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☐ ARM ☐ ENG ☐ PAP

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Purpose of paper:

☒ Input

☐ Information

Agenda item [2] (from agenda)	3
Workplan Task Number / Technical Domain [2]	………………………………
Working Group	WG 3
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Unified Channelization for VDE Transmission Structure

1 SUMMARY

The present document provides a unified channelization and simplified framework for VDE that consists of two closely related siblings or components, the terrestrial component (VDE-TER) and the satellite component (VDE-SAT). Specifically, the VDES slots in a frame are organized into resource blocks; a *resource block* contains different types of physical channels: ASCH, DSCH, and DCH for the downlink, and RACH, DSCH, and DCH for the uplink. A downlink resource block and an uplink resource block are paired to facilitate centralized scheduling. The assignment of DCH channels for both downlink and uplink of a *resource block pair* is indicated in the ASCH of the *resource block pair* by design. The DSCH of the downlink resource block in present resource block pair is for acknowledgement (ACK/NACK) to the uplink DCHs in the previous resource block pair, whereas the DSCH of the uplink resource block in the present resource block pair is for the downlink DCHs in the previous resource block pair. This channel association encloses a complete scheduling-transmission-acknowledgement cycle, which simplifies the centralized scheduling.

1.1 Purpose of the document

This input document aims to provide a unified simple transmission structure for VDE under both FDD and TDD.

1.2 Related documents

[1] IALA Guideline G1139, The Technical Specification of VDES, Working Draft, 201812, Edition 2.

[2] ITU, Technical characteristics for a VHF data exchange system in the VHF maritime mobile band, Rec. ITU-R M.2092-0, 2015.

[3] eNAV 23, VDE-SAT spectrum allocation plan with TDD.

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

2 BACKGROUND

Different types of channels are provided in [1] to enable centralized scheduling for VDE; they are the downlink Bulletin Board Signalling Channel (BBSCH) for defining the network configuration parameters, the downlink Announcement Signalling Channel (ASCH) for medium access control by control stations, and the uplink Random Access Channels (RACHs) used by mobile stations for short message transmissions, e.g., resource request. In addition, the Data Channels (DCHs) are for application and control traffic between mobile and control stations, and the Data Signalling Channel (DSCH) for acknowledgements (ACK/NACK) feedback for the associated DCH channels.

However, the channelization of these channels of the two components of the VDE system, i.e., the terrestrial component (VDE-TER) and the satellite component (VDE-SAT), shares no commonality. This may increase the implementation complexity and cost. Consolidation of these two components into a unified framework will undoubtedly simplify the implementation, reduces the cost, increases the flexibility and reliability (less bugs).

3 BASELINE FRAMEWORK

In the proposed design, the VDE slots in a frame are organized into resource blocks. A resource block contains three types of physical channels: ASCH, DSCH, and DCH on the downlink, and RACH, DSCH, and DCH on the uplink. For ease of centralized data transmission and resource management, a downlink resource block and an uplink resource block are paired as illustrated in Figure 1 such that the logical association of these channels involved in a transmission can be clearly defined so as to simplify the implementation and reduce control overhead.

The resource block pair consists of a downlink resource block and an uplink resource block, each of which are divided into a control zone and a data zone. The control zone of the downlink resource block contains two TDM'ed ASCH+DSCH channels, each of which includes an ASCH field and a DSCH field that are jointly coded into a composite "ASCH+DSCH" channel (i.e., one channel code and one CRC). These two ASCHs (top and bottom) are in charge of the assignment of both uplink and downlink DCHs of this resource block pair. The resources (in slots) of the control and data zones are both configurable (e.g., by BB). Therefore, one ASCH may occupy multiple slots, whereas the number of DCHs in the resource block and the size (in slot) of each of these DCHs is controlled by the current ASCHs. Similarly, the sizes of the uplink DSCH and RACH resources are also configurable (by BB), and both resources are shared by multiple mobile stations in a CDMA fashion.

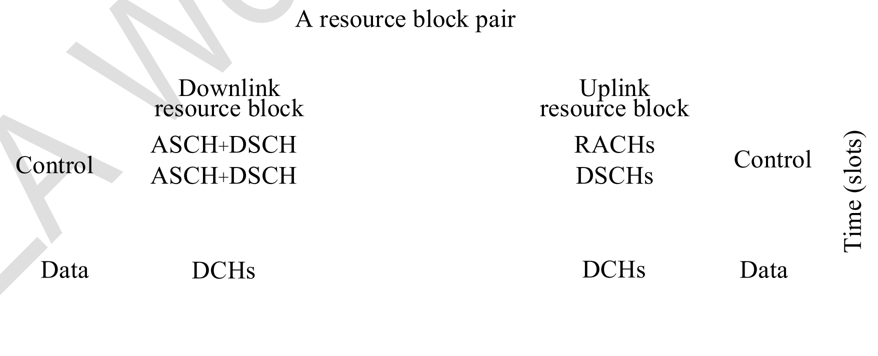

Figure 1 The concept of the resource block pair that consists of a downlink resource block and an uplink resource block.

The VDES slots in the data zone are shared among multiple DCHs in a time-division multiplexing (TDM) fashion. The assignment of DCH channels for both downlink and uplink of a resource block pair is indicated in the *two* ASCHs of the *same resource block pair*. The top ASCH is responsible for the upper data zone and the bottom ASCH for the lower data zone so as to provide a "time buffer" for mobile stations to prepare for the corresponding DCHs especially for the uplink. An ASCH may carry multiple such assignments destined to multiple mobile stations. An assignment includes an MMSI of the destined mobile station, a DCH grant, and the Link ID. Specifically, the assignment for both uplink and downlink data traffic of a mobile station is represented by a 1-bit up/downlink indicator plus a DCH slot bitmap. For example, assuming a 5-slot data zone, a “11000” bitmap indicates that the first two downlink DCH slots (i.e., a 2-slot DCH) are allocated to the mobile station identified by the MMSI field of the assignment. A 2-bit power control command (TPC) is also included in the ASCH to control the uplink transmission power from the mobile station.

DSCH is a control channel for delivering control messages/signalling from a receiver to the transmitter. A control station uses the downlink DSCH to send ACK/NACK information to the mobile station regarding the decoding status on the *corresponding* uplink DCHs. The ACK/NACK information is represented by a bitmap. Specifically, the downlink DSCH carries an n-bit bitmap, assuming an n-slot data zone in the downlink resource block (e.g., n=5). The control station packs the ASCH together with the DSCH into a code block that includes a $n \times 44$ bits assignments plus a ACK/NACK bit map and a 16-bit CRC (cf. Table 1). A mobile station uses the uplink DSCH to report the decoding status (i.e., ACK/NACK) to the control station regarding the transmissions on the *corresponding* downlink DCHs, as well as information such as downlink channel state information (CSI), downlink power control, and uplink scheduling request (SR), etc. It is channel coded with CRC. Multiple mobile stations share the same DSCH resources/slots in a CDMA fashion. The mobile station is assumed to follow the TPC indicated in the ASCH when transmitting, to minimize the interference between the DSCHs from different mobile stations (due to the near-and-far effect).

The RACH channel is reserved for *random* access (contention-based transmission), and hence is not associated with any other channels. A resource request message transmitted on RACH contains a 30-bit MMSI identified the mobile station, an uplink data size (e.g., 4 bits) to help the control station with resource allocation, as well as a downlink CQI (6 bits). Use the same CDMA as uplink DSCH for random access of multiple mobile stations. Each mobile station randomly picks an orthogonal code for spreading and uses the cell-specific PN sequence for scrambling.

3.1 TRANSMISSION STRUCTURE UNDER FULL-DUPLEX FDD

Built on the proposed resource block pair (cf. Figure 1), a baseline transmission framework under full-duplex FDD (e.g., VDE-TER) is laid out as depicted in Figure 2, which illustrates the association between DSCHs and DCHs.

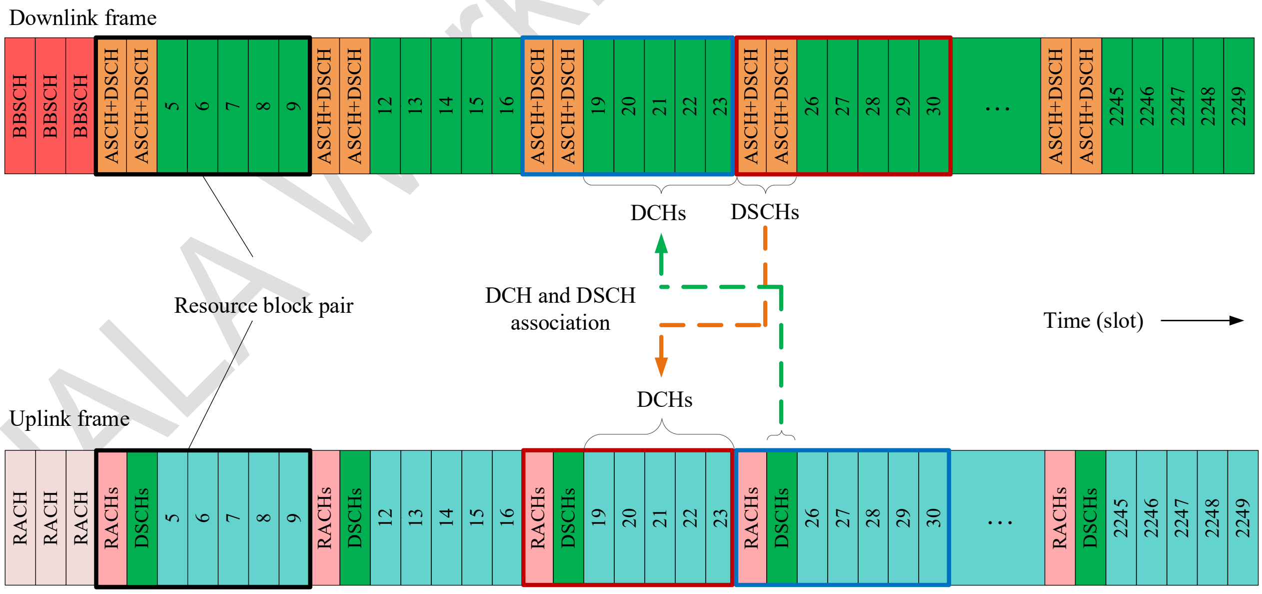

Figure 2 Exemplary transmission framework for VDE under full-duplex FDD.

Table 1 Example of message contents of downlink ASCH+DSCH, and uplink DSCH and RACH.

	Information field		Size	Description
ASCH+DSCH	ASCH	mobile station 1 MMSI	30 bits	9-digit Maritime Mobile Service Identification
		up/down grant	6 bits	1 bit for up/down, 5 bits for slot bit map
		up/down link ID	6 bits	
		TPC	2 bits	uplink transmit power control command
		mobile station 2 MMSI	30 bits	
		up/down grant	6 bits	
		up/down link ID	6 bits	
		TPC	2 bits	
		…	…	…
	DSCH	ACK/NACK	*n* bits	Bitmap
	CRC		16 bits	
	Total			44**n* bits + *n* bits + 16 bits
DSCH	ACK/NACK		5 bits	
	downlink CQI		6 bits	
	uplink schedule request		1 bit	
	downlink TPC		2 bits	
	CRC		16 bits	
	Total		30 bits	
RACH	mobile station MMSI		30 bits	
	uplink message size		4 bits	
	downlink CQI		6 bits	
	CRC		16 bits	
	Total		56 bits	

3.2 TRANSMISSION STRUCTURE UNDER TDD OR HALF-DUPLEX FDD

The channelization framework for TDD is similar to FDD in that the logical association between the channels remains the same except that the downlink and uplink transmissions are no longer time-aligned, but rather time-multiplexed. The half-duplex FDD shares the same transmission structure except that the downlink and uplink are on separate frequencies, and does not overlap in time unlike in the full-duplex FDD.

For the case of VDE-SAT (either TDD or half-duplex FDD), resource block of downlink and uplink may have different sizes (in slot) to allow different transmission time interval (TTI) for downlink and uplink so as to match the difference in link budget between downlink and uplink [2]. The channelization framework for VDE-SAT is illustrated as an example in Figure 3.

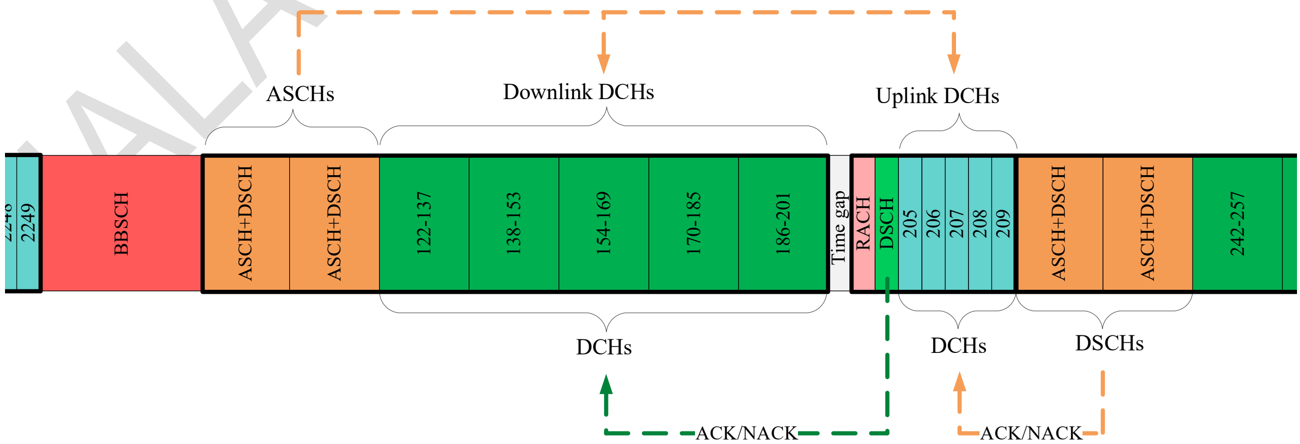

Figure 3 Illustration of the transmission timeline under TDD where the TTI of an ASCH spans 16 slots (exemplary).

4 ACTION REQUESTED OF THE COMMITTEE

Review and adopt.