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The Advanced Radio Communication Technologies for Inland Navigation

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ABSTRACT: The article presents integrated digital and analog radio communication technologies to be used in inland navigation. The communication model of an integrated Iridium satellite system with DSC-VHF in emergency situations for the needs of inland navigation was presented. The functional requirements of the Iridium satellite system for inland navigation were characterized in detail. Finally, the applicability of the Thuraya satellite system for inland navigation was presented.

1 INTRODUCTION

The European Commission in its points out the fundamental importance of inland waterway transport in the entire transport system of the European Union and defines standards for information exchange and directions for the development of radio communication systems for integration and cooperation in maritime and inland waterway transport [2, 3].

Inland navigation, which differs significantly in its characteristics from maritime navigation, requires integrated communication solutions and cooperation of radio systems in the field of communication and navigation data exchange.

Developments in communication technologies such as digital signal transmission and the development of satellite systems provide the opportunity for skippers of inland vessels to effectively support navigational decision-making.

In inland navigation, vessels and traffic management services need reliable communication solutions to ensure efficiency and effectiveness in daily operations as well as in emergency and distress situations. Ensuring effective communication in emergency situations is a priority.

In this context, traditional communication systems such as radio or mobile communications are unreliable, especially in highly urbanized areas or away from land infrastructure [1, 9].

For this reason, new solutions should be sought, e.g. based on satellite-based communication options. Inland navigation vessels are not convention vessels, i.e. they are not part of GMDSS communication [4].

This is important because these ships can also sail in formally maritime areas. In Poland, for example, this is the case for shipping from Wroclaw to Swinoujscie or onwards to Gdansk. An inland unit in Szczecin at Most Dlugi enters maritime waters and navigates in the A1 area in the direction of Gdansk.

Unfortunately, apart from VHF radio, it does not have DSC and is "inaudible" to seagoing vessels with its Automatic Transmitter Identification System (ATIS) identification number. The same applies to the maritime identification number (MMSI), which is not received by inland vessels. Analogous situations exist for Inland AIS and AIS as well as for Inland ECDIS and ECDIS, which are not integrated and do not work together [5, 10].

In European countries, this is the case in Belgium, Croatia, France, Germany, the Netherlands and other countries where maritime and inland shipping also intersect.

2 USE OF THE IRIDIUM SATELLITE SYSTEM IN INLAND NAVIGATION

The geographical position of a ship in inland navigation was continuously determined using traditional navigation methods. Developments in communication technology have enabled the increasing use of satellite-based positioning systems, which have become established. They enable the simultaneous visualisation of the geographical position in real time on an Inland ECDIS screen [12].

The position of a vessel on an inland waterway should not be considered as a point, but as the spatial position of the vessel's waterline due to the proximity of shorelines, infrastructure and other vessels. Navigation in confined inland waterways relies on keeping the vessel's position on the correct side of the safety isobath at all times [8].

Accidents and navigation errors are the result of assuming a point position. Nevertheless, the use of modern positioning systems, such as satellite systems, is a key element in improving the safety criterion of navigation [4].

In inland navigation, there are obstacles such as high banks, elevated urban buildings, which can be a significant obstacle for satellite signals from satellites at lower topocentric heights [12].

One choice for connectivity for an inland vessel is to use satellite communications and the Iridium Lars Thrane LT-3100S solution, which has features such as Iridium SafetyCast and Distress Alert & Distress Call/Distress Alert Relay, which are effective tools in distress communications situations and to ensure safety.

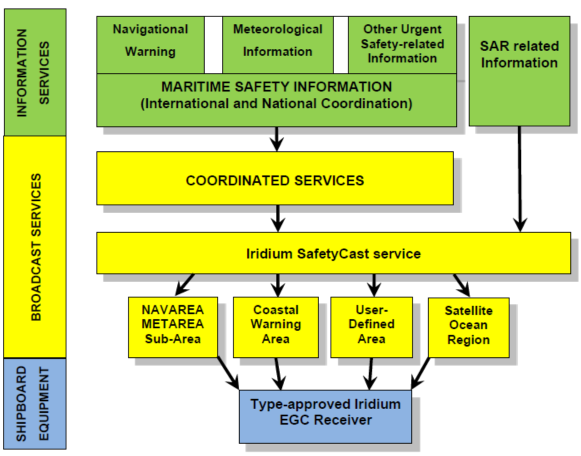

Figure 1.Structure of the SafetyCast system. Source: [7]

The Iridium SafetyCast service provides inland vessels with navigational and meteorological warnings, weather forecasts, information on SAR operations and urgent messages concerning the safety of navigation. It enables the automatic transmission of navigation and rescue information to specific services. Figure 1.

The messages are transmitted by authorised providers via the Iridium system gateway. On board ships, these messages are received by Iridium Ship Earth Station (SES) receivers that are compatible with the EGC system.

Each message contains a preamble that enables the Iridium SES receiver to recognise and display messages related to the vessel's current position and planned route.

An important feature for inland waterway vessels is the ability for continuous and effective Distress Alert & Distress Call / Distress Alert Relay communications.

The emergency function system is programmed to automatically send an emergency message and initiate a direct call to the Rescue Coordination Centre (RCC) when the ‘Distress’ button is pressed. Fig. 2.

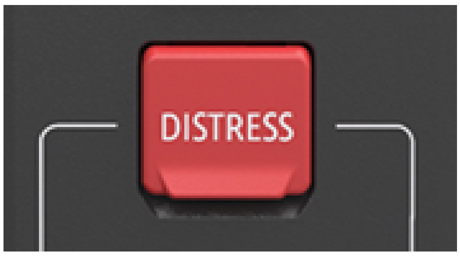

Figure 2. Distress button. Source: User & Installation Manual LT-3100S Iridium Satellite Communications System

If an inland waterway vessel is in distress and requires immediate assistance, the Rescue Coordination Centre (RCC) sends a so-called "Distress Alert Relay" message to sea and inland waterway vessels (e.g. on the Wrocław-Szczecin-Gdansk route) that are located in the A1 area within a radius of up to 50 nautical miles [11].

3 CONCEPT FOR A PROTOTYPE MODULE INTEGRATING DSC VHF WITH THE IRIDIUM SATELLITE SYSTEM.

The integration of DSC VHF with IRIDIUM Satellite System through access to modern radio communication technologies will allow us to obtain the most accurate positioning of a vessel during Search and Rescue operations and Distress/Urgency procedures [5, 10].

A concept for a prototype device integrating DSC VHF with the IRIDIUM Satellite System - Figure 3 - was presented.

Tests show that it is practically possible to integrate the DSC VHF system with Iridium to obtain the improved position and speed vector of the inland vessel.

Figure 4.-below- presented estimation error of the positioning variables x, y inland vessel position using integrating model the DSC VHF and IRIDIUM Satellite System.

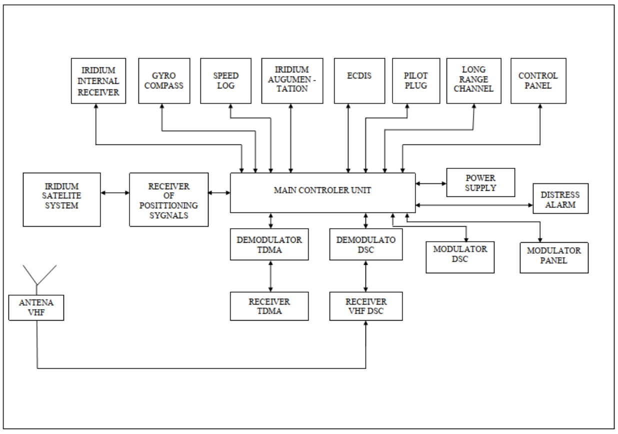

Figure 3. A concept for a prototype device integrating DSC VHF with the IRIDIUM Satellite System[own work, based on [6].

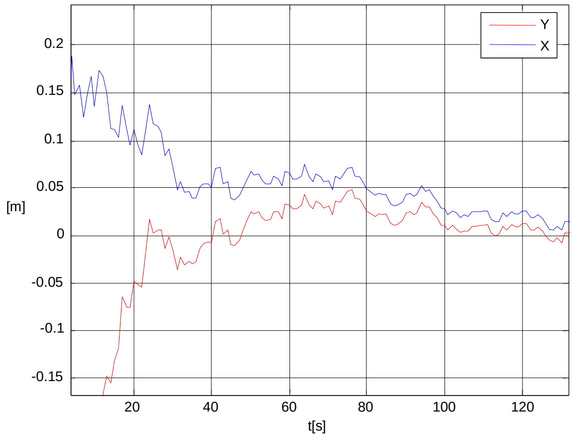

Figure 4. Estimation error of the x,y inland vessel position using integrating model of the DSC VHF and IRIDIUM Satellite System

Figure 5 shows presented estimation error of the Vx, Vy vessel speed vector.

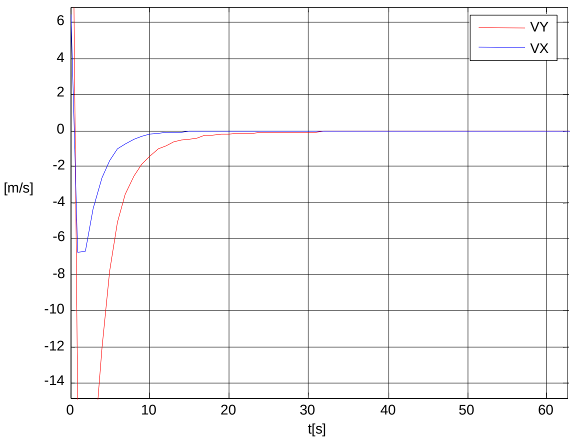

Figure 5. Estimation error of the Vx, Vy vessel speed vectors.

Obtaining an optimally accurate position of the inland transport allows the watch officer on the bridge cooperating with SAR centers and inland vessels.

4 THURAYA SATELLITE SYSTEM APPLICABILITY FOR INLAND NAVIGATION

The use of the Thuraya satellite system as a communication system for inland navigation is a feasible task. The Thuraya T2M-DUAL system is used as an example. This system is already used for real-time tracking of static or mobile systems. For example, this system is often used as a communication device for trucks and for tracking and positioning solar panels and wind turbines.

Figure 6. Thuraya T2M-DUAL. Source: User & Installation Manual Thuraya Satellite Communications System

The following features of the device are its advantages for inland navigation. Firstly, the automatic switching between satellite communication and conventional mobile networks, i.e. the system itself determines which type of positioning is most effective, so that the vessel can always be located in real time and is able to transmit signals and information.

Secondly, the system has built-in resilience to difficult weather conditions, which is an important advantage. And thirdly, it can take advantage of any of the satellite systems shown in Figure 7.

This device can be used in combination with the Thuraya satellite system and others to manage a fleet of ships, especially in areas where there is no or very poor coverage by traditional mobile radio. In addition, the speed of the service is increased by the ability to connect the system to cargo sensors, allowing you to monitor the status of the cargo in real time. The functions also include the recording of input data such as speed, course, position and crew activities.

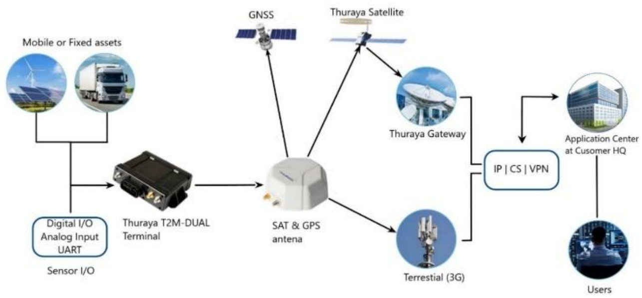

Figure 7. Thuraya T2M-DUAL System Schematic. Source: User & Installation Manual Thuraya Satellite Communications System

This device in combination with the satellite system and the integrated functions is a low-cost and effective solution that can be used as a communication device on barges and other river vessels. Low cost and fast performance are an undeniable advantage of the device, in sum, to transmit information or signals, under all conditions of coverage as well as remoteness. In addition, this system is very practical when crossing borders during transportation and does not require any additional modifications in this regard

If the system needs to send a distress signal or a call for help, this is done as follows. By pressing the emergency button as shown in Figure 8, the signal is sent to a special server via the nearest mobile phone mast via a gateway, the information is then processed by the operator, who directly initiates the rescue measures, i.e. it is guaranteed that the signal is received immediately.

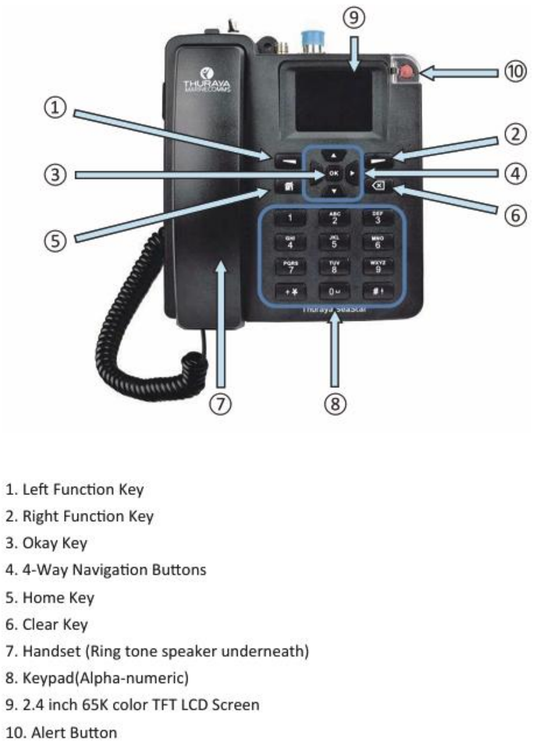

Figure 8 Thuraya device with Alert Button. Source User & Installation Manual Thuraya Satellite Communications System

The company can forward the information packet from the gateway to the nearest Rescue Centre or VTS. If the mobile signal is weak or absent, the information can also be transmitted directly to the Thuraya satellite or to another satellite system.

5 CONCLUSIONS

The use of Iridium and Thuraya satellite systems on inland waterway vessels ensures the safety of communication and navigation thanks to their global coverage and the quality and reliability of their communication.

In remote and inaccessible shipping areas where traditional radio communication methods could fail, satellite technologies enable integration with terrestrial analogue-digital radio systems.

The solution proposed in this paper for the integration of DSC devices with the Iridium system enables precise and accurate tracking of the vessel, immediate transmission of navigational information and instant response and interaction with SAR centres in emergencies where the lives of crew members are in danger.

The integration of the DSC VHF subsystem for shipping with the Iridium satellite system enables the transmission of navigation information for the needs of inland waterway vessels.

The algorithms used in the integration and processing of navigation and operational data enable comprehensive cooperation between ships in maritime and inland traffic.

REFERENCES

[1] Czajkowski J., Korcz K.,“ GMDSS for short-range communication” (in polish) Skryba, Gdansk 2006.
[2] Directive 2002/59/EC of the European Parliament and of the Council of 27 June 2002 establishing a Community vessel traffic monitoring and information system.
[3] Directive 2005/44/EC of the European Parliament and of the Council of 7 September 2005 on harmonised river information services (RIS) on inland waterways in the Community (O. J. L 255, 30/09/2005).
[4] Januszewski J., Wawruch, R., Weintrit, A., Galor W., ” Integrated Navigation Bridge for Sea-River vessels” (in polish), Scientific Journals Nr 63AM Gdynia 2009.
[5] Koshevoy V.M., DSc, Shishkin A.V., The ECDIS modernization for interaction with VHF radio communication system, TransNav: International Journal on Marine Navigation and Safety of Sea Transportation, Vol. 9, No. 3, pp. 92-100, 2015 .
[6] Lisaj A., “Integrated Communications Platform for RIS Centres Supporting Inland Navigation” -12th International Conference on Marine Navigation and Safety of Sea Transportation – TransNav 2017 Gdynia,Poland, 21-23 June 2017.
[7] MSC.1/Circ.1613/Rev.2 5 July 2023.
[8] Neumann T., Weintrit A., “Information, communication and environment” Marine Navigation and Safety of Sea Transportation CRS Press 2015.
[9] SOLAS (2009) Consolidated edition, International Maritime Organization
[10] Urbański J., Weintrit A., „ Electronic navigational chart - twenty years later” (in polish). Hydrographic Review No 2. Bureau of Naval Hydrography, Gdynia, 2006.
[11] Uriasz, J., Lisaj, A. Smacki A., “The BICS advanced method of the Electronic Ship Reporting for the RIS Centre” 20th International Scientific and Technical Conference NavSub Polish Naval Academy Gdynia, Poland, 8-9 November 2016.
[12] Weintrit A.,“ Design considerations for an integrated navigational bridge for units in sea-river navigation” (in polish). |Logistyka 2010 vol. 4.