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VDES-R ADVANCED USER TECHNOLOGIES FOR ALTERNATIVE PNT (VAUTAP)

# Summary

## Purpose of the document

This paper provides information to the committee on the VDES-R ADVANCED USER TECHNOLOGIES FOR ALTERNATIVE PNT (VAUTAP) project being conducted by Telespazio UK and Kongsberg Seatex.

# Background

Global Navigation Satellite Systems (GNSS) have become the primary marine aid-to-navigation and source of Position, Navigation and Timing (PNT) information. Yet, all GNSS are vulnerable to natural interference, deliberate and accidental jamming and spoofing. Maritime trials, and trial in other domains, have demonstrated that degraded GNSS produce hazardously misleading information and erroneous vessel positions without an alarm being raised. As ships’ systems become increasingly digital, with the introduction of a wide range of supporting services and the emergence of autonomous vessels, PNT accuracy, integrity, continuity, and availability become increasingly critical.

Some ESA NAVISP projects have shown that a System-of-Systems approach to the provision of PNT for maritime and other critical infrastructure is preferable to provide resiliency. National Governments, Inter-Governmental Organisations and Multi-National bodies now recognise this System-of-Systems approach.

Having a System-of-Systems approach requires that systems other than GNSS are required to provide resiliency. One such system is the Very High Frequency Data Exchange System (VDES). VDES is a new maritime radio communication system being developed by the international maritime community, with the principal objectives, to:

• Safeguard existing Automatic Identification System (AIS) core functions, such as ship-to-shore and ship-to-ship position reporting, preventing future AIS overload; and

• Enhance maritime communication applications, based on robust and efficient digital data transmission with wider bandwidth than the AIS.

However, at the same time, the international maritime community has been investigating the potential use of these VDES communication signals transmitted from shore-based stations for positioning—a concept commonly referred to as ‘ranging mode’, or R-Mode.

VDES R-Mode is still at a relatively low Technology Readiness Level and much of the standardisation required for such System-of-Systems components are not yet in place, giving developers the opportunity to develop better waveforms, techniques, components, and concepts to provide truly resilient PNT.

Telespazio UK Ltd (TPZ-UK) and Kongsberg Seatex AS (KSX) have won a contract with ESA through its NavISP programme to develop some ideas around VDES R-Mode. KSX also has a wealth of experience in the domain. It has developed special to type equipment and has participated in a vast number of developments for VDES R-Mode in other projects, such as AMNAS, VNADS, SBVT and R-Mode Baltic. Collectively, this means that between the partners in the VAUTAP team have the technical experience, equipment, expertise, and market opportunity to make the project a real benefit to the mariner, with a strong future legacy.

The VAUTAP project will utilise the strong alliance and experience of our Consortium to investigate, consolidate and develop new algorithms, waveforms, software, and hardware, to evolve VDES R-Mode closer to an operational and viable component of a resilient PNT System-of-Systems.

# Discussion

VAUTAP aims to investigate and prove the concepts of novel user segment Very High Frequency (VHF) Data Exchange System (VDES) technologies to enhance key performance figures and indicators of positioning (e.g. accuracy, integrity, and security) and complement ongoing VDES investigations to improve Alternative Position, Navigation and Timing (APNT) capabilities for relevant maritime use cases.

The activity will also investigate and analyse the impact of the key system aspects such as synchronisation/timing issues of VDES Ranging Mode (VDES-R). The activity will consider both terrestrial and satellite components of VDES-R.

The activity will also assess APNT solutions based on the two different components of the VDES system (viz. VHF Data Exchange-Satellite (VDE-SAT) and VHF Data Exchange-Terrestrial (VDE-TER) services. These will be used in combination and be interoperable with each other.

The activity would also make simulated signals and process these both within simulated environments and within real transmitter and receiver within a test bed and in the real environment.

The activity aims to achieve the following specific objectives:

* Investigate and prove the concepts of novel user segment VDES technologies to enhance key performance figures of positioning;
* Complement ongoing VDES investigations to improve APNT capabilities for relevant maritime use cases;
* Investigate and analyse the impact of the key system aspects such as synchronisation/timing issues of VDES-R; and,
* Assess the alternative PNT solutions based on VDE-SAT in combination with VDE-TER services.

A set of techniques, technologies and concepts will be studied, and the most promising ones will be developed. There are:

* VDES-R Waveform development and selection
* Meta-signal Processing
* Antenna Diversity Processing
* Differential Positioning
* Navigation Message Authentication
* Multipath and Interference Mitigation Techniques
* Multi Epoch (Doppler) Based Positioning
* Two-Way Ranging

The committee is requested to note the information presented. It is envisaged that the project will provide further updates to the committee as the project progresses.

Any further information can be requested through Martin Bransby at [martin.bransby@telespazio.com](mailto:martin.bransby@telespazio.com)

1. Input document number, to be assigned by the Committee Secretary [↑](#footnote-ref-2)
2. Leave open if uncertain [↑](#footnote-ref-3)