Input paper: [[1]](#footnote-1) DTEC2-5.2.2.9

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

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X DTEC **□** VTS **□** Information

Agenda item [[2]](#footnote-2) n.n

Technical Domain / Task Number 2 …………………………………

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Implementing digital voice in marine VHF bands

# Introduction

IALA, CEPT, IMO and ITU are considering the introduction of narrow band (6.25 kHz) channelisation to support digital voice in the marine VHF band, principally to alleviate the current over-crowding issues posed by both the increase in marine radio traffic generally and the reduction in available RF spectrum for voice communication following the introduction of AIS, ASM and VDE data transmissions. The principal advantage of the digital voice system is that it allows up to 4 digital voice channels to be available in the same spectrum as one current analogue voice channel. ITU-R M.1084-4 suggests the basis of a suitable channel plan and numbering scheme but rolling this out over the RF spectrum allocated to marine VHF communications across the world whilst still keeping essential emergency and safety services available is a complicated task, especially in a market where equipment may only get replaced or updated after 10 years or more in service.

There are both technical, operational and logistical challenges to be considered, from the performance of cost-effective (affordable) radio equipment as well as how best to integrate it with the existing systems. The marine market is significantly more complex due to its world-wide nature, the requirement to maintain safety critical services at all times, the number of units involved (both commercial and leisure markets probably amount to over 10 million units) and the low cost of the current analogue solutions (in comparison to other digital technologies such as cell phones, TETRA and DMR radios, for instance).

# Possible scenarios:

In order of increasing complexity, the possible scenarios considered[[3]](#footnote-3) here are:

* Interleave channels
* Re-farm a specific block
* Re-farm the entire marine VHF band except for the GMDSS
* Re-farm the entire marine VHF band including the GMDSS

In the first three cases, it is assumed that new VHF radio equipment will be capable of “dual” mode operation – ie, it will operate in either analogue mode or digital mode as instructed by the user based on the channel selected. The channel numbering scheme (based on ITU-R M.1084) determines if the channel is digital or analogue and would be published in the same way that the current analogue-only channel allocations are promulgated to current users.

In the final case, an all-digital solution would be feasible, but only after the whole network has migrated to digital and would then provide scope for savings in equipment design and cost. However, given the longevity of existing equipment and the massive task to migrate the entire world to solely digital operation, this would only be likely to become possible in decades to come.

For the sake of this document, the term GMDSS refers to those channels reserved in the Radio Regulations for safety services as described in ITU-R M.2231:

* Channel 0006
* Channel 0016 distress and calling
* Channel 0013
* Channel 0015
* Channel 0017
* Channel 0070 DSC signalling
* Channel 0075
* Channel 0076

The AIS, ASM and VDES channels are already allocated for data services and so cannot be allocated for digital voice.

## Inter-leaving channels:

ITU-R M.1084 shows a possible “inter-leaved” channel plan where the new digital channels sit in between the existing analogue channels. In this case, it is assumed that the digital modes could operate in tandem with the existing analogue and be used as and when needed or appropriate. Technical constraints on the design of radio equipment make this scenario very difficult to achieve without compromising the performance of one or both systems, especially if the transmitters are expected to be close or co-located. With suitable physical separation between transmitters, (probably around a mile or so – this needs to be confirmed by trials) there may still be situations where this is feasible, but it would not be a universal solution.

Effect on GMDSS: none.

## Re-farm a specific block:

In a similar manner that ITU/IMO have allocated blocks of RF spectrum for data use, it could make a channel block available for digital voice. In the first instance digital voice would have to share the spectrum with any incumbent analogue services, but over time as the digital service become more widely used, they could be elevated to primary usage, and ultimately sole usage. To be most efficient, the block should be a continuous multiple of 25 kHz, as the current ITU-R M.1084 numbering scheme allows for a small guard band at the edge of each channel block, so a single 25 kHz analogue channel would only support 3 digital channels, whereas two contiguous 25 kHz channels would provide 7 digitals channels and four contiguous analogue 25 kHz channels would yield 15 digital channels (note: this is a consequence of the numbering scheme adopted by ITU-R M.1084 which allows for interleaved channels. If inter-leaving is not required, there is no technical reason why a direct 4 digital to 1 analogue channel transition cannot be supported).

One variation on this option would be to concentrate on moving port operations and VTS services onto digital first, as many of the stations using these channels tend to remain “local” to the area and so can be more easily monitored and controlled by the local administration. This would then leave the analogue channels for stations that operate internationally, even those that do not have digital capability.

Effect on GMDSS: none.

## Re-farm the entire marine VHF band except for the GMDSS

This is continuation from the earlier scenario, as more and more stations become equipped with digital-compatible equipment, then it may become feasible to extend the specific digital voice blocks to cover more of the spectrum and reduce the analogue allocation to solely those channels used for safety critical operations. This may be difficult to achieve in some geographic areas due to the re-allocation of parts of the marine VHF band to support other services or private operators.

Effect on GMDSS: none

## Re-farm the entire marine VHF band including the GMDSS

This is a continuation from the earlier scenario but would now include digitising the operation of the GMDSS services. The two schemes would need to operate in tandem during the switch-over period which could cause some confusion, so would need to be carefully managed. DSC operation could remain unchanged during the switch-over, but a digital equivalent message would be transmitted following the DSC signalling. The digital voice protocol scheme outlined by ETSI TGMARINE in TR xxx 1084 has sufficient scope and expandability to replicate all the existing DSC signalling modes. For distress calls made on Channel 16, it would be technically feasible for the radio to record the initial distress call (made either on analogue or digital) and then repeat it automatically in the other mode, either on the same channel or an alternative one. However this would take up precious time which may not be available. At the present time, this is not seen as a viable option.

Effect on GMDSS: significant

# Notes:

The digital voice service outlined in ETSI TR 102 728 can be expanded beyond the current DSC functionality to include trunking operations in areas that could benefit from it (principally port and shore areas) or other features that could be useful.

# Practical implementation possibilities:

Looking at the radio channels currently in use in the Scheldt area, as shown below in a slide provided by Jeffrey Van Gils, the radio spectrum is already heavily used, and as the land mass is essentially flat, channel re-use in the area is virtually impossible as all transmitters are within, or very close to, the Line-of-sight propagation area of each other. The table shown does not include channels used within the area for local / port operations.

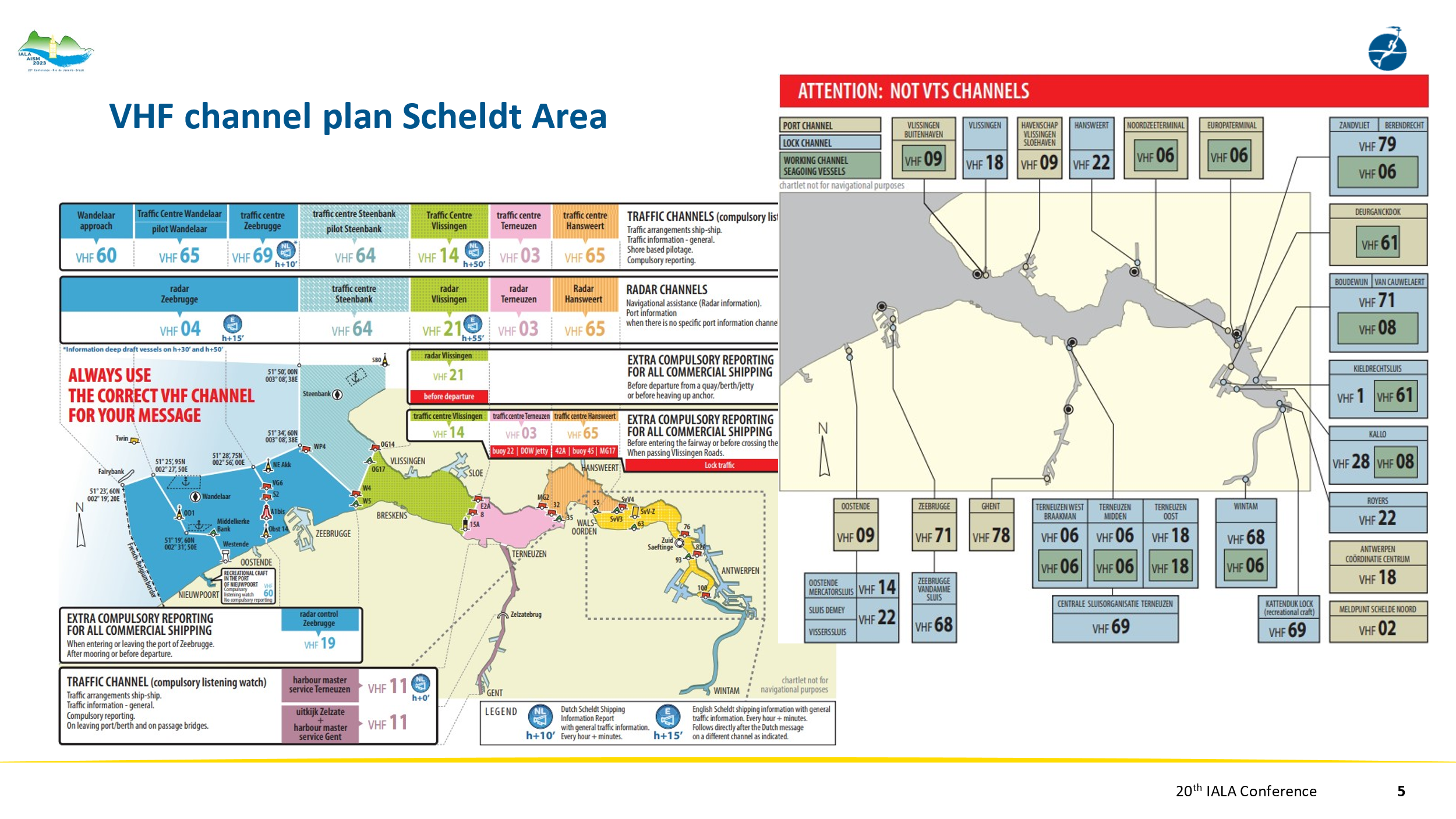


Figure 1 Scheldt area transmitters and channels

The locations of the Transmitter sites for the Port of Rotterdam are shown below. As can be seen, they all have overlapping coverage areas (data provided by Martijn Ebben). The width of the picture is approximately 40 km. The Port of Rotterdam also uses a number of additional channels for port and lock operations.

A close-up of a map

Description automatically generated

Figure 2 Rotterdam area transmitters

The diagram below shows the channel utilization graphically:



Figure 3 Channel usage

Key:

Green: reserved for GMDSS

Red: Used in Scheldt area

Brown: Used in PoR

Orange: Reserved for VDES / ASM

Note that it is still important to have enough inter-ship channels available for use in addition to these specified for port operations.

Implementing the Interleaved scenario for digital voice would be feasible on some transmitters where the interleaved channel is NOT co-located with either of the adjacent analogue voice channels. Where transmitter locations are located at least a kilometre away from each other, this should provide sufficient isolation for both analogue and digital channels to operate without interfering with each other. However, the location of ships within the area also needs to be considered, as coverage areas overlap, although a ship may wish to communicate with one VTS station, its signal could also be heard as an interfering signal at another. This may extend the effective separation to 10 or more kilometres. This should be verified by field trials before committing to this mode as local conditions (antenna height and orientation, buildings and structures causing reflections or dead spots etc) can always play a significant role.

To implement the selective re-farming scenario, it is preferable to find at least two adjacent analogue channels as candidates. As can be seen from the Figure 3 Channel usage, these are not easy to find, however the lower legs of channels 27 and 87 (1027 and 1087) could be candidates for general usage as they are unlikely to have been re-used following the allocation of their associate upper legs to ASM1 and AIS1. This would provide 7 digital voice channels[[4]](#footnote-4) in place of 2 analogue channels.

It is unfortunate that channel 1028 has already been allocated for use at one of the major locks in the area, otherwise a 100 kHz (15 channel) block could have been assigned to digital voice (1027, 1097, 1028 and 1029), however this possibility could still be available in other areas.

Channels 82, 23 and 83 could also be candidates, either as duplex channels, in which case this would yield 14 digital channels, or in simplex mode would yield 28 digital channels.

1. Input document number, to be assigned by the Committee Secretary [↑](#footnote-ref-1)
2. Leave open if uncertain [↑](#footnote-ref-2)
3. There are likely to be other scenarios depending on the circumstances of any given radio system. [↑](#footnote-ref-3)
4. Using the channelisation scheme from ITU-R.1084 results in an offset of 3.125 kHz from the channel edge. Though this does reduce the number of channels available from 8 to 7, it maintains backwards compatibility with existing channel numbering schemes, allows the use of interleaved channels and provides additional protection to the adjacent 25 kHz channels. [↑](#footnote-ref-4)