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Ryszard WAWRUCH [1]

GLOBAL SHIPS' MONITORING SYSTEM

Paper presents technical possibilities and legal limitations in introducing global merchant ships' monitoring system based on the AIS technique. Described system will automatically transmit, collect, process and distribute data about ships' ID, present positions and vectors of movement, places of destination and expected times of arrival, planned routes and number of persons and dangerous and pollutant goods carried on board. Technologies available for this system: ORBCOMM, IRIDIUM, GLOBSTAR and INMARSAT are analyzed.

ŚWIATOWY SYSTEM MONITOROWANIA STATKÓW

Referat prezentuje możliwości techniczne i ograniczenia prawne wprowadzenia światowego systemu monitorowania statków handlowych bazującego na technice AIS. Opisywany system będzie automatycznie przesyłać, zbierać, przetwarzać i rozprowadzać dane identyfikacyjne i o aktualnych pozycjach i wektorach ruchu statków, miejscach ich przeznaczenia i spodziewanych czasach przybycia, planowanych trasach przejścia, a także przewożonej liczbie osób i towarach niebezpiecznych i zanieczyszczających środowisko. Są poddane analizie technologie dostępne dla tego systemu: ORBCOMM, IRIDIUM, GLOBSTAR i INMARSAT.

1. INTRODUCTION

Two years ago was presented on this conference conception of the Polish national ships' monitoring system based on AIS technique in the VHF band [1]. Last year were discussed some quality aspects of information about radar tracked and AIS reported vessel in VTS centre [2]. It was stressed that AIS is an excellent tool for shore based ships' monitoring systems providing in automatic manner and without time delay information about ship's identification, present position and vector of movement, place of destination and time of arrival and passengers and dangerous goods and maritime pollutants on board. Presented monitoring and traffic control systems have one main fault – limited activity area defined by the area of coverage of the shore based VHF radio stations (so called A1 sea area) or shore based radar tracking systems.

[1] Faculty of Navigation, Gdynia Maritime University, Morska 81-87, 81-225 Gdynia, Poland, (58) 6901112, R.Wawruch@am.gdynia.pl

International Maritime Organisation (IMO) practically already decided that littoral states have the right to monitor sea traffic at the distance up to 3700 km (2000 nautical miles) from their coastlines. This requirement will virtually include all open sea and ocean waters leading to a logical conclusion of introducing vessel monitoring from point of departure to point of arrival. AIS working in the VHF band does not fulfil this requirement. It is the reason to introduce Long Range Identification and Tracking of Ships (LRIT).

2. BASIC REQUIREMETS FOR LONG RANGE IDENTIFICATION AND TRACKING

Globally, there is a growing demand from various maritime authorities and regional and national agencies like US Coast Guard and European Maritime Safety Agency for LRIT to enable them to fulfil their individual tasks ranging from navigation safety and search and rescue (SAR) service to environmental protection, prevention of crime and security. The information needs ranged across a continuum from a simple daily position report to close monitoring of a ship's movement and its cargo [5]. Described system should primary enhance security of the coastal state by providing information about ships' traffic in a timely manner to enable the state to take any appropriate action. According to the present considerations LRIT should [3]:

1. Have global coverage;
2. Be defined and mandated by International Maritime Organisation (IMO);
3. Track all ships equipped with AIS on international voyages wherever they are, outside the coverage of shore-based AIS stations working in the VHF band;
4. Provide information to authorised administrations only:
   - the ship's flag state;
   - the port state towards which the ships is sailing;
   - the coastal state through whose waters the ships is sailing; and
   - search and rescue (SAR) authorities or any others authorised by IMO to receive LRIT data;
5. Be capable of providing authorised institutions with only the specific information they are entitled by IMO to receive;
6. Protect the privacy and security of the data reported by ships during its transmission from the ship to the system, within the system, during transfer from the system to authorised recipients and when handling by these recipients; and
7. Be financially self-supporting.
8. Allow:
   - authorised administrations:
     - to mandate a basic LRIT system for use by all ships without additional cost to the ship owner for purchase on board equipment;
     - to receive LRIT data in an assured way to meet the needs of homeland security;
     - to collect and distribute data in a secure and private environment;
     - to remotely instruct ships' LRIT equipment to send more frequent reports under certain circumstances; and
     - to control the operation of the system in a cost effective and efficient manner;
   - ship owners and managers:
     - to choose from a number of approved by IMO LRIT service providers;
     - to provide in automatic manner only the internationally mandated minimum number of reports;

- to use any suitable communication system for reporting; and
- to use their existing ships communications equipment to meet the LRIT requirements without additional equipment cost.

Introducing of LRIT will also give following additional benefits [4]:

1. Knowledge of the presence and movement of shipping could assist in responses to SAR incidents and medical evacuations at sea.
2. LRIT could provide a near real time database, which can be drawn upon to augment national ship reporting systems or provide early warning of the imminent entry of vessels into such systems.
3. LRIT information may be used to enforce compliance with national and international regulations, assist with Exclusive Economical Zone (EEZ) management, monitor so called Particularly Sensitive Sea Areas (PSSA) and compliance with traffic routeing measures. This information could also serve as a deterrent for harm to the environment and assist in pollution investigations.
4. In many cases, LRIT may be the only one method for a coastal state to monitor the transit of ships within their territorial waters or EEZ.

The general scheme of the LRIT system is presented in the Fig.1.

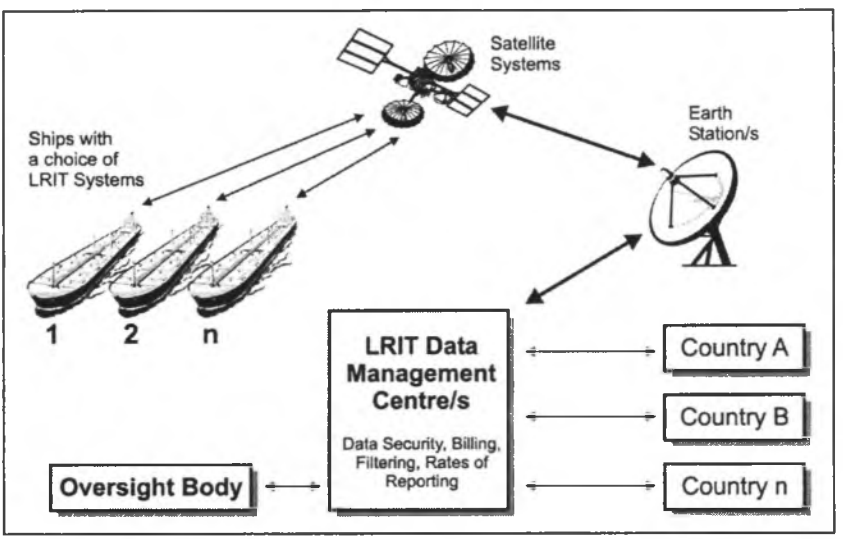

Fig.1. The general scheme of the LRIT system [5]

3. LEGAL ASPECTS

According to the requirements of the International Convention on Safety of Life at Sea (SOLAS), AIS should be installed on:

- all passenger ships irrespective of size;
- cargo ships of 300 gross tonnage and upwards engaged on international voyages; and
- cargo ships of 500 gross tonnage and upwards not engaged on international voyages.

It shall, among other:

- provide automatically to appropriately equipped shore stations, other ships and aircraft information, including the ships identity, type, position, course, speed, navigational status and other safety-related information;
- exchange data with shore-based facilities; and
- conform to the performance standards not interior to these presented in the Annex 3 to the IMO Resolution MSC.74 (69) "Recommendation on performance standards for universal ship-borne automatic identification systems (AIS)".

Above mentioned resolution recommends that AIS should work in the VHF radio band only and be capable of operating as a mean for littoral states to obtain information about a ship and its cargo.

Additionally, according to the conventional requirements, ship-borne AIS might be switched off when ship's master on his professional judgement believes that the continual operation of AIS might comprise the safety or security of his ship, for example in areas where pirates and armed robbers are know to operate.

It means that:

- AIS is and will be installed on passenger and cargo ships (so called conventional vessels) only. Leisure craft, fishing vessels and boats, warships, naval auxiliaries and ships owned or operated by governments might not be fitted with this equipment;
- at present, there is not international requirement or recommendation to connect ship-borne AIS to any radio communication transceiver with global coverage and AIS may not have interface suitable for this purpose;
- there are situations when ship's master may switch off ship-borne AIS.

There is, after the 10th of September 2001, common agreement that littoral states may introduce monitoring of the sea areas at the distance up to 3700 km from their coasts. There is widespread support that this monitoring should include information about identity and present positions of ships in these areas.

At present there are unsolved questions of the financial aspects of introducing and maintaining of the analyzed system. It is difficult to estimate total system cost at so early stage, but according to the calculation presented by experts from International Mobile Satellite Organization (IMSO) the cost for each report in the LRIT service will be on the level of about 20-25 cents US and system set-up cost will be between half and one million dollars US [3].

It is suggested that the primary source of funds should be governments receiving information from system database. They should pay for data they receive, on a "per report" basis or a standard price, accounted probably on annual basis. But there is not decided what does it mean "government receiving information". The answer on this question depends on the implemented methods of ships reports transmission. There are two possibilities:

- some ships (for example passenger vessels or ships with dangerous cargo) should report some of the time (for example when sailing at the distance from the USA coast less than 3700 km); or
- all ships should report all the time, for example 4 times per day.

In the first case, all ships reports should be paid by littoral state asking for information, in the second case, the ship's flag state has to pay for so called routine ships reports and additional reports should be paid by states or institutions asking for them.

4. TECHNICAL POSSIBILITIES

There are already a number of parties with a legitimate interest in LRIT of the ships [5]:

- commercial, bodies (ships owners, cargo forwarders, charterers, etc);
- port authorities and ships' agents;
- search and rescue, immigration, customs, quarantine and navigational services;
- security, environmental protection and Port State Control agencies; and
- fisheries management authorities.

Many different systems have been developed and introduced to cater for these interest, both commercial and government owned and operated. They vary in the type of technology used, the application of different types of ships or areas of operation, and in the frequency and costs of reporting a ship's position and related information [5].

All existing conventional vessels engaged on voyages outside A1 sea areas are fitted and will be invariably fitted with the transceivers (terminals) of the global satellite radio communication system Inmarsat-C for reception of Maritime Safety Information and to meet other requirements of the Global Maritime Distress and Safety System (GMDSS). Those terminals can be used to transmit reports required by LRIT service at no extra cost. Other ships may have to be fitted with additional equipment, but will be able to choose from a range of communication systems offered by their LRIT service providers [3]. Some conventional vessels are already fitted with special equipment for ships reporting purposes introduced as a tool for so called fleet management required by the Company Quality Management System. Many fishing vessels including Polish have already satellite transponders to enable their monitoring when at sea by competent authorities.

Since 1st December 2004 the mandatory ship reporting system in the Great Barrier Reef and Torres Strait Vessel Traffic Service (REEFVTS) has been upgraded by introducing obligatory so called Pre-Entry Report and 15 minutes position updates via Inmarsat-C Automated Position Reporting [5] creating first in the world obligatory LRIT system for conventional vessels.

The quality comparison of the most popular four technologies presently available for LRIT is presented in the Table 1.

Table 1

Technologies presently available for LRIT [4, 6]

Parameter	ORBCOMM	IRIDIUM	GLOB-ALSTAR	INMARSAT
Orbit	Polar	Polar	Polar	Geosynchronous
Frequency range	137MHz 150MHz	1.6GHz	1.6GHz 2.5GHz	1.5GHz 1.6GHz
Gateway topology	Store and forward	Space switched	Earth switched	Earth switched
Coverage	Global	Global	Requires earth station and mobile within single satellite coverage	Global except for polar regions
Data rate per terminal	2.4kb/s	9.6kb/s	9.6kb/s	64kb/s (New M4)
Data cost per kilobit (50k transfer)	~0.10 USD per kilobit	~0.20 USD per kilobit	~0.20 USD per kilobit	~0.11 USD per kilobit
Estimated cost of terminal	$500	$1,000	$1,500	$8,000 (New M4)
Data interface	AT Hayes at terminal	AT Hayes at terminal E-mail at earth station	AT Hayes and TCP/IP at terminal TCP/IP at earth station	AT Hayes and TCP/IP at terminal TCP/IP at earth station
Antenna system	Omni direction-al VHF monopole	Omni directio-nal micro-wave monopole	Omni directio-nal microwave monopole	Tracking antenna on mobile equipment
Primary constraints	Low data rates Data only Network latencies Potential on ship interference issues	Low data rates E-mail return on earth segment	Limited coverage	Complex antenna equipment, M4 said to be power hungry Message sent to ship can be undelivered for over 30 minutes without warning
Primary advantages	Simple interface Low cost Global coverage Low power consumption	Simple interface Data and voice Low cost Global coverage	Simple interface Data and voice Terminals have GSM and satellite capability	High data rates Data and voice Near global coverage

It is now discussed at Maritime Safety Committee (MSC) of International Maritime Organisation (IMO) to entrust International Mobile Satellite Organisation (IMSO) all questions connected with introducing and operation of LRIT system. Under the IMO supervision IMSO should prepare procedures for LRIT service, data collecting and distribution and approval and supervision of the service providers (data centres, tracking services and communication systems). Service providers should work on the basis of contracts (Public Service Agreements) between each one of them and IMSO. It is possible that particular Flag States will reserve the right to approve tracking service providers acceptable for their vessels. According to the IMSO information there is now about 45 000 ships which should participate in the LRIT system. If all of them will send daily even only one report for 20 cents, the total global cost will be around 3285000 USD per year. That is the reason that IMO and IMSO do not suspect any problems with finding the service providers.

5. CONCLUSIONS

1. Worldwide sea traffic is increasing and security, safety and environmental risks are increasing too. These are the reason of introducing Long Range Identification and Tracking (LRIT) system.
2. LRIT is already technically attainable. Technologies are available to provide cost effective solution.
3. The main unsolved questions are:
   - what ships, when and how often shall send reports;
   - what information shall be included in the messages transmitted by ships; and
   - what state and on what basis shall pay for the system.

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Reviewer: Prof. Bernard Wiśniewski