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New Proposal for Search and Rescue in the Sea

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ABSTRACT: Currently the security of a ship would be reduced if among its systems don't have some able to indicate its position, providing the necessary data to try that the Rescue System begin a rescue in the event of emergency or catastrophe. Formerly the localization of a ship was based on warnings transmitted by the sailors or automatic systems. The efficiency of these systems was demonstrated in the rescue services and salvage of human lives obtained along more than a century. Since final of the last century the marine transport introduced a new aid system, the Global Maritime Distress Safety System (GMDSS), based in the automatic alarms through communications for satellites and the radiobeacons use that transmit data that help to the localization of a ship.
In this work is sought to characterize some of the systems of satellites more diffused for the localization of aid signs (INMARSAT, COSPAS-SARSAT), adding the project IRIDIUM for improvement of the search and rescue, by means of the surveillance from satellites in orbit. A comparison will be established among these systems, taking parameters like: global covering, emission of false alarms, portability and economic cost, with the objective of determining the most effective system in case of catastrophes.

1 INTRODUCTION

The beginning of the marine communications at distance born with the use of the telegraphy without threads, the localization of a ship was based on warnings transmitted by the sailors or automatic machines. The effectiveness of these systems was demonstrated in the rescue services and salvage of human lives, during more than a century. Currently the security of a ship would be reduced, if enters its systems don't have some able to indicate its position, providing the necessary data with the objective to beginning a rescue in the event of emergency or catastrophe.

In the XX century, the marine transport began to introduce a new aid system, the Global Maritime Distress Safety System (GMDSS), based in the automatic alarms through communications for satellites and the radiobeacons use that transmit data that help to the localization of a ship.

2 GLOBAL MARITIME DISTRESS SAFETY SYSTEM (GMDSS)

The Global Maritime Distress Safety System (GMDSS), it is a group of procedures of security, devices and communication protocols designed, to increase the security and to facilitate the sailing and the rescue of ships in danger.

This system is regulated by the International Convention for the Safety of Life at Sea (SOLAS), approved under the auspices of the International Maritime Organization (IMO), dependent organism of the UN. It is operative in the merchant ships and of passage from 1999.

The GMDSS it is composed of satellites and terrestrial systems that try to carrying out the following operations: alerts (including position), search coordination and rescue, localization (positioning), provision of marine information, general communications and communications bridge to bridge.

Among the satellites systems are: INMARSAT and COSPAS-SARSAT and in the terrestrial ones we find: HF, MF, VHF, AND NAVTEX. The used communication techniques are: radio, telephony, telegraphy of direct impression and digital selective call [1].

3 SATELLITAL SYSTEMS

When more developed it is a society, more high it is their demand level in all the fields, especially in the communications. The systems of communications by satellites are the answer to this demand. Its privileged location in the space and the absence of obstacles with the users, do that the cellular telephony concept, extends beyond of any impediment, although they are not exempt of such meteorological inconveniences as the rain, atmospheric humidity, ice, sunspots, etc. The communications with satellite way in the ships have supposed the world covering for the same ones, facilitating to connect with any telephone of the world in a quick and effective way. The advantage is that, in all moment it is possible to know which one it is the necessities of the ship to be able to aid them, in the event of emergency or catastrophe.

3.1 *COSPAS-SARSAT*

This satellite system was initially developed under a Memorandum of Understanding among Agencies of the former USSR, USA, Canada and France, signed in 1979.

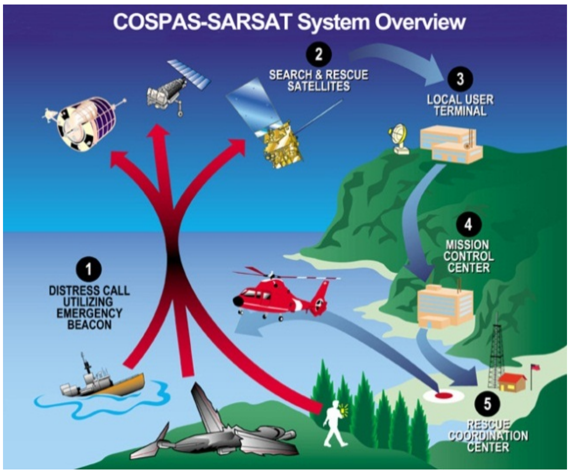

Fig.1. COPAS-SARSAT System Overview.

The mission of the Programme is to provide accurate, timely and reliable distress alert and location data to help Search and Rescue (SAR) authorities assist persons in distress. The objective of the Cospas-Sarsat System is to reduce, as far as possible, delays in the provision of distress alerts to SAR services, and the time required to locate a person in distress at sea or on land and provide assistance to that person, all of which have a direct impact on the probability of survival. To achieve this objective, Cospas-Sarsat participants implement, maintain, coordinate and operate a satellite system capable of detecting distress alert transmissions from radio beacons that comply with Cospas-Sarsat specifications and performance standards, and of determining their position anywhere on the globe (Fig 1). The distress alert and location data is provided by Cospas-Sarsat Participants to the responsible SAR services.

The System is available to maritime and aviation users and to persons in distress situations. Access is provided to all States on a non-discriminatory basis, and is free of charge for the end-user in distress.

The System is composed of:

- distress beacons operating at 406 MHz;
- SAR payloads on satellites in low-altitude Earth orbit and in geostationary orbit;
- ground receiving stations spread around the world; and
- a network of Mission Control Centres (MCCs) to distribute distress alert and location information to SAR authorities, worldwide.
- Satellite processing of old analogue technology beacons that transmit at 121.5 MHz ended on 1 February 2009 [2, 3].

3.2 *INMARSAT*

The company was originally founded in 1979 as the International Maritime Satellite Organization (INMARSAT), a not-for-profit international organization, set up at the behest of the International Maritime Organization (IMO), a United Nations body, for the purpose of establishing a satellite communications network for the maritime community. It began trading in 1982. From the beginning, the acronym "INMARSAT" was used. The intent was to create a self-financing body which would improve safety of life at sea. The name was changed to "International Mobile Satellite Organization" when it began to provide services to aircraft and portable users, but the acronym "INMARSAT", was kept.

Aside from its commercial services, INMARSAT provides global maritime distress and safety services (GMDSS) to ships and aircraft at no charge, as a public service (Fig 2).

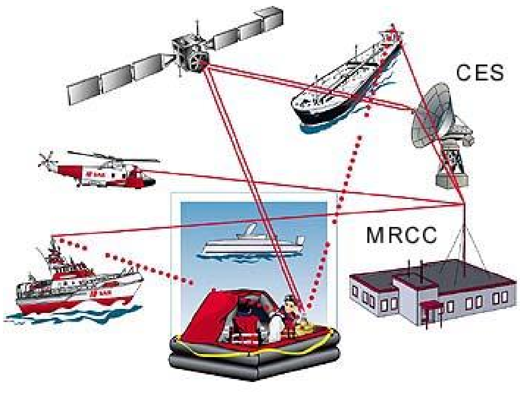

Fig.2. Inmarsat system communication.

Services include traditional voice calls, low-level data tracking systems, and high-speed Internet and other data services as well as distress and safety services. The most recent of these provides GPRS-type services at up to 492 kbit/s ways the Broadband Global Area Network (BGAN) IP satellite modem the size of a notebook computer. Other services provide mobile Integrated Services Digital Network (ISDN) services used by the media for live reporting on world events via videophone.

Today INMARSAT owns and operates three global constellations of 11 satellites flying in geosynchronous orbit 37,786 km (22,240 statute miles) above the Earth [4].

3.3 *IRIDIUM*

Iridium Communications Inc. (formerly Iridium Satellite LLC) is a company, based in McLean, VA, United States which operates the Iridium satellite constellation, a system of 66 active satellites used for worldwide voice and data communication from hand-held satellite phones and other transceiver units (Fig 3). The Iridium network is unique in that it covers the whole Earth in real time, including poles, oceans, terrestrial areas and airways.

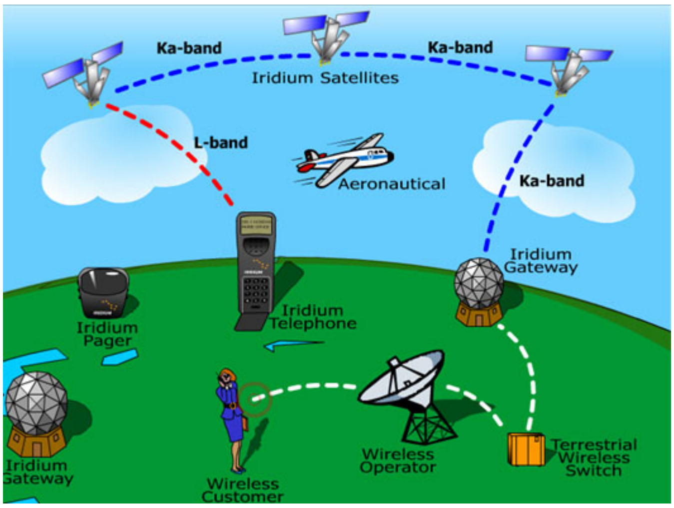

Fig 3. Iridium System communication.

The company derives its name from the chemical element iridium. The number of satellites projected in the early stages of planning was 77, the atomic number of iridium, evoking the metaphor of 77 electrons orbiting the nucleus [5].

The Iridium system requires 66 active satellites in orbit to complete its constellation and spare satellites are kept in-orbit to serve in case of failure. Satellites are in low-Earth orbit (LEO at a height of approximately 485 mi (781 km) and inclination of 86.4°. Orbital velocity of the satellites is approximately 17,000 mph (27,000 km/h) (Fig 4). Satellites communicate with neighbouring satellites via K_a band inter-satellite links. Each satellite can have four inter-satellite links: two to neighbours fore and aft in the same orbital plane, and two to satellites in neighbouring planes to either side. The satellites orbit from pole to pole with an orbit of roughly 100 minutes. This design means that there is excellent satellite visibility and service coverage at the North and South poles, where there are few customers. The over-the-pole orbital design produces "seams" where satellites in counter-rotating planes next to one another are traveling in opposite directions. Cross-seam inter-satellite link hand-offs would have to happen very rapidly and cope with large Doppler shifts; therefore, Iridium supports inter-satellite links only between satellites orbiting in the same direction. [7].

Fig 4. Constellation of the Iridium System.

The satellites each contain seven Motorola/Freescale PowerPC 603E processors running at roughly 200 MHz, connected by a custom backplane network. One processor is dedicated to each cross-link antenna ("HVARC"), and two processors ("SVARC"s) are dedicated to satellite control, one being a spare. Late in the project an extra processor ("SAC") was added to perform resource management and phone call processing.

On the ground, Iridium's network includes gateways in Arizona and Alaska; a satellite network operations center in Virginia; a technical support center in Arizona; and four tracking, telemetry and control (TTAC) stations in Canada, Alaska, Norway and Arizona - all interconnected by advanced fiber-optic and broadband satellite links. As with the satellite constellation, the ground infrastructure is designed with resiliency, permitting voice and data traffic, as well as satellite backhaul data links, to be rerouted as needed. The U.S. Department of Defense also has its own gateway in Hawaii to support U.S. government traffic [5].

The system is being used extensively by the U.S. Department of Defence through the DoD gateway in Hawaii. The DoD pays for unlimited access for up to 20,000 users [7].

The commercial gateway in Tempe, Arizona, provides voice, data, and paging services for commercial customers on a global basis. Typical customers include maritime, aviation, government, the petroleum industry, scientists, and frequent world travellers.

Iridium satellites are now an essential component of communications with remote science camps, especially the Amundsen-Scott South Pole Station. As of December 2006, an array of twelve Iridium modems was put online, providing continuous data services to the station for the first time [7].

Iridium is currently developing, and is expected to launch beginning in 2015, **Iridium NEXT** a second-generation worldwide network of telecommunications satellites, consisting of 66 satellites and six in-orbit and nine ground spares. These satellites will incorporate features such as data transmission which were not emphasized in the original design. The original plan was to begin launching new satellites in 2014. Satellites will incorporate additional payload such as cameras and sensors in collaboration with some customers and partners. Iridium can also be used to provide a data link to other satellites in space, enabling command and control of other space assets regardless of the position of ground stations and gateways. The constellation will provide L-band data speeds of up to 1.5 Mbps and High-speed Ka-Band service of up to 8 Mbps [5, 6, 7].

4 IRIDIUM SYSTEM ADVANTAGES.

1 Iridium system offers a worldwide voice and data communication from hand-held satellite phones and other transceiver units from hand-held satellite phones and other transceiver units, more complete that Inmarsat system, that not cover the poles.

2 The IRIDIUM terminals are smaller that the beacons of the INMARSAT and COPAS-SARSAT systems, in weight and volume, easy to place in the harness of a lifeboat vest.

3 The cost of the communication from hand-held satellite phones services is more economic in the IRIDIUM system that in the INMARSAT system.

4 The speed of answer in the Iridium systems is bigger than the INMARSAT and COPAS-SARSAT systems.

5 The possibility to have a terminal IRIDIUM in the harness in the catastrophe event, would allow us to transmit the alarm sign, the data of coordinated and identity of the ship and with the voice interaction to contrast if it is a real alarm. This would allow reduced the false alarms that in the COSPAS-SARSAT system are very high.

5 CONCLUSION

Today the effectiveness of Global Maritime Distress Safety System (GMDSS) is questioned, for the bad management of the system in catastrophes as the Ferry Al-Salam Bocaccio 98 in the Red Sea in the 2006. It is possible that if the IRIDIUM project dedicates several frequencies for the transmission of data in the event of catastrophe (number of the ship, position and catastrophe type), as well as centres of reception of the calls to contrast that the alerts that take place are true, It is possible that if the IRIDIUM project dedicates several frequencies for the transmission of data in the event of catastrophe (number of the ship, position and catastrophe type), as well as centres of reception of the calls to contrast that the alerts that take place are true, will be an important step to improving the security of the human life in the sea and GMDSS would recover credibility.

REFERENCE.

[1] González Blanco, Ricardo. "Incidencia de las Nuevas Tecnologías en la Seguridad de los Buques". Director: González Pino, Enrique. Universidad Politécnica de Cataluña, Centro de Documentación del Departamento de Ciencias e Ingeniaría Náutica, 1999.

[2] Cospas-Sarsat (International Satellite System for Search and Rescue) "Cospas-Sarsat 1979-2009, a 30-year Success Story" <http://www.cospas-sarsat.org/>

[3] WordLingo "Cospas-Sarsat" [en línea], 2010 <http://www.worldlingo.com/>

[4] INMARSAT "The mobile satellite company" <http://www.inmarsat.com/>

[5] IRIDIUM Everywhere <http://www.iridium.com/>

[6] COIT (Colegio Oficial Ingenieros en Telecomunicaciones) "Iridium: llamando al Planeta Tierra" <http://www.coit.es/>

[7] IRIDIUM. <http://es.wikipedia.org/wiki/Iridium>