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Dynamic Voyage Management Description

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1 General Information

The Sea Traffic Management (STM) concept has been introduced by the MONALISA 2.0 project. An overview description of STM can be found in the document “Sea Traffic Management – a Holistic View.” Within STM, four enabling strategic concepts have been identified as crucial for reaching the target values. These are:

- **Port Collaborative Decision Making (Port CDM)**, 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 optimization before the voyage has started;
- **Dynamic Voyage Management (DVM)** which deals with route planning, route exchange and route optimization whilst the ship is on its way;
- **Flow Management (FM)**, which includes services that will support both land organisations and ships in optimizing 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 (Sea SWIM)**, which intends to be a common framework for information sharing and service distribution for maritime activities.

This document focuses on the definition and operational services included in the DVM concept.

For a common, up-to-date list of abbreviations and definitions, please see The MONALISA 2.0 Definitions and Abbreviations List (STM Wiki, 2015)

2 Introduction

A sea voyage consists of three important phases. The first is the Strategic Voyage Management (SVM) phase, which mainly takes place before the actual voyage starts. The second phase is the Dynamic Voyage Management (DVM), which aims to optimize the voyage plan continuously during the passage. Finally, there is the Tactical Action phase, when the direct conning operation is taking place with course or speed alterations.

The main objective of DVM is to iteratively adjust the original strategic Voyage Plan in order to always run a ship in the most cost-efficient way, using all possible in-data that can affect the Voyage Plan. Main sources for alterations are technical issues

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1 [http://monalisa.viktoria.se/wiki/](http://monalisa.viktoria.se/wiki/)
regarding the ship at hand, weather and ice conditions, availability of berth and pilots, traffic situations, and cargo-related matters.

The results of DVM are constantly available, affecting and affected by other processes involved in a ship’s overall Voyage Plan such as the SVM, the Flow Management (FM) and the PortCDM.

DVM, at present commonly known as route planning and voyage execution, is by nature as old as the shipping industry itself. What STM aims at, is to bring in new technology to speed up and secure the process with real-time access to adequate data from relevant stakeholders and service providers. Today this process is executed mainly onboard with manual updates via traditional sources, such as telephones, fax machines, regular mail, pilot books, charts, etc. Information security and access management to DVM services in order to make them operational and trusted are vital; however, they are not generally included in this document as they are functions and services included in the SeaSWIM concept.

With connected ships, intelligent and structured processes, new tools, and with all stakeholders involved, a much faster, secure and transparent way of exchanging information will optimize voyages and reduce both costs and emissions. This will also improve the common situational awareness and lead to greater safety at sea.

The Unique Voyage ID (UVID) works as a carrier and identifier of all relevant data connected to a specific voyage. Apart from the UVID, the other major tool—invented by the MONALISA projects—is the standardized route plan exchange format (RExF) that makes it possible for all stakeholders, independent of equipment and manufacturer, to receive, read, elaborate on, and transmit routes via a Cloud solution by System Wide Information Management principles.

All of the different processes involved in STM are highly interdependent; therefore, a structured and harmonized data flow between all processes involved is necessary. DVM utilizes the SVM as a basis for its operations. Considerable alteration through the DVM may result in new conditions for the overall voyage planning and the DVM can even be turned back into the SVM phase and give completely new directives, such as a new destination or voyage order.

DVM requires information from Port CDM and FM about desirable arrival and departure times in order to keep an updated ETA/ETD. This affects the time-dimensional and the speed en-route during the whole voyage, which in turn provides opportunities for Just In Time (JIT) operations and a reduction in fuel consumption. At the same time, changed conditions at sea, such as weather or ice conditions, technical issues, and traffic, may affect the ETA, and thus cause a re-evaluation of the JIT process from a port perspective. The same process is valid for the data exchange with FM regarding traffic conditions when optimizing specific routes. DVM can affect and be affected by the traffic patterns in a certain area.
3 Service Descriptions

3.1 Route Exchange

3.1.1 Introduction

The Route Exchange Service is the communication of parts of the route (route segments), ship-to-ship, and possibly also from ship-to-shore centers, such as VTS-areas that only need to know a segment of the route. The route segment could be sent using AIS-ASM or by other means of communication. The complete route used for optimization, etc. is included in the Voyage Information Service and is not considered a part of the Route Exchange Service.

3.1.2 Objectives

The objective with route exchange is to enhance situational awareness by providing ships with surrounding ships’ routes and displaying them on ECDIS. This will inform the OOW/Master about other ships’ intentions, and thus reduce the number of accidents and facilitate better decision-making as more information is available. Better situational awareness is key to increasing safety; according to The Swedish Club: “Poor lookout and lack of situational awareness is likely to continue to be the main cause of Navigational claims” (see report Navigational Claims, 2014).

3.1.3 Description

Today, detailed route information normally stays with the ship (except when reporting to AMVER, LRIT, etc.) and is not shared on a local basis during passages. As a result, ships that meet today have good AIS-data regarding each other concerning position, speed, and final destination, but they do not know the intended route of ships nearby. By adding the route to the information shared via AIS-transponder, ships will also know the intentions of ships nearby. This will help deck officers plan ahead, foresee possible incidents, and thus avoid dangerous situations; this is especially important when navigating in confined waters. The situation is the same with today's Vessel Traffic Service (VTS), the main purpose of which is to function as a decision support for navigators within a set geographic area (a so called VTS-area), as they do not know the details of ships’ routes.

The route exchange is used in a medium-term navigation perspective to avoid incidents and close-quarter situations with the risk of collision. COLREG always applies, and in short-term and close-quarter situations, route exchange should not be used so as not to confuse anti-collision decision-making.

To exchange routes there is a need for a common protocol containing all necessary data for the route which is understood by all parties, and a transmitting device to send and receive the route from party to party irrespective of system manufacturer. The common protocol for the route exchange format and integration with ECDIS has been part of the MONALISA 1 and 2 projects. Since only a segment of the route is distributed on request (to display) by another actor, and only if the request is accepted by the ship at hand, no further encryption or authentication needs regarding
who should be able to access the route segment is anticipated. Note that this applies to the exchange of route segments over AIS only; the confidentiality of the complete route, as a part of the voyage information, will be protected by information security measures and access management control.

### 3.1.4 Area of Operation

When AIS is used for the distribution of routes, the area of operation is within AIS-coverage range; otherwise, the area of operation is not limited.

### 3.1.5 Actors

The following actors are identified as applicable in this service:

- STM compliant ships (i.e. a ship having the required STM functionality implemented onboard).

### 3.1.6 Contribution to STM Performance Targets

The ability to exchange information regarding routing is one of the cornerstones of STM and an enabler for several operational services; it thereby affects most of the STM performance targets in one way or another. To pick one important target that is highly affected, voyage safety, for example, is increased by enabling situational awareness on a whole new level. This will help prevent accidents, but safety reactive actions (SAR) will also benefit from distributing search patterns with the exchange of information about routes. Efficiency, environmental sustainability, interoperability, and security targets will also be supported by the route exchange service.

### 3.1.7 Dependencies on other STM-services

- UVID

### 3.2 Route Cross-check

#### 3.2.1 Introduction

The exchange of information regarding routes ship-to-shore creates new and more efficient possibilities for confirming that a ship’s route is safe and in accordance with local conditions and updated regional area information. The route cross-check relates to existing route planning and checking tools, such as VTS- and SRS-reporting, and also the broadcasting of area information.

#### 3.2.2 Objectives

The objective of the Route Cross-check is to ensure that a ship’s route is accurate and executable from departure to arrival by checking it with various sources. The possibility to exchange information about routes, for example, gives coastal states better tools and possibilities for verifying that the ship’s planned route is in accordance with local conditions and updated regional area information along the route. This will lead to safer routes and a reduced administrative burden onboard and ashore.
3.2.3 Description

Existing ECDIS route-checking tools are used onboard in order to check that a planned route has, for example, the right Under Keel Clearance (UKC), Air draft, and does not pass too close to ground areas. Before the ship enters areas with regulated traffic, such as VTS, SRS, TSS or Port Control, reporting of the ship’s intentions in the area is done by text messages (like e-mails) or, more often, by voice (e.g. VHF, telephone). This communication is time consuming and takes the OOW’s focus away from the matter of safe navigation. The use of different languages can also lead to problems with communication and misunderstandings. There is no possibility for shore-side actors to see ships’ actual routes, to know what parameters have been taken into account in the route plan, or if recent changes, like Maritime Safety Information (MSI), is included.

Utilizing the standard format for route communication, which enables ships to share routes with external actors, ships will be able to send their route to shore-side actors. This will give them the possibility to actually see the intended route and verify if the route is in accordance with all general and local area information and regulations. Additionally, necessary changes can be sent as route proposals from shore-side actors to the ship, which also reduces verbal communication and misunderstandings—often a contributing factor to accidents. Examples of cross-checking parameters include, but are not limited to, UKC, Air draft, ship particulars in relation to fairway restrictions, tidal water restrictions, cargo properties, no violation of MSP no-go areas, MSI and compliance with mandatory routing. No optimization services as such are included in the route validation.

Local area information, provided by the area management service, is today not standardized or even possible to include in the ECDIS route checking. This information instead needs to be taken into account manually using other sources of information. By providing local area information (e.g. legal, navigational, environmental, the latest safety information (MSI), and dynamic no-go areas) directly into the ECDIS, route planning is made more efficient as it can be checked right from the planning stage that these factors are taken into account. When the route is checked, its status is updated and shore-side stakeholders can receive the information that the route is already checked, making the shore-side cross-check obsolete. Since area information is also dynamically updated, changed conditions along the route, such as accidents or new military practice areas, can also be taken into consideration.

3.2.4 Area of Operation

The route cross-check can be done for a route segment, e.g. VTS or SRS-area, or for an entire route where the geographical area around the route is divided into area segments.

Route cross-checks can be performed both before the ship’s departure from port, or before entering a specific area.
3.2.5 Actors

The following actors are identified as applicable to this service:

- **Service Providers:** This service is provided by an administration or private actor appointed by a National Competent Authority (NCA). It is performed by a shore-based operator using ships’ routes and local/regional area information. If all of the information is made available, route-checking could also be performed onboard according to a given standard.

- **STM-compliant ships:** These are ships that have the required STM functionality implemented onboard, so that they can make full use of the STM concept. In practice, this means the functionality of exchanging route plans (or segments of them) with shore-based operators.

3.2.6 Contribution to STM Performance Targets

The possibility for shore-based operators to use route information exchange services to verify that ships’ routes are in accordance with local regulations and conditions without the need for verbal communication, is an example of improved information sharing. This improvement will increase the number of messages sent and received with STM technologies. Safe navigation, leading to a reduction in the number of incidents and accidents, will be supported by safer routes as a result of the route being verified by operators with good local knowledge.

3.2.7 Dependencies on other STM-services

- Route Exchange Service
- Voyage Information Service
- Area Management Service

3.3 Route Optimization

3.3.1 Introduction

The exchange of routes ship-to-shore creates new and more efficient possibilities for optimizing ships’ routes. Existing optimization services will benefit from the standard format which also facilitates multi-criteria optimization and opens up for new optimization services to be developed.

3.3.2 Objectives

The objective with Route Optimization is to optimize ships’ routes, berth-to-berth, using both existing optimization services and information created within other STM-services, such as the better possibilities for ETA-optimization made possible through the Port Call Synchronization Service. The optimization of routes will ensure safer and more efficient routes, leading both to reduced costs and a reduced environmental impact.
3.3.3 Description

Route optimization services are voluntary services requested by the ship or shipping company, provided by different private or public service providers with the intention to optimize the route regarding, for example, weather, currents, ice conditions, MSI, MSP, distance, speed (ETA), bathymetric data, local/regional area information, port availability and traffic conditions. Some of these services are available today and optimization is carried out onboard as well as by service providers ashore. However, the route exchange and new STM services provide new and more effective possibilities for this already existing optimization; they also open up for the possibility for more parameters and for multi-criteria optimization to be taken into account. Simulations performed in the MONALISA 1 project show that in the Kattegat area up to 12% of the sailed distance in the area can be saved by optimized routes. To reach the full potential of optimization, route exchange ship-to-ship is a prerequisite in order to detect areas where traffic conditions allow for shortcuts to be made.

The voyage planning process with its involved actors is depicted in Figure 1, STM Standard Operating Procedures Voyage Planning. The approved route, used for monitoring, forms a commitment that the ship has to follow in order to keep all other involved and authorized actors updated with its intentions. All plans can and must be changeable with short notice; this is even a prerequisite for a dynamic route optimization, but as soon as new orders and optimizations are completed and approved by the ship, the route must be updated and shared with the authorized actors. While within tactical conning mode, sudden maneuvers to avoid dangerous situations can arise, these are not considered part of the route that needs updating but rather an incident-avoiding action by following the COLREG.
3.3.4 Area of Operation

The route optimization is, as already stated, an iterative process and can be performed both pre-departure and continuously en-route as conditions change.

Optimization can and should be done for the whole route, berth-to-berth, but different optimization parameters will be used at different phases of the voyage. During ocean passages, weather optimization will be the main parameter and most of the other parameters will not be applicable. In coastal areas, on the other hand, most of the parameters can be utilized as traffic can be dense and bathymetric conditions greatly influence a ship's fuel-consumption. ETA optimization will be done as soon as new information is received, but is anticipated to be more frequent as the ETA to the port-of-call is approaching and the information from the various port actors becomes more precise. Carriers’ obligations, arising from the contract of carriage, for example, the obligation to exercise due dispatch during the sea voyage, should be taken into consideration.

3.3.5 Actors

The following actors are identified as applicable in this service:

- Service Providers: private and/or public service providers. For some of the optimization parameters, e.g. traffic coordination, a private service provider is likely to require an authorization from a NCA.
• STM-compliant ships: a ship which has the required STM functionality implemented onboard, so that it can make full use of the STM concept. In practice, this means the functionality of communicating its route plan with the shore-based service provider.

3.3.6 Contribution to STM Performance Targets
The better optimization of routes, which takes into account more parameters, will lead to reduced fuel consumption. This will directly affect the STM performance targets on environmental sustainability by reducing emissions of GHG and pollutants. Naturally, efficiency and cost-effectiveness are also improved. If routes are better optimized, they will also have a higher predictability on time calculations (ETA), which supports both voyage and port predictability.

3.3.7 Dependencies on other STM-services
• Voyage Information Service
• Area Management Service
• Port Call Synchronization Service
• Traffic Coordination Service
• SeaSWIM services

3.4 Shore-based Navigational Assistance Services

3.4.1 Introduction
The exchange of information regarding routes between ship and shore provides new possibilities in both enhanced traffic monitoring and navigational assistance. The Shore-Based Navigational Assistance Service (SBNAS) can be regarded as an extra support to onboard navigation, where the final decision is still up to the Master. The purpose of SBNAS is to provide a new tool for the existing services in VTS-areas, as well as to open up for the possibility of implementing similar services in new areas.

3.4.2 Objectives
The objective with SBNAS is to support ships’ own navigation with shore-based navigational assistance, in, for example, confined areas and/or dense traffic conditions. This can reduce the number of accidents and be a cost-efficient alternative to deep-sea pilotage outside of areas with compulsory pilotage.

3.4.3 Description
Today, surveillance and monitoring services can, by radar or AIS, detect ships’ actual positions, their speed and final destination, but these methods cannot identify the intended route of ships in the area. The route information exchange between ships and service providers opens up for more effective and diverse monitoring and assisting services for ships. By adding the route, authorized service providers will be
able to see both the ship and its intended route. Thereby, it is possible to immediately detect deviation, either automatically or manually, from a planned route and thus foresee possible incidents and avoid dangerous situations. This means that existing services where the monitoring of ship traffic is performed, e.g. VTS, SRS and Coastguards, are beneficiaries that can have more efficient and effective operations by knowing ships’ routes.

The new tools for monitoring can also be used for Navigational Assistance Services (NAS). NAS is an existing VTS service which, according to IMO, is defined as “a service to assist onboard navigation decision-making and to monitor its effects, especially in difficult navigational or meteorological circumstance or in case of defect or deficiencies.” In these already-regulated geographical areas, no new services or service levels are suggested; the route information exchange is simply a new tool which can provide new possibilities to conduct actual tasks. These services are solely provided by an NCA. In addition to this regulated NAS, more effective monitoring and information sharing also opens up new possibilities for private service providers authorized by an NCA to offer voluntary NAS for ships in confined areas or dense traffic conditions.

The difference between the SBNAS and Enhanced Shore Based Monitoring is that the latter is a service for all ships transiting sensitive geographical areas. If no deviation from a planned route or critical situation arises, no active support to ships is included. SBNAS, on the other hand, is a voluntary, on-request service that provides active support to ships. The service can be offered for areas of dense traffic or challenging navigational conditions, but outside of VTS- and pilotage areas it does not intervene with compulsory VTS or pilotage services. In some areas, for example, ships which lack regional experience use pilotage even outside of the mandatory pilotage area, a so-called deep sea pilotage. Dependent on the current needs onboard, a more cost-effective solution can be to offer SBNAS as a complementary service.

Examples of the kind of support that SBNAS can offer to ships include: the monitoring of position, course, speed and surrounding traffic, the warning of dangers, the reporting and local knowledge of traffic and of weather conditions. SBNAS can be provided at different levels dependent on a ship’s needs. A rough example of what service levels could include, might look as such:

Active level 1: Service provider monitoring and confirming with the OOW 10 minutes before next waypoint.

Active level 2: Service provider monitoring and confirming continuously in real-time passages through defined areas.

3.4.4 Area of operation

SBNAS could be used for an entire voyage, but it is most likely to be used in coastal areas and regional seas such as the Baltic Sea, outside of pilotage and VTS-areas.
3.4.5 Actors

These new possibilities can be used in several instances, e.g. by shipping companies, through existing services such as VTS and new services/solutions described in the MONALISA 2.0 project.

The following actors are applicable in this service:

• Service Providers: Shore-based private companies or administrations approved by an NCA.

• STM-compliant ships: a ship which has the required STM functionality implemented onboard, so that it can make full use of the STM concept. In practice, the functionality of exchanging information about its route plan with the shore-based service provider.

3.4.6 Contribution to STM performance targets

SBNAS will increase voyage safety, especially in confined, sensitive, or densely trafficked areas as a preventive action. SBNAS could also improve cost-effectiveness and affect the cost of ownership per voyage by providing an economical alternative to non-compulsory deep sea pilotage. Navigation in sensitive areas can be decreased due to better support from operators with local knowledge.

Dependencies on other STM-services

• Voyage Information Service

• Route Exchange

• Area Management Service

• Flow Optimisation Service

• SeaSWIM Services

3.5 Single Reporting

3.5.1 Introduction

When utilizing SeaSWIM, the Voyage Information Service, and Route Exchange, there will be no need for ships to send several reports to different entities during a voyage, as all of the information is made available for authorized parties. In a long-term perspective, no reporting as such will be required, as the information only needs to be entered once and kept up-to-date as prerequisites changes. Related existing processes and services include Single Window initiatives and VTS-and SRS-reporting.

3.5.2 Objectives

Traditionally, some information is sent several times but in different formats and to different stakeholders at different deadlines. The objective with Single Reporting is to remove the need for ships to send similar reports multiple times during a voyage. This will also help to facilitate international trade by including trade data and documentation. The long-term and overall goal is to automate mandatory ship
reporting which will be possible when SeaSWIM is implemented and all information related to a ship’s voyage can be reached by all stakeholders with access rights to the information.

3.5.3 Description

National Single Windows, EC Directive 2010/65/EU (Reporting Formalities for Ships arriving in/departing from EU ports) are currently being implemented in EU-countries to simplify ships’ reporting by creating a single window for all reports to authorities related to a port call in the country. The purpose is to facilitate cross-border trading by submitting regulatory documents to a single entity. The AnNa project fosters a harmonized approach for administrative facilitation and includes the exchange of data between national (Maritime Single Window) networks. Annex C in the directive, concerning national specific legislation and reporting to ports, will not be harmonized in the first version.

The Single Window initiatives is a part of the single reporting, however, SeaSWIM provides additional functionality in that all the information related to a ship’s voyage can be reached by all stakeholders with access rights to the information. This is possible just by entering the information once and sharing it via SeaSWIM; there is no need for additional reporting as the information is already available. The UVID, which is unique for every voyage, will act as a pointer to the voyage information, including route; it can be used not only for reporting but also, for example, for the optimization of routes and ETA, for port reporting, and also for internal use, such as noon-reporting, as different stakeholders can be granted access to different parts of the information. When the information is updated (concerning, for example, the persons onboard, cargo, draft or next port of call), authorized stakeholders can get access to the new information or receive an automated report based on a given time or geo-location which is made possible by knowing the ship’s route.

Ship reporting to the VTS- and SRS-areas along the route can also benefit from the information, because as the ship, cargo and route information is available, there is no need for reporting to specific areas. Rather, these areas will automatically be given access rights to retrieve the information needed. Single reporting areas are under development in several e-navigation projects and these experiences will act as a basis for the development of automated information retrieval for the VTS- and SRS-areas.

3.5.4 Area of operation

The single reporting is not limited to a specific area; it is applicable on the whole voyage.

3.5.5 Actors

The following actors are identified as applicable in this service:

- Shipping companies: a ships’ crew enters ship reporting information only once. The ship needs to be STM compliant; in practice, it must have the functionality of route information exchange and to be able to connect to SeaSWIM.
• Entities using information from ship reports: all entities that receive information from ship reports, e.g. VTS-areas, ports, authorities, shipping companies themselves, and international traders.

3.5.6 Contribution to STM Performance Targets

The single reporting service will impact efficiency by reducing the administrative burden both onboard and shore-side. Less administrative burden will also help operators and OOW to focus on the safe navigation of the ship instead of reporting; this can thereby increase voyage safety by acting as preventive measure that will result in fewer accidents and incidents per year.

3.5.7 Dependencies to other STM-services

• Voyage Information
• Collaborator Nomination
• Voyage ID
• SeaSWIM Services
• Route Exchange
4 Conclusion

With the introduction of the Sea Traffic Management concept, Dynamic Voyage Management plays a vital role with the UVID and the RExF in making it possible to share unique routes between major key players such as ports, carriers, cargo owners, dispatchers, pilots, and other ships. The accuracy and verification of actions and intentions will raise the common situational awareness to a substantially higher level, and at the same time, it will increase the possibility of saving time and fuel, thus reducing emissions.

Optimizing the voyage with the RExF and UVID will change today’s slow, manual handling of data into a standardized, fast, and robust process where alterations will be visible for all service providers involved in the DVM process.

As a result of DVM and Sea Traffic Management, new business models are likely to appear with new kinds of service providers, challenging existing providers and even changing existing processes of reporting, arrival times and traffic separation schemes. These innovations can lead to shorter and safer routes and a safer flow of traffic, which can in turn save on both costs and emissions.
39 partners from 10 countries
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By designing and demonstrating innovative use of ICT solutions
MONALISA 2.0 will provide the route to improved

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