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Model of Radio-Communications Platform Supporting Inland Navigation

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ABSTRACT: The article presents model of the Radio–communications Platform supporting Inland Navigation. The model of integrated satellite, analog and digital radio – communications systems has been presented. Individual blocks included in the module architecture has been developed. A communication model which integrates the Galileo system with Inland-AIS for the purpose of obtaining a reliable position in limited waters has been presented. The functional requirements of the Galileo Satellite System for integration with Inland-AIS in restricted areas was characterized. The integration of satellite systems was analysed in order to improve the compatibility of Communication Systems.

1 INTRODUCTION

European Union Commission transport statistics show an increase in inland transport accidents between 2018 and 2022.[5].

Most incidents involving inland vessels occur in restricted areas, particularly at the intersection of inland and maritime waterways in EU countries such as Poland, the Netherlands, Germany, France and Croatia.[3].

The journey of an inland waterway vessel from Wrocław via Szczecin to Gdańsk takes place on an inland waterway and then on the sea. Unfortunately, despite the many technologies available, inland vessels are not visible on the bridge of a sea vessel and vice versa.[21].

Without integration of communication devices, the MMSI numbers of a seagoing vessel and the ATIS numbers of an inland vessel are incompatible with each other. Also without integration, the maritime AIS and inland INLAND-AIS systems and the maritime and inland ECDIS charts are not compatible.[20].

The integration of navigational and radio - communications equipment makes it possible to increase the safety of navigation through the effective transmission of information to SAR Rescue Centres and the precise determination of position, e.g. when searching for distress situations or underwater hydrological work. [10].

2 THE MODEL OF RADIO-COMMUNICATIONS PLATFORM SUPPORTING INLAND NAVIGATIONS

The integration of communication systems with navigation systems makes it possible to create a management module for data exchange between the masters of inland and maritime vessels as well as RIS and RCC Centres.

The advanced blocks of communication systems are the three modules: Digitals, Radiotelephones and Satellite.

The Digitals are DSC VHF, DSC MF/HF, RADIOTELEX, NAVTEX, EPIRB and SART.[1],[2].

The Radiotelephones are: VHF and MF frequencies.

The Satellite are: GPS, INMARSAT, IRIDIUM, GALILEO, THURAYA, GLOBALSTAR and COSPAS - SARSAT.

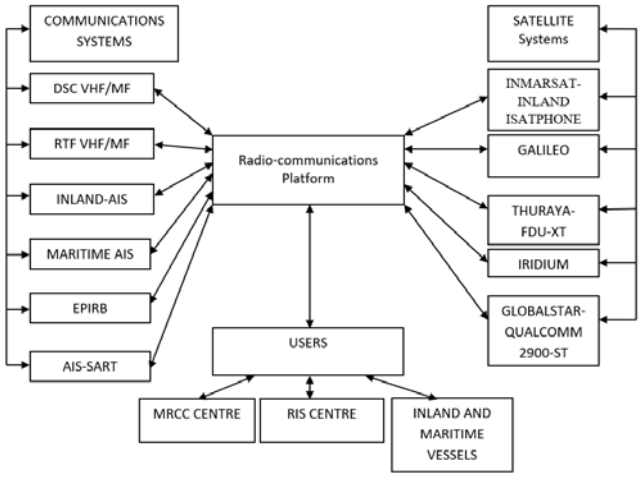

Figure 2.The Radio-communications Platform architecture.[7],[8],[9],[13].[Own work].

The functional requirements of the Radio-communication Platform working for integrated maritime and inland navigation bridges realizes the following functions: [4],[15],[19].

- radio navigation and satellite positioning;
- determination of the traffic characteristics of an inland waterway unit;
- obtaining information on the own motion vector;
- image of the navigational situation on the basis of the ECDIS and Inland ECDIS.;
- image of the anti-collision situation on the basis of the AIS and INLAND -AIS.

Figure 3. Satellite devices supporting Inland navigations. THURAYA – FDU - XT and Inmarsat Inland - ISATPHONE [22],[23].

3 CONCEPT FOR A PROTOTYPE MODULE INTEGRATING INLAND AIS WITH THE GALILEO SATELLITE SYSTEM.

The integration of maritime and inland communication systems through access to modern radio-electronic technology will allow us to obtain the most accurate positioning of a vessel, which is essential during search and rescue operations, e.g. man overboard, as well as during underwater work in restricted areas and manoeuvres of maritime and inland vessels.[6],[9].

A concept for a prototype device integrating INLAND AIS with the GALILEO Satellite System - Figure 4 - was presented

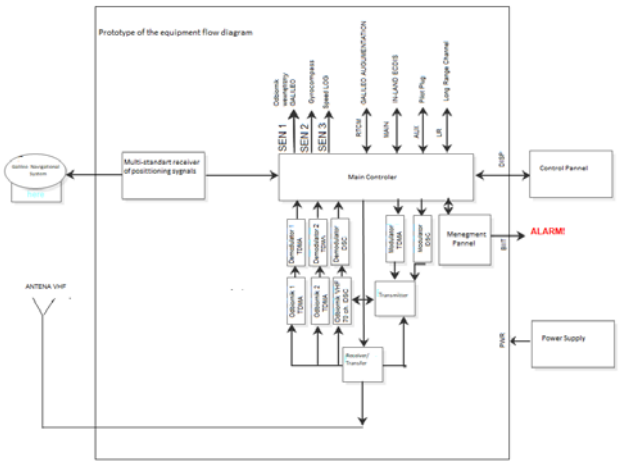

Figure 4. A concept for a prototype device integrating INLAND AIS with GALILEO Satellite System.[7],[own work].

3.1 *The model designed and presented includes the following subsystems:*

3.1.1 *Antenna receiving GALILEO signals.[3].*

For the purposes of this module, the following types can be used:

- Magnetic – mounted on a metal surface, some models are additionally equipped with a self-adhesive set that helps in fixing to other surfaces.
- Body Mount – mounted by screwing in the mounting hole, or self-adhesive mounted on any surface.
- Modular EOMs – without housing, for installation in a user application.

3.1.2 *Multi-standard receiver for positioning signals.*

The above module provides high positioning accuracy in poor satellite visibility (e.g. in densely and highly built - up areas) and a short first position measurement time.[17],[18].

GNSS navigation systems to determine the location of the object are based on data obtained from the navigation message, transmitted by satellites and information provided by wireless communications systems, there for they are equipped with INS modules and other sensors.

3.1.3 *Modules allowing for control of the device.[3],[12].*

- Controller

It is an element that processes and integrates all the activities of individual ports entering the device. The sensors have been installed which will be used by the individual navigation devices in inland navigation.

- Additonal sensors- SEN1, SEN2, SEN3
  They are designed for ports coming out of the device. The device using the sensor is an internal GALILEO receiver which is supposed to control received signals and sent from and to satellites, so as to maintain the greatest possible accuracy when collecting information by the INLAND AIS device. Another devices a gyrocompass, which shows a gyro compass course, which allows to determine the trajectory of the ships movement. The third sensor will be used by the LOG to measure the speed of the vessel, which is equipped with the designer device. In the context of Inland navigation, the synergy of these three sensors by INLAND AIS gives it information in the plane of speed, course and position accuracy. [4],[11],[17].

3.1.4 *GALILEO augmentation*

It is a local system supporting a specific satellite positioning . It is mounted to the controller by means of an entry and exit port. The EGNOS system issued in European waters.[12].

- Main Port:
  Main port adapted to work with INLAND ECDIS device. The devices will use two-way data transmission. INLAND AIS will collect information and send it to other receivers, while INLAND ECDIS will be able to visualize all received information from local stations in an integrated bridge.[14],[15],[16].
- TDMA (Time Division Multiple Access) demodulators:
  Demodulator of TDMA task is to decode messages on normal frequencies. He is connected to the receivers.

3.1.5 *Description of coding and decoding blocks.*

- Demodulator DSC:[7].
  Module decoding messages transmitted on emergency frequencies. Connected directly to the DSC receiver on channel 70.
- TDMA and DSC modulators:
  Devices that are connected directly to the transmitter. They are designed to encode messages on the appropriate frequencies.
- Receive/transfer module.
  It is a block in the presented project where the main task is to integrated all received information by the VHF antenna
- Management system:
  The module which generated with designing the algorithms all integrated navigation information on common interface and display.
- Control Panel.
  The display, which will be responsible for displaying information about nearby objects and units, will also enable the management of information sent by our receiver and other vessels

4 SUMMARY

The proposed concept of integrating terrestrial and satellite radio communication equipment with navigation systems, including satellite navigation systems, is an important direction in order to increase the safety of navigation.

Everything must be done, using the latest electronic and communications technology, to ensure that inland vessels carry cargo safely and that people do not die on them.[3].

Navigation in inland waters and in restricted areas, where the routes of seagoing vessels are located, requires particular precision and attention on the part of skippers.

The enormous amount of data received through radio-navigation devices requires solving many issues related to their management and the development of a correct navigation decision.

International SAR services need to be able to cooperate with all partners in Maritime and Inland Rescue Operation, and an integrated Radio - communications Platform can provide this.

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