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ACRONYMS

AIS – Automatic Identification System
ASM – Application-Specific Messages
BRM – Bridge Resource Management
CCTV – Closed-circuit television
CDM – Collaborative Decision Making
COP – Common Operating Picture
CPA – Closest Point of Approach
CRM – Crew Resource Management
CQS – Close Quarter Situation
DSS – Decision Support System
DST – Decision Support Tools
ECDIS – Electronic Chart Display and Information System
ETA – Estimated Time of Arrival
ETD – Estimated Time of Departure
GOFREP – Gulf of Finland Reporting scheme (supported by the VTS’s in the Gulf of Finland)
IALA – International Association of Lighthouse Authorities and Aids to Navigation
IEC – International Electrotechnical Commission
IMO – International Maritime Organization
INS – Information Service
MSI – Maritime Safety Information Service
NAS – Navigational Assistance Service
OOW – Officer on Watch
Port CDM – Port Collaborative Decision Making
SMCP – Standard Maritime Communication Phrases
SOLAS – Safety of Life at Sea
SOP – Standard Operating Procedure
SOUNDREP – The Sound Reporting scheme (supported by the VTS The Sound)

SRS – Ship Reporting System

STM – Sea Traffic Management

STCW – the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers

TCPA – Time to Closest Point of Approach

TOS – Traffic Organization Service

VDES – VHF Data Exchange System

VHF – Very High Frequency, radio frequency range. Common way of communicating at sea to sea & sea to shore

VM – Voyage Management

VTS – Vessel Traffic Services

VTSO – Vessel Traffic Service Operator

XTD – Cross-Track Distance
DEFINITIONS

**Administrative burdens** are defined as "administrative work which in the opinion of the stakeholder is not adding value proportionate to the resources the stakeholder will have put into the work to comply with specific rules and requirements".

**Application-Specific Messages** Application-Specific Messages (ASM) are messages that have been developed to allow the exchange of information via the Automatic Identification System (AIS) in addition to the standard set of messages defined in ITU-R M.1371-4, *Technical characteristics for an automatic identification system using time-division multiple access in the VHF maritime mobile band*.

**Automatic Identification System** – radio modem that automatically exchanges static (identity) and dynamic (navigation) data between ships and may transport ASM data structures.

**Common Operating Picture** – The combination of all information collected to the VTS centre. It is the information stored and presented on displays to the VTS Operator.

**Cross-Track Distance** – The distance that a ship can deviate from route line before having alert. Defined in RTZ. See also VTS-defined XTD

**Decision Support System**, referring to the technical support system at hand in an operational environment in the Vessel Traffic Service or at bridge. It can incorporate several decision support tools, such as electronic charts.

**Enhanced Monitoring**: Enhanced monitoring will be an anomaly detection to detect if planned schedule is not kept or if ship deviates from planned route that is transferred to operators in a shore centers. Thus, shore centers can monitor that ships are following their planned route and foresee possible dangerous situations and suggest route modifications (geographic and/or speed) due to traffic or other impeding conditions.

**Fairway Library** – Database containing all routes leading to port in a respective VTS area. Existence and utilization of fairway library is an assumption made for user stories.

**Flow Line** – A passage line used to mark the timing of ships passages in Flow Management.

**Flow Management Services** will support both onshore organizations and ships in optimizing overall traffic flow through areas of dense traffic and areas with navigational challenges.

**Flow Management**: Flow Management supports the optimal coordination of multiple ships in congested geographical areas. FM will support both VTS control and ships in optimizing overall traffic flow through areas of dense traffic or those with particular navigational challenges. FM’s objective is to improve the overall flow of maritime traffic through superior information sharing and coordination. VM builds common situational awareness and enhances decision-making with information and advice about traffic and safety. The concept of Flow Management was defined in STM Validation.
**Information Service** – An information service is a service to ensure that essential information becomes available in time for onboard navigational decision-making. See IALA VTS Manual for exact definition.

**Navigational Assistance Service** – Navigational assistance service is a service to assist onboard navigational decision-making and to monitor its effects. See IALA VTS Manual for exact definition.

**Route** – A way or course taken in getting from a starting point to a destination. Shipping routes are the paths taken by ships across the world's seas. They are channels down to a hundred meters wide up to unrestricted, defined by compulsory points of passage (capes, straits, channels), physical constraints (current speed, depth, presence of reefs) and geopolitical contexts.

**Route broadcast** – Ships can broadcast the next 7 waypoints and the last passed waypoint through AIS.

**Route exchange** – Ships can choose to share their route with other ships, the electronic charts will show the surrounding ships routes for easy understanding of the situation. The standard format of the routes for exchange is RTZ used in conjunction with ECDIS to IEC 61174. Routes can be exchanged by means that support standard operating procedures.

**Route Planning** – can be defined as a method of deriving or computing the most cost-, time-, or environmentally effective route involving several waypoints, nodes and/or stopovers by minimizing the distance traveled and/or time taken. In ECDIS and in bridge systems route planning is defined as the operation of entering a route in a chart – checking for grounding hazards, areas where special conditions exist, navigational hazards and checking for geometry. Route plan is part of voyage plan. See also Voyage Plan.

**Schedule** – The estimated timing of a voyage, i.e. ETA/ETD of waypoints, speed on legs, etc.

**Sea Traffic Management**: A concept based on common standards and secure infrastructure enabling interoperable services to enhance the aggregation of the seaborne and shore-based functions (sea traffic services, maritime space management and sea traffic flow management) required to ensure the safe and efficient movement of vessels during all phases of operation.

**Ship domain** – An operational zone around, above or below a vessel within which an incursion by another fixed or moving object, or another domain, may trigger reactions or processes.

**Ship Reporting System** – SRS aims to keep a vigilant eye on the sea traffic. In cases of rendering help, the systems enable to give pieces of information about navigational hazards, medical advice, directing the closest ship towards the vessel in peril, and defining the area of searching. SRS may be voluntary or obligatory.

**Standard Operating Procedure** – The documentation governing the VTS service. It defines everything pertaining the management, development and operations of an VTS.
**STM Messaging** – Capability to send text messages between STM-compatible equipment in ship and on shore.

**STM compliance** implies that ships are equipped with STM-compatible bridge systems or VTS with STM-compatible VTS systems. It also implies

**Tactical Voyage plan** – Tactical voyage plan is: A Dynamic, Voyage plan in conning mode (tactical execution) The vessel is under Captains command and decisions are based on navigational and safety knowledge taken on legal basis (COLREGs). The tactical voyage plan can be transmitted between ships to increase situational awareness and enhance the planning of alternative legs to avoid close encounter

**Traffic Organization Service** – A traffic organization service is a service to prevent the development of dangerous maritime traffic situations and to provide for the safe and efficient movement of vessel traffic within the VTS area. See IALA VTS Manual for exact definition

**Vessel Traffic Management** – Vessel Traffic Management provides Vessel Traffic Service (VTS) to merchant shipping and other marine traffic and maintains safety radio operations. Vessel Traffic Services, a shore-based support service, are provided by the VTS Centers. The Centers’ surveillance areas are typically provided in constrained/confined/congested waters and in those with high shipping traffic intensity.

**Vessel Traffic Services** – VTS – are shore-side systems which range from the provision of simple information messages to ships, such as position of other traffic or meteorological hazard warnings, to extensive management of traffic within a port or waterway.

**VHF radio** – Very High Frequency radio, the primary means of communication for VTS and vessels

**Voyage Management** concerns strategic, tactical and operational decisions about a voyage, such as planned and executed routes of a certain ship and its interaction with nearby ships in a given position. It focuses on the initial planning phase of any sea voyage and the ability to monitor the execution of that plan. VM supports improved route planning, route exchange, and route optimization before and during the maritime voyage. Especially in this phase, VM connects ships, adds intelligent processes and new tools to enable all stakeholders to increase their situational awareness during the voyage, providing faster, more secure and transparent information exchange. VM was defined in STM Validation

**Voyage plan** – Same as Passage Plan. A representation of the planned way to get from point A to point B, consisting of a list of waypoints (geometry) and information associated with the legs between waypoints, plus a schedule, describing the planned time axis of a ships voyage. It is a complete description of a vessel's voyage from start to finish. The plan includes leaving the dock and harbor area, the en route portion of a voyage, approaching the destination, and mooring, the industry term for this is “berth to berth”. SOLAS chapter V states that voyage plan shall identify a route which:
- takes into account any relevant ships’ routeing systems
- ensures sufficient sea room for the safe passage of the ship throughout the voyage
- anticipates all known navigational hazards and adverse weather conditions; and
- takes into account the marine environmental protection measures that apply, and avoids, as far as possible, actions and activities which could cause damage to the environment

**VTS area** – Area in territorial waters in which VTS is provided to the merchant fleet

**VTS centre** – Premises that are equipped with technology to provide Vessel Traffic Services.

**VTS-defined XTD** – XTD that is defined by VTSO. Relative to the routeline defined by ship.

**VTS tools** – Set of functionalities presented and described in STM BALT SAFE work package 4 documentation.

**Waypoint** A position marking the intersection between two legs in a Voyage Plan.
2 Introduction

2.1 Background to the document

In order to support STM BALT SAFE-project the initial definition of the situation and mapping of the compatible VTS-tools was made. A report was compiled by participants of the respective work package using their own expertise in defining the current traffic status. This document provides operational and technical use cases for the development of STM capabilities, extending to the previous document and providing more technical point of view for the development.

2.2 Purpose

This document provides the project with operative and technical use cases supporting the development of STM Shore Center capabilities. It contains suggested implementation of STM capabilities to VTS center along with recommended changes to the STM infrastructure.

2.3 Scope and delimitation

Document deals with the implementation of STM to existing systems and procedures on the shore side. General assumptions are made to limit the scope to the shore side.

The project naturally focuses on implementations in STM framework. Nonetheless the VTS system providers are encouraged to design their solutions as flexible as possible. There might be other secure, standardized, interoperable solutions in the future for communicating for example and in particular voyage plans and route plans. The increased amount of data from ships will lead to an enhanced operational picture.

In STM BALT SAFE work meetings & workshops discussion arose from the importance of communication. Clear communications were recognized as one of the most important themes around vessel traffic services that needs enhancing - the VTS operators’ views on the subject were quite uniform. Further discussion soon made us realize that providing means for better communications are definitely in the project scope, but in order to find overarching use of new technology, the STM–capabilities, and present procedures involving SMCP, we don’t have the resources in this project. This leaves space for further research for the subject that at least in this project has been acknowledged as an important factor in supporting safety of marine traffic. The ongoing research and development of autonomous marine traffic leads us to discovering research questions like “How are closed–loop communications utilized in autonomous or semi–autonomous vessels?” Due to aforesaid facts we will dismiss the subject in this project, but we want to enlighten the fact that the subject needs extensive research in the future taking account the increasing level of autonomy in shipping.
The present VIS (Voyage Information Service) was also found somewhat limited to serve well from the VTS-point of view. This document describes how to implement a VIS as is, but it recommends some changes for the future use. VIS is very useful for vessels, but for shore-side-actors the concept might be broader, maybe something called CSIS (Coastal State Information Service).
3 VTS tools

3.1 Background

VTS System is the hardware, software and their behavior as a coherent entity. This excludes personnel and procedures. Traditionally VTS uses sensors to collect information about ships movement within its area of responsibility. VTS system typically comprises one or more of the following elements:

- Radio Communication
  - VHF
  - Telephone
- Sensors
  - Radar
  - AIS
  - Environmental Monitoring
  - Electro Optical Systems
  - Radio Direction Finder
  - Long Range Sensors
  - Data Processing
  - CCTV
- VTS Human/Machine Interface
- Decision Support
- External Information Exchange

The VTS system will need to reflect the type of VTS Service that the VTS Authority will be implementing (INS, TOS, NAS). In reality, the physical equipment required for the services may be similar, but it is important to ensure that for the more complex types of Service (TOS and NAS) that the functional capabilities of the system will provide the right facilities to support the VTS Operators with their tasks.

VHF Radio communication is the primary means through which Vessel Traffic Services are delivered. It provides the VTSO with a means to deliver timely services and a real-time assessment of the situation in the VTS area.

3.2 Assumptions

Necessary assumption questions ask you to determine what must be true - but was never explicitly stated - for an argument to work. Stated differently, if a necessary assumption were discovered to be false, the argument would fall apart - the
conclusion would not follow logically from its premises. For example, in this
document we need to assume that ships and VTS are using STM- compatible
system, otherwise this document would have no purpose.

This document makes the following assumptions:

- Both the ship and the VTS is using an STM- compatible system
- Ships can find reporting obligations (which VTS requires a route plan) along its
  route by using MCP services.
- Ships have shared their VPs with the VTS/SRS centre.
- Voice vs messages. This document assumes that messages can be sent by
digital means. It is assumed that voice (over VHF) is used as a secondary
medium when digital communication cannot be established. In this document,
by default, STM Messaging is the digital mean.

3.3 References

- http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/Assembly/Do
cuments/A.918(22).pdf
- http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/Assembly/Do
cuments/A.857(20).pdf
- 1141-Ed1-Operational-Procedures-for-VTS_Dec2018
4 Actors

The following actors are identified when interacting between ship and a VTS.

<table>
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<th>Actor</th>
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<tr>
<td>VTS system</td>
<td>VTS system is the system where the VTS tools are integrated/upgraded/updated.</td>
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<tr>
<td>VTS Operator (VTSO)</td>
<td>VTS Operator is the human user of the VTS system and carries out the actual monitoring and other VTS services offered.</td>
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<tr>
<td>Ship system</td>
<td>Ship system is the STM-compatible ECDIS or other system onboard that is the technical endpoint of communication at the ship-end and source of the voyage plans.</td>
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<td>Officer on Watch (OOW)</td>
<td>Ship operator is the human user of the ship system in relevant context, referred as OOW (Officer-On-Watch) for clarity, thus not necessarily keeping watch.</td>
</tr>
<tr>
<td>Ship</td>
<td>Ship is the unit represented in all the systems. It contains the ship system, ship operator, ship master. It represents the subject of monitoring and/or advising, ordering or any other way of potential supporting and influencing.</td>
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4.1 VTS system

Current STM-services can be described as decision support tools, that defined by IALA, are tools that help to assess situations, to plan and to provide timely and necessary information for making decisions. Use of decision support tools are instructed in IALA Guideline 1110 “USE OF DECISION SUPPORT TOOLS FOR VTS PERSONNEL”

According to IMO Resolution A.857(20) Vessel Traffic Services are implemented to improve the safety and efficiency of vessel traffic and to protect the marine environment. The service should have the capability to interact with the traffic and to respond to traffic situations developing in the VTS area.

Decision support is a way to help VTS personnel make decisions in routine or non-routine situations. It is especially useful for VTS personnel facing decisions about developing situations or emergency situations.

Decision Support Tools (DST) are used in VTS centers to enhance situation awareness by assisting VTS personnel. These tools can assist VTS personnel decision making activities at operational, tactical and strategic levels. See IALA document 1110 Use of decision support tools for VTS personnel.

The VTS should be able to handle ships that are sending routes (RTZ).
4.2 VTS Operator (VTSO)

The key person in any VTS operation is the VTS Operator, who is responsible for establishing and maintaining a vessel traffic image, which will facilitate interaction with the vessel traffic thus ensuring the safety of navigation within the VTS area of responsibility. The VTS Operator is also required to decide on actions to be taken in response to developing traffic situations, after careful analysis of the data and information being collected.

The job description for the VTS Operator should include the aims and objectives of the operational work carried out by the Operator, the tasks and responsibilities involved together with the skills and knowledge required to carry out the work efficiently and effectively. The job description should also clearly state what service type the VTSO is authorized to provide.

The following list provides examples of activities carried out by a VTSO:

- Maintain situational awareness and monitor the vessel traffic image with all available sensors within the area of responsibility,
- Maintain communication with ships as appropriate to the service type provided by the VTS using all available communication facilities,
- Operate equipment for communications, data collection, data analysis and establishment of a vessel traffic image,
- In an Information Service (INS), provide relevant information at appropriate times
- In a Traffic Organization Service (TOS), organize and plan the vessel traffic movements within a waterway to prevent congestion, groundings, collisions and other dangerous situations,
- In a Navigational Assistance Service (NAS), assist and provide such information as may be required to aid a ship in difficult navigational or meteorological circumstances or in case of defects or deficiencies. NAS may be given on request by a vessel or when deemed necessary by the VTS,
- Communicate with allied services and other agencies as appropriate,
- Ensure that all adopted standard operating procedures and relevant waterway regulations are adhered to,
- Take appropriate actions in emergency situations and other special circumstances defined for the VTS area. Where appropriate, co-ordinate communications for such situations and/or circumstances and
- Maintain a log of all incidents/accidents and all other relevant events occurring within the area of responsibility.


4.3 Ship system

Ship system in this context is the technical endpoint of communication at the ship-end, and source of the ships voyage plans.

Since the VTS Tools are designed to run in VTS systems, serving ships by means of better support from VTSes, the needs for the ship systems capabilities besides being the sole source of voyage plans are relatively light. It is assumed that ship system is capable to deliver and receive the voyage plan in form of RTZ for the use of the VTS Tools.

The baseline of a ship system is a STM- compatible ECDIS, although in time other working solutions might raise.

4.4 Officer on Watch (OOW)

Ship operator is the human user of the ship system. This might be the captain, navigation officer, officer on watch or supporting officer on bridge; strong assumption is that the person is a deck officer or under a close monitor of such.

The skill level between officers on ECDIS might vary a lot even on a particular ship. Every deck officer onboard a ship with an ECDIS must have an overall certificate as well as a type-specific certificate on the particular navigation system in use, giving that all of them know how to navigate safely using the monitored route as reference. But when it comes to route-planning and system configuration, or any special functionalities that are not needed in day-to-day navigating, it would be good to recognize that route planning is highly handmade process not all deck officers are specialized in.

4.5 Ship

Ship is the unit represented in all the systems. It contains the ship system, crew and ship master. Ship type may be any but excludes small leisure boats. It represents the subject of monitoring and/or advising, ordering or any other way of potential supporting and influencing.

In this context ships might or might not be STM- compatible. In some use cases, for example in CQS, only ships with shared route plans are taken into account, while in some, like Predictions, simulated routes can be utilized. Basic assumption is that ships are compatible, but exceptions occur and are not always stated.
5 User stories

The user stories describe the operational scenarios where the VTS operates. They provide a broader context for the situations where the VTS tools are needed. The use cases described in chapter 6 takes these stories and defines how they are reflected in the work inside a VTS and the corresponding VTS-System.

Please note that due to the variety of VTS systems, local SOP’s, regional characteristics and cultural practices, the solutions e.g. how to manage Route proposals in chapter 5.4, may vary a lot between different systems and nations, but from the vessels point of view, should lead to similar outcome, a route proposal for the vessel, in form of RTZ. The same goes with all the user stories. The reader should take these as exemplary descriptions of potential ways to reach the outcome, as a tool to relay the vision of the kind of supportive functions the writers aim at.

5.1 Route Crosscheck

VTS will have capability to perform automatic route check that considers the ships domain, draught and route plan with XTD–limits. Benefits of this service will be increased awareness of traffic based on true plans instead of assumptions, and increased traffic monitoring support. Performing route check contributes to the safety of the business.

Ship sharing route

- Ship shares its voyage plan with VTS
- VTS system sends acknowledgement “route received” to ship
- VTS system performs automatic route check
- Route check considers ships draught and XTD-limits in relation to fairway limits, AtoNs and depth contours similarly as the ECDIS route check does.
  - A) If voyage plan has been validated by the shore system concerning the variables above, system sends “route checked” (with corresponding disclaimer) to the ship.
  - B) If voyage plan has not been validated due to variables above, system sends notification of hazards within variables above with location
- Location of hazards should be visually presented in the ships system (currently utilizing the functions of STM Messaging)
- Voyage Plan is visually presented by the VTS software at the call of VTSO
- Location of hazards shall be presented by the VTS software in relation with the ships voyage plan
5.2 Close Quarters Situation (CQS)

Identification of close-quarters situations contribute to the safety of the traffic. This solution may use the flow management capabilities developed in STM EfficientFlow.

Meeting between two ships
- Two ships (Ship A and Ship B) will have CQS if present voyage plans are followed
- Both ships share their voyage plans (including planned speeds) with VTS
- Meeting points (CPA) to be calculated and presented in VTS software

VTS uses its own software to identify meeting points with actual and/or planned ship speeds. Actual speed will be used for the current leg and planned speed for other parts of the route. Optionally, calculation can be done using actual and VTS software speeds (e.g. schedule calculated based on AIS speed and/or historical data).

Due to the inaccuracy of simulated routes, only true voyage plans from ships are utilized, even if simulated routes would be at hand, to prevent getting CQS alerts constantly when normal meetings take place.

5.3 Predictions

Predictions are an extension of the flow management capabilities developed in STM EfficientFlow.

Flow of events:
- Meeting with two or more ships in areas where it’s unsafe/forbidden to meet or where there will be congestion
- All ships share their VPs (including planned speeds) with VTS
- Meeting points to be calculated and presented in VTS-system

VTS uses their own software to identify meeting points with actual and/or planned ship speeds. Actual speed will be used for the current leg and planned speed for other parts of the route. Optionally calculation can be done using actual and VTS software speeds

Unlike with the CQS’s, simulated routes can be used in addition to STM- or other ship-sourced RTZ–routes. The assumption is that the meetings considered in this user story are taking place in relatively tight fairways, that makes the accuracy of simulated routes well enough to be used in this context.
5.4 Route proposals

VTS shall be able to send route proposals to ships. Typical example of use of this service is ship approaching port that has two fairways and due to variables, such as draught or present traffic situation, the route planned by the ship is unsuitable even though passed the pre-checks made by ECDIS or any other instance.

Potential flow of events:

- Ship is using wrong/unsuitable route
- Ship passes triggering line on point (e.g. enters monitoring area, 3hrs to monitoring area or another parameter defined in the local SOP)
- VTSO checks visually the route and observes / gets notification from system of a CQS / somehow finds a need to changes in the planned route
- VTSO makes needed alterations to the route / chooses alternative route from Fairway Library / somehow, according to VTS’s SOP, compiles or chooses desired alternative RTZ
- VTSO sends the proposed route to the ship in form of RTZ in appropriate route status.
- VTSO communicates additional needs/ suggestions to ship using STM Messaging.
- OOW receives the route
- OOW attaches the route to the voyage plan and sends the updated version to the VTS(s).
- VTSO receives updated voyage plan of changes from the system
- VTSO checks the new voyage plan visually and sends acknowledgment (same as in route crosscheck) to the ship.

5.5 Route Corridor Deviations

VTS system shall be able to detect if ship is deviating from her XTD or VTS-XTD limits

Potential flow of events:

- VTS system has received a voyage plan from ship (status: in monitoring)
- Ship drifts slowly away from her planned route
- Still navigating in safe waters, ship crosses ships planned XTD limit or VTS-XTD limit
- VTSO gets a notification from the system about a deviating vessel
- VTSO focuses on the situation giving it context-sensitive time to rectify her course
- VTSO is unable to find any obvious reason for the deviation, e.g. ship giving way, and it seems to go on
- VTSO contacts the ship letting OOW know that an un-obvious deviation from the planned route is noted, asking for response
- OOW responses according to the situation (e.g. giving way to pleasure crafts, malfunctions in equipment, unnecessary disregard)
- Necessary measures to correct the deviation will be taken
6 Use cases for VTS tools

The user stories in previous chapter gave the overall operational scenarios whereas this chapter focuses on the inner working of a VTS. The use cases describe how user stories are realized in the VTS.

6.1 High level use case context

The VTS-tools are intended to extend a current VTS services or provide an extension to the current IALA guidelines.

An individual ship is the source of information. The ship is monitored by the means of VTS sensors. In addition, the ship is obliged to provide information about its intentions, SRS, voyage plans etc.

The enhanced monitoring fall under the IALA category of “Decision Support Tools”. The VTS system continuously analyses the maritime traffic updates in the COP and raises occurring situations based on pre-configured rules. See UC: Analyze traffic. The VTSO is provided the situational awareness (Visual COP) he needs for his work. See UC: Monitor traffic. When a situation is identified by the component enhanced monitoring (machine or human) it is passed to use case “flow management” for further analysis and actions.

The flow management corresponds to “Operational Procedures for VTS”, with the assumption that digital communication channels are the default and VHF is used as a support and backup channel for communication. Based on events raised by enhanced monitoring a VTSO analyses developing situations and provides the mariners with the necessary guidance (INS, TOS, NAS) See UC: Analyze situation and rules. Based on events discovered and raised by enhanced monitoring a VTSO can review a voyage plan and provide comments on the route being sent to the VTS. See UC: Route crosscheck
Note that the automatic events passed from “analyze traffic” to flow management are intentionally, for left brevity, out from the overall diagram (see below “interaction between use cases”).

The following chapters provide details into the individual use cases.

### 6.2 Interaction between use cases

The interaction between actors and use cases is depicted in picture below.

The normal flow of events (it could be called business process):

- Ship sends information (Voyage Plan) to the VTS
- The Enhanced monitoring processes the information using rules
- When events are raised either the analyze situation or manual route cross checks takes over
- The STM Messaging is used to communicate with the ship

Rules are the dataset that provides the details used by all use cases. See: Chapter 5 Rules
6.3 UC 1: Analyze traffic

<table>
<thead>
<tr>
<th>Title</th>
<th>Analyze traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>The VTS-System monitors and analyzes the changing maritime traffic situation and environment. The system analyzes the information and raises events when a situation is occurring.</td>
</tr>
<tr>
<td>Rationale</td>
<td>By letting the machine analyze the vast amount of incoming data, a more systematic and comprehensive analysis can be performed, while producing better situational awareness to the VTSO</td>
</tr>
<tr>
<td>Actor</td>
<td>VTS System</td>
</tr>
<tr>
<td>Triggers</td>
<td>The use case is triggered by ANY information provided to the system, be that sensors or humans or an external actor.</td>
</tr>
<tr>
<td>Preconditions</td>
<td>The system has a valid current COP and is ready to take inputs. Assumption is that this precondition is true at an availability level of 100%.</td>
</tr>
<tr>
<td>Postconditions</td>
<td>A valid updated COP</td>
</tr>
</tbody>
</table>
## Frequency of Use

The use case is executed continuously. The frequency is dependent on the area being monitored, but it is estimated that the amount of triggering events to be in excess of 500/s (Based on VTS traffic in the Finnish system).

## Normal flow

1. Data about ships and ship movement is received from various sources. The most important for traffic analysis is currently AIS and route plans.
2. The system recalculates its internal COP.
3. If the object is a route plan, this information is passed to the Route cross check. All findings from COP is attached.
4. If a situation is identified, an event is raised and the VTSO is notified visually about the finding.
5. The visual COP is updated, with the new information, including visualization about raised events.

### Analyse traffic

```
  Analyse traffic
    
    Recive data from any source
    
    Recalculate COP
    
    yes is route?
    
    send route to croscheck
    
    no identified situation?
        yes
            Raise Event
            
            Update Visual (COP)
            
            no
            
            identified situation?
            
            no
            
            yes
            
            Update Visual (COP)
```

2019-BaltSafe
<table>
<thead>
<tr>
<th>Alternative flows</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceptions</td>
<td>-</td>
</tr>
<tr>
<td>Includes</td>
<td>-</td>
</tr>
</tbody>
</table>
| **Special Requirements** | All rules governing the calculations MUST be readable and configurable by operator  
When an Event is raised ALL available information about the situations is Attached to the event. That can by position heading of ship(s), situation that is developing or any information about vessels or results of analytics performed by system (like interpretations about situation).  
The different situations are described in the user stories, but it can be anything that the system can identify as a situation. |
| Assumptions            | - |
| **Notes and Issues**   | The use case is kept at an operational level and only the outputs for human (or that has impact on SOP) are described in detail.  
It is up to the system to define how to implement the actual calculations. |
### 6.4 UC 2: Monitor traffic

<table>
<thead>
<tr>
<th>Title</th>
<th>Monitor traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>The VTSO monitors traffic in designated area by visually inspecting the COP, calculated by the VTS System.</td>
</tr>
<tr>
<td>Rationale</td>
<td>The intention is to provide the VTSO with situational awareness of the monitored area.</td>
</tr>
<tr>
<td>Actor</td>
<td>VTS Operator</td>
</tr>
<tr>
<td>Triggers</td>
<td>The UC Analyze traffic provides an update to the visual COP</td>
</tr>
<tr>
<td>Preconditions</td>
<td>An up-to-date COP</td>
</tr>
<tr>
<td>Frequency of Use</td>
<td>The VTSO is continuously observing the screens containing the COP</td>
</tr>
<tr>
<td>Normal flow</td>
<td>-</td>
</tr>
<tr>
<td>Alternative flows</td>
<td>-</td>
</tr>
<tr>
<td>Exceptions</td>
<td>-</td>
</tr>
<tr>
<td>Includes</td>
<td>-</td>
</tr>
<tr>
<td>Special Requirements</td>
<td>-</td>
</tr>
<tr>
<td>Assumptions</td>
<td>Note that for an operator this use case and the UC analyze situation seems like one single action.</td>
</tr>
</tbody>
</table>

• The VTSO monitors the traffic
• If situations develop, he raises an event for further analysis. Like the previous UC.
### 6.5 UC 3: Analyze situation

<table>
<thead>
<tr>
<th>Title</th>
<th>Analyze situation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>Based on identified situations in the Monitor traffic, the operator analyses the situation and decides on actions to take.</td>
</tr>
<tr>
<td><strong>Actor</strong></td>
<td>VTS operator</td>
</tr>
<tr>
<td><strong>Triggers</strong></td>
<td>The use case is triggered from UC Analyze traffic</td>
</tr>
<tr>
<td><strong>Preconditions</strong></td>
<td>Raised event by UC Analyze traffic</td>
</tr>
<tr>
<td><strong>Postconditions</strong></td>
<td>VTSO has decided to act or not to act</td>
</tr>
<tr>
<td><strong>Frequency of Use</strong></td>
<td>Nil to dozens in hour, in a defined area.</td>
</tr>
<tr>
<td><strong>Normal flow</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Receive event from analyze traffic</td>
</tr>
<tr>
<td></td>
<td>- Inspect situation – The VTSO views the situation and</td>
</tr>
<tr>
<td></td>
<td>- The VTSO decides on actions to take. If no action is needed the VTSO can dismiss the situation. (see below)</td>
</tr>
<tr>
<td></td>
<td>- Send message The VTSO prepares an STM message</td>
</tr>
<tr>
<td><strong>Alternative flows</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Exceptions</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Includes</strong></td>
<td>The messaging is used to provide the details of the &quot;send Message&quot; step.</td>
</tr>
<tr>
<td>Special Requirements</td>
<td>The dismissed situation needs to be documented by VTSO and recorded by system.</td>
</tr>
<tr>
<td>----------------------------</td>
<td>--------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Assumptions</td>
<td>The SOP defines how the decision to dismiss is recorded and to which length.</td>
</tr>
<tr>
<td>Notes and Issues</td>
<td></td>
</tr>
</tbody>
</table>
# 6.6 UC 4: Manual route crosscheck

<table>
<thead>
<tr>
<th>Title</th>
<th>Manual route crosscheck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>The VTSO performs a visual inspection of a route plan submitted by the ship and sends a response to the ship.</td>
</tr>
<tr>
<td>Actor</td>
<td>VTS Operator</td>
</tr>
<tr>
<td></td>
<td>VTS System</td>
</tr>
<tr>
<td>Triggers</td>
<td>The use case is triggered from UC analyze traffic</td>
</tr>
<tr>
<td>Preconditions</td>
<td>The analyze traffic has performed an automated route cross check using the Route plan and the capabilities provided by the system (see analyze traffic /Recalculate COP).</td>
</tr>
<tr>
<td>Postconditions</td>
<td>An analyzed route plan</td>
</tr>
<tr>
<td>Frequency of Use</td>
<td>Once per received route plan and once per every updated change in the said plan</td>
</tr>
</tbody>
</table>

**Normal flow**

- Receive route from analyze traffic. The VTSO is alerted about a route being submitted that affects his area of responsibility.
- Inspect route – The VTSO inspects the route based on the automated notes provided by “analyze traffic”.
- Formulate message – The VTSO formulates an optional message to the ship based on his inspection.
- Send message – The VTSO sends the message to the submitting ship using STM messaging.

### Route crosscheck

- **Receive route from Analyze traffic**
  - **Inspect route**
  - **Formulate message**
  - **Send message**

`false` automated? **true**
### Alternative flows
The VTSO or SOP can under certain conditions automate the response to cross-checks. A standardize message is sent to the ship. This functionality must be used in a managed fashion, where proper process needs to be defined in SOP.

### Exceptions

### Includes
Messaging is used to handle the actual sending of messages. This Use case provides messaging with the necessary information (see messaging input).

### Special Requirements
Disclaimers and standard texts on responses needs to be adapted in SOP.

VTSO (or part of SOP) can decide to automatically “sign-off” a route cross check based on certain rules.

### Assumptions
It is assumed that the route cross check is Informational (INS)

### Notes and Issues
### 6.7 UC 5: STM Messaging

<table>
<thead>
<tr>
<th>Title</th>
<th>Messaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>The VTSO communicates with the OOW using digital STM messaging function provided by STM</td>
</tr>
<tr>
<td>Actor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• VTSO using the VTS system</td>
</tr>
<tr>
<td></td>
<td>• OOW</td>
</tr>
<tr>
<td>Triggers</td>
<td>The messaging can be triggered from anywhere in the VTS system or manually by the VTSO.</td>
</tr>
<tr>
<td>Preconditions</td>
<td>Need for messaging to the ship is identified.</td>
</tr>
<tr>
<td>Postconditions</td>
<td>VTSO and OOW has exchanged all information needed and have identical information about the matter at hand.</td>
</tr>
<tr>
<td>Frequency of Use</td>
<td>The VTS operator uses this for each ship in his area at least once. It is estimated that XX messages/operator/hour is been sent. The frequency is specific to a VTS or VTS area.</td>
</tr>
</tbody>
</table>

#### Normal flow

```
Message: Send Message

VTS-operator: «Human»
VTS-System: «Machine»
Ship system: Ship OOW
```

- **Send Message**
- **ACK**
- **Message read (ACK)**
Exceptions

Includes

Special Requirements

- VTS system MUST keep chronological record of messages being sent and received by VTS Operator or VTS system
- Link to prev. message (in-reply-to)
- Messages can use different communication channels (AIS/VDES/IP).
- Where transport layer doesn’t provide technical acknowledgements, the application (by operator) must send these.
- Standard messages MUST be configurable using Templates (see Rules /messaging).
- The system MUST support usage of IALA message markers. Even force usage of critical terms.
- The message sizes MUST adapt to the variable communication bandwidths
- The message MUST be able to send attachments, where bandwidth available
- The messaging capabilities needs to be described in SOP and published in Master's Guide (or eq.)

Assumptions

- It is assumed that STM-messages can be used, but also AIS messages could be used.
- VDES ASM could extend the usability of the current AIS messages

Notes and Issues

This use case assumes that the VTSO is the initiating party (sender), but it might be the ship as well.

In this document we assume that the current implementation is used, and the “clearness” of messaging is to be designed and implemented at a later point.
6.7.1 Input data

- Message ID
- Sender (Operator ID / VTS area)
- Receiver(s) – The receivers of the message.
- State
- Message marker – A message marker as defined by IMO-SMCP
- Text – Free text. A library of standard phrases can be used to .
- Attachment
- Point, area, waypoints, …
- Reference to previous msg
- Response expected

6.7.2 State diagram for messaging

Figure 1 State diagram for message

<table>
<thead>
<tr>
<th>State</th>
<th>Next state</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEW</td>
<td>Out</td>
<td>New message being prepared by the operator. The message can be saved and deleted prior to sending</td>
</tr>
<tr>
<td>Out</td>
<td>Sent</td>
<td>The operator has put the message in an outbound que</td>
</tr>
<tr>
<td>Sent</td>
<td>Delivered</td>
<td>The system has successfully sent the message</td>
</tr>
<tr>
<td>Delivered</td>
<td>Seen</td>
<td>Message has been delivered to the receiver’s system</td>
</tr>
<tr>
<td>Seen</td>
<td>end</td>
<td>Message has been seen by a human</td>
</tr>
</tbody>
</table>
7 Rules

Rules defines how the VTS system calculates and identifies the situations occurring in the VTS area.

This chapter should not be viewed as normative, but rather give an idea what kind of rules is needed to analyze, monitor and organize traffic in an VTS.

COLREGS are intentionally left out from these rules as they are for most part not the responsibility of the VTS, in addition to which they might be highly interpretable in some cases. If system provider can provide a solid execution taking COLREGS into account, it can be used, but it shall be possible to deactivate.

7.1 General requirements for rules

- Human readable
- Configurable by operator
  - Different user levels for configuring (admin, operator etc.)
- Transparent to mariners – thru clear comm. E.g. The bases for decisions must reflect the rules based on national and international regulations (e.g. IALA).
- It is up to the system to define how the rules are connected. The rules might be hierarchical or networked.
- The rules MUST be defined in VTS SOP.
- The SOP defines who are responsible for changing/configuring different rules.

7.2 Geographical areas

The VTS is by legislation responsible for a specific area, which defines where it has jurisdiction. The VTS area is usually divided into smaller areas based on user defined needs.

- Rules shall be able to define to take place in defined geographical areas
- User must be able to define as many polygonal areas as needed
- Areas may be fully or partially overlapping with no limitations on amount of overlaps/layers
- User must be able to define the hierarchy of following rules on overlapping areas in a clear and simple way
- User must be able to define parameters for different rules to all areas, some (chosen by the user) areas or individual area at a time
- User must be able to copy single monitoring area with all parameters and modify the area or parameters
7.3 Situation types

At the centre of a traffic monitoring are the different situation types, which define what the VTS is monitoring. As what is being monitored is highly dependent on area and vessel type and multiple other factors. These rules MUST be operator configurable. The various situations are described in detail in the chapter "user stories"

For example, a threshold of 0,1NM can be catastrophic in one situation and perfectly normal in another.

7.3.1 Deviations

- User must be able to define variable VTS-XTD values
  - 0.01nm steps
  - minimum 0,0nm
  - maximum 3,0nm at least

User must be able to easily and ship-specific decide whether to
- Alert is triggered if vessel is deviating out of its XTD in RTZ
- Alert is triggered if vessel deviates from its XTD set by VTS (VTS-XTD)
  - or both, whichever comes first
- Alerts are bypassed

- User must be able to define rules both per route and per area and combine those

- User must be able to pre-define roles/profiles and attach them to vessels/routes

7.3.2 CQS

- Ability to recognize fore coming Close Quarter situations related to planned routes

- Optionally, ability to recognize different CQS types by the relative angle of planned route lines
  - If one vessel approaches another in sector 3°- 112,5° from bow, it shall be a Crossing
  - If two vessels route lines differ less than 6° and they travel in opposite directions, it shall be Head-on
  - If one vessel approaches another in sector 112,5°-180° from bow it shall be Overtake

- User must be able to configure triggering values
  - Triggering CPA, 0.1 nm steps, up to 3nm at least
  - Triggering TCPA, 1 min steps up to 45mins at least
• User must be able to define different levels of alert output behavior, option for 3 different outputs, graphics, sounds, resetting

• User must be able to reset the alarm e.g. when the necessary maneuvers has been performed

• There shall be two different speed profiles displayed so that it is very clear for the operator
  o Actual speed
  o Planned speed
  o At some point the planned speed stops to be interesting in this context.

• Display:
  o Easy toggling for different levels of display
    ▪ TCPA
    ▪ Point/area of meeting
    ▪ Vessels involved
    ▪ Routes to point of meeting
  o Markers for different types of CQS, if applicable

7.3.3 Automated Route cross checks

• RTZ routes shall be checked against chart material approved by VTS for its own use or other quality controlled electronic chart material

• The routes shall be checked following guidelines given in MSC.232(82) paragraph 11.3.5. What it comes to areas triggering alerts, it shall be possible to bypass any of the areas listed in MSC.232(82) Appendix 4 and replace them with User defined areas to be avoided.

• Results of the route check shall be graphically and textually represented for the operator.

• Automated message ‘Route Received’ can be delivered to ship

• All other messaging about route shall be triggered by user

7.4 Alert rules

The alert rules are used to help the operator in managing how to bring events to his/her attention. When the enhanced monitoring raises an event (or an alert) the alert rules are responsible for deciding what to do with the alert. The event MUST pass a context to the alert, which can be used to process the specific situation. This behavior must be configurable.
The event can for example be presented in the following way or any combination of them:

- Highlight the alerted object in the COP (e.g. Change color on ship on chart)
- Present the user with an alert dialog including audio.
- Put the alert in an operator work que

The depending on the type of the event the alert can either be dismissed by the operator or can be this missed only after the reason for the event has been managed.

The presentation of alerts shall be based on the share-out in IALA document 1110, “Use of decision support tools for VTS personnel”

### 7.5 Fairway library

Fairway library points to a way for VTS to communicate alternative routes for ships in format of RTZ.

The means are highly dependable of the ways each area wants to work. For example, in Finnish system we see the way to go would be to point out the desired route in the Nordic Pilot Route Service. Not by advising to use the service, but to communicate a straight and clear path to the route, e.g. a link to the file. If STM comms are not able to share links in a good way, operators could download the pilot route file and send it to the ship using STM comms.

In Swedish mindset creating or modifying existing routes and sending them straight to the vessels would be the way.

From ships point of view there is no difference; they will achieve an alternative route suggestion easily, in very utilizable format.

This ruleset has to be defined individually to serve the case in hand.

### 7.6 Messaging rules

NOTE that this chapter is dependent on the messaging capabilities of the VTS-System and at this point time they are not recommendations by STM but rather a placeholder for ideas to take further

Messaging rules are a set of templates and helpers that support the VTSO in his communication. It also contains codes needed to provide mariners with information that can be localized to the mariner’s own language.
These templates should utilize the information in the other rules. For example, if a CQS is identified the messaging should use those parameters when sending a message to the ship.

The templates can also contain standard messages for re-occurring events. For example, if a ship is late on a short report (and the ship has a length of >24m, based on AIS) the system could send a standard message like: “You are approaching Archipelago VTS, we are awaiting your report. See master guide for current services and obligations: [https://tmfg.fi/sites/default/files/2019-09/Archipelago%20VTS_EN.pdf](https://tmfg.fi/sites/default/files/2019-09/Archipelago%20VTS_EN.pdf)

- INS
- NAS
- TOS
  - (i) Instruction
  - (ii) Advice
  - (iii) Warning
  - (iv) Information
  - (v) Question
  - (vi) Answer
  - (vii) Request
  - (viii) Intention
8 Implementation of STM-compatible VTS

8.1 General

The aim with this chapter is to present general requirements for the implementation of VTS system regarding STM-capabilities.

8.1.1 Assumptions

8.1.1.1 Current STM VIS specification

A VTS system must at a minimum implement the STM VIS specification (STM-VIS) in order to be able to communicate with the ships (in their area). This chapter lists the restrictions specific to a VTS in general and things specific to a VTS area.

8.1.1.2 Not a new system

The general assumption is that these functionalities are implemented as an integrated part of an existing VTS system. Most of the functions are dependent of the general functionality and implementing these as a separate system would be a large undertaking and would not help the VTSO in any way.

8.1.1.3 Implemented in VTS

For each function there is a key word describing whether is VTS implements something or not. The following keywords are used:

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandatory</td>
<td>A VTS must implement the interface or use case and provide full support for it.</td>
</tr>
<tr>
<td>Optional</td>
<td>Based on Laws, regulation and SOPs the VTS (or VTS area) can choose to implement or not. It is up to the vendor to decide what they want to support.</td>
</tr>
<tr>
<td>NOT implemented</td>
<td>The functionality MUST NOT be implemented or supported by the VTS.</td>
</tr>
</tbody>
</table>

8.1.1.4 Sharing of routes

The VTS has no obligation or even right to share routes between ships. The VTS utilizes individual ships route plan to improve their own work and provide better service to ships. Therefore, this chapter assumes that the VTS does not act as a router/hub of route plans.
8.2 Identity and service registries

The VTS System MUST conform to Maritime Connectivity Platform Consortium (www.maritimeconnectivity.net) specifications and use the Navelink (navelink.org) infrastructure.

8.2.1 Identity

The VTS MUST create its own identity in the infrastructure.

8.2.2 Service registry

The ship systems are using the MCP service to locate the VTS services for their route. The VTS MUST register a service instance for the VTS in the service registry following the guidelines in: https://maritimeconnectivity.net/docs/Service_Instance_Description_Templatem.doc

Note that the service instance is specific to a VTS area, not to the Shore centre or coastal state. This means for example that Helsinki VTS centre is not represented in the service registry, but the individual VTS areas are, like Hanko VTS. Likewise, if an SRS area is requiring/ supporting a route plan or similar digital reporting, it must be registered as a separate instance.

8.3 Information exchange from ship to VTS

These are the services a VTS system must implement in order to receive information from ships or that the ships need to call in order to retrieve information. The later chapter describes the mandatory services the VTS needs to implement in order to send information to the ship.

8.3.1 VIS Get Interface

This method is used by the ship to fetch their own route from the VTS. Currently the operational logic doesn’t need this, a ship uploads the plan and the VTS sends back the result of the cross-check. The VTS should ONLY return a route plan with the routeStatus flag set to 4 (Cross checked)

The VTS MUST ensure that correct ACL:S are in place.

<table>
<thead>
<tr>
<th>Method</th>
<th>implemented in VTS</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>getVoyagePlans()</td>
<td>Optional</td>
<td>Returns the voyage plan ONLY to the ship that owns the route</td>
</tr>
</tbody>
</table>
### 8.3.2 VIS Subscription Interface

There is no reason for implementing these interfaces as the ship already have their own route and the VTS cannot share other ships routes.

<table>
<thead>
<tr>
<th>Method</th>
<th>implemented in VTS</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>subscribeToVoyagePlan()</td>
<td>NOT implemented</td>
<td></td>
</tr>
<tr>
<td>getVoyagePlanSubscription()</td>
<td>NOT implemented</td>
<td></td>
</tr>
<tr>
<td>removeVoyagePlanSubscription()</td>
<td>NOT implemented</td>
<td></td>
</tr>
</tbody>
</table>

### 8.3.3 VIS Upload Interface

These are the most important services that a ship uses. Note that uploadArea-services MUST not be implemented as a ship cannot send a Navigational Warning as defined in s-124. A ship should send a text Message with an embedded area.

<table>
<thead>
<tr>
<th>Method</th>
<th>implemented in VTS</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>uploadVoyagePlan()</td>
<td>Mandatory</td>
<td>Upload the current planned route to VTS for Route-cross checking.</td>
</tr>
<tr>
<td>uploadTextMessage()</td>
<td>Mandatory</td>
<td>Used for sending a message to the VTS.</td>
</tr>
<tr>
<td>uploadArea()</td>
<td>NOT implemented</td>
<td>The s-124 is a specification reserved for official announcements.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A ship should use uploadTextMessage() when communicating to VTS.</td>
</tr>
</tbody>
</table>
8.3.4 VIS Acknowledgement Interface

The ship system can ask an acknowledgement from the VTS. Care should be taken that the acknowledgement always reflects the true state of the object. For example, it should not return objects in caches or gateways but the state within the VTS systems core and the lastInteractionTime on the ResponseObject MUST be set correctly.

<table>
<thead>
<tr>
<th>Method</th>
<th>implemented in VTS</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>acknowledgement()</td>
<td>Mandatory</td>
<td></td>
</tr>
</tbody>
</table>

Note that the Acknowledgement Interface is unaware of any human interaction, thus it should only send technical acknowledgements, the human interaction Must be defined operationally. For example, this interface can realize on the seen state. (see above: State diagram for messaging).

8.4 Information exchange from VTS to ship

These interfaces are not part of the VTSes published interfaces but lists the interfaces of a Ships VIS that the VTS uses to communicate with the ship.

The biggest challenge for the VTS is the amount of ships in their area. it is not practical to either request or subscribe data to potentially thousands of ships. Therefore, the ship MUST be made obligated to send latest information to the VTS. Therefore, most of the following services are geared for communication with one specific ship at the time.

8.4.1 VIS Get Interface

Currently the operational logic doesn’t need this, a ship uploads the plan and the VTS should not have to ask for it. The VTS can ask, if properly authorized, the current route plan for a specific ship.

- Is The route returned from VIS the correct one?
- Can all ship systems authorize VTses along the route to have permissions?
- Should a VTS be able to ask for the routeplan?
- A VTS could ask for the ship for an updated route plan, by txtMessage().

<table>
<thead>
<tr>
<th>Method</th>
<th>implemented in VTS</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>getVoyagePlans()</td>
<td>???</td>
<td>A VTS MUST NOT return route plans for other ships.</td>
</tr>
</tbody>
</table>
### 8.4.2 VIS Subscription Interface

There is no reason for implementing these interfaces as the ship is obligated to cross-check any relevant changes to the route. Thus there is no need to subscribe the ships current route. Further this would add the burden for the ship to authorize every VTS along its planned route.

The VTS faces a lot of ships entering its area of responsibility and it would not be practical to subscribe to all of them.

<table>
<thead>
<tr>
<th>Method</th>
<th>implemented in VTS</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>subscribeToVoyagePlan()</td>
<td>NOT Implemented</td>
<td></td>
</tr>
<tr>
<td>getVoyagePlanSubscription()</td>
<td>NOT Implemented</td>
<td></td>
</tr>
<tr>
<td>removeVoyagePlanSubscription()</td>
<td>NOT Implemented</td>
<td></td>
</tr>
</tbody>
</table>

### 8.4.3 VIS Upload Interface

These are the core interfaces a VTS uses when communicating with the ship.

The VTS should ONLY return a route plan with the routeStatus flag set to 4 (Cross checked)!

<table>
<thead>
<tr>
<th>Method</th>
<th>implemented in VTS</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>uploadVoyagePlan()</td>
<td>Mandatory</td>
<td>The Ship MUST use “Baltic Navigational Waring Service instance description_1 1” to register interest in NW:s. uploadVoyagePlan on the VTS VIS is used to route cross check, not to register interest in NW:s.</td>
</tr>
<tr>
<td>uploadTextMessage()</td>
<td>Mandatory</td>
<td></td>
</tr>
<tr>
<td>uploadArea()</td>
<td>NOT Implemented</td>
<td></td>
</tr>
</tbody>
</table>
Therefore, the VTS MUST register NWs separately in MCP.

8.4.3.1 Upload s-124 to each ship?

The current STM infra structure doesn’t support one-to-many messaging patterns and therefore the only viable technical solution is to send it to every individual ship. Moving forward this usage pattern is not sustainable when amount of ships is increasing. See recommendations below.

8.4.4 VIS Acknowledgement Interface

A VTS must be able ask for an acknowledgement from a ship. Care should be taken that the acknowledgement always reflects the true state of the object. For example, it should not return objects in caches or gateways but the state within the VTS systems core and the lastInteractionTime on the ResponseObject MUST be set correctly.

<table>
<thead>
<tr>
<th>Method</th>
<th>implemented in VTS</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>acknowledgement()</td>
<td>Mandatory</td>
<td></td>
</tr>
</tbody>
</table>

Note that the Acknowledgement Interface is unaware of any human interaction, thus it should only send technical acknowledgements, the human interaction Must be defined operationally. For example, this interface can realize on the seen state. (see above: State diagram for messaging).

8.5 Implementation of VIS private side interfaces

The VTS system implementation is free to implement the private side of VIS as they see best fit. It is recommended that they terminology and usage patterns of the private side reflects the VIS. This is especially true if the functionality is visible to the operators or administrators.

8.6 VTS Internal

The system needs to reflect the user stories presented in chapter 4 and the process presented in chapter 5 and it is up to the system vendor to decide how said process and use cases are implemented and integrated in their workflow (which MUST follow the given IALA guidelines and regulations).

This solution does not mandate a specific data model for the VTS System. Furthermore, it does not mandate specific User interfaces. It is recommended that the
system keeps records of the interactions with individual traffic in accordance with IALA guidelines.

8.6.1 UC 1: Analyze traffic and UC 2: Monitor traffic

The only input UC 1: Analyze traffic and UC 2: Monitor traffic need are the route plan from the ship, after which various calculations result in an event to either investigate further or not. In the case of a route cross-check an event will always be raised.

8.6.2 UC 3: Analyze situation

User story involved:
- Close Quarters Situation (CQS)
- Predictions
- Route proposals
- Route Corridor Deviations

8.6.2.1 Close Quarters Situation (CQS)

The CQS contains a dialog between the ship and the VTS by utilizing the current messaging service.

8.6.2.2 Predictions

The Predictions contains a dialog between the ship and the VTS by utilizing the current STM messaging service.

8.6.2.3 Route proposals

Issue: The current rtz (uploadRoute()) doesn’t not contain functionality for proper TOS or NAS. The current RTZ doesn’t contain information about the route proposal.
- At a minimum there should be fields to indicate that the VTS is mandating traffic organization and on what grounds.
- the VTS should only send delta to the current route plan (e.g. Proposed changes, not the whole route)

8.6.2.4 Route Corridor Deviations

The Route Corridor Deviations contains a dialog between the ship and the VTS by utilizing the current messaging service.

8.6.3 UC 4: Manual route crosscheck

When a VTS performs a route cross check to a ships route plan it must provide some feed back to the ship. When responding to a route cross check the VTS MUST not change the route but provide feedback on the planned route.

This should be discussed:
- Alt 1: VTS sends back a route plan with the status 4 (cross checked)
Alt 2: VTS sends back a txt message
Alt 3: VTS sends back a list of items (for each wp) of concern to the ship.

None of the above are optimal as of version 2.2

8.6.4 UC 5: Messaging

STM Messaging is currently capable of sending free text, points and areas. Both the ship and the VTS sends message to each other by utilizing each other’s uploadTextMessage-service.

8.6.4.1 Further development

The user story describes a more functional way of making messages clearer by adding more structured data to the messages. It should be considered to enhance the message format to support a more structured dialog between different stakeholders.

Chapter 4.6 suggest using SMCP and how this is reflected as message structure or service realizations must be considered.

8.6.5 Other use cases

The uploadArea-service is not currently described in any of the use cases but is considered part of Normal VTS INS-service. Therefore, the ability to send Navigational Warnings is mandatory for the system (Note that there are variations on how different coastal states handle NW:S)

8.7 Recommended changes in the VIS interfaces

8.7.1 UploadArea() should be deprecated

As the uploadArea-method is defined as containing a s-124 product it would be advisable to deprecate it completely and a) use textmessage (and containing area) for informal messages and b) use an official and endorsed service for the actual s-124 content (Navigational Warnings). See next paragraph.

8.7.2 GetVTSInformation() should be added

A method for the ship to be able to retrieve information about a specific VTS area (a digital version of the master’s guide). First implementation would be to get Navigational Warnings (S-124).

More generally speaking this service could return s-series documents of any kind. Calling without parameters would return a list of supported information products (e.g. Calling the items in the list and you will get everything).
8.7.3 Message broadcasting

Moving forward STM should consider using broadcasting or some other means of sending same message to multiple receivers.

This functionality closely resembles the “overhearing effect” that the VHF channels provide to ships in the same area.

The operational aspects should be analyzed and the need to broadcast everything should be considered carefully before implementation. It is not evident that everything should be automatically broadcasted to everyone in the area.

8.7.4 Create portfolio of Costal state service

The monolithic VIS portfolio of services was originally written to represent a ship. It has during various projects been used to describe land-based information services. This has led to services which implement only a subset of the VIS specification and they have become hard to understand as they are described only as instance documents to the VIS specification.

One of the challenges is that every costal state is slightly different in terms of legislation and separation of concerns.

Another challenge is that the systems are very different when it comes to supporting the ships. e.g. in one VTS there is only one system for everything and in another centre, there can be multiple systems supporting different aspects of Costal services.

Creating a portfolio of standalone service specifications for shore-based services should be considered. This would give each costal state and its administrative functions the freedom to choose which agency (and which system) provides specific services.

By registering each service as a standalone in an MCP service registry it would be easier to document, find and implement said services.

The IALA draft document GUIDELINE 1089 PROVISION OF VESSEL TRAFFIC SERVICES (VTS) could be a good starting point to start identifying costal state services, with focus on VTS.
# 9 Notes and References

## 9.1 Use Case Definition

(from: [https://confluence.csc.fi/download/attachments/49643963/EMREX%20use%20case%20template.docx?version=1&modificationDate=1422011875902&api=v2](https://confluence.csc.fi/download/attachments/49643963/EMREX%20use%20case%20template.docx?version=1&modificationDate=1422011875902&api=v2))

<table>
<thead>
<tr>
<th>Actor</th>
<th>An actor is a person or other entity external to the software system being specified who interacts with the system and performs use cases to accomplish tasks. Different actors often correspond to different user classes, or roles, identified from the customer community that will use the product. Name the actor(s) that will be performing this use case.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Provide a brief description of the reason for and outcome of this use case, or a high-level description of the sequence of actions and the outcome of executing the use case.</td>
</tr>
</tbody>
</table>
| Preconditions | List any activities that must take place, or any conditions that must be true, before the use case can be started. Number each precondition. Examples:  
1. User’s identity has been authenticated.  
2. User’s computer has enough free memory available to launch task. |
| Postconditions | Describe the state of the system at the conclusion of the use case execution. Number each postcondition. Examples:  
1. Document contains only valid SGML tags. |
<table>
<thead>
<tr>
<th>Priority</th>
<th>Indicate the relative priority of implementing the functionality required to allow this use case to be executed. The priority scheme used must be the same as that used in the software requirements specification.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency of Use</td>
<td>Estimate the number of times this use case will be performed by the actors per some appropriate unit of time.</td>
</tr>
<tr>
<td>Normal Course of Events</td>
<td>Provide a detailed description of the user actions and system responses that will take place during execution of the use case under normal, expected conditions. This dialog sequence will ultimately lead to accomplishing the goal stated in the use case name and description. This description may be written as an answer to the hypothetical question, “How do I &lt;accomplish the task stated in the use case name&gt;?” This is best done as a numbered list of actions performed by the actor, alternating with responses provided by the system.</td>
</tr>
<tr>
<td>Alternative Courses</td>
<td>Document other, legitimate usage scenarios that can take place within this use case separately in this section. State the alternative course and describe any differences in the sequence of steps that take place. Number each alternative course using the Use Case ID as a prefix, followed by “AC” to indicate “Alternative Course”. Example: X.Y.AC.1.</td>
</tr>
<tr>
<td>Exceptions</td>
<td>Describe any anticipated error conditions that could occur during execution of the use case and define how the system is to respond to those conditions. Also, describe how the</td>
</tr>
</tbody>
</table>
### Use Case Description

The system is to respond if the use case execution fails for some unanticipated reason. Number each exception using the Use Case ID as a prefix, followed by “EX” to indicate “Exception”. Example: X.Y.EX.1.

### Includes

List any other use cases that are included ("called") by this use case. Common functionality that appears in multiple use cases can be split out into a separate use case that is included by the ones that need that common functionality.

### Special Requirements

Identify any additional requirements, such as nonfunctional requirements, for the use case that may need to be addressed during design or implementation. These may include performance requirements or other quality attributes.

### Assumptions

List any assumptions that were made in the analysis that led to accepting this use case into the product description and writing the use case description.

### Notes and Issues

List any additional comments about this use case or any remaining open issues or TBDs (To Be Determined) that must be resolved. Identify who will resolve each issue, the due date, and what the resolution ultimately is.
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Making the Baltic Sea even safer by improving the situational awareness on ships and shore, building tools that automate work and provide decision support to prevent risk situations and accidents.

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www.seatrafficmanagement.info/projects/stm-balt-safe