



The Architecture of Data Transmission in Inland Navigation

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ABSTRACT

The paper presents feasibility of implementation of the GMDSS subsystems in the architecture of data transmission systems in inland navigation and maritime and inland harbours. Standards of navigational data transmission and communication in the RIS (River Information Services) system are presented. New radio communications technology introduced in the management systems for the safety of harbors and inland vessel traffic are described.

1. Introduction

Advanced information and radio communications technologies play a considerable role in inland navigation. Radio communications equipment with Internet access is being installed on board inland vessels, and satellite positioning systems and electronic navigational charts are being developed and deployed. Satellite positioning systems, electronic navigational charts and AIS receivers ensure stability and reliability of the navigation process.

The European countries have adopted the EU directives concerning the integrated telecommunications systems, to be implemented on their inland waterway areas. One of the objectives is the deployment of harmonised River Information Services (RIS). The RIS system has been developed to ensure safety and support the planning and management of inland waterway traffic (Lisaj A., 2012).

Safety of navigation in variable meteorological and traffic conditions, navigation in poor visibility, and high vessel traffic density give rise to the necessity of vessel traffic monitoring and reliable navigational data transmission. A RIS centre archives

and processes navigational data and makes them accessible to masters of inland vessels.

This paper presents the feasibility of implementation of the GMDSS subsystems in the architecture of data transmission systems in inland navigation and maritime and inland harbours.

2. Ground-based and satellite data transmission technologies in maritime and inland radio communication (Salmonowicz W., 2007)(Lisaj A., 2012)

Modern radio communications systems used in harbours and inland navigation utilize ground-based and satellite radio communications transmission technologies (ITU, 2009).

The development of analogue and digital radio communications systems has made them suitable for use in inland navigation. The Digital Selective Calling (DSC) and VHF communications systems ensure reliable ship-to-shore and ship-to-ship communication between vessels on inland waterways.

Satellite technologies differ in certain aspects from ground-based technologies. The major difference is the existence of an intermediary station, located on a geo stationary or polar earth orbit. The satellite systems used for vessel positioning and communication in maritime and inland harbours include (Salmonowicz W., 2007)(Uriasz J. et al)

- GNSS: GPS, GLONASS,
- EGNOS,

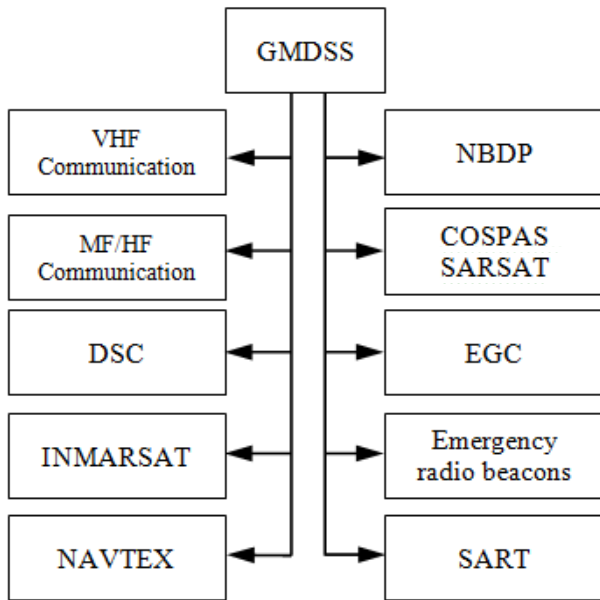
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Figure 1: GMDSS subsystems. Source: Own work, based on (Uriasz J. et al)



Source: Authors

- Inmarsat,
- Iridium,
- COSPAS/SARSAT.

Subsystems of the GMDSS are presented in Fig. 1.

3. Data transmission and communication system architecture in inland navigation and harbour infrastructure (Salmonowicz W., 2007),(Lisaj A., 2012).

Navigational data transmission requires the use of combined radio communications systems. The radio infrastructure of an inland navigation data transmission system should include ground-based radio channels, wireless Internet communication with the vessel, wired Internet connections for inland communication, and satellite channels.

In maritime navigation, vessels are identified with the use of the Automatic Identification System (AIS)(DEP, 2005/44)(Lisaj A., 2012). The AIS provides information on the ship's navigational status. On-board AIS devices continuously transmit the ship's identification and position to other nearby vessels.

Inland vessels, on the other hand, use the Automatic Transmitter Identification System (ATIS) (Lisaj A., 2012). This radio communication system automatically transmits the identification signal of the ship's VHF radiotelephone. The ATIS device works with the ship's VHF radio and transmits the ATIS code at the end of each radio transmission. Rapid and reliable identification of the ship's station facilitates the communication and enhances the safety of inland waterway transport logistics.

The communications system architecture used in harbours and inland navigation is presented in Fig. 2.

4. Navigational data transmission in the RIS system (Lisaj A., 2011)

The RIS communication structure is based on two information levels:

1. Traffic information services:

- Fairway Information Services - FIS,
- Traffic information, traffic management and monitoring, and calamity abatement support.

2. Information services for inland waterway transport management, voyage planning, harbour and terminal management, cargo and fleet management, as well as statistical information and waterway charges and port dues.

The above services are provided by means of notices to skippers and electronic ship reporting.

Fairway Information Services (FIS) provide geographical, hydrological and administrative data that are used by skippers and fleet managers for the planning, execution and monitoring of a voyage. FIS provide dynamic (e.g. water levels) and static (e.g. navigational marks, regular operating times of locks) information regarding the use and status of inland waterway infrastructure, thereby supporting tactical and strategic navigation decisions(Lisaj A., 2013).

In an emergency, Fairway Information Services are provided over radiotelephone (e.g. information on changes of lock operating hours, obstructions in fairways, restricted navigation due to ice, etc.). Information published on a daily basis (e.g. current and predicted water levels, ice situation or flooding) is provided online.

Numerous technological innovations related to the autonomous data transmission have been introduced in the inland shipping industry. Here are some of them(Wolejsza P. *et al*, 20013) (CCNR, 2006).

1. Electronic Navigational Charts (ENC), used to visualise the data on fairways and vessels' positions;
2. Online applications and the Electronic Chart Display and Information System for inland navigation (inland ECDIS), where notices for skippers are published;
3. Electronic ship reporting systems to store voyage-related information (vessel and cargo);
4. Vessel tracking and tracing systems, such as the Automatic Identification System (AIS), for automatic ship position reporting;
5. The Automatic Transmitter Identification System (ATIS), used for identification of vessels' calls, e.g. on approach to a lock in a computer-assisted vessel traffic control system. The signal identification is generated automatically at the end of each radio transmission, using frequency modulation frequency-shift keying (FSK) between the frequencies of 1,300Hz and 2,100Hz. The ship's ATIS code contains the country code, identification and vessel number

5. Data transmission standards in inland navigation (Lisaj A., 2013)

According to the Electronic Data Interchange for Administration, Commerce and Transport (EDIFACT) standard introduced in the EU countries, data is transmitted in the XML (Extended Mark-up Language) format. XML-formatted navigation messages contain the following information sections (Borkowski, 2012)⁴:

- Identification of the message,
- Fairway and traffic related message,
- Water related messages, as:
 - Water level messages,
 - Least sounded depth messages,
 - Vertical clearance messages,
 - Barrage status messages,
 - Discharge messages,
 - Regime messages,
 - Predicted water level messages,
 - Least sounded predicted depth messages,
 - Predicted discharge messages.
- Ice messages.

The fairway and traffic related section contains data on limitations for a fairway and an object.

6. Data transmission in electronic ship reporting (Lisaj A., 2011)(DEP, 2002/59).

The standards of data transmission and signal processing for electronic reporting in inland navigation have been developed by the Expert Group Electronic Reporting International (ERI) in order to: (DEP, 2005/44),(Wolejsza P. *et al*, 20013)

- Facilitate electronic data interchange between competent authorities of the EU Member States and partners in inland navigation;
- Ensure the standardised contents of notices in the communication between ships and the RIS Centres, in compliance with the applicable standards;
- Ensure the use of recognized international code lists and classifications;
- Ensure the use of unique European ship identification numbers.

The processing of navigational data for electronic reporting by the RIS Centres, which operate in the EU Member States under the provisions of the applicable EC directives, is performed with the following objectives(DEP, 2002/6)(Commission Regulation, 2007):

- To enable the transfer of data packages in compliance with the adopted Electronic Data Interchange (EDI) standards;
- To facilitate the sharing of information among inland shipping partners;
- To send dynamic data on the voyage to multiple recipients simultaneously;
- To ensure consistent use of the standards set forth in the United Nations rules for Electronic Data Interchange for Administration, Commerce and Transport (UN / EDIFACT), in accordance with the enacted EU directive adopting the data transmission procedures published in the United Nations Trade Data Interchange Directory (UNTDID);
- To manage inland traffic;
- To transfer comprehensive data on locks, bridges and calamities;
- To manage the loading and unloading of cargoes and monitor the operation of container terminals;
- To control border crossing;
- To provide services to passengers of inland ships.

7. Conclusion

Navigational data processing and transmission systems dynamically improve the quality and reliability of data transmission and collection. Indispensable in inland navigation, advanced radio communications technologies enable communication between shore-based stations and ships' reporting systems with interlinked databases.

In the architecture of data transmission in inland navigation perform an important role following subsystems took into consideration: GMDSS: RTF VHF, Inmarsat, COSPAS-SARSAT.

The effectiveness of data transmission in the VTS and RIS control and decision-making centres enable skippers to receive up-to-date and complete data on navigation and traffic conditions on the fairway. Efficient sharing of logistical and transport management data in inland shipping supports skippers in their decision-making processes., thus increases the safety of inland navigation.

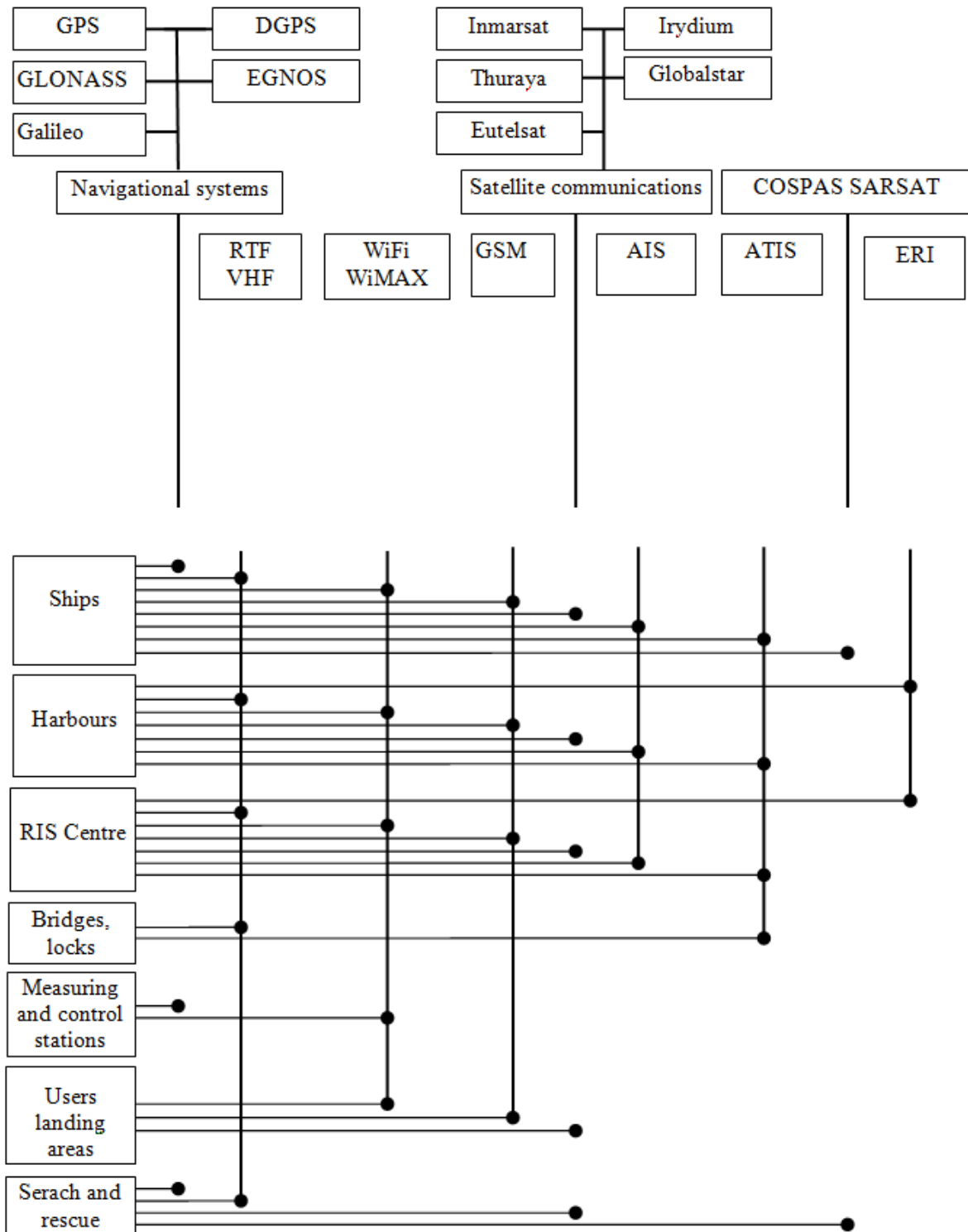
References

Borkowski P. Data fusion in a navigational decision support system on a sea-going vessel. *Maritime Research*, vol. 19, No. 4(76), 2012 (78-85).

Commission Regulation (EC) No 414/2007 of 13 March 2007.

⁴<http://www.ris.eu>

Figure 2: Communications architecture used in harbours and inland navigation. (Salmonowicz W., 2007)(Lisaj A., 2012)



Source: Authors

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 and repealing Council Directive 93/75/EEC.

Directive 2002/6/EC of the European Parliament and of the Council of 18 February 2002 on reporting formalities for ships arriving in and/or departing from ports of the Member States of the Community.

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).

Lisaj A. Navigation data transmission in the RIS system. *9th International Navigational Symposium TransNav, Gdynia, Poland, 15-17 June-2011*.

Lisaj A., Salmonowicz W. Data transmission technology in the maritime and inland harbours. *European Navigation Conference 24-27.04.2012, Gdansk*.

Lisaj A. The Method of the Navigation Data Fusion in Inland Navigation. *Marine Navigation and Safety of Sea Transportation: Navigational Problems. CRC Press 2013*.

Radio Regulations. International Telecommunication Union, Geneva, 2009.

Salmonowicz W. Concept of Inland Shipping Information System. *Polish Journal of Environmental Studies* Vol. 16, No 6B, pp. 127-129. HARD Publishing Company Olsztyn 2007.

Standard for Electronic Ship Reporting in Inland Navigation, Central Commission for the Navigation of the Rhine (CCNR), Strasbourg 2006.

Uriasz J. Majzner P. Systemy łączności morskiej, in Pach A., Rau Z. eds. *Nowoczesne systemy łączności i transmisji danych na rzecz bezpieczeństwa. Szanse i zagrożenia*.

Wolejsza P. Magaj J. Gralak R. Navigation Decision Supporting System (NAVDEC) - testing on full mission simulator. *Annual of Navigation* No 20, pp. 149-162, Gdynia 2013

<http://www.ris.eu>