# Data Transmission in Inland AIS System

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ABSTRACT: The article presents the technical aspects of applying the marine Automatic Identification System (AIS) for the purposes of vessel traffic control in inland shipping. Functional properties and requirements for inland AIS have been discussed as well as protocol alterations in relation to marine AIS, with particular consideration of messages enhancing safety of navigation and the flow capacity of inland waterways.

## 1 INTRODUCTION

The International Maritime Organisation (IMO) has introduced an Automatic Identification System (AIS) for the purposes of marine navigation. All sea-going vessels making international voyages and covered by Chapter V of SOLAS Convention (Safety of Life at Sea) have had to be equipped with AIS since the end of 2004.

AIS technology is also applied in the automatic recognition and control of vessel traffic in inland waterways. In particular, results reached by AIS in the scope of recognition in real time and the accessibility of worldwide standards and guidelines are helpful for safety protection in waterways.

The conformity of inland AIS with IMO SOLAS AIS permits the direct exchange of information between sea-going and inland vessels moving in mixed traffic zones.

## 2 PROPERTIES

AIS system applied for automatic recognition and control of inland vessel traffic has the following properties (Article 5 of Directive 2005/44/EC of the European Parliament and of the Council on Harmonized River Information Services (RIS) on Inland Waterways in the Community):

- it is an IMO-introduced marine navigation system that must be at the disposal of all vessels subject to SOLAS convention,
- it permits information transmission directly from ship to ship, ship to shore or shore to ship,

- it is a safety system fulfilling the high requirements in the range of availability, continuity and reliability,
- it permits information transmission in real time, directly between vessels,
- it is an autonomous system, without a main station, and as such does not need a central for controlling functioning,
- it was prepared based on international standards and procedures conformed to Chapter V of SOLAS convention,
- it obtained a certificate as a system enhancing safety of navigation,
- it is interoperational.

A universal inland AIS deck station, defined by IMO, ITU (International Telecommunication Union) and IEC (International Electrotechnical Commission) and recommended for inland shipping makes use of SOTDMA access method (Self-Organizing Time Division Multiple Access) in the marine VHF range (Very High Frequency). AIS receives on international VHF frequencies: AIS 1 (161.975 MHz) and AIS 2 (162.025 MHz), and can also be switched to other VHF ranges.

An inland AIS station is made up of the following elements:

- sending-receiving VHF terminal (1 transmitter/2 receivers),
- GNSS (Global Navigation Satellite System) receiver,
- processor.

Inland vessel traffic control systems must conform to marine AIS created by IMO. This means that the messages transmitted include the following data: static information, dynamic information, voy-

age-related information and information characteristic for inland shipping like: number of blue cones/lights according to ADN/ADNR (European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways) or the Expected Time of Arrival at lock/bridge/terminal/border (ETA).


# 3  FUNCTIONAL REQUIREMENTS

Inland AIS is used for transmitting information bound with vessel traffic control and safety of navigation; therefore, the messages transmitted should contain the following data (Commission Regulation (EC) No 415/2007 of 13 March 2007 concerning the Technical Specifications for Vessel Traffic Control Systems):


## 3.1  *Static information*

Static information given independently by a particular vessel or furnished at request:

- User identifier (MMSI - Maritime Mobile Service Identifier)
- Vessel's name
- Call sign
- IMO number * (unobtainable for inland vessels)
- Kind of ship and cargo * (altered for inland AIS)
- LOA (Length overall) (with decimetre accuracy) * (altered for inland AIS)
- Breadth overall (with decimetre accuracy)* (altered for inland AIS)
- Kind of vessel or combination (ERI - Electronic Reporting International) (for inland AIS)
- Possible cargo (for inland AIS)

Positions marked with asterisk "*" are different for inland and marine vessels and have been listed in details in the chapter **alterations in inland AIS protocol**.


## 3.2  *Dynamic information*

Dynamic information on the ship has, in so far as possible, the same parameters and the same structure in the case of inland and sea-going vessels. Unused parameters should be marked as "inaccessible":
- Location (WGS 84)
- SMG (speed made good) * (qualitative information) *
- CMG (course made good) (qualitative information) *
- True course (qualitative information) *
- Speed of course alteration
- Accuracy of location (GNSS/DGNSS)
- Time of device for electronic determination of location
- Navigational status
- Set of blue marks (for inland AIS) *

- Quality of information on speed (for inland AIS /from deck sensor or GNSS)
- Quality of information on course (for inland AIS /from deck sensor or GNSS)
- Quality of information on true course (for inland AIS /from certified sensor (e.g. gyro) or non-certified sensor)


## 3.3  *Information on the voyage*

Information on the voyage is given independently by a particular vessel or furnished at request:

- Port of destination (ERI location code)
- Dangerous cargo category
- Expected Time of Arrival
- Maximum current static draft * (altered for inland AIS)
- Classification of dangerous cargo  (for inland AIS)


## 3.4  *Information on traffic management*

Information on traffic management concerns exclusively inland shipping and is transmitted as need arises or at request, to or from inland vessels:

- Identifier of lock/bridge/terminal (UN/LOCODE - United Nations Location Code) (for inland AIS)
- Expected Time of Arrival at lock/bridge/terminal (for inland AIS)
- Number of tugs (for inland AIS)
- Vessel's air draft (for inland AIS)


## 3.5  *Information on the number of persons aboard*

It is recommended that information on the number of persons aboard should be passed on demand in the case of the event happening in the form of addressed messages from ship to shore:

- Total number of persons
- Number of crew members (for inland AIS)
- Number of passengers (for inland AIS)
- Number of deck personnel (for inland AIS)


## 3.6  *Information on signal status*

Information on signal status is transmitted in the form of shore to ship message:

- Signal location (WGS84) (for inland AIS)
- Signal forma (for inland AIS)
- Light signal status (for inland AIS)


## 3.7  *EMMA (European Multiservice Meteorological Awareness) warnings*

EMMA warnings, information on water level and safety messages are transmitted in the form of shore

to ship messages, in the form of addressed or sent messages:

- Location (WGS 84) Local weather warnings (for inland AIS)
- Local information on water levels (for inland AIS)

## 4 ALTERATION IN INLAND AIS PROTOCOL

As platform for inland AIS, inland versions of portable class A stations are recommended or class B "SO" stations with the application of SOTDMA techniques. Class B "CS" stations using CSTDMA (Carrier Sense Time Division Multiple Access) techniques, on the other hand, cannot be used, as they do not secure the same effects as class A or "SO" B equipment. "CS" devices do not ensure successful data transmission by radio, nor do they make possible the transmission of messages on the presented technical specifications required for inland AIS. As long as class B "SO" devices are inaccessible, class A versions are applied adapted to the needs of inland shipping, in accordance with IMO SOLAS regulation (IMO MSC.74(69) Annex 3 "Recommendations on Performance Standards for a Universal Shipborne Automatic Identification System (AIS)" IMO (International Maritime Organisation) 1998).

Function Identifiers (FI) for inland AIS are assigned and applied in accordance with recommendations ITU-R M.1371-1 Table 37B (Recommendation ITU-R M.1371-1 – "Technical Characteristics for a Universal Shipborne Automatic Identification System Using Time Division Multiple Access in the VHF Maritime Mobile Band". ITU (International Telecommunication Union) 2001).

Each FI within the framework of inland AIS is to be assigned to one of the following groups of application areas:

- for general use (Gen),
- vessel traffic control system (VTS - Vessel Traffic System),
- navigation support (A-to-N – Aid to Navigation),
- search and rescue (SAR – Search And Rescue).

### 4.1 *Message FI 10*

Static data on vessel and voyage are presented in table 2 (only inland vessels make use of this message).

Table 2. Message FI 10 (Commission Regulation (EC) No 415/2007 of 13 March 2007 concerning the Technical Specifications for Vessel Traffic Control Systems)

| Parameter | Description |
|---|---|
| Unique European vessel identification number | 8 signs in 6-bit ASCII code |
| Kind of vessel or combination | ERI classification number: 1 Type of ship and convoy, acc. to ANNEX E: Types of ships acc. to ERI |
| Dangerous cargo | Number of blue cones /lights 0–3; 4 = flag B, 5 = default value = unknown |
| Possible cargo | 1 = loaded, 2 = unloaded, 0 = inaccessible/default value, 3 not applied |
| Quality of speed data | 1 = high, 0 = low/GNSS = default value |
| Quality of course data | 1 = high, 0 = low/GNSS = default value |
| Quality of true course data | 1 = high, 0 = low = default value |

Table 1. FI for inland AIS (Commission Regulation (EC) No 415/2007 of 13 March 2007 concerning the Technical Specifications for Vessel Traffic Control Systems)

| FI | Area | Message name | Sender | Message sent | Message addressed | Description |
|---|---|---|---|---|---|---|
| 10 | Gen | Static data on vessel and voyage | Ship | X | | See: Message FI10: Static data on vessel and voyage |
| 21 | VTS | VTS Expected Time of Arrival at lock/bridge/terminal | Ship | | X | See: Message FI21: Expected Time of Arrival at lock/bridge/terminal |
| 22 | VTS | RTA – Requested Time of Arrival at lock/bridge/terminal | Shore | | X | See: Message FI22: RTA – Requested Time of Arrival at lock/bridge/terminal |
| 23 | VTS | EMMA weather warning | Shore | X | | See: Message FI23:EMMA weather warning |
| 24 | VTS | Water levels | Shore | X | | See: Message 24:Water levels |
| 40 | A-to-N | Signal status | Shore | X | | See: Message 40:Signal status |
| 55 | SAR | Signal status | Ship | X | X (best) | See: Message FI55: Number of persons on deck |

### 4.2  Message FI 21: Expected Time of Arrival at lock/bridge/terminal (ETA).

Within 15 minutes from sending the message, message no. 22 should arrive, confirming reception. If there is no such message, message no. 21 should be repeated.

Table 3.  Message FI 21 (Commission Regulation (EC) No 415/2007 of 13 March 2007 concerning the Technical Specifications for Vessel Traffic Control Systems)

| Parameter | Description |
|---|---|
| UN country code | 2 signs |
| UN location code | 3 signs |
| Fairway section number | 5 signs |
| Terminal code | 5 signs |
| Fairway hectometre | 5 signs |
| Expected Time of Arrival at lock/ bridge/terminal | Expected Time of Arrival: MMDDGGMM UTC |
| Number of tugs | 0–6, 7 = unknown = default value |
| Vessel's air draft | 0–4 000 with accuracy to 1/100m |

### 4.3  Message FI 22: Requested Time of Arrival at lock/bridge/terminal (RTA).

Messages about RTA for a given ship are transmitted exclusively by base stations in answer to message no. 21.

Table 4.  Message FI 22 (Commission Regulation (EC) No 415/2007 of 13 March 2007 concerning the Technical Specifications for Vessel Traffic Control Systems)

| Parameter | Description |
|---|---|
| UN country code | 2 signs |
| UN location code | 3 signs |
| Fairway section number | 5 signs |
| Terminal code | 5 signs |
| UN country code | 5 signs |
| Requested Time of Arrival at lock/ bridge/terminal | Requested Time of Arrival: MMDDGGMM UTC |
| Status of lock/bridge/terminal | 0 = active<br>1 = partly restricted service (difficult technical conditions, only one chamber available etc.)<br>2 = inactive, 3 = unavailable |

### 4.4  Message FI 55

Information of number of persons aboard are presented in table 5.

Table 5.  Message FI 55 (Commission Regulation (EC) No 415/2007 of 13 March 2007 concerning the Technical Specifications for Vessel Traffic Control Systems)

| Parameter | Description |
|---|---|
| Number of crew members aboard | 0–254 crew members, 255 = unknown = default value |
| Number of passengers aboard | 0–8 190 passengers, 8 191 = unknown = default value |
| Number of deck personnel aboard | 0–254 deck personnel, 255 = unknown = default value |

### 4.5  Message FI 23: EMMA weather warning

EMMA weather warning is sent to vessel using graphic symbols on ECDIS screen (Electronic Chart Display and Information System). This message serves the purpose of sending EMMA data by means of AIS channel. This message is directed to all vessels in a given zone and is transmitted exclusively by base stations.

### 4.6  Message FI 24: Water levels

This message serves the purpose of informing masters about the current water level in the zone they are in. It is short-term additional information about water levels given by means of messages for masters. The competent authority establishes the frequency of updating. Data coming from more than 4 measuring instruments can be transmitted by means of multiple messages, which are directed to all vessels in a given zone and are sent exclusively by base stations in regular time intervals.

### 4.7  Message FI 40: Signal status

This message, directed to all vessels in a given zone, is sent exclusively by base stations. Information on light signalling is displayed as dynamic symbols on an external ECDIS display. This message is sent in regular time intervals.

## 5  RECAPITULATION

The main task of a VTS system is managing vessel traffic in a designated area, including support of navigation, traffic organisation, optimising the waterway flow capacity, planning the functioning and servicing of bridges or locks. AIS system in the inland version will ensure effective information exchange between all participants of inland transport, thereby accelerating the transport process and increasing its safety.

## REFERENCES

Article 5 of Directive 2005/44/EC of the European Parliament and of the Council on Harmonized River Information Services (RIS) on Inland Waterways in the Community.

Commission Regulation (EC) No 415/2007 of 13 March 2007 concerning the Technical Specifications for Vessel Traffic Control Systems.

IMO MSC.74(69) Annex 3 "Recommendations on Performance Standards for a Universal Shipborne Automatic Identification System (AIS)" IMO (International Maritime Organisation) 1998.

Recommendation ITU-R M.1371-1 – "Technical Characteristics for a Universal Shipborne Automatic Identification System Using Time Division Multiple Access in the VHF Maritime Mobile Band". ITU (International Telecommunication Union) 2001.