

## Annex 4

### Technical characteristics of VDES-satellite downlink in the maritime mobile band

#### 1. Introduction

This Annex describes the characteristics of the satellite downlink of the VHF Data Exchange System (VDES) according to the identified requirements.

In particular, VDE Satellite Downlink is assumed to support the following services:

- Downlink multicast multi-packet data transfer;
- Shore originated unicast multi-packet data transfer via satellite.

In this Annex, Low Earth Orbit (LEO) satellites with 600 km altitude are considered to present typical examples of VDE Satellite Downlink solutions. It should be noted that other orbital selections are also possible according to the overall system design consideration.

#### 2. OSI Layers

This Annex describes the four lower layers of the OSI model; the physical, the link, the network and the transport layers as shown in Figure 1.

Application layer
Presentation layer
Session layer
Transport layer
Network layer
Link layer
Physical layer

**Figure 1. Seven layer OSI model**

#### 2.1 Responsibilities of the OSI layers for preparing VDE data for transmission

##### 2.1.1 Transport layer

This layer ensures reliable transmission of the data segments between a ship and a satellite, including segmentation, acknowledgement and multiplexing.

### 2.1.2 Network layer

This layer is responsible for the management of priority assignments of messages, distribution of transmission packets between channels, and data link congestion resolution.

### 2.1.3 Link layer

This layer ensures reliable transmission of data frames between a satellite and a ship.

The link layer is divided into three sub-layers with the following tasks:

#### 2.1.3.1 Link management entity

Assemble unique word, format header, pilot tones, subframe headers and VDES message bits into packets.

#### 2.1.3.2 Data link services

Applies bit stuffing (if required), calculates and adds CRC check sum and completes the subframe/packet.

#### 2.1.3.3 Media Access Control

Provides methods for granting data transfer access. Both random access and assigned access are used.

### 2.1.4 Physical layer

This layer provides transmission and reception of raw bit streams over a physical medium including signal modulation, filtering/shaping upon transmission, and amplification, filtering, time and frequency synchronization, demodulation, and decoding upon reception.

## 3. Physical layer

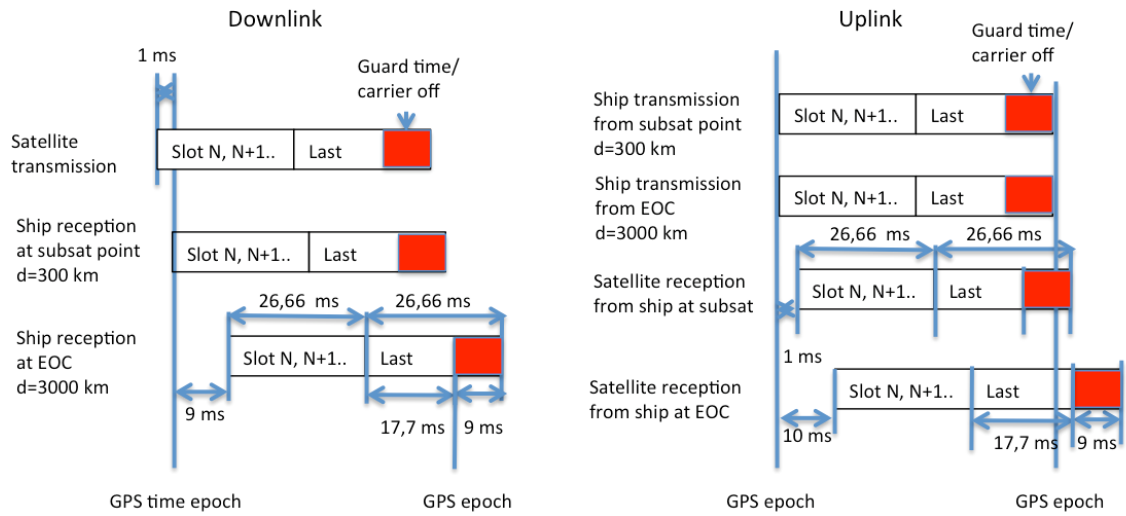
### 3.1 Range (minimum and maximum)

The orbit height determines the satellite range variations. For example, for a 600 km LEO the maximum range is 2830 km. For timing purposes a maximum range of 3000 km will be used.

The minimum range is equal to the orbit height. For a LEO satellite at 300 km altitude the minimum range will be 300 km. This value is used to determine the minimum propagation delay time.

Considering these exemplary values for the minimum and maximum ranges, the path delay will vary from 10 ms to 1 ms, a variation of 9 ms as shown in Figure 2.

In addition to the relative delays between signal receptions at a vessel from different satellites, there could be absolute delay due to other sources. The satellite service provider should pre-compensate for absolute delay.



**Figure 2. Downlink and uplink slot timing for 600 km LEO**

### 3.2 Carrier Frequency error

The frequency error is the sum of the satellite transmission frequency error and Doppler and the frequency uncertainty at the receiver. The transmit frequency error at the satellite shall be less than 1 ppm TBC, i.e. +/- 160 Hz.

A small LEO satellite will move at a speed of about 8 km/s and this will cause a maximum Doppler of +/- 4 kHz at VHF.

### 3.3 Downlink example link budget

The link  $C/N_0$  is determined by the satellite EIRP, path losses, propagation losses, receiver sensitivity/figure of merit and local interference levels.

#### 3.3.1 Satellite downlink EIRP

The EIRP can be derived from Power and Flux spectral Density (PFD) mask given in Table 1.

**Table 1**

**Proposed power spectral and flux density (PFD) mask**

$\theta^\circ = \text{earth} - \text{satellite elevation angle}$

$$PFD(\theta^\circ)_{(dBW/(m^2 \cdot 4 \text{ kHz}))} = \begin{cases} -149 + 0.16 * \theta^\circ & 0^\circ \leq \theta < 45^\circ; \\ -142 + 0.53 * (\theta^\circ - 45^\circ) & 45^\circ \leq \theta < 60^\circ; \\ -134 + 0.1 * (\theta^\circ - 60^\circ) & 60^\circ \leq \theta \leq 90^\circ. \end{cases}$$

Table 2 shows the theoretical maximum satellite EIRP as a function of elevation angles for this mask.

**Table 2. Satellite maximum EIRP vs. elevation angle.**

Elevation angle $\theta$	Powerflux density on ground	Satellite range	Maximum downlink satellite EIRP
(degrees)	(dBW/m <sup>2</sup> /4 kHz)	(km)	(dBW in 25 kHz)
0	-149,0	2831	-1,0
10	-147,4	1932	-2,7
20	-145,8	1392	-4,0
30	-144,2	1075	-4,6
40	-142,6	882	-4,7
50	-139,4	761	-2,8
60	-134,0	683	1,6
70	-133,0	635	2,0
80	-132,0	608	2,6
90	-131,0	600	3,5

### 3.3.2 Example satellite EIRP vs. elevation

Most of the satellite coverage area and visibility time will be at low elevation angles, and high elevation angle coverage may be sacrificed without significant system capacity loss.

The example link budget is optimised for 0 degrees ship elevation angle using a three element Yagi antenna at the satellite pointed at the horizon is given in Table 3.

Assuming a peak antenna gain of 8 dBi, a transmit RF power of -12,4 dBW in 25 kHz will ensure compliance with the PFD limit. Example satellite EIRP vs. ship elevation is shown in Table 3.

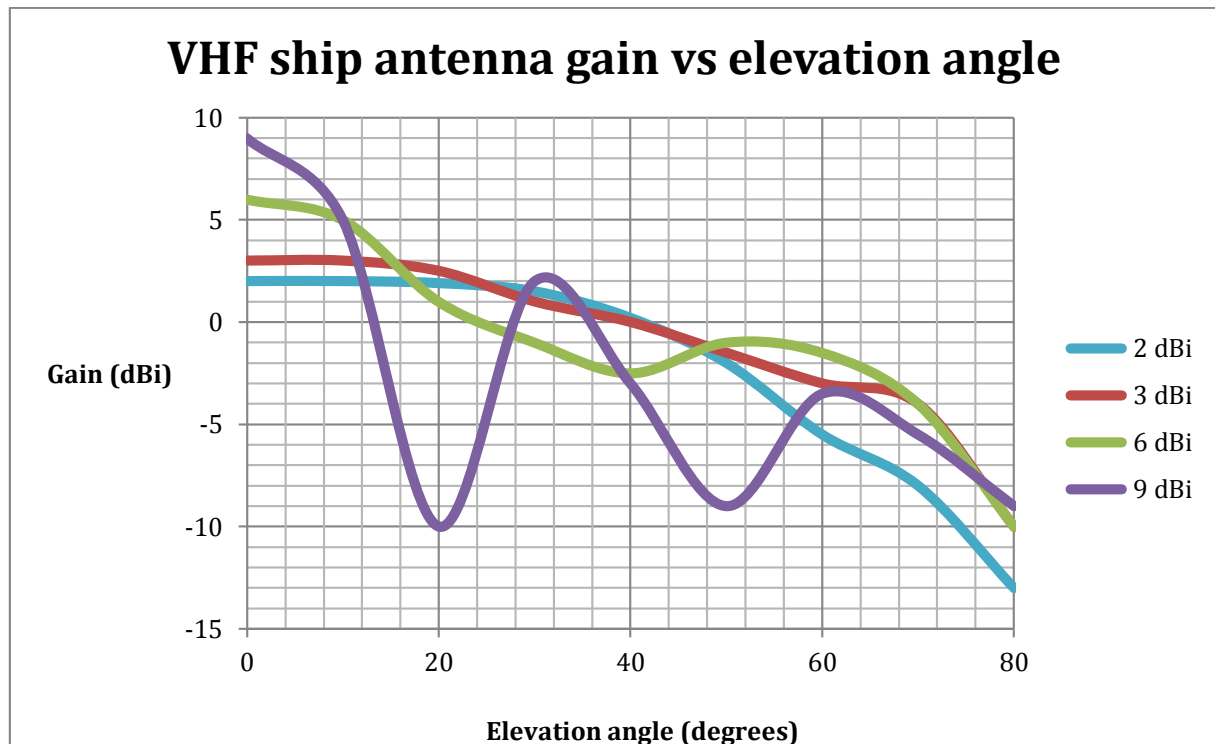
**Table 3. Example satellite EIRP vs. elevation using a Yagi antenna**

Ship elevation angle	Yagi antenna			Satellite EIRP in circular polarization	Satellite range	PFD	Table 1 PFD limit	PFD margin
	Nadir offset angle	Boresight offset	Satellite antenna gain					
degrees	degrees	degrees	dBi	dBW	km	dBW/m <sup>2</sup> /4 kHz	dBW/m <sup>2</sup> /4 kHz	dB
0	66,1	0	8	-4,4	2830	-152,4	-149,0	3,4
10	64,2	1,9	8	-4,4	1932	-149,1	-147,4	1,7
20	59,2	6,9	8	-4,4	1392	-146,2	-145,8	0,4
30	52,3	13,8	7,8	-4,6	1075	-144,2	-144,2	0,0
40	44,4	21,7	6,9	-5,5	882	-143,4	-142,6	0,8
50	36	30,1	5,5	-6,9	761	-143,5	-139,4	4,1
60	27,2	38,9	3,6	-8,8	683	-144,5	-134,0	10,5
70	18,2	47,9	0,7	-11,7	635	-146,7	-133,0	13,7
80	9,1	57	-2,2	-14,6	608	-149,2	-132,0	17,2
90	0	66,1	-5,5	-17,9	600	-152,4	-131,0	21,4

### 3.3.3 Receive antenna gain

Existing ship antennas shall be used for VDES. The maximum antenna gain for these range from 2 to 10 dBi with respect to a vertically polarized reference antenna. Representative antenna patterns are shown in Figure 3.

A ship antenna with a minimum gain at 0 degrees elevation of 3 dBi at the receiver input is required. The antenna gain and noise level can be traded as long as the sum of the two exceeds -113 dBm.



**Figure 3. Ship antenna gain vs. elevation angle.**

### 3.3.4 Received signal to noise plus interference level

The noise floor is a function of many sources such as vessel electronics, other radio equipment, power supplies, etc., and sensitivity is also reduced by RF cabling losses, LNA noise figure. The downlink assumes an expected equivalent noise and interference level that is less than - 116 dBm/25 kHz at the receiver input.

### 3.3.5 Link $C/(N_0+I_0)$

The nominal signal level and  $C/(N_0+I_0)$  vs. elevation for a 25 kHz channel is given in Table 4. The signal level and  $C/(N_0+I_0)$  increase 3 dB for 50 kHz channels and 6 dB for 100 kHz wide channels respectively.

High elevation coverage applies to few satellite passes, and only for a short period, and system operator may select the operational elevation range.

The nominal downlink  $C/(N_0+I_0)$  is 41 to 47 dBHz for ship elevation angles between 0 and 65 degrees in a 25 kHz channel.

The maximum PFD from the satellite transmissions in 4 KHz bandwidth is the same as calculated above and in Table 3, however the increased channel and modulated signal bandwidth increase the maximum transmitted total RF power by the increased bandwidth ratio, i.e. 3 and 6 dB for the 50 and 100 kHz channels over than of a single 25 kHz channel.

It should also be noted that the analyses based on single satellite visibility.

**Table 4. Nominal link budget vs. ship elevation for a 25 kHz channel.**

Ship elevation angle	Satellite EIRP in circular polarization	Satellite range	Pathloss	Polarization loss	Ship antenna gain	Antenna signal level	Noise level in 25 kHz BW	C/(N <sub>0</sub> +I <sub>0</sub> )
degrees	dBW	km	dB	dB	dBi	dBm	dBm	dBHz
0	-4,4	2830	144,6	3	3	-119,0	-116	41,0
10	-4,4	1932	141,2	3	3	-115,7	-116	44,3
20	-4,4	1392	138,4	3	2,5	-113,3	-116	46,7
30	-4,6	1075	136,2	3	1	-112,8	-116	47,2
40	-5,5	882	134,4	3	0	-113,0	-116	47,0
50	-6,9	761	133,2	3	-1,5	-114,6	-116	45,4
60	-8,8	683	132,2	3	-3	-117,0	-116	42,9
70	-11,7	635	131,6	3	-4	-120,3	-116	39,7
80	-14,6	608	131,2	3	-10	-128,8	-116	31,2
90	-17,9	600	131,1	3	-20	-142,0	-116	18,0

### 3.4 Propagation effects

The received signal level on-board a ship will vary due to a number of causes. A Rice distribution with a Carrier to Multipath (C/M) ratio of 10 dB and fading bandwidth of 3 Hz is assumed, however the system shall be adaptable to handle significantly worse and better propagation conditions.

**Table 5. Ionospheric effects for elevation angles of about 30° one-way traversal**  
(derived from Recommendation ITU-R P.531)

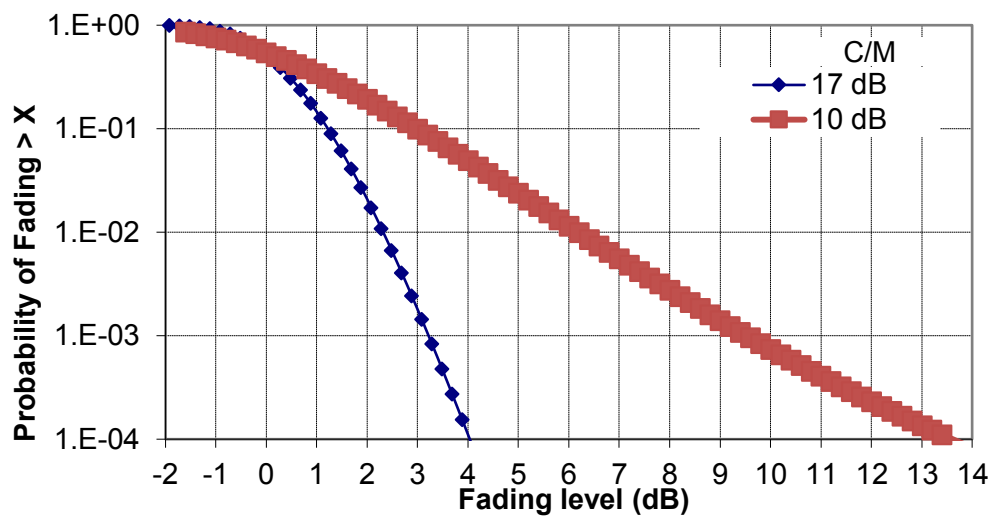
Effect	Frequency dependence	0.1 GHz	0.25 GHz	1 GHz
Faraday rotation	$1/f^2$	30 rotations	4.8 rotations	108°
Propagation delay	$1/f^2$	25 μs	4 μs	0.25 μs
Refraction	$1/f^2$	< 1°	< 0.16°	< 0.6'
Variation in the direction of arrival (r.m.s.)	$1/f^2$	20'	3.2'	12"
Absorption (auroral and/or polar cap)	$\approx 1/f^2$	5 dB	0.8 dB	0.05 dB
Absorption (mid-latitude)	$1/f^2$	< 1 dB	< 0.16 dB	< 0.01 dB
Dispersion	$1/f^3$	0.4 ps/Hz	0.026 ps/Hz	0.0004 ps/Hz
Scintillation <sup>(1)</sup>	See Rec. ITU-R.P.531	See Rec. ITU-R P.531	See Rec. ITU-R P.531	>20 dB peak-to-peak

\* This estimate is based on a TEC of 1018 electrons/m<sup>2</sup>, which is a high value of TEC encountered at low latitudes in day-time with high solar activity.

<sup>(1)</sup> Values observed near the geomagnetic equator during the early night-time hours (local time) at equinox under conditions of high sunspot number.

**Table 6. Mid-latitude fade depths due to ionospheric scintillation (dB)**

Percentage of time (%)	Frequency (GHz)			
	0.1	0.2	0.5	1
1.0	5.9	1.5	0.2	0.1
0.5	9.3	2.3	0.4	0.1
0.2	16.6	4.2	0.7	0.2
0.1	25.0	6.2	1.0	0.3

**Figure 4. Ricean fade depth probability**

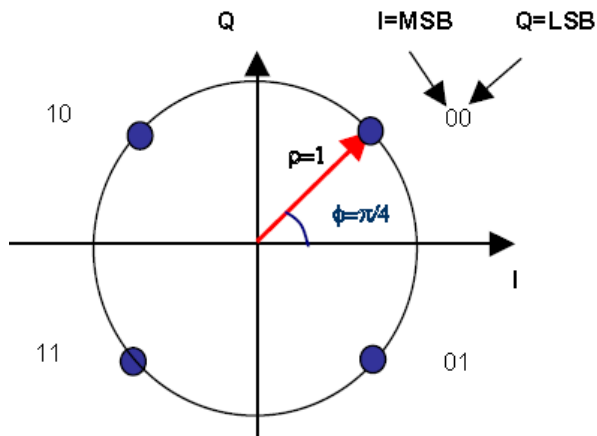
### 3.5 Modulation

VDES uses adaptive modulation and coding to maximise spectral efficiency and throughput. The supported modulation methods are given in Table 7.

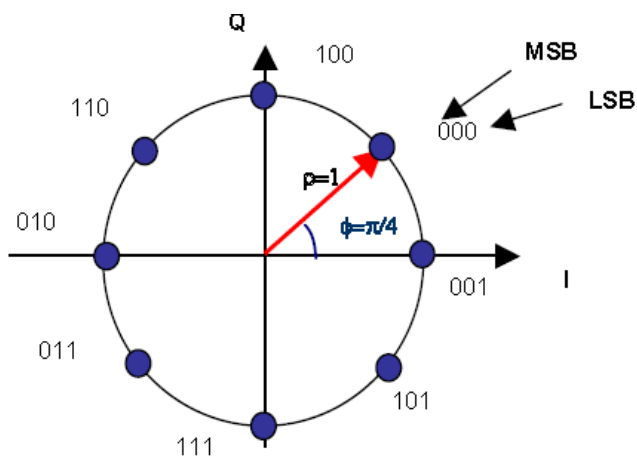
**Table 7. Downlink modulation methods**

Index	Bits/symbol	Modulation type	Bit mapping	Maximum Adjacent Channel Interference level with worst case Doppler
1	2	Grey encoded QPSK	Fig. 5	- 18 dBc
2	3	Grey encoded 8PSK	Fig. 6	- 18 dBc
3	4	16APSK	Fig. 7	- 18 dBc

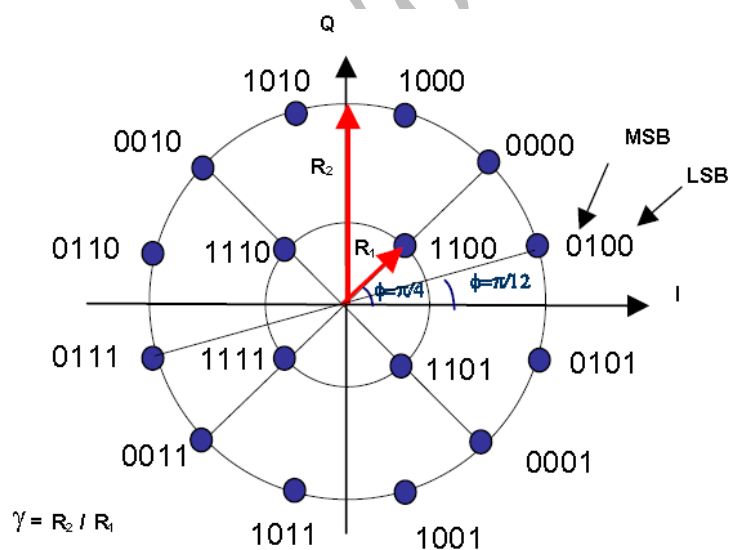




**Figure 5. QPSK symbol to bit mapping**



**Figure 6. 8PSK symbol to bit mapping**



**Figure 7. 16APSK bit to symbol mapping**

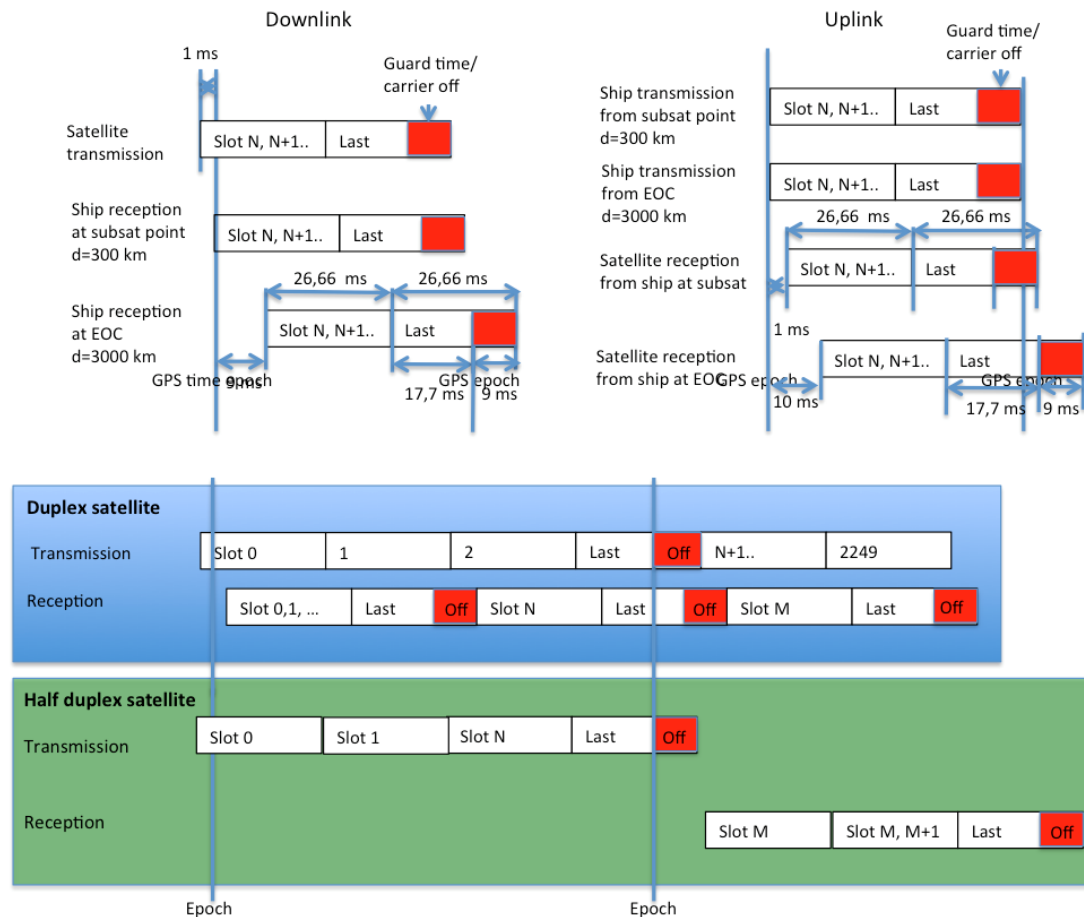
The 16APSK modulation constellation shall be composed of two concentric rings of uniformly spaced 4 and 12 PSK points, respectively in the inner ring of radius  $R_1$  and outer ring of radius  $R_2$ .

The ratio of the outer circle radius to the inner circle radius ( $\gamma = R_2/R_1$ ) shall be equal to 3.  $R_1$  shall be set to  $1/\sqrt{7}$ ,  $R_2$  shall be set to  $3/\sqrt{7}$  in order to have the average signal energy equal to 1.

Similar to AIS, when data is output on the VHF data link it should be grouped in bytes of 8 bits from top to bottom of the table associated with each message in accordance with ISO/IEC 13239:2002. Each byte should be output with least significant bit first.

- 3.6 Symbol timing accuracy (at the output of satellite)  
Less than 5 ppm
- 3.7 Transmitter Timing Jitter  
Less than 5% symbol interval (peak)
- 3.8 Slot Transmission Accuracy at the satellite output  
Less than 50 micro sec (peak) relative for example to GNSS reference timing.
- 3.9 Half duplex and full duplex satellites

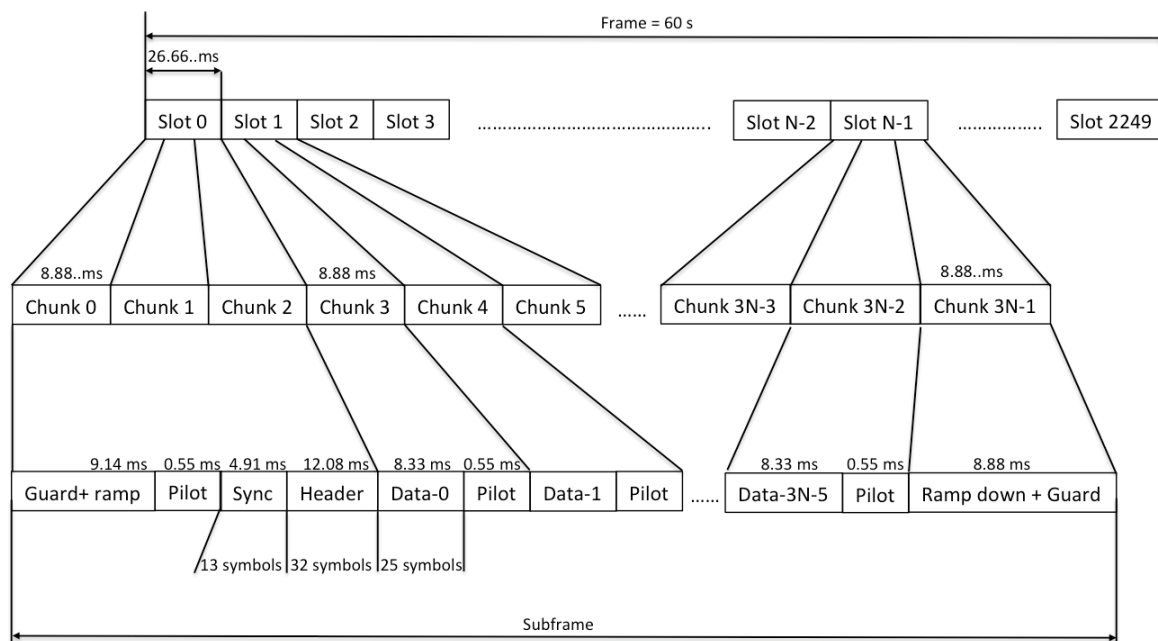
The system can be configured for both half and full duplex satellites as shown in Figure 8.



**Figure 8. Half and full duplex satellite operation**

### 3.10 Frame hierarchy

The VDES frame structure is identical and synchronized in time on the earth's surface to UTC (as in AIS) and the frame hierarchy for a subframe of N slots is shown in Figure 9. Each element is described in the subsequent sections. Frame 0 starts at 00:00:00 UTC, and there are 1440 frames in a day. The impact of leap second should be accounted for to avoid any propagation of error.



**Figure 9. VDES frame hierarchy**

### 3.10.1 Guard time and ramp up

The ramp up time from -30 dBc to -1.5 dBc of the power shall occur in less than or equal to 300 usec ..for 50 kHz channel occupancy. This is a means to maintain compliancy with the adjacent channel interference requirements.

The guard time at the beginning of a subframe may not be required, but has been provided to allow for future expansion of the pilot, synchronisation word and the subframe format header.

### 3.10.2 Synchronisation pilot

This CW signal before the synchronisation word and after every data chunk has a fixed duration of 0,55 ms.

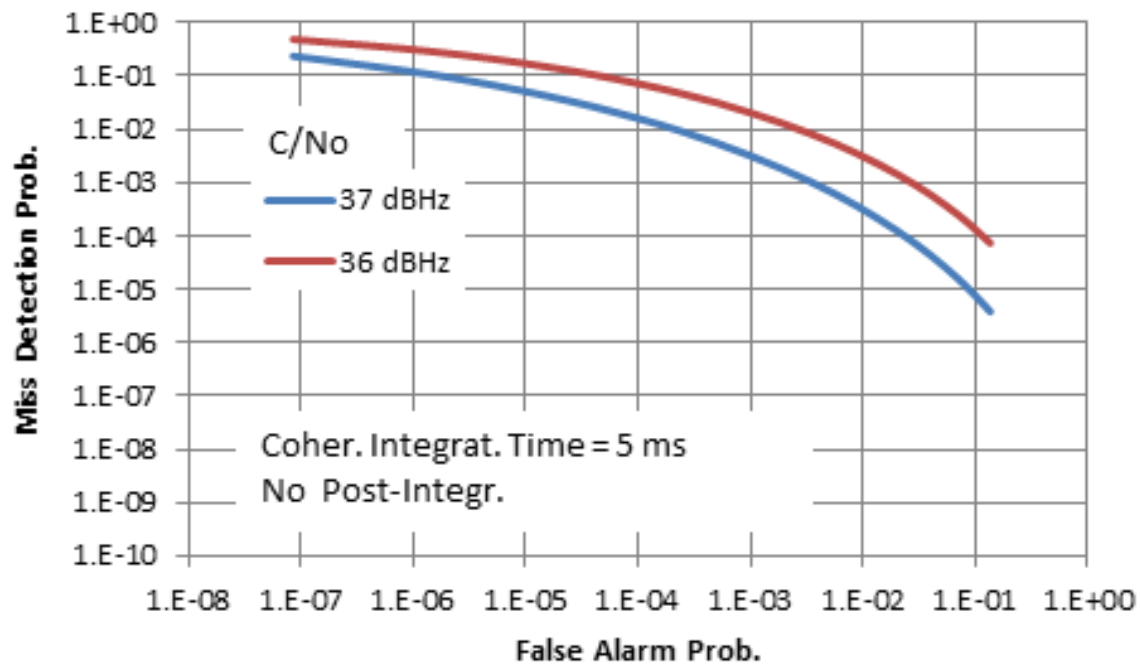
### 3.10.3 Synchronization word

The subframe synchronisation word and header format is fixed for all transmissions. The 13 bit Barker code unique word is defined in Table 8. It is modulated with BPSK at a symbol rate of 2.65 kbps (TBC) . Bit 0 is transmitted first. The duration is 4,91 ms.

**Table 8. Barker sequence unique word**

Bit number												
0	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	1	-1	-1	1	1	-1	1	-1	1

The missed detection and false detection probabilities are shown in Figure 10 for a  $C/(N_0+I_0)$  of 37 dBHz. For a 50 kHz channel, this corresponds to a fade depth of 7 dB, which occurs less than 1% of the time for the Ricean channel ( $C/M=10$  dB). During these short periods a constant false alarm rate threshold set to  $1E-4$  will result in 2% of subframes not detected during the fade.



**Figure 10. Synch loss and false detection probabilities**

#### 3.10.4 Direct Sequence Spreading

The first pilot and BPSK symbols are spread using a 8 bit sequence to a chiprate of 21 kcps to fit in a 50 kHz channel. Spreading sequence SS0 from Table 9 is used.

**Table 9. Spreading sequences TBC**

Sequence name	Chip number							
	0	1	2	3	4	5	6	7
SS0	-1	-1	-1	1	1	-1	1	1
SS1	-1	-1	1	-1	1	1	1	-1
SS2	-1	1	-1	1	1	1	-1	-1
SS3	-1	1	-1	-1	-1	-1	1	-1

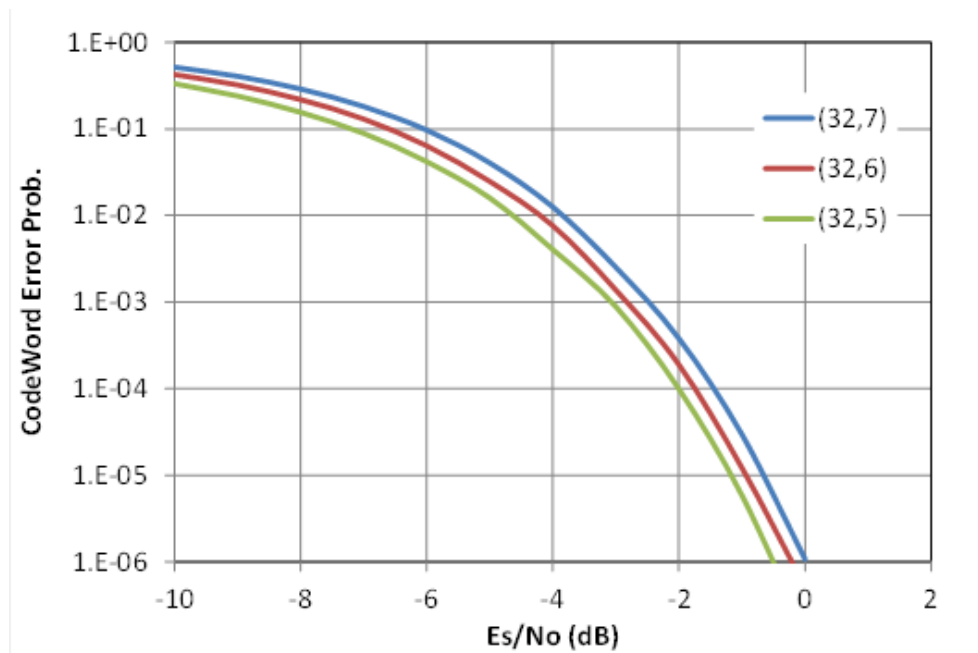
#### 3.10.5 Subframe header

The header is BPSK modulated and spread the same way as the synchronisation word described above. This header defines the following characteristics for the remainder of the subframe:

- Subframe duration
- Number of data chunks
- Symbol rate
- Modulation type
- FEC type
- FEC rate
- Interleaver type

- Scrambler type (to be added at symbol)
- Spreading code length (if used)
- Spreading codes (if used)

The header provides 7 bits to define up 128 subframe formats and uses (32,7) quad orthogonal forward error correction coding. The performance of this FEC is shown in Figure 11. During a 7 dB fade the  $E_s/N_0$  dips to 2,8 dB, resulting in a header loss of less than  $1E-6$ , which is insignificant.



**Figure 11. Header error probability**

#### 3.10.6 Data-N

Segment N of interleaved data. (see sub-frame format for interleaver definition).

#### 3.10.7 Ramp down

The ramp down time from 90% to 10% of the power shall occur in less than 100  $\mu$ s.

#### 3.10.8 Guard time

No transmissions shall occur during the guardtime to avoid partly overlap with terrestrial AIS/VDES slots. The guard time is 8.9 ms.

#### 3.10.9 Downlink subframe formats

The startpilot, sync word and the header are fixed for all subframe formats. It is envisaged that several format will be used based on type of information carried, interference and throughput/latency optimisation.

Currently two subframe formats have been defined, the first intended for multiple access and one way reliable transmission and is defined in Table 10.1. The second in Table 10.2 is intended for high throughput where lost subframes are recovered using retransmissions.

**Table 10.1 Subframe format SF0**

Parameter	Value	Unit
Function	Multiple access reliable one way transmission	
Usage	Bulletin Board	
Header value	0x1	Hex
Channel bandwidth	50	kHz
Single satellite nominal $C/N_0$	44	dBHz
Interfering satellite $I_0/N_0$ (equal rx level)	-3,0	dB
$C/(N_0+I_0)$ with two overlapping satellites	42,2	dBHz
Symbol rate	2,625	kbaud
Modulation	QPSK	
Channel bits/symbol	2	
FEC type	3GPP2	
FEC rate	0,5	
Information rate	2,625	kbps
Nominal $E_b/(N_0+I_0)$	8,0	dB
Required subframe error rate	0,1	%
Required $E_b/(N_0+I_0)$ for Rice $C/M=10$ dB	4,5	dB
Margin	3,5	dB
Subframe size	100	slots
Frame duration	2,67	s
Frame duration in chunks	300	
Chunk duration	8,89	ms
Pilot duration	0,55	ms
Data duration/chunk	8,34	ms
Information bits in a chunk	22	bits
Numer of data chuncks	96	chunks
Number of data bits in subframe	2 101	bits
Number of bytes in subframe	263	bytes
Spreading factor	8	chips
I/Q channel chip rate	21	kchip/s
I spreading code	SS0	Table 9
Q spreading code	SS1	Table 9
Block interleaver height	40	bits
Block interleaver width	53	bits

**Table 10.2 Subframe format SF1**

Parameter	Value	Unit
Function	Dedicated high throughput channel	
Usage	Announcements, messages	
Header value	0x2	Hex
Channel bandwidth	50	kHz
Nominal C/N <sub>0</sub>	44	dBHz
Symbol rate	21	kbaud
Modulation	QPSK	
Channel bits/symbol	2	
FEC type	3GPP2	
FEC rate	0,25	
Information rate	10,5	kbps
Nominal E <sub>b</sub> /N <sub>0</sub>	3,8	dB
Required subframe error rate	1,0	%
Required E <sub>b</sub> /N <sub>0</sub> for Rice C/M=10 dB	0,5	dB
Margin	3,3	dB
Subframe size	100	slots
Frame duration	2,67	s
Frame duration in chunks	300	
Chunk duration	8,89	ms
Pilot duration	0,55	ms
Data duration/chunk	8,34	ms
Information bits in a chunk	88	bits
Numer of data chunks	96	chunks
Number of data bits in subframe	8 406	bits
Number of bytes in subframe	1 051	bytes
Spreading factor	1	chips
I/Q channel chip rate	NA	
I spreading code	NA	
Q spreading code	NA	
Block interleaver height	88	bits
Block interleaver width	96	bits



## 4. Link layer

### 4.1 Data encapsulation

A subframe consist of multiple variable length datagrams and these are encapsulated.

Each datagram contain the following encapsulation fields:

- Datagram type (1 byte)
- Datagram size (3 bytes)
- Destination (4 bytes, optional)
- Transaction ID (4 bytes, optional)
- Datagram sequence number (2 bytes, for multisegment datagrams)
- Source ID (8 bytes, optional)
- Datagram payload (variable)
- Data padding (variable, less than 8 bits)
- CRC (4 bytes)

### 4.2 Cyclic Redundancy Check

The 32 bit ITU polynomial 0x04C11DB7 CRC is appended to the last segment of the datagram. The CRC is calculated over all fragments of the datagram.

$$F(x) = x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x + 1$$

Initial state: 0xFFFF

### 4.3 Automatic repeat request (ARQ)

Datagrams may or may not use ARQ, this is defined for each datagram type. An ARQ will request selective retransmission of a specific lost datagram segment.

### 4.4. Acknowledgement (ACK)

All datagrams without CRC errors are acknowledged over the satellite link.

### 4.5 End delivery notification (EDN)

All datagrams successfully delivered to the destination will be notified to the source.

### 4.5 End delivery failure (EDF)

All datagrams not successfully delivered within the timeout or retry limit will be notified to the source.

### 4.6 Physical and Logical channels

VDES uses several channels to carry data. These channels are separated into Physical and Logical channels. Every satellite transmits a Bulletin Board that defines the configuration of these channels.

### 4.7 Physical Channels

The Physical Channels (PC) are determined by the center frequency, subframe format and start timeslot.

### 4.8 Logical Channels (LC)

The logical channels are divided into signalling and data channels. These are described below.

#### 4.9 Signaling Logical Channels

The following downlink signalling channels are used:

- Bulletin Board
- Datagram announcements
- Media Access Control (MAC)
- Uplink and downlink resource allocation
- Repeat requests/Acknowledgements/End delivery notifications

##### 4.9.1 Bulletin Board Signalling Channel (BBSC)

The Bulletin Board defines the network configuration parameters such as signalling channels (control channels) and data channel(s), protocol versions and future network configuration.

A logical channel is defined by function, index, center frequency, subframe format and startslot. The logical channels are normally repeated every frame, unless a network configuration change has taken place to optimise capacity.

Satellite parameters and network ID are also provided. Information about other satellites and networks may be provided. The Bulletin Board information does not change often, and for a small LEO satellite it is sufficient that the Bulletin Board is received once per pass, a repeat rate of once per minute is sufficient for most passes.

The BBSC uses subframe format SFF0 defined in Table 10.1 and shall be transmitted once every minute, starting at slot 0, the duration is 2.67 s. CDMA is used to allow multiple satellites with overlapping coverage to transmit the Bulletin Board at the same time. The ship receiver shall be able to receive Bulletin Boards from up to 8 satellites at the same time.

The full bulletin board messages may be transmitted over several frames. Essential information of the bulletin board will be repeated over every frame (every 60 s).

##### 4.9.2 Announcement Signalling Channel (ASC)

This channel will normally carry Announcements, MAC information, up/downlink resource allocation, ARQs, ACKs and EDNs.

The channel is received by a large number of ships and a high margin subframe format is used.

To reduce protocol latency the ASC may be repeated several times (different content) during a frame.

Announcements include uni- and multi-cast (broadcast) datagrams.

The ASC uses subframe format SFF0 or SFF1. The format the start slots are given defined in the Bulletin Board.

The MAC information includes network version, congestion control (randomization interval, hold-off and minimum priority level).

The uplink resource allocation provides uplink data channel information to an individual ship following a resource request.

#### 4.9.3 Multicast Data Channel (MDC)

This downlink channel is received by a large number of ships and a high margin subframe format is used.

#### 4.9.4 Unicast Data Channel (UDC)

This downlink channel is allocated a specific ship for the duration of a unicast datagram. This channel is set up after a ship responds to an announcement, and the response includes received signal quality information allowing the satellite to maximise throughput.

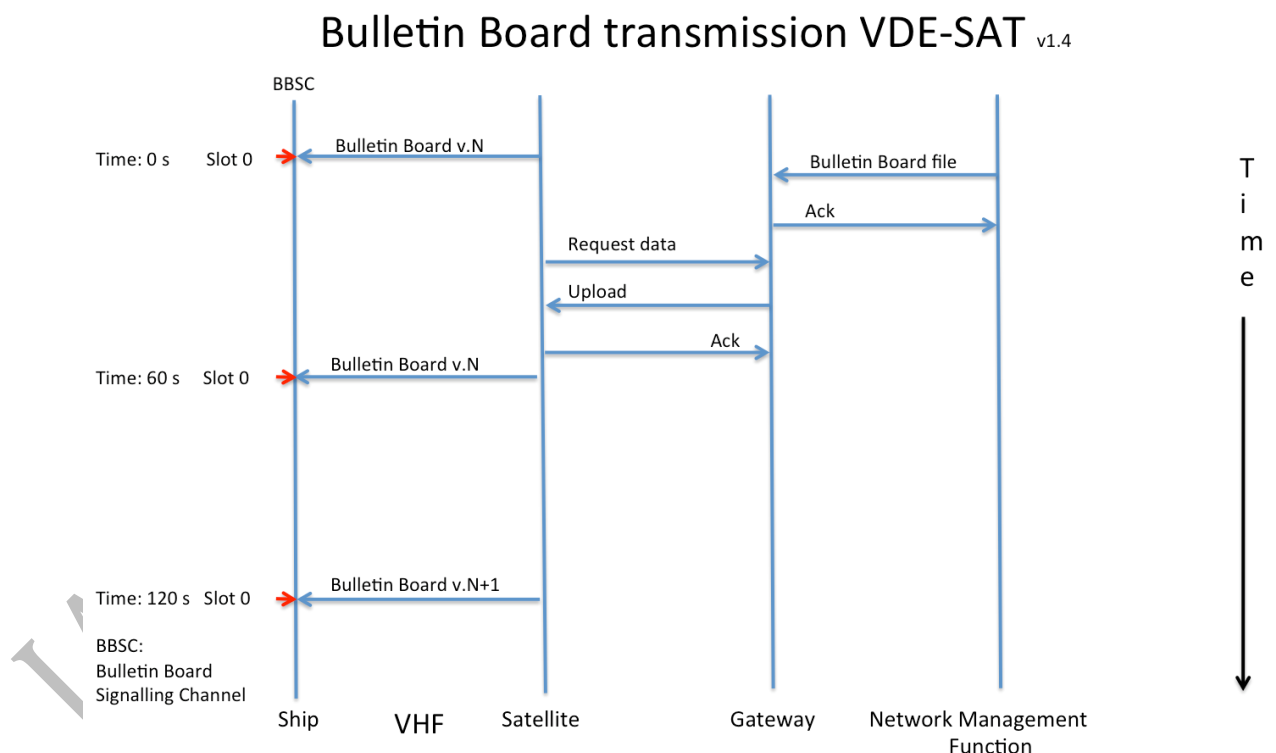
### 5. Network layer

#### 5.1 Downlink data transfer protocols

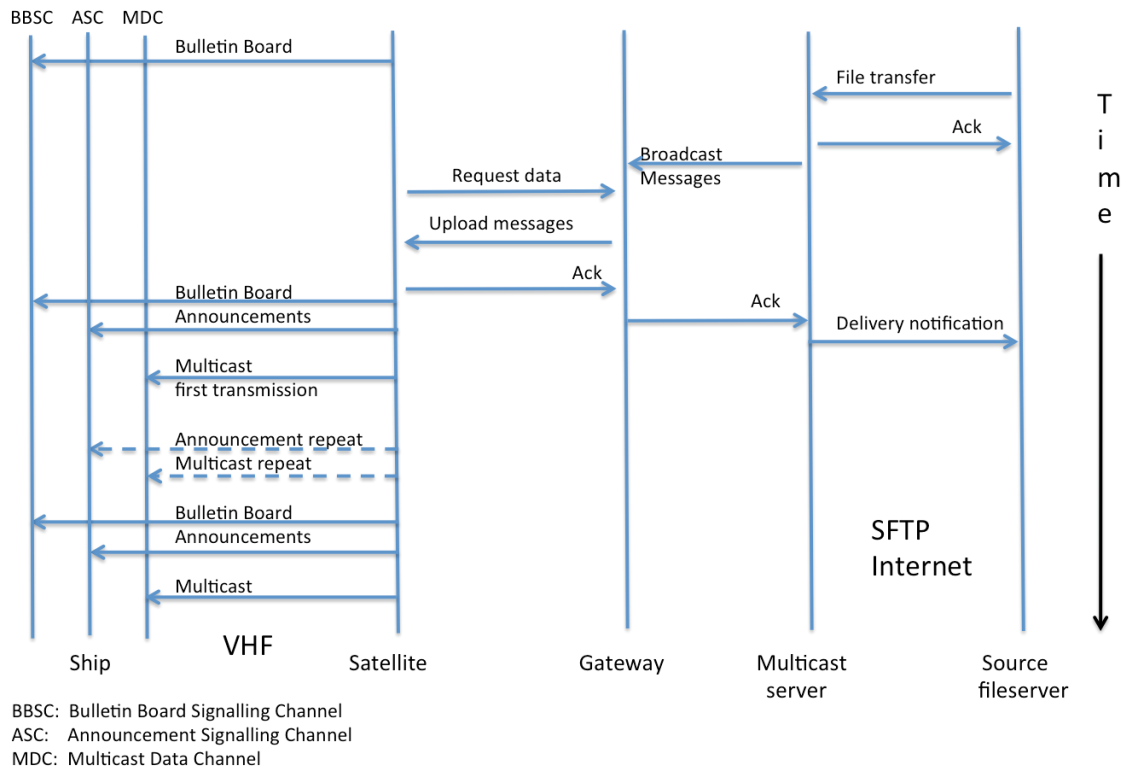
The following downlink protocols shall be supported:

- Bulletin Board transmission (network configuration)
- Multicast (icemaps, weather info, notices to mariners)
- Unicast (shore to ship file transfer, up to 100 kBytes)

The protocols are shown in Figures 12-14.

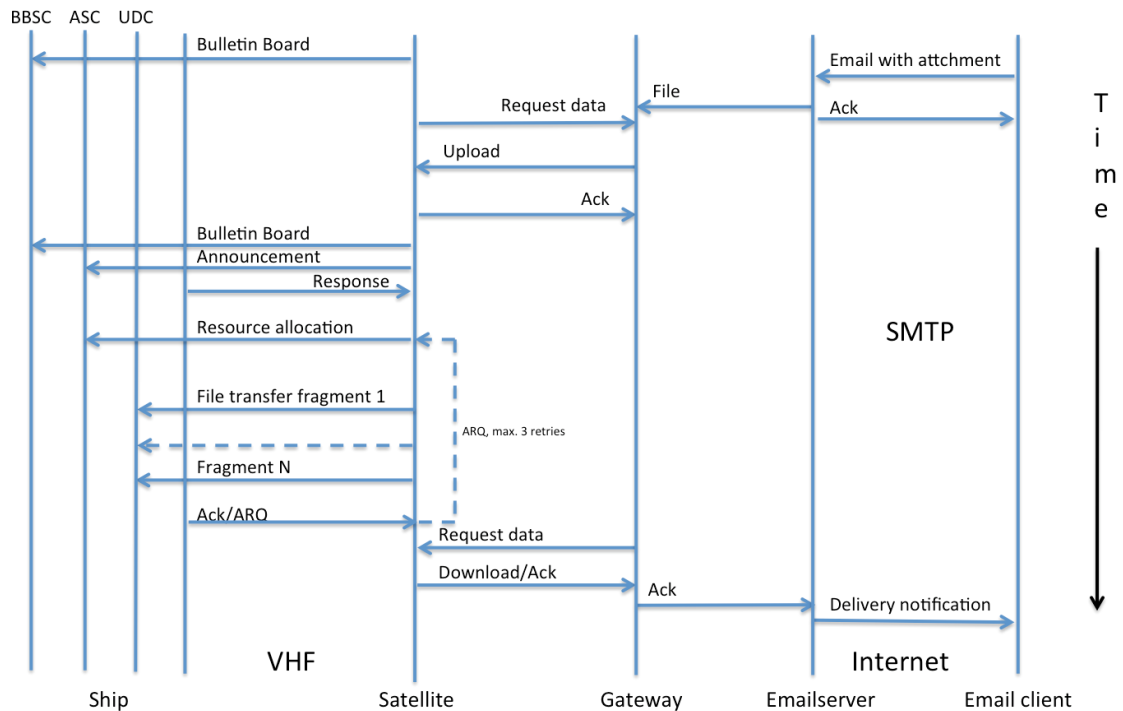


## Multicast protocol VDE-SAT v1.3



**Figure 13. Multicast protocol (one-way)**

## Shore originated unicast protocol VDE-SAT v1.3



**Figure 14. Shore originated unicast (file transfer) protocol**

### 6. Transport layer

### 6.1 End to end protocols

Existing Internet protocols such as UDP, SNMP, Secure File Transfer Protocol (SFTP), Simple Mail Transfer Protocol (SMTP) as shown in Figures 12 to 14 are used.

Terrestrial IP protocols are assumed to be terminated at the satellite gateway.

### 6.2 Ship, gateway and device physical addressing

Most commercial ships use a 7 digit IMO number of which the last is a checksum, thus the IMO system can address 1 million ships. The 3 byte VDES physical addressing field has 16,7 million unique IDs.

The number of networked devices on ships is growing fast and there is a need to directly address local gateways and devices.

In addition to the 3 byte address field, a 1 byte subaddressing has been added. The ship, local gateway and device addressing are shown in Table 11.

**Table 11. Ship, Gateway and Device addressing**

Addressing field	Usage	Range
24 bit physical address (all messages)	Ship terminal ID	16 Million
16 bit subaddress (encapsulated)	Ship gateway and device IDs	Configurable e.g. Gateway 4 MSB: 16 gateways Device 12 LSB: 4096 devices

### 6.3 Shore addressing of ships, gateways and devices

VDES will be accessed from shore using Internet, and it is desirable to use standard protocols such as email.

A database at the Gateway will allow shore users to define their own meaningful ship, gateway and device names. Below are some examples:

#### 6.3.1 Setting engine exhaust gas temperature alarm level

mail address:

olympic.engine1.exhaustgaslimit@nca.no

Main body:

id:whitestar

pw:19101020

egtlimithigh: 250

#### 6.3.2 Sending an icechart

mail address:

olympic.navsystem1.chartplotter@nca.no

Main body:

id:whitestar

pw:19101020

Attachment:  
nmiis201504101500.jpg

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