Automatic Identification System (AIS) and the Role of Information Technology in Vessel Traffic Management

By
Capt. Ehab Etman

الخلاصة

لقد كان استخدام نظام خدمات مرور السفن(VTS) حلا فعالا لأوجه القصور الكامنة في أنظمة إدارة مرور السفن المستخدمة في الماضي, حيث أنها لها القدرة علي التفاعل مع السفن أثناء مروها في مناطق عملها, وذلك عن طريق مراقبة السفن وتقديم المعلومات والإرشادات اللازمة لتأمين سلامة الملاحة, بالإضافة إلي ذلك تقوم محطات خدمات السفن بتبادل المعلومات مع كل الأطراف المعنية بالنقل البحري, مثل الموانئ وخفر السواحل والجمارك وهئيات إرشاد السفن وغيرها, بغرض تسهيل سريان حركة التجارة الدولية.

أقرت المنظمة البحرية الدولية (IMO) تجهيز السفن بنظام التعريف الآلي(AIS), الذي يسمح للسفن بتبادل المعلومات بين السفن وبعضها وبين السفن ومحطات خدمات مرور السفن. سوف يساعد هذا النظام الحديث محطات خدمات مرور السفن في الحصول علي صورة حقيقة وشاملة ومتجددة آليا لحركة السفن بالإضافة إلي المساهمة في الارتقاء بدقة المعلومات المتوفرة لهذه المحطات.

تستعرض هذه الورقة دور تكنولوجيا المعلومات التي يوفرها نظام التعريف الآلي في تحسين إدارة حركة مرور السفن.

Abstract

Many different methods and techniques have been used in the past to manage maritime traffic; however, none of them had the capability of either interacting with the traffic or providing any advice or assistance to the vessels, thus the Vessel Traffic Services (VTS) were developed as a live solution for traffic management and surveillance problems, by interacting with the vessels, to advice and assisting them to ensure the safety and efficiency of navigation.

International Maritime Organization (IMO) adopted a new requirement for ships to carry Automatic Identification System (AIS), which is capable of providing information - about the ship to other ships and to coastal authorities.

AIS could be a great tool for VTS operations in generating a comprehensive view of the traffic, AIS will improve the quality of shipping information service and will contribute positively to many of the VTS applications and allied services. This paper will identify how the information technology may contribute in improving the vessel traffic management.

1. Introduction:

According to IMO Resolution A.857 (20) VTS is defined as:

> A VTS is a service implemented by a competent authority, designed to improve safety and efficiency of vessel traffic and to protect the environment. The

service should have the capability to interact with the traffic and to respond to traffic situations developing in the VTS area.

IMO has acknowledged the contribution of VTS to safety of life at sea, safety and efficiency of navigation and the protection of the marine environment, adjacent shore areas, work sites and offshore installation from possible adverse effects of maritime traffic (SOLAS, 2001).

The invention of radar followed by the invention of further sophisticated systems in tracking and monitoring maritime traffic, including Automatic Radar Plotting Aid (ARPA) and Electronic Chart Display and Information Systems (ECDIS) made it possible to establish an efficient shore based Vessel Traffic Services systems (VTS).

The integration of the AIS with the VTS systems will improve the quality and reliability of information, with regard to target detection and tracking, and will overcome some of shortcomings of such systems, as well as compensate each other for their individual limitations and deficiencies.

Applying the AIS technology will improve many of the VTS functions, if not all of them. The following will identify how the information technology may contribute in improving VTS operations, by clarifying the effect of such technology on each VTS function related to the safety, management and monitoring of maritime traffic.

2. Safety of Navigation in VTS area

The information provided by AIS to VTS operator, the rapid exchange of information between the VTS and traffic and the automatic update of the information will improve the situational awareness, and as a result will have a positive impact on many aspects, which contributes to the safety and quality of navigation.

2.1. Navigational information

In addition to broadcasting static, dynamic and voyage related information of the transiting ships, the safety related messages, which are also broadcast by the AIS, will

provide a tool to VTS and ship's officers to exchange additional information as it occurs, and this will improve the situational awareness of all parties.

The short safety related messages (up to 158 characters) are one type of messages, which are transmitted and received by ship and shore stations. As it is set in free text format, it can be used to broadcast or address different types of information, mainly related to the safety of navigation, such as Maritime Safety Information (MSI), navigational warning and storm warnings.

The binary messages are another type of AIS messages and it is also called AIS telegrams. Binary messages are standard messages, structured in predefined information packages.

Each message is dedicated to a different application and can be broadcast to all stations or addressed to a specific MMSI. Applications include notice to mariners, pilot services, meteorological services; VTS navigational advise e.g. speed limits and tidal information. IMO is in a process of harmonizing, selecting and administering the important applications/functions of the binary messages.

Broadcasting Differential Global Positioning System (DGPS) corrections using AIS by the VTS center will enable all ships equipped with AIS and GPS receivers in the VTS area to navigate with DGPS accuracy, which improves the position fixing accuracy; hence, it will improve the safety of navigation.

Additionally, VTS can use AIS in broadcasting electronic chart corrections for VTS area and local waterways, for ships equipped with electronic charts, which will enhance the chart information validity onboard the transiting ships

Furthermore, VTS can attach the information of a non-AIS vessel to its radar target and broadcast it as Pseudo AIS target message to other vessels equipped with AIS in the VTS area. Moreover, this function will allow non radar equipped vessels, which are only equipped with AIS, to view the VTS radar targets, which will increase their

situational awareness of all the surrounding traffic, and will enhance the level of safety of navigation in the VTS area.

2.2. Aids to Navigation

Aids to navigation such as buoys, light vessels and lighthouses are of different types, shapes and characteristics. They are used for the purpose of navigation assistance among other usages, particularly in near coastal waters, narrow waters, prohibited areas for navigation and other critical navigational areas.

VTS centers use aids to navigation for different purposes, such as marking traffic separations, port approaches and marking or organizing the traffic near a danger to navigation.

A special type of AIS station, introduced by International Telecommunication Union (ITU) recommendations M.1371-1, the (A to N AIS station) when fitted to an Aid to Navigation could provide information including identification of the aid to navigation, state of health of the navigational aid, tide and weather conditions and act as an AIS base station repeater.

Furthermore, it can monitor the performance of the navigational aid, as well as, the collection of AIS data of the transiting maritime traffic for navigational planning purposes, which will facilitate the management and monitoring of traffic by VTS, as well as, improving the ability to monitor the performance of aids to navigation remotely.

Additional potential benefit of the AIS is the transmitting of the so called "Pseudo/virtual aids to navigation" for physically non existing objects, which can be used for many purposes such as, marking a prohibited area for navigation or naval exercise area.

2.3. Metrological and Hydrological Information

The metrological information, such as weather conditions and hydrological information, such as current and tide conditions are the most vital information required by the navigators, in order to proceed safely in their voyages. Receiving accurate information at the right time can save the ship, the crew and the environment.

One of the services provided by VTS centers is the information service, which includes weather information among other types of information as specified by IMO resolution A.857 (20). AIS can play a crucial role in broadcasting the metrological and hydrological information, and such broadcasting will depend on the type and capability of the measuring and processing equipment.

Metrological and hydrological information may be broadcast in separate messages, according to the operational requirement. The message may include wind speed and direction, water level and temperature, wave height, Air temperature, current speed, direction on different depths and Tide information. The benefits of broadcasting such information using the AIS are the delivery of the information to the ship's officers in real time.

2.4. Communication in the VTS area

While the use of radar in VTS was limited to the detection and tracking of ships, the identification and communication, with the traffic passing through VTS areas, was mostly done verbally using Very High Frequency (VHF).

Different methods have been used to identify ships, such as setting mandatory reporting system. Ship reporting schemes are approved by IMO and follow specific reporting formats as laid down in IMO Resolution A.851 (20). Ships in VTS area should adhere to the mandatory reporting system, by identifying their identity and their geographical location. Mostly all methods of identifying and communicating with the traffic were VHF based.

Failure to comply with the reporting system did happen in many situations. It was not uncommon to receive no response from some ships, as well as, situations of communicating to the wrong ship occurred. Nevertheless, certain areas experienced difficulties in communication for many other reasons, such as heavy traffic, misuse of VHF equipment, signal distortion, frequency interference and others.

Moreover, the verbal reporting is a time consuming process. Such difficulties affected the reliability of the VHF verbal communication in many situations, and resulted in creating confusion to the VTS and ship's officers; thus endangering the safety of navigation.

The AIS is providing a great facility in identifying ships by supplying the information of the ships, including ship's name, call sign and Maritime Mobile Service Identity number (MMSI) number, as the ship's name may not be unique in some cases. Knowing the MMSI and call sign of a ship confirms its identity. Using a database management system in a VTS may possibly be another way to confirm a ship's identity.

AIS provides rapid identification of the passing ships and the ability to communicate with them in the VTS area, which is considered to be one of the cornerstones in establishing a comprehensive traffic image. AIS provides such service automatically without the interference of the ship's officers, or depending on their compliance to the mandatory reporting system; moreover, the AIS does this function silently.

The maritime and port authority of Singapore evaluated the performance of the AIS system in a pilot project in 1999, and the results indicated that AIS ship transponders could reduce a VTS operator's time spent on verbal communications by as much as half (Sollosi, 2002).

The use of AIS technology will eliminate the need for voice communication or at least reduce it, which will also facilitate the use of VHF effectively in emergency situations, for non AIS carrying ships and when verbal confirmation is required in certain

situations. Moreover, it will overcome the weaknesses of the current manual reporting process.

3. Management of Maritime Traffic

The appropriateness of the judgments, decisions, interventions, evaluations and conclusions made by VTS operator mainly depend on the credibility, reliability and accuracy of the compiled traffic image, in order to respond to the traffic situations.

Adding AIS as a sensor or additional source to gather the required information to create the traffic image will improve the efficiency of navigation and the management of the maritime traffic in the following fields:

3.1. Monitoring of Targets in the VTS area

Tracking of targets throughout the VTS area is the most crucial operation, following the detection and identification of them. The dynamic information provided by AIS in real time will improve the tracking process. The accuracy of target position being GPS based, particularly after May 2000, when USA discontinued the use of selective availability, added value to the accuracy of AIS information.

For the first time the VTS operator will be able to determine whether the ship is moving ahead or astern, the exact rate of turn of the ship and the ship's navigational status. This will provide the VTS operator with additional vital information such as when the ship is at anchor, moored, aground and not under command, which will improve the reliability of the VTS traffic image.

Ships draught, destination, hazardous cargo type (if any), Estimated Time of Arrival (ETA) and other voyage related information, which are manually fed by the ship's officers, will contribute positively in the monitoring process. For instance VTS operator can decide route plans for the transiting ships or pilot boarding position for a specific ship based on such information.

By broadcasting the route plan using AIS to VTS, a vessel can report its sailing plan (intended route) using AIS to the VTS for verification and approval. (Hogendoorn, 2003).

The information provided by the AIS will facilitate, for the VTS operator, the evaluation of the developing situations in VTS area, including the interaction between individual ships been tracked. Furthermore, it will assist in determining the obligation to give way according to convention on the International Regulations for Preventing Collisions at Sea (COLREG), which will improve and add value to the VTS navigational assistance, when required.

Long range automatic reporting and tracking could contribute significantly to the improvement of maritime safety, traffic management and flow in the congested ports and waterways, using the AIS automatic data transfer, long range tracking could function by VTS, which can satisfy different objectives for many States.

USA proposed the long range tracking to IMO in the Maritime Safety Committee (MSC 78th) session to enhance maritime security, whereas in Europe it was tested in the BAFEGIS project to enhance the safety of the ro/ro ships and ferries, by monitoring them from berth to berth between Sweden and Germany in the Baltic Sea. Numerous applications of the long-range tracking can be utilized.

Long-range tracking could be done using the VHF frequencies and a number of repeater stations; furthermore, it could be used to monitor ships at longer range when interfaced with International Maritime Satellite (INMARSAT) receivers or any long-range communications system. Ferries were tracked between Bilbao/Spain and Southampton/UK in the European project "POSEIDON" using the INMARSAT-C position reports (Harre, 1999).

In order to play its role in the surveillance of maritime traffic, VTS systems are provided with hardware, which includes the surveillance equipment, and software systems.

Hardware includes radars, ARPA, ECDIS, AIS, radio communication systems, video cameras, radars track processor and recording, weather sensors and others. Software includes flexible graphical user interface, flexible map management system, and interface for data exchange. Both hardware and software contribute in creating the VTS traffic image.

VTS systems are provided with software filters, which can integrate both radar and AIS symbols, since the operational principles of both systems are different, according to preset criteria and display it as one target. This is called target fusion or multi/sensor fusion, indicating to the operator which sensor is used for the target data calculations.

Integrating ECDIS with radar/ARPA (the so called radar chart) and AIS will allow VTS operator to monitor the chart, targets and target information in one screen. Such integration would strengthen the ability of VTS operator to observe the geographical and hydrographical features of the VTS area and the traffic situation simultaneously. Moreover, it will improve the ability of providing navigational advice, based on a comprehensive picture.

Utilization of the ECDIS monitoring alarm systems are an added benefit to traffic monitoring, such as off-track deviation and safety contour alarms. For instance, if a deep draught vessel is approaching shallow water patch, ECDIS will warn the VTS operator.

The integration of VTS sensors will provide redundancy in detecting, tracking and displaying systems, which will facilitate the detection and tracking of targets. Consequently, this will ensure the safety and efficiency of navigation, as well as the management and monitoring of maritime traffic.

3.2. Shipping and Port Management

Accommodating AIS as an additional sensor to VTS systems, will contribute in improving the quality of shipping information services, which will support the trend of converting VTS to Vessel Traffic Management and information System (VTMIS) by providing wider comprehensive traffic information.

According to International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA/AISM) guidelines on AIS as a VTS tool (2002, p.9), "Increasing emphasis is being placed on networking VTS centres on a regional basis … the rapid transfer of vessel details between different centres. Adoption of AIS within the relevant VTS centres may contribute toward this process."

AIS information technology will integrate shore and ship in one information network. VTS will be the central point in the network acting like the main bridge, linking the ship with all other parties involved in maritime operations. World Wide Web (internet) or similar technology may contribute to form the required communication link.

Information from ship to VTS will be the first step, followed by information exchange from VTS to another VTS within the same region forming a regional network. Furthermore, information exchange between VTS networks will lead to the establishment of an international shipping information network.

The benefits of exchanging information, such as ETA, destination, carried cargo, hazardous cargo onboard, draught and other voyage related information would serve and facilitate many of the economic performance purposes. Furthermore, it will ensure the efficiency of maritime transport as part of the integrated transport system. Utilizing such information for planning purposes will assist in maximizing the utilization of the available resources.

In Austria transponders are being installed and tested in order to use them as components of the control system for ships dispatching. By this, the waiting time at the locks will be reduced by giving speed recommendations to Masters, which will allow

entering the open locks without previous mooring manoeuvres with waiting time (Hossfeld, 2003).

The information network will facilitate and improve shipping management and logistics chains, in applying the modern logistics approach of "just in time" by providing reliable, valid and accurate information in real time to all parties involved such as shipping companies, pilot organizations, port authorities, maritime administrations, consignees, shipping agents, stevedoring companies, immigration departments, customs and terminals.

What will the situation be when a ship arrives at a port; assuming that all ships and VTS centers are equipped with AIS? As the ship approaches the VTS area, where the port of destination is located, the VTS and ship will commence to exchange information, and through the information network, all other stakeholders will have access to the same information.

Information demand and type of information required, which varies from region to region around the globe, will drive the network design. Nevertheless, all operations will be done automatically without a spoken word or any time wasted in communications; it will be part of the VTS automatic internal communications.

4. Maritime Security

In the current international heightened security situation, following the attacks on the USA in September 2001, and the adoptions of new comprehensive maritime security measures by IMO in international diplomatic conference on maritime security in December 2002, the VTS role in ensuring the national security has grown in many countries.

Handling security related information within the VTS information network, resulted in adding the security organizations such as coastguard organizations to the client's list of VTS. AIS information could be of security advantage to the authorities in monitoring and the traffic approaching or passing through its coastal waters. Furthermore, under

the authorization of the authorities, the polling or controlled mode, as specified in AIS performance standards, will allow the VTS to interrogate specific data from ships at any time within the AIS coverage.

Adopting the long range tracking using the AIS, being discussed in IMO Sub-Committee on Radio communications and Search and Rescue (COMSAR), will improve the efficiency of monitoring the traffic for security purposes by extending the AIS range beyond VHF, using long range communications technology, e.g. INMARSAT, which will facilitate the interrogation of ships in the Exclusive Economic Zone.

Exchanging security related information within VTS networks on regional and international bases will strengthen controlling and combating piracy, hijacking of ships and other crimes or terrorist acts against ships on an international basis.

5. Remote Pilotage

The AIS would contribute positively to shore-based pilotage, using the navigational information provided by the AIS in real time. A pilot located in VTS center could guide a number of ships simultaneously, using his local knowledge of the area and the information technology provided by AIS.

The accurate navigational information provided by the AIS will make the shore based pilotage feasible, for many factors include the accessibility to the ship's navigational data, derived form its sensors, to the pilot in real time, will allow him to take the necessary action in ample time, furthermore, The ability to discriminate precisely on presenting displays the target of the piloted vessel among other targets in the area, as well as, The positive identification of the ship throughout the whole pilotage process.

Another type of remote pilotage could be practiced, using remote Portable Pilot Units (PPU). PPU could consist of a PC provided with electronic chart software and AIS. PPU can provide the master or pilot with a comprehensive traffic image and it can be used in situations including exempt Masters of the regular calling ships of carrying pilot in certain ports or waterways, in addition to that, Pilots can use it onboard ships not

fitted with ECDIS, and non-SOLAS ships or other ships not fitted with modern equipped bridge.

Experiments were carried out in Tokyo Bay in 2002, using the PPU in a project intended to support the safe navigation and berthing manoeuvre in port areas in Japan. (One of a series of Marine Intelligent Transport System projects in Japan). In this experiment, the Port Traffic Management System (PTMS) server receives a planned route of all ships using AIS, and check for dangerous encounter situations. The server transmits a warning signal using AIS if any dangerous encounter situation was detected, (Hagiwara, 2003). Further experiments were carried out in Australia and the Netherlands.

6. Search and Rescue

Search and Rescue (SAR) centers being one of the VTS allied services will benefit from the AIS technology. Rescue Coordinating Centers (RCC) could benefit from the VTS traffic image, which contain all the information of the vessels in the VTS area ready in hand.

The information obtained by AIS, VTS information databases and the other functionality of AIS, will facilitate and improve the efficiency of SAR operations, when SAR units are fitted with AIS transponders.

AIS will facilitate the ability of gathering information about the distressed vessel and monitoring its position and other vessels in the vicinity, as well as, tracking of the SAR units including aircraft, for the best use of the RCC resources and the safety of the SAR units and crew. Furthermore, it will ensure the entire coverage of the search area, as well as reducing the time spent on SAR mission.

7. Other VTS applications

In addition to the benefits associated with the use of AIS, as a VTS tool in the main functions of VTS, implementing the AIS technology will improve many other VTS operations, related to the safety, management and monitoring of maritime traffic.

Furthermore, VTS allied services can benefit from the AIS information technology in many operations including:

- Improving the efficiency of protecting the environment by the continuous monitoring and tracing of traffic,
- The networking of the offshore operation including the movement of offshore supply vessels and helicopters.
- Recording of the AIS information could be used for maritime causality investigations, port state control operations and other maritime administration matters,
- Developing shipping and traffic statistics, as a result of the recording and archiving of the information
- Control of fishing and other economic resources activities, Fleet management, by monitoring and tracking certain fleet.

8. Conclusion

A new system was introduced to the maritime industry by the IMO in the SOLAS convention. The AIS uses the SOTDMA technique, which was invented initially for the aviation industry, allowing stations to broadcast identification and information reports at regular and short intervals. IMO had recognized the importance of AIS information in VTS operations.

AIS will assist VTS in achieving its objectives, in managing and monitoring the maritime traffic safely and efficiently and protecting the environment, as well as serve as a great tool in economical and security related operations. Moreover, it will assist many VTS allied services in performing their operations

Integrating AIS with other display systems, such as ECDIS, ARPA and radar will provide a generic view of the traffic situation. Compiling comprehensive traffic image will assist VTS operators in the early identification of critical situations.

AIS is seen as a solution to many of the VTS problems, however, the AIS is a recently added tool to the VTS. The further use and familiarity of it, in the management and

monitoring of traffic will certainly provide additional operational insights, which may contribute positively to reduce the workload for the VTS operator.

References

Hagiwara, H., Ohtsu, K., Shoji, R., Tamaru, H., Takahashi, H., & Nakaba, A. (2003). New traffic management system based on AIS and planned route information. In *Proceedings of the 11th International Association of Institutes of navigation world congress: Smart navigation systems and services*. Berlin: German Institute of Navigation.

Harre, I. (1999). AIS adding new quality to VTS systems. In *Proceedings of the International Symposium ETT 99/SATNAV 99.* Potsdam: German Institute of Navigation.

Hogendoorn, R. (2004). AIS and the integrated surveillance concept. In *proceedings of the 10th International Symposium on Vessel Traffic Services: Session 5 paper 7 (pp.417-422).* Hong Kong: Marine Department.

Hossfeld, B. (2003). The automatic identification system (AIS) as link to an intermodal transport chain. In *Proceedings of the 11th International Association of Institutes of navigation world congress: Smart navigation systems and services*. Berlin: German Institute of Navigation.

International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA). (2000). *Guidelines on AIS as a VTS tool.* St Germain en Laye: Author.

International Maritime Organization (IMO). (1997, November 27). *Resolution A 857(20): Guidelines for vessel traffic services.* London: Author.

International Maritime Organization (IMO). (2001). *SOLAS consolidated edition, 2001.* London: Author.

Sollosi, M. (2002). The automatic identification system and vessel traffic services. *Proceedings of IMO/IALA Seminar on the Automatic Identification system (AIS).* London: International Maritime Organization.