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Proposal for coordination of VDE terrestrial multiple base station services

# Summary

As a TDMA system, the VDE system requires coordination of communication resources among terrestrial base stations to avoid potential conflicts. This proposal presents a mechanism for allocating and coordinating resources in VDE terrestrial multiple base station services to ensure optimal performance and quality of VDE-TER services.

# [BACKGROUND](javascript:;)

The air interface resources of the VDE terrestrial system mainly include three aspects: physical channels, logical channels, and slots. Physical channels involve bandwidths of 25kHz and 100kHz utilized by VDES-TER. It is advisable, when possible, to avoid using physical channels with overlapping spectra at base stations where signal overlaps occur. Simultaneously, it is essential to maximize the use of all terrestrial physical channels in VDES to ensure a high throughput for VDE-TER. When adjacent base stations with overlapping coverage areas use the same or frequency-overlapping physical channels, their logical channels and slots should be coordinated to avoid potential conflicts. Therefore, it is essential to thoroughly consider resource coordination among multiple base station service areas in the VDE terrestrial system to ensure transmission reliability and efficiency.

# Discussion

VDE terrestrial mobile stations rely on VDE base stations for channel and bandwidth selection, and the base stations need to allocate logical channels for the mobile stations. As shown in *Figure 1* below, due to the signal coverage of VDE base stations being larger than its defined service area, and the transmission range of mobile station signals may also exceed the service area of their respective base stations, it is necessary to conduct resource allocation and coordination among adjacent base stations to ensure the reliable transmission of VDE terrestrial messages.



*Figure 1 VDE terrestrial multi-base station signal coverage*

In general, the coordination of VDE terrestrial multiple base station service resources needs to be considered from two aspects: one is the allocation and scheduling of VDE terrestrial resources, the other is the coordination of bulletin broadcast.

## 3.1 The allocation and scheduling of VDE terrestrial resources

The VDE terrestrial resources mainly include three aspects: physical channels, logical channels, and slots. The physical channels refer to the VDE physical channels used by each terrestrial control station, as specified by ITU-R M.2092-1, which include a total of eight frequency bands: 1024, 1084, 1025, 1085, 2024, 2084, 2025, and 2085. For VDE-TER, each physical channel is defined to contain six TDMA channels, and each TDMA channel can contain one or more logical channels.

Each physical channel in a VDES system will have a valid slotmap definition. By monitoring the terrestrial bulletin board, ships will determine whether they are within the control station service area and match the physical channel and slotmap via the bulletin board. In the absence of a bulletin board, the default physical channel and slotmap will be applied.

Table

Description automatically generated

*Figure 2 VHF data exchange-terrestrial ship to shore default slot functions (lower leg)*

Table

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*Figure 3 VHF data exchange-terrestrial ship to ship and shore to ship default slot functions (upper leg)*

For VDE-TER, the default slotmap keeps all signalling in TDMA 0 channel and on the DSCH slot at the end of each TDMA frame. TDMA 1-5 channels are broken into TDMA frames of 15 slots where data transmission can take place on the first 14 (DC) slots, while the 15th slot (DSCH) is used for ACK/NACK and resource allocation signalling.

Considering VDE has 8 physical channels, only 4 lower leg channels can be used in simplex mode. In duplex mode, although all 8 physical channels can be utilized, the lower leg is restricted for ship-to-shore communication, while the upper leg is reserved for shore-to-ship and ship-to-ship communication. During the fragment transmission between shore and ship, considering ACK, both the lower leg and upper leg need to be utilized simultaneously. As a result, the 8 channels are combined into 4 pairs.

Through resource scheduling, the VDE terrestrial can be divided into corresponding resource blocks, namely 4 pairs of physical channels, with each physical channel containing 5 data channels (TDMA 1 to TDMA 5) available for utilization by base stations, resulting in a total of 20 resource blocks.

The resource coordination of base stations can be classified into the following two [scheme](javascript:;)s:

1. Adjacent base stations use the same 100 kHz channel and coordinate data transmission between interfering stations by allocating TDMA 1 to TDMA 5. This allocation can provide high transmission efficiency and achieve high total throughput. However, it offers a limited number of resource blocks, resulting in lower capacity to handle simultaneous transmission demands from a large number of vessels. Additionally, this method is not suitable for areas with more than five overlapping base station coverage regions.
2. Adjacent base stations use different 25 kHz channels and coordinate data transmission between interfering stations by allocating 4 pairs of physical channels and TDMA 1 to TDMA 5. This allocation scheme can provide up to 20 resource blocks and is suitable for ensuring fair resource distribution in areas with a large number of vessels, allowing simultaneous transmission from numerous mobile stations. However, it entails higher overhead, leading to a lower overall throughput than the first [scheme](javascript:;).

Base stations can promptly respond to resource requests from vessels based on the allocated resource blocks.

The resource coordination of base stations should be dynamically assigned based on interference possibility between base stations, regional VDE load, the number of VDE mobile stations in the area, and the transmission needs of VDE base stations. This [scheme](javascript:;) maximizes resource utilization while satisfying the communication requirements of the region.

## 3.2 Coordination of the transmission of bulletin boards

The terrestrial bulletin board defines the slotmap for each physical channel and specifies the list of physical channels.

VDE stations should always utilize the most recent and valid terrestrial bulletin boards. The terrestrial bulletin boards may be transmitted in either the lower leg of channel 1024 or the upper leg of channel 2024, respectively. Therefore, the mobile station should always monitor the bulletin board announcement on channel 1024 and 2024. To avoid conflicts caused by simultaneous broadcast of bulletin boards, adjacent VDE base stations should alternate the bulletin board messages between physical channels 1024 and 2024, or follow a rotating principle based on minute.

# References

1. ITU-R M.2092-1, *Technical characteristics for a VHF data exchange system in the VHF maritime mobile band, February 2022*

# Action requested of the Committee

The Committee is requested to consider the information provided in this document and take actions as appropriate.

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