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| From: ENAV22 | ENG8-11.13  Formerly ENAV22-12.1.17 |
| To: ENG8 | 12th October 2018 |

LIAISON NOTE

VDES R-mode Development and Standardisation

# Introduction

This Liaison Note provides a summary of discussions on R-mode held at ENAV22 and invites the ENG Committee to provide input on the VDES component of R-mode to ENAV WG3 by the end of October 2018 so that the required changes to the VDES specification can be appropriately assessed and reflected in the revision process for Recommendation ITU-R M.2092-0.

# Details of paper

## Summary of Discussions

An update on R-mode development was provided to ENAV WG3 by representatives of the General Lighthouse Authorities of the UK & Ireland (GLA) and the Dalian Maritime University (DMU), China. The following points were noted:

* *Performance requirements for a maritime backup / contingency system to GNSS*: There was agreement that the requirements on a backup / contingency positioning system could be less stringent than those on the primary system, but the opinion was also expressed that the requirements specified in IALA R-129 (GNSS Vulnerability and Mitigation Measures) are too lenient. Mariners will expect R-mode to have comparable positioning accuracy to that of other terrestrial navigation systems.
* *Coverage requirements*: Preliminary coverage modelling for R-mode suggests the density of existing AIS base station networks typically is insufficient to enable contiguous R-mode coverage along a coastline. Some in the group expressed the view that contiguous coverage is not required and that only high-risk areas need to be covered by R-mode.
* *Impact of R-mode on the communication functions of VDES*: An additional loading on VDES from R-mode in the region of 5% - 7% of the total capacity is considered acceptable by WG3.
* *Fixed vs. random data sequence for R-mode*: The advantage of using a fixed (dedicated) data sequence in R-mode transmissions is that such sequence could be optimised to provide the best achievable ranging performance under given channel conditions. On the contrary, ranging off ordinary VDES transmissions carrying (random) user data provides sub-optimal performance, but has the advantage of a lower additional datalink loading (and potentially a greater number of transmissions available for ranging per unit time).
* *VDES R-mode activities in China*: The DMU has obtained funding from the China Maritime Safety Administration to set up a VDES R-mode testbed in TianJin Port; the project will run from 2019 to 2021.

User equipment used in the original AIS R-mode testbed was equipped with a Rubidium clock. The new testbed architecture should remove the need for an atomic clock in the user’s terminal.

Simulations have been performed with Pi/4-QPSK VDE waveforms confirming that VDE-based R-mode achieves better performance than AIS R-mode.

* *Base station synchronisation methods*: WG3 agreed that GNSS (in combination with high-stability local clock) may be an acceptable method for R-mode base station synchronisation, under the assumption that the main threat to GNSS availability comes from jamming and spoofing, both of which are considered local phenomena. It was recommended that multi-band, multi-system GNSS receivers be used at the base stations to reduce the likelihood of successful jamming / spoofing. It was also noted that Galileo will have a guaranteed timing service.

The DMU are currently using GNSS-disciplined Rubidium clock in the base stations in their R-mode testbed and are planning to conduct research into base-station-to-base-station synchronisation using VHF signals.

* *Use of existing AIS equipment in R-mode*: The AIS technical specification permits relatively large transmission timing jitter (for base stations, the maximum permissible timing error is 54 microseconds, which is equivalent to a 16 km range error). Providing an external synchronisation signal to AIS equipment is unlikely to reduce the jitter to the level required for accurate ranging. New specification / equipment is required for R-mode.

AIS equipment used in trials done by the DMU had to be modified at the baseband signal processing level to make it suitable for R-mode.

* *Regulatory matters*: It should be noted that the VDES channels are currently allocated for radiocommunication only and that a radionavigation allocation may be needed for R-mode use. This would require a change in the Radio Regulations and could be discussed under the e-Navigation agenda item for WRC-23 (note: there already is a preliminary agenda item for e-Navigation from WRC-15).
* *Patent watch*: TrueHeading holds a patent for ‘a method to measure the time of arrival of a received AIS transmission or other binary coded radio messages’ which may be relevant to the on-going R-mode work and should be studied in detail by IALA experts.

All R-mode research done at the DMU is in the public domain. There is a Chinese patent related to R-mode which covers system architecture and baseband signal processing, but this has been made available to the public.

* *ENAV WG3 – ENG PNT WG liaison*: WG3 members believe that a joint ENAV WG3 – ENG PNT WG inter-sessional meeting / workshop on R-mode would be beneficial, once the PNT WG has identified the top-level system requirements for VDES R-mode. The respective responsibilities of the two WGs with regards to R-mode development need to be clarified.

## VDES Standardisation Road Map

The ENAV Committee would like to bring to the attention of the ENG Committee the IALA-proposed VDES Standardisation Road Map, shown here as Figure 1. ENAV WG3 intends to produce a new revision of IALA Guideline 1139 (The Technical Specification of VDES) at ENAV24. This document is intended to become the basis for the revision of Recommendation ITU-R M.2092 on the technical characteristics of VDES, to be carried out by ITU following the World Radiocommunication Conference in 2019. In order to allow ENAV WG3 experts sufficient time to assess the proposed requirements for VDES R-mode and implement the necessary changes in the specification, the group needs to receive these requirements as soon as possible.

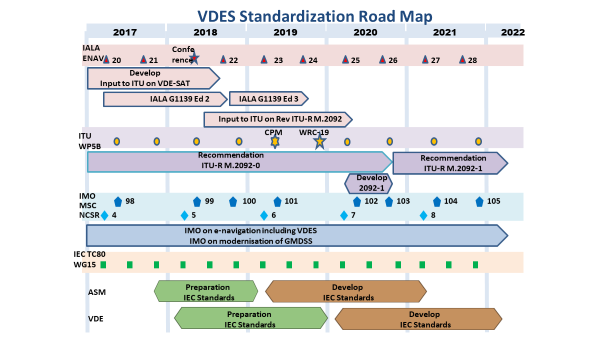


Figure 1: VDES standardisation road map (Source: IALA ENAV WG3).

# Action requested

The ENG Committee is requested to:

1. Note / review the information in the following documents related to VDES R-mode:
   1. Reply to “Is R-Mode the VDES Killer Application?” (ENAV22-9.3.6) (ENG8-11.13.1);
   2. Results of Discussion on VDES R-mode (ENAV22-9.2.5) (ENG8-11.13.2);
   3. VDES R-mode - Development Status Update (ENAV22-9.2.10) (ENG8-11.13.3);
   4. R-mode Baltic - Baseline and Priorities, when available.
2. Provide input on the system requirements for VDES R-mode to ENAV Committee as soon as possible, ideally by the end of October 2018. In particular, requirements on the VDES R-mode waveform; transmission jitter and synchronisation accuracy; and expected transmission duty cycle.
3. Consider the possibility of holding a joint ENG PNT WG – ENAV Comms WG inter-sessional meeting / workshop to progress work on VDES R-mode.