AIS land infrastructure and its utilization

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Abstract

This paper briefly presents the AIS land infrastructure in Sweden and how it is used as a common resource by multiple users. Some of the applications for the AIS information within the Maritime Administration are presented. It also discuss international co-operation concerning AIS land infrastructure, exchange of AIS information and possible future development. Existing and expected problems with AIS are shown and mitigation measures presented.

Keywords: AIS land infrastructure, AIS applications.

1. Introduction

The Swedish Maritime Administration started testing the AIS technology over 12 years ago and has since then actively taking part in the regulatory work in IMO concerning AIS and in the international standardisation of the various types of AIS-units that now are available. Although the opinion in Sweden is that the most important roll of AIS is to increase situation awareness onboard, the AIS information should be used on shore as well. Based on experiences made and the available technology, the AIS land infrastructure and the applications for use of AIS have been developed during this period.

The widespread use of AIS has now really shown that the capacity of the VHF Data Link is limiting factor and that it must be used as a limited resource. The efficient use of the available capacity is first and foremost a question for the shore based systems, leaving as much capacity as possible for the main functions of AIS.

2. AIS infrastructure

2.1 AIS infrastructure in Sweden

In the mid nineties the shore systems consisted of a few local AIS shore stations placed nearby VTS:es with a display system connected directly to the AIS. Although there wasn't many ships with AIS onboard it was soon realized that the AIS information would be useful not just locally but also by distant users. SMA started -97 to build a shore infrastructure with AIS basestations covering all Swedish sea-areas and some inland waterways. The information was transferred from the basestations to SMA head office via point to point leased lines for serial communication. The information was then processed, filtered and redistributed to different users all over Sweden via the general data communication network of the administration and via leased lines or over Internet to other organisations.

When the importance of AIS information increased it was decided to build a more robust system with regional servers and a network type of communication. The five regional servers are connected to the base stations in their region and with each other via a high speed data network. Each regional server get the information from the other regional servers as well and the user can connect to any of the regional servers via SMA network or other leased line and get the data in accordance with his user profile. It is also possible to connect to a separate server via Internet. This gives multiple access ways to the information for the different users. There are 38 base stations in total and some critical areas are covered by two stations.
The availability we have reached now is 99,89 % and over 80 % of the downtime is due to communication errors. We are therefore now investigating the possibility to connect the base stations with redundant communication lines to further improve the availability.

Information from the AIS-network is presently used for different applications within SMA, as discussed below, but it is also used by the Swedish Coast Guard, the Navy, the customs, ports, shipowners. The AIS network is common nationwide system serving different users in accordance with their needs and user rights.

2.2 AIS co-operation in the Helcom framework

The Helsinki Convention was signed by the Baltic Sea States in 1974 with the aim to protect the Baltic Sea from pollution from ships and pollution from land-based sources. The Helsinki Commission, or HELCOM, is the governing body of the Convention. The Contracting parties of the organisation are Denmark, Estonia, European Community, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden.

A new convention was signed in 1992 in order to extend, strengthen and modernize the legal regime for the protection of the marine environment of the Baltic Sea area. A ministerial meeting of HELCOM adopted on 10 September 2001 the Copenhagen Declaration, which includes several measures to increase the safety of sea borne transports.

One measure was to enhance the use of AIS by:

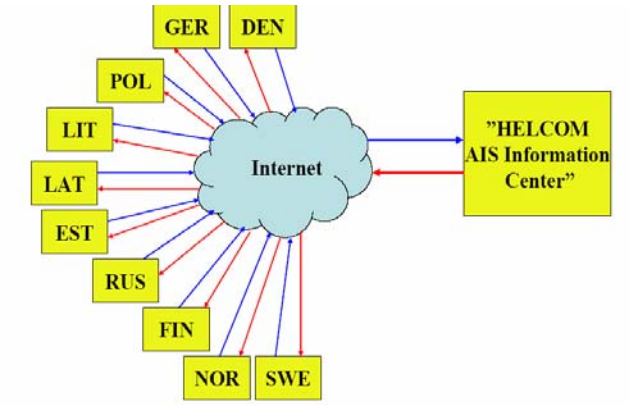
- Establish national AIS based monitoring systems before 1 July 2005.
- Establish a common Baltic Sea monitoring system, based on and with access to all national AIS systems.
- Prepare reliable statistics on ships traffic in the Baltic Sea (based on AIS).

The way to do this is that each country establishes a contact point, called "national server" with a standardized interface to Internet. The system "behind" that server is a domestic affair and not

important for the co-operation, but the national server shall be able to deliver data to the common system and receive data from the common system in accordance with specified rules. It is just these functions of the "national server" that has been agreed – the actual architecture of the national systems may vary. The data format for the exchange is the same as the format used by AIS base stations and ship borne units (IEC 61993-2) and the communication protocol used is TCP/IP. Internet is used as the communication media because of its low cost and flexibility.

To reduce the amount of data to be exchanged is the update rate reduced to once per 6 minutes and that data from a possible future AIS (Class B) on pleasure crafts etc may be filtered away.

The central part of the system is the so-called HELCOM AIS Information Centre, which is developed by the Royal Danish Administration of Navigation and Hydrography and is in operational use since July 2005. These servers connects to the different national servers and collect the national data. The data is processed, compiled and the data for the whole area made available to the national servers. The reporting rate for the "live" AIS data is once per six minutes. The data is also stored for future processing and production of statistics etc Statistics are available via a web-interface where tailor-made reports can be produced and presented.



The system includes over 150 base stations and covers all coastal areas and the main shipping routes in the Baltic Sea and along the Norwegian coast.

Sweden was given a leading roll in the establishment of the system. The main problem was the legal issues. It was quite a challenge to get all the participants to give up their exclusive rights of "their" information and agree on how it may be distributed and used. Eventually all agreed and this agreement is now the model for a co-operation of eight countries around the North Sea that just are starting up a similar system. The core of this agreement is the "agreed list of applications" that the AIS-information from the common system may be used for. It is also agreed that from the central system in Copenhagen is the information distributed only to one recipient in each country. That recipient can then redistribute the information domestically but has to ensure that the usage of the information is in accordance with the agreement.

3. Utilization of AIS information

The Swedish Maritime Administration is responsible for many services where the AIS-information is used to improve the service. Some examples are given below.

3.1 Vessel Traffic Services

The use of AIS in the VTS:es have made it economical feasible to increase the surveillance areas considerably. The automatic identification of the ships have reduced the workload both for VTS-operators and for the OOW onboard. AIS has also increased the quality of the information, for example is a change of course detected much faster by the heading information from AIS compared to the ARPA function of a radar. The information on ships dimension and draught can also be essential for the VTS opeators.

When presenting the information to the operators we have evolved from separate AIS-displays, via a common display for radar and AIS information to a display where the radar and AIS information is merged before presentation. It is not self-evident how this merger of information from different sources shall be performed. The AIS information is normally more accurate than radar and given a bigger weight in fusion equation. If the AIS message indicates "high accuracy" (using DGPS) is radar information almost excluded. If the radar position and AIS position deviates more than a configurable value are two targets presented.

3.2 Maritime Rescue Coordination Center

It was early realized that AIS could be a valuable tool for the SAR coordinators at MRCC as well as onboard the rescue units. In the Swedish MRCC is AIS information integrated into the computerized support system that is used on MRCC. It gives an good overview of available resources, their position and status. Often can the ship in distress been displayed and if a search operation is necessary, the search-tracks can be displayed, both tracks from ships and from the SAR-helicopters. This automatic, visual presentation is of great help to the SAR co-ordinator.

3.3 Pilotage

Due to the exchange of AIS information with our neighbouring countries is it possible to get accurate information on incoming ships well in advance and that facilitates the planning. The local AIS information can also be used for fleet management and to monitor the safe operation of pilot vessels. Particularly is the ability to separate the small pilot vessel from a large ship an important advantage compared with radar.

3.4 Icebreaking

The Finnish and Swedish authorities have built a common command system for the icebreaking operations, where the Swedish and Finnish resources are pooled and utilized in an optimal way. The system use AIS to keep track of icebreaker resources as well as ships in need of assistance. From the shore based central is a satcom-link used to transfer AIS information for the Baltic to the icebreakers, where the information is combined with information from the onboard AIS. The AIS information can be presented as an overlay on a satellite image, radar or visual, of the up to date ice-situation.

3.5 Pollution combating

The Swedish Meteorological and Hydrological Institute has

developed a system that based on historical information on winds and current calculate the possible historical track of a detected oil spill. This track information is combined with historical AIS-tracks. When the tracks of oil spill and a ship coincide in position and time, can a possible polluter be identified.
Live AIS information is also useful in management of pollution combating operations.

3.6 Traffic monitoring EU Directive 2002/59

The EU Directive 2002/59 requires all member states to "provide themselves with appropriate equipment and shore-based installations for receiving and utilising AIS information". It also requires member States to pay particular attention to the monitoring of ships that "pose potential risk to the safety of shipping and the environment". AIS will be the means to monitor large sea areas. The European Maritime Safety Agency (EMSA) is conducting a study of how to collect, compile and use AIS-information from all member states. It seems likely that a regional approach, as used in the Baltic AIS co-operation, will be used for all Europe.

3.7 Safe Sea Net.

The system Safe Sea Net, operated by European Maritime Safety Agency, holds information on all sea transports of dangerous goods. The information is entered by ports and agents but is crosschecked with information from the shore based AIS-system.
A test under the Safe Sea Net framework is presently being set up. The MMSI numbers of ships in the Baltic, received by AIS, will automatically be compared with MMSI-numbers of single hull tankers and when such a tanker is identified an operator will be alerted to investigate further. The plan is to extend the system to also cover banned ships, blacklisted ships etc.

3.8 Accident/incident investigations.

The recorded AIS-information has proven to be valuable when analyzing ship manouvers prior to accidents and incidents. As long as VDR not is available on all ships is recorded AIS information often the only "unbiased" information that is available.

3.9 Traffic statistics

Statistics derived from recorded AIS-information gives a good view of the commercial ship traffic and the compiled information is used in decisions concerning traffic policy and for planning of fairways and routeing measures. Of immediate interest in Sweden is for example to follow up the effects of the recent IMO-decision to declare the Baltic Sea as a "Particularly Sensitive Sea Area" (PSSA).

4 Future developments

4.1 Information quality

AIS has got a kind of bad reputation of distributing erroneous information. It is well known that incorrect or incomplete information is very common. There are different kinds of errors:
- Some errors are caused by a bad design of the AIS equipment and the new ITU Recommendation 1371-3 will to a large extent solve those problems.
-Another type of errors is caused by a bad installation, such as connection of external sensors that don't follow the required standard. This will be dealt with by an intensified inspection of AIS during port state control according to a recent decision within the Paris MoU.
- Perhaps the most common error is human errors. Incorrect data is entered. This may be either at the configuration when incorrect fixed data is entered or during the daily use. Incorrect information is entered or the information is not updated when required. The routines for keeping the information correct should be part of the ISM procedures and authorities must call attention to the problems and consider introduction of fines to underline the importance of the information quality.

4.2 Vulnerability

AIS is strongly dependent on GPS and hence vulnerable to disturbances of that system. GPS is used as a source of information to be transmitted, for the organisation of the transmissions and for resolving possible congestions on the data link. With the renewal of Glonass and introduction of Galileo there seems to be enough redundancy if combined receivers are used in the AIS unit and as source of position information..

4.3 Capacity

AIS has, besides its standardized messages from ships and shore, a limited capability for data communication. According to IMO can this be used for safety related messages. Numerous proposals for information to be transmitted via AIS have been put forward and quite a few of them has been tested. There is obviously a need for data communication but AIS is not the right tool for all needs. We have observed an increasing load on the VHF Data Link. At good VHF conditions one of the Swedish base stations receive reports from 800 ships, although the sea areas around Sweden not are particularly crowded. With an average update interval of 10 seconds, this means that all timeslots are occupied and weaker signals are discriminated. In addition to that load comes reservations of timeslots for the base stations. These timeslots may not be used by ships within 120 NM from the reserving base station. In areas with a high density of base stations, for example the southwest Baltic, up to 45 % of the timeslots can be allocated for base stations if the recommendation from IALA is implemented with the maximum reservation scheme.
For the Class A type of AIS will the high load result in a reduced radio cell area and reduced effective update rates for more distant ships. Base stations may see similar effects. The new Class B CSTDMA AIS unit, for vessels not required by SOLAS to carry AIS, will probably not work well in this environment, since it is designed to wait for free timeslots before transmitting.
There are good reasons to try to limit the "non-essential" load on the data link and Sweden has proposed to IMO to put this item on the work program for the Sub Committee on Safety of Navigation.

4.4 Monitoring

With the huge amount of data available from the AIS network and the increasing demand for surveillance of large sea areas are

new computerized tools necessary. The anticipated system could alert an operator when a ship not is following appropriate rules, regulations and routeing measures.

4.5 Remote pilotage

Can the additional information that AIS gives, both on the ship and on shore, reduce the need for putting a pilot onboard ships? This have been widely discussed and to some extent tested. In general is it likely that the threshold for requiring pilot is dependent on how the ship is equipped and AIS is one important part in the overall picture. In particular is the availability of navigational data, directly transferred from the ship to a shore based central, an important factor that may facilitate remote pilotage or an advanced navigational assistance.

5 Summary

Common infrastructure and sharing of information between different organisations which need AIS information can reduce the cost for shore based infrastructure and minimize reservation of timeslots for use by base stations. When considering the use of AIS for distribution of information from shore to ships must the load on the VDL be taken into account.

Existing weaknesses in the AIS system and the way it is used have several reasons and most of them are being addressed either by technical or administrative measures.

AIS is a new sensor and source of information that is well suited for information systems – applications using AIS are still under development and new applications can be expected. We have only seen the start yet!