The role of AIS for small ships monitoring

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1. INTRODUCTION

AIS technology has been created as a tool for collision avoidance and means of automatic data exchange between ships, but also ships and shore-VTS centers. Nowadays AIS became an important source of information about the marine traffic for national and regional monitoring networks. The AIS standard was developed and approved in result of interaction of international bodies like IALA, IMO, ITU and IEC in 1998. The practical implementation has been speed up by revision of SOLAS Convention in 2001, Copenhagen Declaration 2001 and EU Directive in 2002. This also resulted in establishing in the Community a vessel traffic and information HELCOM system with the view to enhancing the safety and efficiency of maritime traffic improving the response of authorities to dangerous situations at sea. Special attention has been paid to traffic organization, contributing to a better prevention and detection of environmental pollution by ships. Coordinated traffic surveillance includes also search and rescue actions as well as security improvement aspect. There are many potential benefits to be realized with AIS technique and just as many expectations, but also there are issues yet to be resolved.

All mentioned features concern mainly AIS class A - designed for SOLAS ships, but what about the future policy with regard to other smaller ships, including pleasure crafts and yachts?

This paper presents an outlook of HELCOM and AIS-PL monitoring networks, legal regulations, class A versus class B, future AIS requirements, practical implementation of AIS on small craft. It concludes with recommendation for continuing development towards better understanding of system operational features and reliable functioning.

2. AIS AS A TOOL FOR NAVIGATION

The benefit of AIS for all mariners lies mainly in its capabilities for increasing navigational awareness and help in collision avoidance. Wide AIS application requires familiarization of seamen and personnel of monitoring systems with the basics of the AIS technique, its operational features and limitations.

According to the IMO Resolution A.917 (22) “Guidelines for the onboard operational use of shipborne Automatic Identification System (AIS)” adopted in November 2001, before using, the user of ship-borne AIS should be acquainted with description of the AIS system, fully understand the principle of its work, its possibilities and limitations. Should become familiar with the operational features of the equipment, including the correct interpretation of the displayed data.
With a set of static, dynamic and voyage-related data broadcasted through an AIS signals a mariner can “see” a target ship’s location, name, size, draught, navigational status, speed and course over ground, heading, rate of turn and is able to identify that vessel or to agree maneuvers.

Parameters transmitted by AIS are more accurate than measured by radar, however their quality depends on used positioning system (GPS, DGPS, Glonass, Loran) and other onboard sensors as well as their proper set-up. AIS has no blind zones created by island, rocky fiord or high structures in the port, also has no effect of false acquisition if two ships are close each other. AIS transmission is also more robust to weather conditions, have no clutter during heavy rain, however the coverage range is height dependant in similar way to radar.

Apparently the capabilities of AIS as a navigational tool, can not be achieved without enhancement to the mandatory equipment. It is well known fact, that so called MKD (Minimum Keyboard Display) equipped with the ordinary three-line alphanumeric display fulfilling IMO requirement has very limited possibilities. Text on it is difficult to read and process of data scrolling is time consuming, situational awareness requires cooperation with external chart edited in WGS-84 datum.

Real potential of AIS can only be explored when all received ships’ echoes being within VHF range are combined on a common screen or better marine navigation chart. The application of charting software in real time can be used to plot their current positions, and predict future ship’s track to display possible meeting locations (Fig. 1).

![Fig. 1. Ships’ track visualization, HELCOM 05/2006](image)

This kind of current situation visualization can really assist in collision avoidance, piloting, route planning and surveillance from the shore [1]. However, it is still necessary to be aware of fact that not all ships are equipped with AIS, and it should a good practice to integrate radar and AIS echoes on a common screen.

The AIS transponder has also digital communication capabilities that can provide useful information from external to the own ship sources.

Main of these are:
- Safety Related Messages – text messages in relation ship to ship or ship to shore,
- binary massages, like DGPS, EGNOS corrections,
In order to monitor vessel navigation with better than the 10-metre accuracy, a reliable DGNSS correction signals can be made available to all vessels throughout the VTS area. It is technically possible to transmit the relevant corrections using the AIS itself.
- aid to navigation information, virtual aids (buoys),
- radar target broadcasting.

3. LIMITATIONS ASSOCIATED WITH THE USE OF AIS

Although AIS has the potential to greatly enhance VTS operations, the system does have several limitations or potential drawbacks. For example [4]:

- VTS operators may become overly dependent on AIS and, therefore, may treat the system as a sole or primary means for vessel identification; as a result, they may fail to identify contacts, because all vessels may not be equipped with AIS transponders;
- AIS is subject to the same vagaries and vulnerabilities of VHF-FM;
- When a AIS unit reaches its saturation point (maximum number of transmission receipts), TDMA prevents overload of the AIS unit by culling transmissions, accepting those closest to the unit and eliminating those furthest away, a feature particularly useful to ships, which must pay particular attention to those vessels in closer proximity; however, this feature could prove detrimental to VTS operations that must service a large area and must give equal if not more attention to areas distant from a VTS transponder site(s); and
- AIS is not intended to be a general communications means; therefore, to match general communications requirements, mariners and VTS operators should use the appropriate and emerging new general communications technologies.
- Whilst AIS tracks will avoid the great majority of radar shadow effects, the very close proximity of buildings and bridges, sometimes known as the “urban canyon” effect, can cause difficulties for GPS in AIS transponders in heavily built-up areas.

4. WHAT ABOUT NON-SOLAS AIS SET?

Participation by smaller ships and yachts will depend on cost and benefits. With increasing participation the cost will decrease and the added value of joining the network will increase. Generally, AIS sets not fitted compulsorily are known as Class B sets, the format of which is not at present controlled or specified. It is clear that they are aimed at the larger non-Solas ships. Performing close to Class A with similar functionality, power and hardware, also with some functions as optional extras. Some AIS sets are on the market with small text displays or without. These could be used by small crafts.

4.1 Class A and Class B Ship-borne Mobile Equipment

In recognition of this requirement, allowance has been made in the AIS Technical Standards (ITU-R M.1371-1) for both Class A and Class B Ship-borne Mobile Equipment. Class A equipment complies with the IMO AIS carriage requirement while the Class B provides capabilities not necessarily fully compliant with IMO requirements, but necessarily system-compatible, to perform satisfactorily on the VDL.
Administrations have the responsibility of determining the applicability of Class A or Class B equipment to vessel categories.

**Types of AIS**, [2]

ITU-R Recommendation M.1371-1 describes the following types of AIS:

**Class A**

Shipborne mobile equipment intended for vessels meeting the requirements of IMO AIS carriage requirement, and is described above.

**Class B**

Shipborne mobile equipment provides facilities not necessarily in full accord with IMO AIS carriage requirements. IEC has begun work on a Class B certification standard, which had to be completed by 2005. The Class B is nearly identical to the Class A, except the Class B:

- Has a reporting rate less than a Class A (e.g. every 30 sec. when under 14 knots, as opposed to every 10 sec. for Class A)
- Does not transmit the vessel’s IMO number or call sign
- Does not transmit ETA or destination
- Does not transmit navigational status
- Is only required to receive, not transmit, text safety messages
- Is only required to receive, not transmit, application identifiers (binary messages)
- Does not transmit rate of turn information
- Does not transmit maximum present static draught
- Class B devices are not yet available.

**4.2 Inland waterways**

As an example of a regional inland approach to AIS use, modified AIS carriage is contemplated for certain European waterways where the mix of ocean/sea and inland vessels cause great complication and congestion. Multi-national river commissions will regulate policy and practice, setting precedent for other Administrations and regions to follow in similar inland scenarios where radio frequency availabilities permit.

For such inland applications, development of ‘Class A derivative’ AIS equipment has been considered, providing full SOTDMA functionality, but not involving DSC components, to achieve radio frequency agility. As the AIS position sensor may also be the inland vessel’s only position fixing device, new regionalized procedures may be necessary for display interface [4].

**4.3 Use of automatic identification systems by fishing vessels**


The consequences of accidents at sea very often extend beyond the wrecked ship itself and affect all coastal activities. Maritime accidents involving pollution now turn into national or even international emergencies. The “prevention” component of the EU’s maritime safety policy therefore had to be supplemented with a component permitting the operational management of maritime risk at Community level.

Similarly, the proposal to introduce an obligation to carry an automatic identification system (AIS) for fishing vessels of more than 15 metres is a response to the large number of collisions involving fishing vessels which have evidently not been identified by commercial vessels.
It is proposed that any fishing vessel with a length of more than 15 metres overall and sailing in waters under the jurisdiction of a Member State must be fitted with an AIS which meets the performance standards drawn up by the IMO."

- fishing vessel of overall length 24 metres and upwards but less than 45 metres: not later than 1 January 2008;
- fishing vessel of overall length 18 metres and upwards but less than 24 metres: not later than 1 January 2009;
- fishing vessel of overall length exceeding 15 metres but less than 18 metres: not later than 1 January 2010."

4.4 AIS Participation by boats

But will boats carry a UAIS-like transponder? It is predictable that in the near future, VHF and GPS manufacturers will offer a (digital) radio modem of some sort. Boats’ needs are just different. Boats don’t have rate of turn sensors and don’t need remote AIS channel assignment. They do need position updates from SOLAS ships and other boats for collision avoidance, they do want e-mail, both with other boats and with the internet, they do want differential GPS corrections and they do want other services a radio modem could provide such as berth reservations, weather charts and electronic chart updates, even web access. But there probably won’t be enough bandwidth available on AIS channels to accommodate them all.

5. HELCOM and POLISH AIS NETWORK

A legal basis for AIS network implementation was set up by the International Maritime Organization (IMO) in SOLAS Convention, Chapter V “Safety of Navigation” and Directive EU 2002/59/EC. Besides, in 2001 the Helsinki Committee member countries have signed “Declaration on the Safety of Navigation and Emergency Capacity in the Baltic Sea”. The Declaration takes into consideration the matter of navigation safety, the common HELCOM system for ships traffic monitoring, based on adequate international standards and national networks of AIS onshore stations systems. The general idea of a structure (Fig. 5.1) of the Baltic AIS system was agreed and principles of information exchange accepted. [3].

Polish AIS network consists of 11 onshore base stations, linked via IT lines. Domestic and international servers are collocated in VTS Centre Gdynia. The national system is linked to the common HELCOM server in Copenhagen. The HELCOM server collects data streams from all national AIS systems in Baltic’s’ system (Fig. 5.2).
Fig. 5.1 General structure of HELCOM AIS network

Fig. 5.2 AIS Baltic’s traffic screen, April 2006. Yellow dots are land base stations
6. RESCUE BOAT TEST WITH AIS ONBOARD

The rescue boat name PARKER was tested with AIS mobile transponder onboard during the four days trip tracked non-stop around Baltic in August 2005.

Program of the investigation:

- Permanent surveillance of the fast rubber boat under test to observe the coverage ranges of land based AIS/VTS systems within the Polish EEZ.
- Testing the Search and Rescue boat and the HELCOM AIS network possibility of tracking the craft in severe maritime conditions.

6.1 Route of the boat „Parker”

Planned route (Fig. 6.1) was proposed to start from Gdynia via Gdansk Bay towards A1 zone of German and Danish waters, next was planned along the Swedish coast line between Oland and Gotland Islands. Having traversed Visby port, the boat had to turn back to the south-east, next along Latvian and Lithuanian coast was to come back to Poland.

In practice due to very harsh weather conditions the route was modified according to wind and wave parameters. Stormy weather was so danger those days, which resulted in rescue operation in Polish responsibility zone (drifting yacht Rzeszowiak) and SAR operation in Estonian zone. The helicopter with the crew and passengers onboard was drawn. Finally the test lasted 5 days.

Rys. 6.1. Planned route of boat „Parker”(red) and realized (yellow).

Executed route shows 3 stops in the ports. It lasted 5 stormy days with the wind force from 7 to 10B and sea state 3-5, ambient temperature was in the range 18-14C.

6.2 Boat technical data (fot. 1)
Fig. 6.2 Parker - Navigation and radio systems
Chart plotter + echo sounder, GPS – 2 pcs, AIS pilot box type 200P, Radar, passive reflector, fluxgate compass, radio VHF, cellular phones, sat phone,

Fig. 6.3 Technical data of portable AIS.

**Technical data**
- Overall lenght 7.5m
- Beam: 3.12m
- Weigh without engine: 820 kg
- Engines: 2x120 HP
- Crew: 3 persons
- Antenna’s height: VHF – 3 m npm;

Kongsberg AIS 200 P is an “all-in-one” compact AIS mobile station. This rugged AIS unit is designed for easy transportation and installation on board vehicles not carrying an AIS Mobile Unit. The AIS 200 P can run on either 230 VAC or 24 VDC and has an internal battery backup to ensure operation in case of temporary power failure. A built-in state of the art WLAN as well as an external PI interface and sensor interfaces, together with the integrated MKD, ensure easy installation and maintenance.

Fig.6.3. Technical data of portable AIS.
6. 3 Boat Parker - AIS tracks from HELCOM

Fig. 6.4. Boat „Parker” starts from Gdynia Port on 08.08.2005, speed 22 kt

Fig. 6.5 From Bornholm to Carlskrona, crossing Baltic’s D route
Fig. 6.6. Close to Carlskrona, late evening 09.08.05, non-continuous track

Fig. 6.7 Carlskrona, radar fault.
6.4. Conclusions

- Despite of the rough weather conditions AIS on small craft allowed for nearly continuous tracking with the use of HELCOM network.
- AIS range was much longer than radar
- Accurate positioning of the boat allowed for remote navigational assistance
- Surveillance and support from the AIS network positively influenced mood of the crew.

7. GENERAL CONCLUSIONS

Most mentioned above rules are applicable with regard to small ships, crafts and boats

- AIS proves to be beneficial for general safety on the sea
- Minimum requirement AIS set do not satisfies the full potential of the system
- AIS can serve as a navigational tool
- There will be new regulation in EU with regard to fishing ships
- There are still AIS limitations to be learned
- Large area AIS system proves its usefulness for fleet and SAR management

References