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Global Maritime Distress Safety System for Ship Target Detection

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Introduction

During the 18th century, the ships sailing in transnational and coastal waters reliant on the Morse code to send distress signal to a coastal authority or vessels nearby vicinity during emergency. The transmission of texture information using tones or lights was never very clear to understand i.e. what kind of emergency occurred on board ships, which leads to the adoption of internationally agreed safety procedure by IMO under SOLAS chapter IV known as GMDSS (Global Maritime Distress Safety System) and came into picture on 1st Feb 1999 with full implementation, consisting a set standard for usage of communication protocol, safety procedures and equipment to rescue boats, ships and other air craft's at the time of distress. Under it, all passenger ships and cargo ship above 300 GT (involved in the international expeditions) have to carry equipment as per GMDSS, which sends a distress signal using a satellite or radio communication.

Communication frequencies

Different frequencies of specific band are utilized in communication channel, includes medium, high and very high frequencies.

1. **Medium Frequencies:** 300 KHz to 3 MHz
2. **High Frequencies:** 3 MHz to 30 MHz
3. **Very High Frequencies:** 30 MHz to 300 MHz

Very High Frequencies (VHF)

For maritime communication purposes, the range allocated is 156 MHz to 174 MHz. Channel 16 intended for Distress, Urgency and Safety communication is set at 156.800 MHz and

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Channel 70 for routine VHF DSC (Digital Selective Calling) watch is set at 156.525 MHz. In addition the GUARD channels are set above and below Channel 16 to elude interferences and have seamless traffic with regard to other communication apart from distress, safety and urgency. The frequencies of guard channel are 156.775 MHz and 156.825 MHz.

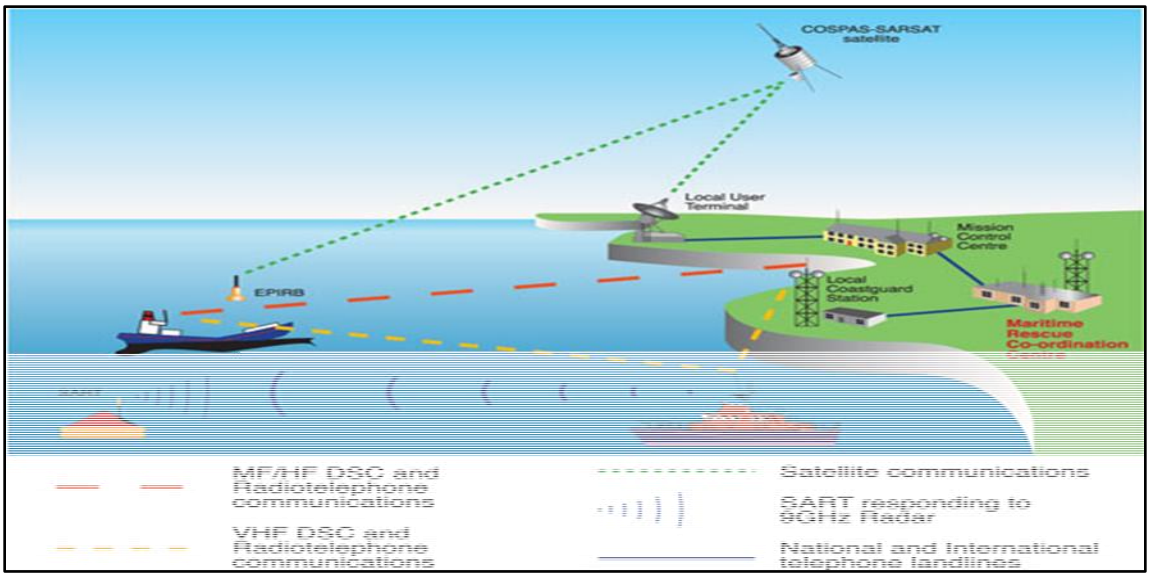

Fig 1. Working concept of GMDSS

Components of GMDSS

1. **INMARSAT:** It is a Satellite operated system that comprises ship earth station terminals-Inmarsat B, C and F77, providing services like telex, telephone and data transfer between ship to ship, ship to shore and shore to ship along with a priority telex in addition to telephone service connected to shore rescue centres.
2. **NAVTEX:** NAVTEX is an internationally adopted automated system which allocates maritime safety information (MSI), including weather forecasts and warnings, navigational warnings, search and rescue notices and other safety related information.
3. **Emergency Position Indicating Radio Beacon (EPIRB):** It is an equipment used to determine the position of survivors during a SAR operation and is a secondary means of distress alerting or warnings.

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4. **Search and Rescue Locating Equipment:** Chiefly the Search and Rescue Radar Transponder, is used to home Search and Rescue units to the position of distress which transmits upon interrogation.

5. **Digital Selective Calling (DSC):** This is a calling service between ship to ship, ship to shore or vice versa for safety and distress information mainly on high or medium frequency and VHF maritime radio.

Permitted on-board documents

1. Ship's Radio License
2. Radio Operators Certificates
3. Safety Radio Certificate
4. GMDSS Radio Log Book
5. ITU List of Cell Signs and Numerical Identities of Stations used by Maritime Mobile and Maritime Mobile Satellite Services
6. ITU List of Coast Stations, Ship Stations, Radio determination and Special Service Stations
7. Antenna Rigging Plan
8. Valid Shore Based Maintenance Certificate

Handling of GMDSS

GMDSS handling requires certified training along with the license from the Telecommunication department. The General Operators Certificate (GOC) is mandatory for an officer allowed to handle GMDSS equipment onboard the ship. To obtain the GOC, attending a short course/ training followed with an exam (written and oral) is compulsory, which needs to be cleared. This training is aimed at Cadets who ought to become licensed Radio Operators to operate all the equipment in conjunction with the regulations laid out for GMDSS.

Automatic Identification System (AIS)

AIS, prerequisite for all vessels over 300 tons on international, 500 tons on non-international voyages and all passenger ships to transmit information such as identification, position, course, speed, sizes, draught, and ship type to other ships and to the shore.

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The main purpose of AIS is

1. To identify vessels
2. To assist target tracking
3. To simplify information exchange
4. To provide additional information to assist collision avoidance

However, by regulation the vessels not required to fit can also fit AIS. Though having the capability most fishing vessels and naval vessels don't transmit AIS. Masters of vessels can switch off their transmissions to protect the security of the vessel and do so in areas where piracy is rife. The expanded system to include AIS transmitters (major navigational marks) well-known as Aids to Navigation or "Atons". It has capability to control over 2000 time slots/minute/ channel and updates as often as every two seconds. The AIS utilize SOT- DMA (Self-organizing Time Division Multiple Access) technology to meet this high broadcast rate and ensures reliable and consistent operation. Timing information is derived from global navigation satellite system receiver and the comprehensive information is available on AIS manual.

Advantages of AIS

1. Real time data (maneuvering data)
2. Broad geographical coverage
3. Improved search and rescue management
4. Superior positional precision
5. Absence of "radar shadow" areas
6. Enhanced vessel tracking
7. Provision of more precise navigational advice

Types of AIS equipment.

For a shipboard fitting there are three types of AIS equipment, which are listed below:

Class A

Class B

Receive only

Class A

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It is intended for vessels where the fit is mandatory. Class A transmits more information regularly at high power than Class B. In AIS transmission most of the information is derived from other instruments on the vessel e.g. course over the ground (COG) and speed over the ground (SOG) from GPS however manual entry is required for selected ones like vessel status i.e. underway, at anchor, alongside, etc. along with number of passengers and next port of call.

Class B

Intended for voluntary fit vessels though being largely "fit and forget" does not require manual updating unlike Class A. Vessel details are entered when it is installed and then transmits vessel name, call sign (MMSI), position, COG and SOG.

"*Both Class A and B receive data from other vessels and use to place icons on the screen of the plotter and these in turn can be interrogated to show all the vessel data*".

Receive only

Suitable for small vessels, receives AIS transmissions from other vessels and display them. Initially, receive only was for small craft later Class B came into the market and is now preferred. Receive only means we will be able to see what other vessels are doing but they cannot see us. Recently AIS Man Overboard devices have become available and integrated into lifejackets. These devices have an advantage over the conventional satellite based units (EPIRBS) in that they will show up on chart plotters on adjacent vessels whereas the EPIRB will only alert shore side search and rescue authorities.

AIS and the technology

There are a number of websites and applications on the internet that allows us to look at AIS, for instance, Marine Traffic (www.marinetraffic.com). These work by taking the data from a number of receiving points around the coast combining to give an overall-image. There are few other applications too which can transmit AIS from smartphone (http://www.marinetraffic.com/en/p/mais).

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AIS is transmitted on two reserved channels in the marine VHF allocation (87B and 88B) and the range is dependent on antenna height although the AIS signal is more rugged than speed which slightly increases the range. To accommodate lots of vessels transmitting on just two channels a system known as TDMA (Time Division Multiple Access) is used where time period is divided into a number of time slots. Switching ON Class A or B looks for a vacant time slot and reserves it. Other sets in range will avoid this slot and select alternative one. Precise timing is required to ensure synchronisation of all vessels and this is derived from GPS and now is possible to receive AIS information globally by satellite. This is available from a number of providers, generally by subscription and is used by fleet operators. The process of "de-confliction" mark guarantee for identification of all vessels and thereby provide a complete picture.

Installation

Adding AIS to a modern system is simple, it unit just needs power, an antenna and a connection to the main system. For current Raymarine systems this is via Seatalk NG. Older systems can be connected via NMEA-0183. This system being limited can only deal with one source of data i.e. talker but can have multiple places for listeners. The system usually runs at 4800 band but for AIS needs to run at a higher speed i.e. 34800. The AIS unit can have its own antenna (or splitter), can use the same antenna as the VHF. The loss in sensitivity to the VHF radio by adding a splitter is marginal but some older VHF aerials may not be suitable for AIS due to the frequencies used on the edge of the marine band and aerials. If we are using an AIS that transmits (Class A/B), the splitter must be suitable for transmit use, this is particularly the case if we are upgrading from receive only to Class B. For Class A and B systems, a new installation requires the vessel details to be entered via PC using Pro AIS program. In the UK, it is acceptable for a boat owner to enter the details whereas, in the US it is essentially done by an authorised installer.

AIS use on the chart plotter

Principally, it is valuable to know the identity of other vessel. AIS information can be displayed both on the chart and screen of radar. Vessels transmitting AIS will show up as a blue wedge shape and the point of the wedge represents the heading of the vessel. Each AIS

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icon can be interrogated and gives the information of target vessel including name, position, size, COG and SOG, Closest Point of Approach (CPA) and Time to CPA (TCPA).

In circumstance of risk, the icon will turn red and an alarm will sound (if alarm switched on). It judges the threat against criteria set by us and also checks whether the target will come within a set distance and set time, for example within 0.5 miles within the next 6 minutes. We can see how close it will come by looking at the CPA.

AIS is an astonishing leaps forward in marine electronics and safety at sea. Coming across the channel, it is a joy to see the commercial traffic ahead of us and pick our way through the streams of ships entering and leaving separation schemes. It is very tempting to concentrate on the AIS targets on the screen and forget the other vessels not transmitting AIS. It allows calculation of Closest Point of Approach (CPA) but does not give an indication of whether we will pass ahead or astern of another vessel. It restricts to use the information and make the right decision in accordance with the regulations (COLREGS) and this has been addressed in the latest software release (R15) for Raymarine a, c, e, gS and eS series multifunction display taking AIS practically a step beyond.

Conclusion

Global Maritime Distress and Safety System replaced old Morse code system (500 kHz) with supreme intention to improve safety of life at sea (probably 85-90%). A major development, AIS, limited to large commercial shipping provides better decision making tendency and must be accepted in mind though there are plenty of hazards out not transmitting AIS data, forcing to have quiet good understanding for COLREGs comprising 41 rules divided into six sections.

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