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Flow Management Description

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## Document Status

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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 of ships 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 shore organizations 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 (SeaSWIM)**, 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 as part of the **Flow Management** 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

This document describes the Flow Management (FM) concept. The scope covers ship traffic flow and operational services that will support both shore organisations and ships by optimizing the overall maritime traffic through areas of dense traffic or restricted waters. The two concepts for Voyage Management look at a ship’s individual voyages, but use information from FM when optimizing the specific routes.

The objective of this concept is to improve both the safety and the efficiency of the overall flow of traffic through better coordination and information sharing. It still leaves all of the final decisions with the Master of the ship, but enhances the operational decision-making process with information and advice about maritime traffic and safety. FM’s information will be provided to ships during the strategic planning and execution stages of their voyages.

The FM concept collects a number of operational services:

- Enhanced Shore-based Monitoring
- Flow Optimization
- Area Management
- Maritime Traffic Patterns Analysis

These services operate on different geographical scales. Area Management Service basically covers all waters; it divides the ocean and coastal regions into 21 NAVAREAS, which are geographical sea areas established for the purpose of coordinating the broadcast of navigational warnings (IMO, 2015). While Flow Optimization Service is only executed in specific areas, such as congested waters, narrow straits, and port approaches, the Enhanced Shore-based Monitoring Service is limited to specifically defined critical areas. The main objective of FM is to increase the safety and efficiency of navigation. However, Flow Optimization Service could also affect the efficiency of the maritime traffic flow.

3 Organisation

FM services could be methods and means for enhancing the execution of today’s VTS services such as the Information Service (IS), Navigational Assistance Service (NAS) and Traffic Organisation Service (TOS). Hence, while FM services would mainly be provided by national authorities, in some cases commercial service providers which are approved by a National Competent Authority (NCA) would also serve these needs. FM services could be provided by the following types of organisations:

- Port Traffic Control
- Ship Traffic Service (VTS)
- Ship Reporting Systems (SRS)
• Shore-based Service Centre (SSC)

The first three organisations already exist today. A possible organisation is depicted below in Figure 1.

![Diagram](image)

Figure 1: Possible organisation for the FM service providers.

Port Traffic Control and VTS are currently only implemented in territorial waters. In the future, FM services could also be implemented outside these sea areas (see, for example, §6, where the Maritime Service Portfolio (MSP) is discussed, and is then implemented as Shore-based Services under the operation of a Shore-based Service Center (SSC)). The different organisations have different geographical areas of operations. For example a SSC area is a geographical sea area outside a VTS areas or a Port traffic Control area. Seamless target handover is implemented between the different areas of operations.

4 Operational Services

This section describes the different operational services that together define FM. These services are:

• Enhanced Shore-based Monitoring
• Flow Optimization
• Area Management
• Maritime Traffic Pattern Analysis

The starting point is that all the above services are voluntary services.
4.1 Enhanced Shore-based Monitoring

4.1.1 Introduction
The technical enabler—the exchange of route information ship-to-shore and shore-to-ship—gives rise to new possible operational services which could increase the efficiency and/or safety of navigation. One example of this is the Enhanced Shore-based Monitoring Service which could be provided in well-defined critical sea areas. This service works solely in the execution phase of a ship’s voyages.

The ship’s route segment, which is inside the area of operation, is exchanged with a shore-based service provider.

4.1.2 Objectives
The objective of this operational service is to perform enhanced shore-based monitoring within a defined sea area in order to increase the safety of navigation. The major operational change when implementing this service will be to give a shore-side monitoring organization an enhanced traffic image consisting of the transiting ship’s planned route within specific geographical areas.

4.1.3 Service Provider
This service is provided by an authority or commercial service provider approved by an NCA.

4.1.4 Area Of Operation
The intention of this service is to operate in coastal regions within a critical sea area. This is a geographical area located within or outside a VTS area. However, the area is defined within a nation’s territorial waters or Exclusive Economic Zone (EEZ). Examples of criteria for critical sea areas are:

- Restricted areas with high traffic-density
- Environmentally-sensitive sea areas
- Oil, gas, wind or wave energy installation areas

Another type of critical sea area is denoted as a dynamic No-Go Area, with the criteria that it is only valid during a certain period of time or only valid for certain types of ships during a certain period of time. This type of critical sea area can also utilize enhanced shore-based monitoring.

4.1.5 Actors
The following actors have been identified as applicable for this service:

- **Shore-based operators**: this is an operator who performs the monitoring of the area of operation. If the critical sea area is located within a VTS area, the service is performed by a VTS operator within its normal service (IS, NAS, or TOS).
• **STM-compliant ships**: these have the relevant STM-compliant equipment and procedures implemented onboard, so that they can make full use of the STM concept. In practice, this means the ability to exchange information about a segment of the ship’s route plan with the shore-based operator.

• **STM non-compliant ships**: these are ships that are not participating in the STM process or do not have the relevant STM-compliant equipment.

### 4.1.6 Operational Description

A shore-based operator is monitoring a defined critical sea area or a dynamic No-Go-Area using:

- An enhanced traffic image defined as consisting of AIS targets and radar targets together, with the planned routes for the STM-compliant ships

- Automatic rule based anomaly detection

If a ship is detected to be heading towards danger, if a ship makes a major deviation from its intended route, or if a ship is entering a dynamic No-Go Area, the shore-based operator establishes a voice or text communication with the ship in order to inform the ship about the developing situation.

### 4.2 Flow Optimization

#### 4.2.1 Introduction

The technical enabler—the exchange of route information ship-to-shore and shore-to-ship—gives rise to new possible operational services which could increase the efficiency and/or safety of navigation. One example of this is the **Flow Optimization Service**, where the ship’s route segment information within the area of operation is exchanged with a shore-based service provider. This service could work both during the planning and the execution phases of a ship’s voyages.

#### 4.2.2 Objectives

The objective of this operational service is to perform traffic synchronization when necessary in restricted geographical sea areas with high traffic density, in order to increase both the safety of navigation and the efficiency of shipping traffic. If the traffic flow keeps within NCA-defined safety margins, no guidance from the shore is needed.

#### 4.2.3 Service Provider

This service is provided by an authority or commercial service approved by an NCA and is performed by a shore-based operator using the enhanced traffic image and decision support tools which include the exchange of route information.
4.2.4 Area of Operation

This service is intended to be operated in coastal regions within a specific critical sea area. This is a geographical sea area located within or outside a VTS area. However, the area is defined within a nation’s territorial waters or EEZ. Examples of criteria for these geographical sea areas are:

- Restricted areas with high traffic-density
- Port entrances with high traffic-density
- Fairways with high traffic-density
- Canals or inland waterways with high traffic-density

4.2.5 Actors

The following actors have been identified as applicable in this service:

- **Shore-based operators**: this is an operator who performs the monitoring of the geographical sea area of operation. If the critical sea area is located within a VTS area, the service is performed by a VTS operator within its normal service (IS, NAS, or TOS).

- **STM-compliant ships**: these have the relevant STM-compliant equipment and procedures implemented onboard so that they can make full use of the STM concept. In practice, this means the ability to exchange information about a segment of the ship’s route plan with the shore-based operator.

- **STM non-compliant ships**: these are ships that are not participating in the STM process or do not have the relevant STM-compliant equipment.

This operational service will only have full effect if all transiting SOLAS ships are STM-compliant.

4.2.6 Operational Description

A shore-based operator performs flow optimization by giving advice to ships within a defined sea area using:

- An enhanced traffic image defined as consisting of AIS targets, and radar targets together with the planned routes for the STM compliant ships.

- As a part of the route schedule, the operator has access to the ship’s ETA to some key waypoint; this is called the *flowpoint* (FPT).

- Based on the above information, the operator continually assesses the overall maritime traffic situation within his sector of responsibility. If a developing traffic situation is identified, the operator can recommend a new ETA for the denoted FPT in order to resolve the situation at an early stage.

- In case of an MSI receipt, e.g. a fairway or traffic lane is closed, the operator can use both re-scheduling and suggested routes (a proposed new route segment).
• In the case of a port approach, the approach could be synchronized with the port call.

The Flow Optimization Service could operate in different phases:
• The planning phase during the optimization of the overall route
• The execution phase during re-planning of the route
• The execution phase manually by an operator

In the future, the Flow Optimisation Service could be one of the many tools which could improve today’s VTS Traffic Organisation Service (TOS). This service is only implemented in a few VTS areas in territorial waters. Currently this service is not enhanced with information regarding ships’ intended routes.

4.3 Area Management

4.3.1 Introduction
The technical enabler—the exchange of geospatial information ship-to-shore and shore-to-ship—gives rise to new possible operational services which could increase efficiency and/or safety. One example of this is the Area Management Service.

4.3.2 Objectives
The objective of this operational service is to establish a Single Page for updated navigational information and especially maritime safety information. The information can be targeted to whom it concerns and bi-directional communication makes it possible to acknowledge the information and maintain traceability.

4.3.3 Service Provider
This service could be provided by a NAVAREA Coordinator, Sub-Area Coordinator or a National Coordinator.

4.3.4 Area of Operation
This operational service is intended to be used in all waters.

4.3.5 Actors
The following actors have been identified as applicable in this service:
• Coordinators: who are responsible for updating the area information and issuing navigational warnings and managing Dynamic No-go Areas.
• STM-compliant ships: these have the relevant STM-compliant equipment and procedures implemented onboard, so that they can make full use of the STM
concept. In practice, this means the ability to exchange information about a segment of the ship’s route plan with the shore-based operator.

- **STM non-compliant ships**: these are ships that are not participating in the STM process or do not have the relevant STM-compliant equipment.

### 4.3.6 Operational Description

Shore-based organizations continually update information about safety within their respective areas of responsibility. The information can be divided into:

- Legal and environmental requirements
- Nautical information
- Notices to Mariners
- Dynamic No-Go-areas
- MSI warnings
- Weather information
- Oceanographic information

Further, this service will provide a dynamic management of sea areas in time and space utilizing dynamic No-Go Areas. The criteria for a dynamic No-Go area is that it is only valid during a certain period of time or only valid for certain types of ships during a certain period of time.

### 4.4 Maritime Traffic Pattern Analysis

#### 4.4.1 Introduction

New information created by the STM concept can also be used in the evaluation process of one or several voyages. Historic data creates statistics which can indicate trends and measure Key Performance Indicators (KPIs). Maritime Traffic Pattern Analysis operates in the evaluation phase.

#### 4.4.2 Objectives

The objective of the **Maritime Traffic Pattern Analysis Service** is to create shipping traffic statistics over critical sea areas. The major operational change when implementing this service will be the planning of sea-area capacity using statistics from both planned routes and actual transit routes.

#### 4.4.3 Service Provider

This service could be provided by an NAVAREA coordinator, Sub-area Coordinator, or by National Coordinators.
4.4.4 Area of Operation
This operational service is intended to be used in defined critical areas.

4.4.5 Actors
The following actors have been identified as applicable in this service:

- **Area coordinators**: those who are responsible for collecting all possible historic data, generating statistics, and analysing the statistics for future decision-making.

4.4.6 Operational Description
All possible data products of the geographical sea area and the shipping traffic is collected and stored. Examples of relevant information are:

- MSI and safety warnings
- AIS data
- Planned routes together with actual routes which give the deviations

Examples of possible end-data products could be:

- The statistical routes and traffic density
- The number of spatial route deviations
- The number of temporal route deviations
- The number of close quarter situations
5 Interaction with Other Concepts

The table below describes FM services which interact; Strategic-, Dynamic-, Voyage Management, and PortCDM are identified and described.

*Table 1: Service interaction for FM services.*

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<tr>
<th>FM’s Operational Services</th>
<th>Other Concept’s Services</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Enhanced Monitoring</td>
<td>Shore-based navigation assistance</td>
<td>Navigational assistance requires Enhanced Monitoring</td>
</tr>
<tr>
<td>Flow Optimization</td>
<td>Route Optimization</td>
<td>Traffic could potentially be an optimization parameter in the overall optimization of the route; however, only with a real affect in congested areas where a “green wave” could be established.</td>
</tr>
<tr>
<td>Flow Optimization</td>
<td>Port Approach Synchronization</td>
<td>Flow Optimization and Port Synchronization could be integrated in the case that Flow Optimization is beneficial also for port operation.</td>
</tr>
<tr>
<td>Area Management</td>
<td>Strategic Voyage Planning</td>
<td>Updated regional information that supports the planning process as a Single Page.</td>
</tr>
<tr>
<td>Area Management</td>
<td>Route Checking (Validation)</td>
<td>A route segment is checked with respect to all relevant navigation and maritime safety information within one critical area.</td>
</tr>
<tr>
<td>Area Management</td>
<td>Route Optimization</td>
<td>Regional conditions and dynamic No-Go areas should be part of the overall optimization of the route.</td>
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6 Discussion

The MONALISA 2.0 project addresses aspects of the identified areas for Maritime Service Portfolios through its work on the Sea Traffic Management concept and its four enablers: Strategic Voyage Management, Flow Management, Dynamic Voyage Management, and PortCDM. Work on these will be further elaborated on in the STM
project, where such developments will be tested and demonstrated in both the established testbeds\(^1\) and in the European Maritime Simulator Network (EMSN).

[Insert a footnote * Refer to MSC.1/Circ.1494 dated 21 November 2014 on Guidelines on Harmonization of Testbed Reporting]

The main question when defining an FM concept for maritime traffic has been to decide at what level FM should manage traffic. The term Sea Traffic Management implies, of course, some kind of management. Basic ideas related to STM are:

- New methods and means to support the navigation process
- That ships perform reporting only once
- That Coastal States perform enhanced shore-based monitoring and maritime traffic flow optimization when or where it is needed

The FM concept has focused on advisory services and guidelines from the shore-side operator. In the future, the Flow Optimisation Service could be one tool of many to implement today’s VTS Traffic Organisation Service (TOS). This service is implemented in only a few VTS areas in territorial waters. Currently, this service is not supported by the ships’ intended routes.

There are discussions within the e-navigation community, as to whether a TOS can in future be implemented within an EEZ or in international waters. In the IMO’s Strategic Implementation Plan (SIP) approved by MSC 94 (NCSR 1/28, annex 7) as part of the improved provision of services to ships through e-navigation, Maritime Service Portfolios (MSPs) have been identified as the means of providing electronic information in a harmonized way.

The following six areas have been identified for the delivery of MSPs:

- Port areas and approaches
- Coastal waters and confined or restricted areas
- Open sea and open areas
- Areas with offshore and/or infrastructure developments
- Polar areas
- Other remote areas

Hence, this is also applicable for MSP 3: TOS. Other relevant e-navigation MSPs for the **Area Management Service** are:

- MSP 1 Information Service (IS)

\(^1\) They will be carried out according to MSC.1/Circ.1494 dated 21 November 2014 on Guidelines on Harmonization of Testbed Reporting. It is available on: [www.ics.org.ir/Downloads/CLD/News/MSC.1-Circ.1494.pdf](http://www.ics.org.ir/Downloads/CLD/News/MSC.1-Circ.1494.pdf)
• MSP 3 Traffic Organization Service (TOS)
• MSP 5 Maritime Safety Information Service (MSI)
• MSP 11 Nautical Chart Service
• MSP 12 Nautical Publications Service
• MSP 15 Real-time Hydrographic and Environmental Information Service

MSP 5 should include dynamic No-Go areas, where a MSI* safety message or safety warning is connected to a geographical sea area.

NOTE:
MSI means the internationally and nationally coordinated network of broadcasts containing information which is necessary for safe navigation. This is the definition as contained in MSC.1/Circ.1288/Rev.1 dated 24 June 2013, which became effective on January 1, 2015.

NOTE:
In the approved IMO SIP, there is a list of 16 proposed MSPs (NCSR 1/28, annex 7, Table 6). IMO’s Maritime Safety Committee at its ninety-fifth session (MSC 95) in May 2015 considered document MSC 95/19/8, annex 6 (Australia et al.). This document proposed the consideration of reports on development and implementation of Maritime Service Portfolios (MSPs) and other e-navigation reports from Member States and other international organizations, and included proposals to deal with the remaining non-prioritized potential e-navigation solutions (documents MSC 95/19/14 [IHO] and MSC 95/19/15 [IMPA]), and comments on the proposal. The majority of the Committee was of the view that the proposal did not comply with the Guidelines on the Organization and Method of Work of the Maritime Safety Committee and the Marine Environment Protection Committee and their Subsidiary Bodies (MSC-MEPC.1/Circ.4/Rev.3). However, recognizing the importance of e-navigation and that the Organization should take a leading role, they invited Member Governments to prepare a full justification for this output in accordance with the information required in annex 3 to resolution A.1062(28), and to submit it to MSC 96 for consideration. The delegation from Norway agreed to coordinate the work with interested parties and submit a revised proposal for consideration at MSC 96 (11 to 20 May 2016).

MSPs are a key part of the e-navigation strategy as the basis for ship-to-shore service provision; hence, harmonization of services and systems around the world is a priority.

7 Conclusion
The overall objective of the Flow Management (FM) concept is to increase the safety of navigation and, in some specific geographical areas, the efficiency of the maritime traffic flow. FM operates on the overall maritime traffic flow within a geographical area and collects and manages all relevant information not only within that specific area but also in the surrounding waters. More precisely, the aim of the FM concept is
to optimize and increase the navigational/operational safety of maritime traffic flow during all of the planning and executing phases of the voyage. Optimization of maritime traffic is achieved by using the advice, not control, of STM technical enablers; hence the final decision is always left to the Master.
8 References

IMO, IMO’s circular - COMSAR.1/Circ.51/Rev.6 dated 10 February 2015.


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