From: IALA
Reference: C60-9.5.9.2
24 April 2015

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Liaison Note to ITU-R WP 5B

REGARDING THE JUSTIFICATION OF THE CHANNEL PLAN FOR VDES UNDER AGENDA ITEM 1.16

Background

IALA thanks ITU-R WP 5B for the opportunity to contribute to studies and the work for WRC-15 agenda item 1.16. In the November meeting of ITU WP 5B a new channel plan was proposed. This liaison note provides an evaluation of the four channel plans. The output document from the November ITU WP 5B meeting Document 5B/761-E "Annex 13 to Working Party 5B Chairman's Report PRELIMINARY DRAFT NEW REPORT ITU-R M.[VDES-SELECT]" 4 December 2014 was amended with tracked changes to include the new channel plan D in the evaluation.

Discussion

The following sections of the document were amended:

Section 3 Comparison of the channel plans;
Table 1 Criteria for comparing the VDES channel plans;
Table 2 Channel plan performance against use cases;
Scenarios 1 to 6 amended.

The rating of channel plan D was revised in the tables and scenarios to reflect the considered expert opinion of IALA.

While each channel plan has merits, Channel Plans B and C are unacceptably susceptible to interference from VHF voice communications and that Channel Plan D is inferior to Channel Plan A with regards to the shore infrastructure, with regards to potential conflicts between regional channel use and the Satellite link and with regards to the added complexity of channel management (switching between global and regional channels).

Conclusion

After careful review IALA supports Channel Plan A as it supports the elaborated Use Cases, fulfils the criteria requirements and transfers to methods A1+B1+C1-B of the CPM text.

Action requested

IALA requests that ITU-R WP 5B consider this Annex during the Working Party 5B meeting in July 2015.

§Radiocommunication Study Groups

Source: Document 5B/TEMP/334

Subject: Agenda item 1.16 WRC-15

Annex 13 to Document 5B/761-E
4 December 2014
English only

Annex 13 to Working Party 5B Chairman's Report

PRELIMINARY DRAFT NEW
REPORT ITU-R M.[VDES-SELECT]

Selection of the channel plan for a VHF data exchange system under WRC-15 agenda item 1.16

[Chairman's comment: If this becomes a report it will survive beyond WRC-15 and hence the text should reflect this e.g. consider deletion of "under WRC-15 agenda item 1.16 in the title and reference to the November 2013 meeting of 5B]

1 Introduction

~~During the November 2014 meeting of WP 5B, f~~Four channel~~ling~~ plans for the VHF ~~date~~data exchange system (VDES) concept have been considered, taken from input contributions from the International Association of Lighthouse Authorities (IALA), a multi-country European group, Canada ~~and~~ China and Russia. ~~All of T~~~~the~~The channel plans~~.~~ are similar in that they use the same group of VHF maritime Appendix 18 channels, ~~and~~ however they are different in the exact way that the channels are used. Plan B introduces channels for low power innovative AIS application causing a conflict with satellite down. Plan D introduces regional channels causing a conflict with the satellite up and down and removes the 50kHz spacing between the VDE and ASM channels. Each plan has its unique merits and limitations, and ~~the~~an agreed criteria for comparing the plans ~~are~~is included in Table 1.

2 Channel Plans under consideration

2.1 Channel plan A

1024 157.200	1084 157.225	1025 157.250	1085 157.275	1026 157.300	1086 157.325
VDE1					
SAT up3					

2024 161.800	2084 161.825	2025 161.850	2085 161.875	2026 161.900	2086 161.925	2027 161.950	AIS1 161.975	2028 162.000	AIS2 162.025
VDE1						ASM1		ASM2	
SAT Downlink						SAT up1	AIS1 uplink	SAT up2	AIS2 uplink

Tableau mis en forme

2.1.1 VHF date exchange system channel usage for channel plan A

2.1.1.1 VHF date exchange system data exchange between terrestrial stations

– Aautomatic Informationdependent sSystem (AIS) use channels AIS 1 (161.975) and AIS 2 (162.025) are AIS channels, in accordance with Recommendation ITU-R M.1371;

– aApplication sSpecific Mmessages (ASM) use channels ASM 1 (161.950) and ASM 2 (162.000) and are non-navigation application specific messages (ASMs);

– VDE 1 lower legs (channels 1024… 1085) are ship-shore VHF data exchange (VDE);

– VDE 1 upper legs (channels 2024… 2085) are shore-ship and ship-ship VDE.

2.1.1.2 VHF date exchange system data exchange between satellites and terrestrial stations

– AIS 1 (161.975) and AIS 2 (162.025) are used as uplinks for receiving AIS messages by satellite;

– SAT up1 (161.950) and SAT up 2 (162.000) are used for receiving ASM by satellite;

– SAT up3 (channels 1024… 1086) is a ship-satellite VDE uplink;

– SAT Downlink (channels 2024… 2086) is the satellite-ship VDE downlink.

2.1.2 Technical characteristics

2.1.2.1 ShipborneVHF date exchange system receivers are protected

As in AIS, shipborne VDES receivers are on the upper legs of RR Appendix 18, 4.6 MHz above the lower legs, which facilitates protection by filtering from receiver blocking by ships VHF radios.

2.1.2.2 Satellite downlink is optimized

The satellite downlink power is spread over 6 channels to minimize interference to terrestrial services and to maximize reception by ship VDES stations.

2.1.2.3 VDE1 uses both legs of the duplex channels

Full channel capacity is utilized for the duplex channels in VDE1 by using the lower legs for ship-shore and the upper legs for shore-ship and ship-ship digital messaging.

2.2 Channel plan B

1024 157.200	1084 157.225	1025 157.250	1085 157.275	1026 157.300	1086 157.325
VDE1					
SAT up3 extension				SAT up3	

2024 161.800	2084 161.825	2025 161.850	2085 161.875	2026 161.900	2086 161.925	2027 161.950	AIS1 161.975	2028 162.000	AIS2 162.025
VDE1				Innovative Applications		ASM1		ASM2	
SAT Downlink						SAT up1	AIS1 uplink	SAT up2	

Tableau mis en forme

2.2.1 VHF date exchange system channel usage for channel plan B

2.2.1.1 Overall considerations:

- to maximize effective use of the channel resources;
- to ~~not to touch~~retain the frequencies AIS1 and AIS2, and minimize interference;
- to use channels 2027 and 2028 for ASM (data vs. Navigation) reducing the ~~off~~loading on the AIS channels~~system~~;
- to focus the AIS sat uplink on channels 75 and 76 which are~~,~~ already allocated for satellite detection;
- to keep all other ship borne transmissions (VDE and voice) in the low band, enabling protection of the AIS system on existing frequencies;
- to use channels 2026 and 2086 ~~are used~~ for low power innovative AIS apps not on board ships which will~~to~~ reduce the~~o~~ load on AIS1 and AIS2, and to create~~make~~ a guard band for coast stations and satellites, to enable protection of their AIS and ASM receivers from the VDE transmitters;
- the large footprint of the satellite.

2.2.1.2 VHF data exchange system data exchange between terrestrial stations

Ship transmissions for point to point communication ship-to-ship and ship-to-shore are in the lower leg frequencies 1024, 1084, 1025 and 1085. Ship to ship will be in simplex mode, and ship-to-shore can be in simplex mode in the lower leg channels and/or semi duplex mode in combination with the shore station transmitting in the upper leg channels 2024, 2084, 2025 and 2085.

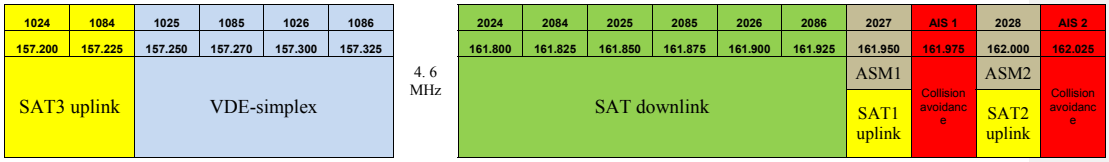
Shore-to-ship transmissions will be in both the upper leg frequencies 2024, 2084, 2015, 2085, and the lower leg 1024, 1084, 1025 and 1085. These transmissions will be either in broadcast, multicast or point to point mode.

2.2.1.3 VHF data exchange systemdata exchange between terrestrial stations and satellite

Taking the large footprint of the satellite into consideration, and the subsequent risk of the satellite receiving many ships transmissions simultaneously, the channels 1026 and 1086 are dedicated ship to satellite uplink. This would avoid terrestrial VDE communications reducing~~to reduce~~ the probability of satellite detection of ship~~s to satellite communication~~. The SAT up3 extension channels 1024, 1084, 1025 and 1085 are allocated to have the possibility of increased data speed in the uplink.

The SAT downlink channels 2024, 2084, 2025 and 2085 are shared with the terrestrial VDE shore-to-ship ~~where terrestrial~~ transmissions. On these channels SAT transmission will have priority. The SAT downlink channels are used both for broadcast and for SAT-to-ship point to point.

2.3 Channel plan C



It is highly desirable for Shore Authorities to preserve AIS receiver sensitivity especially in areas of high traffic density where VDE is targeted to be used the most to communicate marine safety information (MSI). High traffic volume areas are often associated with the greatest AIS loading and it would not be desirable, from a Shore Authority perspective, to have a diminished VDE capacity in these circumstances. In high traffic areas, Shore Authorities are more likely to need all of the VDE capacity. As such, this proposal aims to provide as much separation as possible (given the available spectrum) between AIS and Terrestrial VDE in order to:

a) preserve AIS receiver sensitivity and;

b) isolate the two systems so that the load on AIS does not affect VDE performance and available bandwidth.

This proposed arrangement of the globally available channels and usage is explained below ~~and shown in Table 1. Furthermore, Figure 1 was created to visually demonstrate Table 1~~.

1) A simplex, 100 kHz wide-band channel consisting of the 4 following contiguous channels: 1025, 1085, 1026, 1086 for terrestrial VDE communications. Using Recommendation ITU-R M.1842-1 based modulation, this channel may be able to reach data transfer speed of up to 307.2 kbps. The access scheme would be self-organised time division multiple access (SOTDMA) as with AIS.

2) A 150 kHz wide-band channel consisting of the 6 following contiguous channels: 2024-2084-2025-2085-2026-2086 for VDE satellite downlink.

3) A 50 kHz wide-band channel consisting of the 2 following contiguous channels: 1024-1084 for VDE satellite uplink from ships.

4) Two AIS "ASM" channels consisting of the following contiguous channels 2027 and 2028 to reduce the loading on~~offload~~ AIS 1 & AIS 2.

5) Maintain AIS1, AIS2 and channels 75 and 76 in Appendix 18 of the International Radio Regulations.

2.4 Channel plan D

The possible channel plan D might be as following:

1023 157.150	1083 157.175	1024 157.200	1084 157.225	1025 157.250	1085 157.275	1026 157.300	1086 157.325	1027 157.350	87 157.375	1028 157.400	88 157.425
Regional or national VDE				Global VDE1				Voice	Voice	Voice	Voice
Ship-shore				Ship-shore				Bidirectional	Bidirectional	Bidirectional	Bidirectional
		SAT up3									

2023 161.750	2083 161.775	2024 161.800	2084 161.825	2025 161.850	2085 161.875	2026 161.900	2086 161.925	2027 161.950	AIS1 161.975	2028 162.000	AIS2 162.025
Regional or national VDE				Global VDE1				ASM1	AIS1	ASM2	AIS2
Shore-ship and ship-ship				Shore-ship and ship-ship				Bidirectional	Bidirectional	Bidirectional	Bidirectional
	SAT Downlink							SAT up1	AIS up1	SAT up2	AIS up2

1) According to the result of compatibility studies between VDE and voice application, and between VDEs, the lower leg of CH25, CH85, CH26 and CH86 will be used for the ship-shore transmission of the global harmonized VDES terrestrial element. The lower legs of CH23, CH83, CH24 and CH84 could be used for ship-shore transmission of regional or national VDE, by means of one 100kHz wide band system, two 50kHz wide band systems, or four 25kHz narrow band systems.

2) According to the result of compatibility studies between VDE and ASM application, and between VDEs, the upper leg of CH25, CH85, CH26 and CH86 will be used for shore-ship or ship-ship transmission of the global harmonized VDES terrestrial element. The lower legs of CH23, CH83, CH24 and CH84 could be used for shore-ship or ship-ship transmission of regional or national VDE, by means of one 100kHz wide band system, two 50kHz wide band systems, or four 25kHz narrow band systems.

3) AIS 1 (161.975 MHz) and AIS 2 (162.025 MHz) are AIS channels, in accordance with Recommendation ITU-R M.1371; ASM 1 (161.950 MHz) and ASM 2 (162.000 MHz) are non-navigation application-specific messages (ASM).

4) AIS 1 (161.975 MHz) and AIS 2 (162.025 MHz) are used as uplinks for receiving AIS messages by satellite; SAT up1 (161.950 MHz) and SAT up2 (162.000 MHz) are used for receiving ASM by satellite.

5) SAT up3 (channels 1024… 1086) is a ship-satellite VDE uplink; SAT Downlink (channels 2024… 2086) is the satellite-ship VDE downlink.

3 Comparison of the channel plans

The four proposed channel plans A, B, C and D described above were~~consider all the various channel plans that have been proposed, and these three channel plans A, B, C and D are now evaluated compared~~

- against~~in terms of~~ an agreed set of important criteria which were developed by considering the different aspects of the VDES (Table 1), and
- for channel plan performance in supporting ~~that are considered to be most important when assessing the plans in~~ an agreed set of use cases (Table 2).

~~This document provides an evaluation of the four three channel plans in Document 5B/475 Annex 37. Table 1 of this document is the criteria for evaluating each channel plan, and Table 2 provides Use Cases evaluating each channel plan performance in supporting those Use Cases.~~

[chairman's note: in the final document reference to specific input documents will need to be removed. Ther following text also appears to be inconsistent with Report text]

A series of ~~a~~ informal meetings of an international working group of technical experts was convened ~~(31 March to 4 April 2014)~~ to perform the evaluation ~~prescribed in Document 5B/475 Annex 37~~. This evaluation considered~~s~~ the VDES as defined in the draft new Recommendation ITU-R M.[VDES]~~Document 5B/475 Annex 24~~. Each channel plan was evaluated against each criterion as appropriate, and the results of the evaluation are contained in Table 1.

The group further evaluated six different Use Cases, spanning the needs for ship to ship as well as ship to shore and shore to ship information transfer either by terrestrial or satellite. The Use Cases took into account potential implementation and variations and realistic variations in data volume. Operational priorities were considered to enable design of VDES to support a future modernized GMDSS if so desired. The primary considerations relate to the protection of the integrity of the function of the AIS system and the potential effects on other services, or other maritime services such as VHF voice communications. During the deliberations it became clear that voice VHF service would have significant effects on the effectiveness of the VDES as well as the existing AIS if not addressed. This concern became the primary factor in selecting the preferred channel plan. The Use Cases and the results of the evaluations can be found in Table 2.

While each channel plan has merits, the group agreed that Channel Plans B and C are unacceptably susceptible to interference from VHF voice communications and that Channel Plan D is inferior to Channel Plan A with regards to the shore infrastructure, with regards to potential conflicts between regional channel use and the Satellite link and with regards to the added complexity of channel management (switching between global and regional channels).

4 Conclusion

[TBD]

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TABLE 1

Criteria for comparing~~trading off~~ the VHF data exchange system channel plans

A number of important criteria~~-~~ are considered ~~of importance~~ when assessing the proposed VDES channel plans. The criteria originate from various technical discussions at IALA working groups and specific teleconference meetings in which the maritime regulatory, radio regulatory, maritime radio, manufacturers, national coastguards and satellite community have participated.

In order to compose the agreed list of criteria, the VDES was considered from several different aspects and the criteria are presented below, grouped according to the aspect under consideration.

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This table contains the criteria that are considered of most importance when assessing the proposed VDES channel plans, along with comparisons of the channel plans against these criteria.

Tableau mis en forme

Criteria	Description	Channel Plan Comparison
System Aspects		
AIS ←→ VDE dependency	The overall dependency of the existing AIS system with VDES. This includes ASM and LR-AIS. Could a high AIS load take VDES capacity away? Could a high VDES load take AIS capacity away? Does VDE need to be coordinated with AIS? If so, Do they have to be interfaced? What would happen in case of a AIS failure/overload? Would the VDE stop working? And vice versa	Could a high AIS load take VDES capacity away? Channel Plan A: No Channel Plan B: No Channel Plan C: No Channel Plan D: No Could a high VDES load take AIS capacity away? Channel Plan A: No Channel Plan B: No Channel Plan C: No Channel Plan D: No Does VDE need to be coordinated with AIS? This is not a function of the channel plan. A protocol must be defined that takes into account the ability to maximize AIS reception aboard ship; A ship receiver will be desensitized when transmitting however care must be taken to ensure that the collision avoidance aspects of AIS are maintained (near ships must be heard); Care must be taken to ensure that the Sat downlink does not interfere with ASM channels; Do they have to be interfaced? Yes – coordination is required, especially between ASM channels and AIS; This is true for all four channel plans; What would happen in case of an AIS failure/overload? Would the VDE stop working? And vice versa Failure is defined as over a 50% load on the AIS; The VDE would not be impacted with all four channel plans;

Criteria	Description	Channel Plan Comparison
VDE-Terrestrial → SAT-AIS interference	Interference level caused by VDE terrestrial transmissions to SAT-AIS reception. This includes reception of LR-AIS, ASM1/2, AIS1/2.	Will interference caused by VDE terrestrial transmissions perturb SAT-AIS reception? This includes reception of LR-AIS, ASM1/2, AIS1/2. Channel plans A, B and D would be impacted for the channels shared between satellite and terrestrial. Sharing studies must be conducted. For plans A, B the dedicated satellite channels mitigate this. Channel plan C would not be impacted;~~The only possible interference is to LR-AIS; this is not an issue for any of the channel plans;~~
VDE-SAT → SAT-AIS interference	Interference level caused by VDE satellite transmissions to SAT-AIS reception. This includes reception of LR-AIS, ASM1/2, AIS1/2.	Will interference level caused by VDE satellite transmissions perturb SAT-AIS reception? This includes reception of LR-AIS, ASM1/2, AIS1/2. VDES transmissions will effect reception for AIS/ASM and this is true for all channel plans; LR-AIS will not be impacted; There are available channels for satellite uplink;
VDE-SAT → VDE-Terrestrial interference	Interference level caused by VDE satellite transmissions to VDE terrestrial communications. This includes ship2ship, ship2shore and shore2ship.	Will interference level caused by VDE satellite transmissions perturb VDE terrestrial communications? This includes ship2ship, ship2shore and shore2ship. Channel plans A, B and D would be impacted. Sharing studies must be conducted. Channel plan C would not be impacted;
Capacity	Throughput (at system level) achieved by the proposed plan.	Throughput (at system level) achieved by the proposed plan Channel plan C is simplex for terrestrial VDE, ship and shore must share but satellite is dedicated; Channel plans A and B are semi-duplex and ship and shore may have to share with satellite; Channel plan D has a reduced throughput compared to the other channel plans;
Shore Aspects		

Tableau mis en forme

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Criteria	Description	Channel Plan Comparison
Shore-VDE ←→ Shore-AIS interference	Co-site interference between AIS and VDE. Ease and cost of taking countermeasures and adapting shore equipment.	Co-site interference between AIS and VDE. Co-site interference is an issue with all four channel plans and impact is dictated by installation considerations. Channel plan C simplifies these issues; Channel Plan A allows for the Co-site interference issue to be resolved with the use of a Co-site Interference Mitigation Systems (CIMS); Channel Plan D does not provide the 50kHz separation needed for CIMS;

Tableau mis en forme

Criteria	Description	Channel Plan Comparison
Ship Aspects		
VDE resilience to VHF voice communications	Can the VDE withstand VHF voice interference?	Can the VDE withstand VHF voice interference? Channel plan A and B provide adequate protection; Channel plan C is subject to heavy impact on the VDE from voice; As long as the duty cycle is kept to a minimum VDE communications should not impact voice; Channel plan Dis a duplex channel allotment for VDE, and the studies show that compatibility between the lower leg of these four channels being used for ship-shore transmitting and CH1027 being used for simplex voice could be achieved.
AIS → VDE interference	VDE resilience to AIS transmissions.	All channel plans must coordinate between AIS and VDE;
VDE ship2ship / ship2shore → AIS interference	Impact of VDE communications to the AIS probability of detection and capacity.	Impact of VDE communications to the AIS probability of detection and capacity Channel Plan A: No; Channel Plan B: No; Channel Plan C: No; Channel Plan D: No.
VDE ship2ship → VDE-SAT downlink interference	Amount of VDE-SAT downlink capacity that is taken away by VDE ship2ship communications.	~~Amount of VDE-SAT downlink capacity that is taken away by VDE ship-ship communications.~~ Channel plan A and D may not accommodate sat downlink during ship2ship comms; Channel plans B&C sat downlink does not impact ship2ship comms; Channel plan D ~~has potential~~ conflicts with regional channel use;
VDE-SAT uplink impact on AIS	Impact of VDE-SAT uplink to AIS probability of detection and capacity.	Sat uplink and AIS probability of detection may only be effected by VDE-SAT downlink on channel plans A, B and D;
VDES box complexity	Design, testing and certification.	Channel plans A,B and D may require sharing with satellite – if required, this will drive complexity.
Satellite Aspects		

Criteria	Description	Channel Plan Comparison
Is it possible to combine SAT-AIS and VDE in the same satellite?		None of the channel plans support simultaneous operation with AIS1/2 however, it would be possible for LR-AIS (AIS3/4);

Criteria	Description	Channel Plan Comparison
Commercial Aspects		
Ease of migration from existing shipboard equipment	Is it necessary to interface the VDE box and the AIS box? Is it necessary to replace the existing AIS box?	Is it necessary to interface the VDE box and the AIS box? All four channel plans require an interface between VDE and AIS/ASM; Is it necessary to replace the existing AIS box? This is not required for any of the four channel plans;
Modularity	Does the proposed channel plan/system allow product diversity? i.e. does it allow to have and sell a VDE box separately from the AIS box? or a VDES Rx-only unit?	Does the proposed channel plan/system allow product diversity? i.e. does it allow to have and sell a VDE box separately from the AIS box? or a VDES Rx-only unit? All four channel plans support diversity.

Note: ~~The performance of channel plan D is exactly as channel plan A in all 6 scenario use cases.~~ Channel plan B and D~~D~~ has~~ve~~ a conflict between the international channels used for the Satellite links ~~and the channels designated for regional use~~..

TABLE 2

Channel plan performance against use cases

This table summarises the performance of each channel plan in supporting the use case scenarios which are described in detail on the following pages.

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No	Secenrio	Priority Distress	Priority Urgency	Priority Safety	Priority Routine	AIS / ASM	VDE	ship-ship	ship-short (Terr.)	Ship-Shore (SAT)	Shore-Ship (Terr.)	Shore-Ship (SAT)	Channel Plan A	Channel Plan B	Channel Plan C	Channel Plan D
1A	SAR communication (terrestrial)	x				x	x		x		x		Acceptable	Good	Poor	Acceptable
1B	SAR communication (satellite)	x				x	x			x		x	Good	Good	Good	Poor
2A	MSN / NM (T-&P-) (terr., small)		(x)	x		(x)	x				x		Good	Good	Poor	Good
2B	MSN / NM (T-&P-) (terr., medium)		(x)	x			x				x		Good	Good	Poor	Good
2C	MSN / NM (T-&P-) (sat., small)		(x)	x			x					x	Good	Good	Good	Poor
2D	MSN / NM (T-&P-) (sat., medium)		(x)	x			x					x	Fair	Fair	Acceptable	Poor
3A	Automated reporting (terr. Medium)				x		x		x				Good	Good	Good	Good
3B	Automated reporting (terr. Large)				x		x		x				Good	Good	Good	Good
3C	Automated reporting (sat Medium)				x		x			x			Acceptable	Acceptable	Acceptable	Poor
3D	Automated reporting (sat large)				x		x			x			Fair	Fair	Fair	Poor
4A	VTS services (small)			x		x	x		x		x		Good	Good	Poor	Good
4B	VTS services (medium)			x		x	x		x		x		Good	Good	Poor	Good
4C	VTS services (sat - small)			x			x					x	Good	Good	Good	Poor
4D	VTS services (sat - medium)			x			x					x	Acceptable	Acceptable	Good	Poor
5A	Download large publication (terr.)				x		x				x		Good	Good	Poor	Good
5B	Download large publication (sat)				x		x					x	Fair	Acceptable	Good	Poor
6A	route exchange (ASM)			x		x		x					Good	Good	Good	Good
6B	route exchange (VDE)			x			x	x					Good	Poor	Poor	Good

Good	Channel plan supports use case well;
Acceptabl	Channel plan supports use case with design considerations;
Fair	Channel plan has limited support for the use case;
Poor	Channel plan support may comprimize use case;

No	Scenario	Priority distress	Priority Urgency	Priority Safety	Priority Routine	AIS / ASM	VDE	ship-ship	ship-shore (terr.)	Ship-shore (sat)	Shore-ship (Terr.)	Shore-ship (sat)	Channel plan A	Channel plan B	Channel plan C
1A	SAR communication (terrestrial)	x				x	x		x		x		Acceptable	Good	Poor
1B	SAR communication (satellite)	x				x	x			x		x	Good	Good	Good
2A	MSN / NM (T-&P-) (terr., small)		(x)	x		(x)	x				x		Good	Good	Poor
2B	MSN / NM (T-&P-) (terr., medium)		(x)	x			x				x		Good	Good	Poor
2C	MSN / NM (T-&P-) (sat., small)		(x)	x			x					x	Good	Good	Good
2D	MSN / NM (T-&P-) (sat., medium)		(x)	x			x					x	Fair	Fair	Acceptable
3A	Automated reporting (terr. Medium)				x		x		x				Good	Good	Good
3B	Automated reporting (terr. Large)				x		x		x				Good	Good	Good
3C	Automated reporting (sat Medium)				x		x			x			Acceptable	Acceptable	Acceptable
3D	Automated reporting (sat large)				x		x			x			Fair	Fair	Fair
4A	VTS services (small)			x		x	x		x		x		Good	Good	Poor
4B	VTS services (medium)			x		x	x		x		x		Good	Good	Poor
4C	VTS services (sat - small)			x			x					x	Good	Good	Good
4D	VTS services (sat - medium)			x			x					x	Acceptable	Acceptable	Good
5A	Download large publication (terr.)				x		x				x		Good	Good	Poor
5B	Download large publication (sat)				x		x					x	Fair	Acceptable	Good
6A	route exchange (ASM)			x		x		x					Good	Good	Good
6B	route exchange (VDE)			x			x	x					Good	Poor	Poor
Good	Channel plan supports use case well;														
Acceptable	Channel plan supports the use case with design considerations;														
Fair	Channel plan has limited support for the use case;														
Poor	Channel plan support may compromise use case;														

No	Secenrio	Priority Distress	Priority Urgency	Priority Safety	Priority Routine	AIS / ASM	VDE	ship-ship	ship-short (Terr.)	Ship-Shore (SAT)	Shore-Ship (Terr.)	Shore-Ship (SAT)	Channel Plan A	Channel Plan B	Channel Plan C	Channel Plan D
1A	SAR communication (terrestrial)	x				x	x		x		x		Acceptable	Good	Poor	Acceptable
1B	SAR communication (satellite)	x				x	x			x		x	Good	Good	Good	Fair
2A	MSN / NM (T-&P-) (terr., small)		(x)	x		(x)	x				x		Good	Good	Poor	Good
2B	MSN / NM (T-&P-) (terr., medium)		(x)	x			x				x		Good	Good	Poor	Good
2C	MSN / NM (T-&P-) (sat., small)		(x)	x			x					x	Good	Good	Good	Fair
2D	MSN / NM (T-&P-) (sat., medium)		(x)	x			x					x	Fair	Fair	Acceptable	Fair
3A	Automated reporting (terr. Medium)				x		x		x				Good	Good	Good	Good
3B	Automated reporting (terr. Large)				x		x		x				Good	Good	Good	Good
3C	Automated reporting (sat Medium)				x		x			x			Acceptable	Acceptable	Acceptable	Fair
3D	Automated reporting (sat large)				x		x			x			Fair	Fair	Fair	Fair
4A	VTS services (small)			x		x	x		x		x		Good	Good	Poor	Good
4B	VTS services (medium)			x		x	x		x		x		Good	Good	Poor	Good
4C	VTS services (sat - small)			x			x					x	Good	Good	Good	Fair
4D	VTS services (sat - medium)			x			x					x	Acceptable	Acceptable	Good	Fair
5A	Download large publication (terr.)				x		x				x		Good	Good	Poor	Good
5B	Download large publication (sat)				x		x					x	Fair	Acceptable	Good	Fair
6A	route exchange (ASM)			x		x		x					Good	Good	Good	Good
6B	route exchange (VDE)			x			x	x					Good	Poor	Poor	Good

Good	Channel plan supports use case well;
Acceptable	Channel plan supports use case with design considerations;
Fair	Channel plan has limited support for the use case;
Poor	Channel plan support may comprimize use case;

Scenario 1				
SAR communication				
Description				
A ship sends a distress alert via VHF DSC, MF DSC, INMARSAT C or other appropriate means. The responsible MRCC wish to use VDES to send out a mayday relay and request ships near by to report their SAR capabilities, using a standardized dataformat or cleartext, depending on onboard system capabilities.				
Priority				
Distress				
Variants				
A) In coastal waters near terrestrial shore station				
B) In remote area outside terrestrial coverage				
Assumed solution				
VDE is used to first broadcast a mayday relay, using A) shore station B) Satellite				
VDE is used to multicast a request for SAR capabilities to specific ships in the SAR area using A) shore station B) Satellite				
Ships use VDE to send SAR capability report to MRCC				
Notes Frequency Plan A	**ship shore**	**shore ship**		**Total**
A) Reception of shorestation broadcast is competing with ship-ship comms, satellite transmissions and own ships AIS transmissions, but can be protected by slot reservations and from ships own voice comm through filtering. Repetition of broadcasts should be considered.	Good	Acceptable		Acceptabl
B) Satellite broadcast should be in dedicated satellite part of downlink channel, otherwise likely to be missed due to to ship-ship (or shore-ship) transmissions, own ships AIS transmissions from preventing reception. Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions.	Good	Good		Good
Notes Frequency Plan B				
A) Reception of shorestation broadcast is competing with satellite transmissions and own ships AIS transmissions, can be protected from ships own voice comm through filtering. Repetition of broadcasts should be considered.	Good	Good		Good
B) Satellite broadcast could be affected by own ships AIS transmissions could prevent reception. Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions.	Good	Good		Good
Notes Frequency Plan C				
A) Reception of shorestation broadcast is competing with ship-ship comms, other Shore-ship transmissons and VHF voice. Repetition of broadcasts **must** be applied, and even so, reception may be totally blocked for long periods of VHF voice.	Fair	Poor		Poor
B) Satellite reception may be affected by own ships AIS transmissions, but Repetition of the broadcast may solve this. Reception can be protected from ships own voice transmissions.	Good	Good		Good

Scenario 1

SAR communication

Description

A ship sends a distress alert via VHF DSC, MF DSC, INMARSAT C or other appropriate means. The responsible MRCC wish to use VDES to send out a mayday relay and request ships near by to report their SAR capabilities, using a standardized dataformat or cleartext, depending on onboard system capabilities.

Priority

Distress

Variants

A) In coastal waters near terrestrial shore station

B) In remote area outside terrestrial coverage

Assumed solution

VDE is used to first broadcast a mayday relay, using A) shore station B) Satellite

VDE is used to multicast a request for SAR capabilities to specific ships in the SAR area using A) shore station B) Satellite

Ships use VDE to send SAR capability report to MRCC

Notes Frequency Plan A	ship shore	shore ship	Total
A) Reception of shorestation broadcast is competing with ship-ship comms, satellite transmissions and own ships AIS transmissions, but can be protected by slot reservations and from ships own voice comm through filtering. Repetition of broadcasts should be considered.	Good	Acceptable	Acceptable
B) Satellite broadcast should be in dedicated satellite part of downlink channel, otherwise likely to be missed due to to ship-ship (or shore-ship) transmissions, own ships AIS transmissions from preventing reception. Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions.	Good	Good	Good
Notes Frequency Plan B			
A) Reception of shorestation broadcast is competing with satellite transmissions and own ships AIS transmissions, can be protected from ships own voice comm through filtering. Repetition of broadcasts should be considered.	Good	Good	Good
B) Satellite broadcast could be affected by own ships AIS transmissions could prevent reception. Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions.	Good	Good	Good
Notes Frequency Plan C			
A) Reception of shorestation broadcast is competing with ship-ship comms, other Shore-ship transmissons and VHF voice. Repetition of broadcasts **must** be applied, and even so, reception may be totally blocked for long periods of VHF voice.	Fair	Poor	Poor
B) Satellite reception may be affected by own ships AIS transmissions, but Repetition of the broadcast may solve this. Reception can be protected from ships own voice transmissions.	Good	Good	Good
Notes Frequency Plan D			
A) Reception of shorestation broadcast is competing with ship-ship comms, satellite transmissions and own ships AIS transmissions, but can be protected by slot reservations and from ships own voice comm through filtering. Repetition of broadcasts should be considered.	Good	Acceptable	Acceptable
B) Satellite broadcast should be in dedicated satellite part of downlink channel, otherwise likely to be missed due to to ship-ship (or shore-ship) transmissions, own ships AIS transmissions from preventing reception. Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions. There is a potential conflict with ship to ship regional channel use.	Fair	Acceptable	Fair

Scenario 1				
SAR communication				
Description				
A ship sends a distress alert via VHF DSC, MF DSC, INMARSAT C or other appropriate means. The responsible MRCC wish to use VDES to send out a mayday relay and request ships near by to report their SAR capabilities, using a standardized dataformat or cleartext, depending on onboard system capabilities.				
Priority				
Distress				
Variants				
A) In coastal waters near terrestrial shore station				
B) In remote area outside terrestrial coverage				
Assumed solution				
VDE is used to first broadcast a mayday relay, using A) shore station B) Satellite				
VDE is used to multicast a request for SAR capabilities to specific ships in the SAR area using A) shore station B)				
Ships use VDE to send SAR capability report to MRCC				
Notes Frequency Plan A	**ship shore**	**shore ship**		**Total**
A) Reception of shorestation broadcast is competing with ship-ship comms, satellite transmissions and own ships AIS transmissions, but can be protected by slot reservations and from ships own voice comm through filtering. Repetition of broadcasts should be considered.	Good	Acceptable		Acceptable
B) Satellite broadcast should be in dedicated satellite part of downlink channel, otherwise likely to be missed due to to ship-ship (or shore-ship) transmissions, own ships AIS transmissions from preventing reception. Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions.	Good	Good		Good
Notes Frequency Plan B				
A) Reception of shorestation broadcast is competing with satellite transmissions and own ships AIS transmissions, can be protected from ships own voice comm through filtering. Repetition of broadcasts should be considered.	Good	Good		Good
B) Satellite broadcast could be affected by own ships AIS transmissions could prevent reception. Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions.	Good	Good		Good
Notes Frequency Plan C				
A) Reception of shorestation broadcast is competing with ship-ship comms, other Shore-ship transmissons and VHF voice. Repetition of broadcasts **must** be applied, and even so, reception may be totally blocked for long periods of VHF	Fair	Poor		Poor
B) Satellite reception may be affected by own ships AIS transmissions, but Repetition of the broadcast may solve this. Reception can be protected from ships own voice transmissions.	Good	Good		Good
Notes Frequency Plan D				
A) Reception of shorestation broadcast is competing with ship-ship comms, satellite transmissions and own ships AIS transmissions, but can be protected by slot reservations and from ships own voice comm through filtering. Repetition of broadcasts should be considered.	Good	Acceptable		Acceptable
B) Satellite broadcast does not have a dedicated satellite downlink channel and will be interfered with from ship-ship (or shore-ship) transmissions, own ships AIS transmissions from preventing reception. Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions. There is a potential conflict with ship to ship regional channel use.	Poor	Acceptable		Poor

Scenario 2	
Broadcast of MSI and T-&P- Notice to Mariners	
Description	
Broadcast of Maritime Safety Information (Navigational warnings, Weather warnings, ...)	
Broadcast of Temporary and preliminary Notices to Mariners	
Could also cover broadcasting 'virtual Aids to Navigation' type of information	
Priority	
Safety (or Urgency)	
Variants	
A) In coastal waters near terrestrial shore station, small data packages (<10 kb)	
B) In coastal waters near terrestrial shore station, medium data packages (10-100 kb)	
C) In remote area outside terrestrial coverage (small data packages<10kB)	
D) In remote area outside terrestrial coverage (medium data packages 10-100kB)	
Assumed solution	
VDE is used to broadcast data using S-100 data structures presentable on graphical displays	
(ASM could be used in variant A)	
Notes Frequency Plan A	**shore ship**
A) Reception of shorestation broadcast is competing with ship-ship comms, satellite transmissions and own ships AIS transmissions, may to some degree be protected by slot reservations and from ships own voice comm through filtering. Repetition of broadcasts / request for acknowledge could be considered.	Good
B) -"- May take some time - repetition of broadcasts / request for acknowledge could be considered.	Good
C) Satellite broadcast should be dedicated satellite part of downlink channel, otherwise likely to be missed due to to ship-ship (or shore-ship) transmissions, own ships AIS transmissions from preventing reception. Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions.	Good
D) Large bandwidth needed. Broadcast should be on dedicated satellite part of downlink to avoid conflict with ship-ship, due to size likely to be affected by own ships AIS transmissions - thus repetition needed, due to satellite movement may not be completed until out of sight.	Fair
Notes Frequency Plan B	
A) Reception of shorestation broadcast is competing with satellite transmissions and own ships AIS transmissions, but can be protected from ships own voice comm through filtering. Repetition of broadcasts / request for acknowledge could be considered.	Good
B) -"- May take some time - repetition of broadcasts / request for acknowledge could be considered.	Good
C) Could be missed due to own ships AIS transmissions . Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions or VDE transmissions.	Good
D) Large bandwidth needed - but available, however affected by own ships AIS transmission. Repetition/request for acknowledge should be considered	Fair
Notes Frequency Plan C	
A) Reception of shorestation broadcast is competing with ship-ship transmissions and VHF voice. Repetition of broadcasts / request for acknowledge must be considered.	Poor
B) -"- May take some time - repetition of broadcasts / request for acknowledge could be considered.	Poor
C) Could be missed due to own ships AIS transmissions . Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions or VDE transmissions.	Good
D) Large bandwidth needed - and available, however affected by own ships AIS transmissions. Repetition/request for acknowledge should be considered	Acceptable

Scenario 2	
Broadcast of MSI and T-&P- Notice to Mariners	
Description	
Broadcast of Maritime Safety Information (Navigational warnings, Weather warnings, ...)	
Broadcast of Temporary and preliminary Notices to Mariners	
Could also cover broadcasting 'virtual Aids to Navigation' type of information	
Priority	
Safety (or Urgency)	
Variants	
A) In coastal waters near terrestrial shore station, small data packages (<10 kb)	
B) In coastal waters near terrestrial shore station, medium data packages (10-100 kb)	
C) In remote area outside terrestrial coverage (small data packages<10kB)	
D) In remote area outside terrestrial coverage (medium data packages 10-100kB)	
Assumed solution	
VDE is used to broadcast data using S-100 data structures presentable on graphical displays	
(ASM could be used in variant A)	
Notes Frequency Plan A	**shore ship**
A) Reception of shorestation broadcast is competing with ship-ship comms, satellite transmissions and own ships AIS transmissions, may to some degree be protected by slot reservations and from ships own voice comm through filtering. Repetition of broadcasts / request for acknowledge could be considered.	Good
B) -"- May take some time - repetition of broadcasts / request for acknowledge could be considered.	Good
C) Satellite broadcast should be dedicated satellite part of downlink channel, otherwise likely to be missed due to to ship-ship (or shore-ship) transmissions, own ships AIS transmissions from preventing reception. Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions.	Good
D) Large bandwidth needed. Broadcast should be on dedicated satellite part of downlink to avoid conflict with ship-ship, due to size likely to be affected by own ships AIS transmissions - thus repetition needed, due to satellite movement may not be completed until out of sight.	Fair
Notes Frequency Plan B	
A) Reception of shorestation broadcast is competing with satellite transmissions and own ships AIS transmissions, but can be protected from ships own voice comm through filtering. Repetition of broadcasts / request for acknowledge could be considered.	Good
B) -"- May take some time - repetition of broadcasts / request for acknowledge could be considered.	Good
C) Could be missed due to own ships AIS transmissions . Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions or VDE transmissions.	Good
D) Large bandwidth needed - but available, however affected by own ships AIS transmission. Repetition/request for acknowledge should be considered	Fair
Notes Frequency Plan C	
A) Reception of shorestation broadcast is competing with ship-ship transmissions and VHF voice. Repetition of broadcasts / request for acknowledge must be considered.	Poor
B) -"- May take some time - repetition of broadcasts / request for acknowledge could be considered.	Poor
C) Could be missed due to own ships AIS transmissions . Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions or VDE transmissions.	Good
D) Large bandwidth needed - and available, however affected by own ships AIS transmissions. Repetition/request for acknowledge should be considered	Acceptable
Notes Frequency Plan D	
A) Reception of shorestation broadcast is competing with ship-ship comms, satellite transmissions and own ships AIS transmissions, may to some degree be protected by slot reservations and from ships own voice comm through filtering. Repetition of broadcasts / request for acknowledge could be considered.	Good
B) -"- May take some time - repetition of broadcasts / request for acknowledge could be considered.	Good
C) Satellite broadcast does not have a dedicated satellite downlink channel and will possibly be interfered with from ship-ship (or shore-ship) transmissions, own ships AIS transmissions from preventing reception. Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions. There is a potential conflict with ship to ship regional channel use.	Poor
D) Large bandwidth needed. Satellite broadcast does not have a dedicated downlink channel and will possibly be interfered with from ship-ship, due to size likely to be affected by own ships AIS transmissions - thus repetition needed, due to satellite movement may not be completed until out of sight. There is a potential conflict with ship to ship regional channel use.	Poor

Scenario 2	
Broadcast of MSI and T-&P- Notice to Mariners	
Description	
Broadcast of Maritime Safety Information (Navigational warnings, Weather warnings, ...)	
Broadcast of Temporary and preliminary Notices to Mariners	
Could also cover broadcasting 'virtual Aids to Navigation' type of information	
Priority	
Safety (or Urgency)	
Variants	
A) In coastal waters near terrestrial shore station, small data packages (<10 kb)	
B) In coastal waters near terrestrial shore station, medium data packages (10-100 kb)	
C) In remote area outside terrestrial coverage (small data packages<10kB)	
D) In remote area outside terrestrial coverage (medium data packages 10-100kB)	
Assumed solution	
VDE is used to broadcast data using S-100 data structures presentable on graphical displays	
(ASM could be used in variant A)	
Notes Frequency Plan A	**shore ship**
A) Reception of shorestation broadcast is competing with ship-ship comms, satellite transmissions and own ships AIS transmissions, may to some degree be protected by slot reservations and from ships own voice comm through filtering. Repetition of broadcasts / request for acknowledge could be considered.	Good
B) -"- May take some time - repetition of broadcasts / request for acknowledge could be considered.	Good
C) Satellite broadcast should be dedicated satellite part of downlink channel, otherwise likely to be missed due to to ship-ship (or shore-ship) transmissions, own ships AIS transmissions from preventing reception. Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions.	Good
D) Large bandwidth needed. Broadcast should be on dedicated satellite part of downlink to avoid conflict with ship-ship, due to size likely to be affected by own ships AIS transmissions - thus repetition needed, due to satellite movement may not be completed until out of sight.	Fair
Notes Frequency Plan B	
A) Reception of shorestation broadcast is competing with satellite transmissions and own ships AIS transmissions, but can be protected from ships own voice comm through filtering. Repetition of broadcasts / request for acknowledge could be considered.	Good
B) -"- May take some time - repetition of broadcasts / request for acknowledge could be considered.	Good
C) Could be missed due to own ships AIS transmissions . Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions or VDE transmissions.	Good
D) Large bandwidth needed - but available, however affected by own ships AIS transmission. Repetition/request for acknowledge should be considered	Fair
Notes Frequency Plan C	
A) Reception of shorestation broadcast is competing with ship-ship transmissions and VHF voice. Repetition of broadcasts / request for acknowledge must be considered.	Poor
B) -"- May take some time - repetition of broadcasts / request for acknowledge could be considered.	Poor
C) Could be missed due to own ships AIS transmissions . Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions or VDE transmissions.	Good
D) Large bandwidth needed - and available, however affected by own ships AIS transmissions. Repetition/request for acknowledge should be considered	Acceptable
Notes Frequency Plan D	
A) Reception of shorestation broadcast is competing with ship-ship comms, satellite transmissions and own ships AIS transmissions, may to some degree be protected by slot reservations and from ships own voice comm through filtering. Repetition of broadcasts / request for acknowledge could be considered.	Good
B) -"- May take some time - repetition of broadcasts / request for acknowledge could be considered.	Good
C) Satellite broadcast should be dedicated satellite part of downlink channel, otherwise likely to be missed due to to ship-ship (or shore-ship) transmissions, own ships AIS transmissions from preventing reception. Repetition of the broadcast should be considered. Reception can be protected from ships own voice transmissions. There is a potential conflict with ship to ship regional channel use.	Fair
D) Large bandwidth needed. Broadcast should be on dedicated satellite part of downlink to avoid conflict with ship-ship, due to size likely to be affected by own ships AIS transmissions - thus repetition needed, due to satellite movement may not be completed until out of sight. There is a potential conflict with ship to ship regional channel use.	Fair

Scenario 3	
Automated reporting (IMO FAL forms)	
Description	
Ship pushes information package to National Single Window system, port or similar	
Encryption may be applied to protect sensitive information	
May be packaged into sequence of packages requiring acknowledge or retransmission for each packet	
Not time critical - may take time.	
Priority	
Routine	
Variants	
A) In coastal waters near terrestrial shore station, medium data packages (10-100 kb)	
B) In coastal waters near terrestrial shore station, large data package (<100 kb)	
C) In remote area outside terrestrial coverage (medium data package 10-100 kB)	
D) In remote area outside terrestrial coverage (large data packages >100kB)	
Assumed solution	
VDE is used to transfer data based on IMO FAL form implemented in standard data structure	
Notes Frequency Plan A	**ship shore**
A) Extended time of VDE broadcast may affect AIS reception - limit to dutycycle must be observed	Good
B) -"- Extended time of VDE broadcast will affect AIS reception over a longer period - limit to dutycycle must be observed	Good
C) Large bandwidth available, but many ships in footprint. Extended time of VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed	Acceptable
D) Large bandwidth available, but many ships in footprint. Extended time for Large size transfers may not be compleded until satellite out of sight - but may be continued when next satellite passes, VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed.	Fair
Notes Frequency Plan B	
A) Extended time of VDE broadcast affects VHF voice reception - limit to dutycycle must be observed	Good
B) ship-ship bandwidth may be affected. Extended time of VDE broadcast will affect VHF voice reception over a longer period - limit to dutycycle must be observed	Good
C) Sharing bandwidth with ship-ship, and many ships in footprint. Extended time of VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed	Acceptable
D) Sharing bandwidth with ship-ship, and many ships in footprint. Extended time for Large size transfers may not be compleded until satellite out of sight - but may be continued when next satellite passes, VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed.	Fair
Notes Frequency Plan C	
A) Extended time of VDE broadcast affects VHF voice reception - limit to dutycycle must be observed	Good
B) ship-ship bandwidth may be affected. Extended time of VDE broadcast will affect VHF voice reception over a longer period - limit to dutycycle must be observed	Good
C) Sharing bandwidth with ship-ship, and many ships in footprint. Extended time of VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed	Acceptable
D) Sharing bandwidth with ship-ship, and many ships in footprint. Extended time for Large size transfers may not be compleded until satellite out of sight - but may be continued when next satellite passes, VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed.	Fair
Notes Frequency Plan D	
A) Extended time of VDE broadcast may affect AIS reception - limit to dutycycle must be observed	Good
B) -"- Extended time of VDE broadcast will affect AIS reception over a longer period - limit to dutycycle must be observed	Good
C) Large bandwidth available, but many ships in footprint. Extended time of VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed. There is a potential conflict with ship to ship regional channel use.	Poor
D) Large bandwidth available, but many ships in footprint. Extended time for Large size transfers may not be compleded until satellite out of sight - but may be continued when next satellite passes, VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed. There is a potential conflict with ship to ship regional channel use.	Poor

Scenario 3	
Automated reporting (IMO FAL forms)	
Description	
Ship pushes information package to National Single Window system, port or similar	
Encryption may be applied to protect sensitive information	
May be packaged into sequence of packages requiring acknowledge or retransmission for each packet	
Not time critical - may take time.	
Priority	
Routine	
Variants	
A) In coastal waters near terrestrial shore station, medium data packages (10-100 kb)	
B) In coastal waters near terrestrial shore station, large data package (<100 kb)	
C) In remote area outside terrestrial coverage (medium data package 10-100 kB)	
D) In remote area outside terrestrial coverage (large data packages >100kB)	
Assumed solution	
VDE is used to transfer data based on IMO FAL form implemented in standard data structure	
Notes Frequency Plan A	**ship shore**
A) Extended time of VDE broadcast may affect AIS reception - limit to dutycycle must be observed	Good
B) -"- Extended time of VDE broadcast will affect AIS reception over a longer period - limit to dutycycle must be observed	Good
C) Large bandwidth available, but many ships in footprint. Extended time of VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed	Acceptable
D) Large bandwidth available, but many ships in footprint. Extended time for Large size transfers may not be compleded until satellite out of sight - but may be continued when next satellite passes, VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed.	Fair
Notes Frequency Plan B	
A) Extended time of VDE broadcast affects VHF voice reception - limit to dutycycle must be observed	Good
B) ship-ship bandwidth may be affected. Extended time of VDE broadcast will affect VHF voice reception over a longer period - limit to dutycycle must be observed	Good
C) Sharing bandwidth with ship-ship, and many ships in footprint. Extended time of VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed	Acceptable
D) Sharing bandwidth with ship-ship, and many ships in footprint. Extended time for Large size transfers may not be compleded until satellite out of sight - but may be continued when next satellite passes, VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed.	Fair
Notes Frequency Plan C	
A) Extended time of VDE broadcast affects VHF voice reception - limit to dutycycle must be observed	Good
B) ship-ship bandwidth may be affected. Extended time of VDE broadcast will affect VHF voice reception over a longer period - limit to dutycycle must be observed	Good
C) Sharing bandwidth with ship-ship, and many ships in footprint. Extended time of VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed	Acceptable
D) Sharing bandwidth with ship-ship, and many ships in footprint. Extended time for Large size transfers may not be compleded until satellite out of sight - but may be continued when next satellite passes, VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed.	Fair

Scenario 3

Automated reporting (IMO FAL forms)

Description	
Ship pushes information package to National Single Window system, port or similar	
Encryption may be applied to protect sensitive information	
May be packaged into sequence of packages requiring acknowledge or retransmission for each packet	
Not time critical - may take time.	
Priority	
Routine	
Variants	
A) In coastal waters near terrestrial shore station, medium data packages (10-100 kb)	
B) In coastal waters near terrestrial shore station, large data package (<100 kb)	
C) In remote area outside terrestrial coverage (medium data package 10-100 kB)	
D) In remote area outside terrestrial coverage (large data packages >100kB)	
Assumed solution	
VDE is used to transfer data based on IMO FAL form implemented in standard data structure	
Notes Frequency Plan A	**ship shore**
A) Extended time of VDE broadcast may affect AIS reception - limit to dutycycle must be observed	Good
B) -"- Extended time of VDE broadcast will affect AIS reception over a longer period - limit to dutycycle must be observed	Good
C) Large bandwidth available, but many ships in footprint. Extended time of VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed	Acceptable
D) Large bandwidth available, but many ships in footprint. Extended time for Large size transfers may not be compleded until satellite out of sight - but may be continued when next satellite passes, VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed.	Fair
Notes Frequency Plan B	
A) Extended time of VDE broadcast affects VHF voice reception - limit to dutycycle must be observed	Good
B) ship-ship bandwidth may be affected. Extended time of VDE broadcast will affect VHF voice reception over a longer period - limit to dutycycle must be observed	Good
C) Sharing bandwidth with ship-ship, and many ships in footprint. Extended time of VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed	Acceptable
D) Sharing bandwidth with ship-ship, and many ships in footprint. Extended time for Large size transfers may not be compleded until satellite out of sight - but may be continued when next satellite passes, VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed.	Fair
Notes Frequency Plan C	
A) Extended time of VDE broadcast affects VHF voice reception - limit to dutycycle must be observed	Good
B) ship-ship bandwidth may be affected. Extended time of VDE broadcast will affect VHF voice reception over a longer period - limit to dutycycle must be observed	Good
C) Sharing bandwidth with ship-ship, and many ships in footprint. Extended time of VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed	Acceptable
D) Sharing bandwidth with ship-ship, and many ships in footprint. Extended time for Large size transfers may not be compleded until satellite out of sight - but may be continued when next satellite passes, VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed.	Fair
Notes Frequency Plan D	
A) Extended time of VDE broadcast may affect AIS reception - limit to dutycycle must be observed	Good
B) -"- Extended time of VDE broadcast will affect AIS reception over a longer period - limit to dutycycle must be observed	Good
C) Large bandwidth available, but many ships in footprint. Extended time of VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed. There is a potential conflict with ship to ship regional channel use.	Fair
D) Large bandwidth available, but many ships in footprint. Extended time for Large size transfers may not be compleded until satellite out of sight - but may be continued when next satellite passes, VDE broadcast may affect VHF voice reception - limit to dutycycle must be observed. There is a potential conflict with ship to ship regional channel use.	Fair

Scenario 4	
VTS service Portfolio	
Description	
Ship sending reporting line information to VTS	
VTS requesting ship to send reporting line information	
ship requesting VTS information service (dynamic no-go areas, information on route, METOC information, etc.) and receiving reply	
Priority	
Safety	
Variants	
A) In coastal waters near terrestrial shore station, small data packages (<10 kb)	
B) In coastal waters near terrestrial shore station, medium data packages (10-100 kb)	
C) In remote area outside terrestrial coverage, small data packages (<10 kb)	
D) In remote area outside terrestrial coverage, medium data packages (10-100 kb)	
Assumed solution	
VDE or ASM is used	
Notes Frequency Plan A	**shore ship**
A) Link likely to be busy, can be protected from VHF voice	Good
B) Link likely to be busy, can be protected from VHF voice	Good
C) Link likely to be busy, can be protected from VHF voice	Good
D) Link likely to be busy, can be protected from VHF voice	Acceptable
Notes Frequency Plan B	
A) Link likely to be busy, can be protected from VHF voice	Good
B) Link likely to be busy, can be protected from VHF voice	Good
C) Link likely to be busy, can be protected from VHF voice	Good
D) Link likely to be busy, can be protected from VHF voice	Acceptable
Notes Frequency Plan C	
A) Link likely to be busy, ships reception can NOT be protected from VHF voice	poor
B) Link likely to be busy, ships reception can NOT be protected from VHF voice	poor
C) Link likely to be busy, can be protected from VHF voice	Good
D) Link likely to be busy, can be protected from VHF voice	Good

Scenario 4	
VTS service Portfolio	
Description	
Ship sending reporting line information to VTS	
VTS requesting ship to send reporting line information	
ship requesting VTS information service (dynamic no-go areas, information on route, METOC information, etc.) and receiving reply	
Priority	
Safety	
Variants	
A) In coastal waters near terrestrial shore station, small data packages (<10 kb)	
B) In coastal waters near terrestrial shore station, medium data packages (10-100 kb)	
C) In remote area outside terrestrial coverage, small data packages (<10 kb)	
D) In remote area outside terrestrial coverage, medium data packages (10-100 kb)	
Assumed solution	
VDE or ASM is used	
Notes Frequency Plan A	**shore ship**
A) Link likely to be busy, can be protected from VHF voice	Good
B) Link likely to be busy, can be protected from VHF voice	Good
C) Link likely to be busy, can be protected from VHF voice	Good
D) Link likely to be busy, can be protected from VHF voice	Acceptable
Notes Frequency Plan B	
A) Link likely to be busy, can be protected from VHF voice	Good
B) Link likely to be busy, can be protected from VHF voice	Good
C) Link likely to be busy, can be protected from VHF voice	Good
D) Link likely to be busy, can be protected from VHF voice	Acceptable
Notes Frequency Plan C	
A) Link likely to be busy, ships reception can NOT be protected from VHF voice	poor
B) Link likely to be busy, ships reception can NOT be protected from VHF voice	poor
C) Link likely to be busy, can be protected from VHF voice	Good
D) Link likely to be busy, can be protected from VHF voice	Good
Notes Frequency Plan D	
A) Link likely to be busy, can be protected from VHF voice	Good
B) Link likely to be busy, can be protected from VHF voice	Good
C) Link likely to be busy, can be protected from VHF voice. There is a potential conflict with ship to ship regional channel use.	Fair
D) Link likely to be busy, can be protected from VHF voice. There is a potential conflict with ship to ship regional channel use.	Fair

Scenario 4	
VTS service Portfolio	
Description	
Ship sending reporting line information to VTS	
VTS requesting ship to send reporting line information	
ship requesting VTS information service (dynamic no-go areas, information on route, METOC information, etc.) and receiving reply	
Priority	
Safety	
Variants	
A) In coastal waters near terrestrial shore station, small data packages (<10 kb)	
B) In coastal waters near terrestrial shore station, medium data packages (10-100 kb)	
C) In remote area outside terrestrial coverage, small data packages (<10 kb)	
D) In remote area outside terrestrial coverage, medium data packages (10-100 kb)	
Assumed solution	
VDE or ASM is used	
Notes Frequency Plan A	**shore ship**
A) Link likely to be busy, can be protected from VHF voice	Good
B) Link likely to be busy, can be protected from VHF voice	Good
C) Link likely to be busy, can be protected from VHF voice	Good
D) Link likely to be busy, can be protected from VHF voice	Acceptable
Notes Frequency Plan B	
A) Link likely to be busy, can be protected from VHF voice	Good
B) Link likely to be busy, can be protected from VHF voice	Good
C) Link likely to be busy, can be protected from VHF voice	Good
D) Link likely to be busy, can be protected from VHF voice	Acceptable
Notes Frequency Plan C	
A) Link likely to be busy, ships reception can NOT be protected from VHF voice	poor
B) Link likely to be busy, ships reception can NOT be protected from VHF voice	poor
C) Link likely to be busy, can be protected from VHF voice	Good
D) Link likely to be busy, can be protected from VHF voice	Good
Notes Frequency Plan D	
A) Link likely to be busy, can be protected from VHF voice	Good
B) Link likely to be busy, can be protected from VHF voice	Good
C) Link likely to be busy, can be protected from VHF voice. There is a potential conflict with ship to ship regional channel use.	Poor
D) Link likely to be busy, can be protected from VHF voice. There is a potential conflict with ship to ship regional channel use.	Poor

Scenario 5	
Download of updated digital publication	
Description	
Ship requests download of an updated digital publication (large size, <100kb)	
GMDSS masterplan, the Almanac, ENC update,…	
Data is serialied into packages, and each package acknowledged or repeated	
Priority	
Safety (or Urgency)	
Variants	
A) In coastal waters near terrestrial shore station	
B) In deep sea, outside terrestrial coverage	
Assumed solution	
VDE is used to download	
Notes Frequency Plan A	**shore ship**
A) Ships reception is competing with ship-ship comms, satellite transmissions and own ships AIS transmissions, may to some degree be protected by slot reservations and from ships own voice comm through filtering.	Good
B) Ships reception competing with ship-ship and own AIS transmissions. Will be slow.	Fair
Notes Frequency Plan B	
A) Ships reception is competing with satellit transmissions, own ships AIS transmissions, may be protected from ships own voice comm through filtering.	Good
B) Ships reception competing own AIS transmissions.	Acceptable
Notes Frequency Plan C	
A) Reception of shorestation broadcast is competing with ship-ship transmissions and VHF voice.	Poor
B) Full bandwidth available only affected by own AIS transmissions, may be protected from Voice transmissions	Good

Scenario 5	
Download of updated digital publication	
Description	
Ship requests download of an updated digital publication (large size, <100kb)	
GMDSS masterplan, the Almanac, ENC update,...	
Data is serialied into packages, and each package acknowledged or repeated	
Priority	
Safety (or Urgency)	
Variants	
A) In coastal waters near terrestrial shore station	
B) In deep sea, outside terrestrial coverage	
Assumed solution	
VDE is used to download	
Notes Frequency Plan A	**shore ship**
A) Ships reception is competing with ship-ship comms, satellite transmissions and own ships AIS transmissions, may to some degree be protected by slot reservations and from ships own voice comm through filtering.	Good
B) Ships reception competing with ship-ship and own AIS transmissions. Will be slow.	Fair
Notes Frequency Plan B	
A) Ships reception is competing with satellit transmissions, own ships AIS transmissions, may be protected from ships own voice comm through filtering.	Good
B) Ships reception competing own AIS transmissions.	Acceptable
Notes Frequency Plan C	
A) Reception of shorestation broadcast is competing with ship-ship transmissions and VHF voice.	Poor
B) Full bandwidth available only affected by own AIS transmissions, may be protected from Voice transmissions	Good
Notes Frequency Plan A	
A) Ships reception is competing with ship-ship comms, satellite transmissions and own ships AIS transmissions, may to some degree be protected by slot reservations and from ships own voice comm through filtering.	Good
B) Ships reception competing with ship-ship and own AIS transmissions. Will be slow. There is a potential conflict with ship to ship regional channel use.	Fair

Scenario 5	
Download of updated digital publication	
Description	
Ship requests download of an updated digital publication (large size, <100kb)	
GMDSS masterplan, the Almanac, ENC update,…	
Data is serialied into packages, and each package acknowledged or repeated	
Priority	
Safety (or Urgency)	
Variants	
A) In coastal waters near terrestrial shore station	
B) In deep sea, outside terrestrial coverage	
Assumed solution	
VDE is used to download	
Notes Frequency Plan A	**shore ship**
A) Ships reception is competing with ship-ship comms, satellite transmissions and own ships AIS transmissions, may to some degree be protected by slot reservations and from ships own voice comm through filtering.	Good
B) Ships reception competing with ship-ship and own AIS transmissions. Will be slow.	Fair
Notes Frequency Plan B	
A) Ships reception is competing with satellit transmissions, own ships AIS transmissions, may be protected from ships own voice comm through filtering.	Good
B) Ships reception competing own AIS transmissions.	Acceptable
Notes Frequency Plan C	
A) Reception of shorestation broadcast is competing with ship-ship transmissions and VHF voice.	Poor
B) Full bandwidth available only affected by own AIS transmissions, may be protected from Voice transmissions	Good
Notes Frequency Plan D	
A) Ships reception is competing with ship-ship comms, satellite transmissions and own ships AIS transmissions, may to some degree be protected by slot reservations and from ships own voice comm through filtering.	Good
B) Ships reception competing with ship-ship and own AIS transmissions. Will be slow. There is a potential conflict with ship to ship regional channel use.	Poor

Scenario 6	
Route exchange (ship-ship)	
Description	
Ship broadcasts waypoints related to next 30 minutes of planned, active route evety 10 min, or when changed	
ships may request update of other ships route intention	
Priority	
Safety	
Variants	
A) ASM is used	
b) VDE is used	
Assumed solution	
Notes Frequency Plan A	**ship-ship**
A) affected by own ships AIS transmissions, but may be protected from ships own voice comm through filtering.	Good
B) affected by own ships AIS transmissions, but may be protected from ships own voice comm through filtering.	Good
Notes Frequency Plan B	
A) affected by own ships AIS transmissions, but may be protected from ships own voice comm through filtering.	Good
B) affected by own ships AIS transmissions, and may be blocked by ships own voice comm	Poor
Notes Frequency Plan C	
A) affected by own ships AIS transmissions, but may be protected from ships own voice comm through filtering.	Good
B) affected by own ships AIS transmissions, and may be blocked by ships own voice comm	Poor

Scenario 6	
Route exchange (ship-ship)	
Description	
Ship broadcasts waypoints related to next 30 minutes of planned, active route evety 10 min, or when changed	
ships may request update of other ships route intention	
Priority	
Safety	
Variants	
A) ASM is used	
b) VDE is used	
Assumed solution	
Notes Frequency Plan A	**ship-ship**
A) affected by own ships AIS transmissions, but may be protected from ships own voice comm through filtering.	Good
B) affected by own ships AIS transmissions, but may be protected from ships own voice comm through filtering.	Good
Notes Frequency Plan B	
A) affected by own ships AIS transmissions, but may be protected from ships own voice comm through filtering.	Good
B) affected by own ships AIS transmissions, and may be blocked by ships own voice comm	Poor
Notes Frequency Plan C	
A) affected by own ships AIS transmissions, but may be protected from ships own voice comm through filtering.	Good
B) affected by own ships AIS transmissions, and may be blocked by ships own voice comm	Poor
Notes Frequency Plan A	
A) affected by own ships AIS transmissions, but may be protected from ships own voice comm through filtering.	Good
B) affected by own ships AIS transmissions, but may be protected from ships own voice comm through filtering.	Good

Mis en forme : Normal, Centré

Annex 1

Study from China for channel plan D

1 Task goal

The goals of the task are as following:

- Compatibility analysis between VDE and ASM, between VDE and voice, and between different VDE systems.
- Calculation and simulation of needed isolation space between antennas of VDE and ASM or voice applications subject to implement of compatibility.

2 Task condition

The main condition and input parameter of the task is as following:

1) VDE channel: be consistent with Recommendation ITU-R M.1842-1 Annex 3, or Annex 4:

- The class of emission: 50K0F1DDN (Annex 3), or 100K0F1DDN (Annex 4).
- Modulation: 16×16-QAM (Annex 3), or 32×16-QAM (Annex 4).
- The carrier power: 50W(coast station transmitters), 25W (ship station transmitters).
- The adjacent channel selectivity: at least 70 dB.
- The spurious response rejection ratio: at least 70 dB.
- The radio-frequency intermodulation rejection ratio: at least 70 dB.
- The receiver sensitivity levels: better than -103 dBm for shore stations, and better than -98 dBm for ship stations.
- The power of any conducted spurious emissions at the antenna terminals is not to exceed 2.0 nW.

2) ASM channel: be consistent with Recommendation ITU-R M.1842-1 Annex 1:

- The class of emission: 16K0F1DDN.
- Modulation: π/4 DQPSK, orπ/8 D8-PSK.
- The carrier power: 50W(coast station transmitters), 25W (ship station transmitters).
- The adjacent channel selectivity: at least 70 dB.
- The spurious response rejection ratio: at least 70 dB.
- The radio-frequency intermodulation rejection ratio: at least 70 dB.
- The receiver sensitivity levels: better than -107dBm.
- The power of any conducted spurious emissions at the antenna terminals is not to exceed 2.0 nW.

3) Voice channel: be consistent with Recommendation ITU-R M.489-2:

- The class of emission: F3E/G3E, with 16 kHz of necessary bandwidth.

- Modulation: phase modulation (frequency modulation with a pre-emphasis characteristic of 6 dB/octave).
- The carrier power: 50W (coast station transmitters), 25W (ship station transmitters).
- The adjacent channel selectivity: at least 70 dB.
- The spurious response rejection ratio: at least 70 dB.
- The radio-frequency intermodulation rejection ratio: at least 65 dB.
- The power of any conducted spurious emission at the antenna terminals is not to exceed 2.0 nW.

4) Antenna used by the coastal station:

- Type: 4-loop array.
- Frequency bands: 134 MHz~173 MHz.
- Bandwidth: 8 MHz.
- Length: 6.7 meters.
- Gain: omnidirectional 9 dBi.
- Standing wave ratio: <=1.5.
- Type of polarization: vertical.

5) Whip antenna used by the ship station:

- Length: 1.2 meter.
- Gain: omnidirectional 3 dBi.
- Standing-wave ratio (SWR): <= 1.5.

3 Theoretical analysis

Inter-symbol interference (ISI) is the key factor which brings bit error in digital communication system. It is needed to design the spectrum mask to implement proper adjacent channel rejection ratio value by eliminating ISI. The characteristics of digital communication are related to some key parameters:

- R_b (bit/s or bps): bit transmitting rate in a certain channel.
- R_B (baud): symbol transmitting rate in M-ary system, or the transmitting number of symbol per second.
- T (s): the symbol transmitting period, $T=\frac{1}{R_B}$

If every symbol of information source is equiprobably independent, the relationship of R_b and R_B would be:

$$R_b = R_B \log_2 M$$

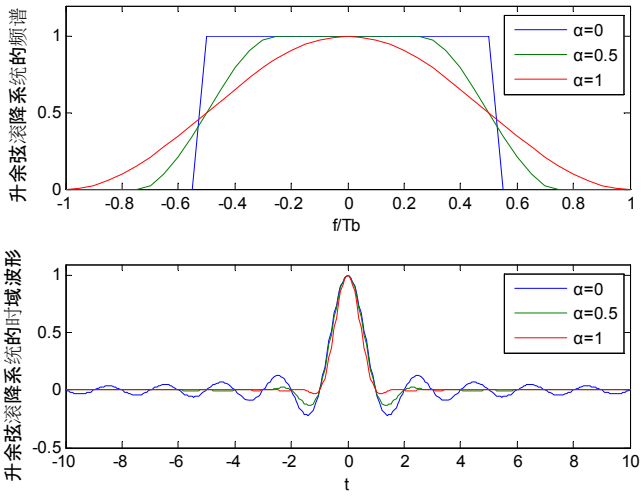
When multi sub-carrier transmission is adopted, the frequency band of a single sub-carrier would be B/N, in which B is the whole band of the channel, and N is the number of sub-carriers. When the whole bit transmitting rate is R_b kbps, the bit rate of a single sub-carrier would be R_b/N.

The inverse Fourier transform of a square root raised-cosine spectrum is defined as following:

$$P_r(f)=\begin{cases} T_b & 0 \le |f| < (1-\alpha)B_N \\ T_b\left\{1-\sin\left[\dfrac{\pi(|f|-B_N)}{2\alpha B_N}\right]\right\} & (1-\alpha)B_N \le |f| < (1+\alpha)B_N \\ 0 & |f| \ge (1+\alpha)B_N \end{cases}$$

Where α is the roll-off factor, which determines the width of the transmission band at a given symbol rate. The frequency and time domain characteristics of α is typically shown as in Figure 1.

FIGURE 1



Subject to no ISI, there would be a relationship expressed as following:

$$B=(1+\alpha)R_B,$$

in which B is the system required frequency band B.

4 Simulation result

4.1 Spectrum characteristics of single sub-carrier of VHF data exchange

The spectrum characteristics of a single sub-carrier of VHF data exchange in different configurations of data transmitting rates and filter performance are respectively shown in Figure 2, Figure 3 and Figure 4. The filter order is set to 100, which is comparatively the optimistic practical value.

FIGURE 2

[title]

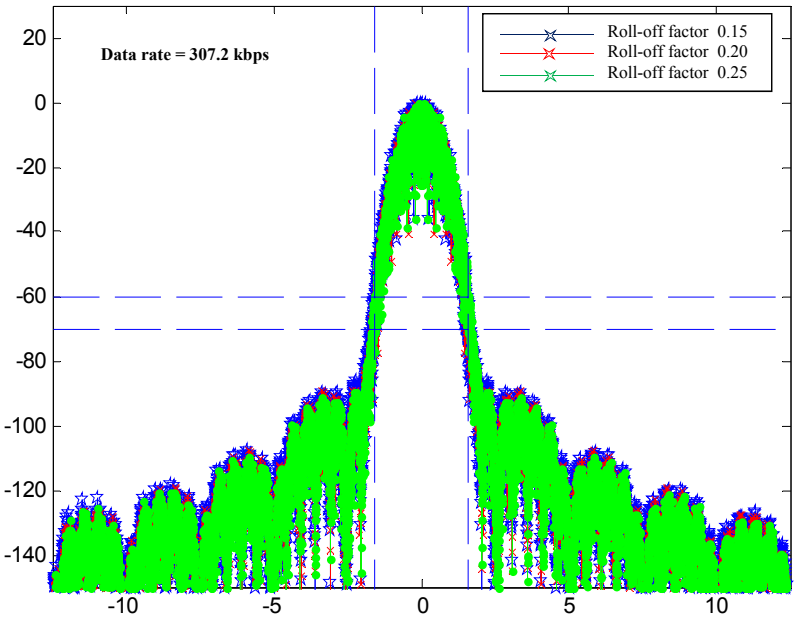


FIGURE 3

[title]

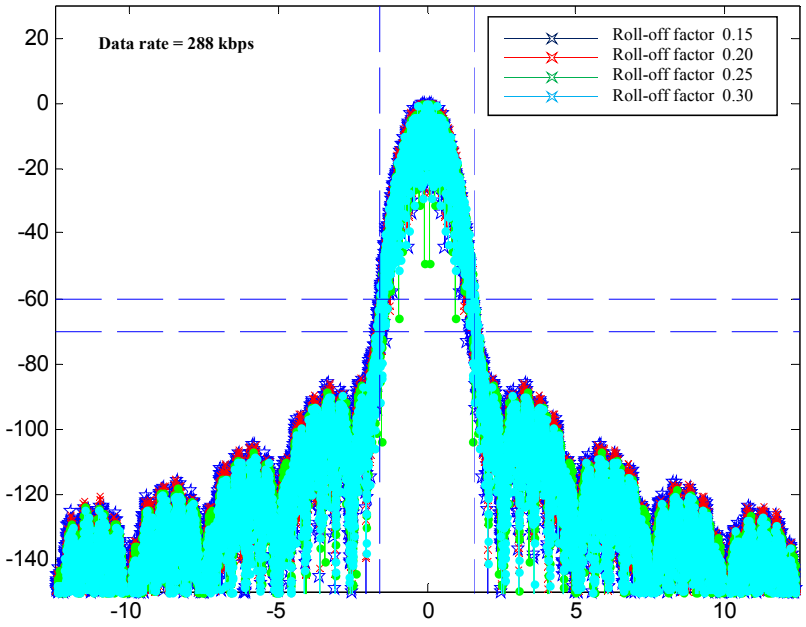
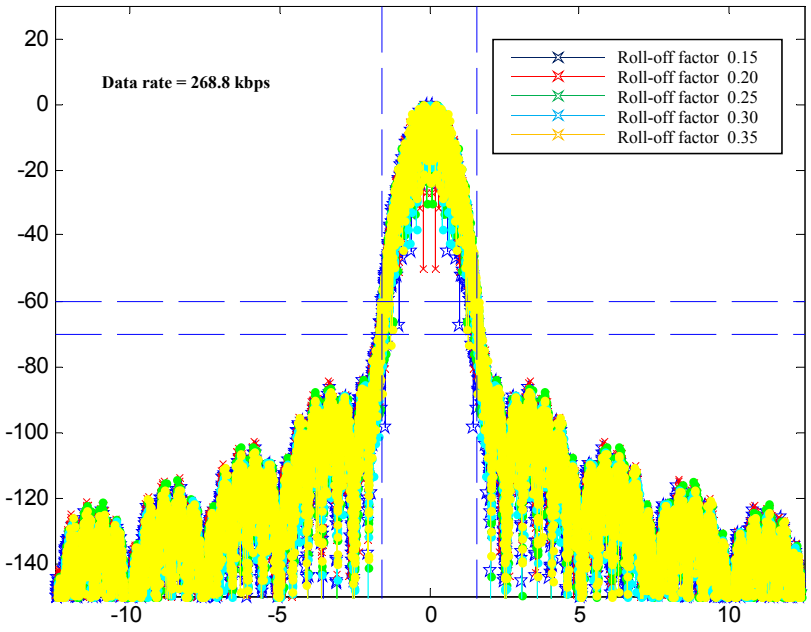


FIGURE 4

[title]



4.2 Spectrum characteristics of VHF data exchange adjacent to voice channel

Figure 5, Figure 6 and Figure 7 show the spectrum characteristics of VHF Data Exchange adjacent to voice channel respectively with data rate of 307.2 kbps, 288 kbps and 268.8 kbps. The filter order is set to 100, and the roll-off factor equals to 0.20, which is comparatively the optimistic practical value.

4.3 Spectrum characteristics of VHF data exchange adjacent to application specific message channel

Figure 8, Figure 9 and Figure 10 show the spectrum characteristics of a VHF data exchange channel adjacent to the ASM channel respectively, with data rates of 307.2 kbps, 288 kbps and 268.8 kbps. The filter order is set to 100, and the roll-off factor equals 0.20, which is comparatively the optimistic practical value.

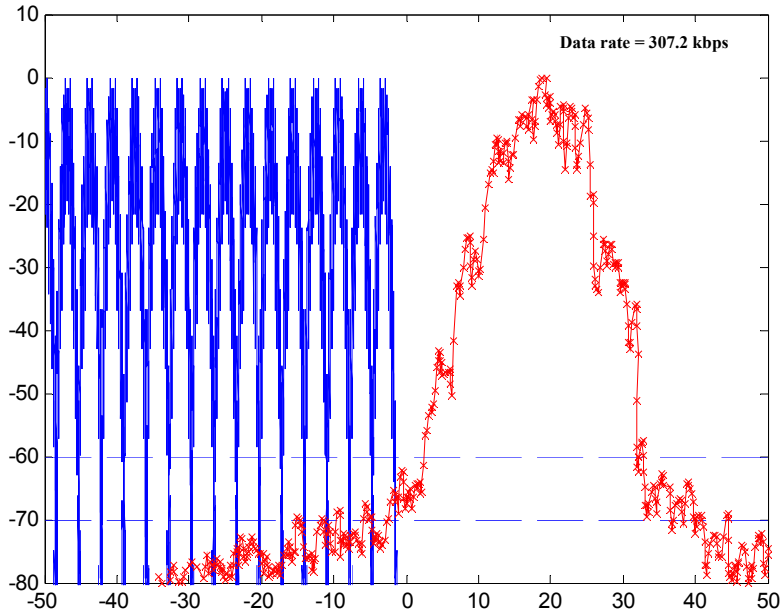


FIGURE 5

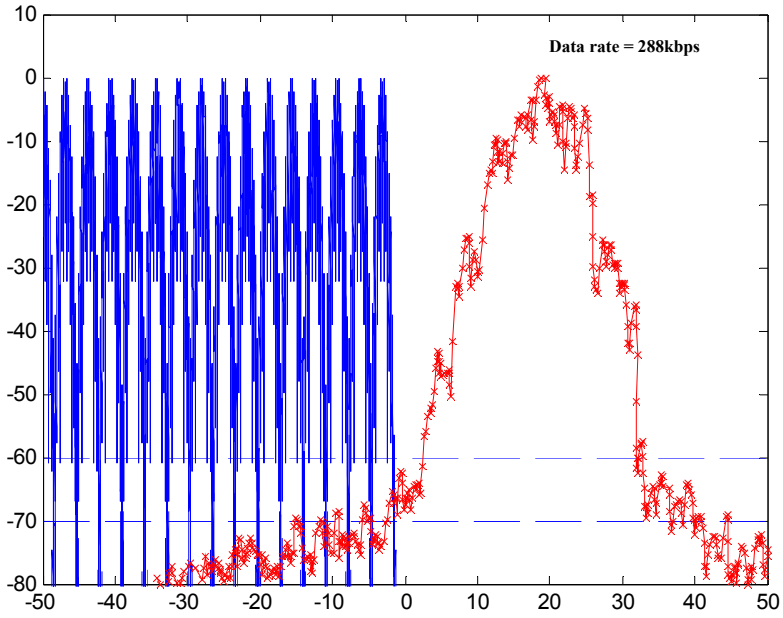


FIGURE 6

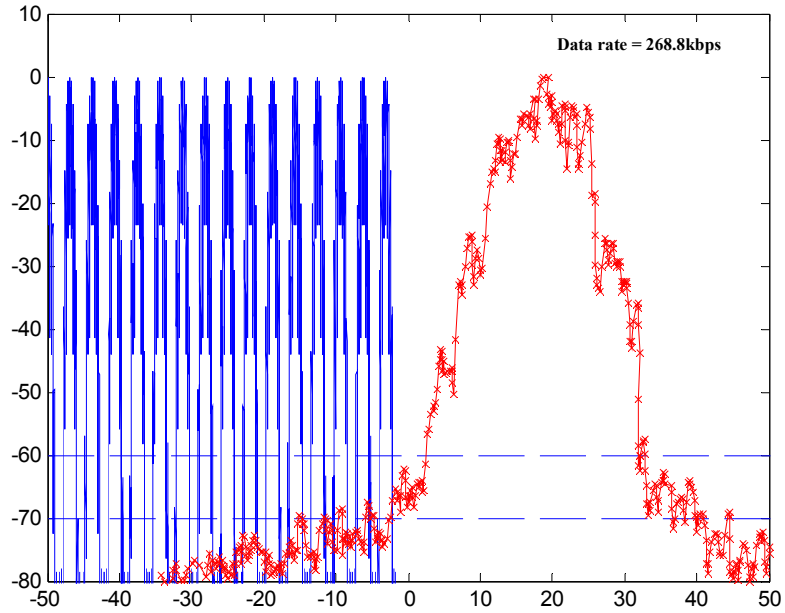


FIGURE 7

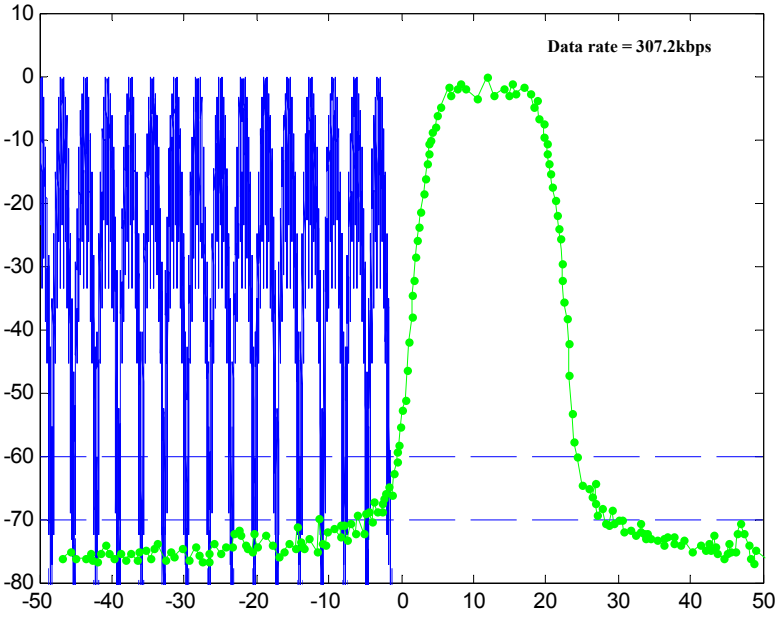


FIGURE 8

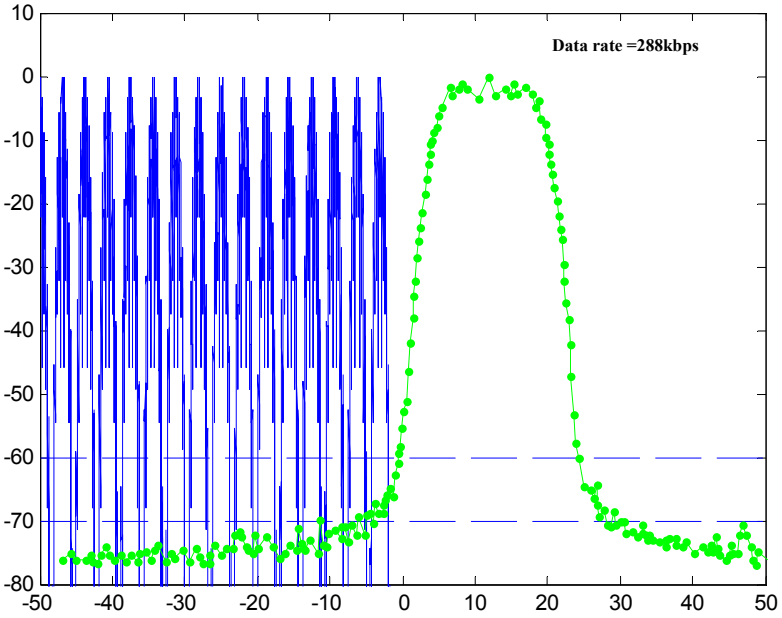


FIGURE 9

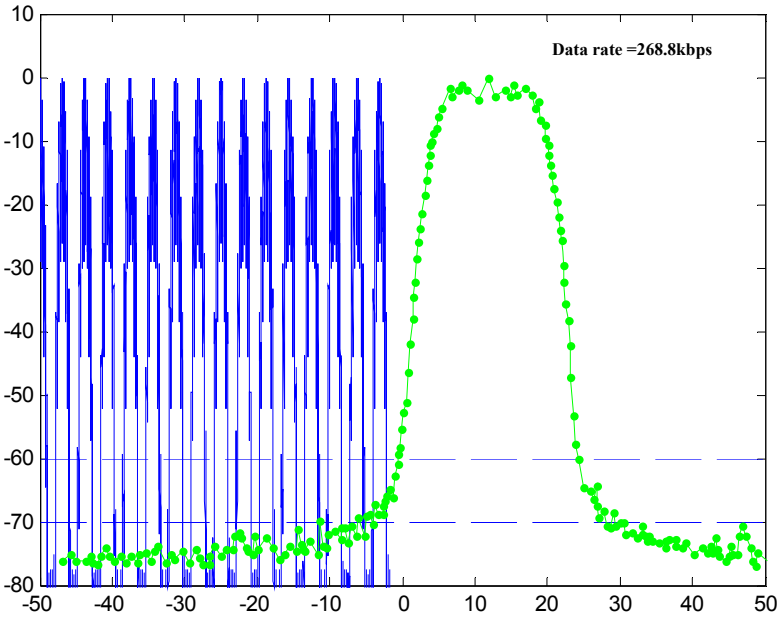


FIGURE 10

[Chairman's note: for consistency could the figure references and an added title be placed above the figure or previous figures have the reference moved below the figure]

4.4 Frequency requirements for VHF data exchange system in different conditions

Table 1 gives some channel parameters and filter performance requirements in different conditions of data transmitting rate and adjacent channel rejection.

TABLE 1

Data rate in the channel/kbps	Data rate of a single sub-carrier/kbps	Symbol rate/Baud	Roll-off factor	Band subject to no ISI	Adjacent channel rejection/dB	Filter shape factor
307.2	9.6	2.4	0.25	3.00	70.00	1.00
				3.00	65.00	1.00
				3.00	60.00	1.00
			0.20	2.88	70.00	1.05
				2.88	65.00	1.05
				2.88	60.00	1.05
			0.15	2.76	70.00	1.07
				2.76	65.00	1.08
				2.76	60.00	1.08
			0.12	2.69	70.00	1.09
				2.69	65.00	1.10
				2.69	60.00	1.10
288.00	9.00	2.25	0.35	3.04	70.00	1.04
				3.04	65.00	1.04
				3.04	60.00	1.04
			0.30	2.93	70.00	1.06
				2.93	65.00	1.06
				2.93	60.00	1.06
			0.20	2.70	70.00	1.09
				2.70	65.00	1.09
				2.70	60.00	1.09
			0.15	2.59	70.00	1.12
				2.59	65.00	1.13
				2.59	60.00	1.13
			0.12	2.52	70.00	1.15
				2.52	65.00	1.15
				2.52	60.00	1.15
268.80	8.40	2.10	0.45	3.05	70.00	1.00
				3.05	65.00	1.00
				3.05	60.00	1.00
			0.40	2.94	70.00	1.00
				2.94	65.00	1.00
				2.94	60.00	1.00

Data rate in the channel/kbps	Data rate of a single sub-carrier/kbps	Symbol rate/Baud	Roll-off factor	Band subject to no ISI	Adjacent channel rejection/dB	Filter shape factor
			0.35	2.84	70.00	1.06
				2.84	65.00	1.06
				2.84	60.00	1.06
			0.30	2.73	70.00	1.08
				2.73	65.00	1.08
				2.73	60.00	1.09
			0.25	2.63	70.00	1.11
				2.63	65.00	1.11
				2.63	60.00	1.12
			0.20	2.52	70.00	1.15
				2.52	65.00	1.15
				2.52	60.00	1.15
			0.15	2.42	70.00	1.19
				2.42	65.00	1.19
				2.42	60.00	1.20
			0.12	2.35	70.00	1.21
				2.35	65.00	1.22
				2.35	60.00	1.23

5 Conclusion

The real world sounding campaign (see Annex 28 of Document 5B/636) and the above analysis could bring the following conclusions:

1) CH25, CH26, CH85 and CH86 of RR Appendix **18** are suitable for a maritime VHF data exchange system. The compatibility between the lower leg of these four channels being used for ship-shore transmission and CH1027 being used for simplex voice, and the upper leg of the four channels being used for shore-ship and ship-ship transmitting and CH2027 being used for ASM could be achieved.

2) The data rate of 307.2kbps using 100kHz frequency bands with16-QAM modulation will hardly be achieved subject to adjacent channel power ratio being at least 70dB, for the reason of practical manufacturing art. Two options are proposed with the reasonable conditions of practical manufacture:

- To reduce the practical system data rate to 268.8kbps (see Figure 2 of Recommendation ITU-R M.1842-1 Annex 1). This means the efficiency of the channel usage has to be lost to ensure the high quality of spectrum, and consequent high quality of data transmitting and receiving. This is crucial to a safety and security-related system.
- To reduce the requirement for the adjacent channel power ratio down to 65dB or 60 dB (see Table 6.14 in provision 6.4.9.2.1 of ETSI 300 392-2 V3.4.1). This option costs the quality of data transmission and reception to ensure the ideal system data rate, and obviously stronger coding and error correction are needed. This might be proper for applications for commercial purposes.

3) Further studies and tests are needed for the physical systems and prototypes in the real world.

6 Antenna spacing

The antenna isolation I_{Req} (dB) could be calculated with the formula:

$$I_{Req} = 137 + 10\lg P_t + S - I_n$$

P_t: transmitting power (W);

S: receiver sensitivity level (dBμV);or$S = P_{min}$(dB) + 113;

I_n: receiver interference rejection index (dB).According to the standard of China, I_n should be more than 100dB.

The vertical isolation I_{AV} (dB) of two VHF antennas could be calculated with the formula:

$$I_{AV} = 39.557\lg H + 22.263$$

H: vertical distance from the top of the lower antenna to the bottom of the upper antenna (m).

The horizontal isolation I_{AH} (dB) of two VHF antennas could be calculated with the formula:

$$I_{AH} = 20\lg d + 12.956$$

d: horizontal distance between two VHF antennas (m).

The following conditions should be implemented for ensuring the isolation of VHF antennas:

$$I_{AV} \geq I_{Req}$$

$$I_{AH} \geq I_{Req}$$

The model and gain simulating scheme of an omnidirectional antenna for a coastal station is shown as Figure 11 and Figure 12.

Figure 13 and Figure 14 give the horizontal gain scheme and the vertical gain scheme respectively.

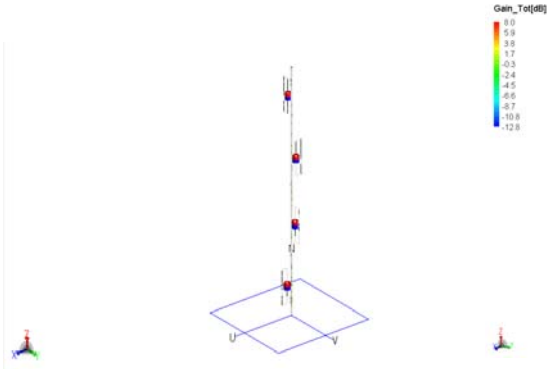


FIGURE 11

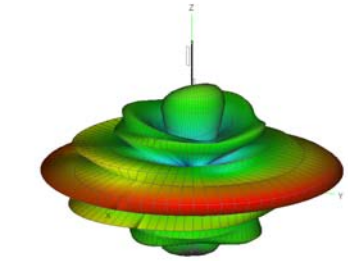


FIGURE 12

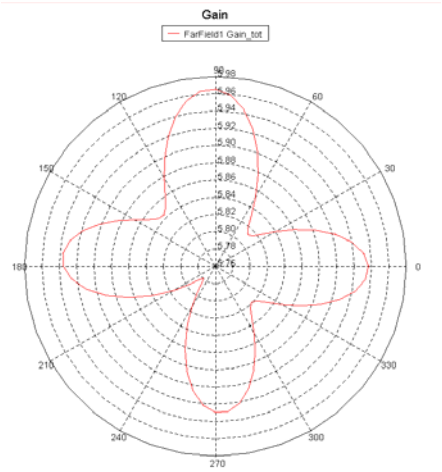


FIGURE 13

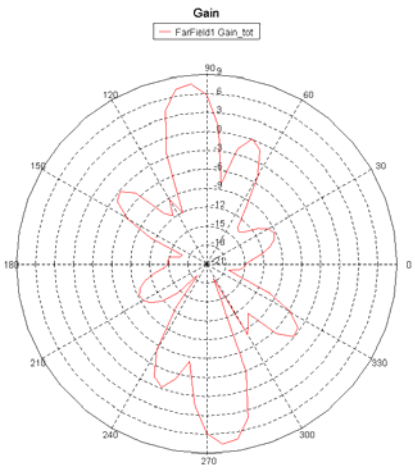


FIGURE 14

Table 2 gives the antenna isolation space for VHF applications.

TABLE 2

Radiant power (W)	Receiving sensitivity (dBm)	Interference rejection index(dB)	Isolation (dB)	Horizontal space (m)	Vertical space (m)
25	-98	100	51	79.18	5.30
	-107	100	42	28.09	3.14
50	-103	100	49	62.97	4.72
	-107	100	45	39.73	3.74

ANNEX 2

Study from Canada for Channel Plan A, B and C

Study from Canada