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AIS information quality report
of static AIS messages:
"AIS Information Quality Report"
Region: HELCOM

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Author

Name	Organization/function	Date
Adri Fluit	DaMSA, IT and AIS Manager	30-oct-2011

Report review

Name	Organization/function	Date
Dimitri van der Ven	Blue Gecko, Inc., Consultant	30-oct-2011
Erik Sonne Ravn	DaMSA, AIS Specialist	30-oct-2011

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Report receiver

Name	Organisation	Function/title
Mr. Edmunds Belinskis	European Maritime Safety Agency (EMSA)	Project Officer, SafeSeaNet, Vessel Traffic and Reporting Services

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Purpose of this document

This document describes methods and criteria for reporting development, based on agreements in the Service Level Agreement (SLA) between DaMSA and EMSA for the hosting, maintenance and operation of the HELCOM and the North Sea regional AIS Regional Servers and their connection with SafeSeaNet (SSN).

In the SLA, Annex 4 is written that:

Begin quote:

"DaMSA shall support EMSA in supplementing/validating information collected by EMSA about AIS data.
In particular, DaMSA shall provide with statistics in monthly and annual basis related to AIS data provided by each country participating in the North-Sea and Helcom agreements. Moreover DaMSA shall provide information and figures by each one of the participating states server per month. The figures shall be obtained querying [server] database, according to the following criteria:

- avoid duplication
- store all dynamic data
- static- and voyage- related data stored only once, unless they change

The detailed format of reporting shall be agreed with EMSA.
DaMSA together with EMSA shall develop a report that will provide lists (in computer readable format):

- of ships transmitting false ship particulars (invalid IMO, MMSI)
- of ships detected to transmit valid IMO and MMSI, but assigned actually to other vessels
- statistics indicating the improvement made on the quality of data transmitted by ships"

End quote.

DaMSA is receiving AIS data from countries participating in the Northsea and Helcom agreements. DaMSA is storing AIS static- and dynamic- AIS data in the respective databases for the NORTHSEA and HELCOM Regions and all above criteria, as described above, are met.

The report, which is discussed in this document is named the "AIS Information Quality Report", which is based on static AIS messages.

Generation of report data from static AIS data

Definition of static AIS data

AIS transponders automatically broadcast information, such as their position, speed, and navigational status, at regular intervals via a VHF transmitter built into the transponder. The information originates from the ship's navigational sensors, typically its global navigation satellite system (GNSS) receiver and gyrocompass. Other information, such as the vessel name and VHF call sign, is programmed when installing the equipment and is also transmitted regularly. The signals are received by AIS transponders fitted on other ships or on land based systems, such as VTS systems. The received information can be displayed on a screen or chart plotter, showing the other vessels' positions in much the same manner as a radar display.

The AIS standard comprises several sub-standard 'Types' which specify individual product types. The specification for each product type provides a detailed technical specification which ensures the overall integrity of the global AIS system within which all the product types must operate. The major product type described in the AIS system standards is:

- Class A Vessel mounted AIS transceiver (transmit and receive) which operates using self-organized time-division multiple-access (SOTDMA). Class A's must have an integrated display, transmit at 12 W, interface capability with multiple ship systems, and offer a sophisticated selection of features and functions. Default transmit rate is every few seconds. AIS Class A type compliant devices receive all types of AIS messages.

- AIS message 5 contains static and voyage related data and is a scheduled static and voyage related vessel data report; (Class A ship borne mobile equipment). Message 5 has a total of 424 bits, occupying two AIVDM sentences. Parameters in the message:
    - Message ID
    - Repeat indicator
    - User ID
    - AIS version indicator
    - IMO number
    - Call sign
    - Name
    - Type of ship and cargo type
    - Overall dimension/reference for position
    - Type of electronic position fixing device
    - ETA
    - Maximum present static draught
    - Destination
    - DTE
    - Spare
    - Number of bits

AIS Message 5

Parameter	# of bits	Description
Message ID	6	Identifier for this Message 5
Repeat indicator	2	Used by the repeater to indicate how many times a message has been repeated. Refer to § 4.6.1, Annex 2; 0-3; 0 = default; 3 = do not repeat any more
User ID	30	MMSI number
AIS version indicator	2	0 = station compliant with Recommendation ITU-R M.1371-1 1 = station compliant with Recommendation ITU-R M.1371-3 2-3 = station compliant with future editions
IMO number	30	1-999999999; 0 = not available = default
Call sign	42	7 = 6 bit ASCII characters, @@@@@@@ = not available = default
Name	120	Maximum 20 characters 6 bit ASCII "@@@@@@@@@@@@@@@@@@@@" = not available = default
Type of ship and cargo type	8	0 = not available or no ship = default 1-99 = as defined below 100-199 = reserved, for regional use 200-255 = reserved, for future use
Overall dimension/ reference for position	30	Reference point for reported position. Also indicates the dimension of ship (m) (see below)
Type of electronic position fixing device	4	0 = undefined (default) 1 = GPS 2 = GLONASS 3 = combined GPS/GLONASS 4 = Loran-C 5 = Chayka 6 = integrated navigation system 7 = surveyed 8 = Galileo 9-15 = not used
ETA	20	Estimated time of arrival; MMDDHHMM UTC Bits 19-16: month; 1-12; 0 = not available = default Bits 15-11: day; 1-31; 0 = not available = default Bits 10-6: hour; 0-23; 24 = not available = default Bits 5-0: minute; 0-59; 60 = not available = default
Maximum present static draught	8	In 1/10 m, 255 = draught 25.5 m or greater, 0 = not available = default; in accordance with IMO Resolution A.851. The depth of a loaded vessel in the water, taken from the level of the waterline to the lowest point of the hull.
Destination	120	Maximum 20 characters using 6-bit ASCII; @@@@@@@@@@@@@@@@@@@@ = not available
DTE	1	Data terminal equipment (DTE) ready (0 = available, 1 = not available = default)
Spare	1	Spare. Not used. Should be set to zero. Reserved for future use.
Number of bits	424	Occupies 2 slots

This table shows the fields, length (#of bits) and other information of an AIS message.

Field	Len	Description	Member/Type	T	Encoding
0-5	6	Message Type	type	u	Constant: 5
6-7	2	Repeat Indicator	repeat	u	Message repeat count
8-37	30	MMSI	mmsi	u	9 digits
38-39	2	AIS Version	ais_version	u	0=[ITU1371], 1-3 = future editions
40-69	30	IMO Number	imo	u	IMO ship ID number
70-111	42	Call Sign	callsign	t	7 six-bit characters
112-231	120	Vessel Name	shipname	t	20 six-bit characters
232-239	8	Ship Type	shiptype	e	See "Codes for Ship Type"
240-248	9	Dimension to Bow	to_bow	u	Meters
249-257	9	Dimension to Stern	to_stern	u	Meters
258-263	6	Dimension to Port	to_port	u	Meters
264-269	6	Dimension to Starboard	to_starboard	u	Meters
270-273	4	Position Fix Type	epfd	e	See "EPFD Fix Types"
274-277	4	ETA month (UTC)	month	u	1-12, 0=N/A (default)
278-282	5	ETA day (UTC)	day	u	1-31, 0=N/A (default)
283-287	5	ETA hour (UTC)	hour	u	0-23, 24=N/A (default)
288-293	6	ETA minute (UTC)	minute	u	0-59, 60=N/A (default)
294-301	8	Draught	draught	U1	Meters/10
302-421	120	Destination	destination	t	20 6-bit characters
422-422	1	DTE	dte	b	0=Data terminal ready, 1=Not ready (default).
423-423	1	Spare		x	Not used

Description	Value	Value Description
Vessel Name	MUZAFFER BEY	
NMEA Sentence	!AIVDM,2,2,8,A,j@KII0BC`{	
Sentence Type	!AIVDM	{Msg ID = 8, part 2 of 2}
Fragments in this message	2	
Fragment No	2	
Sequential Message ID	8	
Radio Channel	A	
Payload	j@KII0BC`888880	88 bits (15 6-bit words)
Fill bits * CRC check	2*24	
AIS Message		424 bits (53 8-bit words)
AIS Message Type	5	Ship and Voyage Report
Repeat Indicator	0	Repeatable
MMSI	370 824 000	Panama (Republic of)
AIS Version	0	Compliant with ITU-R M.1371-1
IMO Number	IMO 9452127	
Call Sign	3FME7	5 characters
Vessel Name	MUZAFFER BEY	12 characters
Ship Type	70	Cargo-all ships of this type
Dimension to Bow	82 meters	
Dimension to Stern	20 meters	Length is 102 meters
Dimension to Port	10 meters	
Dimension to Starboard	6 meters	Beam is 16 meters
Position Type Fix	1	GPS
ETA month	03	
ETA day	05	
ETA hour	01	
ETA minute	30	
Draught	3.3 meters	
Destination	VALENCIA/SPAIN	14 characters
DTE	0	Data Terminal Ready
Spare	0	1 bits

This screendump shows the result of an AIS message, decoded by an AIS decoder.

Criteria and methods

The report, which is discussed in this document is named the "AIS Information Quality Report".
The report is based on data containing AIS static messages 5, which are sent from Class A ships.

Criteria	Approval	Method
IMO	Valid IMO number.	IMO number validation algorithm.
MMSI	Valid MMSI number.	• DaMSA reference table • Lloyds database (license acquired) • Online ITU Maritime database(s): only used in individual situation for 'double-check' reasons
Callsign Ship name Type of ship Dimension of ship (m)	Checked if IMO and MMSI numbers are valid, and is used to complete the validation of a ship.	References: • DaMSA reference table • Lloyds database (license acquired) • Online ITU Maritime database(s) : only used in individual situation for 'double-check' reasons

IMO number validation

Method to validate IMO numbers

- IMO Numbers are made up of letters "IMO" and seven decimal digits.
- The digits to be checked are weighted from right to left by 2, 3, 4, 5, 6 and 7.
- Products are added up.
- The sum is divided by 10.
- The remainder is the check digit.
- Example: IMO 9074729 (Pacific Frontier, Hong Kong)

  9 - 0 - 7 - 4 - 7 - 2 - 9

  7 - 6 - 5 - 4 - 3 - 2

  63+0+35+16+21+4=139

  MOD(139,10) = 9 => This IMO is valid.

Database function for validation of IMO numbers

```sql
CREATE OR REPLACE FUNCTION validate_imo (imo_num IN NUMBER)
  RETURN VARCHAR2
AS
  /* Function to validate IMO numbers. @RETURN: 1 = VALID 0 = INVALID */
  v_imo            VARCHAR (100 BYTE);
  v_last_num       NUMBER;
  v_sum_products   NUMBER;
  v_return         VARCHAR2 (100);
BEGIN
  v_imo := TO_CHAR (imo_num);
  /* IMO numbers are made up of 7 decimal digits */
  IF (LENGTH (v_imo) = 7)
  THEN
    v_last_num := SUBSTR (v_imo, 7, 1);
    v_sum_products :=
        7 * SUBSTR (v_imo, 1, 1)
      + 6 * SUBSTR (v_imo, 2, 1)
      + 5 * SUBSTR (v_imo, 3, 1)
      + 4 * SUBSTR (v_imo, 4, 1)
      + 3 * SUBSTR (v_imo, 5, 1)
      + 2 * SUBSTR (v_imo, 6, 1);

    IF (MOD (v_sum_products, 10) = v_last_num)
    THEN
      /* valid imo */
      v_return := 'Valid';
    ELSE
      v_return := 'Failed validation';
    END IF;
  ELSE
    v_return := 'Wrong length';
  END IF;

  RETURN v_return;
END;
/
```

Excluded ship types for IMO identification

Ship type	Size	Remarks
Diving	Often small ships.	IMO number not required.
Dredging	Often small ships.	IMO number not required.
Fishing	Small ships.	IMO number not required.
Law Enforcement	Often small ships	IMO number not required.
Medical Transport	Often small ships.	IMO number not required.
Military		Military ships follow different rules.
N/A	Often small ships.	IMO number not required.
Other	Often small ships.	IMO number not required.
Passenger		The smallest do not require IMO number.
Pilot Vessel	Small ships.	IMO number not required.
Pleasure Craft	Small ships.	IMO number not required.
Port Tender	Small ships.	IMO number not required.
Sailing	Often small ships	IMO number not required.
Search and Rescue	Small ships.	IMO number not required
Ships according to RR		RR Resolution No. 18 (Mob-83)
Spare 57	Assignments to local vessels.	IMO number not required.
Undefined	Often small ships.	IMO number not required.

Ships according to RR   Recommendation ITU-R M.493-11*,
                               Digital selective-calling system for use in the maritime mobile service

Spare 56   Spare – for assignments to local vessels

Spare 57   Spare – for assignments to local vessels

From SOLAS regulation XI/3 of 1994:

- All passenger ships above 100GT must have an IMO number
- All cargo ships over 300 GT must have an IMO number

We assume, that this means that IMO is required for:

- Passenger ships equal and greater than 30m. in length
- Cargo ships equal and greater than 60m. in length

Excluded passenger and cargo ships:

- Passenger ships less than 30m. are excluded from the report
- Cargo ships less than 60m. are excluded from the report

MMSI validation

Validation of MMSI numbers

1. The MMSI number must have a length of 9 digits; this means that MMSI=0 (= Known error) and missing MMSI numbers are weeded

2. MMSI numbers known as 'Known Errors' are weeded, such as 9 equal digits:
   a. 000000000
   b. 111111111
   c. 222222222
   d. 333333333
   e. 444444444
   f. 555555555
   g. 666666666
   h. 777777777
   i. 888888888
   j. 999999999
   k. 123456789

3. Other MMSI Known Errors:
   a. MMSI = 0 (default)
   b. MMSI = 1193046 (default/resetting value for Nauticast AIS instruments)

4. Main root causes of MMSI errors:
   a. MMSI number wrongly inserted in the AIS instrument.
   b. MMSI number and IMO number have been interchanged, when the AIS instruments was installed (i.e. MMSI has got 7 figures, IMO has got 9 figures).

5. MMSI numbers can be checked in the DaMSA reference table; please see the description for this table in this document

6. MMSI numbers can be checked in the Lloyds tables (license acquired)

7. Individual MMSI numbers can be checked in the Online ITU Maritime database(s)

Conversion of shiptype number to shiptype name

```
CREATE OR REPLACE function shiptype_to_name (ship_type in number)
return varchar2
is v_return varchar2(100);
  /* Function to convert the ship type number to ship type name. */
begin
  case
    when ship_type in (0) then v_return := 'Undefined';
    when ship_type in (1) then v_return := 'N/A';
    when ship_type in (2) then v_return := 'Reserved';
    when ship_type in (3) then v_return := 'WIG';
    when ship_type in (4) then v_return := 'Pleasure Craft';
    when ship_type in (5) then v_return := 'HSC';
    when ship_type in (6) then v_return := 'Pilot Vessel';
    when ship_type in (7) then v_return := 'Search and Rescue';
    when ship_type in (8) then v_return := 'Tug';
    when ship_type in (9) then v_return := 'Port Tender';
    when ship_type in (10) then v_return := 'Anti Pollution';
    when ship_type in (11) then v_return := 'Law Enforcement';
    when ship_type in (12) then v_return := 'Spare 56';
    when ship_type in (13) then v_return := 'Spare 57';
    when ship_type in (14) then v_return := 'Medical Transport';
    when ship_type in (15) then v_return := 'Ships according to RR';
    when ship_type in (16) then v_return := 'Passenger';
    when ship_type in (17) then v_return := 'Cargo';
    when ship_type in (18) then v_return := 'Tanker';
    when ship_type in (19) then v_return := 'Other';
    when ship_type in (20) then v_return := 'Fishing';
    when ship_type in (21) then v_return := 'Towing 1';
    when ship_type in (22) then v_return := 'Towing 2 long/wide';
    when ship_type in (23) then v_return := 'Dredging';
    when ship_type in (24) then v_return := 'Diving';
    when ship_type in (25) then v_return := 'Military';
    when ship_type in (26) then v_return := 'Sailing';
    else v_return := 'Other';
  end case;
  return v_return;

end;
/
```

Conversion of MMSI number to Region

```
CREATE OR REPLACE function mmsi_to_region (mmsi_in in number)
return varchar2
is
 /* Function to convert the MMSI number to a region code string */
 v_first_digit number;
 v_return varchar2(100);
begin
 v_first_digit := substr(mmsi_in,1,1);
 case
   when v_first_digit in (0) then v_return := 'Ship group, coast station, coast station group';
   when v_first_digit in (1) then v_return := 'Not used - Inmarsat A';
   when v_first_digit in (2) then v_return := 'Europe';
   when v_first_digit in (3) then v_return := 'North and Central America, Caribbean';
   when v_first_digit in (4) then v_return := 'Asia';
   when v_first_digit in (5) then v_return := 'Oceana';
   when v_first_digit in (6) then v_return := 'Africa';
   when v_first_digit in (7) then v_return := 'America';
   when v_first_digit in (8) then v_return := 'Regional';
   when v_first_digit in (9) then v_return := 'National';
   else v_return := 'Undefined';
 end case;
 return v_return;
end;
/
```

Conversion of MMSI number to Country

```
CREATE OR REPLACE function mmsi_to_country (mmsi_in in number)
return varchar2
is
 /* Function to convert the mmsi number to a country string */
 v_country_digits number;
 v_country varchar2(100);
begin
 v_country_digits := substr(mmsi_in,1,3);
 SELECT CTRY_NAME INTO v_country FROM TBL_CTRY WHERE MID = v_country_digits;
 return v_country;
end;
/
```

DaMSA reference tables

DaMSA has created three tables, which are used for validation and report generation.

1. TBL_REGION: This table contains all global regions, such as:
    2 – Europe
    3 - North and Central America and Caribbean
    4 – Asia
    5 – Oceana
    6 – Africa
    7 - South America

2. TBL_CTRY: This table is based on the ITU table of Maritime Identification Digits (MID) and contains MIDs and country names

3. FRVREF:
    a. This table contains static ship particulars from ships, which have been sailing in the HELCOM or NORTHSEA Region, since the 31st of January 2005.
    b. Ships in this table are in possession of a valid IMO number, according 'IMO number validation'
    c. Ships in this table are in possession of a valid MMSI number; according 'Criteria for the validation of MMSI numbers'
    d. The length of the ship must have a positive value
    e. The width of the ship must have a positive value
    f. Ships, which meet the requirements of above mentioned conditions A-E, and are existing in the Lloyds table, are marked as IMO validated.

    The FRVREF table is updated every month and extended with an extra month of data from the Regional databases.
    This reference table is considered as a very reliable reference table, due to the fact that IMO and MMSI validations have taken place and that the data is based on highly updated and valid static AIS messages from a period of seven (7) years.

Known errors

1. Information in these AIS messages 5 fields (especially ETA and destination) are not reliable,
   as it has to be hand-updated by humans rather than gathered automatically from sensors.

2. Some errors may immediately be identified as errors, either because they have a default value or because the value is obviously wrong.
   Other errors may be more difficult to detect, and in this situation comparisons with other registers may prove valuable.
   At the DaMSA there is a special focus on the IMO numbers, since these numbers uniquely identify the ships.

   The IMO numbers are (like all other static and voyage related parameters) manually entered in the AIS instrument and are therefore subject to errors/typos.

Parameter	Known errors	Comment
IMO	IMO missing IMO = 0 (default) IMO >= 10,000,000	Default means, that no IMO number was inserted on the transponder. If > 10.000.000: For instance if IMO and MMSI have been interchanged.
MMSI	MMSI = 0 (default) MMSI = 1193046 (default/resetting value for Nauticast AIS instruments) MMSI = 123456789 MMSI = 111111111	MMSI wrongly inserted in the AIS instrument. MMSI and IMO have been interchanged, when the AIS instruments was installed (i.e. MMSI has got 7 figures, IMO has got 9 figures). A way to check the correctness of MMSI numbers is to compare with the ITU database: Here you can manually enter an MMSI number, a call sign or a ship name and check the existence of the ship in the ITU database. In principle, all legal MMSI numbers should be in the ITU database, but it is of course not water proof: http://www.itu.int/cgi-bin/htsh/mars/ship_search.sh#start

Ship name	Ship name missing (the name field is empty or filled with blank characters: @) "@@@@@@@@@@@@@@@@@@@@" = not available = default	All static and voyage related parameters are manually entered in the AIS instrument and are therefore subject to errors/typos.
Call sign	Call sign is missing @@@@@@@ = not available = default	All static and voyage related parameters are manually entered in the AIS instrument and are therefore subject to errors/typos. A call sign can have up to 7 characters (figures or letters).
Type of ship and cargo type	0 = not available or no ship = default	
Size_a and size_b	Size_a = 0 and size_b=0 Ship dimensions in AIS messages (5) will be 0 if not available. For the dimensions to bow and stern, the special value 511 indicates 511 meters or greater. The length is a negative value.	The length of the ship is size_a + size_b. Therefore, if may be correct if one of the parameters is 0, if only the other one is not. The sum of size_a and size_b should correspond to the ship length given in the Lloyds register (an exact match is, however, not to be expected). Note that size_a and size_b represent the location of the GPS antenna on board the ship. There may, however, be two antennas, and the ship position information system switches antennas, new values of size_a and size_b may turn up. Still the sum of these values should correspond to the length of the ship. If the installer of the AIS instrument was unaware of the fact, there should be two antenna positions installed, the static messages may switch between size_a and size_b having correct values and being 0.
Size_c and size_d	Size_c = 0 and size_d=0 For the dimensions to port and starboard, the special value 63 indicates 63 meters or greater. The width is a negative value.	The width of the ship is size_c + size_d. The comments above to size_a and size_b also apply to size_c and size_d.

Type of electronic position fixing device	Type of electronic position fixing device = 0 = undefined (default)	All static and voyage related parameters are manually entered in the AIS instrument and are therefore subject to errors/typos.
ETA	Bits 19-16: month; 0 = not available = default Bits 15-11: day; 0 = not available = default Bits 10-6: hour; 24 = not available = default Bits 5-0: minute; 60 = not available = default	
Maximum present static draught	0 = not available = default;	In accordance with IMO Resolution A.851
Destination	@@@@@@@@@@@@@@@@@@@@ = not available	
DTE	Data terminal equipment (DTE) ready 1 = not available = default)	

Procedure for report generation

For the generation of the "AIS Information Quality Report", the following procedure is followed:

1. The *total number of distinct ships* over a period is collected from the Regional database.
   Distinct means: Two or more ships are distinct if the ship is found with equal ship particulars and valid IMO/MMSI numbers.

2. The *total number of distinct ships per ship type* over a period is collected from the Regional database.
   Certain ship types, as described under 'Excluded ship types for IMO identification', can be found in the report as 'Other ship types'.

3. The *total number of distinct ships per region* over a period is collected from the Regional database.
   Considered regions are:
   2 – Europe
   3 - North and Central America and Caribbean
   4 – Asia
   5 – Oceana
   6 – Africa
   7 - South America

4. The *total number of distinct ships per European country* over a period is collected from the Regional database.

5. *IMO validation* is performed and ships with invalid data are collected in a separate table 'INVALID_IMO'. This table is used to document all ships in this category.
   The total number and percentage per ship type, per region and per European country is registered in the report.
   The report contains IMO validation based on two (2) assumptions:
   a. SOLAS regulation XI/3 from 1994. Passenger ships over 100 GT need an IMO#.
      Assumption: Passenger ships larger than 30 m in length, are over 100 GT and need an IMO#.
   b. SOLAS regulation XI/3 from 1994. Cargo ships over 300 GT need an IMO#.
      Assumption: Cargo ships larger than 60 m in length, are over 300 GT and need an IMO#.

6. *MMSI validation* is performed and ships with invalid data are collected in a separate table 'INVALID_MMSI'. This table is used to document all ships in this category.
   The total number and percentage per ship type, per region and per European country is registered in the report.

7. The following categories exist in the report:
    a. *Ships with an invalid IMO number*
    b. *Ships with an invalid MMSI number*
    c. *Ships with an invalid IMO and MMSI numbers*
    d. *Ships detected transmitting valid IMO/MMSI numbers , but with discrepancies in the callsign or in the name*
    e. *Reporting MMSI only: Where IMO = 0 or IMO is NULL and with valid MMSI*

8. *Known errors* are described in this document, based on findings in the databases and in other documentation.

9. No *root cause analysis* on reported invalid AIS data is performed, due to the fact that this is outside the scope of report generation.

Copenhagen, 04-nov-2011,

Adri Fluit
AIS and IT Manager
Innovation And Project Division
DaMSA - Denmark