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COMPARATIVE ASSESSMENT OF THE SATELLITE AND SHORE BASED SHIPS MONITORING SYSTEMS

ABSTRACT

Different types of seagoing ships monitoring systems has been established or will be introduced into exploitation in near feature: global satellite long range identification and tracking system (LRIT), satellite monitoring system based on AIS technique and monitoring system utilizing net of shore based AIS stations. Each one of them has advantages and weaknesses. Paper presents comparative assessment of these systems and their suitability, mainly for SAR and e-navigation purposes, conducted on the basis of the experience in exploitation of the shore-based AIS monitoring system and analysis of the legal and technical requirements for these systems.

Keywords: Monitoring Systems.

INTRODUCTION

There are three different types of ships monitoring systems introduced during last few years or planned for establishing in the near future:

- AIS monitoring systems utilising net of the shore based AIS stations working in the VHF band;
- Global satellite long range and identification system (LRIT); and
- Global satellite monitoring system utilising shipborne AIS equipment working in the VHF band.

Each one of these systems has its advantages and weaknesses and not any of them comes up all users' expectations.

AIS MONITORING SYSTEMS

AIS is a worldwide mandatory digital information transfer system for all seagoing ships of 300 GT and upwards and all passenger ships falling under the IMO carriage requirements as described in the SOLAS Convention. It automatically provides vessel position and other data to other vessels and shore stations and facilitates the communication of vessel traffic management and navigational safety data from designated shore stations to vessels. The onboard AIS continuously and automatically broadcasts ship's identification, position, vector of movement and other vessel and voyage related data, and receives messages from other ships and shore stations. AIS was developed on the basis of so called 4S transponder constructed in Sweden and designated to automatic data exchange between ships and between ships and centre of vessel traffic service. Due to that, some of transmitted data is introduced into onboard AIS manually, transmission is not coded and utilised VHF band frequencies are not restricted. Transmission interval is between 2 seconds and 6 minutes.

IMO sets clear requirements for onboard AIS equipment only. There is not direct stipulation by this organization to any competent authority for implementation of AIS shore based installations or recommendations for AIS monitoring system. Requirements for shore based AIS stems from national and regional regulations, e.g. from Directive 2002/59/EC, whereby, EU Member States (MS) had to provide themselves with shore based installations for receiving and utilising the AIS information by the end of 2007. Moreover MS shall ensure that the appropriate equipment for relaying the information to, and exchange it between the national systems of MS shall be operational by the end of 2008.

The shore based AIS infrastructure that EU Member States implement in accordance with Directive 2002/59 includes a current estimation of almost 500 AIS shore stations, with coastal coverage in all of the maritime Member States. In addition to these networks, many ports, VTS authorities, maritime surveillance authorities and other interested parties have set up other isolated AIS base-stations or local networks, to use the AIS information transmitted by ships. Some MS have also set up regional networks in co-operation with neighbouring States. Such a network is already an operational reality in the Baltic Sea region where Member States and Russia have implemented the HELCOM AIS system. A similar system is developed for the North Sea and developments are in progress between the Mediterranean MS for implementing a similar system in that region [1].

There are a number of potential threats to the safe and reliable functioning of AIS monitoring systems, mainly related to the planning, configuration and misuse of AIS shore based stations and networks. Factors with a potential detriment effect upon AIS functioning are as follows:

– Increasing numbers of AIS stations;
– Diversity of AIS applications; and
– Commercial networks.

The number of AIS stations is steadily increasing since:

– AIS continue to be fitted on ships in accordance with SOLAS, national and regional requirements and non-mandatory by some owners. An amendment to Directive 2002/59 will very likely require a high number of fishing vessels to be fitted with AIS;
– The introduction of the low cost AIS Class B will also result in voluntary AIS installations on many small boats (e.g. pleasure craft); and
– Many administrations are introducing AIS onto aids to navigation, especially in areas with a high density of traffic and in some places AIS repeaters are planned in order to improve coverage in "shadow" areas.

This has an impact upon the effective coverage area of a shore-based AIS network in high-density traffic areas. The service area is smaller than the coverage area of the shore based VHF radio station in case of dense traffic.

The AIS system can be used for supporting additional applications requiring a large part of the available timeslots. Examples of such applications are the "short safety-related messages" and the so-called "binary messages". Some Administrations have already begun to transmit, using binary messages, meteorological and hydrological information and differential corrections for GPS, while others use them for navigational aid monitoring, dredge monitoring and inland navigation. The resulting AIS messages require many time slots. The danger is that AIS may be opened up to too many different applications, even non-safety related. This possibility must be very much avoided if the efficiency of shore based AIS is to be maintained.

Another emerging issue are the commercial AIS networks. Commercial companies have created a networks of agents fitted with AIS receivers connected to the server via the Internet. Information is updated at regular intervals (every 5 or 6 minutes) and available on companies' websites. AIS data may be provided in any electronic format including ASCII, MS Access, Excel, Oracle, and XML. It can be supplied in raw data format or as a movie capable of being replayed on PC.

Hard copy reports are supplied on demand. Commercial companies offer interactive options allowing the user to zoom, pan, filter and add vessel tracks. The position of each vessel is displayed on electronic chart. By placing the cursor over specific vessel users can display additional details including geographical position, course, speed and destination port. For subscribers of Internet Ships Register there is also a dynamic link which gives comprehensive additional information on vessel and ownership details provided by existing ship reference databases.
The system functionality allows the user to study total AIS traffic patterns and it is possible to filter by type, classification, flag, gross and deadweight tonnages. Commercial systems may also provide AIS analysis of vessels involved in casualty incidents. Users have to subscribe to get access to the services and subscription charges are normally yearly. The cost depends also on the number of users licences. Specific companies allow access to regional specific AIS information for free. Growing commercial network coverage includes Europe, North and South America, the Caribbean, Mediterranean, the Arabian Gulf and Far East. With coverage on four continents, they will soon give a global view, in real or near rear time, of vessel positions in coastal areas [1].

At its 79th session in December 2004, the IMO Maritime Safety Committee (MSC) urged Member Governments, subject to the provisions of their national laws, to discourage those who make available AIS data to others via publication on the worldwide web, or by other means, from doing so.

In summary, the increased number of different type of stations and applications will result in a higher utilisation of the AIS channels and the possible overload of the AIS VHF Data Link (VDL). Although the AIS standards and specifications allow a high load of traffic but the effective coverage area of the transmissions will gradually decrease.

LRIT SYSTEM

LRIT system shall provide global identification and tracking of suitable equipped merchant ships sailing outside the GMDSS A1 areas or outside areas of coverage of the shore based AIS stations working in the VHF band (this question is still discussed). According to the amended SOLAS requirements, following types of ships engaged on international voyages shall participate in the described system:

– Passenger ships, including high-speed passenger crafts and mobile offshore drilling units; and
– Cargo ships, including high-speed crafts, of 300 gross tonnage and upwards.

The onboard LRIT equipment transmits, continuously and fully automatically, ship's equipment identification, position and data and time associated with this position. Transmitted data are coded and may be received by authorised receivers designated by particular governments as flag state, coastal state, port state and state responsible for SAR service only. Standard transmission interval is equal to 6 hours and on demand may be automatically decreased up to 15 minutes.
Like AIS equipment, LRIT onboard equipment may be switched off on all ships when the master on his professional judgement believes that its continual operation might comprise the safety or security of his ship. IMO Resolution MSC. 210(81) defines system architecture and principle of work. All components of the LRIT system should conform to functional requirements not inferior to those specified in the annex to this resolution. All costs connected with the introducing and work of the LRIT system shall be covered by receivers of LRIT data other than SAR services. More detailed description of the LRIT system may be found in [2].

GLOBAL SATELLITE MONITORING SYSTEM UTILISING SHIPBORNE AIS EQUIPMENT WORKING IN VHF BAND

According to the amended SOLAS requirements ships shall be fitted with radar or AIS search and rescue transponders (SART). AIS transponder shall conform recommendations contained in the IMO Resolution MSC.246(83) "Adoption of performance standards for survival craft AIS search and rescue transmitters (AIS-SART) for use in search and rescue operations". Low orbital satellites may receive the signals transmitted by AIS-SART. In response to this new possibility, World Radio Conference in 2007 (WRC-07) added a secondary mobile-satellite service allocation on AIS-1 and AIS-2 frequencies to allow satellite reception of AIS on a secondary basis. Additionally, satellite detection of AIS messages has been studied and documented in Report ITU-R M.2084 "Satellite detection of automatic identification system messages". The technical limitations specifically cited were [3]:

– The length of the AIS message in the time slot (insufficient time buffer for the satellite detection range);
– The large number of messages in the satellite antenna footprint (excess re-use of the time slots in the VDL as detected by the satellite); and
– The sharing of the AIS frequencies by terrestrial services within the satellite antenna footprint (coverage pattern).

The differences in propagation delay between vessels and the satellite causes the AIS messages to overlap. Thus, the slot composition must be adjusted to increase the time buffer so that the satellite in separate slots without a time overlap can receive the AIS transmissions. Additionally, the large number of messages in the satellite antenna footprint (excess re-use of the time slots in the VDL as detected by the satellite) is attributable to both the large number of ships and the reporting rate.

It means there is a need for establishing a special AIS message that is shortened in length and can be transmitted on a special reporting schedule on two other frequencies when those frequencies will be designated. To solve these questions, the working group proposes to [3]:

– Introduce new message 27 for satellite detection of AIS and 3 minutes reporting interval for this message;
– To designate separate frequencies for this service that fit within the tuning range of the onboard AIS; and
– Limit the satellite service to AIS Class A only and not to AIS Class B.

The interference environment resulting form the existing services in the VHF band must be taken into account in determining the feasibility of accommodating satellite AIS in any given band or channel, due to the large satellite antenna footprint that overlaps both land and sea. Only three frequencies (channels 16, 75 and 76) are exclusively dedicated to maritime use and restricted from terrestrial use on a global basis. The group suggests that the use for satellite detection of AIS channels 75 and 76 adjacent to the distress and calling channel 16, transmission of short message 27 at 12.5 watts once every 3 minutes for 17 milliseconds alternating between channels 75 and 76, would not interface with voice communications on any of these channels (16, 75 and 76). It means those VHF channels may be utilised for AIS transmissions.

CONCLUSIONS

Three different seagoing ships monitoring systems were shortly presented in this paper. It shall be stressed that not any of them fulfils all users' expectations as a source of data necessary for ships monitoring and organisation of search and rescue action and source of data and means of radio communication for e-navigation purposes.

Main weaknesses of both AIS monitoring systems are:

– Open (not coded) method of ship's data transmission not guarding security of ships; and
– Increased number of different types of AIS stations and applications resulting in a higher utilisation of the AIS channels and the possible overload of the AIS VHF Data Link decreasing the effective coverage area of the system.

Additionally, it should be stressed that:

– Establishing of the global satellite monitoring system utilising ship AIS equipment working in VHF band will be possible after modification of the Appendix 18 to the Radio Regulation (by ITU) and performance standards for ship AIS equipment (by IMO and IEC); and
– Global satellite monitoring system utilising ship AIS equipment working in VHF band will be probable possible for AIS Class A only.

Main disadvantages of the global LRIT system are:

– Transmission of data about ships positions only;
– Unknown and variable cost of LRIT data received by authorised users;
– Introducing costs of additional communication equipment for the sole purpose of transmitting LRIT reports on ships sailing exclusively in the GMDSS A1 and A2 areas and not fitted with satellite communication terminals; and
– Availability for SAR services, free of charge, last routine ships reports only.

Costs related to requesting LRIT data may be avoided when similar or more detailed information can be obtained through national or regional AIS networks. Moreover, the integration of AIS reports into the data managed by the LRIT system would avoid unnecessary fitting of equipment onboard ships sailing in maritime areas within the coverage of AIS monitoring stations (in the GMDSS A1 and A2 areas only). AIS could be considered to constitute the primary candidate for production of LRIT data on the basis of its reporting rates, report content and cost. When AIS and LRIT are used in combination, they have the potential to provide a combined traffic image.

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