

# **MONALISA in ICE (MICE)**

## **– A Practical Approach to Sea Traffic Management in Ice Operations**

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### **ABSTRACT**

The Arctic Sea holds some of the richest and most diverse marine life on our planet and is extremely vulnerable to change. With transit now feasible through the northern sea routes new challenges will be posed in the Arctic. The shorter routes for maritime transport that are emerging from the retreating ice will help reduce global emissions, but we need to make sure that the environment is kept safe. The need to monitor and assist shipping in these areas is vital.

MICE (MONALISA in Ice), is the designation of a research and development project being conducted in cooperation between the Swedish Maritime Administration (SMA) and the Chalmers University of Technology (Chalmers). MICE is aimed at capitalising on the more wide-ranging MONALISA and MONALISA 2.0 projects, which both are led by SMA, defining the Sea Traffic Management (STM) concept. STM offers a solution to the need for improved situational awareness in the Arctic region, here denoted the MICE concept. Ships' voyage plans are exchanged with the shore-based service centre in a hand-shaking procedure. Changes can be suggested based on the latest information about weather, ice conditions or the ever changing needs and behaviour of marine wildlife.

MICE helps to optimise icebreaking operations as the ice breaker can send information about newly broken routes directly to the ship's navigational system. Further, the icebreaker also works as a local base station for monitoring surrounding ships, providing a high real time situational awareness on land – also in areas which are out of reach for regular Automatic Identification System (AIS) base stations and radio communications.

The MICE concept was successfully tested on the SMA's icebreaker Oden during her summer expedition to the Arctic in August 2013 and 2014. Oden's whereabouts were monitored by VTS operators in Sweden and her intended routes were known in advance. MICE provides a solution for the necessities of improved sea traffic monitoring, coordination and support in the Arctic region.

### **KEYWORDS**

MICE, MONALISA, ice operation, ice navigation, sea traffic management, and route exchange.

### **INTRODUCTION**

Ice navigation and especially navigation in the Arctic are difficult and challenging modes of navigation. Both crews and ships are more exposed to high risks and dangerous situations, [1]. This includes sailing in remote areas with possibly insufficient infrastructure for communication, positioning, Search and Rescue (SAR) units and exposed for a harsh environment with highly dynamic conditions affecting the visibility, wind, sea state and ice conditions. Increased shipping in the Arctic could lead to larger risks for accidents and pollutions in environmental sensitive geographical areas. Hence, with more activities in these remote regions, the need for awareness of traffic will increase, [2]. By an enlarged degree of connectivity and situational awareness enabled

by MONALISA in Ice (MICE), the most optimal routes could also be taken with high safety and efficiency, and a low environmental footprint.

The purpose of this paper is to present findings from the MICE project, which combines a number of issues raised within ice operations utilising the basic concept developed in the EU TEN-T MONALISA and MONALISA 2.0 projects - the Sea Traffic Management (STM). STM is defined for shipping in general, but has a strong potential in providing specific applications for e.g. ice navigation and Search and Rescue (SAR) operations.

The MICE project is a feasibility study conducted in cooperation between the Swedish Maritime Administration (SMA) and the Chalmers University of Technology (Chalmers). The study has focused on improved situational awareness in the Arctic and Baltic ice regions. However, this paper is focusing on the findings which are applicable for the Arctic regions.

## **SEA TRAFFIC MANAGEMENT**

STM is a proposed concept with the aim to increase safety and efficiency in operations within and between ports, [3, 4]. The concept takes a holistic approach to operational services and processes by setting the berth-to-berth voyage in focus and uses that as a core element for process optimisation, actors and stakeholder interaction, and information sharing. More sharing of information ship-to-ship, ship-to-shore, and shore-to-shore would be an important enabler for increased situational awareness potentially leading to more efficient and safe sea transports. Improved safety is based on an increased ship-to-shore interaction which is achieved by right information at the right time to the right recipient. Sea Traffic Management is enabled by extending the time horizon, i.e. enabling sharing of information throughout the berth-to-berth voyage between nominated stakeholders, and adopting a unique voyage identifier. As one example, shore based organisations can contribute considerable by adding valuable information, recommendations and advice based on:

- An enhanced traffic image, which can be used to detect potential collisions, groundings and traffic congestions alerting vessels; and
- Updated regional information and effective way of informing ships about potential hazards.

One example on information exchange and sharing is the exchange of the ship's intended route. When exchanging route information large focus need to be put on commercial, legal and information security aspects. Main principles could be:

- Exchange of the whole route for optimisation; and
- Only exchange of segment of the intended route for ship-shore interaction.

STM builds upon continuous real-time based information sharing about intentions and actual achievements among maritime actors. The operational services are organised into four strategic enabling concepts, which are [3]:

- PortCDM (Collaborative Decision Making) [4], in which the process for arrivals and departures is made more efficient through information sharing, common situational awareness and improved processes;
- Strategic and Dynamic Voyage Management, which deals with route planning and route optimisation; and
- Flow management, which includes services that will support both land organisations and ships in optimising overall traffic flow through areas of dense traffic and areas with particular navigational challenges.

where all of these build upon:

- Information sharing by Sea System Wide Information Management (SeaSWIM), a common framework for information sharing and service distribution for maritime activities to be adopted by different infrastructural providers.

Further, STM relates to existing practices and initiatives e.g. the International Maritime Organisation's (IMO's) e-navigation strategy, [5].

## MONALISA IN ICE (MICE)

This feasibility study has made an operational analysis of ice operations and particularly identifying the information needs during ice navigation. The STM concept is used to fill the identified gaps in the information flow during these types of operations. Further, the proposed solutions need to be user driven. The Guidelines on Human Centred Design (HCD) for e-navigation systems [6], which were adopted by IMO Maritime Safety Committee (MSC) 95, 2015, has been used as reference. The main services and decision support tools have been used during simulations in advanced ship simulators for usability testing. Communication and information exchange have been tested in field trials. The study's operational context has been to focus on navigation in ice infested waters, especially in remote areas. Both the strategic phase, including the forward-looking plan, when the ship is still outside the ice regime and the tactic phase, including the follow-on in-area plan, starts when entering the ice regime has defined in [7].

Sweden and Finland has a long experience, since the 1970's, of keeping all year around shipping going in the northern parts of the Baltic Sea and the Bay of Bothnia. During these 40 years Swedish and Finnish ice breakers has gained a long experience in escorting merchant ships in first-year ice. In the long term it is possible that these experiences will be valuable if new traffic patterns in the Arctic region start to form. This knowledge and experience have been incorporated in the study.

Some of the STM operational services were adopted for ice navigation and are here denoted as the MICE concept. The MICE concept could support both the strategic and tactical phases in ice navigation using route exchange as a technical enabler. If also an enhanced information management is established, the following operational services could be implemented:

- route optimisation;
- enhanced monitoring; and
- remote assistance.

In more detail:

- Ships' voyage plans could be exchanged with the shore-based service provider or an icebreaker in a hand-shaking procedure. This would give shore-based operator or the icebreaker a comprehensive situational awareness enabling them to verify that routes are followed, provide early warnings to ships and stakeholders, and to identify elevated risk situations to be used for improvement of operation.
- Route recommendations can be suggested based on latest information; weather, ice, wildlife, etc. in combination with decision support using table top multi-touch screen as a bridge planning station.
- Optimise icebreaking operations, as the icebreaker can send information about newly broken routes directly to the ship's navigational system.

Further, the above operational services could also support a SAR or pollution response operation in an ice infested region.

Information technology is of great importance in the work of the icebreakers and ships conducting ice operations. One example is given in the picture below, where the bridge crew of the Swedish icebreaker Frej is seen gathered in front of a monitor to look at the latest update of the satellite picture of the ice in the Bay of Bothnia, [8]. The rest of the charted information is on the rightmost screen in the picture, where the ECDIS

screen is. The ECDIS has no way of displaying the satellite picture on top of the chart information (left image in Fig 1.).



**Fig 1. Left, the bridge team on the icebreaker Frej looking at the fresh satellite photo. Right, using an interactive table is facilitating collaborative team working on ice management and navigation. (Photo: T. Porathe). [8]**

New methods of collaborative work need to be found instead of crowding around the limited space of a 21 inch monitor lacking much of the needed information. Using state of the art table top multi-touch screens might be a way forward allowing large amount of data to be overlaid and manipulated in an accessible collaborative area. Such a table top back bridge planning station opens great opportunities for data integration and cognitive off-loading using a single work space (see the right image in Fig 1.).

## **PRACTICAL TRIALS**

The MICE concept has been tested in two different set of test campaigns. In the first communication of routes between ship and shore was successfully tested on the Swedish icebreaker Oden during her summer expeditions to the Arctic in August 2013 and 2014. During these tests Oden's whereabouts was monitored by Vessel Traffic Service (VTS) operators in Sweden and her routes were known in advance. The communication was performed via an Iridium satellite link proved very stable throughout Oden's Arctic expeditions and with a system latency of only 2-5 seconds. In Oden's 2014 expedition, the data collection also included the ship's surrounding AIS targets.

Further, the concept of dynamic ice routes implemented as route exchange between ship-to-shore, ship-to-ship, where demonstrated and tested at Chalmers' Simulator Centre using an advanced TRANSAS NAVISAILOR 4000 ship simulator. The use of dynamic ice routes were tested with experienced icebreaker masters as operators. Tests were performed during two occasions in November 2014 using two ship bridges equipped with corresponding software supporting route exchange. One of the bridges was equipped with a table top multi-touch screen. The following scenarios were executed:

- **A normal ice breaking situation** - A merchant vessel gets stuck in the ice and is supported by the icebreaker.
- **Route exchange** - Merchant vessels are transiting in ice covered or partially ice covered waters and at some points get stuck. The beset vessel is assisted by the icebreaker and receives an additional suggested or recommended route in order to continue its voyage to a specific destination.
- **Change of convoys** – Two icebreakers are transiting in ice covered waters and should exchange convoys, the different ice breakers use its historic tracks and create a own route based upon its previous tracks in the other direction.
- **Ice breaking management and coordination of resources** - A number of vessels in operating in ice and the icebreakers are coordinated to assist or by providing different route recommendations for the merchant vessels by a main coordinator.

During the second scenario when route exchange was simulated and the recommended route appeared on the merchant vessel's navigation display it was concluded that the icebreaker needs extensive information about the vessel in order to be able to give good recommendations and advise. For instance, the vessel's draught, ice class, power capabilities, crew experience and ballast condition would be important input for be able of giving route suggestions.

If this data is known and could be incorporate and then compared with updated satellite images, ice and weather conditions, other historic tracks or ice channels a more detailed, safe and accurate route can be suggested. Further, it's important that the merchant vessel validates the suggested route after receiving one. It should not replace the master's judgment and it should come with an underlying recommendation. Ice routes are dynamic and vessel's masters and officers should always evaluate the conditions and possible changes in the ice that they are facing.

## NEXT STEPS

After the success of the MICE study, SMA and Chalmers have looked at ways to move the ice aspects of STM further. Two actions already in place are the integration in two newly started projects.

In the EU HORIZON 2020 project EfficienSea II, the MICE concepts and results will be integrated with the Arctic web. The Arctic web is a common information platform developed by the Danish Maritime Authority. By sharing and showing routes, safer passages can be planned, for example by minimising distances to nearest vessel. By using some vessels as "base stations" for AIS, more accurate data will be displayed.

In the EU Motorways of the Sea project STM Validation, the route exchange function and especially the exchange of recommended ice routes will be tested in the Baltic Sea. Since this area has one of the most frequent use of icebreaking for merchant ships, the feedback will help building experience and models that can be applied worldwide.

## CONCLUSIONS

MICE is a feasibility study performed by SMA and Chalmers with the aim at making a concrete contribution to efficient, safe and environmentally friendly maritime transport in the Arctic, capitalising on the more wide-ranged STM concept. STM offers a solution to the need for improved situational awareness in the Arctic by facilitating exchange of ships' voyage plans with the shore-based service providers in a hand-shaking procedure. Changes to the route can be recommended based on the latest information about weather, ice conditions or the ever changing needs and behaviour of marine wildlife. Execution of the agreed voyage plan, called the dynamic route, is then monitored in real time on-board and on shore.

The concept could offer solutions meeting the need for improved *situational awareness* in ice regions:

- The dynamic ice route concept assists ships in creating the most environmental and cost effective voyage;
- Permits monitoring of maritime traffic without the need for shore-based infrastructure; and
- Increased decision support in ice operations and management.

Findings from this study can provide key insights for supporting safe and efficient shipping in the Arctic regions.

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