

Input paper for the following Committee(s): check as appropriate

- ☐ ARM ☐ ENG ☐ PAP
☒ ENAV ☐ VTS

Purpose of paper:

- ☒ Input
☐ Information

Agenda item ² (from agenda)

3

Workplan Task Number / Technical Domain ²

Working Group

WG 3

Author(s) / Submitter(s)

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Potential “Ambiguity” Issues with VDE Signals

1 SUMMARY

Currently, most VDE signals are not station-specific. This could cause several potential problems. For example, the lack of station-specific nature makes the SyncWord or pilot of a VDE burst common to all stations; hence, the channel estimated from the received SyncWord is a *composite channel*, i.e., a superposition of channels from different transmitters, resulting in erroneous channel estimation when used by the receiver to decode data from a specific station. This is due to lack of identification in waveforms among signals transmitted from different VDES stations.

1.1 Purpose of the document

This input document identifies a potential ambiguity issue in VDES signals and to provide a method to resolve the issue.

1.2 Related documents

- [1] IALA Guideline G1139, The Technical Specification of VDES, Working Draft, 201812, Edition 2.
- [2] ITU, Assignment and use of identities in the maritime mobile service, Rec. ITU-R M.585-7, May 2015.

2 BACKGROUND

As defined in [1], a VDE-TER transmission burst includes ramp up, synchronization word (SyncWord), link ID (optional), data, ramp down and guard time as shown in Figure 1. SyncWord used in the VDE-TER has a unique waveform that is common to all bursts regardless of the transmitting station, which is good for detecting the presence of an ongoing transmission and the corresponding timing and frequency. Furthermore, for VDE-TER, SyncWord is also used for channel estimation for data demodulation and decoding at a receiver.

¹ Input document number, to be assigned by the Committee Secretary

² Input papers should be assigned to a work task as listed in the Committee work plan which is available in input papers. Leave open if uncertain but consider how the paper is to be processed if not relevant to a work task



Figure 1 Illustration of a VDE transmission burst

3 PROBLEMS

The lack of distinctive waveforms for channel estimation may cause erroneous channel estimation in the presence of multiple transmissions from different transmitters. This is because the inability of a receiver to differentiate the signals from different transmitters if the waveforms used for channel estimation are identical and the receiver is interested in receiving only one of the transmissions. We demonstrate this issue using the following setup as illustrated in Figure 2, where Ship A is receiving transmissions from Station A and Ship B is receiving transmissions from Station B. Since the transmissions from Stations A and B have identical SyncWords – 100% cross-correlation, Ship A has no way of separating them – zero interference rejection capability. Consequently, the channel estimate that Ship A obtains from the received SyncWords is a composite channel that is not the actual channel that data A go through.

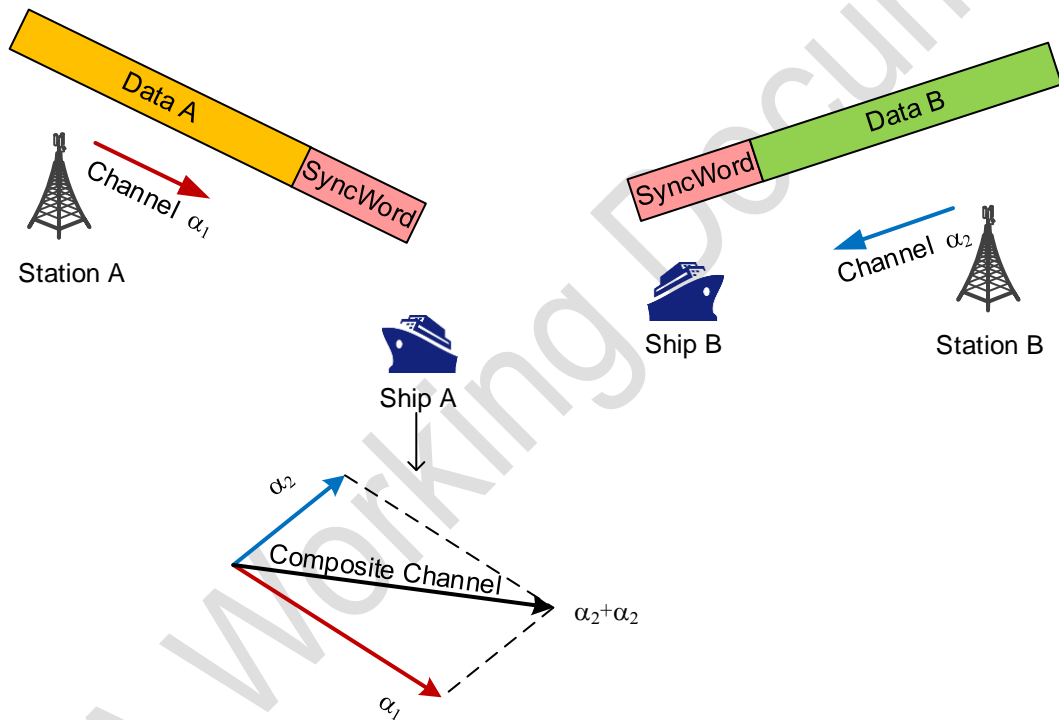


Figure 2 Illustration of a “composite channel” – a typical scenario at the cell edge.

We use simulations to demonstrate the impact of this erroneous channel estimate on the receiver performance. Figure 3 plots Ship A’s decoding performance at various interference level represented by B/A, i.e., Station B’s signal strength relative to Station A seen by Ship A. It is clearly seen that the Ship A’s receiver is extremely sensitive to the transmission from Station B.

Furthermore, the simulation shows that when the SyncWord waveforms of Stations A and B are uncorrelated (Station B’s SyncWord is replaced by random QPSK symbols in the simulation), the impact to the receiver’s performance is significantly suppressed.

4 CONCLUSION

The findings in this document signify a redesign of the VDE-TER SyncWord waveform that provides better co-channel interference rejection capability. Detailed design is provided in a separate document.

5 ACTION REQUESTED OF THE COMMITTEE

Review and confirm.

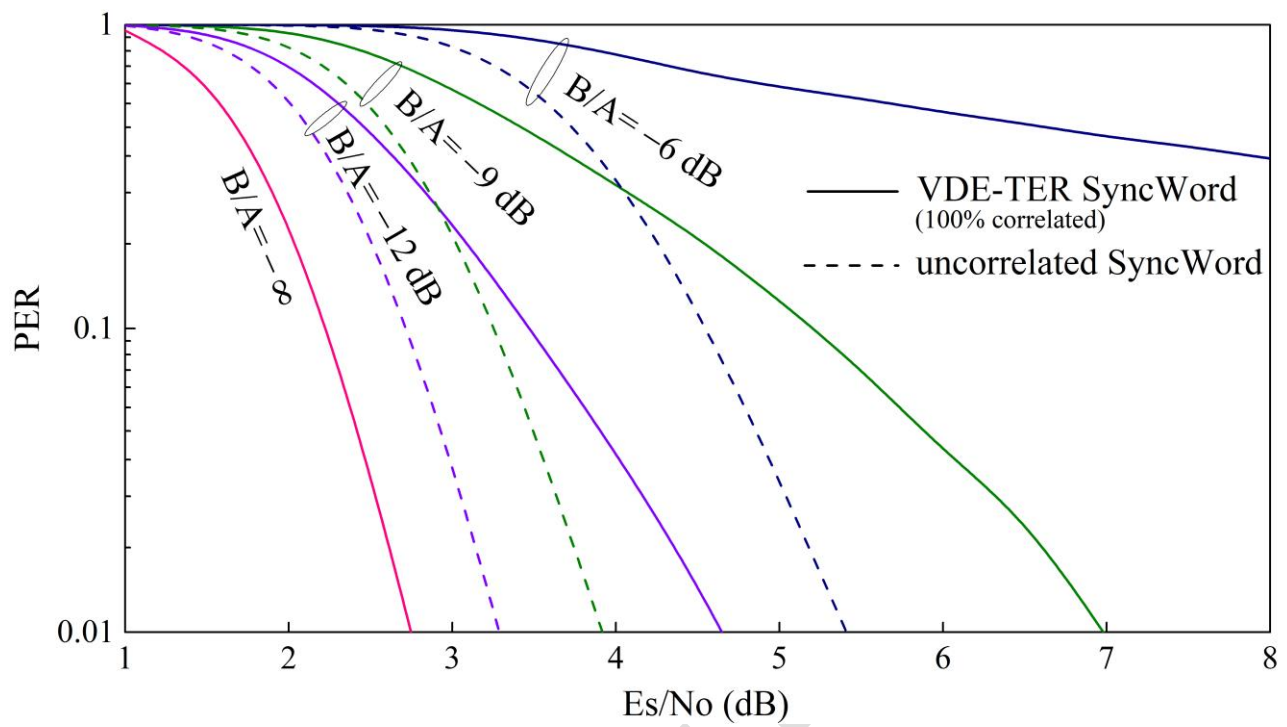


Figure 3 Receiver decoding performance with VDE-TER SyncWord in the presence of co-channel interference.