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Agenda item [[1]](#footnote-1) 6.2

Technical Domain / Task Number 2 …………………………………

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Research on Resource Coordination System among AIS, ASM and VDE-TER for Improving Resource Utilization Efficiency

# Summary

With the advancement of maritime digital wireless communication technology, the VHF Data Exchange System (VDES) has established itself as an integrated communication system that includes AIS, ASM, and VDE. However, following the introduction of VDES, issues such as frequency conflicts and slot interference with existing AIS and ASM have emerged, necessitating research on optimizing resource utilization. The Korean VDES R&D project team has been developing a resource coordination system to suppress resource conflicts among AIS, ASM, and terrestrial VDE while efficiently utilizing the limited slot resources. This system operates by constructing an integrated slot map to effectively identify available resources and using a scoring algorithm to allocate the optimal slots for data transmission. The research results indicate that the proposed system enables more efficient resource allocation compared to existing methods and is expected to contribute to enhancing the stability of maritime communication networks in the future.

## Related documents

1. ITU-R M.2092-1, *Technical characteristics for a VHF data exchange system in the VHF maritime mobile band, February 2022*
2. IALA G1117, *VHF Data Exchange System(VDES) Overview, December 2022*

# Background

As the digitalization of maritime traffic and communication accelerates, the International Maritime Organization (IMO) has established an e-Navigation strategy and is working on standardization for digital data exchange between ships and shore-based infrastructure. In line with this trend, VDES (VHF Data Exchange System) has been developed as a next-generation maritime digital communication system, integrating AIS (Automatic Identification System), ASM (Application Specific Messages), and VDE (VHF Data Exchange). VDES has been allocated new frequencies in the VHF band through the WRC-15 (2015) and WRC-19 (2019) conferences.

With the publication of ITU-R M.2092-1, the technical specifications for VDES development were established, and organizations such as IALA have been verifying and refining the detailed technical aspects, with experts reviewing the latest technical amendments. The latest revision toward ITU-R M.2092-2 further refines the technical characteristics of VDES, addressing advancements in technology and feedback from field implementations.

In Korea’s VDES R&D project, while developing VDES TER (terrestrial) equipment, researchers questioned whether it would be possible to allocate sufficient resources for maritime services in environments where slot resources are limited between AIS-equipped vessels and base stations. Based on real-world experiments, they aimed to examine the need for improvements in the resource allocation algorithm of ITU-R M.2092-1.

# Discussion

## Resource Coordination System Demonstration

The Korean VDES R&D project conducted a resource allocation demonstration in a simulation environment to validate the performance of the resource-sharing system. The key demonstration process included the following steps:

1. Configuration and implementation of an integrated resource coordination system

* To avoid interference and conflicts based on communication priority and prevent duplicate allocation with neighboring coastal stations, the key components of a VDL message generation software were defined and implemented, allowing virtual resource occupation by non-existent VDES ship communication devices.
* The virtual VDL messages were implemented using actual RATDMA (Random Access TDMA), ITDMA (Incremental TDMA), and SOTDMA (Self-Organizing TDMA) methods, enabling them to have specific reporting rates. This allows for dynamic control of the data link load rate.
* The VDES integrated resource coordination software operates with a reverse data flow compared to the virtual VDL message generation software. It utilizes key parameters from the virtual VDL messages, such as the communication state’s Keep Flag and Slot Timeout Information, allowing it to mark virtual resource occupancy on the slot map for up to seven frames.
* Through the resource analysis and allocation process, a score is assigned to each TDMA channel required for VDE transmission. When a resource request is received, the system is implemented to allocate the highest-scoring TDMA channel on a first-come, first-served basis.
* The figure 1 below shows the actual operational interface of the integrated resource coordination software that has been implemented

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[Figure 1 - Resource Coordination SW]

1. Defining Protocol

* As of now, the resource coordination system is not mandatory, and therefore, international technical recommendations and test standards do not define a protocol for exchanging resource request and allocation information with the resource coordination system.
* Therefore, it was necessary to define the structure of input and output messages for the presentation interface between the coastal station and the resource coordination system, covering VDE signal information, transmission resource requests, and transmission resource allocation. To achieve this, new messages were defined based on the structure of other NMEA sentences in the existing IEC 61162 standard.

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[Figure 2 – Interface Protocols for Resource Allocation/Sharing]

## Test Results

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[Figure 3 – Allocable Transmission Resource of VDE-TER upper leg at a VDL rate of 35%]

If the VDE transmission resource group does not include resources used for AIS or ASM transmissions, which have a higher priority than VDE, the effectiveness of VDE is significantly reduced. The Korean VDES R&D project demonstrated this through testing, and at a relatively high VDL load rate of 35%, it was found that resource allocation within 1 frame (1 minute) was only possible when at least 11 out of 64 data channels in the VDE transmission resource group were allocated for AIS or ASM transmissions.

* Analyzing the slots that can be allocated within 1 frame (1 minute) after a resource request was received showed a tendency for the number of available slot blocks to increase when the allowed count was 11 or more.
* On the other hand, at the slot timeout expiration point, data link re-entry was required, resulting in cases where actual allocation could not be performed.
* By applying the score-based slot evaluation algorithm, it was confirmed that faster and more accurate slot allocation was possible compared to conventional methods.

Including resources used for AIS or ASM transmissions in the VDE transmission resource group does not cause interference or conflicts with higher-priority communication systems. Since communication devices can recognize the resource occupancy status and plans of other radio stations participating in the data link, they can skip data fragment transmission in resources occupied by AIS or ASM and resume transmission in the next available data channel.

## Conclusion

An analysis of the slots available for allocation within 1 frame (1 minute) after a resource request was received showed a tendency for the number of available slot blocks to increase when the allowed slot count was 11 or more. By efficiently allocating slots using a score-based slot availability evaluation algorithm under VDL load conditions, it is expected to enhance communication efficiency and stability. Future research should focus on experimentally verifying resource sharing with satellite ground stations and assessing its applicability in various maritime environments.

# Action requested of the Committee

The Committee is requested to note the information provided.

1. [↑](#footnote-ref-1)