Message exchange for flow management in maritime traffic management systems.

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Abstract

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Chapter 1. Introduction

As part of — and as a contribution to — the MONA LISA 2.0 [MONALISA2] project, the Danish Maritime Authority has worked to define message conversation scenarios and detailed message formats for *flow management* in the context of *sea traffic management (STM)* as defined by [ARCH].

The results contain inputs, contributions, and insights from DMA and project partners.

This paper documents the process and the the results, by

1. defining the domain problem,
2. setting the scope of work,
3. establishing design criteria,
4. proposing message conversation scenarios,
5. defining message formats in different formats,
6. validating message formats against desig criteria,
7. introducing a reference implementation for AIS using application specific messages, and by
8. supplying test data to validate its correctness.

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1.1. Problem definition

1.1.1. Flow management

As defined by [ARCH] flow management is communication which takes place between ships in a peer-to-peer situation, or between ships and a coordinating organisation (e.g. VTS, STCC) in order to:

1. Increase safety and prevent delays through a good flow in narrow channels with high traffic density

Support vessel in arriving at final destination in due time as efficient as possible

3. Provide information to interested parties about planned and predicted time of arrival to final destination or other point of interest.

For item 1 the term "good" means that collisions and dangerous situations are avoided and that vessels can safely follow their announced tactical voyageplan through the area.

Flow *management* is based on knowledge of vessels' tactical voyageplans; i.e. announcements from each vessel regarding their intended manouvers in the immediate short-term future. When this knowledge is known either centrally at a coordinating center or distributed between nearby vessels, it is possible for the coordination centre or the nearby vessels to suggest and negotiate tactical voyageplans to obtain a "good" flow. It is this process which is called *flow management*.

If flow management takes place in a self-organizaing manner between vessels on a peer-to-peer basis it is called *autonomous flow management*. When a coordinating center is performing it the process is called *controlled flow management*. In a fully managed scenario — whether autonomous or controlled — all vessels can safely and efficiently follow their tactical voyageplans through their entire passage of the area.

Tactical voyageplan

In order to facilitate flow management vessels in the area must transmit their tactical voyageplan and optionally basic information concerning their manouvering capabilities.

Suggested tactical voyageplan

A suggested change to an tactical voyageplan is called a *flow management suggestion*. A flow management suggestion can be transmitted from either a coordination centre or a peer vessel. It can take one of two principal forms:

1. Geometry-based (adding, deleting or changing waypoints)

2. Speed-based (not changing any waypoints)

Changing the geometry of an tactical voyageplan is a relatively complex operation for the vessel’s navigator. Among other things the process involves a safety check of the new route and reprogramming of navigational equipment. The cost/workload of this operation reduces the likelihood of a vessel complying with suggested changes.

Changing the vessel’s speed (or waypoint ETA’s) is a far simpler operation for the navigator. This involves only adjustment of the vessel’s speed and recalculation of the wheel-over-point in advance of each waypoint. It is therefore expected, that the likelihood of a of vessel complying with a suggested change of this type is higher than suggested changes to geometry.

1.1.2. Controlled flow management

Controlled flow management always takes place inside a defined geographical area called the *controlled area*. The controlled area is a closed polygon.

Vessels can be located inside the controlled area — or outside the controlled area.

Vessels outside the controlled area can be in state

- *entering* — meaning that the vessel intends to enter the controlled area.

Vessels inside the controlled area can be in states

- *leaving* — meaning that the vessel intends to leave the controlled area.
- *staying* — meaning that the vessel intends to seek berth, drop anchor, or elsehow keep manouvering inside the area.

Some of the vessels are aware of some of the other vessels' tactical voyageplans, and the coordination centre is aware of some of the vessel’s tactical voyageplans.

The coordination centre is continuously receiving an AIS data stream, including type 1-3 position messages and type 5 ship and static voyage messages, so that it can maintain an updated real-time picture of the current traffic situation.

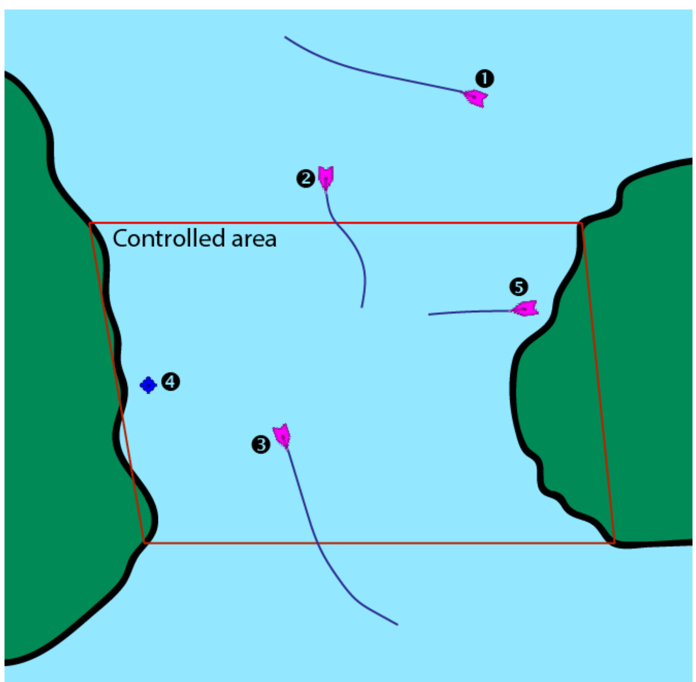

Figure 1. A controlled area and five vessels showing their intended routes. There are vessels outside (1, 2) and vessels inside (3-5) the controleld area. A vessel (2) is entering, a vessel is leaving (3), and two vessels are staying (4 ,5).

1.1.3. Autonomous flow management

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1.2. Scope of work

The scope of the work in this paper is *controlled flow management in a limited area (in order of size as a VTS area) based on flow management suggestions in the speed-based form*.

The objective is to define *which* information (i.e. payload, data fields) that need to be exchanged and to define the criteria/triggers for *when* this information is transmitted.

The outcome is a set of message definitions, transmission criteria, test data, and a reference implementation to support controlled and autonomous flow management.

Chapter 2. Use cases

2.1. Use cases for controlled flow management

2.1.1. Use case: Vessel enters the controlled area

Table 1. Use case.

No.	Event	Action
1	The coordination centre detects, that a vessel has entered the controlled area.	The control centre transmits an addressed message to the vessel requesting it broadcast tactical voyageplans. [This is done even if the coordination centre already has this information in order to distribute this information to other vessels in the area.]
2	The vessel receives the message.	The vessel responds by broadcasting message, which contains its tactical voyageplans.
3	The broadcast is received by the coordination centre (and likely some of the other vessels in the area).	The control centre recalculates optimal speeds per vessel. [with priority to suggest speed changes for V_0 over other vessels, and fewest possible other vessels, and only for vessels intending to leave A.]
	Exception: The broadcast is never received by the coordination centre.	The coordination centre retransmits its message to the vessel.
4	The coordination centre's recalculation of optimal speeds completes.	The coordination centre transmits an addressed messages with flow management suggestion s to those vessels which (according to the calculation) require changes.
5	A vessel receives its flow management suggestion from the coordination centre.	The navigator is alerted.
	Exception: The flow management suggestion is never received by the vessel.	*May lead to special case: Coordination centre discovers new suggestions needed.*
6	Navigator of approves flow management suggestion .	The vessel broadcasts a message containing its new tactical voyageplan.

2.1.2. Use case: Coordination centre determintes new flow management suggestion s needed

Table 2. Use case.

No.	Event	Action
1	The coordination centre detects that the current flow is not optimal ("good")	The control centre recalculates optimal speeds per vessel.
2	The coordination centre's recalculation of optimal speeds completes.	The coordination centre transmits an addressed messages with flow management suggestion s to those vessels which (according to the calculation) require changes.
3	A vessel receives its flow management suggestion from the coordination centre.	The navigator is alerted.
	Exception: The flow management suggestion is never received by the vessel.	*May lead to special case: Coordination centre discovers new suggestions needed.*
4	Navigator of approves flow management suggestion .	The vessel broadcasts a message containing its new tactical voyageplan.

2.1.3. Use case: Vessel broadcasts its tactical voyageplan

2.1.4. Use case: Vessel changes or resends its tactical voyageplan

2.1.5. Use case: Vessel cancels its tactical voyageplan

2.1.6. Use case: A tactical voyageplan expires

2.1.7. Use case: A vessel suggests tactical voyageplan for another vessel

(in a controlled flow management scenario)

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2.2. Use cases for autonomous flow management

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Chapter 3. Design criteria

Messaging in the maritime domain has been available many years and communication standards have evolved and been added and augmented several times to accomodate the increasing demand for handling more and more complex scenarios in the maritime domain.

When suggesting message exchange for advanced use cases, such as for flow management, we want to take lessons learned from the past years into account. Literature, has as [TOILS], has therefore been studied to establish a set of design criteria for the messages that are defined for flow management.

In section Validation against design criteria it will be validated, that the suggested messages layouts and payloads are in compliance with these design criteria.

3.1. General design criteria

3.1.1. Design with the end-user in mind

In accordance with [ARCH], §3, all systems shall be designed with the end user (e.g. mariner, ship owner, operator), in mind.

> This shall be achieved, by carefully identifying and defining use cases expressed in user domain terms and approved by user domain experts (such as navigators) before the actual design of message conversations and message layouts takes place.

3.1.2. Design for multivendor environment

In accordance with [ARCH], §3 p.6, one of the main goals (here interpreted as *design criteria*) of the MONALISA 2.0 project is to "achieve full and seamless interoperability of systems in Sea Traffic Management (STM) […] in a multi-vendor environment".

> This shall be achieved by ensuring that relevant stakeholders in government and industry can contribute to and review the design of conversations and messages in flow management.

3.1.3. Information transfer involving ships must be bandwidth efficient

In accordance with [ARCH], §7 p.23, information transfer involving ships must be highly bandwidth efficient.

> This shall be achieved by designing messages to be as compact as possible, avoiding redundant information in message layouts, and using bit-level compression where applicable and possible.

3.1.4. Ship-shore interactions must be robust

In accordance with [ARCH], §7 p.23, ship-shore interactions must be robust to unstable, changing, high latency links.

> This shall be achieved by ???

3.1.5. Ship-shore data IP connections must be initiated from ship

In accordance with [ARCH], §7 p.23, ship-shore data connections must be initiated from ship, to address cyber security.

> This shall be achieved by designing the required mechanisms of communication, such that ship-to-shore communication is based on IP-based connection-oriented communication (e.g. TCP/IP), then such a connection can only be initiated from the ship-side.

3.2. AIS-specific design criteria

3.2.1. Consider updated definitions of ASM and related guidance, before developing new ASM;

In accordance with [IALA144], recommendation 4, IALA recommends that members make use of the IALA ASM collection [AISASM] by taking into account other updated definitions of ASM and related guidance, before developing new or implementing the use of existing Regional ASM.

> This shall be achieved by consulting the ASM collection [AISASM] to ensure that no other existing ASM already fulfills the requirements of any newly designed message before it is submitted for approval.

3.2.2. Contribute to the IALA AIS ASM collection

In accordance with [IALA144], recommendation 6, members are recommended to contribute to the IALA ASM collection through their National IALA Member.

> This shall be achieved by ensuring that the final and agreed ASM messages to support flow management are submitted to the IALA ASM collection by the national IALA member, in this case the Danish Maritime Authority.

3.2.3. Low transmission frequency

In accordance with [AISG289], §3.3, the frequency of message transmission should be limited in order to prevent system overload.

> This shall be achieved by careful design of the criteria which trigger a message transmission, in order to minimise the number of transmissions to the lowest possible.

3.2.4. Limit no. of VHF transmission slots

In accordance with [AISG289], §3.4, AIS messages occupying more than three (3) slots should be avoided, unless there is a low load on the VDL or a compelling reason to do so.

> This shall be achieved by designing messages to avoid occupying more than 3 slots.

3.2.5. Use 6-bit ASCII

As pointed out by [TOILS] the decision to use 6-bit ASCII encoding in AIS messages is a *blunder*. But as it states: "Some major defects, such as the handling of string data, are too deeply embedded to be removed". Thus in the design of new messages, the 6-bit encoding scheme will be maintained to avoid further complexity to [AISSPEC5] and related recommendations and guidelines.

> This shall be achieved by designing string fields of new messages to use the 6-bit character encoding scheme defined by [AISSPEC5] annex 8.

3.2.6. Fixed length messages

By experience and in accordance with [TOILS], "types 1 through 4: Fixed-length felicity", fixed-length messages are simple to parse and can be regarded as one production in the message *grammar*. [TOILS] further states, that "from a reliability-engineering point of view, this [fixed-length messages] is a best case scenario".

> This shall be achived by designing any new messages, so that they have fixed bit-length and fixed field-offsets, unless there are important and documented reasons why this cannot be achieved.

3.2.7. Fixed bit-offset for fields

[TOILS], "Ways forward for AIS", recommends to avoid fields with variable offsets.

This shall be achieved by designing new ASMs to have fixed bit-length for each data field to ensure that each data fields starts at a fixed bit-offset.

3.2.8. Variable fields last

According to [TOILS], "Drawing lessons from the defects", it is a minor defect not to have variable-length fields be the last in the message (such as the variable-length binary payload in message type 26 followed by a radio-status field). Variable-length fieds should first and foremost be avoided. And if, for compelling reasons, they cannot - they should be transmitted last in the message to preserve fixed-offset for as many data fields as possible.

This shall be achieved by designing new ASMs so that any variable-length data fields are at the end of the message.

3.2.9. One dispatch field

[TOILS] states in several places that the no. of protocol extension mechanisms should be minimal and preferably limited to 1. Any *dispatch fields* used to control message variants (such as the message type field), should precede any of the data fields it controls.

This shall be achieved by designing new ASMs so that no new extension mechanisms are introdued, to use a minimal no. of dispatch fields, and take dispatch fields into use in the following order: Message ID, Application Identifier, Message-specific dispatch.

3.2.10. Minimum no. of datatypes

[TOILS] states that good practice is "for there to be just one type per natural kind; e.g. in a geolocation protocol all longitudes should be encoded with the same length, signedness, and special values. Ditto all latitudes, bearings, timestamp fields, etc.". This also holds for the encoding of numeric values [Such as e.g. the "Rate of Turn field in the Common Navigation Block required taking a (sign-preserving) square root and then scaling" - which is different from all other numeric fields.] and the indication of non-existent values in order to avoid complicating exception and variants.

This shall be achieved by designing new ASMs so that they do not introduce any unnecessart new data type or encodings, and so that they (re-)use the most common and widely used type encoding used elsewhere in [AISSPEC5].

3.2.11. Single point of truth

[TOILS] recommends, based on lessons learned from message types 6 and 8, that messages should obey the "single point of truth" principle. This means that there should be no information redundancy inherint in the message, and that one piece of information can only be deduced from a single source in the message.

> This shall be achieved by designing new ASMs so that no piece of information is redundant with other information in the same message.

3.2.12. Support stream-based parsers

[TOILS] recommends, based on lessons learned from message type 22, that in order to preserve memory and reduce decoder complexity, stream-based decoders must be supported by the message layouts. I.e. decoders which can decode incoming messages without looking ahead in the bit stream.

> This shall be achieved by designing new ASMs so that any dispatch-field, changing the interpretation of the message, is transmitted *before* the data fields whose interpretation it influences.

3.2.13. Don’t split data fields across datagrams

As pointed out by [TOILS] some AIS messages, such as type 24, need to be reconstructed from two individually transmitted datagrams. This increases decoder complexity by requiring it to hold state between datagrams - and it adds a new dimension to the set of edge cases and problem scenarios, that must be foreseen. Therefore messages split across multiple datagrams must be avoided and all datagrams must be independent.

> This shall be achieved be designing any new ASMs to that their entire state is communicated in a single datagram.

3.2.14. Check design using ASN.1

[TOILS], "Drawing lessons from the implementations", recommends "that application-protocol designers should, as a routine part of their process, render the design as a specification in [ASN.1] or [BDEC]."

> This shall be achieved by supplying ASN.1 notation for each new ASM proposed.

3.2.15. Provide a reference implementation

[TOILS], "Drawing lessons from the implementations", recommends to "do a reference implementation before you publish an application protocol as a standard" and "as a best practice, the reference implementation should be open source".

> This shall be achieved by developing an open source reference implementation of a decoder for each proposed ASM. This reference implementation must be able to decode all variants of the ASM and should be developed before the protocol is published as a standard.

3.2.16. Provide test data sets for all message variants

[TOILS], "Drawing lessons from the implementations", recommends that "an example binary datagram in each of every possible variation of message shape together with a textual, human-readable decode of that datagram" is supplied to enable test and validation of decoders.

> This shall be achieved by supplying example datagrams together with a human-readable decode of that datagram for each message variant.

Chapter 4. Design of flow management message types and conversations

4.1. High-level design

In the high-level design of support for flow management no assumptions are made about the characteristics of the underlying transport layer. Focus here, is to identify which pieces of information need to be exchanged, between whom, and when. Following this are detailed specifications for mapping this outcome to real-world protocols, such as AIS [AISSPEC5].

4.1.1. Message types

Based on the Use cases it is noted, that the following messages are involved in flow management:

- **tactical voyageplan broadcast**. For a vessel to broadcast its tactical voyageplans.
- **tactical voyageplan inquiry**. An addressed message transmitted by coordination centers and vessels to inquire a vessel about its tactical voyageplan.
- **flow management suggestion**. An addressed message transmitted by coordination centers and vessels to suggest changes to a vessel's announced tactical voyageplan.

4.1.2. Message payloads

The payloads of these message types are the following:

Table 3. Payload of message type **tactical voyageplan inquiry**.

Data field	Description
Sender	Sender identification
Receiver	Receiver identification
Timespan	Time period inquired

Table 4. Payload of message type **tactical voyageplan**.

Data field	Description
Sender	Sender identification
…	…

*Table 5. Payload of message type *flow management suggestion *.*

Data field	Description
Sender	Sender identification
…	…

4.2. Detailed message design

4.2.1. ASN.1

4.2.2. MSDL

4.2.3. AIS

The AIS messages to support flow management should have priority of the following characteristics:

- The message payload should be related to the current tactical execution, the imminent future. I.e. the message should not be designed for planning purposes or announcement of future intentions.
- The message should have carrying capability for maximum no. of waypoints
- The message should optionally support ETA per waypoint, turn radius per waypoint and SOG per leg between waypoints.

Existing ASMs

A search in [ASMCOLL] reveals to candidate ASM's worth considering for the "tactical voyageplan" broadcast:

Title	Msg	DAC	FI	SU	Status	Registrant	Spec
Route information	8	1	27	5	in force	IMO Circ. 289	[ASM_001_27]
Intended route	8	219	1	3	initiation	Danish Maritime Authority	[ASM_219_01]

Comments on ASM DAC=001; FI=27 - "Route information"

Comments on the application specific message DAC=001; FI=27 defined by [ASM_001_27]:

1. [ASM_001_27] specifies that "*13.1 This message … should only be used in when important route information … – not already provided by current official nautical charts or publications – needs to be relayed by authorities or vessels*".

   It is unclear whether a tactical voyageplan (in MONALISA terms) is "important route information".

Certainly tactical voyageplans are not normally on any charts or publications; but are they "important" in the context of this message type?

2. [ASM_001_27] specifies that "*13.4 In order to allow advance notice, this message should be transmitted prior to the start date and time specified for the routing information. It should not be transmitted more than one day in advance*".

   The statement that the message should not "should not be transmitted more than one day in advance" indicates that this message is for planning purposes, and not related to the imminent tactical situation.

3. In the message layout [ASM_001_27] there is a field called "sender classification" which can only take one legal value: "1 = authority". Values 2-7 are reserved for future use. The value 0 is not defined in the specification, but since §13.1 indicates that the message can be used by vessels, perhaps 0 means that the sender is a vessel. But this is unclear.

4. The data field "duration" occupies 18 bits and thus supports a max. value of 262142 minutes (using 262143 to indicate value not available) [ASM_001_27]. 262142 minutes equals 4.369 hours or 182 days. This is far beyong the needs for a tactical voyageplan and is therefore not efficient bit-usage for this purpose.

5. In [ASM_001_27] the data field "number of waypoints" is redundant with message length and thus violates the design criteria Single point of truth. Since the specification states that "The number of waypoints is determined by the length of the message." the presence of this field is a mystery. 5 bits could be saved.

6. The message does not support individual ETA or turn radius per waypoint or SOG between waypoints.

In conclusion, DAC=001; FI=27 has an unclear specification, inefficient bit usage, and appears to be intended for planning purposes rather than the imminent tactical situation.

Therefore DAC=001; FI=27 is not suitable or recommmended for use in flow management.

Comments on ASM DAC=219; FI=01 - "Intended route"

Comments on the application specific message DAC=001; FI=27 defined by [ASM_219_01]:

1. It is well-defined *when* this message must be sent.

2. First waypoint is always active waypoint - thus the message only carries future intentions.

3. The data field "ETA active WP" can be set one year ahead. The good thing about this, is that it complies with the Minimum no. of datatypes design criteria; but the bad thing is that it wastes bits; since the lifespan of a tactical voyageplan can probably be expressed in the order of hundres of minutes correponding to 10 bits of information.

4. In [ASM_219_01] the data field "number of waypoints" is redundant with message length and thus

violates the design criteria Single point of truth. It is unclear whether message length or data field "number of waypoints" determines the no. of waypoint. In either case, the bits used for the data field "number of waypoints" could be saved.

5. The message does not support individual ETA or turn radius per waypoint or SOG between waypoints.

In conclusion, DAC=219; FI=01 has some of the same discrepancies as DAC=001; FI=27, but the events which trigger transmission are more well-defined, it is clear that this message is transmitted by vessels (not shore stations); and it is clear that this message intended for communicating immediate navigation intentions in the same way as required for tactical voyageplans.

Therefore it is recommended - to use DAC=219; FI=01 as a means for vessels to broadcast their tactical voyageplans flow management. - to suggest one new message, with the same purpose as DAC=219; FI=01, but with the extended capability of expressing individual ETA and turn radius per waypoint.

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Following the arguments above, the following AIS messages are required to be used and defined for use in flow management:

Message purpose	Message type	Defined by
Tactical voyageplan broadcast	ASM DAC=219; FI=01	[ASM_219_01]
Tactical voyageplan broadcast, extended	ASM DAC=219; FI=02	*To be defined*
Tactical voyageplan inquiry	ASM DAC=001; FI=03	*To be defined*
Flow management suggestion	ASM DAC=219; FI=04	*To be defined*

Chapter 5. Validation against design criteria

5.1. General design criteria

No.	Criteria	Validation
1	Design with the end-user in mind	-
2	Design for multivendor environment	-
3	Information transfer involving ships must be bandwidth efficient	-
4	Ship-shore interactions must be robust	-
5	Ship-shore data IP connections must be initiated from ship	-

5.2. AIS-specific design criteria

No.	Criteria	Validation
1	Consider updated definitions of ASM and related guidance, before developing new ASM	-
2	Contribute to the IALA AIS ASM collection	-
3	Low transmission frequency	-
4	Use 6-bit ASCII	-
5	Fixed length messages	-
6	Fixed bit-offset for fields	-
7	Variable fields last	-
8	One dispatch field	-
9	Minimum no. of datatypes	-
10	Single point of truth	-
11	Support stream-based parsers	-
12	Don’t split data fields across datagrams	-
13	Check design using ASN.1	-
14	Provide a reference implementation	-

No.	Criteria	Validation
15	Provide test data sets for all message variants	-

Chapter 6. Test data

6.1. AIS

Chapter 7. Reference implementation

7.1. AIS

Chapter 8. Recommended further work

- autonomous flow management

Reader’s guide

The following typographic conventions are used throughout this paper.

Icons

	A …

Glossary

Definitions

Term	Definition
Strategic voyageplan	MONALISA 2 term for long term planning that consists of a route with a voyage number (and other Route information), a list of waypoints (geometry), a schedule, charter parties, legal conditions, and more. When a Strategic voyage plan is given to the ship as a voyage order it changes to *dynamic voyageplan*.
Dynamic voyageplan	MONALISA 2 term for an optimised version of the *strategic voyageplan*
Tactical voyageplan	MONALISA 3 term for a dynamic voyageplan in conning mode; i.e. under tactical execution. Whole or parts of the tactical voyage plan can be transmitted to increase situational awareness and support flow management.

Abbreviations

Abbreviation	Expansion	Description
MSDL	Maritime Service Definition Language	A computer language used to defined services in a maritime
AIS	Automatic Identification System	A tracking system used on ships and by vessel traffic services for identifying and locating vessels by electronically exchanging data with other nearby ships, base stations, and satellites.
ASM	Application Specific Message	Used only in the context of the automatic identification system, as a method of allowing "competent authorities" to define additional AIS message subtypes, based on message types 6, 8, 25, and 26 which support a custom payload.
CC	Coordination Center	A term specific to this document invented to cover all types of VTS, STCC, and other centres with responsibility for traffic management and coordination.

Abbreviation	Expansion	Description
STM	Sea Traffic Management	The aggregation of the seaborne and shore-based functions (sea traffic services, maritime space management and sea traffic flow management) required to ensure the safe and efficient manouvering of vessels during all phases of operation.
STCC	Sea Traffic Coordination Center	A central, shore-based, hub maintaining record of all vessels at sea using AIS and/or radar to enable managed distribution of vessel routes between ship-to-ship and ship-to-shore.
VTS	Vessel traffic service	A vessel traffic service is a marine traffic monitoring system established by public or port authorities, somewhat similar to air traffic control for aircraft.
IALA	International Association of Lighthouse Authorities	The International Association of Marine Aids to Navigation and Lighthouse Authorities is a non-profit organization founded collect and provide nautical expertise and advice.
ITU	International Telecommunication Union	The International Telecommunication Unio is an agency of the United Nations that is responsible for issues that concern information and communication technologies, such as coordinating the shared global use of the radio spectrum, promoting international cooperation in assigning satellite orbits, assisting in the development of worldwide technical standards.
ASCII	American Standard Code for Interformation Interchange	A character encoding scheme used in computers, communications equipment, and other devices that use text, to represent text with numbers.
ETA	Estimated time of arrival	-
SOG	Speed over ground	Speed made good measured in knots.

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[TOILS] "The Toils of AIS: A Case Study in Application Protocol Design And Analysis" by Eric S. Raymond and Kurt Schwehr. 2013. Available from http://gitorious.org/toils-of-ais/toils-of-ais/

[ARCH] "Architecture for STM in EMSN and STM Data format for Route Exchange".

Web resources

[ASN.1] "Abstract Syntax Notation One (ASN.1)". A standard and notation that describes rules and structures for representing, encoding, transmitting, and decoding data in telecommunications and computer networking. http://en.wikipedia.org/wiki/Abstract_Syntax_Notation_One.

[BDEC] "bdec". A set of tools for creating decoders and encoders for binary files given a high level specification. http://www.protocollogic.com/docs/tutorial.html.

[MONALISA2] "MONALISA 2.0". A joint project from 10 different countries in the European Union to introduce Sea Traffic Management (STM) and make real-time information available to all interested and authorised parties in the maritime world. http://monalisaproject.eu/.

[ASMCOLL] "Application Specific Messages". A collection of application specific AIS messages approved by IALA-AISM. http://www.e-navigation.nl/asm.

[ASM_001_27] "Specification of Route information - (broadcast)". Specification of the AIS application specific message for route information broadcast. http://www.e-navigation.nl/content/route-information.

[ASM_219_01] "Specification of intended route - (broadcast)". Specification of the AIS application specific message for intended route broadcast. http://www.e-navigation.nl/content/intended-route.

Appendix A: AIS message definitions

The following AIS message definitions are proposed for flow management support.

Tactical voyageplan broadcast

Formally proposed specification as available in [ASM_219_01].

This message allows the communication of a vessels intended route to other vessels and shore stations.

The rules for broadcasting this message are the following

a. Only broadcast when the vessel is following an activated route.
b. The route must be broadcast every six minutes, due to what is stated in ITU-R M.1371-4 (§4.2.1) regarding sending interval for voyage related information.
c. On route activation the route must be broadcast.
d. When active waypoint changes the route must be broadcast.
e. On route deactivation, or when a route is completed, an empty message with no waypoints must be sent to indicate that the vessel is not following an intended route.

The broadcast waypoints must start with the current active waypoint and include up to the 15 following waypoints, giving a maximum of 16 waypoints.

Broadcasting 16 waypoints will result in a 5-slot message. It is recommended to avoid messages with more than 3 slots, equivalent to no more than 8 waypoints.

See http://enav.frv.dk/ais_route_suggestion.pdf for usage and portrayal details.

Registrant: Danish Maritime Authority
Message number: 8
DAC: 219
FI: 1
Used by: DMA, EfficienSea
Number of Slots (max): 3
Reporting rate: Every 6 minutes and on active route change
How portrayed: See http://enav.frv.dk/ais_route_suggestion.pdf for usage and portrayal details.

Permitted as from: 11/03/2011
Status: initiation
Technical Point of contact:
Ole Borup
Danish Maritime Authority
obo@frv.dk

Details:
Table 2.1
Intended route (broadcast)

Parameter	No. of bits	Description
Message ID	6	Identifier for Message 8; always 8.
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. 0 - 3 0 = default 3 = do not repeat anymore
Source ID	30	MMSI number of source station.
Spare	1	Not used. Set to zero.
IAI	16	**DAC = 219; FI = 1**
ETA active WP		The ETA at the active waypoint (first waypoint). For a cancellation of active route, the default values can be used.
UTC Month	4	1 - 12 0 = not available = default
UTC Day	5	1 - 31 0 = not available = default
UTC Hour	5	0 - 23 0 = not available = default
UTC Minute	6	0 - 59 0 = not available = default
Duration	18	Minutes from ETA at active waypoint to ETA at the last broadcast waypoint. The duration allows for the calculation of an average intended speed on the broadcast route. 0 = not available = default

Parameter	No. of bits	Description
Number of Waypoints	5	Number of Waypoints 1 - 16 0 = no active route = cancel route 17 - 31 (not used)
Waypoints	n × 55	Variable number of waypoints 0 – 16 (55 bit each), refer to table 2.2.
Spare		Not used. Set to zero.
Total	**99-979**	**Occupies 2 – 5 slots.** 1 - 4 waypoints = 2 slots 5 - 8 waypoints = 3 slots 9 - 12 waypoints = 4 slots 13 – 16 waypoints = 5 slots

Table 2.2
Waypoints

Parameter	No. of bits	Description
WP Longitude	28	Longitude in 1/10,000 min, ±180 degrees as per 2’s complement (East = positive, West = negative).
WP Latitude	27	Latitude in 1/10,000 min, ±90 degrees as per 2’s complement (North = positive, South = negative).

Tactical voyageplan broadcast, extended

Tactical voyageplan inquiry

Flow management suggestion