

AIS

Current Problems and Future Directions

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The Automatic Identification System (AIS) is a VHF broadcast system intended to enhance safety of marine traffic, by providing positive identification, position and other information. AIS became a mandatory carriage requirement for ships governed by the IMO Safety of Life at Sea Convention (SOLAS) by the end of 2004. This date had been brought forward by several years because it was felt that AIS could assist with the security of shipping. Since the system was designed for safety purposes, rather than security its vulnerability to interference needs to be considered. The accelerated introduction has also limited the opportunity for training and education about the system and has resulted in some problems in the early stages. Problems have included incorrect data entry, poor installations and inadequate data presentation. Solutions to these problems are being found and this paper reviews progress and considers the display situation. The development of AIS networks, long range applications and alternative communications links are then considered.

AIS Vulnerability and Performance

As a safety system AIS must operate with certain minimum levels of availability and continuity. AIS is dependent on other systems, principally Global Navigation Satellite Systems (GNSS) for position input and to a lesser degree, timing. The vulnerability of the GNSS to interference, deliberate or accidental, must be considered in the assessment of AIS performance. Since it is now envisaged that AIS will be used for security as well as safety applications the importance of understanding any threat to its reliable operation is increased.

Required levels of performance must be established in order to determine whether the system is working adequately. The principal measure of performance is availability, usually defined for radionavigation systems as: "the probability that a system will be working at the required level at any given moment in time". The "required level" of performance might be a defined level of messages being transmitted successfully. This figure will vary from one user to another depending on local noise and distance between transmitter and receiver. An example could be the 95% probability of receiving 80% of messages correctly. Given the likely variation in performance between vessels and over time, it might be necessary to base the measurement on test messages sent for that purpose between base stations.

Causes of Vulnerability

The sources of AIS vulnerability can be divided into four categories: accidental interference; deliberate

interference; loss of position data and overloading of the datalink.

Accidental interference:

VHF channels are not generally susceptible to atmospheric or ionospheric interference, but may be affected by local, man-made interference, for example from onboard machinery. This would only affect the station in that vicinity and would probably be rectified if the operators were aware of the problem.

However, anomalous propagation, which results in extended VHF range is relatively common. This can have a very detrimental effect on the VHF Data Link (VDL). Slots may be reserved by base stations in the Fixed Access Time Division Multiple Access (FATDMA) protocol and these slots should not be re-used less than 120 miles from the base station. Many manufacturers have programmed their equipment not to re-use FATDMA reservations at any distance. Under conditions of anomalous propagation, vessels may receive many base stations, resulting in a high proportion of slots being "reserved" for FATDMA transmissions. This could have the effect of overloading the VDL as vessels concentrate their transmissions in the remaining slots.

Deliberate interference:

AIS uses dedicated channels which would not normally be provided on VHF transmitting equipment used for non-AIS purposes. However, generating these channels on unauthorised equipment would not present any technical difficulty. Simple jamming of the channels would be detected by shore-based facilities and could be located and dealt with through normal

regulatory enforcement procedures. More difficult to deal with would be spoofing – broadcasting false information. Again this would not be technically difficult, but would eventually be recognised by shore operators and the transmitting station could be located by direction-finding equipment. Integrity monitoring of AIS broadcasts with independent equipment, which could be receive-only, should ensure rapid detection of spoofed shore-station transmissions.

Loss of position data:

The position input for AIS comes almost exclusively from GPS. Other studies have dealt with the vulnerability of GNSS to interference (1) and the mitigation measures which should be applied. Relevant points which have come out of these studies are the advisability of using GPS receivers conforming to the latest standards, the possible need for a backup positioning system and the importance of making users aware of the possibility of losing GPS.

Overloading of the datalink:

A potential source of AIS vulnerability is overloading of the datalink. The factors determining the capacity of the system and the loading of the channels are the number of vessels in an area, their status and therefore reporting rate, the propagation conditions and the FDMA slot allocations discussed earlier. The effects of high traffic density and reporting rates have been investigated using simulation and there appears to be no threat of overloading from the Class A traffic, even in areas of high density such as the Strait of Dover. The possible effects of large numbers of Class B AIS (non-SOLAS) vessels have also been studied and the degradation of the service to Class A users is not expected to be significant. In general the system “degrades gracefully” by reducing the range of reception, rather than ceasing to function altogether.

Factors affecting AIS Performance

The main factors affecting AIS Performance are the noise floor on the vessel and antenna positioning.

The traditional methods of testing the RF noise floor using analog communications monitors and test equipment are not

AIS : problèmes actuels et orientations futures

Le système d'identification automatique (AIS) est un système de communication en VHF conçu pour accroître la sécurité du trafic maritime en fournissant une identification et une position, et toute autre information utile. Les problèmes rencontrés lors de sa mise en place étaient principalement dus à des saisies de données incorrectes, des installations médiocres et une présentation inadéquate des données. Des solutions sont en train d'être trouvées pour remédier à ces problèmes. Cet article montre les progrès effectués et identifie d'autres facteurs affectant les performances. En tant que système de sécurité, l'AIS doit fonctionner selon des niveaux minima de disponibilité et de continuité. L'AIS est dépendant d'autres systèmes, principalement le DGNSS, pour ce qui est de la position et, dans une moindre mesure, de la synchronisation. La vulnérabilité de ces autres systèmes aux interférences, qu'elle soit délibérée ou accidentelle, doit être prise en compte lors de l'évaluation des performances. On envisage actuellement d'utiliser l'AIS pour la sûreté, en complément de sa fonction de sécurité. Il est donc plus important de bien comprendre tous les facteurs pouvant affecter sa fiabilité. L'un d'entre eux est la surcharge des lignes de transmission de données. Les facteurs déterminant la capacité du système et de la charge des canaux sont évalués dans cet article.

L'identification et le suivi des navires à longue distance en tant que moyen d'accroître la sécurité et la sûreté ont été largement évoqués à l'OMI et à l'AISM. La mise en service d'un AIS à longue portée est l'une des approches envisagées. Un certain nombre de systèmes par satellites a été examiné, et l'on a étudié l'interface, le déploiement et les aspects opérationnels. L'utilisation de liaisons satellites peut être considérée comme un développement logique de l'AIS du futur. D'autres propositions prennent la forme d'un recours à l'Internet, indépendamment de moyens de communication spécifiques. L'article évalue les diverses possibilités pour le futur AIS, en tenant compte des diverses applications envisagées. ♦

applicable to AIS since a regular RF pulse of interference of $\pm 100\mu\text{s}$ duration is sufficient to destroy a single bit in the AIS slot and thus the entire report. Noise and interference pulses of such short duration are difficult if not impossible to measure using analog instrumentation especially where the pulse repetition rate is less than 10Hz. Special test equipment and procedures are required to measure the noise floor in these conditions.

All VHF systems that are installed in a vessel need a good antenna position if they are to meet performance expectations. Vertical and horizontal separation of antennas and avoidance of obstructions are among the aspects that need to be considered.

This subject is covered in an IMO Circular (3).

Data Entry

Data is entered into the AIS units at different stages. The installer of an AIS is required to input ship static data and the deck officers should enter a number of parameters as voyage data before the vessel leaves port. This information is broadcast, and shore-based networks rely upon

its accuracy. Incorrect data entry has been observed, including wrong vessel names and MMSI numbers, length and beam information, speed and navigational status.

Maritime administrations have taken action to correct these problems, initially by informing the master of the vessel. Then, if this is not effective, by informing the owners or operators. If necessary the vessel may be held in port until the AIS setup is corrected.

AIS Interfacing

It has been found that connecting the AIS unit to existing navigational equipment (e.g. GNSS and gyrocompass) may not always result in correct performance. In particular, older gyrocompasses may have interfacing problems with AIS, especially as there is often no means to verify the integrity of the information emanating from the gyro and there are normally no alarms generated when the gyro input to the AIS is misaligned.

GNSS receivers installed prior to the 2000 amendments to SOLAS Chapter V do not necessarily meet the IMO and IEC performance and testing standards for input to the Automatic Identification

System (AIS). Information on this problem has been circulated, to ensure the installation of compatible navigation equipment and amendments have been proposed to the IMO Circular on AIS installation to reinforce this point.

AIS Displays

Displays are the means by which AIS data are converted into useful information for the operator. Little has been done to define the information needs and priorities that would establish display parameters. During the introduction of AIS, emphasis has been given to the shipboard unit and the shore infrastructure. The Minimum Keyboard Display (MKD) is generally recognised as inadequate to meet the information needs of mariners in different operational settings. It is important to establish new minimal display requirements before the MKD becomes the default standard.

Further development is needed, with particular regard to the HMI (Human Machine Interface). Achieving a proper shipboard display of AIS information will be a dynamic process, with a correct balance between human integration, information processing and automated support for each key task. Multi-modal interfaces may be effective in supporting the mariner's needs for attention management. There may be a trade-off between information requirements and the cost of shipboard AIS displays (2).

Future Development

National AIS Networks are developing rapidly and international agreements are being reached on the interchange of data (4). First generation AIS networks were mostly based on existing communications infrastructure, often provided for military purposes. They were specified on the basis of information available from IALA and IMO at the time. Since then the base station specification has been developed and updated and the functionality required from an AIS network when deployed in ports, by security, coastal and aids to navigation authorities has become much clearer. AIS networks are now being deployed that are entirely web based.

Long Range Identification and Tracking as a means of improving the safety and security of shipping has been

AIS problemas actuales y futuras orientaciones

El Sistema de Identificación Automática [Automatic Identification System (AIS)] es un sistema de emisión en VHF concebido para mejorar la seguridad del tráfico marítimo proporcionando una identificación fiable, posición y otra información adicional.

Los problemas durante su puesta en funcionamiento incluyeron datos incorrectos, instalaciones deficientes y presentación inadecuada de los datos. Se están encontrando soluciones a estos problemas y en este informe se revisan los progresos y se exploran otros factores que afectan a su funcionamiento. Como sistema de seguridad, el Sistema AIS debe funcionar dentro de unos ciertos mínimos de disponibilidad y continuidad. El AIS depende de otros sistemas, principalmente el GNSS para determinar la posición y, en menor medida, la sincronización. La vulnerabilidad de estos otros sistemas a las interferencias, accidentales o deliberadas, debe ser tenida en cuenta a la hora de evaluar el funcionamiento del AIS. Hoy se prevé que el Sistema AIS se empleará para seguridad. Esto aumenta la importancia de entender las causas que pueden alterar su funcionamiento fiable. Una causa habitual es la sobrecarga en la transmisión de datos (datalink). En este artículo se evalúan los factores que determinan la capacidad del sistema y la carga de los canales.

La identificación y seguimiento a larga distancia como modo de mejorar la seguridad de los buques se ha debatido largamente en la OMI / IMO y la IALA. La implementación a larga distancia del Sistema AIS es uno de los enfoques que se están teniendo en cuenta; se han examinado varios sistemas de satélite y se han estudiado la interfaz, la integración, el despliegue y los aspectos de su funcionamiento. La transmisión de datos por vía satélite puede verse como un desarrollo lógico futuro para el Sistema AIS. Otras propuestas incluyen la aproximación a través de Internet, que no depende de enlaces particulares de comunicación. Se evalúan estas posibilidades para el futuro del Sistema AIS, teniendo en cuenta las distintas aplicaciones previstas. ♦

discussed at length in IMO and IALA. A long-range implementation of AIS is one of the approaches considered and a number of satellite systems have been examined, with regard to the interface, integration, deployment and operational aspects. The use of satellite datalinks may be seen as a logical development for future AIS. However, the process of standardising on one system may be a long and difficult one. Inmarsat C may seem an obvious choice and it has been promoted as the solution to Long Range Tracking, but it does not have the capability to provide all the information currently given by AIS and is subject to the delays inherent to a store and forward system. Low Earth Orbit systems such as Iridium and OrbComm are also seen as candidates, but do not have the international recognition enjoyed by Inmarsat.

Another approach is to make AIS a web-based system, not dependent on particular communication links. In this concept public networks such as GSM could be used where available, with satellite services for more remote locations. There are obvious problems

of compatibility and interoperability to be resolved, although there are already commercial, proprietary systems of this kind. Third generation mobile services such as the Universal Mobile Telephone System (UMTS) might provide a solution that could be accepted internationally, but interoperability with satellite communication links would be a requirement.

References

1. International Association of Marine Aids to Navigation and Lighthouse Authorities. *GNSS Vulnerability and Mitigation Measures*. IALA Recommendation R.129, 2004.
2. Transportation Research Board of the National Academies. *Shipboard Automatic Identification System Displays – Meeting the Needs of Mariners* – TRB Special Report 273, 2003.
3. International Maritime Organization. *Guidelines for the Installation of a shipborne Automatic Identification System (AIS)* IMO SN/Circ.227.
4. Helsinki Commission. *Agreement on access to AIS Information - 2001*.