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# Oplegnotitie

Definition study on Intention sharing

In November 2022 a symposium was organized on Intention sharing. In this meeting, the results of a simulator study on Intention sharing by MARIN were communicated. Since there was much interest in the concept, from both private companies as authorities, it was decided to continue with a definition study.

In the definition study the concept of Intention sharing for inland shipping is further refined and a concrete proposal is delivered for the technical design of, in particular, the communication of intention information. Intention sharing on inland waters will only work when communication between systems from different suppliers is possible.

With the release of the report 'Definition Study of Intentions Sharing', there is now a supported proposal for what information should be exchanged and how this should be done technically. Ideally, this proposal will be converted into a standard.

A hybrid solution was chosen in which some waypoints are shared via AIS and more detailed information is exchanged via a client/server system. An exchange platform ('central hub') should be created for this.

Almost all suppliers of inland ECDIS systems and track pilots were involved in the elaboration, which means that the final proposal is widely supported. However, the designed concept is open, it also supports new (types of) users.

# Intention Sharing for Inland Shipping

definition document

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# CONTENTS

# INTRODUCTION

Letting other skippers know what you intend to do navigation wise, is not a new concept in the inland shipping industry. In fact, it is one of the key usages of radio communication between ships and between ships and traffic centres. AIS-equipped ships broadcast information like position, speed and course to surrounding vessels and others, which can also be seen as a form of sharing intent. Propelled by the fast rise of track pilots on board, a project has been set up to further explore the possibilities of (digital) intention sharing for inland shipping.

The idea of digitally informing other ships of one's foreseen itinerary is not new either. In fact, the AIS message set contains a message type to broadcast it. This mechanism is, however, rarely used and, if so, only on sea routes where routes are simpler and more stable. Inland routes usually have more waypoints, are more volatile and become less reliable the further ahead they are planned. Local situations have a large influence on short-term decisions by the skipper. This is less of an issue for the forenamed radio communications, since the transferred information is relatively little detailed. A key difference with radio communication is that such communication is mostly driven by relevance: it only happens if either party deems the information as relevant. Automatic intention sharing always happens, regardless of its presumed relevance and based upon trustworthy calculations instead of estimations.

The introduction of track pilots shifts this image. A track pilot steers the ship reliably over a digitally defined route. As a result, the route is available in a digital form. Also, reliable calculations can be made to determine where the ship will be at a certain timestamp, provided that the track pilot is active. This opened up the possibility to further research the possibilities and use of digitally broadcasting this information in a uniform and manufacturer independent way. Rijkswaterstaat has set up a project for this purpose that has resulted in a literature study, a technical Proof of Concept (PoC) and a simulation pilot. The results of this project show[1] that this form of intention sharing can be beneficial at several levels.

**TCA, TGAIN or track pilot**

*The idea of intention sharing is linked to the use of track control assistants or TCA's. They are also known as Track Guidance Assistants for Inland Navigation or TGAIN. Neither those long forms, nor their abbreviations attribute to the readability of documents. For that reason, in this document the common, popular and readable term* ***track pilot*** *is used as a generic reference to the device.*

Notwithstanding the perfect match between track pilots and reliably knowing the intentions, it is a good idea to tear the subject of intention sharing loose from track pilots. There are, after all, other sources of intentions like plotted routes, suggested shipping lanes, etc. Additionally, the use of the information shared is not limited to ships equipped with a track pilot, which brings additional requirements to the table.

This document defines the concept of intention sharing for inland shipping, summarizing the goals and defining the scope. It further contains a functional and technical description of the exchange mechanism. The document is the result of close collaboration between stakeholders, like ECDIS (Electronic Chart Display and Information System) manufacturers, track pilot developers and authorities like Rijkswaterstaat and port authorities.

[1] See Digital intention sharing : simulation study on the benefits of intention sharing - Rijkswaterstaat Publicatie Platform

# DEFINITIONS, OBJECTIVES AND SCOPE

To adequately articulate and technically delineate the notion of sharing intentions, it is imperative to initially define what intentions mean and establish the underlying purpose of sharing these. Drawing upon the findings of prior research and a workshop conducted with relevant stakeholders, a number of objectives can be identified. Consequently, to facilitate a more streamlined progression, it becomes essential to establish a scope that discerns the objectives to be pursued and those to be omitted. This chapter commences by enumerating the identified objectives and culminates with the formulation of a scope definition.

## DEFINITIONS

### *ROLES*

It is beneficial to initially identify the two primary roles involved in the concept of intention sharing: supplier and subscriber. An entity can assume the role of a supplier, a subscriber, or both.

#### *Supplier*

A supplier is an entity that shares its intentions through the exchange mechanism. Typically, this entity is (the shipper of) a vessel, but in this document, it can also pertain to the equipment responsible for such sharing. An entity can qualify as a supplier only when it possesses intentions for sharing.

#### *Subscriber*

A subscriber is an entity that receives and utilizes shared intentions. Subscribers primarily consist of vessels (the onboard equipment) seeking to access and use the intentions of neighbouring vessels. Another group of subscribers comprises traffic posts and port authorities. Lastly, service providers can also function as subscribers, integrating this information into their offerings for customers. Anyone can be a subscriber, and generally, subscribers fall into two categories: those near the supplier (e.g., other vessels, traffic posts, etc.) and those who are not at all (e.g., service providers).

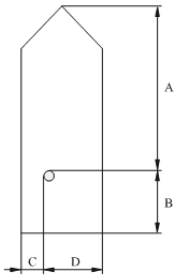
### *INTENTIONS*

Within the context of this document, intentions are specifically referred to as 'displacement intentions' emitted by suppliers, so subscribers get the ability to ascertain the anticipated location of a vessel at a particular time. An intention usually manifests as a sequence of consecutive waypoints that delineate the trajectory of the vessel's reference point. Functionally, each route waypoint comprises a coordinate, the vessel's heading, and the estimated time of arrival at that point. The supplier's equipment should incorporate an algorithm that generates the fewest waypoints necessary for subscribers to generate – through linear interpolation along the waypoints – a course closely resembling the planned route of the supplier.

Apart from such a series of waypoints, an intention may also be a signal that a previously broadcast itinerary is suspended or that there is no intention to sail.

## REFERENCE POINT

Within the context of intention sharing, the vessel's reference point aligns with the reference point utilized for AIS positioning (see image).




| | Number of bits | Bit fields | Distance (m) |
|---|---|---|---|
| A | 9 | Bit 21-Bit 29 | 0-511<br>511 = 511 m or greater |
| B | 9 | Bit 12-Bit 20 | 0-511<br>511 = 511 m or greater |
| C | 6 | Bit 6-Bit 11 | 0-63;<br>63 = 63 m or greater |
| D | 6 | Bit 0-Bit 5 | 0-63;<br>63 = 63 m or greater |

The dimension A should be in the direction of the transmitted heading information (bow)
Reference point of reported position not available, but dimensions of ship are available: A = C = 0 and B ≠ 0 and D ≠ 0.
Neither reference point of reported position nor dimensions of ship available; A = B = C = D = 0 (= default).
For use in the message table, A = most significant field, D = least significant field.

1371-42

(Source: International Telecommunications Union Recommendation ITU-R M.1371-5)

## OBJECTIVES

### *SUPPLIERS*

Generally, it is challenging to determine the suppliers' objectives for sharing intentions. Within the concept of sharing intentions, suppliers are dependent on whether their shared information is used. Suppliers can hugely benefit if a subscriber uses the intentions, but they cannot really influence this. However, just like the classic chicken-and-egg dilemma, intention sharing will only succeed if there are suppliers. Therefore, it is valuable for subscribers to also become suppliers. A specific subset of suppliers aims to utilize automated vessels. To ensure a proper deployment, a well-functioning intention-sharing system is essential. Hence, there is an interest in initiating this process.

### *SUBSCRIBERS*

The objectives for subscribers vary depending on their type. Vessels aim to utilize the intentions of other vessels for planning purposes, determining aspects such as which side to pass the nearest vessel on, overtaking considerations in general, and the safety of potential turns.

Traffic posts leverage this information to strategize vessel movements within their jurisdiction. Utilizing shared intentions can concurrently reduce radio traffic and enhance the level of detail in their operations.

One advantage of digitally sharing intentions is the reduction in reliance on (spoken) radio communications, which, in turn, mitigates the risk of language-related issues. This proves advantageous for both vessels (operators and skippers) and traffic control centres, potentially streamlining or altering the required skill set for personnel.

Service providers offering apps for non-commercial ships may seek to integrate these intentions, thereby informing non-professional shippers about anticipated conditions. This information can be seamlessly integrated into the existing positional data.

In general, subscribers near the supplier (e.g., other vessels) require minimal latency as they rely on timely information for anticipation. Conversely, for other subscribers (e.g., service providers), a slight latency is acceptable.

## SCOPE

Observing from a distance, the proposed trajectory between departure and destination can be viewed as an intention. However, for the defined objectives, the time frame for this intention is excessively broad, considering the relatively low reliability. Several external and uncontrollable factors will impact the journey, thus rendering the intention not usable.

To achieve the defined objectives, shared intentions must meet a minimum level of reliability, representing an intention that, under typical circumstances, is feasible. Each shared intention must come with an assigned reliability level, and a minimum reliability threshold will be established. A shared intention should not encompass more than 10 minutes, and even less if the reliability of route points falls below the established minimum.

# FUNCTIONAL DEFINITION FOR INTENTION SHARING

This chapter further defines the concept of intention sharing, including the definition of (functional) messages and information elements to share. The contents of this chapter are largely based on the outcome of earlier research. The description focuses on functionality, without incorporating any optimizations. The technical description can introduce optimizations, provided that the core functionality remains unaffected.

## CONCEPT OF INTENTION SHARING

The basic concept of 'intention sharing' primarily means that a vessel shares its planned itinerary, ie. providing a sequence of waypoints through one or more exchange mechanisms. This information is updated whenever necessary but at least every 1 minute. An intention that has not been updated for 2 minutes should be deemed invalid and rejected.

The intention must further include an indication of its source and a corresponding reliability marker. The value and significance of this marker are dependent on the source. For instance, if the source is an active track pilot, the reliability marker may indicate 'navigating towards track'. Specific values for sources and reliability markers are defined later in this chapter.

Any changes to the previously shared intention, regardless of the aspect, must be communicated as soon as possible. That can be done by updating the waypoint sequence, in case for instance if the track is changed or the speed is altered. A track pilot can also be switched off or set to manual control, which must be communicated as well. Other events, like the (temporary) interruption of an itinerary, shall also be published.

The current concept of Intention Sharing operates on a broadcast model. In this model, the supplier provides its intentions to all subscribers without receiving feedback or gaining insights into how the subscribers utilize this information.

## SHARING 'INTENTION'

### *GENERAL*

The intention contains a series of consecutive waypoints, each labelled with a timestamp. When linearly interpolating between two waypoints (assuming constant speed and rate of turn), the interpolation must not deviate by more than 5 meters from the actual location of the reference point at any given time. Similarly, the interpolated heading of the vessel should not deviate by more than 2° from the actual heading at any given time. The number of route points is limited by (a) the maximum horizon in time (10 mn) and (b) a maximum set by the exchange mechanism.

The route intention further contains a source and a reliability:

| | | Reliability | | |
|---|---|---|---|---|
| Source | **Very High** | **High** | **Medium** | **Low** |
| **Track pilot**<br>*At least the rudder of the vessel is controlled by a track pilot.* | following track, controlling rudder and throttle | following and on track, controlling rudder | nearing track | starting and/or too far away from track |
| **Navigation Guidance**<br>*A shipper sails the vessel, following a track set out by an active route planner or similar device.* | - | - | equipment choice | equipment choice |
| **Projected Shipping Lane**<br>*A shipper sails the vessel, following projected shipping lane.* | - | - | - | (fixed) |

Only intentions originating from a track pilot can be labelled with 'high' reliability, but this is contingent on the track pilot being active and on course[2]. If the track pilot is navigating towards a track, the reliability shall be set to 'low', or 'medium' if it is near following the track. Intentions based on a projected shipping lane are inherently classified as low reliability. When navigation guidance serves as the source for the intention, the reliability can be designated as 'medium' or 'low,' with the determination left to the discretion of the source. It is envisaged that such intentions do not stretch to the maximum time horizon – a time frame of 5 minutes seems to better match the necessary reliability of the intention.

### *Information Elements*

| Route Intention | | |
|---|---|---|
| **Vessel Identification** | | A unique identifier of the vessel |
| **Source** | | The source of the intention (see table) |
| **Reliability** | | The reliability of the intention (see table) |
| **Reference point** | | The parameters of the reference point |
| *set of:* | | |
| | **Coordinates** | The coordinates of the point on the itinerary |
| | **Heading** | The vessel's heading at that point on the itinerary |
| | **ETA** | The ETA for that point |

*Note: some of these functional information elements might (already) be part of or separately distributed via the exchange mechanism used.*

## Sharing 'Cancel intention'

### *General*

Any supplier who has shared intentions shall proactively communicate when they no longer have an active intention, should such a situation arise.

A 'cancel intention' communication shall be broadcasted/made available for at least 2, but no longer than 5 minutes – or until a new intention is available.

Please note that if an intention changes, there shall be no 'cancel intention' sent. Broadcasting the updated intention will automatically invalidate any existing intention.

### *Information Elements*

| No Intention | |
|---|---|
| **Vessel Identification** | A unique identifier of the vessel |
| **Source** | The source of the intention (see table in previous section) |

## Sharing other intention related information

At this time, it is not foreseen that other information will be shared.

[2] If, in addition to controlling the rudder via the autopilot, a track pilot also manages the throttle, the reliability can be elevated to *very high*.

# CONFIDENTIALITY, SECURITY AND SAFETY

This chapter deals with the conceptual notions of confidentiality, security and safety of intention sharing in general and the intentions shared. The concept of safety is the odd one out, as it is derived from making intentions available.

## CONFIDENTIALITY

Currently, the real-time positions of commercial vessels are widely accessible through AIS. By collecting and analysing these positions over time, one can gain valuable insights into their routes and behaviour, not only at a general level but also at the individual vessel level. This in itself diminishes the confidentiality of intentions. Given that an intention is inherently what it is—an intention—the value of protecting it is less significant than safeguarding the actual routes that vessels follow. Consequently, there is no compelling reason to take measures to prevent the collection of shared intentions.

## SECURITY

Intention Sharing is foreseen to operate as a publishing service, and hence security primarily concerns the subscriber side. Suppliers can conveniently disseminate information through the exchange mechanism without requiring incoming connections or data retrieval for its functionality.

An issue may arise if a source, whether intentionally or accidentally, floods the system with excessive data. This could disrupt the exchange mechanism and potentially overwhelm the receiving systems of subscribers. In response, these systems should incorporate measures to filter out redundant intentions and maintain their functionality. Suppliers must also implement methods for identifying malfunctions and initiating shutdown procedures when necessary to prevent accidental overloads.

A more critical concern is the risk of malicious intent to manipulate intentions. This entails the injection of non-existent intentions or overriding legitimate vessel intentions with incorrect data from a malicious source. As subscribers adapt their actions based on the received intentions, spoofed data could lead to undesirable or even catastrophic situations. Therefore, the exchange mechanism should include one or more methods to allow subscribers to verify the authenticity of the intentions they receive.

Note that the lack of authentication and being prone to spoofing are well-known issues in (AIS based) information exchange for shipping.

## SAFETY

This definition study focuses on the functional and technical aspects of intention sharing, guided by specific objectives. Embedded within these objectives is the desire for increased efficiency achieved through behaviour adaptation, reduced reliance on other communication methods, and more. However, it's crucial to exercise caution because one can share intentions, but should never assume they are received.

While this document doesn't delve into this topic, it's plausible for vessels to demonstrate their capability to receive intentions in some way. This could involve transmitting a dedicated AIS message (even though it currently doesn't exist) or including such information in static vessel data. However, even when a vessel is known to be capable of receiving information, it doesn't guarantee that it is actively used.

To ensure that all involved parties share a consistent understanding of the situation, it's essential to remain aware of the potential for information gaps and take proactive measures to minimize these gaps as much as possible.

# HUMAN MACHINE INTERFACE (HMI) CONSIDERATIONS

Shared intentions can serve various purposes, some of which involve interactions with humans, such as skippers or VTS operators. Each application comes with its unique USER INTERFACE requirements. Therefore, this document does not include an extensive section on HMIS. Instead, this chapter provides a couple of considerations that can be further developed for specific use cases.

## SUPPLYING SYSTEMS

Apart from the option to enable or disable the sharing of intentions, there is little need for user interaction with supplying systems. It may even be advisable to restrict users from adjusting settings to prevent miscommunication on the water.

## SUBSCRIBING SYSTEMS

Given the wide range of applications for shared intentions, providing specific guidelines for human-machine interfaces related to intentions is impractical. However, it's essential to recognize that the exchange mechanism's objective is to make as much relevant information available as possible to address the combined set of objectives. This implies that some filtering or weeding out of information may be necessary for many applications.

For instance, a skipper may not be interested in the intentions of every vessel in the vicinity. Overloading a display with a multitude of intention lines is counterproductive. Intentions displayed don't necessarily need to be shown in full detail. Some systems might find it beneficial to display intentions only from specific sources or of particular reliability.

The use of colouring, line thickness and style and the possibility of filtering will all turn out to be beneficial, given certain uses of the information. This is left to the requirements analysis for each specific application.

# EXCHANGE MECHANISM

Various options are available for exchanging intention-sharing messages, each with distinct advantages and limitations.

## GENERAL

From the supplier's perspective, subscribers can be categorized as those in close proximity (such as other vessels and VTS posts) and those at a distance (such as service providers). The exchange mechanism should cater to both groups, necessitating a distribution method via the internet as a short-range mechanism would be too limited. However, as previously outlined, most subscribers near the supplier require real-time information being pushed with minimal latency.

Taking the latter into account, an internet-based mechanism is currently not a practical option for facilitating all communication, given the coverage challenges on waterways. A more effective approach is to integrate an internet mechanism with the utilization of AIS (Automatic Identification System) which , despite its name, encompasses more thanmere identification. It functions as a comprehensive framework for communication between vessels and Vessel Traffic Service (VTS) posts, encompassing various message types designed to convey vessel identification, location, safety-related data, and other information. AIS is not solely intended for broadcasting information; it also facilitates bidirectional communication through requests and responses between involved parties.

Given its widespread use, its ease of access and its suitability for broadcasting information, AIS would be the preferred method of short-range exchange. Unfortunately, AIS has limited capacity and is prone to congestion in busy maritime regions. Since this congestion issue is not exclusive to intention sharing, it prompted the development of a successor system called VHF Data Exchange System (VDES). Regrettably, VDES has not seen widespread implementation – and probably will not see this in the foreseeable future – due to constraints related to available frequencies, equipment, and the absence of a compelling application that necessitates its use. For this reason, incorporating this technique is, for now, not considered.

Summarizing, the suggested approach involves leveraging (preferably mandatory) AIS for short-range, short-term and immediate intentions and introducing an internet based platform for comprehensive data exchange. This latter platform could be established as a central hub, offering not only efficient bandwidth utilization but also accommodating non-navigational subscribers such as service and application providers. The use of this platform is voluntary.

## AIS

AIS has various message types defined, each tailored for specific purposes. Among these are four message types intended for 'application-specific messages,' which include sharing intentions. Among these, message type 8 is designated for broadcasting information. There are two options to proceed: either to define a specific application-specific message (ASM) for sharing intentions or to utilize an existing ASM. The latter option offers the advantage of avoiding a definition process, but the downside is that it may not perfectly align with the functional concept.

### *EXISTING ASM*

There are two existing ASMs that could potentially be suitable: within the international set of ASMs (DAC=1), there is an ASM designed for broadcasting route information (FI=27). The Danish Maritime Authority (DAC=219) has developed a slightly modified version for broadcasting

'intended routes.' The primary distinctions include the removal of unnecessary data elements and a different definition for a timestamp.

Both ASMs lack the capability to assign individual waypoints an ETA, which raises doubts about their suitability for sharing intentions as outlined in this document. The absence of methods to indicate the source and reliability of the intention further discourages their use. Finally, although there are ways to signal the cancellation of an intention with both ASMs, these do not fit the purpose for intention sharing. Therefore, it is not worthwhile to explore the utilization of these ASMs any further.

## *DEDICATED* ASM

To properly address the messages foreseen within the context of intention sharing, two ASMs will be defined: one for sharing a route and one for sharing the 'cancel intention'.

### *ASM for sharing a route*

The ASM for sharing a route offers room for up to 9 waypoints (lat/lon/heading/eta) and additional information regarding source and reliability. When completely filled, the ASM takes up 2 AIS slots.

| Parameter | # bits | Description | Value |
|---|---|---|---|
| Message ID | 6 | Identifier for Message 8 | 8 |
| Repeat Indicator | 2 | Used by the repeater to indicate how many times a message has been repeated:<br>• 0 = default<br>• 3 = do not repeat any more | 0 – 3 |
| Source ID | 30 | MMSI number of ship | |
| Spare | 2 | Not used | 0 |
| IAI | 16 | | DAC = 200; FI = tbd |
| Intention Source | 3 | Source of the intention | 0 – Track Pilot<br>1 – Navigation Guidance<br>2 – Projected Shipping Lane<br>*3-7 reserved for future use* |
| Intention Reliability | 2 | Reliability of intention | 0 – Low<br>1 – Medium<br>2 – High<br>3 – Very High |
| Update Time | 17 | Time of update (UTC, same day assumed) | |
| Hour | (5) | | 0 – 23 |
| Minute | (6) | | 0 – 59 |
| Seconds | (6) | | 0 – 59 |
| Number of Waypoints | 3 | 0 = intention published via central hub | 0 – 7 |
| WP 1 Longitude | 27 | in 1/6,000 min, per 2's complement (positive = East) | -180 – 180 |
| WP 1 Latitude | 26 | in 1/6,000 min, per 2's complement (positive = North) | -90 – 90 |
| WP 1 Heading | 9 | in degree (0 = North) | 0 – 360 |
| WP 1 ETA delta | 10 | ETA in seconds past Update Time | 0 - 4095 |
| Waypoints 2 .. | (n-1) x 53 | Variable number of additional waypoints 0 – 6 (max 8) | |
| WP i Longitude delta | (12) | in 1/20,000 min, per 2's complement | |
| WP i Latitude delta | (12) | in 1/20,000 min, per 2's complement | |
| WP i Heading | (9) | in degree (0 = North) | 0 – 360 |
| WP i ETA delta | (10) | ETA in seconds past previous WP | 0 - 4095 |
| Spare | | Not used, set to zero | |
| **Total** | **81 – 497** | ***1–2 slots*** *(1 slot: up to 3 WP)* | |

= standard ASM header, = dynamic, depending on number of waypoints

The updated AIS message shall be broadcast at least once every minute and immediately whenever the previously broadcast intention changes.

Notes:

- The difference between the time of broadcast and the update time shall not exceed ±60 sec.
- An intention renders all previously (i.e. with an earlier update time) broadcast intentions invalid.
- To avoid excessive slot usage, the number of waypoints shall be kept to a minimum – only as many as needed to meet the functional requirements.
- Sharing an intention with 0 waypoints implies that the intentions are made available (only) via the central hub.
- Although the MMSI identifies the AIS equipment, it is considered an acceptable means of identifying the ship.
- The AIS message only contains the waypoints of the intention, a subscriber will take the current position of the vessel (broadcast via a different AIS message) as starting point.

### *ASM for sharing 'cancel intention'*

The ASM for sharing 'cancel intention' is relatively small and takes up 1 AIS slot.

| Parameter | # bits | Description | Value |
|---|---|---|---|
| Message ID | 6 | Identifier for Message 8 | 8 |
| Repeat Indicator | 2 | Used by the repeater to indicate how many times a message has been repeated:<br>• 0 = default<br>• 3 = do not repeat any more | 0 – 3 |
| Source ID | 30 | MMSI number of ship | |
| Spare | 2 | Not used | 0 |
| IAI | 16 | | DAC = 200; FI = tbd |
| Intention Source | 3 | Source of the intention | 0 – Track Pilot<br>1 – Navigation Guidance<br>2 – Projected Shipping Lane<br>*3-7 reserved for future use* |
| Spare | | Not used | |
| **Total** | **59** | ***1 slot*** | |

This AIS message shall be broadcast immediately upon cancellation of an intention and repeated twice within the following minute.

Notes:

- The 'cancel intention' message shall also be broadcast by vessels that publish their intention via the central hub only (number of waypoints in intention equals 0).
- If a previously broadcast intention changes, it shall be updated with a newly broadcast intention – no 'cancel intention' shall be sent in such case.
- A 'cancel intention' message shall not be repeated if a new intention is broadcast.

### *AIS REPEATERS*

It is common practice for AIS messages to be picked up and rebroadcast by AIS repeaters. However, due to the limited range of an intention (with a time horizon of 10 minutes), it is advised not to repeat these ASMs.

### AIS PROXY

In most current installations, the ECDIS is directly connected to the AIS transponder via serial connection, utilizing it for both sending and receiving AIS messages. Other equipment seeking access to AIS messages typically connects in parallel to this serial connection and 'sniffs' the serial traffic. This allows such equipment to receive AIS messages transmitted by the transponder and messages sent by the ECDIS to the transceiver. However, in this setup, the other equipment is unable to send AIS messages independently.

For the purpose of intention sharing, ECDIS systems will incorporate an AIS proxy and make it accessible to other equipment, notably track pilots. The primary function of the proxy is to receive AIS messages sent by the connected equipment and transmit them to the AIS transponder. To minimize redundant efforts, the proxy also relays any AIS messages received or sent by the ECDIS to the connected equipment, which then does not need to sniff the serial connection.

Note: although essential for intention sharing, an AIS proxy function is beneficial to any solution requiring access to AIS messages, as sniffing serial connections can lead to malfunction either through electronic interference or double sending.

## CENTRAL HUB

As the bandwidth in AIS is limited, a central facility is implemented in parallel to facilitate the broadcasting of intentions. This central facility can be accessed via (mobile) internet and both receive and transmit intentions. It is available for use by suppliers, subscribers, and service providers alike.

### BASICS

Various methods are available for exchanging information over a (mobile) internet connection, ranging from simple HTTP to more sophisticated pub/sub protocols and advanced service bus architectures. Due to the suboptimal coverage of internet services on waterways, a robust and stateless implementation of a portal supporting basic HTTP requests has been chosen for now.

Any request to the central hub must be secure (using https), authenticated using basic authentication with a username/password combination. Additionally, the central hub may support the creation and use of API keys to facilitate communication. To further optimize the exchange of information, the central hub will support compression and reuse of connections.

### SERVICE FOR SUPPLIERS

#### *Submitting and retrieving intentions*

Suppliers submit their intentions to the central hub at least once per minute and immediately when the intention changes. They do so via a POST-request to an (https-)endpoint. Usually the response code will be 200 and the intentions of vessels within a predefined perimeter around the communicated current location will be in the body of the response. The endpoint supports filtering of the received intentions (see below) and complete suppression of a response. In case there are no intentions to return, the response code will be 204 and the body of the response empty.

The endpoint will be monitored and access is blocked when malpractice is detected. When blocked or unauthorized, the submitted intentions are ignored, no data is returned and the response code is 403

### *Additional services*

A human friendly portal (also requiring authentication) is available to set parameters for the supplying vessel, tune the response and limit distribution. A supplier can (not limitative):

- Link the account to a vessel.
- Create API keys.
- Set the parameters for the reference point.
- Set a (smaller than default) perimeter around the ship for which they want to receive intentions of other vessels or suppress sending intentions back altogether.
- Limit the distribution of their intentions to specific subscribers or only suppliers (suppliers can never be excluded), Government services involved in waterway traffic management will always have access (see below).
- See the history of their submitted intentions.

By default, intentions are shared with suppliers and government services and not with other subscribers. The default perimeter is 5 kilometres.

#### *SERVICE FOR SUBSCRIBERS*

Subscribers need to describe the purpose for which they want to use the intentions and are subject to restrictions regarding storing and manipulating data. Suppliers can limit the sharing of intentions and thus shut out specific (groups of) subscribers.

### *Retrieving intentions*

Subscribers retrieve intentions via a GET-request. When authorized, the response code will be 200 and the intentions will be in the body of the response. The endpoint supports filtering (see below). If no intentions are available (filtered or not) the response code will be 204 and the body of the response empty.

The endpoint will be monitored and access is blocked when malpractice is detected. When blocked or unauthorized, no data is returned and the response code is 403

### *Additional services*

A human friendly portal (also requiring authentication) is available to tune the service, allowing te subscriber to (not limitative):

- Create API keys.
- Create predefined filters.
- Describe the service offered
- (Re)set password

An additional service will be created for subscribers without access to AIS to retrieve information about the reference point of vessels.

#### *RESPONSE FILTERING AND COMPRESSION*

The central hub supports filtering of the response (ie. Intentions of (other) vessels) through url parameters or as part of the submitted (JSON) data. Both subscribers and suppliers can can utilize this filtering to efficiently tailor the response to their needs.. Filter options, that can be combined, shall include the abilities to:

- … restrict the response to intentions around a specified coordinate (for vessels that are not supplying intentions);
- … apply predefined filters and/or override set parameters like the perimeter;
- … limit the set of intentions to a specific selection of vessels;

- … limit the set of intentions to those that have changed since a supplied timestamp (incremental update);

The central hub supports compression of the response via the usual mechanism embedded in the HTTP protocol.

### *INTENTION FORMAT*

Intentions, whether submitted or retrieved, are coded using JSON, with a single intention built up like this:

| Parameter | Type | Description | Value |
|---|---|---|---|
| Vessel ID | string | MMSI number of ship | |
| Intention Source | string | Source of the intention | "trackPilot"<br>"navigationGuidance"<br>"projectedShippingLane" |
| Intention Reliability | number | Reliability of intention | 0 (= Low)<br>1 (= Medium)<br>2 (= High)<br>3 (= Very High) |
| Update Time | string | Time of update in ISO 8601 format | |
| Current Location | object | | |
| Actual Longitude | number | Format ±DDD.MMmmmm (positive = East) | -180.000000 – 180.000000 |
| Actual Latitude | number | Format ±DD.MMmmmm (positive = North) | -90.000000 – 90.000000 |
| Waypoints | array | | |
| Waypoint | object | | |
| WP i Longitude | number | Format ±DDD.MMmmmm (positive = East) | -180.000000 – 180.000000 |
| WP i Latitude | number | Format ±DD.MMmmmm (positive = North) | -90.000000 – 90.000000 |
| WP I Heading | number | Heading of vessel in degrees (0° = North) | 0.0 – 360.0 |
| WP i ETA | string | ETA at waypoint 'i' in ISO 8601 format | |

Notes:

- The difference between the time of broadcast and the update time shall not exceed ±60 sec.
- An intention renders all previously (i.e. with an earlier update time) broadcast intentions invalid.
- An intention always contains the current location and at least 1 waypoint.
- The number of waypoints is only limited by the functional time horizon.
- A set of intentions is returned as an array of intentions.

# IMPLEMENTATION

The implementation of the mechanism for sharing intentions in inland shipping entails the development and realization of several elements. While most of these are technically unrelated, they serve as enablers for each other.

## CENTRAL HUB

The specification, development, and realization of the Central Hub is a largely self-contained activity. While the hub alone cannot fulfil all requirements, particularly those related to availability and immediate broadcasting, it is advisable to commence work on the hub without delay. This will enable the rollout of intention sharing and, with appropriate considerations, its utilization in modern shipping.

## AIS

To make the sharing of intentions possible via AIS, several steps need to be set.

### *AIS PROXY*

It is important to have ECDIS systems implement an AIS proxy. This functionality is beneficial not only for intention sharing, so it is considered a parallel development.

### *ASM DEFINITION*

This document defines two specific ASM messages for the exchange of intention related information. In order for these messages to be formally allowed, a set of steps need to be performed:

1. Submit this and other documents sustaining the need and necessity for intention sharing to VTT for initial assessment.
2. Finalise the format and exchange parameters based on feedback and including additional insights from stakeholders.
3. Deploy a pilot where the exchange mechanism is built and tested
4. Finetune the exchange mechanism and submit for official deployment\

At any time during this process it is possible that the process halts. As previously stated the bandwidth for AIS is limited, (the “VDL load” is high), and sharing intentions will add significant load.