Ref: Document 5B/475 Annex 24 (9 January 2014)
Document 5B/636 Annex 5 (30 June 2014)
Document 5B/636 Annex 28 (9 July 2014)
Document 5B/636 Annex 29 (9 July 2014)
Document 5B/636 Annex 30 (9 July 2014)

WORKING DOCUMENT TOWARD A PRELIMINARY DRAFT NEW RECOMMENDATION ITU-R M.[VDES]*

Technical characteristics for a VHF data exchange system in the VHF maritime mobile band

Scope

This Recommendation provides the technical characteristics of a VHF data exchange system (VDES) which integrates the functions of VHF data exchange (VDE), application specific messages (ASM) and the automatic identification system (AIS) in the VHF maritime mobile band (156.025-162.025 MHz).

Keywords:

[TBD]

Glossary:

ACPR	Adjacent channel power ratio
AIS	Automatic identification system
AMSL	Above mean sea level
ASM	application specific messages
CIRM	Comité International Radio Maritime
DA	Doherty Amplifier
DPD	Digital Pre-Distortion

* This Recommendation should be brought to the attention of the International Maritime Organization (IMO), the International Civil Aviation Organization (ICAO), the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), the International Electrotechnical Commission (IEC) and the Comité International Radio Maritime (CIRM).

DSC	digital selective calling
ET	Envelope Tracking
FATDMA	fixed access time-division multiple access
FEC	Forward error correction
HAAT	Height above average terrain
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ICAO	International Civil Aviation Organization
IEC	International Electrotechnical Commission
IMO	International Maritime Organization
ITDMA	incremental time division multiple access
LEO	low-earth orbiting
MEO	medium-earth orbiting
MMSI	maritime mobile service identity
OFDM	orthogonal frequency division multiple access
PAPR	peak to average power ratio
PFD	power flux-density
QoS	Quality of Service
RR	radio regulations
SOLAS	safety of life at sea convention
SOTDMA	self-organized time division multiple access
VDES	VHF data exchange system
VDL	AIS VHF data link
VTS	vessel traffic services

The ITU Radiocommunication Assembly,

considering

a) that the International Maritime Organization (IMO) has a continuing requirement for a universal shipborne automatic identification system (AIS);

b) that the use of a universal shipborne AIS allows efficient exchange of navigational data between ships and between ships and shore stations, thereby improving safety of navigation;

c) VDES should use appropriate access schemes that ensure the protection of AIS while making efficient use of the spectrum and accommodate all users;

d) that while AIS is used primarily for surveillance and safety of navigation purposes in ship to ship use, ship reporting and vessel traffic services (VTS) applications, a growing need for other maritime safety related communications has developed;

e) that the VHF data exchange system (VDES) shall give priority to AIS, and also accommodate future expansion in the number of users and diversification of data communications applications, including vessels which are not subject to IMO AIS carriage requirements, aids to navigation and search and rescue;

f) that the VDES has data communications capacity and technical characteristics that support the harmonized collection, integration, exchange, presentation and analysis of marine information onboard and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment;

recognizing

that the implementation of VDES must ensure that the functions of digital selective calling (DSC), AIS and voice distress, safety and calling communication (Channel 16), are not impaired;

noting

that the report ITU-R M.[VDES-SELECT] describes the use cases and requirement for VDES,

recommends

1 that VDES should be designed in accordance with the operational characteristics given in Annex 1 and the technical characteristics and examples given in the following Annexes;

2 that applications of the VDES which make use of application specific messages (ASM) designed for AIS, as defined in Recommendation ITU-R M.1371 should also take into account the international application identifier branch, as specified in IMO SN Circ. 289, maintained and published by IMO;

3 that the design and installation of VDES should also consider relevant technical requirements, recommendations and guidelines published by IMO, IEC and IALA.

ANNEX 6

Sharing options for the VDE Terrestrial and VDE Satellite services

1 Scope

This Annex presents methods to share the VHF spectrum available to VDES between terrestrial and satellite services. Methods for sharing spectrum among different VDE satellite systems are also presented. The baseline frequency assignment per each service is according to the frequency usage illustrated in Figure 1 of Annex 1 and described in the following clauses thereof. Proposed methods rely on the characteristics of VDE terrestrial and VDE Satellite components as described in Anne 3 to Annex 5 of this recommendation.

2 Frequency Sharing Considerations

2.1 VDE-SAT Downlink

Although the PFD mask is selected to minimize interference to the land mobile service and to maximize reception by ship VDES stations, there is a potential effect of raising the noise floor for reception of the terrestrial VDES links during satellite VDE downlink transmissions when the satellite is the field of view.

Issues to be considered for the sharing the VDE1-B frequencies and the VDE-SAT Downlink are:

- When shipborne VDES transceivers are simplex they cannot receive while transmitting.
- VDE-SAT downlink transmission levels, by raising the noise floor, will potentially have an impact on reception of ship-to-ship and shore-to-ship VDES.
- Ship-to-ship and shore-to-ship VDES transmissions, depending on the distance, by co-channel interference, will potentially interfere with reception of the VDE-SAT downlink

2.1.1 Frequency division multiple access (FDMA)

Frequency division multiple access is accomplished by using only the upper 50 kHz for the VDE-SAT downlink, i.e., only the two channels 2026 and 2086. The frequency division multiple access would mitigate the last two issues stated above. Compared to other techniques proposed below, the FDMA would be the most straightforward to implement. However it would result in a reduction of the bandwidth to 1/3, and cause the VDE-SAT downlink transmissions to last three times longer for the same payload, and it would not mitigate the first issue stated above.

2.1.2 Time division multiple access (TDMA)

Time division multiple access approach for shore-ship/ship-ship and VDE SAT downlink services would allow the full use of the spectrum assigned to each service in a time sharing manner. Time sharing can mitigate all the three of the issues stated in Section 6 above. However, it would impose some design challenges for the VDE-SAT components and compromise the throughput of the VDE-SAT Downlink.

The AIS-based TDMA slot structure (2250 slots/minute/frame) and access schemes (ITDMA, CSTDMA and FATDMA) that are used for VDES are defined in Recommendation ITU-R M.1371-5. This TDMA organization scheme protects the integrity of the AIS and is used to organize and synchronize the ASM and VDE transmissions.

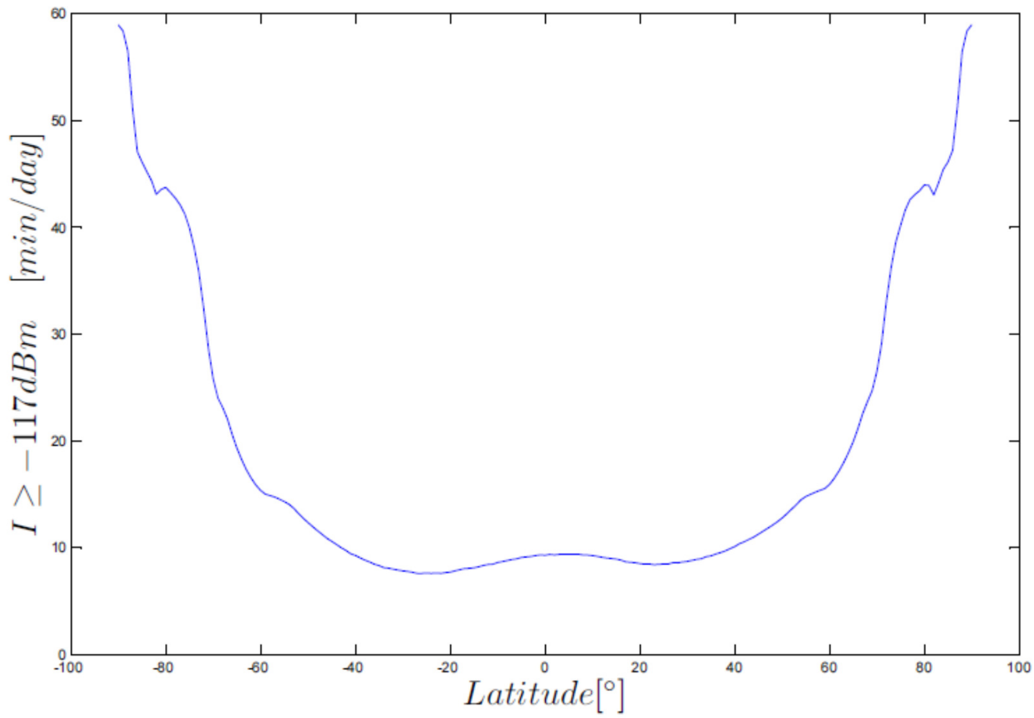
2.1.3 Full Frequency reuse (superposition)

In this approach, the terrestrial and satellite components are allowed to simultaneously use channels 2024, 2084, 2025 and 2085. The VDE-SAT downlink will additionally use channels 2026 and 2086. The VDE-SAT downlink could continuously broadcast to maximize the data dissemination to a large number of ships in its field of view. This would allow for more efficient implementation of the VDE-SAT receivers. The interference caused by the VDE-SAT downlink on the VDE terrestrial could, in principle, be compensated for by the use of more protected coding scheme in the terrestrial link, only during the satellite passage.

For a most likely scenario of Low Earth Orbit satellites with a polar orbit, the impact of satellite interference could be limited to only less than 15 minutes per day per satellite for geographical locations with latitudes within ±50 degrees, as shown in Figure 1.

Figure 1

Time duration where signal level exceeds -117dBm as a function of geographical position



2.2 VDE Terrestrial (VDE1-A) and VDE-SAT Uplink

Due to the large field of view, a passing satellite would receive a number of colliding messages from different VDE-terrestrial links (ship-to-shore) simultaneously that would interfere with ship to satellite links (channel 1024, 1084, 1025, 1085). The following multiple access schemes can be envisaged to mitigate/minimize the impact of VDE terrestrial link on VDE satellite uplink.

2.2.1 Frequency Division Multiple Access (FDMA)

The frequency division multi-access scheme separates the satellite channels into two groups: Channels 1024, 1084, 1025 and 1085 that are subject to terrestrial interference are considered as a single or multi-carrier satellite uplink channel(s). Highly robust waveforms would be selected for these channels to allow for interference mitigations caused by VDE terrestrial.

The second group of carriers are considered to occupy Channel 1026 and 1086 where no VDE terrestrial transmission is present.

2.2.2 Time Division Multiple Access (TDMA)

VDE-SAT uplink follows the same frame structure as VDE terrestrial occupying VDE1-A channels. There are pre-assigned time slots dedicated to satellite transmission preventing interference from any VDE terrestrial link.

Alternatively, noting that Recommendation ITU-R M.1371-5 specifies the access schemes for the AIS Messages, including ITDMA, on the AIS channels, and it specifies the structure for ASM with various contents. VDES takes ASM to another level by providing dedicated ASM channels to relieve congestion on the AIS channels. Under VDES, the access scheme for using the ASM channels could be initially by CSTDMA (Carrier-Sense TDMA) for the first transmission in a frame, followed by ITDMA for subsequent transmissions in that frame. This scheme mitigates simultaneous transmissions by ships and/or shore stations on the ASM channels.

2.2.3 Full Frequency reuse

The terrestrial and satellite components are allowed to simultaneously use channels 1024, 1084, 1025 and 1085. The VDE-SAT uplink would use properly designed waveforms occupying the VDE-SAT uplink channels to minimize the impact of interference caused by the VDE terrestrial transmissions.

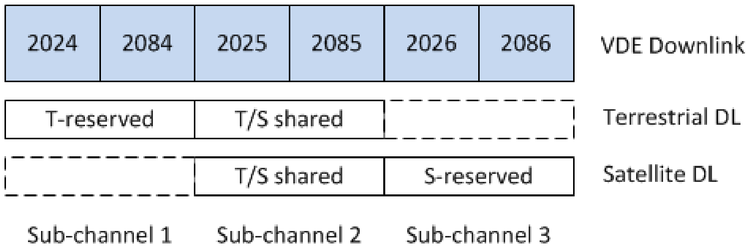
3 Sharing Strategies among different VDE Satellite systems

4 Example of Deployment Method

4.1 VDE-SAT Downlink and VDE Terrestrial

This section provides an example of frequency sharing that allows experiments using VDE-SAT and VDE terrestrial. Figure below illustrates an interim use of frequency bands:

- Channel 2014 and 2084 are used for terrestrial VDE
- Channel 2016 and 2086 are dedicated to VDE Satellite downlink
- Channel 2025 and 2085 are assigned according to the time sharing strategy described in Section 2.1.2.



4.2 VDE-SAT Downlink and VDE Terrestrial

This section describes examples of frequency assignment for VDE-Sat uplink.

Ideas to be explored:

- Channel bandwidth
- Interference mitigation
- Load control strategies.

5 Implementation of resource Sharing

The example of a LEO satellite with downlink (only) or with downlink and uplink capability.

Bulletin Board Definition: (Possible use of the terrestrial signaling).

- In line with Annex 4
- Static and Dynamic
- BBSC Validity 11 bits (x0 = indefinite) this is to remove the need to go through the whole table.
- The resource allocation plan (time, frequency and U/L, D/L)
- Define the random access and dedicate access
- Announcement channel will defined in BBSC
- TLE
- Backup frequency for the BSSC
- Network ID 8 bits
- Satellite ID 8 bits
- Pointing to NIT (Network Information table)

Note: We may add example of BBSC to support a half-duplex scenario (5 sec up and 10 sec down).

(Action: To tabulate this information)

Actions: Nader to write

Observation:: The solution allow to implement all three proposed methods of resource sharing (to be elaborated (NA).