.3.9 p.36). This fact is considered as limiting for application of STM during implementation and voluntary phase of STM.

The STM services can reduce language issues/barriers by making the routes visible. The point is not just providing necessary information, but the visualization of the operation enables better understanding and thus reducing the possibility of misunderstanding and human error. (3.3.9 p 34)

4.9.4 Workload

In general, the participants of SAR exercises expressed opinion, that the workload and stress were naturally reduced due to use of STM tools, allowing them to put focus on “seamanship side” and searching instead of other secondary or administrative as well as reporting tasks. The same was mentioned regarding reduced strain and eased fatigue on board ships. (3.3.9 p.33).

However, some other participants experienced increase of workload,

“most likely due to using cognitive resources in an exclusive way (e.g., “normal communication via VHF allows simultaneous attention to several other things, whereas when using the chat all attention needs to be directed to that activity”). (3.3.9 p.36).

Other explanation might be that introducing STM services may also increase the amount of information exchanged, when using STM services. (3.3.9 p.40)

The real-life testbeds results show, that the workload on SRU was decreased. Less work in difficult conditions, reduced administrative burden, followed by time saving, allowed using saved resources for constructive work in operations. (STM, 2019b p.55)
4.9.5 Training
Concerning somewhat negative experience, reported by the participants, the dominant category was related mostly to functional limitations that the participants felt during its practical use. These were, however, supplemented by other non-functional concerns, where important from the operational point, was lack of training. (3.3.9 p.34) Participants were also of opinion, that education and training might need to change, (3.3.9 p.39), making this statement, however, without any more detailed information. Most participants considered the services useful and, with some training gained, rather easy to use. (3.3.9 p.42)

While some of the usability issues were due to technical or regulatory limitations (e.g. the way the information may be presented on the ECDIS) others may have been be due to the participant’s lack of familiarisation with the equipment. (3.3.9 p.43)

4.10 Winter Navigation
Data and internal reports from the EMSN (STM, 2019c: 3.3.5) performed tests were available, thus the simulation runs and the feedback from participants has been mainly taken into account for analysis of winter navigation services. The data was collected by observations of the bridges, debriefing interviews and, to some extent, feedback questionnaires.

Further elaboration and analyses were carried out by the EMSN team, including HF experts, and summarised in the STM 2019c (3.3.5) report.

It was considered by the EMSN team, that the appropriate data could be collected, and usability of the winter navigation services best determined and evaluated through observations and debriefings interviews, as the exercises were run only for two days, encompassing a limited number of participants in the exercises on 6 manned bridges. The observers focused on two main areas: the general situational awareness of the bridge team and their communication, both internal and external.

Furthermore, appropriate results from ACT.2 STM live testbeds report (STM, 2019b) were, to some extent, taken into consideration in this report.

4.10.1 Information and communication
During winter navigation tests in EMSN both internal and external type of communication has been observed. However, the research and data collection effort has been rather focused on capturing characteristics of communication in both, i.e. without STM tools and with these tools used, than on gaining insight in question if “the right information was available/accessible at the right time” for test persons. Thus, the analysis and discussion in this report is of general character. Due to EMSN simulations peculiarity and the scope of ice navigation exercises in the EMSN, the analysis is rather of indicative than any full-scale character.

Without STM:
The data collected allows making a statement, that there was quite a lot of ship to ship communication on the VHF regarding coordination about how to meet with other ships. The internal communication between the bridge team members was from good to excellent, even though a couple of points were made about less closed loop communication without STM services.

Some participants pointed out, that following the external VHF discussion it is also possible to get hints about the general traffic situation, thus to raise situational awareness of bridge team. This aspect was also pointed out by test persons in case of other type of EMSN exercises. (3.3.5 p.10)
With STM tools:
In particular situation, one test participant had some difficulties controlling the ship in the ice channel as he was replying to the Chat message while manually steering the ship. It has been observed, that Chat message tool may take the attention away from the navigation if the same person is writing an answer and steering the ship. (3.3.5 p.11,12) This occurrence, however, relates rather to the Chat message functionality, than informing about any specific attribute of the Winter navigation service.

4.10.2 Situational awareness
The general situational awareness of the bridge team was one (besides communications) of the focus area of the observers.

Without STM tools:
The situational awareness without STM tools was in general good. Teams with good communication and interaction had also good mutual shared understanding and situational awareness about the location of the ice channel and meeting point. Some difficulties were observed occurring to the teams in following general traffic situation. Keeping in mind, that one ECDIS was in use, updating the ice channel caused restrictions in ability to use the same equipment for purpose of following the traffic. In one specific situation, concerning the non-familiar with ECDIS functionalities crew, updating of ice channel information in ECDIS lasted for 20 minutes, causing complete loss of situational awareness. Uncertainty about ships position, lack of decision-making about adjustment of speed, lost ability to execution of voyage (the entrance of the ice channel) and lost picture of general traffic in the area, were the consequences. (3.3.5 p.10) This particular case also shows importance of proper training and familiarisation with navigational equipment on board.

It has been pointed out that following the external VHF communications allows being updated about the general traffic situation, thus to raise situational awareness of bridge team. (3.3.5 p.10)

Test persons in case of other type of EMSN exercises also pointed out this aspect.

With STM tools:
In general, improved situational awareness was noted (3.3.5 p.11) with STM tools. The time, otherwise spent on updating the ECDIS with waypoints of ice routes, could have been used for navigation. (3.3.5 pp.10-2)

It has been pointed out by test persons, that higher benefits are achieved in case of more extended ice route instructions with higher number of waypoints. (3.3.5 p.10) No cases of decreased or, more, lost have been reported from Ice scenario exercises with STM tools available.

The suggested route from the SC (or Icebreaker) together with the S2SREX service enhances the awareness of the traffic situation. Route suggestion sent from a local VTS/SC is also seen as a way of sharing local knowledge, which is deemed to be valuable and useful information, thus contributing to enhanced situational awareness and safe navigation. (3.3.5 p.11,12)

However, the risk of focussing too much on ECDIS, as a main source of information, instead on gaining situational awareness by “all available means” appropriate in the prevailing circumstances and conditions, has been pointed out by test persons. The tendency to use “less” radar in the favour of ECDIS has been pointed out by one of participants. (3.3.5 p.11)

There were also some other points, noted by the observers, like missing immediate reception of navigational warning or chat messages. At the same time, it has been also noted, that the bridge team paid their main attention to the ECDIS. (3.3.5 p.11) This situation might be HMI/interface and design related issue. However, reception of the message within 3 minutes...
or even somewhat more, as observed in other EMSN exercises with STM-tool, and “consumption” of it, yet is advantageous in comparison to the contemporary way of distribution of navigation warning. Thus, it would be unlikely to be hindering improvement of SA. Still, if we look at situational awareness, the Chat message tool may take the attention away from the navigation if the same person is actively engaged in information exchange of this type, while at the same time performing other navigational tasks. (3.3.5 p.12)

4.10.3 Usability

The STM service usability data was collected by observations on the bridges, debriefing interviews and feedback questionnaires. It was considered that the usability of the services could be best determined through observations and interviews rather than analysing numerical data as the exercises were run only for two days (once with STM services and once without) and only encompassed a limited number of bridges participating in the exercises (6 manned bridges).

Without STM:

It has been observed, that one bridge team updated the ice channel into ECDIS for 20 minutes. The causative factor was that they were not familiar with the functionalities of ECDIS. Due to occupying the only ECDIS for such a long time, the bridge team lost their situational awareness completely. In consequence, the participants “were uncertain as to where they were (they did not reduce speed), where they were supposed to go (the entrance of the ice channel) and about the other traffic in the area. Due to this confusion, the situation escalated and the bridge team could not make predictive plans about the future, ending up crossing in front of other vessels, entering the ice channel in a wrong angle and getting stuck in the ice.” (3.3.5 p.10)

This occurrence has been considered as of relevance to the safety of navigation.

With STM:

The feedback from test persons allows for stating, that the provided information (STM service suggested route/provided WPTs for ice the channel and planned meeting point) improves safety and efficiency in navigation. There is some indication that especially sending the waypoints as a route suggestion does reduce workload for navigators and therefore can have a positive effect on safety. (3.3.5 pp.11-2)

It has been observed, that the suggested route from the SC together with the S2SREX service enhances the awareness of the traffic situation, lowers the navigator’s workload and releases mental resources for other matters. Suggested route sent from a local VTS or S/C is also seen as a way of sharing local knowledge, which is seen as valuable and useful information, contributing to safe navigation. Shared routes (both new route suggestions and S2SREX) contribute, according to the participants, to release of time through reduction of workload. This in turn, makes possible to cope with other tasks, especially these upcoming in dynamic situations, thus considered as being safety critical. (3.3.5 pp.11-2)

However, at the same time, the Chat message tool may take the attention away from the navigation, if the same person is writing an answer and steering the ship. It has been observed, that one test participant had some difficulties controlling the ship in the ice channel, replying to the chat-message while manually steering the ship. (3.3.5 p.11)

Some points were made, that following the external VHF discussion it is also possible to get hints about the general traffic situation. (3.3.5 p.10) This possibility might be otherwise reduced by using STM-tools, thus potentially influencing the safety of navigation.
4.10.4 Workload

**Without STM:**
Higher workload was noted on several bridges without STM tools. It has been observed, that it was difficult to follow development of general traffic situation during the time of updating and simultaneous setting the ice channel information into the ECDIS. In case of one of the bridge teams, not familiar with ECDIS, this operation has ended up in loss of situational awareness, despite all efforts made by the team to get it working.

Due to this confusion the situation escalated, the workload increased, whilst the bridge team could not make predictive plans about the future, ending up crossing in front of other ships, entering the ice channel in a wrong angle and getting stuck in the ice. (3.3.5 p.10)

**With STM:**
With the STM services Route suggestions and S2SREX, the burden on navigators due to execution of navigational task was lowered. The time was not spent on updating the waypoints into the ECDIS. It was also pointed out, that NRS tools are very helpful especially when you have a lot of waypoints. Receiving the new route and waypoints from the SC reduces workload. Moreover, these services release time for other important tasks, especially in safety critical and dynamic situations. (3.3.5 p.10, p.12)

4.10.5 Training

During the Ice navigation exercises in the EMNS one specific occurrence has been observed, resulted in loss of situational awareness (see § 4.10.2). That case of a non-familiarised with ECDIS functionalities bridge team was found not to be in direct relevance to familiarisation with STM-compliant equipment on board, but rather of general importance of proper familiarisation and training in broader meaning. Mentioning this, the winter navigation simulations might be reflecting on or catalysing main occurrences during EMSN exercises.

**Without STM:**
As previously mentioned in this report, the need of proper training of OOW has been pointed out by the test persons and importance of it, aiming at ensuring appropriate skills to use the equipment. This is very true in case of ECDIS, as it has been observed during the ice navigation exercises that in contrary situation, the behaviour and performance of OOW is unsatisfactory. Thus, in certain cases, adventurous to safety of navigation.

Resulting from lack of familiarisation with the equipment and subsequent confusion, the bridge team lost the capability to make predictive plans about the future, ending up in unsafe situations, adventuring the safety of navigation. (3.3.5 p.10) Thus, the importance of training to ensure appropriate skills to use the equipment is of highest importance as well as complimenting familiarisation on board.

**With STM:**
The results are positive towards the use of several services even though more training is needed. In other case, tasks might take much more time to accomplish, adventuring good situational awareness and safe navigation as well as increasing workload. However, this does apply to the use of any kind of equipment. At the same time, the Chat message service may take the attention away from the navigation if the same person is dealing with chat messaging and performing other tasks at the same time (as e.g. steering the ship). (3.3.5 p.12)

Therefore, the need for training was pointed out to fully utilize the STM tools. More profound training on STM and it tools is still needed. The user manuals need to be simpler, according to test participants. (3.3.5 p.12)
5 SHORE (Shore Centre, MRCC)

5.1 Introduction
The appropriate data for Chapter 5 of this report has been collected during series of simulation runs in the EMSN and in the life-testbeds. For further insight into collection, pre-analysis, as well as analysis and evaluation process, applied for this report, please refer to Chapter 2 and relevant parts of introduction in § 4.1.1.

Further, the explanation need to be given, that some opinions, noted during post simulation de-briefings, however not expressed by VTSO/SCOs, have been deemed adequate and of relevance in the analysis of operational aspects of the “Shore” section of this report.

5.2 Chat message function

5.2.1 Information need and communication
Chat message function, was found useful for ship–shore/shore – ship communication, resulting in less misunderstandings as well as enabling fast and clear information exchange. (3.3.6 p.15)

Pointed out as advantageous in using Chat message function, was the possibility of reading the message again, meant that OOWs or SCOs “can always go back to check” (CTH, 2018-06-12) the message.

From the VTSO/SCO point of view, it must be ensured that navigators take notice of the Chat message, sent to them by VTS/SC. An update with the new function was proposed, aiming at allowing SCO to be notified if the message was delivered and seen on bridge, i.e. a kind of “Whats-App functionalities required (e.g. transmission info, confirmation for read messages.)”. (FUAS, March 2018)

Current way of communicating via VHF makes it possible to have closed loop of communication, while using only STM tools might lead to the loss of this possibility. (3.3.9 p.37)

Pointed out and discussed by the participants was the concern, that ships around would not receive the information sent by the mean of Chat. Consequently, ships, remaining outside information loop “won’t hear the agreements”. (CTH, 2018-03-13) Thus, the idea of group Chat message for certain area was discussed and pointed out as a kind of remedy, allowing passing partly this barrier in information distribution. (3.3.6 p.15)

However, what was also argued, the “exclusion” would remain, concerning non-STM-compliant ships that could “benefit from hearing the information.” Thus, “there is still a need for VHF as the information passed is often useful for ALL vessels in the vicinity to hear.” (WMA, 2018-03-14)

Chat message functions together with Route exchange functions, were found usable for VTS/SC, making an operator “able to share requested route changes with ships before making VHF contact and acknowledging with Chat.” (WMA, 2018-06-14)

It was also emphasised, that implementation of STM would enable providing “mariners (i.e. Masters and OOWs) with written instructions” from SC through Chat message function. (WMA, 2018-06-14)

5.2.2 Situational awareness
From an operational perspective, the observed shift in communication pattern towards alternative means of integrated communication, as e.g. Chat message function, instead of VHF, could lead to an unintentional negative impact on situational awareness as well as information overload for VTS operators. (3.3.6 p.22)

Pointed out and discussed by VTS/SC staff was the access to the information, broadcasted via STM tools, in this case Chat message function, when ships would remain outside information loop (ref.to §§4.2.1, 4.2.2) Needless to say, that this would be also the case for any non-STM compliant ship. Thus, “there is still a need for VHF as the information passed is
often useful for ALL vessels in the vicinity to hear.” (WMA, 2018-03-13) That is extremely important in case of safety related information, as e.g. broadcasted by VTS/SC, which, invariably, need to be sent over VHF.

Nevertheless, it is difficult to escape the conclusion, that STM through e.g. Chat message function, improves SAW, when “allows for excellent important/non urgent promulgation of information and reduces VHF traffic allowing operators to concentrate on important tasks.” (WMA, 2018-06-14)

5.2.3 Usability
The VTSO/SCO saw the need of knowing, that navigators took notice of the information, sent to them by SC, thus a new function to the Chat service was proposed, allowing SCO to be notified if the message was delivered and seen on bridge. (FUAS, March 2018)

5.2.4 Workload
From an operational perspective, the observed shift in communication pattern could have an unintentional negative impact on situational awareness, and information overload for VTS operators (3.3.6 p.22) Implementation of STM services (incl. Chat message function) improves transfer and exchange of information. However, it might also increase the amount of information exchanged (3.3.9 p.40), and thus might end up in an unwelcomed overload effect and thus increased workload for VTSO/SCO.

Some VTSO/SCO were of opinion, that “Chat function is overloading and disrupting for the Shore Centre Operator” and “Distracting for all concerned.” (WMA, 2018-03-13)

The results from the de-briefing indicated a potential shift of workload from the bridge crew to the VTS/ shore centre (3.3.6 p.18), however, that was not exclusively relevant to Chat, but rather a general statement about STM.

5.2.5 Training and familiarisation
Regarding Chat services, opinion was presented that “features such as Enhanced Monitoring and Chat would be fine, not much additional training would be required”. (WMA, 2018-03-14) However, as previously stated, the “generation gap” might be the issue at that point. Thus, the opinions of younger seafarers may differ from these of elder colleagues (3.3.6 p.15) in terms of the training needs as well as familiarisation at the workstation.

5.3 Route cross check and NRS
5.3.1 Information need
As already mentioned in previous paragraphs, participants were of opinion, that validation of ship’s route at VTS/SC would have to be based on appropriate information about ships characteristics, available to the VTSO/SCO. (CJ, 2018-03-14) Nevertheless, the final decision about acceptation or rejection of any suggested route would be to the Master’s discretion and his/her final judgement. (SOLAS, 1974 Chapter V, Regulation 34-1)

Moreover, with e.g. Route exchange, Route cross check, Route suggestion, “Routes of inbound vessels could be checked and acknowledgements made more efficiently than VHF” by using Chat. (WMA, 2018-06-14)

From the point of view of some VTS controllers, these functions will be crucial for Vessels traffic control centres, especially in high traffic density areas. (CJ, 2018-03-14)

5.3.2 Usability
Some of participants pointed out that they “saw the value” of Route exchange function and the ability to send Route suggestion. (WMA, 2018-03-15) while other expressed their opinions about NRS that “this function is impractical in most VTS areas. It can be applied in some concrete VTS areas, of course, but, I insist, in most of them t will be impracticable. (CJ, 2018-03-14)
5.3.3 Workload

Establishing the SC and STM-functionalities would “improve efficiency for ships. Checking a route takes less time than creating and checking a route. Master and OOW can do it together.” (WMA, 2018-06-15) In particular, this aspect was also discussed in regard to workload shift towards VTS/SC operators: “If there is too much information and data, capacity is reduced. Route monitoring, altering and sending Routes increased workload” for VTSO/SCO. (WMA, 2018-03-15)

The covered area for VTS/SC Route Cross-Check service would have an impact on VTSO/SCO’s workload: “The English Channel Exercise was considered too large an area to cover, especially in regard to Route-checking etc.” (WMA, 2018-03-13) and thus “More personnel/equipment would be required in a real Shore Centre covering such a large area”. (WMA, 2018-03-13) and “with designated areas and responsibilities”. (WMA, 2018-03-14)

5.3.4 Training and familiarisation

Participants were right, when stated about VTS/SC operators need that “to validate a ship route you should know the ship characteristics and its basic data (draft, length, ROT, company policy on safety parameters, etc.)”. (CJ, 2018-03-14)

Clearly expressed was the opinion, that VTS/SC operators must gain “appropriate skills & training in order to be able to conduct Route Checking/Route suggestions etc.” (WMA, 2018-03-13)

5.3.5 Navigational safety

“If done properly with the right people, properly qualified to conduct things such as recommended changes to Route etc. and in the right place”, (WMA, 2018-03-14) the use of Route exchange and Route suggestion functionalities would be contributory to increased safety of navigation - “If used correctly it will increase safety.” (CTH, 2018-03-14)

5.3.6 Operational procedures

REX was appreciated during VTS/SC operations,” because traffic management will become easier when planned routes are known at the SC.” (CML, 2018-03-13) Similarly, the possibility of “adjusting ETAs [was found] good for Flow Management/de-confliction.” (WMA, 2018-03-13)

5.4 Enhanced Monitoring Service (EMS)

5.4.1 Information need and communication

As argued by the participants, the STM services and functions, as EMS and Route Sharing, enable that SCO would be able to communicate with numerous ships without needing to use VHF. (WMA, 2018-06-14)

“Enhanced Monitoring Service can also be used to foresee dense traffic situations. Supposing that all, or nearly all, ships in e.g. Dover Strait or Gibraltar Strait are STM equipped a prediction can be made well in advance of the time and position of complex traffic situations. Furthermore, shore centres can transmit information regarding temporarily restricted areas for example military exercises, SAR operations etc.” (STM, 2019b p.72)

5.4.2 Usability

Without giving more explanation, one of VTSO/SCO made a statement, that EMS was very poor. (WMA, 2018-03-13)
Too many alarms produced during the exercises, explained the fact, that EMS was the only service that scored slightly lower in questionnaires, than the other STM-services. The usability could be improved with slight technical alterations, according to HF experts. (3.3.6 21)

5.4.3 Workload
One of the VTSO/SCO was of the opinion, that “the workload was quite high because due to some technical reason, “information was not readily available it seemed” (WMA, 2018-03-15) Availability of information and data could have led to reduced capacity of VTSO/SCO. That, in turn, caused increased workload for the SC Operator, during route monitoring, altering and sending routes proposal. (WMA, 2018-03-15)

It was argued that EMS might become complex in a sea area with several ports and busy traffic. (FUAS, March 2018) Thus, more personnel/equipment would be required in a real Shore Centre, covering such a large area. (WMA, 2018-03-13)

Furthermore, “more people [would be] required in the Shore Centre with [clearly] designated areas and responsibilities”. (WMA, 2018-03-14)

Some participants were of opinion, that traffic management would become easier when planned routes were available and known at the SC. (CML, 2018-03-13)

5.4.4 Training and familiarisation
Some inconsistency was noted between opinion that “features such as Enhanced Monitoring and Chat would be fine, not much additional training would be required.” (WMA, 2018-03-14), and the other argued, that “personally as a VTSO I would not have the capacity to check and send new updated Routes”. (WMA, 2018-03-14)

5.4.5 Navigational Safety
Participants identified the risk that EMS “might result in increased laziness”. (AM, 2018-03) of Bridge Teams.

The question of skills and competency of SC staff was pointed out, as
“ability to see Routes and monitor them was very useful indeed but personally as a VTSO I would not have the capacity to check and send new updated Routes. Few VTSO will have the experience and skills required” (WMA, 2018-03-14)

From the point of view of some VTS controllers, “these functions will be crucial for Vessels traffic control centers, especially in high traffic density areas.” (CJ, 2018-03-14)

Enhanced Monitoring Service can also be used to foresee dense traffic situations and thus, to act in advance to minimise or eliminate associated risks for ships traffic. “Furthermore, shore centers can transmit information regarding temporarily restricted areas for example military exercises, SAR operations etc.” (STM, 2019b p.72)

5.4.6 Operational Procedures
Implementation of STM and EMS would “increase the control over ships from the shore side, and crews will be reduced in number and qualification.” (CJ, 2018-03-13)

Participants expressed opinions that, “more people [would be] required in the Shore Centre with designated areas and responsibilities” (WMA, 2018-03-14), thus relevant procedures, with regard to appropriate duties and area of responsibility need to be on place.

It was observed during life-testbeds that a whole Voyage Plan, i.e. a route with ETA at its respective waypoints, of STM-compliant ship had been need to be transmitted to SC in order to ensure proper functionality of the service. Exchange of geographical data and time-related information is a prerequisite of this service that need to be transmitted from ship.

Furthermore, some legal and organisational aspects were pointed out, as e.g.: “who will observe and why” and “who will suggest and why”. (FUAS, 2018-03) These issues were partly
taken into consideration and, to some extent, answered in other document, i.e. “Legal and liability report”, STM_M23.

5.5 VTS and Shore Centre

For further insight into the topic please refer to IALA Recommendation V-127, IALA Guideline 1056,1032,1089 Provision of VTS Services INS, TOS & NAS and IMO Resolution A.857(20).

5.5.1 Information and communication

One of the aspects, the participants related to, was the scope of information needed at SC from and about the ship. Mentioning this, the meaning was that the SCO would need for providing specific services and operations, some information and data about the ship the operational services is aimed to. The opinion was expressed, that in order to cross-check and validate ship’s route a SCO should know the ship characteristics and its basic data, such as, but possibly not limited to, ships particulars, draft, ROT, speed, as well as some data on ships manoeuvrability. Furthermore, company policy on safety parameters required should also be informed and considered, when providing with e.g. Route suggestion. (CJ, 2018-03-14)

Some issues related to communication in the course of simulations (and observed even in real life testbeds) were discussed during de-briefings. Making general annotation, it was stated that specific functionalities, provided by SC service, mainly via Route exchange and Chat messages, were useful for ship – shore/shore – ship communication, resulting in less misunderstandings as well as fast and clear information exchange. However, “problem not usually is that the communications are not fast enough, but the issue is when one person doesn’t understand. Then someone must repeat information.” (CTH, 2018-06-13)

It has been pointed out by the HF-observer, that in one of the scenarios, “VTS sent almost as many chat messages as calls on VHF and a LOT less VHF traffic. (That was a) big difference from baseline runs.” An estimation from HF-observer was made, that “75% of communications were through chat and 25% on VHF” and “much more decreased than other simulations.” Judged by this measure, it was put simply “Lots less VHF communication and less chaos.” (CTH, 2018-03-13)

Furthermore, it must be ensured that navigators take notice of the information, sent to them by SC. It was proposed to add new function to the Chat service, allowing SCO to be notified if the message was delivered and seen on bridge. That meant, that a kind of “Whats-App functionalities required (e.g. transmission info, confirmation for read messages.” (FUAS, March 2018)

It was pointed out, that due to peculiar character of specific scenarios, as in Baltic Sea, the “Shore Centre personnel & Bridge Teams quite busy dealing with lots of information.” (WMA, 2018-03-13)

Affected by some technical disturbances, “the workload was quite high and this information was not readily available it seemed”, according to one of participating VTSO. (WMA, 2018-03-15)

A general remark was made, that sending of NRS from SC to ship, “must be in conjunctions with information on the reason for the route suggestion.” (FUAS, March 2018) It is of vital importance to provide ships with such kind of information, giving understanding of NRS proposal and supporting bridge team in each particular case.

There were some risks identified and pointed out by the participants during the post-exercise debriefings.
One of mentioned risks was “risk talking too much on the radio, i.e. your route is this, are you going there?” Related to this risk is also the statement from the HF-observer/SC instructor that “with STM Tools, there was actually much less talking on the VHF compared to previous exercises” (i.e. baseline scenarios). (CTH, 2018-03-13)

Another risk, pointed out and discussed by VTS/SC staff, is access to the information, broadcasted via STM tools, in this case Chat function, namely that ships around do not hear the information sent by this mean. In consequence, ships, remaining outside information loop “won’t hear the agreements”. Needless to say, that this would be also the case for any non-STM-compliant ship. That could lead to “win or a loss” situations. (CTH, 2018-03-13)

The participants agreed, that the “chat function [is] very useful for vessels out of range, but all navigational information should be done on VHF so that those not using the system can benefit from hearing the information.” (WMA, 2018-03-14)

One of participants pointed out, that STM tools, used correctly, would be helpful in performing SCO’s tasks, but “there is a risk that too much information could lead to important things being missed.” And “If there is too much information and data, capacity is reduced.” (WMA, 2018-03-15)

It was seen as a limitation or a gap in the information loop, if all interested or potentially involved, would not be able to receive that important information or would miss the agreements made. In conjunction with other STM simulations, i.e. STM-SAR exercises, the idea of group chat for certain area was discussed and pointed out as a kind of remedy, allowing passing partly this barrier in information distribution. However, what was also argued, the “exclusion” would remain, concerning non-STM compliant ships, that “can benefit from hearing the information.” Again, “there is still a need for VHF as the information passed is often useful for ALL vessels in the vicinity to hear. (WMA, 2018-03-13)

Another issue, taken into consideration during post-exercise debriefings, was the probable “risk of ‘over trusting’ by vessels”, when using e.g. NRS. The bridge team would be in all cases obliged “to check the route anyway, so why not just create it themselves.” (WMA, 2018-03-14)

Awareness should also be raised, that beside “duplication of work” thus increased workload, less controlled information exchange may cause increased level of misuse of services, as “sometimes ships changed their Routes at the same time as the Shore Centre was doing it.” (WMA, 2018-03-14)

### 5.5.2 Usability

One of the opinions, expressed during post-exercise debriefings was: “the STM concept is pretty good, but will it work in reality?” (WMA, 2018-03-13)

The Enhanced monitoring service in simulations was found working very poor, according to VTSO/SCO. (WMA, 2018-03-13) A general explanation might be some technical issues and immaturity of this service at the time the subject simulation was carried out.

For the sake of the good order, this opinion needed to be confronted with appropriate opinion from the life-testbeds. No corresponding opinions in the subject were found expressed by SCO's but on the contrary, a number of effective interventions were reported by Tarifa SC. (STM, 2019 e)

During de-briefings the view was presented, that STM functionalities might be of assistance to VTS/Ports for long term planning. More organised routes and exchange of information about will allow the analysis of vessel intentions operating on varying VHF channels and adjusting plans to keep operations seamless.

Consideration was given to the area of responsibility and, what could be called for, operational arena for the SC services. The opinions were presented that in extended area, as e.g. English
Channel (in the ESMN exercise), the area of operational services for SC “was considered too large an area to cover, especially in regard to Route-checking etc.” (WMA, 2018-03-13)

It was commonly recognised by the participants that, considering usability of the service of Route cross check service and Route exchange service, the SCO “should know the ship characteristics and its basic data (draft, length, ROT, company policy on safety parameters, etc.).” (CJ, 2018-03-14) Again, this was found to be of high importance for these functionalities. Furthermore, in order to get the Route exchange service usable, proposals sent to ships “must be in conjunctions with information on the reason for the route suggestion”. (FUAS, March 2018)

Opinions were expressed, that Route exchange and S2SREX were “Usable for ship – shore / shore – ship: less misunderstandings, fast and clear information exchange.” However, further notion was made, that “it must be ensured navigators take notice of the information.” and a kind of “Whats-App functionalities required (e.g. transmission info, confirmation for read messages.)” (FUAS, March 2018)

It was argued by HFO at VTS/SC, that STM tools would be useful when considering “Risk talking too much on the radio.” (…) “With STM Tools, there was actually much less talking on the VHF compared to previous exercises.” (…) “and a LOT less VHF traffic big difference from baseline runs.” (CTH, 2018-03-13)

However, usability of Chat function was questioned, due to the fact, that “Ships around you don’t hear the information (…) – all ships won’t hear the agreements.” (CTH, 2018-03-13) Thus, conclusion was made that “there is still a need for VHF as the information passed is often useful for ALL vessels in the vicinity to hear.” (WMA, 2018-03-13)

Whilst Chat message function was found very useful for communication with ships out of VHF range, further consideration was given to the fact, that “all navigational information should be done on VHF so that those not using the system can benefit from hearing the information.” (WMA, 2018-03-14) The pointed out advantage in using Chat was the possibility of reading the message again, meant that OOWs of SCOs “can always go back to check” the message. (CTH, 2018-06-12)

It was found important in terms of usability “to ensure that people understand what you are trying to say which could be achieved with Chat.” (CTH, 2018-06-12) This aspect was found appreciated as preventing situations when “(…) someone must repeat information.” (CTH, 2018-06-13)

On the other side, some VTSO/SCO were of opinion, that “Chat function is overloading and disrupting for the Shore Centre Operator” and “Distracting for all concerned.” or even “There was a general feeling that Chat was pointless. We can already do this by AIS. E-mail is useful for most things”. (WMA, 2018-03-13)

However, Chat messages together with Route exchange functions, were found useful for VTS/SC, making an operator “able to share requested route changes with ships before making VHF contact and acknowledging with Chat.” (WMA, 2018-06-14)

Further considerations were expressed, making points on usability of some services, as e.g.

“Navigation Assistance. I didn’t understand the STM Tool concept. In my opinion this should always be done on VHF and only when required or requested. Exceptional circumstances unless pre-planned like Pilot Routes (…). How is STM expected to work in this area?” (WMA, 2018-03-14)

There was another risk pointed out by one of the participants about usefulness of STM functionalities, namely “that they could help if used correctly but there is a risk that too much information could lead to important things being missed”. (WMA, 2018-03-15)

The opinion was expressed about Route suggestion:
“Suggested route from shore centre: I think that this function is impractical in most VTS areas. It can be applied in some concrete VTS areas, of course, but, I insist, in most of them it will be impracticable.” (CJ, 2018-03-14)

REX was appreciated during VTS/SC operations,” because traffic management will become easier when planned routes are known at the SC.” Similarly, the possibility of “adjusting ETAs [was found] good for Flow Management/de-confliction.” (WMA, 2018-03-13)

Under condition of adjusts of operating procedures, some of functionalities and services, provided by SC, were found usable: “With integration of STM to Port Management software, auxiliary services will have real time updates.” (WMA, 2018-06-14) Consequently “Port arrivals especially with integration of all services. Ability to see real time information.” would be fit for use and “Chat” could be useful for Port arrivals.” (WMA, 2018-06-14)

Furthermore “It should not be vessels requesting new route – should be VTS sending out a route. Change course as would for another vessel, visual is better than oral in terms of oil spill”, (CTH, 2018-06-12) or in other circumstances, if further action on a ship would be required.

“Example: once the ship got the NW – some ships changed routes – wasn’t necessary to send a new route. VTS sent to either one that requested or ones that did not alter their route.” (CTH, 2018-06-12)

However not tested in EMSN-simulations, one of participants liked “the idea of weather routeing.” which might be provided in specific cases even by SC. (WMA, 2018-03-14)

One of participants pointed out that he/she “saw the value” of Route exchange tool and the ability to send Route suggestion. Even information exchanges for port entries as well as NW feature were found useful. (WMA, 2018-03-14)

Some thoughts were given to vulnerability of the information to the cyber-attack, which might be really of concern in regard to operational usability of the STM. However vital for whole STM, this topic will not be considered in this report.

Ability to see Routes and monitor them was found very useful for VTS/SC, but the matter of careful consideration was the capacity and skills of VTO/SCO to check and send new updated Routes, as a few VTSO would have the experience and skills required.

Usefulness of REX/Route Cross Check was also discussed, pointing out at possible duplication of work and somewhat the risk of “over trusting” by vessels.

The usefulness of NRS was questioned, as ships “have to check the Route anyway, so why not just create it themselves.” (WMA, 2018-03-14) According to one of the VTSO/SCO “sometimes ships changed their Routes at the same time as the Shore Centre was doing it.” (WMA, 2018-03-14)

It was commonly agreed, when stating, that S2SREX between each other was very practical and usable feature. Related to situations, when a lot of ships changing route (example oil spill exercise) was the statement that the S2SREX can be dangerous and usability highly questioned due to unclear and confusing presentation of the routes on users’ screens. However, assumption was also made, that “in real life this would be very useful, and generally improve safety.” (CTH, 2018-06-15)

A major uncertainty about usability of SC was associated with ability of STM of getting the equipment widely used, when the point was made that “these functions are useless unless most vessels use them as if not, numerous redundancies need to be maintained.” (WMA, 2018-06-14)

Participants were also concerned about the compatibility of STM tools and equipment with the same currently in use at VTS and on ships’ bridges. (WMA, 2018-06-14)
5.5.3 Operational procedures

New set of working and new operational mind-set by developing/update of operating procedures should be taken into consideration.

Today the VTS procedures pertain to VTS functions and its role in organisation of traffic within the area of responsibility.

Test persons pointed out during de-briefings “that in some legal systems, the public authority could be responsible for the recommendations and advices they suggest.” (CJ, 2018-03-14) It was emphasised, that implementation of the STM proposals, thus SC and its services (in this particular case Route Exchange and Route Cross Check), will result in increased control over ships from the shore side. (CJ, 2018-03-13) Thus, appearance of some “legal / organisational aspects: who will observe and why” and “who will suggest and why” is expected and taken into further consideration prior to implementation of the STM. (FUAS, March 2018)

Related to above stated is the opinion, that implementation of STM could lead towards the development, that some tasks, works, capacity and resources etc. would be shared between bridge and SC. Thus, expected development in this direction led to rise of questions about liability and amenability, such as, but not limited to:

“I believe it increases risk if the system is not regulated and a clear way forward is needed for Shore Stations – who is responsible for an incident that happened due to using STM!” (WMA, 2018-06-13)

However important also from operational point of view, this topic will not be considered in this report. For further insight about legal considerations please refer to the document STM_M 23 “Legal and Liability Report”, that provided analysis of the feasibility of the STM project from a legal and commercial perspective.

In the opinions, expressed during post-scenario de-briefings, the test participants pointed out some specific issues, which, however not necessarily direct, might result in or lead to changes in operating procedures for VTS, when acting as SC. Notwithstanding, the participants were of opinion, that implementation of SC functionalities will not be possible to happen all at once or “overnight”. As stated above, legal considerations (as to e.g. amenability) must be addressed prior to taking STM SC into operational use. But giving that technically and formally, thus even on legislative field, “if it took off and everything was integrated, it could develop rapidly.” (WMA, 2018-03-14)

A general opinion, related to SC, was expressed, that “in a medium traffic density area, you would need more than one VTS operator complete dedicated to this task.” (CJ, 2018-03-14)

But other opinion was provided in regard to possible changes in VTS, in case the STM functionalities would “allow VTS Stations to operate with fewer trained staff or fewer stations due to Chat and Route plan features.” (WMA, 2018-06-14)

This situation might result in the “need [of] more resources "shore side" thus "More people required in the Shore Centre with designated areas and responsibilities". (WMA, 2018-03-14)

But other opinion was provided in regard to possible changes in VTS, in case the STM functionalities would “allow VTS Stations to operate with fewer trained staff or fewer stations due to Chat and Route plan features.” (WMA, 2018-06-14)

This situation might result in the “need of more resources "shore side" thus "More people required in the Shore Centre with designated areas and responsibilities". (WMA, 2018-03-14)

It was stated, that STM and SC (through REX and Route Cross Check as well as EM) will “increase the control over ships from the shore side”, that, in turn, might lead to the situation, that “crews will be reduced in number and qualification. (CJ, 2018-03-13)

Indeed, according to voices during de-briefings, some work and task will be shared between ships bridge and SC. Opinions were expressed, that changes in operational role of VTS towards SC would also raise the question about capability of VTS personnel, mainly VTSO, to perform new duties and undertake SC-related tasks in safe manner, e.g.

“Ability to see Routes and monitor them was very useful indeed but personally as a VTSO I would not have the capacity to check and send new updated Routes. Few VTSO will have the experience and skills required (...)” (WMA, 2018-03-14)
and further “Personnel working in the Shore Centres must have the appropriate skills & training in order to be able to conduct Route Checking/Route suggestions etc.” (WMA, 2018-03-13)

Furthermore, some risks and undesired consequences were identified and pointed out by the participants, as e.g. when inadvisable changes might “(...) make the Officer on the Bridge complacent and in turn the Officer in a Shore Station”. (WMA, 2018-06-13)

STM Validation Project expects that development and implementation of appropriate SC and bridge operational procedures should prevent these risks from happening.

It has been stated by test persons in EMSN simulations, that implementation of STM tools would make an impact on communication procedures of VTS when acting as SC. This statement, in turn, leads to further considerations about the use of VHF with some of its inconveniences and weaknesses mentioned, such as e.g. risk of miscommunication and lower level of accuracy when using VHF.

Participants acknowledged that use of the STM tools as e.g. REX will enable direct transfer of information to the SC and ability to liaise with specific required Shore Services. This, in turn, “could mean earlier decision making and enhanced service provision”. (WMA, 2018-03-15)

New procedures in communication, thus increased ship-shore/shore-ship interaction, “would assist both parties and the ability to contact a vessel before it reaches VHF range would mean forward planning is more possible.” (WMA, 2018-06-15) It was also assumed, that STM functions and services might “assist VTS/Ports for long term planning etc.” (WMA, 2018-06-13)

It was also emphasised that “Changing route schedules and plans by Chat and clicking buttons will provide mariners [i.e. Masters and OOWs] with written instructions” from the VTSO/SCO. This procedure was found more appreciated than “relying on VHF, which due to many factors, can be more inaccurate.” (WMA, 2018-06-14)

During debriefing the participants also argued, that due to “enhanced monitoring and route sharing, one operator will be able to communicate with numerous vessels without needing to use VHF.” Thanks to the possibility of “integration of STM to Port Management software, auxiliary services will have real time updates.” (WMA, 2018-06-14)

Beside specific traits of STM mentioned above, some other changes in communication set and procedures ship-to-shore and shore-to-ship were pointed out. The participants were of opinion, that availability and use of STM tools will contribute to reduction of VHF communications and consequently, to reduction of misunderstandings, that might arise from the use of verbal communication via VHF.

It was confirmed by VTS/SC HF-observer, that “VTS sent almost as many chat messages as calls on VHF and a LOT less VHF traffic.” That was also found to entail “big difference from baseline runs”. (CTH, 2018-03-13)

Above-mentioned statement, however, would need confirmation from quantitative analysis of record of ship-to-shore/shore-to-ship communication over VHF, maintained during simulations in EMSN. This data was not available when writing this report.

It should also be noted the HF-observer point, that VTSO usually knows the procedures and how to handle communication with ships, but “there were situations where they were unsure how to handle situations. VHF or tools?” (CTH, 2018-03-13)

It should also be emphasised, that the participants discussed the issue related to the “rules of the road”. It was pointed out, that STM would not be contradictory to the rules provided by the Convention on the International Regulations for Preventing Collisions at Sea. The STM provides the tools that “will help a lot from VTS”. (CTH, 2018-03-14)

Furthermore, the participants were of the opinion that with appropriate procedures and better “visibility of everyone’s planned routes and intentions would mean that people have better situational awareness.” (WMA, 2018-06-15)
What was clearly pointed out and cannot be missed, is that SCO and STM is “advisory to
Master – he is the final judge.” (CTH, 2018-06-12)

With attention to this statement and its enforcement in SOLAS, there is no subject to discuss
new or any significant change in contemporary procedures but rather how the STM would need
to be implemented into those in the appropriate way.

Discussion

Quite substantial part of opinions, expressed during de-briefings, was the concern about
changes in shared working tasks and elements, thus amendments in existing or further
development needed in several areas of activities. These could be characterised as shared
works, tasks, skills, amenability but also work capacity and resources. The designated area of
responsibility and surveillance, as well as the scope of duties, need to be described and
defined for SCO and in relation to functions and services of the SC to be provided to ships.
Further insight may be obtained from SA 5.8 report on development of operational concepts
within STM (STM, 2019), in this particular case ship-to-shore/shore-to-ship.

The key point to note is that the Master and OOW are still responsible for safe navigation and
Master has the overriding role.

It should also be emphasised that designated areas and areas of responsibility need to be
designated and clearly defined.

Responsibility of Designated Authority, of the SC and of SCO need to be further discussed and
analysed from the operational and legal point of view. Thus, further efforts need to be put on
in order to get more detailed picture of “status quo” and clear indications as to the way forward
and, if case might be, possible changes needed.

5.5.4 Situational awareness

To great extent, the situational awareness is depending on exchange of information, its
perception and understanding. The risk of talking too much on VHF might be resulting from the
lack of information. Judged by these criteria, it has been found justified to connect SAW with
intensity of traditional verbal communication and compare to same in case of STM means of
sharing information. Thus “Risk talking too much on the radio (i.e. your route is this, are you
going there?)” was found to be illustrative of deficient situational awareness. In comparison,
“with STM Tools, there was actually much less talking on the VHF compared to previous
exercises.” (CTH, 2018-03-13)

However, the participants were of opinion, that “there is still a need for VHF as the information
passed is often useful for ALL vessels in the vicinity to hear” (WMA, 2018-03-13) in order to
serve SAW needs of non-STM compliant ships. However, it might be extended to STM-ships
being outside the information loop, e.g. in case of using Chat: “Ships around you don’t hear
the information. This is something that VTS have been discussing – all ships won’t hear the
agreements”, (CTH, 2018-03-13) that could make unwelcomed worsening impact on
(common) situational awareness.

However, it is difficult to escape the conclusion, that STM functionality improves situational
awareness, when “allows for excellent important/non urgent promulgation of information and
reduces VHF traffic allowing operators to concentrate on important tasks.” (WMA, 2018-06-14)

It was also emphasised, that “some tools as ship to ship routes interchange, will reduce VHF
communications and reduce misunderstandings”, (CJ, 2018-03-13) thus positively influence
perception and understanding of information. It is difficult to escape the conclusion, that it
would also be the case of ship-shore route exchange and Route suggestion, both for VTS/SCs’
and ships’ gains on situational awareness.
“Distracting for all concerned” (WMA, 2018-03-13) was one of the opinions about the Chat function, expressed during debriefing. However, other opinion in regard to VTSO/SCO, was more precise, stating that it should be matter of their priority to decide how to focus the attention. (WMA, 2018-03-15) As there are different bridge and VTS/SC systems in use, the lack of priorities in task focus my lead to confusing the VTSO/SCO. If used correctly, the tools could be helpful, “but there is a risk that too much information could lead to important things being missed”, (WMA, 2018-03-15) what might mean negative impact on situational awareness at SC. It was also argued that “chat function is overloading and disrupting for the Shore Centre Operator.” (WMA, 2018-03-13)

It was also noted that “more organised routes allow the analysis of vessel intentions operating on varying VHF channels and adjusting plans to keep operations seamless”, (WMA, 2018-06-14) thus the “traffic management will become easier when planned routes are known at the SC”, as emerging from and contributing to an increased situational awareness. (CML, 2018-03-13)

Proper allocation of the area of responsibility, both in geographic and in the scope of tasks, would have an impact on situational awareness. The opinion was expressed after one of EMSN exercises in the English Channel, that “too large an area to cover, especially in regard to Route-checking etc.” (WMA, 2018-03-13) led to increased stress in performing the VTSO/SCO duties. In consequence, it “might become complex in a sea area with several ports and busy traffic” (FUAS, March 2018) and “focus can be lost, especially when covering both inshore and offshore areas”, thus disadvantageous to situational awareness of SCO. (WMA, 2018-06-15)

The opinion about limited functionality of Chat message in crowded and congested waters was expressed. However, that statement was made in regard to tasks of OOWs, who “should be looking out the window instead of having a chat”, but as “all participants agreed with this. It could take your attention away from a vital point” (CTH, 2018-06-12) this statement might also be relevant for taking into consideration when discussing SC.

Opinions were expressed, that “ships around you don’t hear the information”. Consequently, worries and concerns in the subject were discussed in VTS/SC as “all ships won’t hear the agreements”. (CTH, 2018-03-13)

It is clear, that “Greater visibility of everyone’s planned routes and intentions would mean (…) better situational awareness.” (WMA, 2018-06-15)

### 5.5.5 Navigational safety

As already mentioned in previous paragraphs, participants were of opinion, that validation of ship’s route at VTS/SC would have to be based on appropriate information about ships characteristics, available to the VTSO/SCO. That would be of high importance for route cross check and Route suggestion.

Opinion was expressed during EMSN exercises de-briefing, that STM functionality and establishing SC “…will increase control over ships from the shore side”, resulting in “crews will be reduced in number and qualification”. (CJ, 2018-03-13) Although this argument has some merit, the other point is that “more organised routes allows the analysis of vessel intentions operating on varying VHF channels and adjusting plans to keep operations seamless”. (WMA, 2018-06-14)

Clearly expressed was the opinion, that SCOs must be given and gain “appropriate skills & training in order to be able to conduct Route Checking/Route suggestions etc.” (WMA, 2018-03-13). “If done properly with the right people, properly qualified to conduct things such as recommended changes to Route etc. and in the right place”, (WMA, 2018-03-14) the use of
Route exchange and Route suggestion functionalities was assessed contributory to increased safety of navigation.

However, more cautious opinions also were expressed, pointing out that

“ability to see Routes and monitor them was very useful indeed but personally as a VTSO I would not have the capacity to check and send new updated Routes. Few VTSO will have the experience and skills required.” (WMA, 2018-03-14)

S2SREX and REX with SC was found reducing VHF communications and verbal misunderstandings. Nevertheless, it was also argued, that “there is still a need for VHF as the information passed is often useful for ALL vessels in the vicinity to hear” (WMA, 2018-03-13), when discussing navigational safety. Furthermore, discussion was initiated about traditional “rules of the road”, but no contradictions were found between COLREGs and STM. The more, the assertion was supported, that the “tools will help a lot from VTS” to improve safety. (CTH, 2018-03-13)

Crucial for some functions of SC were the questions as “who would do which sections of the Route? Multiple Shore Stations?” (WMA, 2018-03-14) Some of SCO were critical, when pointing out “duplication of work” as well as risk of “over-trusting” by vessels”. (ibid)

Another opinion stated that SCs’ “functionalities could help if used correctly but there is a risk that too much information could lead to important things being missed.” (WMA, 2018-03-15)

Specific criticism was given to Chat functionality and its influence on safety of navigation. Limited functionality in crowded and confined waters was pointed out. Further consideration was given to behaviour of OOW, who definitely need to concentrate on navigation and lookout, than on messaging. Chat was found the source of overloading and disrupting for SC operators. (WMA, 2018-03-13) Thus, appropriate SOP need to be implemented, as discussed in Ch.7.

Concerning REX and NRS, the critical opinion was expressed about possible risk of re-inforce of the “follow the line” philosophy (…), especially regarding Routes being sent from Shore Authorities.” (WMA, 2018-06-14) Indeed, in case of SC under direct supervision of responsible authority, that risk cannot be ignored.

Special attention was given to the influence of workload, perceived to be shifted from the bridge towards SC and its effect on safety of navigation from the SC-perspective. There was opinion about no gains on safety, if people become overloaded. Focus can be lost, especially when covering both inshore and offshore areas. Thus, for safety reason, “more people would be required in the Shore Centre with designated areas and responsibilities.” (WMA, 2018-03-14)

The EMSN-test participants were of the opinion, that traffic management will become easier when planned routes are known at the SC and that the tools will increase safety, when VTS/SC can see the route the vessel has planned. Even Routes cross-check was considered a good feature, improving safety.

Moreover, the general opinion was expressed, that increased visibility and transparency of information and information exchange will increase/improve safety, when vessels, thus the more the SCO, can see “what others “may” do”, but with stipulation that the “data should not be over-relied upon.” (WMA, 2018-03-15) The VTS/SC observer was of the opinion, that the tools will improve safety, when explained “If a vessel has a plan – this is how he will take vessel into port – improves safety a lot. Huge improvement for the VTS. (CTH, 2018-06-12)

Positive impact of SC functionalities on safety of navigation is to happen through allowing improved planning and route organization. It was also stated, that SC tools, when working correctly, with sufficient manning and well organized, could help to improve safety. (CTH, 2018-03-14)

On the other side, some negative opinions, that “it distracts and overloads the user (Shore Centre)”, (WMA, 2018-03-16) through more particularly about NRS- “No, standardisation of
Routes”, (WMA, 2018-03-16) were expressed, when discussed the impact on improvement of safety.

Related to the safety of navigation, even at SC, was the question: “how vulnerable would STM information be to cyber-attack?” (WMA, 2018-06-15), as well as discussion about increased risk for SC, if the system is not regulated. The latter resulted in the opinion that "a clear way forward is needed for Shore Stations – who is responsible for an incident that happened due to using STM". (WMA, 2018-06-13)

Mention should also be made at this point, that legal aspects of STM were deeply analysed by SA 5.2 and presented in the document STM_M 23 Legal and Liability Report

5.5.6 Workload

VTSO test persons, working at SC, reported high workload and, in consequence, their opinion, was that STM-operational implementation would probably “need more resources “Shore Side”. (WMA, 2018-03-13) Depending on the characteristics of the area, the statement was made that “in a medium traffic density area, you would need more than one VTS operator complete dedicated to this task.” (CJ, 2018-03-14) However, reference was made in regard to REX impact that the “traffic management will become easier when planned routes are known at the SC.” (CML, 2018-03-13)

The VTSO/SCO pointed out some cases of duplication of work, as “sometimes ships changed their Routes at the same time as the Shore Centre was doing it.” The experienced level of workload at SC also depended on organisation of the STM-services: “Who would do which sections of the Route? (…) Duplication of work. (…) They have to check the Route anyway, so why not just create it themselves?” (WMA, 2018-03-14)

Led by this criteria, the participants discussed if the workload had “shifted somewhere else”. As shown above, it might be the case, despite changes in the ways of ship-shore/shore-ship communication (about. 75% versus 25% on VHF) in comparison to baseline scenarios. (CTH, 2018-03-15)

Based on experiences from simulation scenarios, the VSO asked to “cut down on workload, or prepare the VTS much more for the situation. What is he supposed to do, what is supposed to happen, what tools required to use?” (CTH, 2018-06-15)

The VTSO/SCO participants highlighted the need of properly considered and thus defined area of responsibility of the particular SC to cover, as the experience was that in some scenarios the designated area “was considered too large an area to cover, especially in regard to Route-checking”. (WMA, 2018-03-13) It “might become complex in a sea area with several ports and busy traffic” (FUAS, March 2018), thus “could end up doing one or the other!” (WMA, 2018-03-13)

In consequence, “more personnel/equipment would be required in a real Shore Centre covering such a large area” (WMA, 2018-03-13) and thus clearly designated areas and responsibilities required. (WMA, 2018-03-14) Some consideration was also given to economic issues, as e.g. expected costs for manpower required, but this issue is behind the scope of this report.

To some extent, related to workload at SC were either opinions, that STM services (e.g. REX) might “assist VTS/Ports for long term planning etc.” (WMA, 2018-06-13), thus, allowing “ports to co-ordinate support services (…) in real time, especially helpful for busy Ports to reduce delays.” (WMA, 2018-06-14)

The participants were of opinion, that “more organised routes allow the analysis of vessel intentions operating on varying VHF channels and adjusting plans to keep operations seamless” (WMA, 2018-06-14), thus, to put it simply, in less work-demanding way.
Moreover, with e.g. Route Exchange, Route Cross check, NRS, "Routes of inbound vessels could be checked and acknowledgements made more efficiently than VHF" by using Chat. (WMA, 2018-06-14)

In consequence, the SC and STM-functionalities “improve efficiency for ships. Checking a route takes less time than creating and checking a route. Master and OOW can do it together.” In particular, this aspect was also discussed in regard to workload on ship. (WMA, 2018-06-15)

The opinion was expressed that “Shore Centre personnel & Bridge Teams [were] quite busy dealing with lots of information”, (WMA, 2018-03-13) despite the VTS/SC HF-observers assertion, regarding VHF communication from/to VTS/SC: “Very quiet now on the VHF compared to baseline”. (CTH, 2018-03-15)

It was also argued, that “added workload decreases efficiency for the Shore Centre where it is multi-tasking.” Solution could be found “if, as planned, an external authority takes on this role, it would help.” (WMA, 2018-06-15)

Despite perceived (not quantitatively confirmed at that stage) decrease on VHF communication, the opinion of the one of VTSO/SCO was expressed that “chat function is overloading and disrupting for the Shore Centre Operator.” (WMA, 2018-03-13)

Resulting from some malfunctions, experienced during simulation, “the workload was quite high and this information was not readily available it seemed”, (WMA, 2018-03-15) that, in turn, led to stressful situations, when the VTSO/SCO had not seen the routes, thus was not able to perform assigned tasks.

Furthermore, “If there is too much information and data, capacity is reduced. Route monitoring, altering and sending Routes increased workload”, (WMA, 2018-03-15) which in complex situations with high density of traffic might “end up doing one or the other!” (WMA, 2018-03-13)

Consideration has been given to possible risk of work overloading due to lack of proper introduction and familiarisation at SC-working station: “cut down on workload, or prepare the VTS much more for the situation. What is he supposed to do, what is supposed to happen, what tools required to use?” (WMA 2018-06-15)

Further, some concerns were expressed, related to economics and Manning, as “the Shore Centre will be too costly for the amount of manpower required.” (WMA, 2018-03-16) Although this mention has some merit, it might be in contradiction to the apprehension, that implementation of SC and STM functionalities would “allow VTS Stations to operate with fewer trained staff or fewer stations due to Chat and Route plan features. (WMA, 2018-06-16/14)

Discussion
New tools, new operational mind-set and, to some extent, shift of workload from ship to shore as contributory factors as well as technical constraints/malfunctions observed, influenced the perceived level of workload.

5.5.7 Training and familiarisation
The data collected for defining possible training needs and expectations, shows very outspread opinions, ranging from “little training required” to deep and comprehensive requirements.

Training requirements
The opinions about extent and level of training required for an SCO are very different.
As mentioned above, less demanding or minimalistic opinion was noted, however some more detailed and demanding as to the scope and level expectations were also expressed. The first group was represented by opinions as above quoted, followed by “features such as Enhanced Monitoring and Chat would be fine, not much additional training would be required” and “Perhaps this could be achieved by an add-on to existing courses.” (WMA, 2018-06-14), while the more demanded expectations were expressed as follows: “A good level of system training” and “Thorough system training.” (WMA, 2018-03-14,15)

The highest demands in regard to desired level of training for SC-operators’ in order to fulfil expected operational needs, were these requiring “Full training, including ethos and accountability.” as well as “The main aspect with increased reliance on technology for the VTS, is the ability to understand how and why the software works and understanding the limitations.” (WMA, 2018-06-14)

New STM-features and new services type, provided by SC, would need new set of skills, required to be demonstrated by SCOs. Participants asked and discussed about qualifications of SC personnel would be required to gain in order to be able to provide ships with specific STM services. Related to such discussion was the statement during one of de-briefings, namely that “If VTS personnel are manning the Shore Centre, it would need additional Navigation Training to be able to safely conduct Route Cross Checking & Route Change suggestions etc.” (WMA, 2018-06-14)

Indeed, SCOs must have the appropriate skills and probably would “need to be fully trained OOWs, may be, to understand route planning and effects of this on the vessels. Full equipment training and nautical knowledge greater than is given to VTSOs would be required.” (WMA, 2018-06-15)

Nevertheless “The same basic principles (as in case of OOW) would need to be taught, however, training needed to become proficient with the system would be minimal.” (WMA, 2018-06-14)

Related to operational issues is the mention, that training “would need regulating and constant updating.” (WMA, 2018-06-13) Nevertheless, given the space available, this thread will not be considered in the report.

Technical issues
Organisationally, these high demanded skills could be achieved by providing SCOs with “On-going training during implementation”. (WMA, 2018-03-15) Participants expected that “probably not much on the technical side” (WMA, 2018-03-14) would be required to fulfil the training needs in order to operate STM-tolls at SC.

Despite the above quoted about training requirements as to technical issues, the opinion was expressed about the need of understanding the principles and, the more, limitations of whole arrangement. “The main aspect with increased reliance on technology for VTS is the ability to understand how and why the software works and understanding the limitations.” (WMA, 2018-06-14)

Discussion
As it was seen, the SCO would need to be involved in some tight nautical/navigational process and advices in decision-making. It would also be argued if, consequently to the case of a pilot in the BTM system, the SCO could be assigned (at least in some specific tasks, services and/or traffic situations) a “temporary” bridge team member, thus considered in the BTM system. This, however, will not be considered in the discussion here.

Judging by criteria of involvement in various operational scenarios and myriad of traffic situations, it might be argued that an SCO would need to go through a basic nautical training and thus to gain the knowledge or to be recruited amongst persons with nautical officer’s
education, ideally with some sea-going experience. It is tempting to pose another question at this point, namely if the SCO position would be the future working place for contemporary OOWs.

Captivating, however, further consideration of this topic could be found of speculative character, thus inadequate in this report. For further insights into the training aspects, please refer to the appropriate STM_D5.7.1 “Catalogue of new competences related to the stakeholders involved in STM in shore, on board and for operational safety” report.

5.6 Maritime Rescue Coordination Centre

Please note, that the terms Maritime Rescue Coordination Centre (MRCC) and Joint Rescue Coordination Centre (JRCC) are coequal in the meaning of this report and used accordingly. In some occasions (Ch.7) the term Rescue Coordination Centre, abbreviated RCC, has been provided in order to avoid taking into consideration peculiarity of above-mentioned terms.

5.6.1 Information and communication

More effective coordination of the SAR operation by the MRCC under STM is achievable mostly because of the holistic approach, utilised in the STM concept through sharing information with all actors in a clear and effective way, such as the visualization of the operation. (3.3.9 p.40) This was also supported by participants’ positive evaluation of STM tool and could be seen as an appreciation of an emerging holistic approach in coordination of SAR activities, improving the overall coordination. (3.3.9 p.31)

The VTS/SC/MRCC operators expressed the opinion, that the STM service can reduce language issues and barriers in information exchange by making the routes visible. Besides providing necessary information, the visualization of the operation enables better understanding and thus reducing the possibility of misunderstanding and human error. (3.3.9 p.34)

Easy access to SAR operation related information and traffic information is considered critical for planning their SAR operations and sharing information helps to maintain a higher level of situation awareness and safety during the operations. (3.3.9 p.40)

MRCC can “selectively call vessels of opportunity” and “easily monitor the movement of the involved vessels in the rescue” operations when “it is easier for the leadership to make planning and communication”. (3.3.9 p.34)

It is also believed that the use of STM services will increase information exchange efficiency, improve collaborative operations performance and save time. Search pattern broadcasts were highly valued by the participants, as both sides (ship and shore) could see the big picture and make sense of it in an efficient and effective way. (3.3.9 p.40)

Test participants see the introduction of STM services as an improvement in the transfer and exchange of information. However, introducing STM services may also increase the amount of information exchanged (3.3.9 p.40), and thus might cause an unwelcomed overload effect on the users.

Not discussed in case of SAR simulations but related to operational parameter of “information need” (i.e. the right/correct information available at the right time) and fully justified, is the question of availability for MRCC of appropriate ships data and manoeuvring characteristics in order to use it for elaboration of search pattern in the safe way.

SAR exercises in life testbeds showed, that use of STM tools made possible to transfer more data from MRCC to SRU (STM, 2019b p.55)

“From the JRCC prospective the digital communication is quicker to produce and distribute, especially when the information includes many figures, like positions in latitude-longitude. Text message was easy to produce, allocate and broadcast to one or several units at a time. Contrary to work without STM tools, only short
voice message had to be supplied to SRU, usually only for confirmation purpose, instead of giving the entire message over voice communication.”

“Also due to reduced workload and saved time for the SAR mission coordinators, there were more time to reflect over the mission as a whole. This opens up possibilities to create and distribute information regarding the current status in order to increase the situational awareness. This information was distributed both digitally as a text message and by voice communication.” (STM, 2019b p.55)

5.6.2 Usability
Usability issues pointed out by life-testbeds participants, were related mainly to creation of routes/search pattern, that did not work on board due to improper rate of turns (STM, 2019b p.54) Thus, appropriate information about maneuverability of SRU need to be available for MRCC coordinators. (STM, 2019b p.54) Mention should also be made at this point, that SAR mission coordinator felt relatively safe with the new STM tools after a short period. (STM, 2019b p.55)

5.6.3 Operational procedures
The participants’ positive evaluation of STM tools and services could be synthesized as an appreciation of an emerging holistic approach in coordinated SAR activities. Participants agreed that the overall SAR coordination is improved mostly because of the holistic approach utilized in the STM concept, whilst operational procedures simplified. (3.3.9 p.31,32)

Implementation of STM services in SAR operations would conceivably improve the MRCC’s overview and provide the possibility to direct and monitor SAR-units and vessel of opportunities in search and rescue operations. (3.3.9 p.39). However, it needed to be assumed by all parties involved in simulated SAR operations, that all other vessels are STM-compliant ships, use the services and actually follow their monitored routes, otherwise it would likely pose a risk. (3.3.9 p.36)

Majority of the participants expressed the opinion, that communication and information procedures would be changed. Participants assumed, that there would likely to be less traditional communication because the future use of STM services would increase information exchange efficiency, improve collaborative operations performance and save time, by keeping “everyone in the communication loop”. (3.3.9 p.33). Not only providing necessary information, but also the visualisation of the operation enables better understanding and thus reducing the possibility of misunderstanding and human error. (3.3.9 p 34)

Both operational planning and communication procedures were mentioned as an example, enabling MRCC to “selectively call vessels of opportunity” and “easily monitor the movement of the involved vessels in the rescue” operations. From this perspective, the changes in procedures were not considered as a standalone improvement, but rather as a part of emerging synergy, which includes the operational practice enhancement, contributing to observed desired system (e.g. vessels of opportunities, other vessels, MRCC and/or Shore Center) performance as a whole. (3.3.9 p.34)

New communication procedures would probably require an organizational structural adjustment and new distribution of roles in a SAR operation. (3.3.9 p.39)

Introducing the STM concept in SAR operations would likely influence the operational and management procedures on both shore and ship sides. The possible changes on the procedures do not concern ships only but would include the operational and management practices of all parties involved in SAR. This system perspective, in turn, suggests the importance of information coordination via technological means and may have implications on (…) operational practices for regulatory authorities, organizations and shipping companies. (3.3.9 p.41)
The need of establishing new Standard Operational Procedures (SOP) for MRCC was pointed out also in the life testbeds. (STM, 2019b p.55) The issue of short messages, exchanged between MRCC coordinator and SRU for confirmation/acknowledge should be discussed and eventually included there. (STM, 2019b p.55)

5.6.4 Workload

For SAR operations, broadcasts of search pattern were highly valued by the participants, giving both sides (ship and shore) the means to see the big picture and to apply it in an efficient and effective way. Using STM services, the test participants on the bridges considered the coordination of the SAR operation by the MRCC as more effective. (3.3.9 p.40) Thus, it is tempting to suggest any lessening of the workload for MRCC staff. However an opinion was that the workload and stress for the crews on bridge were naturally reduced during SAR operations (3.3.9 p.33), no specific data was collected concerning MRCC operators. Keeping in mind the OOWs’ opinion that “crews can focus on searching, the rest will be delivered from shore”, it might be argued that in consequence, workload could be shifted towards MRCC, as observed already in case of VTSO/SCO.

Report from the life-testbeds exercises with STM tools stated, that reduced administrative burden for MRCC coordinator was observed. (STM, 2019b p.55)

“Also due to reduced workload and saved time for the SAR mission coordinators, there were more time to reflect over the mission as a whole. This opens up possibilities to create and distribute information regarding the current status in order to increase the situational awareness.” (STM, 2019b p.55)

5.6.5 Training

No specific familiarization issues or difficulties were reported from the life testbeds SAR exercises. Mention should also be made at this point, that SAR mission coordinator felt relatively safe with the new STM tools after a short period. (STM, 2019b p.55)

The dominant category identified is mostly functional limitations that the participants felt during the exercises.

While some of the usability issues were due to technical or regulatory limitations (e.g. the way the information may be presented on the ECDIS) others may have been be due to the participant’s lack of familiarization with the equipment. (3.3.9 p.43)

Not discussed in case of SAR simulations but related to training and familiarisation topic and justified is the question of manning of MRCC and training requirements for MRCC operator, skill sets, and liability issues as discussed in case of VTSO/SCO. (3.3.6 p.18)

New STM services and tools, provided and used by MRCC, would need a new set of skills, required to be demonstrated by MRCC operator. New set of qualifications of MRCC personnel would be required in order to gain appropriate proficiency in providing ships with specific STM services. Related to such discussion was the statement during one of debriefings, namely that “If VTS personnel are manning the Shore Centre, it would need additional Navigation Training to be able to safely conduct Route Cross Checking & New Route Suggestions etc.” The same would be the case for MRCC coordinator in charge.
6 PORT

Chapter 6 analyses and evaluates the operational aspects of STM in the third of projects area of interest, namely port. PortCDM is one of four strategic concepts within the STM, as described in Ch.2.

6.1 Introduction

When looking at ports, governance models have a great influence on operational aspects, since these models affect directly the way that a port addresses the port call process. A number of factors influence the way ports are organised, structured, and managed, including the socioeconomic structure of a country, historical developments, location of the port and types of cargoes handled, among others. Four main categories of ports have emerged over time, and they can be classified into four main models: the public service port, the tool port, the landlord port, and the fully privatised port or private service port. These models are distinguished by how they differ with respect to such characteristics as:

- Public, private, or mixed provision of service;
- Local, regional, or global orientation;
- Ownership of infrastructure (including port land);
- Ownership of superstructure and equipment (particularly ship-to-shore handling equipment, sheds, and warehouses);
- Status of dock labour and management.

Service Ports

Service ports have a predominantly public character. The number of service ports is declining. Many former service ports are in transition toward a landlord port structure. However, some ports in developing countries are still managed according to the service model. Under it, the port authority offers the complete range of services required for the functioning of the seaport system, including the port call operative.

Tool Ports

In the tool port model, the port authority owns, develops, and maintains the port infrastructure as well as the superstructure, including cargo-handling equipment such as quay cranes and forklift trucks. Port authority staff usually operates all equipment owned by the port authority. Other cargo handling on board ships as well as on the apron and on the quay is usually carried out by private cargo handling firms contracted by the shipping agents or other principals licensed by the port authority.

Landlord Ports

As noted, the landlord port is characterised by its mixed public-private orientation. Under this model, the port authority acts as regulatory body and as landlord, while port operations (especially cargo handling) are carried out by private companies. Today, the landlord port is the dominant port model in larger and medium-size ports.

Fully Privatised Ports

Fully privatised ports are few in number, and can be found mainly in the United Kingdom and New Zealand. It suggests that the state no longer has any meaningful involvement or public policy interest in the port sector. In fully privatised ports, port land is privately owned, unlike the situation in other port management models.

Further, as characterised within the project (Lind et al, 2018a), three types of ports in three broad classes have been distinguished. These are to a large extent determined by their size and their ability to move goods onward in the transport chain. This will enable us to investigate and discuss their different data needs. The four main categories of ports can characterise any of the three classes of distinguished ports.
First tier – global hubs
First tier ports have regularly scheduled visits from vessels belonging to the three major alliances\(^1\). They handle much of the world’s cargo, and they are large transhipment centres serving second and third tier ports. The world’s top 20 ports handle about 50% of the world’s cargo (WSC, 2019). It is the cut-off point that we have used to differentiate between tier 1 and tier 2 ports. Accordingly, tier 1 includes Shanghai and Singapore in Asia, Rotterdam in Europe, Dubai in the Middle East, and Los Angeles in North America. Given the volume of business, first tier ports can face considerable competition, particularly in the transhipment arena, when there are other first tier ports in their vicinity, such as the on eastern seaboard of Asia.

Second tier – regional hubs
The second tier comprises ports that have significant transhipment volume but are not in the first tier. They are typically national or regional hubs and are often an intermediary between first and third tier ports. Their success depends on the aggregate demand of the third-tier ports that they service. Thus, they compete with other second tier ports for business in their region. Valencia, Barcelona, and Limassol, among many others, fall into this tier.

Third tier – local hubs
Third tier ports have little transhipment traffic. They typically serve a limited geographic area, and their main competition usually comes from nearby third tier ports. Depending on their geographic location, road and rail might be a competitive threat by enabling the land movement of cargo from second tier ports directly to importers.

The characteristics of these different types of ports and the need for enhanced situational awareness, information transparency, and real-time data sharing have been taken into account in the development of PortCDM as one of the enablers of STM concept (Lind et al, 2019). Within the STM validation project, the different participants in the PortCDM testbed (Activity 1) identified the following needs that PortCDM is expected to fulfil:

- Increase the efficiency, decreasing costs and saving emissions through just-in-time arrivals;
- Provide better knowledge and a broader image of what is happening within the port so as to avoid delays;
- Provide better access to information;
- Gather all relevant information in one place. Information such as berth availability, mooring personnel progress, tug availability, etc.;
- Avoid duplicated information by creating a better communication basis where all actors involved in a port call rely on the same reliable information for planning;
- Reduce the volume of emails and daily telephone communication, thereby minimizing administrative burdens and time taken chasing for information;
- Facilitate real time reporting;
- Enable real time situational awareness based on reliable data in order to plan operations;
- Reduce interaction among the actors by avoiding such things as unnecessary phone calls (e.g. pilots, traffic control, etc.) requesting updates on port call status;
- Encourage data transparency, which is essential for fair play among the port actors;
- Reduce delays and demurrage costs for the terminals.

\(^{1}\) i.e. The ocean alliance (CMA CGM, COSCO, OOCL, APL, Evergreen), The Alliance (NYK Group, MOL, “K” Line, Hapag Lloyd, UASC, Yang Ming), and the 2M Alliance (Maersk Line, MSC, HMM, Hamburg Sud)
6.2 Information need and communication

Within the project, a series of interviews, questionnaires, and workshops (Living Lab meetings) among the testbed ports were conducted of which the following biggest challenges were identified (see Figure 11 below).

According to the answers from the interviews and the online questionnaires covering all the ports, the biggest challenge for planning and realising an optimal port call is **changes not being communicated among relevant participants (77%)**, while a lack of information ranked second (66%). Low reliability of shared information (37%), low credibility of information (37%), departure delays caused by cargo operations (34%) and information not shared to all actors (31%), were also notable challenges highlighted by the interviewees and respondents.

Lesser challenges were resource planning (8.5%), pilot not available (8.5%) and flexibility to changes (8.57%).

One of the core aspects of STM is to ensure better access to reliable information.

The PortCDM validation participants were asked to provide their opinion on whether PortCDM, as used in the testbeds, enabled better access to reliable information. 48% of the respondents fully agreed with the statement that PortCDM enabled better access to reliable information. Another 20% agreed at a great extent, while 24% of the participants agreed to some extent. Only 8% agreed to a small extent. None disagreed, Figure 12.
In the case of a full-scale implementation of PortCDM in the future, the validation participants were also fairly unanimous in their estimate that a full-scale implementation of PortCDM in their port would enable better access to reliable information, as can be seen in Figure 13. 56% fully agreed that PortCDM would enable better access to reliable information in a situation where PortCDM was fully implemented in their port, 20% agreed to a great extent, 12% agreed to some extent, and 12% agreed to a small extent. None disagreed.

6.3 Usability and usefulness

In the interviews, the participants were asked to provide their opinion about the influence of STM through PortCDM on their ability to plan and make estimates in the port call process. 90% of interviewees evaluated their ability to plan or estimate to remain the same, but saw the potential of STM to enable better planning in the future. The reason of that situation was, to certain extent, some usability problems, related to the testbed service (crashes and suchlike), that prevented them from using the service. In turn, some other participants did not use it due to specific nature of the interviewees work. One of the respondents explained, that they used PortCDM as a backup system for the port calls where they already had sufficient information, while the other “referred to the fact that currently there was no automatic connector from their own systems so it was difficult to use the system by someone who has to do berth planning” (STM, 2019a p.87). Another primal problem, mentioned by respondents, was that the system sometimes displayed incorrect information.
10% of respondents pointed out improvement in their ability of planning. As an example, one of the agents in Gothenburg appreciated the fact that through the PortCDM demonstrator they could follow the updates in the port berth planning which was something they had been able to do before.

“The remainder of the interviewees who reported that PortCDM had had a limited impact on them so far, still believed that PortCDM would help towards a better situational awareness regarding port call status and better coordination of services in the future.” (STM, 2109a, p.86)

6.4 Working and operating procedures

The port call process involves many agents or actors, both from the ship and the port perspectives who must cooperate and exchange relevant information under different means and formats. As such, this presents a significant number of barriers and opportunities associated with efficient coordination to achieve the just-in-time arrival of ships. A metromap presentation of those involved parties and important events related to a typical port call process, are depicted in Figure 14 below.

![Figure 14: The metromap of a port call process](Source: STM, 2019a)

6.4.1 Scope for Improvement in the Port Call Process

Analysis of over 1.5M port call messages covering over 4000 port calls by a variety of classes of vessel in nine testbed ports indicated significant scope for improving the efficiency and outcomes of the port call process.

Figure 15 below shows that on average container ships spent only about 70% of their time at berth, while only 58% of that time was spent doing operations; so, the remaining time can be considered as idle time. Turn-around times for passenger ships and Ro-Ro vessels were the
most efficient, with larger inefficiencies observed for bulk, off-shore, tanker, container and other vessel types.

![Figure 15](image)

*Figure 15*  
Distribution of time at berth and time doing operations  
Source: STM, 2019a

Analysis of the various stages of the port call process revealed that the predictability for programmed events reduces as the port call progresses prior to departure. This reflects the cumulative effect of poor estimates and insufficient notice being provided to actors further down the port call chain, see Figure 16.

![Figure 16](image)

*Figure 16*  
Predictability in the different stages of the port call process  
Source: STM, 2019a

### 6.4.2 Process Actors

In order to identify potential improvements, and to develop specific solutions, it is important to first understand the actor hierarchies (decision makers) involved in the planning processes.

The port actors hierarchy has been classified into three groups, primary, secondary and tertiary actors (Lind et al, 2018b).
A. Primary process actors

a) **Ship Operators.** Ship operators are the ultimate “decision makers” when it comes to planning and fine-tuning port calls and terminal stays. If a ship is delayed within a port/terminal, the ship operator must decide whether to:

- extend the ship’s stay, then steam faster to maintain the expected arrival at the next port;
- extend the ship’s stay, steam at the originally intended speed and then arrive later than expected at the next port/terminal; or
- cut and run (leave cargo behind) in order to sail as per the original schedule, steam as per the existing plan and arrive at the next port on-time.

Only the ship operator can make this call, and the decision-making process can be highly complex because of the multiple profitability impact factors to be considered.

b) **Terminal Operators.** We place terminal operators slightly ahead of port operators (Authorities) within the decision-making hierarchy on the basis that in many Tier 1 and Tier 2 Ports, the port services and channel navigation provided by the port operators are generally available with only limited possibilities for disruption. However, where this is not the case, the port operator assumes our #2 position. A terminal operator’s decisions are normally driven by:

- utilization, especially at both quay wall and quay crane;
- honouring service commitments (to the ship operators), either as they exist within Service Level Agreements (SLA’s) or as previously committed to; and
- minimising costs, through avoiding over-time costs as well as running minimum quantities of equipment to reduce energy costs and wear-and-tear.

c) **Port Operators.** Most are government-controlled (central, regional or local) entities. They are driven more by objectives like facilitating business rather than generating profits. Safe navigation clearly is their highest priority. They often also need to balance the requirements and priorities of different ship types, multiple ship and terminal operators as well as the requirements of the port as such. We have assumed that pilots are employed and assigned by the port operator which is the most common model, however where this is not the case, pilots/pilotage process requirements may be considered as secondary process actors.

B. Secondary Process Actors

Secondary process actors are those that play a direct role in the berthing and un-berthing of ships within a port but whose decision-making is driven by the primary actors. Where a secondary actor has capacity constraints, they might assume the role of a primary actor. However, this is potentially only temporary, as scaling their services and capacity to facilitate the needs of the primary actors can usually be accomplished relative quickly.

a) **Tug Boat Operators.** These might belong to the port operator. In some ports they could also be a sub-division of the terminal operator(s) but acting somewhat independently. A more common model, however, is that they are stand-alone entities within the port eco-system and there can often be more than one provider operating within a single port. Within the planning processes, they are generally served by being informed of needs and changes and then optimizing their resources to satisfy the requirements of their customers – who are generally the ship operators. In the event that constraints exist and that the plans made by the primary actors cannot be executed, there is and will always need to be a feedback-loop for re-planning ship arrivals and departures.

b) **Mooring Services.** These fall under either/or the terminal or port operators, or they can be stand-alone private service providers. Any constraints are driven primarily by labour shortages, and while this might be considered as rare, it happens, certainly for
temporary periods. The mooring service providers operate within the ecosystem in a similar way to the tug boat operators, where they need to have access to dynamic and accurate information to be able to plan/re-plan their resources, and in the event that they cannot execute the plan, they need to notify the primary actors.

C. Tertiary Process Actors

Tertiary process actors do not significantly influence the port and terminal planning processes, but they still need to receive planning and progress information in order to execute their tasks and deliver services on time or just-in-time. Their needs are summarised as follows:

a) **Regulatory.** This includes Customs, Immigration, Port Health, Safety, and other entities that perform a number of “clearance activities”. They need to know the arrival and departure timings for ships.

b) **Husbandry Agents and Suppliers.** Need to synchronise their deliveries, supplies or services to meet the schedule of arriving and departing ships.

c) **Bunker providers.** Need to synchronise their activities to meet the ship’s schedules.

d) **Importers, Exporters and their Agents.** Need to understand deadlines (exports) or dates/times of availability (imports) of the cargo/containers being exchanged by a ship.

e) **Feeder ship and Barge operators.** Need to adjust their “schedules” based on any changes to scheduling experienced by the deep-sea ships that they service/connect with.

f) **Rail and Truck operators.** Need to adjust their plans when changes to ship schedules occur.

g) **Co-loading parties.** These might include Alliance partners, Vessel Sharing Agreement (VSA) partners, Slot Charter parties, etc. As their operated containers (cargo) are affected, and deadlines might change, they need to be aware. However, they usually play no part in the decision-making processes, which are the sole prerogatives of the ship operator.

All tertiary process actors require outputs (information) from the overall process but do not normally need to provide any inputs, unless authorities detain a ship.

6.4.3 Basic Planning Process

For port calls, there are three distinctly different processes (Lind et al, 2018b):

A. **Pro-forma Plans.**

These are baseline plans that are made/amended infrequently. Any decisions are usually reached well in advance between the ship operator (who typically will have already discussed and agreed standard schedules with its alliance members or VSA partners) and the terminal operators.

B. **Initial Plans.**

This is a one-off process, the link between pro-forma and dynamic planning, where the detailed plan for a specific voyage is created initially. The data requirements are the same as for the dynamic planning process and this data input then feeds the dynamic processes.

C. **Dynamic Plans.**

This is the process where any disruptions to the initial plans are handled. Changes are primarily driven by port ETA changes announced by the ship operator, which in all likelihood are driven by changes in the ETD at previous terminals (in previous port). Such changes can occur at very short notice and they potentially impact the schedule and plans of many down-stream ports, terminals and other actors.

In the preceding list, the first two are not short-term or daily activities; we have not considered them as part of the initial PortCDM solution. However, the data that they generate as outputs could be useful input in PortCDM and serve a purpose from a statistical or analytical perspective.
perspective. It would assist the assessment of overall scheduling success, as well as the reliability and accuracy of forecasting and planning.

### 6.4.4 The Dynamic PortCDM process

As has been highlighted in a STM concept note (Lind et al, 2018c), PortCDM has the potential to address many of the existing shortcomings and time-losses in the port call process. Importantly, PortCDM does not call for process changes but proposes to facilitate a more dynamic and effective delivery of existing processes through enabling greater collaboration through higher quality data made available almost real-time to all the relevant actors in the maritime transportation ecosystem.

The PortCDM process is intended to be dynamic and transparent through the use of standardised messaging and interfaces that trigger and prompt the various actors to review exception alerts and take actions based upon their physical capabilities, preferences, and requirements. As actors amend individual plans within ports, this then affects subsequent ports and terminals, and revisions to their planning processes should therefore be dynamically handled. Thus, there could be several or multiple revisions required during a single port call.

The following flow chart, Figure 17 (Lind et al, 2018c, cited in STM, 2019a), illustrates the procedure, that the primary actors would follow, when an existing plan is no longer executable due to delays at the current terminal. In the event of a delayed (at sea) ETA, the process would be initiated by the ship operator at the “Change in ETA” box. The normal progression follows the full lines. Dotted lines indicate repeat loops where a planning process must be redone or re-worked.

![Flow Chart Figure 17 Procedure for primary actors when delays occurs](source: STM, 2019a)

In relation to the flow chart, readers should note that:

- “Ship operator” can include the local agent, the ship operator’s regional or global management function as well as the ship’s command.
- The entry point for the port and terminal operators will usually be the local agent who will discuss any disruptions with the regional/global management, after which new plans are communicated by the local agent to the ship’s command (Captain or Chief
With greater accuracy and visibility of a ship’s overall situation facilitated by a PortCDM solution, it might be possible for the regional/global function to assume a more direct control and communication with port and terminal operators as well as the ship’s command.

- There is a dotted-line feedback loop between the Port and Terminal operators at the current port indicating that the optimal channel slot and/or pilot availability cannot be provided. In this case, the terminal and port actors would need to jointly develop an executable plan that could be sent for approval by the ship operator.
- Where the disruption of current plans is the result of a delayed ship already in transit, the first process step would be “Change of ETA next port made?” The ship operator would trigger this.
- Where the terminal at the next port cannot berth a ship in line with the ship operator’s request, there could be a dotted-line feedback loop, where the terminal (or port) operator could select a reason from a limited list and provide some “free text” options in a PortCDM software information interface.
- Where inclement weather, channel congestion, pilot shortages, etc. impact either the ETB or ETD, a port operator would initiate a re-planning process by updating either of these dates/times - for which both the terminal and ship operators would be alerted to also revise and update their own plans.

6.4.5 The two sub-processes of a port call from an authority point of view

The port call process can be divided into two sub-processes:

1) Port Call Request (see Figure 19);
2) Port Call Execution (see Figure 20).

The port call request takes place prior to the ship arrival and comprise important formalities and exchange of information among national authorities and the shipping company / ship agent aiming at calling at a certain port. The port call execution comprises the operative execution of the port call once all the corresponding authorisations have been approved prior to the ship arrival. Depending on the port’s governance model, different barriers may manifest or influence both processes. The port call request involves the following agents:

- Ship Agent;
- Port Authority;
- Maritime National Authority;
- Port National Authority.

The following diagram shows the information flows established by the aforementioned agents when managing a port call request according to the guidelines established by the Convention on Facilitation of International Maritime Traffic, 1965, as amended. This diagram, Figure 18, shows a generalised version of this sub-process, which may vary depending on the world region and national / local regulations.
This sub-process starts with the request by the shipping agent of a port call to the corresponding port authority. This request can be made electronically through a Port Community System or similar port information-exchange system or by other means (e-mail, fax, paper format).

If the request is made digitally, the information exchange between the shipping agent and the port authority takes place by means of the standardised EDI messages BERMAN (Berth Management Message) and APERAK (Application Error and Acknowledgement Message). As part of the STM validation project, the internationally recognised standardised message format S-211 has been developed for sharing time stamps (Lind et al, 2018d, cited in STM, 2019a, p.42) to complement this information exchange.

The Berth Management Message, in accordance with the UN/EDIFACT², is a message from a carrier, its agent or means of transport to the authority responsible for port and waterway management, requesting a berth, giving details of the call, ship, berth requirements and expected operations. The BERMAN message is used in Electronic Data Interchange (EDI). The Berth Management Message may be used for both national and international applications. It is based on universal practice related to administration, commerce and transport, and is not dependent on the type of business or industry.

If the port call request is correct, the Port Authority informs both the shipping agent and the corresponding Maritime National Authority about the port-call reference number assigned to the port call request. The Port Call Execution corresponds to the operative process of facilitating approach, berthing and departure of ships at ports. The following diagram, Figure 19, shows a generalised port call process.

---

² United Nations/Electronic Data Interchange for Administration, Commerce and Transport UN/EDIFACT is the international EDI standard developed under the United Nations. For further insight please refer to https://www.unece.org/cefact/edifact/welcome.html
The port authority plays the role of port call coordinator in most ports regardless of the port governance model (service, tool, landlord or private).

Today, the landlord port is the dominant port model in larger and medium-sized ports, although service and tool port models are still in place in developing countries. Under the landlord port governance model, the port authority usually leases the nautical services defined as pilotage, towage and mooring to specialised companies or corporations. This scheme is widely adopted in developed countries.

Taking the landlord port governance model as the most extended in the sector, the port call process can be described as starting usually with a planning task by the port authority where it takes into consideration the current situation of the port (number and location of ships berthed at present) and the foreseen situation within the next hours (scheduled Estimated Time of Arrivals and Departures). This task is repeated under an iterative cycle and is adapted according to the operational reality of the port.

Within this process, the port authority establishes coordination for the next iterative cycle (for example, next 24 hours) with the nautical service providers, who are the agents in charge of executing the berthing and departure operations of ships. In this respect, when a ship enters the approach area of a port and has berth authorisation (for example, one hour before arrival), it establishes contact with the port via VHF radio, usually with the pilots organisation being the first agent contacted. Pilots usually monitor the approach of the ship and give instructions according to the current and expected situation at port. Examples of these instructions are:

- … increase speed to arrive early to the pilot boarding area, since a berth slot will be released earlier than expected;
- … reduce speed to arrive lately to the pilot boarding area, since a berth slot will be released later than expected;
- … sail towards the anchorage area due to different reasons: port congestion, ship technical constraints, prioritisation of traffics (e.g. passenger ships), etc.
If the port has a berth slot available for a certain ship, pilots start to coordinate with the tug boat company and mooring companies in order to organise the port call operations: number of tug boats required, type of manoeuvring, berth allocation, etc. In parallel, communication with the ship takes place in order to confirm the pilot boarding at the designated boarding area. All the aforementioned communications take place via radio under the same VHF channel (commonly known as the port control channel).

The type and complexity of operations involved in port calls can vary significantly from one port to another, ranging from less than one hour of port call and berthing operations (open seaports) to several hours (river ports), especially in ports which require channel navigation until reaching the cargo terminal.

Once the ship is moored at the berth, the port call process is finished from the operative perspective. Then the cargo handling process starts with loading and unloading operations (container, bulks, Ro-Ro, passengers, etc.). The departure process can be described as a mirror of the port call process, since the last event of the port call process is the first action of the departure process.

From the port operative perspective, the most relevant factors influencing port barriers in port call synchronisation are those associated to the agents involved in the port call management and their level of coordination when planning and executing a port call. In this sense, performance of nautical services operations and port traffic management are key factors to analyse in order to assess their impact over port call synchronisation. The level of port congestion, for instance, represents a relevant factor affecting ships’ arrivals and departures and may affect the ability of the port to adopt port call synchronisation on a wide basis.

Moreover, the level of technological integration of port call actors within the port and their information exchange procedures can also affect in a significant way the adoption of port call synchronisation. Reference can be made to Port Community Systems where port call information is shared among involved actors (included shipping agents) or the adoption of information exchange standards applied to port calls as explained in previous sections of this report.

Other factors related to the port’s physical location (seaports, river ports) and its configuration (distribution and type of cargo terminals) are relevant for the study. The physical configuration of a port directly influences port call operations (resources involved, type of manoeuvring, time to execute operations, etc.).

### 6.5 Situational awareness

From data collected from interviews, questionnaires, and workshops (LivingLabs), an ideal port call is conceived as well-coordinated between the different parties/ service providers taking part in a port call and moreover the call where all involved actors share a common situational awareness picture in order to plan their operations better.

As reported in the validation of PortCDM (STM, 2019a) and as shown in Figure 20, 92% of respondents from all the ports agreed (either fully or to a great extent) with the statement that PortCDM contributed to a shared situational awareness of port calls. None disagreed. This indicates particularly strong support for PortCDM.
When respondents were asked if they believed that a future full-scale implementation of PortCDM would enable a shared situational awareness of port calls in their ports, the evaluation was equally positive.

As can be seen in Figure 21, 84% of respondents from all the ports agreed (either fully or to a great extent), that PortCDM would enable a shared situational awareness of port calls in the case of a full scale implementation in their ports. None disagreed.

The PortCDM validation participants were asked to provide their opinion on whether PortCDM provided an enhanced basis for making better estimates. The responses are reflected in Figure 22. 72% of all respondents in the ports agreed (either fully or to a great extent) that PortCDM provided an enhanced basis for making better estimates. 28% agreed “to some extent” with the statement, and none disagreed. This was another very positive response to PortCDM.
When asked whether a full-scale implementation of PortCDM would enable an enhanced basis for making better estimates in a situation where PortCDM was fully implemented in their port, positive support for PortCDM continued; 87.5% agreed (either fully or to a great extent), none disagreed, see Figure 23.

The PortCDM validation participants were asked to provide their opinion on whether PortCDM had created a greater awareness of different actors' intentions. 24% fully agreed that PortCDM had created a greater awareness of different actors' intentions. 48% agreed at a great extent while 28% agreed to some extent. None disagreed. This is shown in Figure 24.
In the case of a full-scale implementation of PortCDM in the future, the validation participants also showed a high level of consensus regarding whether greater awareness of different actors’ intentions could be achieved. In line with the previous results, 48% fully agreed that in a situation where PortCDM was fully implemented in their port, the system would create a greater awareness of the intentions of different actors. 36% agreed at a great extent while 12% agreed at some extent. 4% agreed to a small extent. None disagreed. These results are shown in Figure 25.

6.6 Workload

The following results concerning workload were obtained in the validation of PortCDM. As shown in Figure 26, 16% fully agreed that PortCDM had improved their work procedures, 20% agreed to a great extent, 28% agreed to some extent and 24% agreed to a small extent. 12% did not agree that PortCDM had improved their work procedures as it stood during the focus month.
In a case of a full-scale implementation of PortCDM, the respondents were slightly more optimistic about the extent to which this would improve work procedures in the future.

As shown in Figure 27, 19% fully agreed that PortCDM would improve their work procedures, 26% agreed to a great extent, 33% agreed to some extent and 15% agreed to a small extent. 7% did not agree.

6.7 Waiting time and predictability

The concept of PortCDM includes six key performance indicators (KPIs): *Duration time, waiting time, berth productivity, capacity utilization, predictability, and punctuality*. Wherever possible, data to evaluate these KPIs is shared by machine-to-machine (M2M) interaction between different systems using a standard data format such as the port call message standard S-211, which builds on the international definition of a port call event. Other criteria include estimated time of arrival of the ship to the berth (ETA Ship Berth) and estimated time of cargo operations commenced (ET_cargo operations commenced).

The difference between the timing of planned and estimated events and the actual event is an indication of the predictability or reliability of the port-call process. Any deviation between
planned/estimated and actual events represents the predictability of the port as such (as a representation of an ecosystems of actors) and represents a measure of how well a port is performing in a synchronised transport chain (enabled by STM).

Different planning horizons are associated with different levels of tolerance for deviation between the estimated and the actually reached state (the outcome) as shown in Figure 28. (Lind et al 2014, cited in STM, 2019a p.44)

![Figure 28 Acceptable deviations between estimate and actual occurrence in different time slots. Source: STM, 2019a](image)

Deviations ought to diminish with time; the closer to the execution phase the smaller the tolerance for deviation should be, until the actual moment of occurrence is reached for a certain state. This acknowledges the planning processes, performed by the different actors, with different time horizons (long-term, mid-term, and short-term planning) to be performed efficiently, based on information about the interval of the outcome (for example, a time span of when a certain state is reached).

Monitoring performance through the KPI’s and associated analysis enables the different actors to improve their operations and utilization of physical infrastructure and variable resources.

### 6.8 Incremental Implementation

During the project, incremental improvements were made to the PortCDM testbeds, their operation and to the underpinning PortCDM doctrine. This enabled the development of a maturity model, depicted in Figure 29, and a complementary incremental implementation strategy that can be applied across a port as a whole, or progressively to individual sectors of a port – for example, passenger ship operations, then container traffic, and so on.
Figure 29 The seven-step maturity framework for developing PortCDM capabilities in ports

Source: STM, ACT1
7 OPERATIONAL SCENARIOS

7.1 Introduction

This chapter continues the operational description that started in chapter 3 by giving a more details on the operational services. Only those services which were implemented and tested in ACT 1, 2 and 3 are discussed further. These services are listed below and classified in the following way:

Table 4 Classification of tested operational services.

<table>
<thead>
<tr>
<th>Implemented and tested service</th>
<th>Classification</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chat message</td>
<td>STM function</td>
<td>Using STM TXT message</td>
</tr>
<tr>
<td>Ship-to-ship route exchange</td>
<td>STM function</td>
<td>Including RDV</td>
</tr>
<tr>
<td>Route suggestions</td>
<td>STM function</td>
<td>Ship to shore route exchange</td>
</tr>
<tr>
<td>Route cross check</td>
<td>STM operational service</td>
<td>Ship to shore route exchange</td>
</tr>
<tr>
<td>Nordic navigation warning service</td>
<td>STM operational service</td>
<td>Using S-124</td>
</tr>
<tr>
<td>Enhanced monitoring service</td>
<td>STM operational service</td>
<td>Can be using Route suggestion</td>
</tr>
<tr>
<td>Baltic Pilot route service (ACT2)</td>
<td>STM operational service</td>
<td>Not tested in the EMSN</td>
</tr>
<tr>
<td>STM SAR service</td>
<td>STM operational service</td>
<td>Complex, considered to be an operational scenario</td>
</tr>
<tr>
<td>STM Winter navigation service</td>
<td>STM operational service</td>
<td>Complex, considered to be an operational scenario</td>
</tr>
<tr>
<td>PortCDM: Port call coordination</td>
<td>STM operational service</td>
<td>All PortCDM services are together more as an operational scenario</td>
</tr>
<tr>
<td>PortCDM: Port call synchronization</td>
<td>STM operational service</td>
<td>- \ -</td>
</tr>
<tr>
<td>PortCDM: Port call monitoring</td>
<td>STM operational service</td>
<td>- \ -</td>
</tr>
<tr>
<td>PortCDM: Port call improvement</td>
<td>STM operational service</td>
<td>- \ -</td>
</tr>
</tbody>
</table>

It should be noted that the STM SAR service, the STM Winter navigation together with services connected to PortCDM are more than just operational services thus they are treated as operational scenarios.

Following the discussion in §3.3.2 regarding operational parameters, the description of the services above will follow the structure:

- Objectives; this part states the purpose of the service;
- Description; describes the service in its operational context;
- Operating nodes; elements that participate in the service interaction e.g. ship, VTS, etc.;
- Actors; users or providers of the service, e.g.;
  - Service provider; and
  - Users of the service.
- Area of operation; and
- Operational elements:
  - Information.
The results of these operational descriptions are also summarised in the STM Concept of Operation, provided in the STM Final Report (STM, 2019).

7.2 Chat messages

7.2.1 Discussion
Today, ships larger than 300 GT are equipped with AIS transponders. AIS can send binary addressed messages, message 6 and broadcast messages 8. However, a typical range to be expected at sea is 20 to 30 nautical miles depending on the antenna height (IMO, Resolution A.1106 (29)).
The original idea with using STM TXT messages was to support other information exchange functions (ML2, 2015), e.g.:
- Route suggestion, explaining the reason for proposing a new route;
- STM SAR service, sending out text messages, individual or group;
- STM Winter navigation service, sending out text messages; and
- Route optimization, explaining the rationale for a proposed route.

The objective is to improve the reliability of the communication in the above listed cases.
The main users are identified as the STM ship's bridge teams, STM equipped VTS and SC operators, icebreaker bridge team, icebreaking management, RCC operators, and SRU bridge teams.
The area of operation is in this case not depending on VHF coverages instead it requires IP communication.
It is recommended that this mean of communication should be used with care for ship-to-ship communication in e.g. anti-collision situations, referring to the fact that communication in a potential collision situation should not be solved by voice communication, (COLREG, 1972, as amended)
Further, it is important that the text messages must not affect the lookout or other tasks on the bridge (ref. STCW watch keeping guides and Chapter 4).

7.2.2 Operational parameters
The following operational parameters are identified:

<table>
<thead>
<tr>
<th>Name: Chat messages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective:</strong></td>
</tr>
<tr>
<td>To support other operational services with reliable text messages.</td>
</tr>
<tr>
<td><strong>Operational description:</strong></td>
</tr>
<tr>
<td>Transmitting addressed text messages between navigation systems using the ship’s internet connection.</td>
</tr>
<tr>
<td><strong>Operating nodes:</strong></td>
</tr>
<tr>
<td>STM compliant ships</td>
</tr>
<tr>
<td>STM compliant SRU and Icebreaker</td>
</tr>
<tr>
<td>STM compliant VTS, SC and RCC</td>
</tr>
<tr>
<td><strong>Actors/users:</strong></td>
</tr>
<tr>
<td>Ship’s bridge team</td>
</tr>
</tbody>
</table>
SRU and Icebreaker bridge team  
VTS, SC, and RCC operators

<table>
<thead>
<tr>
<th><strong>Area of operation:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>In principle global but depending on the availability of internet connection, which is depending on satellite or terrestrial communication.</td>
</tr>
<tr>
<td>All vessels/ships are not equipped with this functionality.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Information:</strong> (examples of type of information)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Text message including rationale for route suggestion</td>
</tr>
<tr>
<td>• Text message including rationale for route optimisation</td>
</tr>
<tr>
<td>• Text message including information connected to SAR operation</td>
</tr>
<tr>
<td>• Text message including information connected to ice navigation</td>
</tr>
<tr>
<td>• Text message including safety related information</td>
</tr>
</tbody>
</table>

### 7.2.3 Operational recommendations

Based on the discussions performed in chapter 4, 5 and in the previous paragraphs the following should be noted when using the STM Chat messages or when developing this function further:

**Usability:**

- It is important that the message does not clutter the navigation display. User centre design should be considered, e.g. (IMO User, 2015);
- Function for confirmation of message reception should be included; and
- Group chat would be appreciated, especially during a SAR operation.

**Limitations and restrictions:**

- Should not be used in anti-collision situations, compare guides regarding voice communication in anti-collision situations; and
- Communication is depending of internet connection.

**Operating procedures, the following should be considered in the bridge procedures:**

- It should be noted that not all ships/vessels are equipped with this function;
- Should be used with care in anti-collision situations, compare guidance regarding voice communication in anti-collision situations;
- Closed loop, compare with internal and external voice communication;
- Consider the fact that the messages can be logged;
- Not take away attention from navigational and look-out; and
- Limitations to be known by OOW.

**Training:**

Included in the ship’s ECDIS/INS familiarisation and STCW Model Courses:

- ECDIS (Model course 1.27);
- GMDSS GOC (Model course 1.31);
- Integrated Navigation System (Model course 1.32);
- and
- IALA VTS Operator Guides (IALA VTS Model Course 103/1; V-103/2; V-103/3; V-103/4).
7.3 Ship-to-ship route exchange

7.3.1 Discussion

There is a need to increase situational awareness in traffic situations. Especially, meeting, crossing and overtaking situations in combination with navigational constraints such as the proximity of shallow waters. Further, mariners have pointed out (IMO’s SIP, 2010), as stated in chapter 3: “Mariners would be grateful if e-navigation could facilitate better detection of targets.”

The ship-to-ship route exchange service (S2SREX) provides the navigator with a route segment consisting of the next 7 WPT of the monitored route of another ship. The route segment is sent by using AIS ASM and displayed at adjacent ships’ navigation display, if equipped with STM compatible equipment. The exchange of route information between ships is within the distance of horizon or AIS VHF/FM range. A typical range to be expected at sea is 20 to 30 nautical miles depending on antenna height (IMO resolution A.1106 (29)). The routes will not be displayed unless activated. The present route leg and the upcoming six route legs will be visible. The operator will be able to make a choice if the ship should share the route with other ships or not. The route information can also be broadcast to SC and VTS.

Operationally, the route is loaded for monitoring in the navigation system and activated. Choices are made to allow other surrounding vessels within AIS coverage to see a segment of the ship’s intended route. Only the route segments of a monitored/activated route are exchanged.

Provided that the ship has agreed to enable the S2SREX function, this new Route Message broadcast will automatically be initiated by the on-board equipment when any of the below events occurs (STM, 2019b):

- Six minutes have passed since last Route Message broadcast;
- A Route Message interrogation was received and over one minute has passed since last Route Message broadcast on that channel;
- Any of the data in the last Route Message broadcast has been changed;
- When passing a waypoint;
- The Monitored Route has been deactivated; and
- A Monitored Route is activated.

Rendezvous (RDV) Function is an integral part of the S2SREX, allowing the navigator to view where own ship will meet a target ship if both vessels continue along their monitored broadcasted route with the present speed over ground. This function provides a route-based (STM, 2019b):

- Closest Point of Approach (CPA/TCPA) Meeting Points;
- Closest Point of Approach (CPA/TCPA) - Rendezvous (RDV) calculations;
- Predictions – Decision Support, out of Route; and
- AIS target deviation.

Route segments give additional information to the presently available data obtained by radar/ARPA and AIS. Nothing in the S2SREX information exonerates the navigator from applying COLREG and rather than being used in a close quarter situation, the S2SREX may be used as a strategic tool for supporting decision-making and situational awareness at a longer range. Hence, it needs to be considered as an additional information source enabling the navigator to foresee critical situations within a wider time frame and thereby potentially achieve a smoother traffic flow.

In summary, the introduction of this function would give the navigators an additional tool to provide for enhanced situational awareness and improved decision-making by (STM, 2019b):

- Being able to see other ships’ routes;
- Being able to predict the meeting point based on actual speeds and monitored routes; and
- Being able to predict a new meeting point if speed and/or route is changed using a trial manoeuvre.
Further, this mode of operation could also be used in SAR or oil spill response operations, providing search path/patterns as route changes to participating ships.

### 7.3.2 Operational parameters

The following operational parameters are identified:

**Table 6 STM S2SREX’s operating parameters.**

<table>
<thead>
<tr>
<th>Name: Ship-to-ship route exchange (S2SREX)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective:</strong> Increase situational awareness regarding future traffic situations.</td>
</tr>
</tbody>
</table>

| **Operational description:** S2SREX provides the navigator with a route segment consisting of the next 7 WPT of the monitored route of another ship. The route segment is sent by using AIS ASM/VDES and displayed at adjacent ship’s navigation display. |
| **Operating nodes:** STM compliant ships, STM compliant SRU and Icebreaker, STM compliant VTS, S/C and RCC |
| **Actors/users:** Ship’s bridge team, SRU and Icebreaker bridge team, VTS, SC, and RCC operators |
| **Area of operation:** This function uses AIS ASM/VDES as communication carrier. In one case it is depending on AIS range. A typical range to be expected at sea is 20 to 30 nautical miles depending on antenna height. All vessels/ships are not equipped with this functionality. |
| **Information:** Ships intended route, which is active in the navigation system, including |
| - Next 7 WPT |
| - Legs between the WPT |
| - Turning radius |

### 7.3.3 Operational recommendations

Based on the discussions performed in chapter 4, and in the previous paragraphs the following should be noted when using the STM S2SREX or when developing this function further:

**Usability:**

It should be possible to select/remove an object’s route with one key stroke. Easy identification as to which route belongs to which ship. User centre design should be considered, e.g. (IMO User, 2015);

**Operating procedures:**
• It should be noted that not all ships/vessels are equipped with this function;
• It should be noted that this is the intended and monitored route, which may not necessarily be followed by the ship:
  • Follow up intended route with Radar, ARPA, AIS and if possible visual observations.
• It should be used in the strategic navigation in order to avoid future traffic situations and not be used for tactical navigation/anti-collision purposes; and
• Not clutter navigation display, not display all possible routes, needs good user instructions.

Training:

Included in the ship’s ECDIS/INS familiarisation and IMO’s STCW Model Courses:

- RADAR and ARPA Radar (Model course 1.07);
- RADAR, ARPA, BTM (Model course 1.08);
- ECDIS (Model course 1.27);
- GMDSS GOC (Model course 1.31);
- Integrated Navigation System (Model course 1.32);
- AIS (Model course 1.34);

and

- IALA VTS Operator Guides (IALA VTS Model Course 103/1; V-103/2; V-103/3; V-103/4)

7.4 Route suggestion

7.4.1 Discussion

One cornerstone in the STM concept is the ship-to-shore and shore-to-ship exchange of route information. One case is a route suggestion from shore-to-ship. This function is used together with another operational service and uses the RTZ message format to transmit and propose a new or updated route segment. This can both include spatial – WPT changes and temporal – schedule usually a combination of both. Hence, route suggestions can be used, as example, in combination with:

- Route optimisation, where the optimised route is transmitted from the shore-based service provider to the ship;
- SAR, where a search pattern is transmitted from the ship to RCC, or from RCC to the ship or OSC to a ship;
- Winter navigation, where a dynamic ice route (Dir.Way) is transmitted from SC or from icebreaker to the ship navigation in the ice regime; and
- Fleet Operation Center (FOC), transmitting a route change to a ship in its fleet.

Hence, the users or actors are the ship’s bridge team and different types of service providers like VTS, SC, RCC, and route optimisations. The area of operation is in this specific case connected to the SC area of responsibility. In general, the function has no coverage limit as long as the ship has satellite Internet coverage.

Here, only the first bullet is further discussed. Bullet two and three can be found in §7.8 and §7.9, respectively. Further, a SC might use the function in order to change the traffic flow in case of an accident. Information regarding the accident can be sent using the Navigation warning service, see further §7.6.

It is important to note that this is only a suggestion, or a recommendation and the route needs to be checked by the bridge team with respect to the ship’s:
- Under Keel Clearance (UKC) and loading conditions;
- Ship's particulars and manoeuvring characteristics;
- Navigation safety margins; and
- Navigational hazards,
and approved by the master before being included in the active route in the navigation system.

### 7.4.2 Operational recommendations

The following operational parameters are identified:

#### Table 7 STM Route suggestion’s operating parameters.

<table>
<thead>
<tr>
<th>Name: Route suggestion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective:</strong></td>
</tr>
<tr>
<td>to send a proposed route to a ship from a shore-based service provider</td>
</tr>
<tr>
<td><strong>Operational description:</strong></td>
</tr>
<tr>
<td><strong>Operating nodes:</strong></td>
</tr>
<tr>
<td>STM compliant ships</td>
</tr>
<tr>
<td>STM compliant SRU and Icebreaker</td>
</tr>
<tr>
<td>STM compliant VTS, SC and RCC</td>
</tr>
<tr>
<td>STM compliant FOC</td>
</tr>
<tr>
<td><strong>Actors:</strong></td>
</tr>
<tr>
<td>Ship’s bridge team</td>
</tr>
<tr>
<td>SRU and Icebreaker bridge team</td>
</tr>
<tr>
<td>VTS, SC, and RCC operators</td>
</tr>
<tr>
<td>FOC operator</td>
</tr>
<tr>
<td><strong>Area of operation:</strong></td>
</tr>
<tr>
<td>Depended on the availability of internet connection, which is depending on satellite or terrestrial communication. Further, depending on SC, VTS, RCC area of operation</td>
</tr>
<tr>
<td><strong>Information:</strong></td>
</tr>
<tr>
<td>Route information in the context of:</td>
</tr>
<tr>
<td>- Route optimisation, where the optimised route is transmitted from the shore-based service provider to the ship.</td>
</tr>
<tr>
<td>- SAR, where a search pattern is transmitted from the ship to RCC, or from RCC to the ship or OSC to a ship.</td>
</tr>
<tr>
<td>- Winter navigation, where a dynamic ice route (Dir.Way) is transmitted from S/C or from icebreaker to the ship navigation in the ice regime, and</td>
</tr>
<tr>
<td>- FOC, transmitting a route change to a ship in its fleet.</td>
</tr>
</tbody>
</table>
7.4.3 Operational recommendations

Based on the discussions performed in chapter 4, and in the previous paragraphs the following should be noted when using the STM Route suggestion service or when developing this function further:

**General:**
- The VTS/RCC/SC should note that not all ships/vessels are equipped with this function;

**Usability:**
When further designing the functions managing the route exchange, user centre design should be considered, e.g. (IMO User, 2015);

**Operating procedures:**
- The suggested route should be checked by the bridge team with respect to at least:
  - Navigation safety
  - Ship’s characteristics and updated voyage data (draft, UKC required etc.)
- Should be used combined with STM Chat message or voice communication explaining the rationale and restrictions of the suggested route;
- The route suggestion should follow close loop communication;
- Consider the fact that the messages can be logged;
- Route consideration as “deviation” up to the Master (SOLAS and company SMS)
- When receiving a route, it should be checked and confirmation for disapproval or approval sent to the service provider;
- Nautical competence for the service provider should be assured; and
- Risk of increased workload for SC, VTS operator.

**Training:**
Service provider needs nautical competence
Included in the ship’s ECDIS/INS familiarisation and STCW Model Courses:
- ECDIS (Model course 1.27);
- Integrated Navigation System (Model course 1.32);
  and
- IALA VTS Operator Guides (IALA VTS Model Course 103/1; V-103/2; V-103/3; V-103/4)

7.5 Pilot route service

7.5.1 Discussion
The route plan shall include the whole voyage berth to berth. However, in many cases the pilotage phase in the beginning and end of the voyage requires mandatory pilot service. The Nordic Pilot Route Service (PRS) is an onshore service that provides pilot routes to ships when planning their voyages (STM, 2017a). Ships can send their voyage plan to PRS and receive back one or several pilot routes, which can be merged with the route plan. If the ship’s voyage plan is planned from/to the berth, PRS will calculate the best pilot route(s) and, if the voyage plan ends near a pilot boarding point, all pilot routes from that boarding point will be returned. The voyage planning needs then to be approved by the master before the voyage starts. Potential benefits with this service are (STM, 2019b):
- Efficient planning;
- Basis for a shared mental model of the bridge team and the pilot; and
- Safe navigation berth-to-berth.
7.5.2 Operational parameters

The following operational parameters are identified:

Table 8 STM Pilot route service’s operating parameters.

<table>
<thead>
<tr>
<th>Name: Pilot route service</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective:</strong></td>
</tr>
<tr>
<td>to send a proposed pilot route to a ship from a shore-based service provider</td>
</tr>
<tr>
<td><strong>Operational description:</strong></td>
</tr>
<tr>
<td>Ships can send their voyage plan to this service and receive back one or several pilot routes, which can be merged with the voyage plan.</td>
</tr>
<tr>
<td><strong>Actors:</strong></td>
</tr>
<tr>
<td>Bridge team</td>
</tr>
<tr>
<td>Pilot</td>
</tr>
<tr>
<td>VTS and SC operator</td>
</tr>
<tr>
<td>The service is organised by port authority</td>
</tr>
<tr>
<td><strong>Area of operation:</strong></td>
</tr>
<tr>
<td>Local compulsory pilot area</td>
</tr>
<tr>
<td><strong>Information:</strong></td>
</tr>
<tr>
<td>• Pre-planned pilot route within a local compulsory pilot area</td>
</tr>
</tbody>
</table>

7.5.3 Operational recommendations

Based on the discussions performed in chapter 4, and in the previous paragraphs the following should be noted when using the STM PRS service or when developing this function further:

**Usability:**
Consider user centred design should be considered, e.g. (IMO User, 2015); and
The user needs to know how the service selects a route and which parameters are used.

**Operating procedures:**
• This function should be used already in the planning phase of the voyage;
• Ship’s manoeuvring characteristic with respect to generic route;
• Turning points, radii and navigation marks should be added by the bridge team, based on the ship’s characteristics;
• The pilot route be checked and approved by the master; and
• The pilot route should be included in the master/pilot exchange.

**Training:**
Included in the ship’s ECDIS/INS familiarisation and IMO’s STCW Model Courses:
• ECDIS (Model course 1.27);
• Integrated Navigation System (Model course 1.32); and
• IALA VTS Operator Guides (IALA VTS Model Course 103/1; V-103/2; V-103/3; V-103/4).
7.6 Navigational warning service

7.6.1 Discussion

This service is related to and supports the intention of IMO MS 5 “Maritime Safety Information Service (MSI)”. MSI is crucial for the ship’s safe navigation. MSI consists of three main type of information:

- Navigational warnings;
- Meteorological information; and
- Urgent other safety information.

In SOLAS Chapter IV, regulation IV/4.7 defines the seventh functional requirement as:

"Every ship, while at sea, shall be capable of transmitting and receiving maritime safety information”.

Today, Navigation warnings are broadcast either by NAVTEX or GMDSS SafetyNet. This will give an additional source of transmitting navigation warnings emphasising usability and workload of the operator and the STM goal of “right information at the right time”. The MSI service is an internationally co-ordinated network of broadcasts of MSI from official information providers, such as:

- National Hydrographic Offices, for navigational warnings and chart correction data;
- National Meteorological Offices, for weather warnings and forecasts;
- Rescue Co-ordination Centres (RCCs), for shore-to-ship distress alerts; and
- the International Ice Patrol, for Oceanic ice hazards.

Specific information on Aids to Navigation and restrictions on safe navigation are part of MSI services provided by National Authorities. This can include but is not limited to, the following type of information to be available to mariners:

- status of Aids to Navigation;
- status of GPS and DGPs;
- buoy tendering operation; and
- restriction on safe navigation such as bridge/hydro cable air gap, new hazards, construction or dredging operations.”

The Baltic Navigational Warning Service, is one example of this, which provides navigational warnings to concerned STM ships in the Baltic Sea. The service is initiated when a ship shares its route plan with the service. In response, the service initially provides the ship with all related safety notices in the concerned area(s) and then continuously all updates in the concerned area(s). Notices that are within the sub-areas that the route crosses, are deemed as relevant and sent to the ship (see Figure 30). Notices in other sub-areas will not be sent. When ship has left the service coverage area, the Baltic navigational warning service stops sending updates to the ship. (STM, 2019d)

The service provides the following navigational safety notices:

- Coastal warnings - Navigational warnings that apply to open waters are classified as coastal;
- The same information that today is transmitted on NAVTEX;
- Local warnings for Swedish waters - Warnings that apply only to waters inside the belt of the skerries are regarded as local. Today transmitted only on VHF; and
- Temporary and Preliminary notices for Swedish waters.
The users (actors) are here the ship’s bridge team that today use other means of receiving navigational warnings. There are now new procedures for the Navigation warning service providers more than a new channel to transmit information through. Today, this service is only implemented in the Baltic region, coverage is depicted in the Figure 30 below.

![Service coverage area and example of relevant notices based on ships Voyage Plan and sub-area division.](image)

**Figure 30** Service coverage area and example of relevant notices based on ships Voyage Plan and sub-area division.  
Source: STM, 2019b

It is important to note that today’s transmissions are based on a very high availability using NAVTEX and the GMDSS, which is a set of radio and satellite-based communications options. The STM service uses Internet, which would require e.g. satellite connection.

This service is expected to increase situational awareness and decreasing workload, hence implying an increase in safety. There are several stakeholders for increased safety of navigation but here ship owner, cargo owner, insurance companies and maritime authorities have been highlighted.

The information transmitted is a combination of navigational warnings and geographical warnings using the S-124 standard.
Table 9 STM Navigational warning service’s operating parameters.

<table>
<thead>
<tr>
<th>Name: Baltic navigational warning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective:</strong></td>
</tr>
<tr>
<td>Transmitting navigational warnings directly to the ship’s navigation system</td>
</tr>
<tr>
<td><strong>Background:</strong></td>
</tr>
<tr>
<td>IMO has divided the world’s oceans into NAVAREAS where appointed area coordinators are responsible for providing Maritime Safety Information (MSI) as part of the Global Maritime Distress and Safety System (GMDSS). In addition, every ship, while at sea, must comply with these regulations and notices are typically received from the coordinators by voice (radio) communication at specified time intervals and by the receipt of textual information, typically received at a NAVTEX printer. The ship enters different area codes into the receiver to receive those notices applicable for its area of operation. Some ECDIS’s can show notices as text at correct geographic positions but no functionality or standards on showing actual affected areas exist.</td>
</tr>
<tr>
<td><strong>Operational description:</strong></td>
</tr>
<tr>
<td>When a voyage plan is received by the service, the ship is added in a subscription list for navigational warnings in the Baltic Sea area. The ship will initially receive all active warnings concerning the sub-areas that the route crosses and then continuously receive updates, new and cancelled messages until the route leaves the area and subscription is removed by the service.</td>
</tr>
<tr>
<td><strong>Actors:</strong></td>
</tr>
<tr>
<td>Ship’s master, navigation officer and OOW.</td>
</tr>
<tr>
<td><strong>Area of operation:</strong></td>
</tr>
<tr>
<td>National MET/NAV AREAS</td>
</tr>
<tr>
<td><strong>Information:</strong></td>
</tr>
<tr>
<td>- Geographical area</td>
</tr>
<tr>
<td>- Time and date</td>
</tr>
<tr>
<td>- Navigational warning in S-124 format</td>
</tr>
</tbody>
</table>

7.6.2 Operational recommendations

Based on the discussions performed in chapter 4 and in the previous paragraphs the following should be noted when using the Navigation warning service or when developing this function further:

**General:**
No chart related Temporary and Preliminary notices and no chart corrections should be transmitted this way. Instead, use the normal procedure for chart corrections.

**Usability:**
It is also important to be able to turn on and turn off the navigation warning information on the display in order not to clutter the screen using only one key stroke. User centred design should be considered, e.g. (IMO User, 2015);
Operating procedures:

- This service should already be used in the planning phase of the voyage;
- It is important to understand how old navigational warnings are presented in the system. Today, the operator only receives a visual alarm when a new navigational warning has been received;
- Operational procedures, it is good that the navigation warnings are automatic plotted and logged in the system;
- Acknowledge reception of message; and
- Acknowledge of information when changing watch.

Training:

Included in the ship’s ECDIS/INS familiarisation and STCW Model Courses:

- ECDIS (Model course 1.27);
- GMDSS GOC (Model course 1.31);
- Integrated Navigation System (Model course 1.32);
- IALA VTS Operator Guides (IALA VTS Model Course 103/1; V-103/2; V-103/3; V-103/4).

7.7 Enhanced monitoring

7.7.1 Discussion

As discussed in chapter 3, during the execution of the voyage the ship will pass through of a number of ship reporting and VTS areas. The ship-to-shore and the shore-to-ship interaction are a very important mode of operation for the STM concept. Shore-based organizations can contribute considerably by adding valuable information and local knowledge. E.g. VTS or other types of SC can support the ship’s navigation with the objective to improve navigation safety and maritime security achieved by increased situational awareness and right information at the right time also in order to establish a better ship and shore team work. In Enhanced monitoring, the shore-based operator has received the ship’s intended route. The combination of Radar and AIS, showing the dynamic position and identity of the ship in combination with the intended route, will give the shore operator an enhanced monitoring capability of the traffic in his/her area of operation.

Enhanced monitoring could be a corner stone in IMO MS 1, 2 and 3 as defined in Annex 7 (SIP, 2014) supporting the VTS service in all configurations (INS, TOS, and NAS). If the ship is deviating notably from her planned route or is heading into danger, the shore-based operator can establish voice contact with the ship and/or use STM Chat messages.

The distinction between shore center and VTS is provided in IMO RESOLUTION A.857 (20) - definition of VTS:

“Vessel traffic service (VTS) - a service implemented by a Competent Authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and to respond to traffic situations developing in the VTS area.” All others are considered to be shore centers.
7.7.2 Operational parameters

The following operational parameters are identified:

Table 10 STM Enhanced monitoring service’s operating parameters.

<table>
<thead>
<tr>
<th>Name: Enhanced monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective:</strong></td>
</tr>
<tr>
<td>To increase situational awareness and safety</td>
</tr>
<tr>
<td><strong>Operational description:</strong></td>
</tr>
<tr>
<td>The ship’s intended route is shared with SC or VTS along the ship’s voyage. The SC/VTS operator monitors the traffic image and compares it with the intended route.</td>
</tr>
<tr>
<td><strong>Operating nodes:</strong></td>
</tr>
<tr>
<td>STM compliant ships</td>
</tr>
<tr>
<td>STM compliant VTS, SC and RCC</td>
</tr>
<tr>
<td><strong>Actors/users:</strong></td>
</tr>
<tr>
<td>Ship’s bridge team</td>
</tr>
<tr>
<td>VTS, SC, and RCC operators</td>
</tr>
<tr>
<td><strong>Area of operation:</strong></td>
</tr>
<tr>
<td>Is typically the SC/VTS area of responsibility</td>
</tr>
<tr>
<td>All vessels/ships are not equipped with this functionality</td>
</tr>
<tr>
<td><strong>Information:</strong></td>
</tr>
<tr>
<td>- Ships intended route, which is active in the navigation system</td>
</tr>
</tbody>
</table>

7.7.3 Operational recommendations

Based on the discussions performed in chapter 4, 5 and in the previous paragraphs the following should be noted when using the Enhanced monitoring service or when developing this function further:

**General:**

Can be used as part of VTS INS, TOS, NAS or other type of SC.

Need to implement a support to the VTS/SC operator to detect anomalies and large or critical deviations in order to strengthen the service.

**Operating procedures:**

- The VTS/RCC/SC should note that not all ships/vessels are equipped with this function;
- The ship should transmit current route which is active in the navigation system;
- Handshaking procedure (ship reporting) when entering area of operation;
- Updated schedule information should be included in the route message; and
- Communication between VTS/RCC/SC should use voice communication or STM Chat message.

**Training:**

Included in the ship’s ECDIS/INS familiarisation and STCW Model Courses:

- ECDIS (Model course 1.27);
- Integrated Navigation System (Model course 1.32); and
• IALA VTS Operator Guides (IALA VTS Model Course 103/1; V-103/2; V-103/3; V-103/4).

7.8 SAR service

The STM SAR service is very complex and is here treated as an operational scenario.

7.8.1 Discussion

The service supports the intention of IMO Maritime Service No. 16 as defined in Annex 2 (IMO SIP - Update 1, MSC.1/Circ.1595, 2018) see below:

“The SAR service performs distress monitoring, communication, coordination and search and rescue functions, including provisions of medical advice, initial medical assistance or medical evacuation, through the use of initial medical assistance. A Maritime Rescue Coordination Centre (MRCC) provides reliable communication links to the system’s network for efficient handling of shore-to-ship distress alert relays and distress traffic. In maintaining a state of full readiness, the MRCC may perform rescue functions for the following:

• survivors of any aircraft (not in an act of war) crashes or forced landings at sea;
• crew and passengers of vessels in distress; and
• survivors of maritime accidents or incidents.

The SAR services must also coordinate the evacuation of a seriously injured or ill person from a vessel at sea when the person requires medical treatment sooner than the vessel would be able to get him or her to a suitable medical facility.” …

In a situation with a vessel in distress a number of ships, vessels of opportunity and SRUs need to be coordinated in order to perform an effective search and later rescue operation. The STM concept can support this type of operations with standardized ways of geo-fencing – dynamic geographical areas, exchange of routes and sending and receiving of text communication. (ML2, 2016) The overall purpose with these tools is enhancing the operational efficiency by increasing the situational awareness and is gathered in one STM SAR service.

A SAR operation is organized by a RCC with an area of operation concentrated to the scene of the event together with the area where passing traffic might be affected by the SAR operation. Further, SAR operations are, in part, normally carried out by a specially trained unit of the national organizations within the SAR community. SAR coordination is normally not carried out by a VTS Authority but the VTS system can be a useful tool. Based on this, the following uses are identified:

• Ship in distress;
• Participating vessels; and
• Non-participating vessels,

together with shore-based centres as RCC and VTS. The RCC is here assumed to lead and coordinate the operation and the VTS is monitoring the passing traffic. The STM concept supports both the vessels participating in the operation and nearby passing ships. Participating vessels could here be: (ML2, ACT4, 2016)

• Designated SRU;
• Air units;
• Vessels of opportunity; and
• Designated On Scene Coordinator.
7.8.2 Operational scenario

To illustrate the overall STM SAR service an operational scenario is given below:

RCC:
- Send dynamic NoGo/restricted areas to the VTS;
- Send search area/sectors directly to the vessels'/ships' navigational display;
- Send search patterns directly to the vessels'/ships' navigational display;
- Receive positions and datum as AIS Virtual ATONs;
- Perform enhanced monitoring of search vessel by monitoring the AIS/Radar target together with search patterns; and
- STM Chat messages directly to the navigational display (direct or broadcast).

Accordingly, the OSC can use the STM functionality e.g.:
- Send search area/sectors directly to the vessels'/ships' navigational display;
- Send search patterns directly to the vessels'/ships' navigational display;
- Receive positions and datum as AIS ATONs;
- Perform enhanced monitoring of search vessels by monitoring the AIS/Radar target together with search patterns; and
- Text messages directly to the navigational display (direct or broadcast).

Further, ships passing in the proximity of the distress, but not participating in the operation can:
- Receive MSI (safety information) displayed at vessels'/ships' navigational displays; and
- Receive Dynamic NoGo/Restricted areas.

The VTS (or RCC) could perform:
- Enhanced monitoring of not participating vessels using AIS/Radar target integrated with intended route;
- Enhanced monitoring of participating vessels using AIS/Radar target integrated with intended route; and
- Send new suggested geometrical route via handshaking procedure in order to re-direct traffic.

Example on the last bullet is that a VTS can be an aid in SAR planning and monitor the SAR operation as a back-up to RCC. However, the main task should be to take an active part regarding non-participating ships.

Figure 31 below, captures the visualization of search areas and search path in the navigation display.
Below the operational services as summarised:

Table 11 STM SAR service’s operating parameters.

<table>
<thead>
<tr>
<th>Name: STM SAR service</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective:</strong> Support SAR operations with increased situational awareness among the actors</td>
</tr>
<tr>
<td><strong>Operational description:</strong> The STM concept can support this type of operations with standardize ways of geo-fencing – dynamic geographical areas; exchange of routes; sending and receiving of text communication. The overall purpose with these tools is enhancing the operational efficiency by increasing the situational awareness.</td>
</tr>
<tr>
<td><strong>Actors:</strong> RCC operator, VTS operator, SRU master and crew, Vessel of opportunity’s master and OOW, Non-participating vessel’s master and OOW</td>
</tr>
<tr>
<td><strong>Area of operation:</strong> National SAR area.</td>
</tr>
<tr>
<td><strong>Information:</strong> SAR area and datum in S-124 format, Search path in RTZ format using Route suggestion function, Information sent out as TXT message using STM Chat message, Navigational warnings in S-124 format</td>
</tr>
</tbody>
</table>
7.8.3 Operational recommendations

Based on the discussions performed in chapter 4, 5 and in the previous paragraphs, the following should be noted when using the STM SAR service or when developing this function further:

Usability:
- The search pattern should not clutter the screen and user centred design should be considered, e.g. (IMO User, 2015); and
- Differentiation between participating/not participating ships on ECDIS.

Operating procedures:
- Analysing the effect on present regulatory, organisation, and management of SAR operations;
- Update of today’s operating procedures especially regarding communication;
- Navigation warning service should be used;
- It should be noted that not all ships/vessels are equipped with this function;
- Transmitted search pattern needs to take ship’s characteristics in consideration;
- Transmitted search pattern should not contradict traffic flow; and
- Directed group chat message should be used.

Training:
Included in the ship’s ECDIS/INS familiarisation and STCW Model Courses:
- RADAR, ARPA, BTM and SAR (Model course 1.08);
- ECDIS (Model course 1.27);
- GMDSS GOC (Model course 1.31);
- Integrated Navigation System (Model course 1.32);
and
- IALA VTS Operator Guides (IALA VTS Model Course 103/1; V-103/2; V-103/3; V-103/4).

7.9 Winter navigation service

The STM Winter navigation service is very complex and is treated as an operational scenario.

7.9.1 Discussion

The service supports the intention of IMO Maritime Service No. 13 is defined in Annex 2 (IMO SIP – Update 1, MSC.1/Circ.1595, 2018), see below:

“The ice navigation service is critical to safeguard the ship navigation in ice-infested waters, given how quickly the ice maps become outdated in the rapid changing conditions of the ice-covered navigational regions. Such services include:
- ice condition information and operational recommendations/advice;
- ice condition around a vessel;
- vessel routeing;
- vessel escort and ice breaking;
- ice drift load and momentum; and
- ice patrol.”
The STM winter navigation service addresses the following of the above bullets:

- ice condition information and operational recommendations/advice;
- ship routeing;
- ship escort and ice breaking.

The aim of this service is to utilize the STM concept for ice management and ice operations. STM offers different solutions to the need for improved situational awareness in ice regions. Introducing route exchange will give both Icebreaker services and assisted ships better information in more automated procedures reducing workload and risk for misunderstandings. Information regarding best route, waiting positions, preparations for assistance, position in convoy, time for departures from port is important for the Icebreaking services. The information is transmitted directly to ship’s navigational system.

Further, this service helps to optimize icebreaking operations as the icebreaker can send information about newly broken routes directly to the ship’s navigational system as a dynamic ice route. This can be summarised as:

- **Dynamic ice routes (waypoints, legs, Estimated Time and Arrival Time) as recommendations** can be suggested based on latest information: weather, ice, wildlife, ice convoy and port status, etc. in combination with a decision support using table top multi-touch screen as a bridge planning station on board the Icebreaker.
- **Optimise icebreaking operations**, as the icebreaker can send information about newly broken routes directly to the ship’s navigational system.

When approaching an ice regime, the ship should contact the nearest ice service, e.g. VTS, Icebreaker management center, icebreaker, or a pilot station. Normally, a ship should report its entrance to the area of operation to the Service Provider. The Service Provider decides if this reporting is voluntary or mandatory. During this reporting process ship information like destination, ETA, type of ship, ice class and engine power are exchanged with the Service Provider and the Service Provider gives information regarding conditions, navigational safety, makes recommendations, gives advice and recommends ice routes. The recommended ice routes could be based on:

- History tracks from other ships;
- In-situ reports from other ships;
- Satellite images;
- Ice forecast – ice movements;
- Port/Pilot/Ice breaker availability; and
- Meeting traffic/ stopping traffic.

Further, the icebreaker also works as a local base station for monitoring surrounding ships, providing a high real time situational awareness on land.

The recommended ice routes can be implemented as a dynamic ice route, hence exchanging route information, e.g. as a list of waypoints, legs and **ice condition, ice drift loads and momentum** along the leg. A new dynamic ice route is transmitted to the ship. The ship assesses the new recommended route and agreement is confirmed by a hand shaking procedure.
7.9.2 Operational scenario

An operational scenario or use case where a ship is bound for an ice port and requires ice breaking assistance is summarized below, divided into the phases: voyage planning, voyage, assistance and port arrival.

Voyage planning:

- Ship’s bridge team checks the ice situation and forecast and traffic restrictions for destination area/port using e.g. Baltice.org;
- Application/Request for an exemption to winter traffic restrictions;
- Acceptance of winter traffic rules and regulations; and
- Ship receives general ice waypoints (Dir.Way) as ECDIS route information to destination port using STM route format (RTZ).

Voyage:

Ship bound for Finnish ports in Sea of Bothnia or Bay of Bothnia passing lighthouse “Svenska Björn”:

- Ship receives general ice waypoints (Dir.Ways) from Swedish ICEINFO (or substitute during the verification period) as ECDIS route information to destination port.

Ship bound for ports in Gulf of Finland will receive ice waypoints from Helsinki Traffic as ECDIS route information to destination port:

- Ship receives updated ice class restrictions;
- Ship receives information about Berth from port;
- Distribution of ETA/PTA information from ship; and
- System suggest PTA changes to ship + receives acknowledgement from ship.

Voyage in ice regime:

- Ship receives general ice waypoints as ECDIS route information;
- Ship receives updated ice class restrictions. Possibly needs to apply for an exemption;
- Information about berth from port;
- Distribution of ETA/PTA information from ship;
- System suggest PTA changes to ship + receives acknowledgement from ship; and
- Ship receives information about icebreaker availability and assisting order.

Approaching icebreaker working area:

- Ship receives detailed WPT from icebreaker/VTS;
- Ship receives detailed information about icebreaker availability and assisting order;
- Ship receives acknowledgement/verification about berth from port;
- Ship receives detailed information about required type of assistance (ship needs towing, pilot arrives from icebreaker etc.);
- Ship uses a messaging system to communicate with icebreaking (STM Winter Navigation Service); and
- Ship sends corrected ETA information when needed.

Assistance:
- Ship receives corrected/detailed RTA (recommended) information from icebreaker;
- System calculated ETA is distributed to all actors (icebreaker, ship, port etc.);
- Ship sends corrected ETA/PTA information when needed; and
- Active messaging needed between ship and icebreaker, VHF.

Arrival to port:

- Ship’s ATA updated to STM/IBNext/VTS system automatically.

Departure from ice port:

- Ship, STM application, IBNext and VTS system receive ETD from port;
- Ship receives general ice waypoints from STM Winter Navigation application;
- STM Winter Navigation application receives voyage plan from ship, including ship’s ETD; and
- Ship receives detailed ice waypoints from STM Winter Navigation application as an answer.

7.9.3 Operational parameters

Based on the above contextual description the following operational parameters can be identified:

<table>
<thead>
<tr>
<th>Table 12 STM Winter navigation service’s operating parameters.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name:</strong> STM Winter navigation service</td>
</tr>
<tr>
<td><strong>Objective:</strong> to send a proposed ice route to a ship from a shore-based service provider</td>
</tr>
<tr>
<td><strong>Operational description:</strong></td>
</tr>
<tr>
<td>- Icebreaker(s)</td>
</tr>
<tr>
<td>- Ships entering/leaving the ice regime</td>
</tr>
<tr>
<td>- Shore-based service centre</td>
</tr>
<tr>
<td>- ICEINFO/VTS for ship reporting</td>
</tr>
<tr>
<td>- BaltICE.org for ice information and Dir.Way</td>
</tr>
<tr>
<td>- VTS for ice information and Dir.Way</td>
</tr>
<tr>
<td>- Ice port</td>
</tr>
<tr>
<td><strong>Actors:</strong></td>
</tr>
<tr>
<td>- Icebreaking management</td>
</tr>
<tr>
<td>- Icebreaking master</td>
</tr>
<tr>
<td>- Icebreaking officer on the watch</td>
</tr>
<tr>
<td>- Ship’s master</td>
</tr>
<tr>
<td>- Ship’s officer on the watch</td>
</tr>
<tr>
<td>- Pilot</td>
</tr>
<tr>
<td>- Shore-based operator</td>
</tr>
<tr>
<td><strong>Area of operation:</strong></td>
</tr>
<tr>
<td>Swedish and Finnish ice managements’ area of responsibility</td>
</tr>
<tr>
<td><strong>Information:</strong></td>
</tr>
<tr>
<td>1) Strategic navigation phase:</td>
</tr>
</tbody>
</table>
• Static / dynamic no-go-areas
• Dynamic ice routes as dir.WPT
This STM information should be combined with information from other sources:
• Sailing directions
• Operational requirements and ice service information
• Weather/Ice analysis and forecasts/satellite images
• Ice reports
• Safety information

2) Tactical navigation phase:
• Ice service information
• Dynamic no-go-areas
• Recommended routes
This STM information should be combined with information from other sources:
• Operational requirements
• Recommendations, advice
• Visual from ship’s bridge
• Ship’s Radar image
• Weather/Ice analysis and forecasts/satellite images
• Ice reports
• Safety information

7.9.4 Operational recommendations
Based on the discussions performed in chapter 4 and the discussion conducted in the previous paragraph, the following operational recommendations are summarised.

General:
The search pattern shouldn’t clutter the screen, consider user centre design principles.

Operating procedures:
• This function should be already used in the planning phase of the voyage;
• Current dynamic ice routes should be in line with routes available at Baltice.org and ICEINFO;
• Ship’s route plan sent to the service should include schedule information;
• Update the ship reporting procedures before entering the ice for STM compliant ships;
• Bridge procedures should be update with respect to handling dynamic ice route:
  • Receiving updated routes from Icebreaker, SC; and
  • Use of STM Chat message to receive additional information regarding ice route and conditions.

Training:
Included in the ship’s ECDIS/INS familiarisation and STCW Model Courses:
• ECDIS (Model course 1.27);
• Integrated Navigation System (Model course 1.32);
  and
• IALA VTS Operator Guides (IALA VTS Model Course 103/1; V-103/2; V-103/3; V-103/4).
7.10 PortCDM

The operational scenarios for PortCDM are summarised in this paragraph.

7.10.1 Discussion

The overall goal of PortCDM (Lind et al, 2018e) is to improve the predictability of the core operations in the port call process, providing efficiency, safety, and sustainability benefits for all the stakeholders involved. This is driven from two points of view:

- the demands of shipping companies as the prime customers of a port and the terminal, for accurate timing in operations associated to the port visit and to shorten total turnaround time through just-in-time operations, and
- demands from port actors for more efficient operational port visits by ships.

To satisfy these demands, the different port call actors need to perform operations just-in-time in order to ensure a well-synchronized port visit. To do this, the sharing of relevant planning and progress data is fundamental to achieving more efficient port calls. This is done using standardized timestamps capturing the planning and estimated and actual progress of key events forming common situational awareness. The timestamps are intended to be updated and made available to all relevant actors as soon as things change.

Besides operational procedures on collaboration and interaction, PortCDM includes an interoperable machine-to-machine data sharing mechanism that allows involved port call actors, including the ship as a key port call actor, to share data among each other. Additional manual input connectors might also be necessary to enable non-connected, or semi-connected actors to share data, thereby ensuring the best coordination possible in a port call. Both machine to machine and manual connectors are based on the use of standardized formats and protocols, which have now been approved as the internationally recognized port call message format standard S-211.

7.10.2 Operational scenarios

Three different operational scenarios are described below illustrating operational benefits of the overall PortCDM concept.

A. Green steaming

“Successful green steaming and the determination of green steaming starting points and speeds relies on information from the three key components of the STM concept, namely, VM, FM, and PortCDM.

An important element in this is to minimize resource queuing in ports so that high value investments, such as a terminal, are maximally deployed. This is where PortCDM comes in to play by focussing on optimizing port resource utilization. By taking information from the STM information domain regarding forecast arrivals and voyage progress, PortCDM can help optimise available port resources and thereby enable the identification of optimal arrival times for incoming ships. This can then provide feedback to STM to determine which vessels should be targeted for green steaming. As a ship approaches, there is a continual exchange of data between the PortCDM and the STM information domains to help to fine-tune arrival times and the allocation of supporting resources.” (Watson et al, 2015, cited in STM, 2019a p.36)

B. Enhanced collaboration

“In addition to the significant role that PortCDM plays in supporting enhanced collaboration in port call operations, PortCDM can also play a role in supporting collaboration between actors from one end of a voyage to the other. Figure 10 indicates four primary areas of collaboration: port operations (collaboration arena #1), pre-sailing and pre-arrival planning and timing (collaboration arena #2), port and hinterland transport planning (collaboration
arena #3), and port-to-port information exchange (collaboration arena #4). The latter collaboration arena is of special concern in short-sea shipping.” (Michaelides et al, 2019, cited in STM, 2019a p.37)

“Ports are complex organizations as they are hubs, and even though they may look like a single actor serving sea and land transport, they consist of multiple actors who must act cooperatively to be an effective hub.

When visiting a port, shipping companies and hinterland operators are episodically tightly coupled with a range of port facilities. They must cooperate by closely coordinating both external and internal processes.” (STM, 2019a p.48)

Figure 32 The two related collaborative processes in port call optimization

Source: STM, 2019a

Figure 32 (Lind et al, 2018f, cited in STM, 2019a) illustrates both the internal and external collaborative processes associated with the various episodes of tight coupling of port call optimization. As to be noted PortCDM does cater for generating basis for optimization through capturing collaboration but does not include procedures of optimization since this would require multiple dimensions of data sources.

“The efficient accomplishment of port visits needs the currently minimal data exchange and sharing practices of sea operations (e-navigation) and port operations (port (e-)logistics) to become more integrated than they are today. This means better data sharing within and between the two regimes by pursuing the following (...) activities:” (STM, 2019a p.48):

The concept for facilitating the ecosystem logic for port call coordination (internal collaboration) and port call synchronization (external collaboration): From an operational point of view, PortCDM can be divided into four services:

- **Port call coordination.** The sum of each port call actor’s actions to align their operations in relation to other actors for a holistic coordination of the port call process as the common object of interest. This concerns internal coordination among involved port call actors.
- **Port call synchronization.** The continuous process of coordinating a ship’s approach, its previous and next ports’ operations, hinterland transport operators plans, and the progress of a port call. This concerns external coordination among actors involved in
the sea transport chain berth-to-berth. As there are significant differences between ship-to-terminal (port) synchronization, port-to-port synchronization, and port-to-hinterland synchronization, driven by different logics, similarities and differences need to be considered.

- **Port call improvement.** The process of making the port call process as efficient as possible according to the needs of the involved actors in the sea transport value chain as part of the larger transportation system.
- **Port call monitoring.** The process of bringing common situational awareness to the involved stakeholders based on upstream progress and plans for forthcoming operations.

For further insight into the topic, please refer to Lind et al, 2018f.

### C. Coordination and synchronization

A core goal of the STM concept is to minimize the resources required to steam between two ports, while maximizing the utilization of resources within a port, with increased safety. For shipping companies, the turnaround process at a port should be as expeditious as possible to enable high utilization of the ships in their fleets. The PortCDM concept builds upon two principles of coordination to provide a basis for enabling just-in-time operations and optimal resource utilization: (Lind et al, 2018g, cited in STM, 2019a, p.49)

- **Minimal state-driven coordination** in which involved actors share critical spatial temporal data and status data about the time and location of a status change to allow others to coordinate their actions in relation to these plans. As only critical data are shared, a majority of the status reports in the port call process are not revealed, and just a few of them are shared among actors.

- **Full state-driven coordination** in which the actors share spatial-temporal and process data about the duration and location of all substantive port visit processes. All status reports, except the most minor, of a port call process are shared among involved actors.

However, the maritime ecosystem as a network, is a self-organized ecosystem, where a range of more or less autonomous/independent actors provide different kinds of services for other actors. Traditionally, all the actors have been driven primarily by self-interest as they pursue their goals of providing services that the other actors need. Paradoxically, the efficiency of the entire ecosystem is determined by the extent to which the actors effectively collaborate in order to achieve the overall purpose of the ecosystem.

Minimal state-driven coordination is the first step towards enabling port call actors to align their actions in relation to their common goals of efficiency and effectiveness. It provides an entry point for improving coordination but will not ensure the highest levels of synchronization. However, any level of effective coordination through data sharing opens the door and provides examples that should motivate a move towards full status coordination because of the benefits that begin to accrue. This is an important reason why the PortCDM concept follows its incremental implementation process. A PortCDM maturity model for supporting ports to grow in its capabilities of collaboration and data sharing has been developed, see Figure 30.

### 7.10.3 Operational parameters

Based on the above contextual description the following operational parameters can be identified for the Port Call Synchronization. This service has been implemented in two versions; a ship centric view and a port centric view. The two together enables the synchronization between the STM and port domain.
Table 13 STM Port call synchronization ship’s view operating parameters.

<table>
<thead>
<tr>
<th>Name: Port Call Synchronisation – ship’s view</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective:</strong></td>
</tr>
<tr>
<td>To optimize a ship’s ETA with the port’s capabilities of serving the ship, i.e. realizing the ship’s purpose of call loading or discharge can begin.</td>
</tr>
<tr>
<td><strong>Operational description:</strong></td>
</tr>
<tr>
<td>The service synchronizes the port’s collective capabilities with the ship’s planned approach potentially based on a recommended / requested time of arrival provided from the port.</td>
</tr>
<tr>
<td><strong>Actors:</strong></td>
</tr>
<tr>
<td>• The port as the representative of the key port actors (port authority, port control, terminal, ship agent, etc)</td>
</tr>
<tr>
<td>• SC/VTS operator</td>
</tr>
<tr>
<td><strong>Area of operation:</strong></td>
</tr>
<tr>
<td>Port approach and port area.</td>
</tr>
<tr>
<td><strong>Information:</strong></td>
</tr>
<tr>
<td>• Ship’s schedule in RTZ format</td>
</tr>
<tr>
<td>• RTA sent as Route suggestion to ship</td>
</tr>
<tr>
<td>• Ship’s schedule in PCMF (S-211)</td>
</tr>
<tr>
<td>• Information sent out as TXT message using STM Chat message</td>
</tr>
</tbody>
</table>

The operational sequence can be summarized as: (STM ACT2, 2019, p.49)

“ETA – Estimated Time of Arrival. In this context this is the time that ship submits to state when they expect to arrive to the anchorage, pilot, berth or other locations referred to.

RTA – Requested time of Arrival. After having shared and reviewed the ETA given by the ship with actors important for this particular port call it will be reviewed if the ETA given is the optimal time for the ship to arrive.”

The above-mentioned chain could be described as having the following parts:

1. The ship submits their Voyage Plan (route and valid schedule) with Port Control and with Shore Center. (PC/SC).

2. The ETA for the port that the ship submits along with its’ Voyage Plan is forwarded from PC/SC to three key actors in the port which have been chosen since their information regarding the particular port call must be known to the ones (PC/SC) trying to calculate a RTA for the ship.

The three key actors in the port, and the information asked of them, are:

• The terminal who needs to provide information regarding if the cargo is ready or not.
• The production coordinator responsible for planning of the use of the different berths.
• The agent, which is the actor that has the best overall information regarding all details of the port call.
3. If it is found that the ETA initially submitted by the ship is earlier than the earliest possible time that the ship can be served in the port, this may imply a possibility for the ship to arrive later, thus saving fuel and emissions. For example, the ship has submitted their ETA to be at 06:00 but no berth will be available until 1000. The RTA will then be set to 10:00 by PC/SC and this will be forwarded to the ship and to the ship owner/operator.

4. The decision and the responsibility now fully lie with the ship owner/operator. If they decide to slow down the ship in order to reduce the fuel consumption, the economic win of these saving benefits the ship owner/operator alone. Should such a decision cause the ship owner/operator any loss e.g. losing their turn in a queue, the ship owner/operator will stand the full loss.

5. Outcome. Basically, four outcomes of the process are possible:
   - For some reason, no RTA can be calculated, meaning no change of plan is made.
   - A RTA is calculated but the vessel does not adopt it.
   - A RTA is calculated and the vessel adopts it and a saving is made.
   - A RTA is calculated, the vessel adopts it but subsequent changes in the port call process result in additional costs or resources being used.

Table 14 STM Port call synchronization port’s view operating parameters.

<table>
<thead>
<tr>
<th>Name: Port Call Synchronisation – port’s view</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective:</strong> Synchronise port actors in order to be ready for the ship’s arrival and departure to/from port/berth by improving the port’s actor’s readiness for a port call to serve the ship’s port visit based on the transmitted ETA from the ship.</td>
</tr>
<tr>
<td><strong>Operational description:</strong> The service supports each port actor’s coordination. Synchronisation to be ready for the ship’s arrival and departure to/from port/berth. The service might also include that Recommended / Requested Time of arrival is transmitted to the ship from an authorized port actor acting on behalf of the port. Further, this also includes the continuous process of coordinating a ship’s approach, its previous and next ports’ operations, hinterland transport operators plan and the progress of a port call. This concerns external coordination among actors involved in the sea transport chain berth-2-berth. As there are significant differences between ship-2-terminal (port) synchronization, port-2-port synchronization, and port-2-hinterland synchronization, driven by different logics, similarities and differences need to be considered.</td>
</tr>
<tr>
<td><strong>Actors:</strong> Port actors, such as ship agents, terminal operators, pilots, tug operators, linesmen etc. SC/VTS operator</td>
</tr>
<tr>
<td><strong>Area of operation:</strong> Port approach and port area.</td>
</tr>
<tr>
<td><strong>Information:</strong> Receiving ship’s schedule in RTZ format, transformed into PCMF Internal port timestamp in PCMF</td>
</tr>
</tbody>
</table>
7.10.4 Operational recommendations
Based on the discussions performed in chapter 6 and the discussion conducted in the previous paragraph, the following operational recommendations are summarized for the four operational services:

Port Call Coordination
General:
The actors need to become more coordinated in relation to each other on when and where to provide port call services.

Operating procedures:
- Share data about plans and outcomes of operations;
- Use of standardized message formats (S-211) to provide and consume time stamps;
- Use of shared timestamps (S-211 as a standardized format) to develop common situational awareness used in port call monitoring;
- Ensure that all time stamps refer to the same port call (i.e. use of universal port call identifier); and
- Use indicators and warnings to detect mis-coordination.

Training:
Establish a collaborative area with the common objective of collecting lessons learn from actors using the service.
Training courses for the different types of actors/stakeholders should be established.

Port Call Synchronisation
General:
There is a need to synchronize actions to be taken by the different actors associated to a port call.

Operating procedures:
- Bridge team should update the voyage’s schedule in the active route.
- For each port, identify port actor’s role and responsibility. Who should be authorised to send RTA, on behalf of the port, to approaching ships?
- Share data about plans and outcomes of operations within the port, between ports, between ships and ports, and between hinterland operators and ports, allowing events that are dependent on two or more actors to be synchronized;
- Introduce standardized procedures for collaborative decision making; and
- Overcome the barriers of ship and carrier centric approaches vs. port centric approaches.

Training:
Establish training courses for the different types of actors and stakeholders.
Establish a forum for common decision making using continuous lesson learn.

Port Call Monitoring
General:
There is a need to achieve an overarching image of the situation prior, during, and after the port call.

Operating procedures:
• Build upon the common object of interest to improve the coordination of the whole port call process; and
• Develop common situational awareness of the interdependent relationships of actors in the port call process and the need to share relevant data.

Training:
Establish training courses for the different types of actors and stakeholders. Learn from each other from successful planning and coordination.

Port Call Improvement
General:
There is a need to improve port call operations based on the performance achieved when serving ships during their port visits.

Operating procedures:
• Measure performance based on the KPI:s (Total Turnaround Time, Predictability, Waiting Times, Punctuality, Berth Productivity, and Capacity Utilization) based on shared timestamps in a standardized format (S-211);
• Identify different segments (trades) of port call operations to improve the overall process; and
• Gather participants of the port call process to continue identify, implement, and follow-up improvement actions.

Training:
Establish training courses for the different types of actors and stakeholders. Learn from each other from successful planning and coordination.

7.11 Generic aspects of manual and training
This paragraph shortly summarizes some generic aspects regarding user manuals and training. It has been noted that equipment manual and training is key aspects of using the STM functions.

7.11.1 User manuals
It is important to describe the STM functions in the right context. Therefore, the following structure is proposed:
• General description;
• Purpose and use of tool (including disclaimer/limitations);
• Generic user guide;
• User manual (type specific) on-board equipment (done by manufacturer); and
• Failure mode manual and description.

In more detail they will include the following topics with respect to the different users:

On-board users:
• General description of the STM concept;
• Description of each service (including disclaimer) and its purpose;
• Generic user guide for each envisaged service;
- User manual (type specific) on-board equipment (done by manufacturer); and
- Failure mode manual and description.

**Shore center and VTS users:**
- General description of the STM concept;
- Description of each service (including disclaimer) and its purpose;
- Generic user guide for each envisaged service;
- User manual (type specific) for SC equipment (done by manufacturer); and
- Failure mode manual and description.

**Port actors:**
- General description of the STM concept;
- Description of each service (including disclaimer) and its purpose;
- Generic user guide for each envisaged service;
- User manual (type specific) for PortCDM user views/AP (done by manufacturer); and
- Failure mode manual and description.

### 7.11.2 Training

One very important operational parameter is training. Training can be connected to the following levels:

- **New equipment:**
  - Training element in IMO model course. This could be implemented as a short CBT for the new “ECDIS” functions (equipment manual); and
  - Training element in IALA model course for new SC functions/services using equipment manual:
  - STM concepts and services could also be included in relevant model course; and
  - Procedures for utilizing the different services should be part of operating procedures.

Training is further elaborated in the SA 5.7 Competence and Training and reported in the Document No: STM_D5.7.1: *Catalogue of new competences related to the stakeholders involved in STM in shore, on board and for operational safety*. 

---

*STM VALIDATION 5.24 – STM Operational Aspects*
8 reference documents


(COLREG, 1972) Convention on the International Regulations for Preventing Collisions at Sea (COLREG), 1972, as amended


(IEC 61174) Maritime navigation and radio communication equipment and systems – Electronic chart display and information system (ECDIS) – Operational and performance requirements, methods of testing and required test results.

(IMO, 1997) IMO, Resolution A. 857(20)

(IMO, 2015) REVISED GUIDELINES FOR THE ONBOARD OPERATIONAL USE OF SHIPBORNE AUTOMATIC IDENTIFICATION SYSTEMS (AIS), IMO resolution A.1106(29)


(IMO SIP, 2018) NCSR 1/28, ANNEX 7, DRAFT E-Navigation Strategy Implementation Plan. UPDATE 1, MSC.1/Circ.1595 25 May 2018

(IMO User, 2015) IMO Guidelines on Human Centred Design (HCD) for e-navigation systems. MSC.1/Circ.151, 2015


hubs: A new role for container terminal operators, Concept Note #15, STM Validation Project


(Lind et al, 2018d) Lind M., Bergmann M., Watson R.T., Haraldson S., Park J., Gimenez J., Andersen T., Voorspuij J. (2018). Towards Unified Port Communications - from a project format to a global standard, Concept Note #9, STM Validation Project


(Lind et al, 2018f) Lind M., Bergmann M., Haraldson S., Watson R.T., Park J., Gimenez J., Andersen T. (2018). Port Collaborative Decision Making (PortCDM): An enabler for Port Call Optimization empowered by international harmonization, Concept Note #1, STM Validation Project


EU project MonaLisa 2.0 homepage


CONCEPT OF OPERATION FOR STM IN SAR OPERATIONS, SUB-ACTIVITY 4.6.5 SAR TRAINING, MonaLisa 2.0, 2015. Act 4

CONCEPT OF OPERATION AND STANDARD OPERATING PROCEDURES FOR SEA TRAFFIC MANAGEMENT SERVICES. SUB-ACTIVITY 1.2, STM SOP and HMI, MONALISA 2.0

Port Call Message Format. (Described in e.g. STM, 2019a, p.57)

International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended

STM Validation 5.21. Version 2.0 of the Information Environment Created and Tested. STM Validation Project. June 2017. STMVaD5.21


Abbreviations used:

Aboa Mare (AM);
Centro Jovellanos (CJ);
Frauenhofer CML
Chalmers University of Technology;
Flensburg University of Applied Sciences (FUAS);
Warsash Maritime Academy (WMA);
Emden Leer (EM), Maritime Institute Willem Barentsz (WB); Sikkerhetssenteret Rørvik (SSR); UPC Barcelona (UPC))

(STM, 2019) STM Validation D5.8.2. STM Concept of Operation. STM Validation Project. May 2019. STM_ID D5.8.2

(STM, 2019a) STM Validation 1.3. Improving port operations using Port Collaborative Decision Making, 2019. STM Validation Project. 17 March 2019. STM_ID1.3.


(STM, 2019c) ACT3 EMSN Test Reports, 2019 (as follows):
(3.3.5) STM EMSN: Test Report: Evaluation of STM services - Ice Scenario. Report on results from Ice Navigation simulation in the EMSN, STM Validation Project. December 2018. STM_ID3.3.5

(3.3.6) STM EMSN: EMSN Test Report - Evaluation of STM services: Human Factors. Report on results from EMSN simulations, STM Validation Project. March 2019. STM_ID3.3.6 Extension

(3.3.8) STM EMSN: Ship to Ship Route Exchange (S2SREX)-controlled simulation trial. Report on results from S2SREX simulations in the EMSN, STM Validation Project. December 2018. STM_ID3.3.8

(3.3.9) STM EMSN: Test Report: Evaluation of STM Services in SAR operations. Report on results from Search and Rescue operations simulations in the EMSN, STM Validation Project. March 2019. STM_ID3.3.9


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SAFETY - ENVIRONMENT - EFFICIENCY

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