

# AIS Binary Messages – Developments in the Baltic and Progress in IMO

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## **ABSTRACT**

The Automatic Identification System (AIS) is a powerful tool for ship identification and tracking. However, AIS could be exploited more efficiently to improve the preparedness of the authorities in case of an accident and the situational awareness onboard ships as well as reduce the workload on ship bridges by minimising the need for VHF communication and facilitating the fulfilment of reporting obligations. In the Baltic AIS trial project (AISBALTIC), five new AIS Application-Specific Messages, also known as binary messages, were developed based on the operational needs of the authorities in the Baltic Sea countries. The worldwide development work was coordinated by a Correspondence Group established in 2008 by the International Maritime Organization (IMO). As a result, the IMO Sub-Committee on Safety of Navigation prepared in 2009 a new draft SN Circular to guide the use of 15 new and two previously published AIS Application-Specific Messages.

## **RESUME**

*Le Système d'Identification Automatique (AIS) est un outil puissant pour l'identification et le suivi des navires. Toutefois, l'AIS pourrait être exploité de manière plus efficace afin d'améliorer la préparation des autorités en cas d'accident et la conscience de la situation à bord des navires tout en réduisant la charge de travail sur la passerelle de commandement en diminuant le plus possible le besoin de communication VHF et en facilitant l'exécution des obligations de rapport. Dans la Baltique le projet d'essai de l'AIS (AISBALTIC), cinq nouveaux « AIS Application-Specific Messages », aussi appelé messages binaires, ont été développés en fonction des besoins opérationnels des autorités des pays de la mer Baltique. Le travail de développement mondial était coordonné par un Groupe de travail par correspondance créé en 2008 par l'Organisation Maritime Internationale (OMI). En conséquence, le sous-comité de la sécurité de la navigation de l'OMI a préparé en 2009 une nouvelle ébauche de circulaire SN pour aider à l'utilisation de 15 nouveaux « AIS Application-Specific Messages » et de deux précédemment publiés.*

## 1. INTRODUCTION

The Automatic Identification System (AIS) is a mandatory piece of navigational equipment for automatic data exchange between ships and with shore-based facilities. The aim of AIS is to improve safety at sea by assisting target tracking and simplifying information exchange. The VHF radio frequencies used in AIS data transmission have limited capacity, and therefore the transferred information is arranged as 26 standardised message types with carefully chosen contents [1]. Whereas the other messages have a fixed structure, there are two message types, Binary addressed message (Message ID 6) and Binary broadcast message (Message ID 8), for which multiple content structures can be defined. They are commonly called binary messages which is, however, somewhat misleading, since all AIS messages are coded in binary form. Therefore, the term Application-Specific Message is used as recently established in the International Maritime Organization (IMO).

The potential offered by the flexibility of the Application-Specific Messages has not been fully exploited. IMO had only published seven Application-Specific Messages for international trial use for the period 2004-2008 [2]. This paper describes recent efforts by the Baltic Sea countries and IMO to enhance the use of AIS by exploiting the Application-Specific Messages more efficiently.

The paper is organised as follows. Section 2 presents the background of Application-Specific AIS Messages. Section 3 describes the work done in the Baltic AIS trial (AISBALTIC) project and Section 4 the work by IMO's Correspondence Group on AIS Binary Messages. Section 5 presents progress and decisions at the 55<sup>th</sup> session of IMO's Sub-Committee on Safety of Navigation (NAV55). Section 6 concludes the paper.

## 2. BACKGROUND

After IMO established the mandatory carriage of AIS, the Maritime Safety Committee (MSC) gave guidance for the use of internationally agreed Application-Specific Messages in SN Circular 236 [2] in May 2004. The intention was to facilitate their use for a trial period of four years. Seven trial messages were developed based on operational needs and current technical possibilities. In addition, four system related messages defined in the ITU standard for AIS [1] were selected for the trials. During the test period, mainly two messages were tested and evaluated in the Baltic Sea, one of the most active testing areas: Meteorological and hydrological data (shore to ship) and Number of persons on board (ship to shore).

The testing showed the potential of Application-Specific Messages. In addition, the messages were appreciated by the users. Despite initial efforts by the AIS manufacturers, the main obstacle for a successful implementation and use of the messages was the lack of a standardised operator interface onboard, both for the display of received information and for the input of information to be transmitted from the ship.

Both the Application-Specific and other AIS messages contained information defined in a less than optimal form or even based on outdated definitions [3], while other relevant information was totally lacking. Therefore, it was foreseen that AIS could be exploited more efficiently by amending the trial messages and introducing new ones. This would enhance the communication between ships and shore thus improving the level of maritime safety and the protection of the environment.

In 2007, the Baltic AIS trial (AISBALTIC) project led by VTT Technical Research Centre of Finland was founded in order to improve the information content in AIS. The whole Baltic

Sea region was involved in the project which reported its results, including new Application-Specific Message proposals, to IMO in 2009.

In 2006, MSC82 put guidance on the use of AIS Binary Messages on the agenda for NAV according to a proposal of Sweden, in order to evaluate the trials and update the earlier guidance [2]. The completion date was 2009. Message proposals and descriptions of the development work were submitted to NAV 54 (2008) by Japan [4, 5], USA [6], Finland and Estonia [7] and Sweden [8]. The Sub-Committee decided, as proposed by Sweden [8], to set up an intersessional Correspondence Group on AIS Binary Messages (CG) to coordinate the progress on AIS messaging and report to NAV55 in 2009.

### **3. THE BALTIC AIS TRIAL (AISBALTIC) PROJECT**

VTT Technical Research Centre of Finland, the Finnish<sup>1</sup>, Swedish and Estonian Maritime Administrations, the Finnish Environment Institute and the Finnish Coast Guard launched a project called the Baltic AIS trial (AISBALTIC) in May 2007 to improve the information content in AIS. (For a short summary, see [9].) The aim of the project was to enhance the use of AIS Application-Specific Messages in information exchange between vessel traffic and authorities. The technical usability of the AIS Application-Specific trial Messages [2] was tested and their information content evaluated. Furthermore, a thorough information need survey was conducted among the maritime authorities in the Baltic Sea countries to assess what information could be relevant to introduce into AIS. Based on the survey, new messages were designed. From the beginning, it was decided that the whole Baltic Sea region should be involved in the project and the results should be reported to IMO. The project, finished in 2009, is a part of the HELCOM<sup>2</sup> Baltic Sea Action Plan.

#### **3.1 Testing the Trial Application-Specific Messages**

The technical usability of the trial messages was tested and their information content evaluated in field tests between the Helsinki GOFREP Traffic Centre and dedicated vessels in the Gulf of Finland. The tests included applications 1, 2, 3, 5 and 7: Meteorological and hydrological data, Dangerous cargo indication, Fairway closed, Extended ship static and voyage related data and Pseudo-AIS targets. Five ships equipped with laptop computers connected to the AIS through the Pilot Plug with dedicated software for sending and receiving the messages, participated in the tests.

According to the field tests, the trial messages contained relevant information, albeit not in an optimal form. E.g. the proper interpretation of the radius parameter in the Fairway closed message was unclear and the message could be further generalised. The Dangerous cargo indication message involved reporting of one main dangerous good with no instructions on how to determine which dangerous good is the main one. The message was neither compatible with all codes for dangerous cargo.

The older versions of navigational systems were not compatible with the messages. Onboard certain vessels not participating in the tests the integrated bridge system generated alarms when being passed broadcasted trial messages from the AIS equipment. Furthermore, the tests revealed that the Pilot Plug, although being part of the mandatory equipment, was not always coupled properly.

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<sup>1</sup> The part of the Finnish Maritime Administration participating in AISBALTIC is now part of the Finnish Transport Infrastructure Agency.

<sup>2</sup> Baltic Marine Environment Protection Commission

### 3.2 From Information Need Survey to New Application-Specific Messages

To assess the need for amendments to the AIS messages, a thorough survey was conducted. A preliminary national trial was carried out in Finland. Based on this experience, an international survey among the authorities in the Baltic Sea countries was structured as depicted in Figure 1. To ensure a high quality of the survey results, a set of four workshops was arranged. The workshop approach activated the participants and encouraged interaction and made the explanation of the methods and purpose of the study easier. A computer aided working method [10] was chosen to make the workshops more efficient, enable a large group of participants and add the possibility to work over the Internet. Two workshops were face-to-face sessions and two held over the Internet, so that people could participate at any time from any place during a set time period.

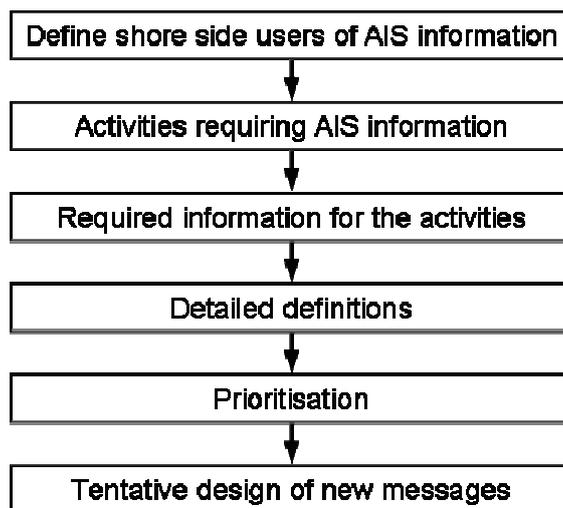


Figure 1 Structure of the international information need survey.

The workshops were organised in cooperation with HELCOM and participants were invited mainly through the HELCOM contact persons of each country. The survey results can be considered extensive and reliable because the participants represented a variety of authorities dealing with marine issues from nearly all Baltic Sea countries. All in all, 42 persons from Finland, Sweden, Norway, Denmark, Estonia, Lithuania, Poland, Germany, European Maritime Safety Agency, European Commission and HELCOM participated in the workshops, the subsequent working groups or by active email correspondence. They represented authorities responsible for maritime safety, search and rescue, environment and pollution preventing and combating as well as maritime security.

In the first workshop it was commonly agreed, that all participants can be interpreted as the competent AIS using authorities referred to in the AIS performance standards [11]. To achieve a complete description of the AIS information needs, the study started with identification of all the activities of the competent authorities requiring AIS or whose performance would be significantly improved if relevant information was available through AIS. The information needed for each activity was identified and more precisely defined resulting in a long list of potentially relevant information divided according to the activities. Since certain information is relevant for several activities, the information items were regrouped into logical categories (see Table 1) and prioritised by voting.

Table 1 Information categories

Information category	Number of identified information items
Ship information	24
Persons onboard	3
Management of ships' contact information	6
Cargo and bunker oil onboard	18
Pilotage	3
Route and timetable information	6
Route planning (including ice conditions)	8
AtoN information	9
Meteorological and hydrological information	35
Geographical area	7
Emergency and response operation management	13
Ship reporting	2
Safety warnings	8
Pilot Boarding	5
Port State Control	3
Security	3
<i>Total</i>	<i>153</i>

The survey indicated a need for changes in the existing AIS messages [1, 2] and introduction of new ones. Potential areas for improvements were identified: More accurate information on dangerous cargo was desired. The cargo information in the Static and voyage related data message is based on outdated definitions (see [3]) and the trial Application-Specific Message on dangerous cargo allows only reporting of one cargo. The Meteorological and hydrological data trial message was regarded inflexible, including information from one location only. Amendments of the ship type definition were also called for. The Extended ship static and voyage related data trial message could be extended with other relevant data than the currently contained air draught. In addition, new messages for communicating information concerning a specified geographical area or route were proved to be needed.

After the workshops, the work on transforming the identified information needs into new Application-Specific AIS Messages was continued in three working groups. All participants from the workshops were invited, but only experts from Finland, Sweden and Norway took part. The working groups developed three new Application-Specific Message proposals: Dangerous cargo indication, Extended ship static and voyage-related data and Area, route or positions to be noticed.

In October 2008 the three message proposals were submitted to the CG. Because of obvious similarities in area messages proposed by the AISBALTIC project and the United States RTCM's Ad Hoc Working Group on Expanded Uses of AIS, the two messages were merged in a common effort to produce three new ones.

Table 2 New Application-Specific Messages developed in the AISBALTIC project.

Message	Transmission type	Content
Dangerous cargo indication	Addressed	Total amount of dangerous cargo (in kg, tonnes or thousand tonnes) and the codes, classes, divisions or categories under which the cargo is carried, reported using the relevant code (IMDG, MARPOL Annex II IBC Code, IGC Code, MARPOL Annex I List of oils or IMSBC Code).
Extended ship static and voyage-related data	Broadcast	Several static and voyage related information items. E.g. air draught, ports of call using UN/LOCODE, ship types using Lloyd's Register Fairplay Statcode 5, ice class and bunker oil.
Area notice	Addressed or broadcast	Multiuse message for communicating time-dependent information concerning a specified geographical area, polyline or positions. E.g. caution or distress areas or traffic instructions.
Route information	Addressed or broadcast	Time-dependent route information in the form of waypoints.
Text description	Addressed or broadcast	Free text message designed to be attached to another Application-Specific Message for additional information.

The five final messages compiled in the AISBALTIC project are presented in Table 2. The new Dangerous cargo indication message was designed as a compromise between the desire for detailed information by the various authorities and what was seen reasonable to ask the navigators to fill into the system. The message contains the total amount of dangerous cargo and the divisions, classes or categories the cargo belongs to.

The new Extended ship static and voyage related data message contains several parameters too generally defined or even lacking from the current AIS. One clear improvement is a more detailed ship type definition. Another advantage is ports of call reported using UN/LOCODE [3, 12] which, in combination with a proper user interface, is much more reliable and easier to understand both by humans and machines than free text. The message contains also other relevant parameters such as ice class and type and amount of bunker oil.

The Area notice message was designed for communicating time-dependent information concerning a specified geographical area, polyline or positions. The message is versatile and can be used e.g. to inform on caution or distress areas. The Route information message can be used to transmit route information in the form of waypoints either from ship to shore or shore to ship. Both the Area notice and Route information messages are intended to be displayed on the Electronic Chart Display and Information System (ECDIS). The Text description message was designed to be attached to another Application-Specific Message to give additional information in the form of free text.

Hence, the efforts in the AISBALTIC project resulted in five messages. The messages were submitted both to the CG as the final view of the project and proposed to IMO NAV55 in July 2009 for international adoption in a joint submission by Denmark, Estonia, Finland, Latvia, Lithuania, Poland and Sweden [13].

#### 4. INTERSESSIONAL CORRESPONDENCE GROUP ON AIS BINARY MESSAGES

The CG was established by NAV54 with the task to revise the Guidance on the Application of AIS Binary Messages [2]. Under the coordination of Sweden, the CG included representatives from 14 flag states (Australia, Canada, China, Denmark, Finland, Germany, Japan, Marshall Islands, Netherlands, Norway, Singapore, Sweden, Turkey and USA), and two inter-governmental organisations (International Hydrographic Organization and World Meteorological Organization).

The work of the CG was divided into seven subtasks:

1. Development of criteria for the selection of international Application-Specific Messages.
2. Development of guidance for the use of Application-Specific Messages with respect to the technical limitations and risk of hampering the main function of AIS.
3. Collecting proposals for AIS Application-Specific Messages, evaluating, possibly modifying and defining the information content.
4. Selection of messages to be proposed for implementation by the CG.
5. Considering the display issues and proposing possible solutions. Here must also the means for entering information onboard be considered.
6. Designing the messages in detail
7. Evaluating the need for additional communication capacity.

The CG concluded that international Application-Specific Messages should be designed for purposes that serve shipping in general, not only regional or closed user groups, thus requiring an internationally agreed data format. The information content should enhance the safety of life at sea, the safety and efficiency of navigation, the protection of the marine environment and be able to be effectively and usefully displayed by an appropriate user interface.

For transmissions from ships to shore or other ships, the Application-Specific Messages should in addition help to reduce the workload onboard by reduced manual reporting. This could be achieved by e.g. information from sensors or systems connected to AIS and transferred with low or none manual effort or information that can be entered in advance and automatically transferred to shore or other ships on request.

The CG further concluded that any deterioration caused by overloading of the VHF Data Link (VDL) by transmitting Application-Specific Messages or other transmissions from the shore would primarily effect the shore-based monitoring function. However, since the function of AIS for relatively short distances is quite robust, the ship-to-ship anti-collision function would not be affected.

To determine if the VDL load is impairing the main function of AIS, the received throughput rate of messages from ships in the coverage area can be compared with the reporting rate that is required for the intended use of the AIS information. If the received reporting rate is considered to be too low, the cause may be a high load on the VDL by different types of transmissions from the shore stations.

Regarding the portrayal of the messages, the CG concluded that it would be premature to propose specific display standards for AIS Application-Specific Messages. More experience is needed to determine how AIS Application-Specific Message information should be displayed in conjunction with other chart-related and operational information. Furthermore,

the display of AIS Application-Specific Message information should conform to the concept of operation envisioned for e-Navigation.

The CG considered the need for additional means of communication. The need for data communication capacity is presently studied in the work on the implementation plan for e-Navigation. Although the results of these studies are not yet available, it seems obvious that the present AIS cannot accommodate the future communication needs. Several different technical solutions, or combinations of solutions, are possible. AIS may be part of the solution, for example Application-Specific Messages can be used for channel management of other communication systems that are using local frequencies.

New and modified messages were proposed to the CG by the AISBALTIC project, USA and Japan. The CG considered these together with the existing trial messages [2]. After an intensive work and with a spirit of cooperation, the CG agreed on a set of Application-Specific Messages to be recommended for international use. The best ideas from the different participants were merged together and combined to messages that met the requirements of all. The group reported as requested to NAV55 [14].

## 5. PROGRESS AT THE 55<sup>TH</sup> SESSION OF IMO SUB-COMMITTEE ON SAFETY OF NAVIGATION

The report of the CG was considered by a drafting group at NAV55 (July 2009) in order to develop a new draft SN Circular on guidance on the use of AIS Application-Specific Messages. The basis for the work was the report from the CG which was supported by a submission by seven Baltic Sea countries reporting the results of the AISBALTIC project [13]. Only minor changes were made to the proposal from the CG during the work at NAV55. The resulting list of messages is given in Table 3.

*Table 3 AIS Application-Specific Messages recommended for international use.*

Message Name	Identifier	Comments
Meteorological and hydrological data	11	SN/Circ 236 Trial Message 1*
Dangerous cargo indication	12	SN/Circ 236 Trial Message 2*
Fairway closed	13	SN/Circ 236 Trial Message 3*
Tidal window	14	SN/Circ 236 Trial Message 4*
Extended ship static and voyage related data	15	SN/Circ 236 Trial Message 5*
Number of persons on board	16	SN/Circ 236 Trial Message 6; corrected
Pseudo-AIS targets VTS-generated/synthetic targets	17	SN/Circ 236 Trial Message 7; renamed to "VTS-generated/ synthetic targets"
Clearance time to enter port	18	New
Marine traffic signal	19	New
Berthing data	20	New

Weather observation report	21	New
Area notice – broadcast	22	New
Area notice – addressed	23	New
Extended ship static and voyage related data	24	New
Dangerous cargo indication	25	New
Environmental	26	New
Route information - broadcast	27	New
Route information - addressed	28	New
Text description - broadcast	29	New
Text description - addressed	30	New
Meteorological and hydrographic data	31	New
Tidal window	32	New

\* not to be used after [1 Jan 2013]

The new draft SN Circular [15] contains 15 new messages some being very flexible and usable for many different purposes. The drafting group proposed that five trial messages [2] are replaced by improved versions and two transferred to the new draft SN Circular with only editorial corrections.

The draft was approved in principle by the Sub-Committee, but the drafting group pointed out that due to the time constraint, some information was still missing and the secretariat was tasked to make some refinements and introduce clarifications. A small group volunteered to assist the secretariat in this work, which was finished in September 2009. The draft SN Circular will be submitted from NAV to MSC87 for approval in May 2010.

## 6. CONCLUSIONS

The relevance of the results of the AISBALTIC project and the IMO CG is mainly based on cooperation between different maritime authorities and countries. This ensured the comprehensiveness of the results.

One of the starting points for the AISBALTIC project was the increased workload caused to navigators by inconsistent and frequent reporting requirements set by national vessel traffic services (VTS) and national or multinational ship reporting systems (SRS). The burden caused by reporting can be minimised and distribution of relevant information to navigators increased by improving automated, non-verbal communication between ships and shore stations and harmonising the reporting requirements enabling limited reporting from ships by introducing extensive information exchange between authorities. Some argue that due to the differences in reporting requirements by different VTS, SRS and other maritime authorities, the AIS Application-Specific Messages cannot be defined to meet all the requirements. On the contrary, the authors believe that by compiling messages accommodating the

information needs of various authorities e.g. responsible for the operation of VTS and SRS, the new messages will promote the standardisation of reporting requirements.

As the present user interfaces do not support the displaying of the AIS Application-Specific Messages, measures should be taken to correct the situation. An external user interface would be more feasible than developing the AIS equipment display. For the position related information such as the VTS targets and Area notice messages, ECDIS seems to be the correct presentation platform, whereas a bridge computer could be the appropriate user interface for non-position related information such as Dangerous cargo indication or Number of persons on board. However, messages such as Meteorological and hydrographic data may be displayed on both: navigation related information from latest messages on ECDIS and the comprehensive message information and trends based on message history on the computer. Naturally dedicated software needs to be developed and made available for shipping.

The development aiming for exploitation of AIS Application-Specific Messages in practise will continue among the international organisations and projects. In EfficienSea, a European Union funded Interreg project, message transmissions are tested in e-Navigation test beds for broadcasting navigational safety related information. Another ongoing project initiated by the Baltic Sea Action Group (BSAG) aims at converting AIS Application-Specific Messages to XML format using standardised schemes and creating free software to manage, display and create the messages in an external user interface.

The e-Navigation concept was just emerging when the work described in this paper started. AIS Application-Specific Messages can be considered one of the first concrete e-Navigation solutions. IMO NAV55 envisaged that additional or amended AIS Application-Specific Messages would be an important part of the development of services related to the e-Navigation.

The results of the AISBALTIC project, the CG and other related projects in e.g. USA and Japan reveal the potential of the AIS Application-Specific Messages. The communication enabled by the exploitation of AIS Application-Specific Messages ensures that the quality and quantity of available information both onboard and among authorities is significantly improved. As the information content of the developed new messages originates from the present deficiencies in information exchange, improved conditions will ensure improved level of maritime safety, better preparedness of authorities in case of an accident and truly contribute to the protection of the marine environment.

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