MANUAL ON DETAILED TECHNICAL SPECIFICATIONS FOR THE VDL MODE 4 DIGITAL LINK

Includes changes agreed up to and including AMCP WG-M2 meeting

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NOTE: In order to address some issues with the currently specified DLS protocol (based on AVLC) that were identified in AMCP WG-M, the WG-M is progressing a proposal to replace the current DLS protocol with a new DLS protocol which will resolve the issues. This work is expected to be complete by the WGM/5 meeting. The adoption of the proposal will affect Sections 1.4 and 1.5 of this Manual. Section 1.4 is the specification of the DLS and a new section will replace the existing one to introduce the DLS changes. Section 1.5 deals with the LME and changes will be introduced to describe the interface between the LME and the new DLS protocol.

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1.SECTION LINK LAYER PROTOCOLS AND SERVICES

1.1 GENERAL INFORMATION

1.1.1 Functionality

Note.— The VHF digital link (VDL) Mode 4 link layer is divided into four sublayers:

a) media access control (MAC) sublayer requiring the use of time division multiple access (TDMA);

b) a VDL Mode 4 specific services (VSS) sublayer providing communication using a flexible burst format and associated transmission and reservation protocols over the MAC sublayer;

c) a data link service (DLS) sublayer providing connection-oriented and broadcast services over the VSS sublayer;

d) a link management entity (LME) which establishes and maintains connections.

1.1.2 Services

1.1.2.1 Connection-oriented

The VDL link layer shall provide a reliable point-to-point service using a connection-oriented DLS sublayer.

1.1.2.2 Connectionless

The VDL link layer shall provide an unacknowledged broadcast service using a connectionless DLS sublayer.

1.1.3 Acronyms, abbreviations and parameter symbols

Note 1.— The following terms relating to VDL Mode 4 are used in this document as they are defined below.

Autotune Function. This function, performed by the Link Management Entity, allows a ground VDL Mode 4 station to command an aircraft to change the operating characteristics of synchronization burst transmissions.

Burst length. The number of slots across which the VDL Mode 4 burst is transmitted.

Delayed Burst. A VDL Mode 4 burst that begins sufficiently after the beginning of a slot so that the transmitting VDL Mode 4 station is confident that no other VDL Mode 4 station that it could receive from and is within the guard range is transmitting in the slot. The delayed VDL Mode 4 burst terminates by the end of the slot in which it began (its length is shortened to ensure completion by the nominal time).

Primary Time Source. The normal operation timing mode in which a VDL Mode 4 station maintains time synchronization to Universal Coordinated Time (UTC) second.

Secondary Time Source. A timing source used in a failure mode, which applies when the primary time source fails, in which a VDL Mode 4 station maintains time synchronization to UTC second.

VDL Mode 4 Station Address. A 27-bit identifier used to uniquely identify a VDL Mode 4 station.
Note 2.— A combination of the 24-bit ICAO aircraft address plus 3 additional bits may be used to identify aircraft.

Superframe. A group of slots that span a period of one minute. The start of the current superframe is aligned with the start of the slot that is currently being used for transmission. The next superframe starts one minute after the current slot.

Synchronization burst (or "sync" burst). A VDL Mode 4 burst which announces, as a minimum, existence and position.

Tertiary Time Source. A timing source used in a failure mode, which applies when the primary and secondary time sources fail, in which a VDL Mode 4 station maintains time synchronization to an estimate of the mean slot start times of a set of VDL Mode 4 stations.

Note 3.— The following acronyms and abbreviations are introduced in this Section as they are defined below. Other acronyms, abbreviations and parameter symbols have been listed in previous sections of these SARPs.

Acronym	***Description***
AVLC	Aviation VHF link control
BND	Big negative dither
CPR	Compact position reporting
CRC	Cyclic redundancy check
DM	Disconnected mode (frame)
DME	Distance measuring equipment
FRMR	Frame reject (frame)
GBAS	Ground based augmentation system
GNSS	Global navigation satellite system
GSIF	Ground station information frame
hex	Hexadecimal
HPL	Horizontal protection limit
IA5	The character set defined in ISO 646 Table 5
INFO	Information (frame)
ISO	International Standardization Organization
N/A	Not Applicable
NPA	Non-precision approach
PECT	Peer entity contact table
QoS	Quality of service
RNP	Required navigation performance
RR	Receive ready (frame)
RTS	Request to send (burst)
SBAS	Spaced-based augmentation system
SPS	Standard positioning service

Acronym	*Description*
SREJ	Selective reject (frame)
TCP	Trajectory Change Point
UA	Unnumbered acknowledge
UI	Unnumbered information (frame)
UN	United Nations
WGS	World geodetic system

Note 4.— The following are the symbols for parameters, timers, and counters that are introduced in this Section as they are defined below.

Table 1-1. Parameters, timers and counters for link layer protocols and services

Parameter	Name	Section or table defined in
CG1	CG1 filter	Table 1-94
CG1_decay	Decay rate for CG1 filter	Table 1-92
CG1_inc	Digital filter increment when a synchronization burst from a previously unknown station is detected	Table 1-92
CG1_limit	Digital filter threshold which triggers network entry due to station being “exposed”	Table 1-92
CG1_plea	Minimum pool size of peer stations for Plea	Table 1-92
CG1_range	Range limit used in digital filter for “exposure” determination	Table 1-92
CG1_reach	Maximum unreachability time	Table 1-92
G1	Maximum number of missed reservations	1.5.5.1
kw	Window size	Table 1-58
M1	Number of slots per superframe	1.2.2.1
M2inc	Filter increment for receiver blocking check	1.2.2.2
M2limit	Filter threshold for receive blocking check (network entry)	1.2.2.2
N1	Maximum number of bits in any frame	Table 1-58
N2	Maximum number of transmissions	Table 1-58
N3	Maximum length of DLS transmission	Table 1-59
p	Persistence	1.3.7.1.2
Q1	Priority	1.3.4.1
Q2a – d	Slot selection range constraint for level n	1.3.4.2
Q3	Replace queued data	1.3.4.3
Q4	Number of available slots	1.3.4.4
Q5	VSS retransmission parameters	1.3.4.5
Q5min	VSS retransmission parameters	1.3.4.5
Q5max	VSS retransmission parameters	1.3.4.5
Q5mult	VSS retransmission parameters	1.3.4.5
Q5exp	VSS retransmission parameters	1.3.4.5
Q5num	VSS retransmission parameters	1.3.4.5
Q5wait	VSS retransmission parameters	1.3.4.5
T1	Delay before retransmission	Table 1-58
T2	Delay before acknowledgement	Table 1-58
T3	Link initialization time	Table 1-58
T4	Maximum delay between transmissions	Table 1-58

Parameter	Name	Section or table defined in
TG1	Minimum frequency dwell time	Table 1-88
TG2	Maximum idle activity time	Table 1-88
TG3	Maximum time between transmissions	Table 1-88
TG4	Maximum time between GSIFs	Table 1-88
TG5	Maximum link overlap time	Table 1-88
TG6	Maximum delay for plea response	Table 1-92
TG7	Minimum time delay for CG1 filter	Table 1-92
TM2	Channel busy timer	1.3.7.1.1
TV11	Reservation hold time	1.3.10.2.1
TV11min	Reservation hold timer minimum value	1.3.10.3.1
TV11max	Reservation hold timer maximum value	1.3.10.3.1
TV61	Second frame block reservation timeout	1.3.17.5.1
V11	Nominal periodic rate	1.3.10.3.2
V12	Periodic dither range	1.3.10.3.3
V21	Nominal incremental period	1.3.11.2.1
V22	Maximum incremental dither range	1.3.11.2.2
V32	Minimum response delay	1.3.14.2.1
V33	Maximum response delay	1.3.14.2.2
V34	Source/destination control	1.3.14.2.3
V35	Broadcast control	1.3.14.2.4
V36	Length of reserved block	1.3.14.2.5
V42	Length of information transfer	1.3.15.2.1
V43	Minimum information transfer delay	1.3.15.2.2
V44	Maximum information transfer delay	1.3.15.2.3
V45	Minimum response delay	1.3.15.2.4
V46	Maximum response delay	1.3.15.2.5
V52	Minimum response delay	1.3.16.2.1
V61	Superframe block start offset	1.3.17.3.1
V62	Superframe block length	1.3.17.3.2
V63	Superframe block repeat rate	1.3.17.3.3
V64	Superframe block re-broadcast request	1.3.17.3.4
V65	Superframe block re-broadcast offset	1.3.17.3.5
V66	Second frame block size	1.3.17.5.2
V67	Second frame block repeat rate	1.3.17.5.1
VS1	Number of ground quarantined slots	1.3.3.1
VS2	Minimum co-channel interference (CCI) performance	1.3.3.2

Parameter	Name	Section or table defined in
VS3	Maximum number of access attempts	1.3.7.1.3
VS4	Quarantine slot re-use range	1.3.3.3

Note 5.— The following are the symbols for subfields and variables defined in this section.

Table 1-2. Symbols and variables for link layer protocols and services

Parameter	Name	Section or table defined in
a	application	Table 1-85
ai	additional service information	Table 1-85
a_j	Additional slot j	Table 1-35
a/d	Autonomous/directed flag	~~Table 1-66~~1.5.2.2
anum	application number	Table 1-85
ao	Acknowledgement offset	Table 1-30
a_slot	Acknowledgement slot	1.3.15.4.3
balt	Base altitude	Table 1-66
bd	Backoff delay	Table 1-53
b/g	Baro/geo altitude	Table 1-66
bl	Burst length	1.3.5
blg	Block length	Table 1-41
bo	Block offset	Table 1-41
br	Block repeat rate	Table 1-41
bs	Block start	Table 1-41
bt	Block timeout	Table 1-41
cnt	RTX retransmission count	1.5.3.1
c/r	Command/response status bit	1.4.2.2.2
cprf	CPR format even/odd	Table 1-66
ct_slot	Current transmission slot	1.3.10.5.2
d	Destination address	Table 1-27
da	Data age	Table 1-66
do	Directed offset	Table 1-35
dt	Directed timeout	Table 1-35
ei	Extra information included	1.4.2.2.1
ent	Entry number	Table 1-85
eo	Easterly offset parameter	1.5.4.4.1
erid	Extended reservation ID	Table 1-7
err	Error type	Table 1-53

Parameter	Name	Section or table defined in
f	Frequency	Table 1-30
ft_slot	Future transmission slot	1.3.10.5.6
gsc	GSC flag	Table 1-85
id	Information field identity	Table 1-66
id1, id2, id3…	ID extension	Table 1-66
in	Information field	1.4.2.2.1, Table 1-66
io	Incremental offset	Table 1-21
lat	Latitude	Table 1-66
lg	Length	Table 1-27
$lg_{1\text{-}d}$	Length for frames a to d	1.4.2.2.1
lon	Longitude	Table 1-66
m2	Measure of the uncertainty of the reservation data	1.2.2.2
mi	Message ID	1.3.2.3
mode	Mode flag	Table 1-51
nd	Negative dither	Table 1-25
no	Northerly offset parameter	1.5.4.4.1
nr	Nominal update rate	Table 1-33
nsf	N(s)	1.4.2.2.1
n_slot	Nominal slot	1.3.10.5.1
nucp	Position navigation uncertainty category	Table 1-66
off	Offset to first reserved slot	Table 1-35
ok	Confirm/failure flag	Table 1-53
or	Override flag	Table 1-35
$p_{1\text{-}e}$	Priority for frames a to e	1.4.2.2.1
po	Periodic offset	Table 1-16
pr	Priority	Table 1-26
pr_flag	Plea response flag	1.3.16.1
prm	VSS user specific parameter	Table 1-51
pt	Periodic timeout	Table 1-16
rcvr	Receiver control	Table 1-35
rd	Reservation data	Table 1-5
res	Reserved bit	Table 1-53
rid	Reservation ID	1.3.2.5
r-mi	Requested message ID	Table 1-51
ro	Response offset	Table 1-27

Parameter	Name	Section or table defined in
roff	Re-broadcast offset	Table 1-41
r_slot	Reserved slot	1.3.11.4.2
retrans	Number of times that a burst has been transmitted	1.3.21
s	Source address	1.3.2.2
s_avail	Slot availability	1.3.10.5.3
sdf	Source/destination flag	Table 1-27
seq	XID sequence number parameter	1.5.3.1
si	Service information	Table 1-85
sit	Service information type	Table 1-85
sz	Size	Table 1-43
tc	TCP change flag	~~1.3.2.6~~Table 1-66
tfom	Time FOM	Table 1-66
t_slot	Transmission slot	1.3.11.4.1
ver	Version number	1.3.2.1
vt	Timeout	Table 1-43

All division operations, unless otherwise stated, shall be integer divisions (and thus an implied truncation shall occur after the division).

Note 6.— References in this document to "VDL Mode 2 Technical Manual" mean "Manual on VHF Digital Link (VDL) Mode 2 Technical Specifications".

1.2 MAC SUBLAYER

The MAC sublayer shall acquire the shared communication path so as to provide the services defined in Section 1.2.1.

Note.— This function should be "transparent" to higher functional layers, meaning that the way in which supporting communications resources are utilized to achieve this should not be visible to the higher layers and sublayers (e.g. the VSS and DLS).

1.2.1 MAC sublayer services

Note.— The MAC sublayer provides

a) TDMA media access;

b) time synchronization of the start of each time slot in the channel (Section 1.2.3);

c) transmission (Section 1.2.5) and reception (Section 1.2.6) processing.

The MAC sublayer shall accept from the physical layer a continuous indication of channel idle/busy status (see Section 1.2.4). The MAC sublayer shall accept from the VSS sublayer a burst for transmission, accompanied by the time to transmit it. The MAC sublayer shall provide to the VSS sublayer the received burst data, slot busy/idle status, and the status of bursts sent for transmission.

1.2.2 MAC sublayer parameters

MAC service system parameters shall be as described in Table 1-3.

Table 1-3. MAC service system parameters

Symbol	Parameter Name	Minimum	Maximum	Default	Increment
M1	Number of slots per superframe	60 slots	15360 slots	4500 slots	60 slots
M2inc	Filter increment for receiver blocking check	1	256	2	1
M2limit	Filter threshold for receive blocking check (network entry)	1	65536	160	1

1.2.2.1 Parameter M1 (number of slots per superframe)

The parameter M1 shall be the number of available slots per superframe. A superframe shall span a period of 60 seconds.

Note.— M1/60 slots spans a time interval of 1 second. The M1 increment forces M1/60 to be an integer. This simplifies the protocol since a slot counter (or equivalent) can be started at the boundary between any two consecutive UTC seconds.

1.2.2.2 Parameter M2inc and M2limit (MAC layer control parameters for network entry)

Note 1.— For a station that is able to make reservations on a channel as defined in Section 1.3.6.1, the need to execute a network entry procedure, as defined in Section 1.5.6.3, as a result of temporary loss of receiving function on the channel due to known cosite transmissions, is controlled by the m2 filter.

An m2 filter shall be maintained by a station for each active channel as a measure of the uncertainty of the reservation data. Each m2 filter shall be controlled by parameters M2inc and M2limit, which define the parameters of the following algorithm in which m2 is updated after every slot:

$m2_{k+1} = m2_k + M2inc$ if receiver function *on the channel* is blocked by own station transmission on another channel, e.g. through a common antenna;

$= \max((m2_k - 1), 0)$ if receiver function is not blocked.

If m2 >= M2limit, m2 shall be reset to 0 and the station shall execute a network entry procedure in accordance with Section 1.5.6.3.

Note 2.— The objective is to force re-entry when the reservation table may have been corrupted by lack of recent reservation data, without requiring re-entry as a result of minor gaps in reception as may be caused by limited and isolated transmissions on other channels. Parameters M2limit and M2inc can be reset by ground station command on a per channel basis.

1.2.3 Time synchronization

Note.— Time synchronization is described as set out in the following table:

Table 1-4. Operating modes and time synchronization

Operating mode	***Synchronization mode***	***Data quality level***	***Synchronization***
Normal	*Primary*	*Certified*	*UTC*
	Primary	*Non-certified*	*UTC*
Failure	*Secondary*	*Non-certified*	*UTC*
	Tertiary	*Non-certified*	*Non-UTC*

1.2.3.1 Primary

Under normal operating conditions, a station shall maintain time synchronization such that the start of each successive group of M1/60 slots is synchronized with the start of any Universal Coordinated Time (UTC) second to within a two-sigma value of 400 ns.

Note.— This is defined as the primary time source.

1.2.3.2 Secondary

A station shall be capable of maintaining time synchronization such that the start of each successive group of M1/60 slots is synchronized with the start of any UTC second to within a two-sigma value of 15 microseconds.

Note 1.— This is defined as the secondary time source.

Note 2.— One method is to synchronize to slot boundaries defined by a station declaring primary time.

Only when the primary source fails shall secondary time be used.

A station using secondary time shall revert to primary time whenever primary time is available.

Note 3.— Secondary time is regarded as a failure mode.

1.2.3.3 Alignment to UTC second

For stations maintaining primary or secondary time, the start of each successive group of M1/60 slots shall be aligned with a UTC second.

1.2.3.4 Tertiary

A station shall be capable of maintaining time synchronization to an estimate of the mean slot start times of a set of stations to within a two-sigma value of 20 microseconds.

Note 1.— This is defined as the tertiary time source.

When a mixture of secondary and tertiary time sources is available, the station shall derive time from the secondary time source(s) and exclude the tertiary time source(s).

Only when both the primary and secondary sources fail shall tertiary time be used.

A station using tertiary time shall: a) revert to primary time whenever primary time is available or b) revert to secondary time whenever secondary time is available and primary time is not available.

Note 2.— Tertiary time is regarded as a failure mode.

1.2.3.5 Data quality level

The certified quality level shall indicate that timing and position information provided by the station can be used by other stations as a means of deriving position information.

When a station is deriving position information from the transmissions of other stations it shall only use data from stations declaring the certified quality level.

Secondary and tertiary timing levels shall not indicate the certified quality level.

Note.— Certification of stations for use as "pseudolites" to support secondary navigation, will be under control of an authority, such as an aviation administration.

1.2.4 Slot idle/busy notification

1.2.4.1 Slot idle detection

A station shall consider the slot idle if the channel idle/busy status (see VDL SARPs Section 6.9.5.3) is idle at the start of the slot.

1.2.4.2 Slot busy detection

A station shall consider the slot busy if the channel idle/busy status (see VDL SARPs Section 6.9.5.3) is busy at the start of the slot.

1.2.4.3 Slot occupied detection

A slot shall be considered occupied if the channel is considered to be continuously busy for a period of at least 5 msec during the slot.

Note.— The slot occupied detection is used to monitor the operations of peer stations, including the G1 counter. This is different from the channel idle/busy state, which affects in part the station's ability to make a random transmission.

1.2.5 Transmission processing

Bursts received from the MAC sublayer shall be forwarded to the physical layer, together with the time for transmission.

With the exception of certain delayed bursts, a station shall begin transmissions only at the beginning of the slot boundary as determined by its local clock. Delayed bursts shall begin 4 msec after the beginning of the slot boundary, if the channel is idle at that point.

Note.— The delay allows time for any other station to begin transmitter ramp-up, for the signal to travel the propagation distance, and for the channel busy detector to determine the appearance of a signal. A delayed burst can fit in a single slot, and preserve nominal propagation guard time, even if transmission begins late. The delay could be somewhat shorter but no longer; the 4 msec value was selected to ease design and ensure robustness of the channel busy detector.

1.2.6 Received transmission processing

Bursts with an invalid cyclic redundancy code (CRC) shall be discarded. Bursts with valid CRCs shall be forwarded to the VSS sublayer, along with the received time of transmission and signal quality parameters.

1.3 VSS SUBLAYER

Note 1.— There is one VSS sublayer entity for each VDL Mode 4 channel accessed by the station. The VSS sublayer provides service to the VDL Mode 4 management entity (VME) as well as the link management entities (LME) associated with other VDL Mode 4 peer systems, their associated DLEs and the DLS. The VSS is served by the MAC associated with its particular VDL Mode 4 channel.

Note 2.— This Section describes the services that bursts can provide and some example protocols and procedures, which may be amended, extended, or ignored by any specific burst application.

Note 3.— Other protocols may be defined for unique applications; however, it is expected that most bursts will use one of the below defined protocols. Regardless of this, the various reservation fields for the protocols defined below cannot be redefined.

1.3.1 Services

1.3.1.1 Multiple access

Note.— The VSS sublayer implements protocols to allow all stations the opportunity to transmit while providing for high system throughput, low transit delays, and low probability of collisions. These protocols include:

a) reserved access (see Section 1.3.6):

1) null reservation (see Section 1.3.9);

2) periodic broadcast (see Section 1.3.10);

3) incremental broadcast (see Section 1.3.11);

4) combined periodic and incremental broadcast (see Section 1.3.12);

5) big negative dither broadcast (see Section 1.3.13);

6) unicast request (see Section 1.3.14);

7) information transfer request (see Section 1.3.15);

8) directed request (see Section 1.3.16);

9) block reservation (see Section 1.3.17);

10) response (see Section 1.3.18).

b) random access (see Section 1.3.7); and

c) fixed access (see Section 1.3.8).

The designation of "reserved access", "random access" and "fixed access" apply to the protocols in the transmitting station, and not to any message indicator or flag in the transmitted frame or burst.

1.3.1.2 Error detection

The VSS sublayer shall compute a 16-bit CRC according to ISO 3309 to facilitate detection by the MAC sublayer (see Section 1.2.6) of data corruption during transmission.

1.3.1.3 Channel congestion

The VSS sublayer shall notify the LME sublayer whenever channel congestion is detected (see Section 1.3.7.1.1).

1.3.2 Burst format

VSS bursts shall conform to ISO 3309 frame structure except as specified in Table 1-5. The maximum burst length shall be N1 bits.

Note 1.— A burst occupying a single slot has 24 octets for data. Thus, assigning 8 bits for bit stuffing and 2 octets for the flags, a maximum single-slot burst has a value of 'n' equal to 21. Note that a burst can be up to N1 bits in length and can therefore occupy more than one slot. Bursts can consist of the single block of data between two flags, as illustrated in Table 1-5, or can consist of a number of blocks of data with each block separated from the next by a flag.

Table 1-5. Burst format

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
flag	-	0	1	1	1	1	1	1	0
~~TCP change flag (tc)~~autonomous/directed flag (a/d), reservation ID (rid), version number (ver)	1	s_{27}	s_{26}	s_{25}	ver_3	ver_2	ver_1	rid	~~tc~~a/d
source address (s)	2	s_{24}	s_{23}	s_{22}	s_{21}	s_{20}	s_{19}	s_{18}	s_{17}
	3	s_{16}	s_{15}	s_{14}	s_{13}	s_{12}	s_{11}	s_{10}	s_9
	4	s_8	s_7	s_6	s_5	s_4	s_3	s_2	s_1
message ID (mi)	5	in_k	mi_k	. . . . .		mi_4	mi_3	mi_2	mi_1
information	6								
	7 - n-5			. . . . .					
	n-4								
reservation data (rd)	n-3		in_1	rd_k	. . . . .				
extended reservation ID (erid)	n-2	$erid_k$	. . . . .			$erid_1$			rd_1
CRC (c)	n-1	c_9	c_{10}	c_{11}	c_{12}	c_{13}	c_{14}	c_{15}	c_{16}
	n	c_1	c_2	c_3	c_4	c_5	c_6	c_7	c_8
flag	-	0	1	1	1	1	1	1	0

			. . . . .		Denotes variable length field

Note 2.— ATN applications are supported by compressed frame bursts (see Section 1.4.2.2.2).

Note 3.— The lengths of the message ID and information fields depend on the message type being used.

Note 4.— The lengths of the extended reservation ID and reservation fields depend on the reservation protocol being used. The reservation field may also be subdivided into further fields, depending on the reservation protocol.

1.3.2.1 Version number

The version number (ver) subfield shall indicate the version of VDL Mode 4 supported by the station. It shall be set to 000binary on transmit. If the station receives a burst in which the version number is non-zero, it shall inform the VSS user that a non-zero version number has been received and ignore the rest of the burst.

1.3.2.2 Source address

The source address (s) of the transmitting station shall be encoded in the 27-bit field as described in Table 1-5. The address format shall be as described in Section 1.4.2.1.

1.3.2.3 **Message ID**

The message ID (mi) of the burst shall be encoded in the variable length field as defined in Table 1-5. The first four bits of the burst message ID field shall be as defined in Table 1-6.

Table 1-6. Message ID assignment

Message ID field							**Assigned burst type**	**VSS user**
mi_7	mi_6	mi_5	mi_4	mi_3	mi_2	mi_1		
x	x	x	x	x	0	0	Autonomous synchronization burst (see 1.5.6.1)	LME
x	x	x	x	x	1	0	Directed synchronization burst (see 1.5.6.1)	LME
0	0	0	0	0	0	1	General request burst	Defined by r-mi
0	0	0	0	1	0	1	No operation	
0	0	0	1	0	0	1	Reserved for future use	
0	0	0	1	1	0	1	Reserved for future use	
0	0	1	0	0	0	1	General response burst	Defined by r-mi
0	0	1	0	1	0	1		
			to		0	1	Reserved for future use	
0	0	1	1	1	0	1		
0	1	0	0	0	0	1	RTS burst format	DLS
0	1	0	0	1	0	1		
0	1	0	1	0	0	1	Reserved for future use	
0	1	0	1	1	0	1		
0	1	1	0	0	0	1	Compressed frame burst format	DLS
0	1	1	0	1	0	1	Reserved for future use	
0	1	1	1	0	0	1	Reserved for future use	
0	1	1	1	1	0	1	Compressed XID burst	LME
1	0	0	0	0	0	1	RTX burst	LME
1	0	0	0	1	0	1	Network entry burst	VSS
1	0	0	1	0	0	1	Bursts defined in ADS-B application standards	ADS-B application
1	0	0	1	1	0	1		
			to		0	1	Reserved for future use	
1	1	1	1	1	0	1		
0	0	0	0	0	1	1		
			to		1	1	Reserved for future use	
1	1	1	1	1	1	1		

Note.— Bits denoted as x are available for use within the information field.

The message ID shall define the VSS user which is responsible for handling the message, following completion of processing required within the VSS.

1.3.2.4 **Information field**

The optional information field (in) shall contain VSS user defined data.

Note.— The content of the information field is generally a matter for definition by applications using VDL Mode 4. General request and general response message formats are specified in Sections 1.3.19 and 1.3.20 respectively.

1.3.2.5 **Reservation fields**

The reservation ID (rid) of the burst shall be encoded in the 1-bit field as defined in Table 1-5. If the reservation ID equals 1, this shall indicate that the reservation type is either a null reservation (see Section 1.3.9), a periodic broadcast reservation (see Section 1.3.10) or a combined periodic broadcast and incremental broadcast reservation (see Section 1.3.12) and that there is no extended reservation ID (erid); otherwise, the extended reservation ID field shall indicate other reservation types as defined in Table 1-7.

Note 1.— The rid (and erid if present) subfield defines the interpretation of the reservation data (rd) field.

Table 1-7. Extended reservation ID field (erid)

Extended reservation ID field (erid)					Reservation type
Octet n-2					
Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	
0	0	0	0	0	Response burst (no reservation)
0	0	0	0	1	Big negative dither (BND) reservation
0	0	0	1	0	Superframe block reservation
0	0	0	1	1	Second frame block reservation
0	0	1	0	x	Unicast request reservation
0	0	1	1	0	Reserved for future allocation
to					
0	1	0	0	1	
0	1	0	1	0	Information transfer request reservation
0	1	0	1	1	Reserved for future allocation
0	1	1	0	0	Directed request reservation
0	1	1	0	1	Reserved for future allocation
to					
0	1	1	1	1	
1	0	x	x	x	Incremental broadcast reservation
1	1	0	0	0	Reserved for future allocation
to					
1	1	1	1	1	

Note 2.— Bits denoted x are available for use within the reservation data (rd) field.

~~**1.3.2.6 TCP change flag**~~

~~The TCP change flag (tc) shall be encoded as defined in section 3.6 if the message ID (see Table 1-6) indicates that the burst is a directed synchronisation burst. Otherwise it shall be reserved for future definition and set equal to 1.~~

1.3.3 VSS sublayer parameters

VSS service system parameters shall be as described in Table 1-8.

Table 1-8. VSS sublayer parameters

Symbol	Parameter name	Minimum	Maximum	GFSK default	Increment
VS1	Number of ground quarantined slots	0 slots	15 slots	4 slots	1 slot
VS2	Minimum CCI performance	P2 dB	60 dB	12 dB	1 dB
VS4	Quarantine slot re-use range	0	1000 nmi	300 nmi	10 nmi

Note.— P2 is defined in Table 2-2.

1.3.3.1 Parameter VS1 (number of ground quarantined slots)

The parameter VS1 shall define the number of ground quarantined slots (see Section 1.3.6.4).

1.3.3.2 Parameter VS2 (minimum CCI performance)

The parameter VS2 shall be used to control the CCI conditions by which a station may transmit given that another station has reserved the same slot. In the case where a station X and Y transmit in the same slot and station Y's transmission is directed to another station Z, CCI conditions shall be fulfilled if the ratio defined below:

$$ratio = 10\log\left(\frac{dist(Y \mid Z)^2}{dist(X \mid Z)^2}\right)$$

is greater than VS2.

1.3.3.3 Parameter VS4 (quarantine slot re-use range)

The parameter VS4 shall be used to control the range at which a quarantined slot may be re-used by a distant station (see Section 1.3.6.4).

1.3.4 VSS quality of service parameters

Every burst processed by the VSS sublayer for transmission shall be associated with the parameters defined in Table 1-9.

Table 1-9. VSS quality of service system parameters

Symbol	Parameter Name		Minimum	Maximum	Default	Increment
Q1	Priority		0	2	2	1
Q2a	Slot selection range constraint for level 1		0	1000 nmi	150 nmi	1 nmi
Q2b	Slot selection range constraint for level 2		0	1000 nmi	150 nmi	1 nmi
Q2c	Slot selection range constraint for level 3		0	1000 nmi	0 nmi	1 nmi
Q2d	Slot selection range constraint for level 4		0	1000 nmi	300 nmi	1 nmi
Q3	Replace queued data		FALSE	TRUE	FALSE	--
Q4	Number of available slots		1	20	3	1
Q5min	VSS retransmission parameters	minimum	0 s	20 s	0	1 ms
Q5max		maximum	1 s	20 s	5 s	1 ms
Q5mult		multiplier	1	2.5	1	0.01
Q5exp		exponent	1	2.5	1.5	0.01
Q5num		number of attempts	1	15	4	1
Q5wait		maximum time to wait for a reply	1 s	120 s	60 s	1 s

1.3.4.1 Parameter Q1 (priority)

The parameter Q1 shall be the priority of the transmission and shall be as defined in Table 1-10.

Table 1-10. Priority levels

Message categories	Priority	Q1
Network/systems management	high	2
Distress communications	high	2
Urgent communications	high	2
High priority flight safety messages	high	2
Normal priority flight safety messages	high	2
Meteorological communications	medium	1
Flight regularity communications	medium	1
Aeronautical information service messages	medium	1
Network/systems administration	medium	1
Aeronautical administrative messages	low	0
Urgent priority administrative and UN charter communications	low	0
High priority administrative and state/government communications	low	0
Normal priority administrative	low	0
Low priority administrative	low	0

1.3.4.2 Parameters Q2a to Q2d (slot selection range constraint for level n)

The parameters Q2a to Q2d shall be used to impose range constraints on the slot selection process for levels 1 to 4 defined by Table 1-11.

1.3.4.3 Parameter Q3 (replace queued data)

The parameter Q3 shall be a Boolean switch that shall be used to control queuing of repeated bursts on a congested channel. If Q3 = TRUE, then a new data field shall replace a queued data field of the same type. Otherwise, both the old and new data fields shall be transmitted.

Note.— Thus, if a channel is busy and, e.g., a synchronization burst containing ADS-B data cannot be transmitted, then a second synchronization burst (although with potentially different data) will overwrite the first burst.

1.3.4.4 Parameter Q4 (number of available slots)

The parameter Q4 shall be used to control the number of slots added to the available slot list during the slot selection process (see Section 1.3.6.2).

1.3.4.5 Parameters Q5 (VSS retransmission parameters)

The parameters Q5min, Q5max, Q5mult, Q5exp, Q5num and Q5wait shall control the retransmission of bursts for which an expected response has not been received (see Section 1.3.21).

1.3.5 Received transmission processing

A station shall be capable of recognizing and processing all possible reservation types as defined in Sections 1.3.9 through 1.3.18. When a station receives a burst with an unrecognized reservation type, it shall discard the burst without updating the reservation table.

When a station receives a known reservation type with an invalid subfield, or a known reservation type with valid subfields but an invalid combination, it shall reserve the slots indicated by the valid sub-fields; however, the station shall not transmit a response, nor shall the burst be passed to a VSS user.

When a station receives a burst with a known reservation type and a non-zero reserved subfield, it shall ignore the data in the reserved subfield.

The current slot for a burst shall be the slot in which the received transmission begins. The burst length (bl) shall be the number of slots across which the burst is transmitted.

Note.— Current slot and burst length are used throughout the text in protocol definitions. In the text, unless otherwise stated, references to particular slot numbers (e.g. for calculating the position of new reservations) are relative to the current slot which is taken to be slot 0. If a transmission extends across a slot boundary, it is considered to occupy the slots on both sides of the boundary for reservation purposes.

Valid bursts shall be forwarded to the appropriate VSS user, along with the time of receipt of the transmission. The received signal quality (see VDL SARPS Section 6.9.5.1.5.1) and the time of receipt of the bursts shall be passed to the VME. If the appropriate VSS user cannot be identified (i.e., the message ID is reserved or that functionality is not implemented) and the burst contains one or more reservations for the receiving station only, then the station shall transmit a general failure (see Section 1.3.20) with an error type of 00 hex or 80 hex (i.e., unsupported function) in the first slot of each of the reservations.

1.3.6 Reserved access protocol specification

Note.— Procedures for processing bursts containing specific reservation types are described in Sections 1.3.9 through 1.3.18.

1.3.6.1 Reservation table

A station shall maintain a table of all reservations in the next 4*M1 + 128 slots. For each reserved slot, the reservation Table entry shall consist of the 27-bit address of the intended transmitter, the 27-bit address of the destination (if any) and the type of reservation made. For periodic broadcast reservations (see Section 1.3.10) and directed request reservations (see Section 1.3.16), the reservation table shall also include pointers to all other reserved slots associated with the same reservation stream.

The reservation table shall be updated before the end of the first slot after the end of the burst.

With the exception of delayed bursts (see Sections 1.2.5, 1.5.6.3.3.1 and 1.5.6.3.4), and cases where a station has been directed to transmit by another station, a station shall wait for at least M1 slots after starting to listen to a channel before starting to transmit or reserve slots.

Note 1.— This allows sufficient time to build up the reservation table data.

Note 2.— A reservation table is for specification purposes only and the implementer is free to choose the method by which the reservation information is stored and processed. A station is required to record all reservations for a slot for possible use in slot selection algorithms because several stations may intentionally share a slot.

Note 3.— There may be more than one reservation associated with a particular slot.

1.3.6.2 Selecting slots for transmission or reservation

A station shall select slots for transmission or for reservation for later transmissions using the algorithm specified below.

Note.— When the channel is low to moderately loaded, the station will be able to select unreserved slots for transmission (level 0 in Table 1-11). When the channel is congested, the station is able to use slots that have been reserved by other stations by applying rules defined below (levels 1 to 4 in Table 1-11).

The VSS user shall specify one or more groups of quality of service parameters Q1, Q2a, Q2b, Q2c, Q2d and Q4 for slot selection. The station shall attempt to select slots using the first group of quality of service parameters. If slot selection is unsuccessful, the station shall use the next group and continue with successive groups until a slot has been selected. If, having used all groups of quality of service parameters, no slot has been selected, the VSS user shall be informed that slot selection has been unsuccessful.

1.3.6.2.1 Specification of candidate slots

The VSS user shall specify a range of candidate slots for slot selection.

Note.— The method for specifying candidate slots is protocol dependent (see Sections 1.3.9 to 1.3.18).

1.3.6.2.2 Derivation of a list of available slots

1.3.6.2.2.1 Slot selection criteria

A list of available slots shall be chosen from the candidate slots using the following rules:

a) all unreserved slots shall be added to the list of available slots (shown as level 0 in Table 1-11).

b) if, having completed stage a), the number of available slots is less than Q4, further available slots shall be selected from slots that have been previously reserved by other stations. The station shall initially select from slots which obey conditions specified as level 1 in Table 1-11 until Q4 available slots have been chosen. If, having applied level 1 conditions, the number of available slots is still less than Q4, slot selection shall continue using level 2 conditions. The process shall continue using subsequent levels until Q4 slots have been selected or until all levels have been applied. At each level, selection shall start with slots reserved by the most distant station and proceed in decreasing range order.

Table 1-11. Slot selection criteria

	Selection conditions		
Selection priority	**Planned transmission by station A**	**Previously reserved transmission by station B**	**Minimum distance between station A and station B**
Level 0	Any	Unreserved	Not applicable
Level 1	Broadcast or CCI protected communication with station C	CCI protected communication with station D	Q2a
Level 2	Broadcast or CCI protected communication with station C	Broadcast	Q2b
Level 3	Broadcast or CCI protected communication with station C	Broadcast or CCI protected communication with station D	Q2c
Level 4	Broadcast or CCI protected communication with station C	Any transmission	Q2d

In Table 1-11, the following definitions and specifications shall apply:

Station A	The station attempting to select a slot.
Station B	A station that has previously reserved a slot.
Station C	A station to which station A wishes to address a point-to-point communication.
Station D	A station for which station B has reserved a slot for point-to-point communication.
CCI protected	A point-to-point communication between two stations which fulfils the CCI conditions as defined in Section 1.3.3.2 and is therefore protected if a third station simultaneously transmits in the same slot.

Note 1.— The decision criterion in Table 1-11 is the distance between station A and station B; however, the requirement to check for CCI protected communications requires station A to also examine the distance relationship between station B and station C, and station A and station D, if known. It is possible to disable the selection process at any of the levels in Table 1-11 by setting the appropriate range constraint (Q2a to d) large (1000 nmi).

Note 2.— For certain applications Q2d could be set to zero so that a slot can always be chosen even if this is at the expense of another application.

1.3.6.2.2.2 Recommendation

In selecting the list of available slots at level 0, priority should be given to candidate slots which are not reserved for transmission on any channel monitored by the station, and which also do not violate quarantine constraints (see Section 1.3.6.4) on the desired transmit channel.

1.3.6.2.2.3 **Recommendation**

A mobile station should exclude from consideration any slots which have been previously reserved for a point-to-point transmission, on any channel, where it is the intended destination.

1.3.6.2.2.4 Additional considerations for slot selection for transmission

Note 1.- It is assumed that ground stations will have the capability to transmit in all the active channels in the region they serve. However, mobile stations, especially with a single transmitter, will not be able to transmit in the same slot in different channels.

A mobile station A, when selecting the list of available slots for transmission in a channel for itself or another mobile station B, shall exclude from consideration the specific slots, which the station A knows are reserved for transmission for the intended station (either A or B) in other channels monitored by A.

Note 2.-If the selecting station is a ground station, then the station can select a conflicting slot if the ground station expects to overide the existing reservation. Procedures to resolve transmission conflict for mobile stations are described in section 1.3.6.6

1.3.6.2.3 **Additional constraints applying to global signalling channels**

On channels designated as global signalling channels (GSCs) (see VDL SARPs Section 6.9.2.2.1), mobile stations maintaining primary or secondary time shall exclude the first V66 (see Section 1.3.17.5.2) slots of every UTC second. The first V66 slots after every UTC second shall comprise the VLMC and shall be allocated for ground station use only.

1.3.6.2.4 **Selection of slots from available slots**

If, having completed the derivation of a list of available slots, the number of available slots is zero, no slot shall be selected and the VSS user shall be informed that slot selection was unsuccessful. If the number of available slots is greater than or equal to 1, a slot shall be chosen from the list of available slots such that the probability of choosing a given slot is the same as the probability of choosing any other slot.

1.3.6.2.5 **Selection of slots for burst lengths greater than 1**

For burst lengths greater than 1, the process specified in Section 1.3.6.2.2 shall be applied to continuous blocks of slots of length equal to the burst length. A block of slots shall be regarded as available at a particular level number (see Table 1-11) if all slots within the block are available at the same or lower level number. The procedure described in Section 1.3.6.2.4 shall then be used to select one of the available blocks.

1.3.6.2.6 **Limits on selection of reserved slots**

A station which has selected a slot that was reserved by another station, shall not select another slot reserved by that station within M1 - 1 slots after the selected slot.

1.3.6.3 **Reserved transmissions**

When a station has a burst to transmit for which it has a reservation, it shall transmit the scheduled data in the reserved slots, except as noted below.

1.3.6.3.1 Unavailable data

If the data for a burst for which a slot was reserved is unavailable when it is time to transmit, then the station shall send a general failure (see Section 1.3.20).

1.3.6.3.2 Reservation no longer valid

A station shall check that a reservation is valid according to the procedures of Section 1.3.6.5 before transmitting.

1.3.6.4 Ground quarantine

1.3.6.4.1 Establishment of ground quarantine

With the exception of a delayed burst (see Sections 1.2.5, 1.5.6.3.3.1 and 1.5.6.3.4), a mobile station, A, shall not reserve a slot or transmit on the slot boundary of the VS1 slots after a slot which has been reserved by a ground station, B, using a periodic broadcast reservation (see Section 1.3.10) or which has been reserved by a mobile, C, using a synchronization burst with the autonomous/directed bit set to 1 (see Section 1.5.2) and a periodic broadcast reservation field, unless the station (B or C) that has reserved the slot is at a range greater than VS4 from station A, in which case station A shall consider the slot to be unreserved.

Note 1.— The periodic broadcast reservation would be used to place a reservation for subsequent transmissions by the ground station. The directed request reservation would be used to reserve slots for broadcast by mobile stations and these mobiles will subsequently use periodic broadcast reservations and directed synchronization bursts to maintain the directed reservation (see Section 1.3.16.5).

Note 2.— Quarantine as defined in Section 1.3.6.4.1 does not apply to a delayed burst. If no normal transmission is detected (i.e., no transmission starting on the slot boundary), the slot may be used for a delayed burst regardless of its perceived quarantine status. This is to allow the ground system to provide opportunities for network entry unimpeded by other traffic. Note, however, that delayed bursts must not be made when ground quarantine is established using a block message (see Section 1.3.6.4.3).

1.3.6.4.2 Maintenance of ground quarantine after cancellation of a directed request broadcast

If a station receives a periodic broadcast burst with the periodic offset (po) subfield set to 0 and the periodic timeout (pt) subfield set to 0 (see Section 1.3.10.5.9), then it shall maintain ground quarantine as described in Section 1.3.6.4.1 for the current slot and for M1 slots after the current slot if it had previously contained a reservation associated with the same stream (see Section 1.3.10.4). Ground quarantine behaviour for any other slots associated with the same stream shall be cancelled.

Note.— This applies to the cancellation of a stream that was set up using a directed request and also to the cancellation of a ground station's periodic broadcast stream.

1.3.6.4.3 Ground quarantine established by block message

A mobile station, A, shall not reserve a slot or transmit in slots which have been reserved by a ground station, B, or a mobile station, C, using a block reservation (see Section 1.3.17), unless the station (B or C) that has reserved the slot is at a range greater than VS4 from station A, in which case station A shall consider the slot to be unreserved.

Note.— It is not possible to transmit a delayed burst in a reserved block.

1.3.6.5 **Reservation conflicts**

Note.— The following rules determine the action that a station takes in the event of detecting a reservation conflict. This is a normal event which is expected to occur as a result of slot re-use under CCI protection. In the event of a conflict, generally the slot selection criteria are re-applied to determine whether the slot could still have been selected in the knowledge of the new conflicting reservation. Generally, a station required to transmit in a slot that was reserved for it by another station will always transmit, since it cannot be assumed to have possession of the necessary information to determine the optimum action.

If a station, A, receives a burst containing a reservation from another station, B, for a slot which has already been reserved for station A to transmit, then station A shall take the following action:

a) if the conflicting reservation from station B also requires station A to transmit, then station A shall transmit (i) the response with the higher priority (as determined by Q1), or (ii) the first requested transmission in the case of equal priority, or else;

b) if station A no longer requires to transmit in the existing reservation, or does not have the necessary information to transfer, then it shall not transmit in the slot, or else;

c) if the existing reservation for station A to transmit was made by a station other than A (i.e. by a unicast request (sdf = 0), information transfer, or directed request reservation), then A shall transmit in the slot in accordance with the existing reservation, or else;

d) if the existing reservation for station A to transmit was made by A itself, then A shall apply the procedure described in 1.3.6.2.2 to determine whether, in the knowledge of the reservation made by station B, the slot is available at any level 1, 2, 3 or 4, using the same values of Q2 and other parameters as originally used to select the slot. If the slot is determined to be available by this process, then A shall transmit according to its existing reservation. If the slot is no longer available, the actions specified in Table 1-12 shall be performed.

Table 1-12. Action in the event of reservation conflict

Protocol for A's existing reservation (made by A)	Protocol for B's conflicting reservation	Action by A
Slots reserved by station A using ground quarantine (see Section 1.3.6.4)	Any	Transmit according to existing reservation.
Periodic broadcast	Incremental broadcast, big negative dither unicast request, or information transfer	Transmit according to existing reservation.
Periodic broadcast	Periodic broadcast (autonomous/directed), directed request, slots reserved by ground quarantine (see Section 1.3.6.4)	If the conflict occurs later than A's next transmission in the stream, then select a new transmission slot and reduce the value of TV11 so as to cause the stream to dither to the new slot prior to the conflict; otherwise, do not transmit in the former slot, and re-establish the stream in a new slot.
Incremental broadcast or big negative dither	Any	Do not transmit in the existing reservation, and make the transmission in an alternative slot by random access (Section 1.3.7).
Unicast request (sdf = 1), or information transfer	Any	Do not transmit in the existing reservation, and apply the retransmission procedures (Section 1.3.21).

1.3.6.6 Transmission conflicts for mobile stations

Note.- The following rules describe the action that a mobile station will take when it is detecting that it is requested to transmit simultaneously in the same slot in different channels.

If a mobile station is requested to transmit in the same slot in different channels, then the station shall take the following action:

a) If there is only one transmission with the highest priority among the required transmissions, then the station shall transmit this highest priority transmission, or else;

b) If there is only one ground initiated transmission among the transmissions with the same highest priority, then the station shall transmit this ground initiated transmission, or else;

c) If there is more than one ground initiated transmission among the transmissions with the same highest priority, then the station shall transmit the last requested of these ground initiated transmission, or else;

d) If there are no ground initiated transmissions among the transmissions with the same highest priority, then the station shall transmit the first requested transmission.

1.3.7 Random access protocol specification

The station shall implement a non-adaptive p-persistent algorithm to allow equitably all stations the opportunity to transmit while maximizing system throughput, minimizing transit delays, and minimizing collisions.

Note.— Transmissions which use the random access procedures may be used to place reservations for future transmissions using the reserved access procedures (Section 1.3.6) or they may be "one-off" transmissions which place no reservations and which will conform to either the null reservation burst format (Section 1.3.9.1) or the response protocol burst format (Section 1.3.18.1)

1.3.7.1 Random access parameters

Table 1-13. Random access VSS system parameters

Symbol	Parameter name	Minimum	Maximum	Recommended default	Increment
TM2	Channel busy timer	20 slots	9000 slots	1500 slots	20 slots
p	Persistence	1/256	1	64/256	1/256
VS3	Maximum number of access attempts	1	65535	24	1

1.3.7.1.1 Timer TM2 (channel busy timer)

Timer TM2 indicates the number of slots (TM2) that a sublayer shall wait after receiving a request to transmit. This timer shall be started if it is not already running, when the VSS sublayer receives a request for random transmission. Upon a successful random transmission access attempt, the timer shall be cleared if the random transmit queue is empty and reset if it is not empty. When the timer expires, the VSS user shall be informed that the channel is congested.

1.3.7.1.2 Parameter p (persistence)

Parameter p shall be the probability that the station will transmit on any random access attempt.

1.3.7.1.3 Counter VS3 (maximum number of access attempts)

Counter VS3 shall be used to limit the maximum number of random access attempts (VS3) that a station will make for any transmission request. This counter shall be cleared upon system initialization, Timer TM2 expiring, or a successful access attempt. The counter shall be incremented after every unsuccessful random access attempt. When the counter reaches the maximum number of random access attempts, authorization to transmit shall be granted as soon as the channel is available.

1.3.7.2 Random access procedures

1.3.7.2.1 Random access procedures for transmissions starting on a slot boundary

When the station has one or more bursts to transmit for which it does not have a reservation, it shall use the p-persistent algorithm as defined in the VDL Mode 2 Technical Manual, Section 5.2.4, with the additional constraints defined below:

a) access attempts shall only be made and transmission shall only begin on a slot boundary of available slots. A station shall regard a slot or block of slots as available for a random transmission if it conforms to the criteria of any of Levels 0 through 2 in Table 1-11 using default or VSS user-supplied quality of service parameters; and

b) transmission shall not begin if the station has not previously made or received a reservation for the prior slot, and the slot is busy as defined in Section 1.2.4 at the slot boundary.

If the station is unable to select a slot, this shall be regarded as an unsuccessful random access attempt.

Note.— Consider the case where a station intends to apply a p-persistent algorithm for random transmission at the start of slot k. If the prior slot (k-1) is reserved and slot k is unreserved or effectively unreserved, the station may be confident that the transmission in slot (k-1) will terminate and garble will not occur. However, if slot (k-1) is unreserved (according to the reservation table of the station) but nonetheless busy, the station has no way of knowing whether the transmission will terminate or continue. So in this case, a physical layer measurement is necessary to ensure that the transmission has terminated. Since the measurement process takes finite time, an apparently unreserved transmission which ends close to the end of slot (k-1) may forestall a random transmission in slot k. This is unavoidable.

1.3.7.2.2 **Random access procedures for delayed transmissions**

Delayed transmissions shall use the p-persistent algorithm as defined in the *VDL Mode 2 Technical Manual*, Section 5.2.4, with the additional constraints defined below:

a) transmissions shall be delayed relative to the slot boundary in accordance with Section 1.2.5; and

b) a station shall not start a transmission if the channel is busy, as defined in Section 1.2.4, at the intended (delayed) start time.

1.3.7.2.3 **Recommendation**

When possible, a station should use the reserved access protocols described in Section 1.3.6 to reserve slots for new transmissions by adding reservation fields to transmissions for which slots have already been reserved. The random access protocol should be used only if there is no suitable opportunity to reserve a slot.

1.3.7.2.4 **Recommendation**

When possible, if there has been no previous reservation, a ground station should use ground quarantined slots (see Section 1.3.6.4) for transmission. The random access protocol should be used only if there is no suitable opportunity to use ground quarantined slots.

1.3.7.2.5 **Transmit queue management**

There shall be a single queue for all random transmissions which do not have reserved slots for transmission. This queue shall be sorted in priority order, with a higher value of Q1 being transmitted before a lower value of Q1. If Q3 is TRUE, then the queue shall be searched to determine if a burst of the same type has been queued.

1.3.8 Fixed access protocol specification

A ground station shall be capable of being pre-programmed either to not transmit in certain slots with times expressed in UTC or to transmit specific transmissions in specific slots with starting times expressed in UTC (without necessarily announcing a reservation).

1.3.8.1 Recommendation

The user should specify the use of an appropriate reservation protocol to protect future fixed transmissions.

Note 1.— The user will be able to specify a time or slot for a particular transmission and can also specify a reservation protocol to protect the next fixed transmission. For example, the user could specify a certain ground transmission at a certain time and then specify the use of the periodic reservation block to reserve the same slot in the next minute.

Note 2.— The ground infrastructure service provider is able to use this protocol together with the blocking reservation protocol (see Section 1.3.17.7.1) to organise a series of coordinated reserved slots for ground transmissions.

1.3.9 Null reservation protocol specification

1.3.9.1 Null reservation burst format

A reservation ID (rid) = 1 and a reservation data (rd) field in accordance with Table 1-14 shall indicate a null reservation. In this case, the information field shall extend up to the last 10 bits prior to the CRC.

Table 1-14. Null reservation bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
reservation data (rd) field	n-3	x	x	x	x	x	x	0	0
	n-2	0	0	0	0	0	0	0	0

Note.— Bits denoted x are available for use within the information field.

1.3.10 Periodic broadcast protocol specification

Note.— The periodic broadcast protocol is intended for those VSS users transmitting one or more times per superframe for a number of superframes. A sequence of reserved slots linked by a periodic reservation is known as a "stream". A periodic broadcast reservation burst reserves a slot in the next superframe for its own stream (i.e., a VSS user transmitting 3 times a minute has 3 streams).

1.3.10.1 Periodic broadcast reservation burst format

A reservation ID (rid) = 1 and a reservation field in accordance with Table 1-15 shall indicate a periodic broadcast reservation. In this case, the information field shall extend up to the last 10 bits prior to the CRC.

Table 1-15. Periodic broadcast reservation bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
periodic timeout (pt)	n-3	x	x	x	x	x	x	pt_2	pt_1
periodic offset (po)	n-2	po_8	po_7	po_6	po_5	po_4	po_3	po_2	po_1

Note 1.— Bits denoted x are available for use within the information field.

Note 2.— If the reservation field is all zeros, then a null reservation is being made (see Section 1.3.9). In the case of pt = 3, a combined periodic broadcast and incremental broadcast is indicated, in which case the periodic offset (po) subfield is replaced by the incremental offset (io) subfield, as described in Section 1.3.12. When io = 0 binary, only a periodic reservation is made.

The subfields shall be as defined in Table 1-16.

Table 1-16. Periodic broadcast reservation field encoding

Subfield	Range	Encoding	Definitions
periodic offset (po)	-127 to +127	two's complement math po = -128 is invalid	po identifies a slot relative to the first slot of the transmission in a future superframe
periodic timeout (pt)	0 to 3		pt is the number of superframes in the future for which a reservation is being made.

1.3.10.2 Periodic broadcast timers

1.3.10.2.1 Timer TV11 (reservation hold timer)

The timer TV11 shall control the number of successive superframes which will use the same slot for transmission (see Section 1.3.10.5) before moving to a new slot. There shall be one TV11 timer for each slot used for periodic broadcasts.

1.3.10.3 Periodic broadcast parameters

The periodic broadcast protocol shall implement the system parameters defined in Table 1-17.

Table 1-17. Periodic broadcast VSS system parameters

Symbol	Parameter name	Minimum	Maximum	Recommended default	Increment
TV11min	Reservation hold timer minimum value	0 superframes	15 superframes	4 superframes	1 superframe
TV11max	Reservation hold timer maximum value	1 superframe	16 superframes	8 superframes	1 superframe
V11	Nominal periodic rate	1 per superframe	60 per superframe	1 per superframe	1 per superframe
V12	Periodic dither range	(2/M1)*V11	1.00	0.10	0.01

TV11min shall be less or equal to TV11max.

The VSS user shall provide any of the parameters TV11min, TV11max, V11, V12 and quality of service parameters (Q2a to Q2d, Q4 and Q5) for which the default values are not desired.

1.3.10.3.1 Parameters TV11min and TV11max (reservation hold timer minimum and maximum values)

Parameters TV11min and TV11max shall be used to determine the start value for the TV11 timer, consistent with the procedure defined in Section 1.3.10.5.4.

1.3.10.3.2 Parameter V11 (nominal periodic rate)

The parameter V11 shall be the number of times per superframe that a VSS user will transmit a burst.

1.3.10.3.3 Parameter V12 (periodic dither range)

The parameter V12 shall define the range for candidate slots on either side of the nominal slot (see Section 1.3.10.5.1) from which the station shall choose a slot or group of slots to be reserved for transmission once the TV11 timer expires. V12 shall be specified as a fraction of the nominal periodic rate.

Note.— The selected slot may be chosen from a range between the nominal slot - truncate((V12/2)(M1/V11)) and the nominal slot +truncate((V12/2)*(M1/V11)) or, if this range is greater than +/- 127, a range between nominal slot - 127 and the nominal slot + 127.*

1.3.10.4 Periodic broadcast reception procedures

Upon receipt of a burst containing a periodic broadcast reservation, the station shall update its reservation table and carry out the actions as specified in Table 1-18. All reservations associated with a single periodic broadcast reservation burst shall be known as a stream.

Table 1-18. Action on receipt of periodic broadcast reservation burst

Periodic offset (po)	Periodic timeout (pt)	Action
0	0	No reservation. *Note 1.— reservation format is the same as null reservation (see Section 1.3.9)*
Any except 0	0, 1 or 2	Reserve the following slots for the source to broadcast: if pt = 1 or 2 then for j = 1 to pt, the slots equal to (j * M1) through (bl - 1 + (j * M1)) after the first slot of the received burst AND for j = pt + 1 to 4, the slots equal to (po + (j * M1)) through (bl - 1 + (po + (j * M1))) slots after the first slot of the received burst
0	1 or 2	Reserve the following slots for the source to broadcast: for j = 1 to pt, the slots equal to (j * M1) through (bl - 1 + (j * M1)) after the first slot of the received burst
any	3	Reserve the following slots for the source to broadcast: for j = 1 to 4, the slots equal to (j * M1) through (bl - 1 + (j * M1)) after the first slot of the received burst *Note 2.— The interpretation of the periodic offset subfield in the case of periodic timeout = 3 and io ? 0 binary is described in Section 1.3.12.*

The actions defined in Table 1-18 shall cancel any previous reservations for the same stream.

If a station was expecting to receive a transmission from a peer station containing a periodic broadcast reservation, but receives a transmission from the peer station containing an incremental reservation (see Section 1.3.11) or a unicast request with the source/destination flag set equal to 1 (see Section 1.3.14), the station shall cancel the periodic broadcast reservation stream for the peer station.

1.3.10.5 Periodic broadcast transmission procedures

1.3.10.5.1 Selection of nominal slots

When operating without any directed slot reservations (see Section 1.3.16.1.1) for a given VSS User application which requires periodic broadcast transmissions, a station shall select nominal slots (n_slot) which form a periodic sequence in time, considering all frequencies used, with a variation of no more than +/- 1 slot as required to accommodate the constraints imposed by the nominal reporting rate for the application and the slot rate on the channel.

When operating with a mixture of directed slot reservations (see Section 1.3.16.1.1), autonomous and directed rate reservations (see Section 1.3.16.1.1) for a given VSS User application which requires periodic broadcast transmissions, a station shall select nominal slots (n_slot) for the autonomous or directed rate which form a periodic sequence in time, considering all frequencies used, with a variation of no more than +/- 1 slot as required to accommodate the constraints imposed by the nominal reporting rate for the application and the slot rate on the channel.

Note 1.— For an application that requires periodic broadcast transmissions on multiple frequency channels, for which no directed-slot reservations have been received, the aggregate of all required transmissions should be used when calculating the nominal rate. Example 1: Two frequencies with a required update rate of once per 10 seconds on each frequency. In this case, nominal slots should be interleaved and equally-spaced to achieve an aggregate nominal rate of once per 5 seconds (i.e. considering the two channels together). Example 2: two frequencies with a required update rate of once per 15 seconds on frequency F1 and once per 5 seconds on frequency F2. In this case, the aggregate nominal rate should be once per 3.75 seconds with three successive nominal slots on F2 spaced 3.75 seconds apart, followed by a 7.5 second gap centred on a nominal slot for F1, followed by another three successive nominal slots on F2 etc.

Note 2.— A station may shift equally all the nominal slots associated with an application's autonomous or directed rate reservations forward or backward in time, so as to enhance the likelihood of finding appropriate transmission slots for the application as a whole (i.e. within the dither bands surrounding each nominal slot).

Note 3.— A station may shift individual slots or sets of slots as required to satisfy the needs of this section. This may be required, for example, if the application adds a new frequency or if the nominal rate on one of the existing frequencies is changed in real time (i.e. with a directed rate request).

Note 4.— This paragraph is relevant for transmissions using periodic reservations. It does not apply to transmissions using other reservation types, or random transmissions. For example, transmissions made using random and incremental protocols are excluded.

1.3.10.5.2 **Selection of slots for a periodic broadcast transmission**

If there is no existing periodic reservation for the VSS user, the station shall select a current transmission slot (ct_slot) corresponding to each nominal slot by inspection of the reservation table data, using the following procedure:

The station shall use the slot selection procedure specified in Section 1.3.6.2 using all slots that are within truncate((V12/2)*(M1/V11))) of n_slot and within 127 slots of n_slot, as candidate slots and the parameter settings defined in Table 1-19.

Table 1-19. Periodic broadcast QoS parameters

Symbol	Parameter name	Default
Q2a	Slot selection range constraint for level 1	300 nmi
Q2b	Slot selection range constraint for level 2	300 nmi
Q2c	Slot selection range constraint for level 3	1000 nmi
Q2d	Slot selection range constraint for level 4	1000 nmi
Q4	Number of available slots	3

*Note 1.— The station first tries to find unreserved slots in the range V12 * M1/V11 on either side of the nominal slot.*

If slot selection is unsuccessful, the station shall re-apply this slot selection, using the same candidate slots and VSS user supplied quality of service parameters.

Note 2.— If the first stage is unsuccessful, the station can use previously reserved slots of the most distant users (assuming that the quality of service parameters supplied by the VSS user allow this).

1.3.10.5.3 Calculation of slot availability

After selection of a new current transmission slot, the station shall compute the slot availability (s_avail), indicating how many consecutive superframes are available until the equivalent slot is reserved by another user. The value of s_avail shall indicate the slot (ct_slot + s_avail * M1) which is reserved by another user and shall range from 1 (for a slot that is reserved in the next superframe) to 4 (for slots that currently have no reservation for at least 3 superframes). The calculation of s_avail shall use the following rules:

a) if the current transmission slot has not been previously reserved, s_avail shall be the number of superframes that are left before the equivalent slot is reserved;

b) if the current transmission slot has been previously reserved by a station, s_avail shall be the number of superframes that are left before the equivalent slot is reserved by a different user.

1.3.10.5.4 Transmission in a new slot

If there is no prior reservation or if the station is using for the first time a slot for which there has been a prior reservation, the station shall start the timer TV11 at a value equal to s_avail, if s_avail = 1,2 or 3, and otherwise equal to a random value uniformly chosen between TV11min and TV11max.

Note.— The reservation for the new slot is maintained for TV11 superframes unless s_avail indicates that only 1, 2 or 3 superframes are available before another station has placed a reservation.

1.3.10.5.5 Transmission for TV11 greater than 3

If the TV11 timer is greater than 3 and there is no requirement to associate the current transmission with an incremental reservation, the station shall transmit a burst containing a periodic broadcast reservation in the current transmission slot with io = 0 and pt = 3. After transmission, the timer TV11 shall be decremented by one and the current transmission slot shall be incremented by M1.

1.3.10.5.6 Reservation of a new slot for TV11 equal to 1,2, or 3

If the TV11 timer is equal to 1,2 or 3 and if the VSS user requires that periodic broadcast reservations are maintained after the current transmission slot reservation expires, the station shall reserve a future transmission slot (ft_slot) for subsequent transmissions. If a future transmission slot has already been selected, there shall be no further slot selection. Otherwise, selection of ft_slot shall be carried out using the procedure set out in Section 1.3.10.5.2 using all slots that are within truncate((V12/2)*(M1/V11))) of n_slot and within 127 slots of n_slot and within 127 slots of ct_slot, except slot (ct_slot + TV11 * M1), as candidate slots.

Note.— This process selects a new slot to which the periodic broadcast transmission will move in TV11 superframes after the current transmission slot. This new slot will occupy a different position in the superframe to the current transmission slot.

1.3.10.5.7 Transmission for TV11 equal to 1, 2 or 3

If the TV11 timer is equal to 1,2 or 3 the station shall transmit a burst containing a periodic broadcast reservation in the current transmission slot with po = (ft_slot - ct_slot) and pt = TV11-1.

If a future transmission slot has not been selected and the VSS user does not require the reservation to be maintained, the value of the po shall be set to 0.

After transmission, the timer TV11 shall be decremented and the current transmission slot set equal to ct_slot + M1.

1.3.10.5.8 **TV11 equal to 0**

If the TV11 timer is equal to 0, and the VSS user requires a reservation to be maintained, then if a new slot has not been selected for further periodic broadcasts, the station shall select a new current transmission slot using the procedures set out in Section 1.3.10.5.2. If a new slot has been selected for further periodic broadcasts, the station shall set the current transmission slot equal to the future transmission slot.

The station shall start to transmit in the new current transmission slot carrying out the procedures set out in Sections 1.3.10.5.3 to 1.3.10.5.8.

If the VSS user does not require a reservation to be maintained, no further action shall be taken.

1.3.10.5.9 **Reservation cancellation**

A station wishing to cancel a stream of reservations for its own transmissions, in the absence of a reservation conflict, shall transmit a periodic broadcast reservation burst with po = 0 and pt = 0 in the next reserved slot and the timer TV11 shall be cleared. A station receiving such a burst shall clear all reservations known to be associated with the stream.

Note 1.— Because all existing reservations for a stream are cancelled on receipt of a periodic reservation burst and are replaced according to the reservation information contained in the burst (see Section 1.3.10.4), this action has the effect of cancelling the whole stream.

Note 2.— Reservation conflicts are mediated in accordance with Section 1.3.6.5, and the requirement to transmit a reservation cancellation (i.e. po = 0 and pt = 0) does not apply if the transmission would be disallowed by the considerations of that section.

1.3.11 **Incremental broadcast protocol specification**

Note.— The incremental broadcast protocol is intended for those VSS users which are transmitting multiple times per minute, but only for a minute or two. A burst reserves a number of slots for a time later in the same superframe. The number of slots reserved is equal to the burst length (see Section 1.3.5) of the burst containing the reservation.

1.3.11.1 **Incremental broadcast reservation burst format**

A reservation ID (rid) = 0 with extended reservation ID and reservation fields set in accordance with Table 1-20 shall indicate an incremental broadcast reservation. In this case, the information field shall extend up to the last 10 bits prior to the CRC.

Table 1-20. Incremental broadcast reservation bit encoding

Description	Octet	Bit Number							
		8	7	6	5	4	3	2	1
	n-3	x	x	x	x	x	x	io_8	io_7
incremental offset (io)	n-2	1	0	io_6	io_5	io_4	io_3	io_2	io_1

Note.— Bits denoted x are available for use within the information field.

The subfields shall be as defined in Table 1-21.

Table 1-21. Incremental broadcast reservation field encoding

Subfield	Range	Encoding	Definitions
incremental offset (io)	0 to 255	(See Section 1.3.11.4)	io identifies a slot relative to the first slot of the transmission

1.3.11.2 Incremental broadcast parameters

The incremental broadcast protocol shall implement the system parameters defined in Table 1-22.

Table 1-22. Incremental broadcast VSS system parameters

Symbol	Parameter name	Minimum	Maximum	Recommended default	Increment
V21	Nominal incremental period	960/M1 sec	60480/M1 sec	1.0 sec	0.1 sec
V22	Maximum incremental dither range	720/(V21* M1)	MIN(1.001-240/(V21*M1), 61200/(V21* M1) – 0.999)	MIN(0.75, maximum allowed value of V22)	0.001

The VSS user shall provide any of the parameters V21, V22 and quality of service parameters (Q2a to Q2d, Q4 and Q5) for which the default values are not desired.

Note.— The maximum value of V21 is set by the maximum allowed value of the incremental offset subfield. The minimum value of V21 and V22 is set to ensure that there are at least 5 candidate slots from which to choose a slot to be reserved.

1.3.11.2.1 Parameter V21 (nominal incremental period)

The parameter V21 shall be the nominal time after the first slot of the incremental broadcast transmission that a VSS user will transmit a burst.

1.3.11.2.2 **Parameter V22 (maximum incremental dither range)**

The parameter V22 shall define the range for candidate slots on either side of the nominal slot from which the station shall choose a slot or group of slots to be reserved for transmission. V22 shall be specified as a fraction of the nominal incremental period.

*Note.— The selected slot may be chosen from a time range between V21 +/- V22*V21.*

1.3.11.3 **Incremental broadcast reception procedures**

Upon receipt of a burst containing an incremental broadcast reservation, a station shall reserve the slot equal to (4 * io) through (bl - 1 + 4 * io) after the first slot of the received burst for the source to broadcast.

When a burst contains an incremental broadcast reservation with io = 0, then no incremental reservation shall be placed.

1.3.11.4 **Incremental broadcast transmission procedures**

1.3.11.4.1 **Selection of the transmission slot for the incremental broadcast reservation**

If no slot or group of consecutive slots, has been reserved for transmission of an incremental reservation, and if the incremental reservation is not to be combined with a periodic broadcast reservation (see Section 1.3.12), the station shall select a slot or group of consecutive slots using the random access procedures (see Section 1.3.7).

The transmission slot (t_slot) shall be the first slot of the incremental broadcast transmission.

1.3.11.4.2 **Selection of the reserved slot for the incremental broadcast reservation**

The station shall choose a slot or group of consecutive slots to reserve using the slot selection procedure specified in Section 1.3.6.2:

a) using VSS user supplied quality of service parameters; and

b) candidate slots in the range (V21*M1/60 - V22 * V21*M1/60) through (V21*M1/60 + V22*V21*M1/60 + bl -1) such that the chosen slot, or the first slot in the chosen group of slots, is an exact modulo 4 difference from t_slot.

The reserved slot (r_slot) shall be the chosen slot or the first slot in the chosen group of slots.

1.3.11.4.3 **Incremental broadcast burst transmission**

The station shall transmit an incremental broadcast burst in the transmission slot with the io set to (r_slot - t_slot)/ 4.

1.3.12 **Combined periodic broadcast and incremental broadcast protocol specification**

Note.— The periodic broadcast reservation (see Section 1.3.10) can be combined with an incremental broadcast reservation (see Section 1.3.11) when the periodic broadcast timer (TV11) is greater than 3, enabling the station to reserve a fourth slot up to 1020 slots in the future (as well as three slots in the subsequent superframes). A station may therefore use the opportunity presented by a combined periodic broadcast and incremental broadcast to reserve a slot for a different VSS user which happens to be in the

random access queue or to improve net entry performance (see Section 1.5.6.3.5) by reserving both in the next superframe (periodic broadcast) and this superframe (incremental broadcast).

1.3.12.1 Combined periodic broadcast and incremental broadcast reservation burst

A reservation ID (rid) = 1 and a reservation field in accordance with Table 1-23 shall indicate a combined periodic broadcast and incremental broadcast reservation. In this case, the information field shall extend up to the last 10 bits prior to the CRC. The periodic timeout (pt) subfield shall be set to 3. The incremental offset (io) subfield shall be as defined in Section 1.3.11.1.

Table 1-23. Combined periodic/incremental broadcast reservation bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
periodic timeout (pt) = 3	n-3	x	x	x	x	x	x	1	1
incremental offset (io)	n-2	io_8	io_7	io_6	io_5	io_4	io_3	io_2	io_1

Note.— Bits denoted x are available for use within the information field.

All other parameters and procedures shall be as specified in Sections 1.3.10 and 1.3.11.

1.3.13 Big negative dither (BND) broadcast protocol specifications

Note.— The BND can be used by a VDL Mode 4 station intending to enter a VDL Mode 4 channel/network (i.e. begin transmitting synchronization bursts on an autonomous basis), in cases where the station has listened to the channel for a few seconds but has not yet built a complete reservation table, and either: 1) it has fewer current reservations for synchronization bursts than required; or 2) it has a sufficient number of reservations, but one or more of them is about to expire (pt = 0), and the station wishes to initiate or continue periodic streams using the reservation opportunities presented by these existing reservations. The BND can be transmitted in a normal or delayed burst. The BND can also be used in the context of a normal stream of synchronization bursts, to meander a stream outside the existing maximum dither range (e.g. when the flow channel must be adjusted).

1.3.13.1 BND reservation burst format

A reservation ID (rid) = 0, an extended reservation ID (erid) = 00001binary, and reservation data set in accordance with Table 1-24 shall indicate a Big Negative Dither (BND).

Table 1-24. BND broadcast reservation bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
negative dither (nd)	n-3	x	x	x	x	x	x	nd_5	nd_4
extended reservation ID (erid)	n-2	0	0	0	0	1	nd_3	nd_2	nd_1

Note.— Bits denoted x are not used by this reservation type and shall be available for use within the information field.

The subfields shall be as defined in Table 1-25.

Table 1-25. BND broadcast reservation parameters

Subfield	Range	Encoding	Definitions
negative dither (nd)	0 to 31		nd identifies a slot relative to and earlier than the current slot +M1 - 128 slots.

1.3.13.2 BND broadcast parameters

There are no BND parameters.

1.3.13.3 BND broadcast reception procedures

Upon receipt of a burst containing a BND broadcast reservation, a station shall reserve the slots from (M1- 128 - (4 * nd)) through (M1 - 128 - (4 * nd) + (bl - 1)) after the first slot of the received burst for the source to broadcast.

Note.— This reservation type allows a station to place a reservation for a future transmission, in a slot which is likely to be unreserved (see associated transmission procedures).

1.3.13.4 BND broadcast transmission procedures

A station shall not transmit a BND reservation until it has listened to a channel for at least 254 slots and can select a slot for transmission from among those slots addressable by the BND reservation using the slot selection procedures defined in Section 1.3.6.2 and VSS user supplied quality of service parameters, Q2 and Q4.

1.3.14 Unicast request protocol specification

Note.— This protocol is intended for a VSS user which requires a response from a peer VSS user.

1.3.14.1 Unicast request reservation burst format

A reservation ID (rid) = 0 with an extended reservation ID and reservation fields set in accordance with Table 1-26 shall indicate a unicast request reservation.

Table 1-26. Unicast request reservation bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
destination address (d)	n-8	d_{24}	d_{23}	d_{22}	d_{21}	d_{20}	d_{19}	d_{18}	d_{17}
	n-7	d_{16}	d_{15}	d_{14}	d_{13}	d_{12}	d_{11}	d_{10}	d_9
	n-6	d_8	d_7	d_6	d_5	d_4	d_3	d_2	d_1
	n-5	ro_{12}	ro_{11}	ro_{10}	ro_9	res	d_{27}	d_{26}	d_{25}
response offset (ro)	n-4	ro_8	ro_7	ro_6	ro_5	ro_4	ro_3	ro_2	ro_1
length (lg)	n-3	lg_8	lg_7	lg_6	lg_5	lg_4	lg_3	lg_2	lg_1
source/destination flag (sdf), priority (pr)	n-2	0	0	1	0	sdf	res	pr_2	pr_1

The subfields and associated actions shall be as defined in Table 1-27. Bits 25, 26 and 27 of the destination address (d) subfield shall be the address type field. In the case that the address type field is equal to 7, bits 1 through 24 of the destination subfield (d) shall be absent and the information field shall extend up to the last four octets prior to the CRC. Otherwise, the information field shall extend up to the last seven octets prior to the CRC and the burst shall include the all of the destination subfield (d).

Table 1-27. Unicast request reservation field encoding

Subfield	Range	Encoding / Actions	Definitions
response offset (ro)	0 to 4095		ro identifies a slot relative to the first slot of the transmission
destination address (d)	0 to 2^{27}-1	(See Section 1.4.2.1)	d is the 27-bit address of the destination station.
source/destination flag (sdf)	Boolean	If sdf = 0, reserve the response slot for the destination station to transmit. If sdf = 1, reserve the response slot for the source station to transmit.	sdf indicates which station will respond in the reserved response slot. Note that the source station is the station placing the reservation.
length (lg)	0 to 255		lg is one less than the number of slots that are reserved for the response
priority (pr)	0 to 2	See Table 1-10	

1.3.14.2 Unicast request parameters

The unicast request protocol shall implement the system parameters as defined in Table 1-28.

Table 1-28. Unicast request VSS system parameters

Symbol	Parameter name	Minimum	Maximum	Recommended default	Increment
V32	Minimum response delay	2 slot	500 slots	20 slots	1 slot
V33	Maximum response delay	2 slot	4095 slots	1000 slots	1 slot
V34	Source/destination control	0	1	0	1
V35	Broadcast control	0	1	0	1
V36	Length of reserved block	1 slot	256 slots	N/A	1 slot

The VSS user shall provide the destination address and any of the parameters V32, V33, V34, V35, V36 and Quality of Service parameters (Q2a to Q2d, Q4 and Q5) for which the default values are not desired.

1.3.14.2.1 Parameter V32 (minimum response delay)

Parameter V32 shall be the minimum delay, measured in slot intervals, that a station will provide to a responder in order to ensure that the responder can generate the response before its reserved slot.

*Note.— V32*60/M1 is the maximum time that a station is provided with to generate a response to the request.*

1.3.14.2.2 Parameter V33 (maximum response delay)

Parameter V33 shall be the maximum delay, measured in slot intervals. that a station will provide to a responder in order to ensure timely delivery in case a retransmission is required.

1.3.14.2.3 Parameter V34 (source/destination control)

Parameter V34 shall control whether the unicast reservation protocol is used to reserve a slot for the destination station to transmit a response to the source (V34 = 0) or for the source station to transmit a response to the destination (V34 = 1). If the broadcast control parameter (V35 = 1), the value of V34 shall be ignored.

Note.— If the destination subfield is omitted (V35 = 1), then the reservation is for the source to broadcast and the value of V34 has no meaning.

1.3.14.2.4 Parameter V35 (broadcast control)

Parameter V35 shall control whether the lowest 24 bits of the destination subfield (d) are included in the reservation. If V35 = 0, then the lowest 24 bits of the destination subfield shall be included and the reservation will be for the station to transmit to or receive from a peer station. Otherwise the lowest 24 bits of the destination subfield shall be omitted, the address type field shall be set to 7 and the reservation will be for the station to make a broadcast transmission.

1.3.14.2.5 Parameter V36 (length of reserved block)

Parameter V36 shall be the number of reserved slots required for the unicast reservation protocol response.

1.3.14.3 Unicast request reception procedures

Upon receipt of a burst containing a unicast request reservation, a station shall reserve all of the slots from (1 + ro) through (1 + ro + lg) after the first slot of the received burst for:

a) the destination to transmit a response to the source (if sdf = 0 and address type field ≠ 7);

b) or for the source to transmit a response to the destination (if sdf = 1 and address type field ≠ 7); and

c) or for the source to make a broadcast transmission (if address type field = 7).

1.3.14.4 Unicast request transmission procedures

1.3.14.4.1 Selection of the transmission slot for the unicast request reservation

If no slot has been reserved for transmission of a unicast reservation, the station shall select a slot using the random access procedures (see Section 1.3.7)

The transmission slot (t_slot) shall be the slot containing the unicast request reservation transmission.

1.3.14.4.2 Selection of the reserved slot for the response

A block of slots of length V36 to be reserved for the response (address type field ≠ 7) or broadcast transmission (address type field = 7) shall be selected using the slot selection procedure specified in Section 1.3.6.2, using VSS user supplied quality of service parameters, and candidate slots in the range V32 to V33 after the transmitted burst.

The reserved slot (r_slot) shall be the chosen slot or the first slot in the chosen group of slots.

1.3.14.4.3 Unicast request burst transmission

A station sending a unicast request burst to its peer (V35 = 0) shall include the unicast request reservation field. It shall set the destination (d) subfield to the destination of the burst, the response offset (ro) subfield to a value of (r_slot - t_slot -1), the length (lg) subfield equal to (V36 – 1), the priority (pr) subfield equal to the priority of the burst to be transmitted as defined by Q1 and the source/destination flag (sdf) to V34.

A station sending a unicast request burst to reserve a slot for a subsequent broadcast (V35 = 1) shall include the unicast request reservation field. It shall set the response offset (ro) subfield to a value of (r_slot - t_slot - 1), the length (lg) subfield equal to (V36 – 1), the priority (pr) subfield equal to the priority of the burst to be transmitted as defined by Q1 and the address type field equal to 7.

1.3.14.4.4 Retransmission after no response

In the case of address type subfield ≠ 7 and sdf = 0, if a response is not received by the end of the reserved response slot(s), then the station shall retransmit the unicast burst according to the procedures of Section 1.3.21.

1.3.15 Information transfer request protocol specification

Note.— This protocol is intended for a VSS user which requires a peer VSS user to send a response of length, lg. The protocol also allows the requesting VSS user to place a reservation for an acknowledgement by the requesting VSS user to the response field.

1.3.15.1 Information transfer request reservation burst format

A reservation ID (rid) = 0 with extended reservation ID (erid) = 01010binary and reservation fields set in accordance with Table 1-29 shall indicate an information transfer request reservation. In this case, the information field shall extend up to the last nine octets prior to the CRC.

Table 1-29. Information transfer request reservation bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
acknowledgement offset (ao)	n-10	res	ao_7	ao_6	ao_5	ao_4	ao_3	ao_2	ao_1
length (lg)	n-9	lg_8	lg_7	lg_6	lg_5	lg_4	lg_3	lg_2	lg_1
response offset (ro)	n-8	ro_8	ro_7	ro_6	ro_5	ro_4	ro_3	ro_2	ro_1
	n-7	ro_{12}	ro_{11}	ro_{10}	ro_9	f_{12}	f_{11}	f_{10}	f_9
frequency (f) destination address (d)	n-6	f_8	f_7	f_6	f_5	f_4	f_3	f_2	f_1
	n-5	d_{24}	d_{23}	d_{22}	d_{21}	d_{20}	d_{19}	d_{18}	d_{17}
	n-4	d_{16}	d_{15}	d_{14}	d_{13}	d_{12}	d_{11}	d_{10}	d_9
	n-3	d_8	d_7	d_6	d_5	d_4	d_3	d_2	d_1
	n-2	0	1	0	1	0	d_{27}	d_{26}	d_{25}

The subfields shall be as defined in Table 1-30.

Table 1-30. Information transfer reservation field encoding

Subfield	Range		Encoding
response offset (ro)	See Table 1-27		
length (lg)	See Table 1-27		lg is one less than the number of slots that are reserved for the response
acknowledgement offset (ao)	0 to 127		ao identifies a slot relative to the end of the block of slots reserved by the response offset and length subfields
response offset (ro)	See Table 1-27		ro identifies a slot relative to the first slot of the transmission
destination address (d)	See Section 1.4.2.1		d is be the 27-bit address of the destination station for which the block of slots is being reserved.
frequency (f)	bit 12: frequency band indicator: 0: VHF band 108 — 136.975 MHz 1: reserved for future allocation bits 1 to 11: frequency allocation for bit 12 = 0: 1 to 1160 per frequency band in 25kHz increments. 1161 to 2047 reserved for future allocation. 1 indicates bottom of band. f = 001 hex = 108.000 MHz f = 000 hex if the subfield is to be ignored		The frequency subfield (f) identifies the frequency on which the reservation is to be made for the response. (See Section 1.3.15.5)

1.3.15.2 Information transfer request parameters

The information transfer request protocol shall implement the system parameters defined in Table 1-31.

Table 1-31. Information transfer request VSS system parameters

Symbol	Parameter name	Minimum	Maximum	Recommended default	Increment
V42	Length of information transfer	1 slot	256 slots	N/A (depends on information to be transmitted)	1 slot
V43	Minimum information transfer delay	2 slot	500 slots	20 slots	1 slot
V44	Maximum information transfer delay	2 slot	2047 slots	1000 slots	1 slot
V45	Minimum response delay	2 slot	500 slots	20 slots	1 slot
V46	Maximum response delay	2 slot	2047 slots	1000 slots	1 slot

The VSS user shall provide the destination address and any of the parameters V42, V43, V44, V45, V46 and quality of service parameters (Q2a to Q2d, Q4 and Q5) for which the default values are not desired.

1.3.15.2.1 **Parameter V42 (length of information transfer)**

Parameter V42 shall be the number of slots required for information transfer.

1.3.15.2.2 **Parameter V43 (minimum information transfer delay)**

Parameter V43 shall be the minimum delay, measured in slot intervals, that a station will provide to a responder in order to ensure that the responder can generate the required information for transfer before its reserved slots.

*Note.— V43*60/M1 is the maximum time that a station is provided with to generate a response to the request.*

1.3.15.2.3 **Parameter V44 (maximum information.transfer delay)**

Parameter V44 shall be the maximum delay, measured in slot intervals, that a station will provide to a responder in order to ensure timely delivery in case a retransmission is required.

1.3.15.2.4 **Parameter V45 (minimum response delay)**

Parameter V45 shall be the minimum delay, measured in slot intervals after the information transfer that the requesting station will require in order to generate an acknowledgement to the information transfer in order to ensure that the requesting station can generate the acknowledgement before its reserved slot.

*Note.— V45*60/M1 is the maximum time that a station is provided with to generate an acknowledgement to the information transfer.*

1.3.15.2.5 **Parameter V46 (maximum response delay)**

Parameter V46 shall be the maximum delay, measured in slot intervals after the information transfer that the requesting station will require in order to ensure timely delivery of the acknowledgement in case a retransmission is required.

1.3.15.3 **Information transfer request reception procedures**

Upon receipt of a burst containing an information transfer request reservation, a station shall reserve on the specified frequency all of the slots from (1 + ro) through (1 + ro + lg) after the first slot of the received burst for the destination to transmit one or more information frames to the source. Also, the slot equal to (2+ ro + lg + ao) after the first slot of the received burst shall be reserved for the source to transmit an acknowledgement to the destination.

1.3.15.4 **Information transfer request transmission procedures**

1.3.15.4.1 **Selection of the transmission slot for the information transfer request reservation**

If no slot has been reserved for transmission of an information transfer request reservation, the station shall select a slot using the random access procedures (see Section 1.3.7).

The transmission slot (t_slot) shall be the slot containing the information transfer request reservation transmission.

1.3.15.4.2 **Selection of the reserved slots for the response**

A block of slots of length V42 to be reserved for the response shall be selected using the slot selection procedure specified in Section 1.3.6.2, using VSS user supplied quality of service parameters, and candidate slots in the range V43 to V44 after the transmitted burst.

The reserved slot (r_slot) shall be the chosen slot or the first slot in the chosen group of slots.

1.3.15.4.3 **Selection of the reserved slot for the acknowledgement**

The acknowledgement slot (a_slot) shall be selected using the slot selection procedure specified in Section 1.3.6.2, using VSS user supplied quality of service parameters, and candidate slots in the range V45 to V46 after the end of the slot or group of slots reserved for the response.

1.3.15.4.4 **Information transfer request burst transmission**

A station sending an information transfer request burst to its peer shall include the information transfer request reservation field. It shall set the destination (d) subfield to the destination of the burst, the response offset (ro) subfield to a value of (r_slot - t_slot -1), the length (lg) subfield equal to (V42-1), the frequency (f) subfield set to the channel on which information transfer is required and the acknowledgement offset (ao) subfield set to a value of (a_slot - r_slot - lg - 1).

1.3.15.4.5 **Retransmission after no response**

If a response is not received by the reserved information transfer slots, then the station shall retransmit the information transfer burst according to the procedures of Section 1.3. 21.

1.3.15.5 Information transfer request acknowledgement procedures

The acknowledgement shall be on the same frequency as the information transfer reservation burst that was used to reserve a slot for the acknowledgement.

1.3.16 Directed request protocol specification

Note.— This protocol is intended for a VSS user which is responding to a plea for slot reservations (rapid network entry), or which requires periodic broadcast responses from a peer VSS user. Both of these scenarios involve reservations calculated and declared for use by the peer station. In addition, this protocol allows a VSS user to request that a peer VSS user autonomously transmit at a specified rate.

1.3.16.1 Directed request reservation burst format

A reservation ID (rid) = 0, an extended reservation ID (erid) = 01100binary, and reservation fields set in accordance with Table 1-32 shall indicate a directed request reservation. The length of the reservation field shall be determined by the value of the plea response flag (pr_flag). For the case of pr_flag = 1, the information field shall extend up to the last fourteen octets prior to the CRC. For the case of pr_flag = 0, the information field shall extend up to the last ten octets prior to the CRC. The nominal update rate (nr) field shall be encoded in accordance with Table 1-33. The 27-bit destination address (d) shall be the 27-bit address of the destination station for whom reservations are being created.

Note.— The directed request reservation burst may be used for a plea response, autotune, or other directed request application.

Table 1-32. Directed request reservation bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
identification of additional reservation data	n-15								
	n-14								
	n-13								
	n-12								
	n-11		per tables 1-34, 1-36 through 1-37						
	n-10								
	n-9								
	n-8								
	n-7								
nominal update rate (nr); plea response flag (pr_flag)	n-6				pr_flag	nr_4	nr_3	nr_2	nr_1
destination address (d)	n-5	d_{24}	d_{23}	d_{22}	d_{21}	d_{20}	d_{19}	d_{18}	d_{17}
	n-4	d_{16}	d_{15}	d_{14}	d_{13}	d_{12}	d_{11}	d_{10}	d_9
	n-3	d_8	d_7	d_6	d_5	d_4	d_3	d_2	d_1
extended reservation ID (erid)	n-2	0	1	1	0	0	d_{27}	d_{26}	d_{25}

Table 1-33. Nominal update rate encoding

Encoded data				Nominal update rate (transmissions per minute)
nr_4	nr_3	nr_2	nr_1	nr
0	0	0	0	1
0	0	0	1	2
0	0	1	0	3
0	0	1	1	4
0	1	0	0	5
0	1	0	1	6
0	1	1	0	8
0	1	1	1	Invalid
1	0	0	0	10
1	0	0	1	12
1	0	1	0	15
1	0	1	1	20
1	1	0	0	30
1	1	0	1	60
1	1	1	0	0
1	1	1	1	Special

1.3.16.1.1 Autotune reservation burst format

A directed request reservation burst with pr_flag = 0 shall indicate an autotune reservation. Additional reservation data shall be set in accordance with Table 1-34 with subfields defined in accordance with Table 1-35.

A reservation with do = 0, rcvr = 00binary and f ≠ current frequency is invalid and shall be handled as per Section 1.3.5.

Table 1-34. Encoding of additional data in autotune reservation burst

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
directed timeout (dt)	n-11	dt_4	dt_3	dt_2	dt_1	f_{12}	f_{11}	f_{10}	f_9
frequency (f)	n-10	f_8	f_7	F_6	f_5	f_4	f_3	f_2	f_1
length (lg)	n-9	lg_8	lg_7	lg_6	lg_5	lg_4	lg_3	lg_2	lg_1
transmit control (trmt)	n-8	res	res	trmt	do_{13}	do_{12}	do_{11}	do_{10}	do_9
directed offset (do)	n-7	do_8	do_7	do_6	do_5	do_4	do_3	do_2	do_1
override flag (or); receiver control (rcvr); nominal update rate (nr); pr_flag = 0	n-6	or	$rcvr_2$	$rcvr_1$	0	nr_4	nr_3	nr_2	nr_1

Table 1-35. Directed request reservation field encoding

Subfield	Range	Encoding	Definitions
length (lg)	0 to 255	See Table 1-27	lg is one less than the number of slots that are reserved
directed timeout (dt)	0 to 15	A value of 15 cancels the reservation	dt = the number of planned future transmissions reserved in slots spaced M1 slots apart
nominal rate (nr)	0 to 60	See Table 1-33 When pr_flag = 0, nr = special is invalid	See Table 1-33
override flag (or)	0 to 1	See Section 1.3.16.3.1	or indicates whether the current directed request reservation burst overrides all previous directed request reservations issued by the station on the indicated frequency
receiver control (rcvr)	0 to 3	00 = Station must continue to monitor the current frequency; 01 = Station must monitor the indicated frequency; 10= Autonomous decision; 11 = Station must continue to monitor the current frequency and also the indicated frequency	Defines handling of receiver tuned to frequency used to receive this burst.
transmit control (trmt)	0 to 1	0 = cancel transmissions on the current frequency (see 1.3.10.5.9)	

Subfield	Range	Encoding	Definitions
		1 = continue transmission on the current frequency (see 1.3.16.5.3)	
directed offset (do)	0 or 2 to 2^{13} – 1	do = 1: invalid	do = 0 implies directed rate reservation. do >1 implies directed slot reservation. For do>1, do = the first slot in which to transmit.
offset to first reserved slot (off)	2 to 2^{9}-1	off = 0,1: invalid	off = the first slot in which to transmit (for plea response)
additional slots (a_j)	1 to 2^{k}-1 (k=6,12)	a_j = 20 hex and nr ≠ special: invalid *Note: k is the number of bits in each a_j. k=6 for nr ≠ "special", and k=12 for nr = "special". j is the number of additional slots*	For nr ≠ "special", a_j is encoded as two's complement offset about a nominal slot defined by the offset to the first slot, and the nominal rate. For nr = special, a is encoded as a binary increment from the previously-reserved slot. a_j refers to the additional slot
frequency (f)	See 1.4.1.2	See Table 1-30	Defines new frequency for transmissions of required data.
plea response flag (pr_flag)	See 1.3.16.1		

1.3.16.1.2 Plea response burst format

A directed request reservation with pr_flag = 1 shall indicate a network entry plea response. In this case, the reservation data not previously defined shall be encoded as indicated in Tables 1-36 and 1-37 with subfields set in accordance with Table 1-35, and shall consist of: a) the offset to a first reserved slot; and b) offsets to an additional n reserved slots as appropriate. Additional reserved slots shall be encoded as follows: slots 1 to n shall be encoded in additional slots a_1 to a_n; additional slots a_{n+1} to a_N, where N is the maximum number of additional slots that can be accommodated in the formats defined by Tables 1-36 and 1-37, shall be set to zero.

Note 1. – In the format defined by table 1-36, up to 11 additional slots can be accommodated with offsets encoded using 6 bits. In the format defined by table 1-37, up to 5 additional slots can be accommodated with offsets encoded using 12 bits.

Note 2.— This protocol is intended as a response for a VSS user which has no knowledge of the reservation table and must be given a large number of reservations in a single transmission. It is primarily intended as a response to a plea for help during rapid network entry (e.g., when a peer station asks for help in setting-up a sequence of streams for synchronization bursts). However, it may be transmitted by the destination station to give itself quickly a large number of reservations.

Table 1-36. Encoding of additional data with nr ≠"special"

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
additional slots (a_j)	n-15	$a_{11,6}$	$a_{11,5}$	$a_{8,6}$	$a_{8,5}$	$a_{8,4}$	$a_{8,3}$	$a_{8,2}$	$a_{8,1}$
	n-14	$a_{11,4}$	$a_{11,3}$	$a_{7,6}$	$a_{7,5}$	$a_{7,4}$	$a_{7,3}$	$a_{7,2}$	$a_{7,1}$
	n-13	$a_{11,2}$	$a_{11,1}$	$a_{6,6}$	$a_{6,5}$	$a_{6,4}$	$a_{6,3}$	$a_{6,2}$	$a_{6,1}$
	n-12	$a_{10,6}$	$a_{10,5}$	$a_{5,6}$	$a_{5,5}$	$a_{5,4}$	$a_{5,3}$	$a_{5,2}$	$a_{5,1}$
	n-11	$a_{10,4}$	$a_{10,3}$	$a_{4,6}$	$a_{4,5}$	$a_{4,4}$	$a_{4,3}$	$a_{4,2}$	$a_{4,1}$
	n-10	$a_{10,2}$	$a_{10,1}$	$a_{3,6}$	$a_{3,5}$	$a_{3,4}$	$a_{3,3}$	$a_{3,2}$	$a_{3,1}$
	n-9	$a_{9,6}$	$a_{9,5}$	$a_{2,6}$	$a_{2,5}$	$a_{2,4}$	$a_{2,3}$	$a_{2,2}$	$a_{2,1}$
	n-8	$a_{9,4}$	$a_{9,3}$	$a_{1,6}$	$a_{1,5}$	$a_{1,4}$	$a_{1,3}$	$a_{1,2}$	$a_{1,1}$
offset to first reserved slot (off)	n-7	$a_{9,2}$	$a_{9,1}$	off_9	off_8	off_7	off_6	off_5	off_4
nominal rate(nr); pr_flag = 1	n-6	off_3	off_2	off_1	1	nr_4	nr_3	nr_2	nr_1

Table 1-37. Encoding of additional data for nr = 'special'

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
additional slots (a_j)	n-15	res	res	res	res	$a_{5,12}$	$a_{5,11}$	$a_{5,10}$	$a_{5,9}$
	n-14	$a_{5,8}$	$a_{5,7}$	$a_{5,6}$	$a_{5,5}$	$a_{5,4}$	$a_{5,3}$	$a_{5,2}$	$a_{5,1}$
	n-13	$a_{4,8}$	$a_{4,7}$	$a_{4,6}$	$a_{4,5}$	$a_{4,4}$	$a_{4,3}$	$a_{4,2}$	$a_{4,1}$
	n-12	$a_{4,12}$	$a_{4,11}$	$a_{4,10}$	$a_{4,9}$	$a_{3,12}$	$a_{3,11}$	$a_{3,10}$	$a_{3,9}$
	n-11	$a_{3,8}$	$a_{3,7}$	$a_{3,6}$	$a_{3,5}$	$a_{3,4}$	$a_{3,3}$	$a_{3,2}$	$a_{3,1}$
	n-10	$a_{2,8}$	$a_{2,7}$	$a_{2,6}$	$a_{2,5}$	$a_{2,4}$	$a_{2,3}$	$a_{2,2}$	$a_{2,1}$
	n-9	$a_{2,12}$	$a_{2,11}$	$a_{2,10}$	$a_{2,9}$	$a_{1,12}$	$a_{1,11}$	$a_{1,10}$	$a_{1,9}$
	n-8	$a_{1,8}$	$a_{1,7}$	$a_{1,6}$	$a_{1,5}$	$a_{1,4}$	$a_{1,3}$	$a_{1,2}$	$a_{1,1}$
offset to first reserved slot (off)	n-7	res	res	off_9	off_8	off_7	off_6	off_5	off_4
nominal rate (nr); pr_flag = 1	n-6	off_3	off_2	off_1	1	1	1	1	1

1.3.16.2 Directed request parameters

The directed request protocol shall implement the system parameters defined in Table 1-38.

Table 1-38. Directed request VSS system parameters

Symbol	Parameter Name	Minimum	Maximum	Recommended default	Increment
V52	Minimum response delay	1 slot	500 slots	20 slots	1 slot

The VSS user shall provide the destination address and any of the parameters V52 and quality of service parameters (Q2a to Q2d, Q4 and Q5) for which the default values are not desired.

1.3.16.2.1 Parameter V52 (minimum response delay)

Parameter V52 shall be the minimum time that a station will provide to a responder in order to ensure timely delivery in case a retransmission is required.

1.3.16.3 Directed request reception procedures

1.3.16.3.1 Autotune reception procedures

Upon receipt of a burst containing an autotune reservation (pr_flag = 0), the station shall update its reservation table and carry out the actions as specified in Table 1-39.

Table 1-39. Action on receipt of an autotune reservation burst

Directed offset (do)	Directed timeout (dt)	Action
0	any	See 1.3.16.5.2.
1	any	Invalid
1 < do < M1	dt < 15	Reserve the following slots for the destination to broadcast: for j equal to 0 to 3 and k equal to 0 to nr - 1, the slots equal to truncate (do + (k * M1/nr) + j * M1) through (lg + truncate (do + (k * M1/nr) + j * M1)) after the first slot of the received burst
1 < do < M1	dt = 15	Reserve the following slots for the destination to broadcast: for k equal to 0 to nr - 1, the slots equal to truncate (do + (k * M1/nr)) through (lg + truncate (do + (k * M1/nr))) after the first slot of the received burst
do > M1-1	any	Invalid

If the override (or) flag is set to 1, the destination station shall cancel all previously placed autotune reservations made by the source station on frequency f (see Section 1.3.10.5.9), otherwise it shall retain them.

Note 1.— In the case of dt = 15, slots are reserved in the current superframe for the destination to transmit periodic broadcast reservation bursts with po = 0 and pt = 0. These bursts have the effect of cancelling the directed reservations for each slot (see Sections 1.3.16.4.4 and 1.3.16.5.4).

Note 2.— Only the destination station cancels previously placed reservations (e.g. due to a directed request with the override bit set). Other stations wait until the destination station announces its intent before updating their reservation table.

The burst is invalid, and shall be handled as per Section 1.3.5, if the frequency subfield is equal to 000 hex, or fails to map to a known frequency, or indicates a frequency on which the transmitter cannot transmit.

1.3.16.3.2 Plea response reception procedures

Upon receipt of a burst containing a plea response reservation (pr_flag = 1), a station shall reserve the slots equal to 'off' after the first slot of the received burst and the series of slots r_j for the destination to broadcast.

If nr ≠ 'special', then r_j shall be:

$$r_j = (\text{off} + \text{truncate}\ (j * M1/nr) + a_j) \text{ for } j = 1 \text{ to } N,$$

where N is the maximum number of additional slots defined in the additional slots subfield (see Section 1.3.16.1.2),

If nr = 'special', then r_j shall be defined as:

$$r_j = (\text{off} + \Sigma_{m=1}^{j} a_m) \text{ for } j = 1 \text{ to } N$$

Note.— Burst length is not included in the plea response, so these reservations are for single slots only.

1.3.16.4 Directed request transmission procedures

1.3.16.4.1 Recommendation

Note.— Selection of slots for directed request transmission can use the general procedures set out in Section 1.3.6.2 or use fixed transmission procedures (1.3.8). Since it is expected that the autotune reservation protocol will be used only by ground stations, the fixed transmission procedures are recommended, implemented in a manner that takes advantage of ground quarantining (see Section 1.3.6.4) and causes the formation of contiguous groups of ground directed slots.

The directed request protocol with pr_flag = 0 (autotune reservation) should only be used by ground stations and should use fixed transmission procedures to select slots for transmission of the autotune reservation burst and to form contiguous blocks of directed reservations.

The transmitting station should ensure that, if two users are allocated the same slots, they are sufficiently separated and on divergent paths such that the possible loss of communications between them is not significant.

1.3.16.4.2 Autotune transmission procedures

A station sending an autotune reservation (pr_flag = 0) to its peer shall set the destination (d) subfield to the destination of the burst, the frequency (f) subfield to the frequency on which the responder shall transmit, the directed offset (do) subfield to either 0 (for a directed rate reservation), or the offset from the

first slot of the autotune reservation burst to the first slot in which to transmit (for a directed slot reservation), the nominal rate (nr) subfield to the number of times per M1 slots that a response is requested using the encoding defined in Table 1-33, and the directed timeout (dt) subfield to the span of dt*M1 slots over which the destination shall transmit. The value of the directed offset (do) subfield shall be greater than V52.

1.3.16.4.3 **Retransmission after no response**

There shall be no automatic retransmission of plea response bursts (pr_flag = 1). For autotune reservation bursts (pr_flag = 0), if a response is not received in the first directed slot after the autotune burst was transmitted, then the station shall retransmit the autotune reservation burst according to the procedures of Section 1.3.21.

1.3.16.4.4 **Cancellation of autotune reservation**

A station shall cancel an autotune reservation (pr_flag = 0) by transmitting an autotune reservation field with the directed timeout subfield set to 15. It shall set the destination subfield to the destination of the burst, the frequency subfield to the frequency on which the responder has previously been directed to broadcast, the directed offset (do) to the offset from the first slot of the autotune reservation burst to the first slot for which a reservation shall be cancelled and the nominal rate subfield to the number of slots per M1 slots for which a reservation shall be cancelled.

Note.— The settings of the directed offset and nominal rate subfields are the same as the original settings used to place the reservations. Hence this form of the autotune reservation can be used to exactly cancel a previous reservation. This protocol can also be used to cancel a subset of the reports established by the original autotune command. For example, if the directed reporting rate is 12/minute, a cancellation with nominal rate subfield set to 6/minute would leave a net reporting rate of 6/minute.

1.3.16.4.5 **Plea response transmission procedures**

A station transmitting a plea response (pr_flag = 1) shall set the destination (d) to the destination of the burst, the offset (off) subfield to the offset from the first slot of the reservation burst to the first slot in which to transmit, and the nominal rate (nr) subfield to the nominal number of times per M1 slots that a synchronization burst is to be sent on the frequency used for transmission. The value of the offset (off) subfield shall be greater than V52. A station shall ensure that the slots selected in the transmission satisfy the nominal update rate requirements and all of the requirements of Section 1.3.6.2. A station shall check to determine if a previous plea response had been sent to the mobile making the plea (i.e. the destination ID for this plea response), and if so, it shall begin the list of reserved slots with the remaining (future) reservations from the earlier plea response.

Note.— When the plea response can not encode sufficient reservations for a full 60 seconds, the destination station may issue a subsequent plea as the initial set of reservations is consumed.

1.3.16.5 **Directed request response procedures**

1.3.16.5.1 **Response to an autotune reservation with do > 1**

On receipt of an autotune reservation transmission (pr_flag = 0) with the directed offset subfield (do) greater than 1, the responder station indicated by the destination address shall set the TV11 timer (see Section 1.3.10.2.1) equal to the value of the directed timeout (dt) subfield for each of the slots indicated in the autotune reservation transmission. The responder station shall transmit in each of the reserved slots. Each response burst shall contain the periodic broadcast reservation field with the periodic offset (po) subfield set to 0 and the periodic timeout (pt) subfield set to min(3, TV11-1). After transmission, the timer TV11 shall be decremented. When TV11 reaches zero, the responder shall not transmit a response

to the directed request. Upon cessation of directed transmissions, the responder shall resume default autonomous behaviour on the GSCs, reserving new slots as required.

Note 1.— For example, when a station completes its series of directed synchronization burst transmissions on a local channel, it will resume autonomous synchronization bursts on the GSCs. This behaviour allows a ground station to implicitly hand-off a mobile as the mobile departs a defined airspace, and also ensures appropriate behaviour if the mobile unexpectedly flies out-of-coverage or the ground station fails.

Note 2.— When a station is no longer required to transmit a response to the directed request, it will revert to the autonomous mode as described in Section 1.5.6.1.2.

1.3.16.5.1.1 **Recommendation**

To simplify and ease the transition from a) directed slot operations on local channels, to b) directed rate or autonomous mode operations on another channel, ground stations should attempt to autotune mobile stations (using a directed slot reservation) to the new channel, for a period of at least 60 seconds, prior to release. The mobile station should then use the BND reservation to continue the stream while it is building the reservation table and operating under ground control.

1.3.16.5.2 **Response to an autotune reservation with do = 0.**

If the directed offset subfield is equal to 0, the responder station shall operate autonomously using the periodic broadcast procedures with the nominal periodic rate (V11) set to nr in the autotune reservation transmission for the next dt*M1 slots, with the first two bits of the message ID field set to "00". Upon cessation of directed transmissions, the responder shall resume default autonomous behaviour on the GSCs, reserving new slots as required.

Note 1.— For example, when a station completes its series of directed synchronization burst transmissions on a local channel, it will resume autonomous synchronization bursts on the GSCs. This behaviour allows a ground station to implicitly hand-off a mobile as the mobile departs a defined airspace, and also ensures appropriate behaviour if the mobile unexpectedly flies out-of-coverage or the ground station fails.

Note 2.— When a station is no longer required to transmit a response to the directed request, it will revert to the autonomous mode as described in Section 1.5.6.1.2.

1.3.16.5.3 **Cancellation of autonomous periodic broadcasts**

If trmt = 0 and if the responder was transmitting autonomously the VSS user data for which a directed request reservation was received, then it shall cancel its existing reservations in accordance with paragraph 1.3.10.5.9, and operate in accordance with the parameters of the directed request. If trmt = 1 and if the responder was transmitting autonomously on the channel on which a directed request reservation was received, then it shall maintain its autonomous transmissions on the channel.

1.3.16.5.4 **Cancellation of directed request broadcasts**

If the responder receives a directed request reservation burst with the directed timeout subfield set to 15, then it shall cancel its existing reservations in accordance with paragraph 1.3.10.5.9.

1.3.16.5.5 **Response if unable to support directed request**

If the responder is unable to support the directed request it shall transmit a general failure (see section 1.3.20.1) with error type 05 hex. If there are insufficient receiver resources to meet the request it shall set bit 1 of the parameter sub-field to 1. All other bits in the parameter sub-field shall be set to 0.

1.3.16.5.6 **Recommendation**

If possible, a responder sending a general failure should use slots reserved by the ground station on the channel indicated in the directed request. Otherwise, the station should use the combined periodic/incremental reservation protocol to place the transmission on the channel on which the directed request was received.

1.3.17 **Block reservation protocols specification**

Note.— These protocols are intended for a VSS ground station which requires to reserve a block of slots for its own use. The superframe block reservation protocol establishes a series of blocks of slots in which no other station is allowed to place a reservation or to transmit. The second frame block reservation protocol establishes a block at the beginning of each UTC second. Network entry transmissions are also prohibited (see 1.3.6.4.3) in both types of blocks. The superframe block reservation protocol provides a facility for re-broadcasting of the block reservation by a mobile.

1.3.17.1 **Superframe block reservation burst format**

A reservation ID (rid) = 0, an extended reservation ID (erid) = 110, and reservation fields set in accordance with Table 1-40, with subfields defined in accordance with Table 1-41, shall indicate a superframe block reservation. The information field shall extend up to the last nine octets prior to the CRC. A burst containing a superframe block reservation shall not exceed twenty-one octets (not including the CRC).

Table 1-40. Superframe block reservation bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
destination address (d)	n-10	d_{24}	d_{23}	d_{22}	d_{21}	d_{20}	d_{19}	d_{18}	d_{17}
	n-9	d_{16}	d_{15}	d_{14}	d_{13}	d_{12}	d_{11}	d_{10}	d_9
	n-8	d_8	d_7	d_6	d_5	d_4	d_3	d_2	d_1
block length (blg)	n-7	blg_5	blg_4	blg_3	blg_2	blg_1	d_{27}	d_{26}	d_{25}
re-broadcast offset (roff)	n-6	$roff_8$	$roff_7$	$roff_6$	$roff_5$	$roff_4$	$roff_3$	$roff_2$	$roff_1$
block repeat rate (br)	n-5	res	res	res	res	br_4	br_3	br_2	br_1
block start (bs)	n-4	bs_8	bs_7	bs_6	bs_5	bs_4	bs_3	bs_2	bs_1
block offset (bo)	n-3	bo_8	bo_7	bo_6	bo_5	bo_4	bo_3	bo_2	bo_1
extended reservation ID (erid), block timeout (bt)	n-2	0	0	0	1	0	res	bt_2	bt_1

Table 1-41. Superframe reservation field encoding

Subfield	Range	Encoding	Definitions
block timeout (bt)	0 to 3		bt * M1 = the number of slots for which the block reservation should be maintained
block repeat rate (br)	1 to 60	See Table 1-33. Codes 0111, 1110 and 1111 are invalid	Defines the number of blocks per minute
re-broadcast offset (roff)	2 to 255	bs = 0,1 invalid	roff indicates the slot in which the re-broadcast transmission should be made
block start (bs)	2 to 255	bs = 0,1 invalid	bs identifies a slot relative to the transmission slot which is the first slot of the first reserved block
block offset (bo)	–127 to +127	Two's complement math	bo identifies an offset of each reserved block at a future time defined by bt * M1
block length (blg)	0 to 31		blg is one less than the number of slots reserved for the block
destination address (d)	See Table 1-27	Ignored if ro = bs and octets n – 10 through n – 8 available for use within the information field.	d is the 27-bit address of the destination station which is required to re-broadcast the blocking message

1.3.17.2 Second frame block reservation burst format

A reservation ID (rid) = 0, an extended reservation ID (erid) = 00011, and reservation fields set in accordance with Table 1-42, with subfields defined in accordance with Table 1-43, shall indicate a second frame block reservation. The information field shall extend up to the last two octets prior to the CRC.

Table 1-42. Second frame block reservation bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
timeout (vt)	n – 3	vt_6	vt_5	vt_4	vt_3	vt_2	vt_1	sz_5	sz_4
size (sz)	n – 2	0	0	0	1	1	sz_3	sz_2	sz_1

Table 1-43. Second frame block reservation field encoding

Subfield	Range	Definitions
size (sz)	0 to 31	Number of slots to block after the start of each UTC second.
timeout (vt)	1 to 60	Value of TV61

1.3.17.3 Superframe block reservation parameters

The superframe block reservation protocol shall implement the system parameters defined in Table 1-44.

Table 1-44. Superframe block reservation VSS system parameters

Symbol	Parameter name	Minimum	Maximum	Default	Increment
V61	Superframe block start offset	2	255	20	1
V62	Superframe block length	1	32	3	1
V63	Superframe block repeat rate	1	60	5	See Table 1-33 for allowed values
V64	Superframe block re-broadcast request	No	Yes	No	-
V65	Superframe block re-broadcast offset	2	255	10	1

For each superframe block reservation, the VSS user shall provide one or more sets of parameters consisting of:

a) the time of the required superframe block ground transmission;

b) the parameters V61 and V65 for which the default values are not desired;

c) quality of service parameters (Q2a to Q2d, Q4 and Q5) for which the default values are not desired.

The station shall use the first set of parameters to calculate the position and subfield settings for the first ground station transmission as specified in Section 1.3.17.7.1 and then use each following sets to move the position of the reserved blocks. Where possible, the station shall pre-announce that a block is to move using the block offset subfield as defined in Section 1.3.17.7.1.

1.3.17.3.1 Parameter V61 (superframe block start offset)

Parameter V61 shall be the offset to the start of the first reserved block from the slot containing the ground transmission.

1.3.17.3.2 Parameter V62 (superframe block length)

Parameter V62 shall be the length in slots of each reserved block.

1.3.17.3.3 Parameter V63 (superframe block repeat rate)

Parameter V63 shall be number of reserved slots per M1 slots encoded as defined in Table 1-33.

1.3.17.3.4 **Parameter V64 (superframe block re-broadcast request)**

Parameter V64 shall determine whether the superframe block reservation request is to be re-broadcast by a mobile using the procedures defined in Section 1.3.17.7.2.

1.3.17.3.5 **Parameter V65 (superframe block re-broadcast offset)**

Parameter V65 shall be the offset to the slot containing the re-broadcast from the slot containing the ground transmission.

1.3.17.4 **Superframe block reservation reception procedures**

Upon receipt of a burst containing a superframe block reservation, the station shall update its reservation table and carry out the actions as specified in Tables 1-45 and 1-46.

Note.— The actions defined in Table 1-45 establish a series of reserved blocks of slots.

Table 1-45. Actions on receipt of a superframe block reservation burst

Block start (bs)	Block offset (bo)	Block timeout (bt)	Action
bs < 2	Any	Any	Invalid
bs ≥ 2	Any except 0	0, 1, 2	Reserve the following slots for the source or a mobile directed by the source to broadcast: if bt = 1 or 2 then for j equal to 0 to bt and k equal to 0 to br – 1, the slots equal to truncate (bs + (k * M1 / br) + j * M1) through (blg + truncate (bs + (k * M1 / br) + j * M1)) after the first slot of the received burst AND for j equal to bt + 1 to 3 and k equal to 0 to br – 1, the slots equal to truncate (bs + bo + (k * M1 / br) + j * M1) through (blg + truncate (bs + bo + (k * M1 / br) + j * M1)) after the first slot of the received burst
bs ≥ 2	0	0, 1 or 2	Reserve the following slots for the source or a mobile directed by the source to broadcast: for j equal to 0 to bt and k equal to 0 to br – 1, the slots equal to truncate (bs + (k * M1 / br) + j * M1) through (blg + truncate (bs + (k * M1 / br) + j * M1)) after the first slot of the received burst Thereafter, terminate the reservations.
bs ≥ 2	Any	3	Reserve the following slots for the source or a mobile directed by the source to broadcast: for j equal to 0 to bt and k equal to 0 to br - 1, the slots equal to truncate (bs + (k * M1 / br) + j * M1) through (blg + truncate (bs + (k * M1 / br) + j * M1)) after the first slot of the received burst

Note.— The actions in Table 1-46 reserve the slot used by the station to provide a superframe block reservation in subsequent superframes.

Table 1-46. Further actions on receipt of a superframe block reservation burst

Block offset (bo)	Block timeout (bt)	Action
Any except 0	0, 1, 2	Reserve the following slots for the source to broadcast: if bt = 1 or 2 then for j equal to 1 to bt, the slot equal to (j * M1) after the first slot of the received burst AND for j equal to bt + 1 to 3, the slot equal to (bo + j * M1) after the first slot of the received burst
0	0, 1 or 2	Reserve the following slots for the source to broadcast: for j equal to 1 to bt, the slot equal to (j * M1) after the first slot of the received burst Thereafter, terminate the reservations.
Any	3	Reserve the following slots for the destination to broadcast: for j equal to 1 to bt, the slot equal to (j * M1) after the first slot of the received burst

If the re-broadcast offset (roff) is not equal to the block start (bs), the station shall carry out the actions specified in Table 1-47.

Note.— The actions in Table 1-47 are carried out if a ground station wishes to re-broadcast the block message via a mobile.

Table 1-47. Action on receipt of a superframe block reservation burst if roff is not equal to bs

Re-broadcast offset (roff)	Block offset (bo)	Block timeout (bt)	Action
roff < 2	Any	Any	Invalid
roff ≥ 2	Any except 0	0, 1, 2	Reserve the following slots for the destination to broadcast: if bt = 1 or 2 then for j equal to 0 to bt, the slot equal to (roff + j * M1) after the first slot of the received burst AND for j equal to bt + 1 to 3, the slot equal to (roff + bo + j * M1) after the first slot of the received burst
roff ≥ 2	0	0, 1 or 2	Reserve the following slots for the destination to broadcast: for j equal to 0 to bt, the slot equal to (roff + j * M1) after the first slot of the received burst Thereafter, terminate the reservations.
roff ≥ 2	Any	3	Reserve the following slots for the destination to broadcast: for j equal to 0 to bt, the slot equal to (roff + j * M1) after the first slot of the received burst

1.3.17.5 Second frame block reservation parameters

The VSS user shall provide a value for the parameter TV61, defined in Table 1-48, for which the default values are not desired.

Table 1-48. Second frame block reservation parameters

Symbol	Parameter Name	Minimum	Maximum	Default	Increment
TV61	Second frame block reservation timeout	1 superframe	60 superframes	4 superframes	1 superframe
V66	Second frame block size	0	31	8	1
V67	Second frame block repeat rate	0	60	3	See Table 1-33 for allowed values

For each second frame block reservation, the VSS user shall provide one or more sets of parameters consisting of the parameters V66 and V67 for which the default values are not desired and quality of service parameters (Q2a to Q2d, Q4 and Q5) for which the default values are not desired.

1.3.17.5.1 Timer TV61 (second frame block reservation timeout)

The timer TV61 shall control the time which a second frame block reservation is valid. When timer TV61 times out the mobile station shall return to the initial state defined in Table 1-48.

1.3.17.5.2 Parameter V66 (second frame block size)

Parameter V66 shall be the size of the second frame block.

1.3.17.5.3 Parameter V67 (second frame block repeat rate)

Parameter V67 shall be number of times per M1 slots that a second frame reservation transmission is repeated encoded as defined in Table 1-33.

1.3.17.6 Second frame block reservation reception procedures

Upon receipt of a burst containing a second frame block reservation, the station shall update its reservation table by reserving the first sz slots of every UTC second and set the timer TV61.

1.3.17.7 Superframe block reservation transmission procedures

1.3.17.7.1 Recommendation

Note.— Selection of slots for superframe block transmission can use the general procedures set out in Section 1.3.6.2 or use fixed transmission procedures (see Section 1.3.8). Since it is expected that the superframe block reservation protocol will be used only by ground stations, the fixed transmission procedures are recommended.

The superframe block reservation protocol should only be used by ground stations and should use fixed transmission procedures to select slots for transmission of the superframe block reservation bursts. The superframe block reservation should only be used by a mobile under ground direction as the result of a prior superframe block reservation burst issued by a ground station with the re-broadcast offset (roff) subfield not equal to the block start (bs) subfield.

1.3.17.7.2 Procedures for establishment of reserved blocks of slots

A station shall establish reserved blocks of slots by broadcasting a superframe block reservation. The station shall set the block start (bs) subfield to the offset from the first slot of the transmitted burst to the first slot of the first reserved block of slots as defined by parameter V61, the block repeat rate (br) subfield to the number of blocks per M1 slots defined by V63 using the encoding defined in Table 1-33, the block length (blg) equal to one less than V62 and the block timeout (bt) subfield to the span of bt*M1 slots over which the reservations defined by bs and br should be maintained. If the value of bt is equal to 0, 1 or 2, the value of the block offset (bo) subfield shall be set to 0 if it is intended that the superframe block reservation shall terminate after bt*M1 slots, or the offset from the first slot of the first reserved block if it is intended that the block reservation shall move after bt*M1 slots. The value of bt shall not be set to –128.

1.3.17.7.3 Cancellation of reserved blocks of slots

A station shall cancel a superframe block reservation by transmitting a superframe block reservation field with bt equal to 0, 1 or 2 and bo equal to 0, in which case the superframe block reservation will be cancelled after M1 * bt + bs slots. It shall set the block start (bs) to the offset from the first slot of the transmitted burst to the first slot of the first block for which a reservation shall be cancelled as defined by parameter V61, the block length (blg) equal to one less than V62 and the block repeat rate (br) subfield to the number of blocks per M1 slots defined by parameter V63 for which a superframe block reservation shall be cancelled, using the encoding defined in Table 1-33.

Note.— The settings of the block start and block repeat rate subfields are the same as the original settings used to place the reservations.

1.3.17.7.4 Procedures to request re-broadcasting of a superframe block reservation

To request that a station, B, re-broadcast the superframe block reservation, station A shall transmit a superframe block reservation. Station A shall set the destination (d) to the address of station B and set the re-broadcast offset (roff) subfield to the offset from the first slot of the reservation burst to the first slot in which B should transmit. The value of the re-broadcast offset (roff) subfield shall be less than the value of the block start (bs) subfield.

If no re-broadcast of the superframe block message is required, the ground station shall set the re-broadcast offset (roff) subfield equal to the block start (bs) subfield and shall not include a destination (d) subfield.

Note.— The ground station establishes a reservation for station B to respond with the re-broadcasted superframe block message.

1.3.17.8 Rebroadcast request superframe block reservation response procedures

On receipt of a superframe block reservation directed to itself, station B shall transmit a superframe block reservation in the directed slot. The station shall set the block repeat rate (br), block offset (bo) and block timeout (bt) subfields to the values contained in the received burst. The station shall set the block start (bs) so as to indicate the same first slot of the first block as was directed in the received superframe block reservation, calculated relative to the first slot of the transmission. The station shall set the re-broadcast offset (roff) subfield equal to the block start (bs) subfield and shall not include a destination subfield.

1.3.17.9 Second frame block reservation transmission procedures

1.3.17.9.1 Recommendation

A ground station infrastructure which needs to maintain a virtual link management channel (VLMC) should not set the size (sz) subfield to zero.

Note.— The second frame block reservation protocol is used to extend or reduce the VLMC.

1.3.17.9.2 Procedures for establishment of reserved blocks of slots

When a ground station wishes to modify the length of the reserved blocks of slots in each second, it shall broadcast a second frame block reservation, V67 times per M1 slots. The station shall set the block size (sz) subfield to the desired number of slots after the start of each UTC second as defined by parameter V66.

1.3.18 Response protocol specification

1.3.18.1 Response burst format

A reservation ID (rid) = 0 with extended reservation ID (erid) = 00000binary and reservation fields set in accordance with Table 1-49 shall indicate a response burst. In the case that the address type field (see Section 1.3.14.1) is equal to 7, bits 1 through 24 of the destination subfield (d) shall be absent and the information field shall extend up to the last one octet prior to the CRC. Otherwise, the information field shall extend up to the last four octets prior to the CRC and the destination subfield (d) shall be the 27-bit address of the destination station (for which the response is addressed). No reservation shall be made as a result of receiving a response burst.

Table 1-49. Response burst reservation bit encoding

Description	Octet	Bit Number							
		8	7	6	5	4	3	2	1
destination address (d)	n-5	d_{24}	d_{23}	d_{22}	d_{21}	d_{20}	d_{19}	d_{18}	d_{17}
	n-4	d_{16}	d_{15}	d_{14}	d_{13}	d_{12}	d_{11}	d_{10}	d_9
	n-3	d_8	d_7	d_6	d_5	d_4	d_3	d_2	d_1
reservation ID	n-2	0	0	0	0	0	d_{27}	d_{26}	d_{25}

The VSS user shall provide the destination address.

Note 1.— In the typical application, the response will be broadcast; however, some applications might require a unicast response.

Note 2.— The response burst with the address type field set equal to 7 is intended as an alternative to the null reservation type defined in Section 1.3.9.

1.3.19 General request protocol specification

1.3.19.1 General request burst format

To request a peer station to transmit a particular burst, a station shall send the burst described in Table 1-50 to the desired destination station. VSS user-specific parameters shall be encoded starting in the octet following the most significant (high order) bit of the r-mi field. Unused bits (x) shall be filled with 0 on transmit and shall be ignored on receive.
The values of the subfields shall be computed as defined in Table 1-51.

Table 1-50. General request bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
	5	$r\text{-}mi_1$	0	0	0	0	0	0	1
requested message ID (r-mi)	6	x	$r\text{-}mi_n$	. . . . .					$r\text{-}mi_2$
VSS user specific parameter (prm)	7	prm_{18}	prm_{17}	prm_{16}	prm_{15}	prm_{14}	prm_{13}	prm_{12}	prm_{11}
	8	prm_{28}	prm_{27}	prm_{26}	prm_{25}	prm_{24}	prm_{23}	prm_{22}	prm_{21}
	9	prm_{38}	prm_{37}	prm_{36}	prm_{35}	prm_{34}	prm_{33}	prm_{32}	prm_{31}

	. . . . .		Denotes variable length field

Table 1-51. General request field encoding

Subfield	Range	Encoding	Notes
requested message ID (r-mi)	(See Section 1.3.2.3)		
VSS user specific parameter (prm)			defined by the VSS user

The requested message ID (r-mi) shall define the VSS user, in accordance with Table 1-6, which is responsible for handling the request.

1.3.19.2 General request procedures

1.3.19.2.1 Requester action

For a VSS user to request that a peer VSS user transmit (either broadcast or unicast request response) certain information, the VSS user shall transmit a general request burst with the requested ID (r-mi) field set to the desired response. The unicast request reservation field shall be used if a single response is required from a single station. The directed request reservation field shall be used if multiple responses are required from a single station.

1.3.19.2.2 Responder action

The addressed responder(s) shall respond in the indicated slots with the requested bursts except for the conditions specified in Section 1.3.6.5.

1.3.19.2.3 Exceptional cases

If the requested function is not supported, the responder shall send a general failure (see Section 1.3.20) with the ok bit set to 0, the requested ID (r-mi) field set to the requested VSS user, the backoff delay (bd) set to FF hex, and the error type (err) set to 00 hex (if that ground station does not support the requested function but other ground stations in the same system could support it).

If the requested function is supported, but there has been no response in time for transmission in the reserved slot, then the responder shall transmit a general failure (see Section 1.3.20) with the ok bit set to 0, the requested ID and extended ID fields set to the requested VSS user, the backoff delay set to an estimate of when the data will be available, and the error type set to either 7E hex or FE hex. Ground

stations shall use 7E hex to indicate that mobile stations might get a quicker response via a different ground station. A ground station not capable of responding because of network problems shall use the error type of either 03 hex if no response can be expected or 04 hex if a response can be expected but will be delayed.

1.3.20 General response protocol specification

1.3.20.1 General response burst format

A station shall transmit a general response burst (either a general failure or general confirm) as defined in Table 1-52 with the parameters defined in Table 1-53 in response to certain requests from another station as described below. The requested message ID (r-mi) shall indicate the identity of the peer VSS user to which a response is being generated. The general response burst shall include one of the following reservation fields: unicast request reservation, information transfer request or response. The destination subfield contained in the reservation field shall indicate which VSS user is being responded to.

Table 1-52. General response bit encoding

Description	Octet	Bit number							
		8	**7**	**6**	**5**	**4**	**3**	**2**	**1**
confirm/failure flag (ok)	5	ok	0	0	1	0	0	0	1
requested message ID (r-mi)	6	res	$r\text{-}mi_k$	. . .					$r\text{-}mi_1$
reserved bit (res)	7	res	res	res	res	res	res	res	res
backoff delay (bd)	8	bd_8	bd_7	bd_6	bd_5	bd_4	bd_3	bd_2	bd_1
error type (err)	9	err_8	err_7	err_6	err_5	err_4	err_3	err_2	err_1
VSS user specific parameter (prm)	10	prm_{18}	prm_{17}	prm_{16}	prm_{15}	prm_{14}	prm_{13}	prm_{12}	prm_{11}
	11	prm_{28}	prm_{27}	prm_{26}	prm_{25}	prm_{24}	prm_{23}	prm_{22}	prm_{21}
	12	prm_{38}	prm_{37}	prm_{36}	prm_{35}	prm_{34}	prm_{33}	prm_{32}	prm_{31}

	. . . . .		Denotes variable length field

Table 1-53. General response field encoding

Subfield	Range	Encoding	Notes
confirm/failure flag (ok)		1 = General confirm 0 = General failure	
requested message ID (r-mi)	(See Section 1.3.2.3)		can extend into octet 7 for long extended ids
reserved bit (res)	0	0	send 0, ignore on receive
backoff delay (bd)	0 to 255	integer seconds, FF hex = forever	in seconds, ignore on confirm
error type (err)	See Table 1-54		
VSS user specific parameter (prm)	Defined by the VSS user		

The requested message ID (r-mi) shall define the VSS user, in accordance with Table 1-6, which is responsible for handling the response.

If the ok bit is set to 1 (i.e., a general confirm), and the response does not utilise the parameter field, the information field shall contain the requested message ID (r-mi) subfield only and the remaining parameters shall be omitted. If the ok bit is set to 1 and the parameter field is used, then the bd and err fields shall be included and set to 00 hex. If the ok bit is set to 0 (i.e., a general failure), then the remaining parameters shall define the reason why the request failed.

Error type (err) shall be encoded in accordance with Table 1-54; error types 00 hex to 7F hex shall apply to the responding station; error types 80 hex to FF hex shall apply to the responding system. A VSS user receiving a general failure with an error type less than 80 hex shall not transmit another request to that peer station for the duration of time designated by the backoff delay (bd) subfield (in seconds). A VSS user receiving a general failure with an error type greater than 7F hex shall not transmit another request to that peer system for the duration of time designated by the backoff delay (bd) subfield (in seconds).

Note.— That is, a mobile VSS user receiving a ground station-based error type from one ground station may immediately transmit the same request to another ground station of the same ground system.

Table 1-54. Error type definition

<table>
<tr><th rowspan="2">Cause</th><th rowspan="2">Function</th><th colspan="8">Parameter Encoding (prm bits 1 to 8)</th></tr>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td>00 hex</td><td>Unsupported local function.
The parameters (defining the protocol options supported) will be filled in when defined.</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>01 hex</td><td>Out of local resources</td><td colspan="8">Reserved</td></tr>
<tr><td>02 hex</td><td>VSS user-specific local error</td><td colspan="8">Defined by the VSS user</td></tr>
<tr><td>03 hex</td><td>Terrestrial network not available</td><td colspan="8" rowspan="5">Reserved.
Set to zero on transmit, ignore on
receipt.</td></tr>
<tr><td>04 hex</td><td>Terrestrial network congestion</td></tr>
<tr><td>05-7D hex</td><td>Reserved</td></tr>
<tr><td>7E hex</td><td>No response from VSS user</td></tr>
<tr><td>7F hex</td><td>Other unspecified local reason.</td></tr>
<tr><td>80 hex</td><td>Unsupported global function.
The parameters (defining the protocol options supported) will be filled in when defined.</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>81 hex</td><td>Out of global resources</td><td colspan="8">Reserved</td></tr>
<tr><td>82 hex</td><td>VSS user-specific global error</td><td colspan="8">Defined by the VSS user</td></tr>
<tr><td>83 to FD hex</td><td>Reserved</td><td colspan="8" rowspan="3">Reserved.

Set to zero on transmit, ignore on receipt.</td></tr>
<tr><td>FE hex</td><td>No response from VSS user</td></tr>
<tr><td>FF hex</td><td>Other unspecified system reason.</td></tr>
</table>

1.3.20.2 General response procedures

If a reservation has been placed for a response or acknowledgement but the VSS sublayer has not received the response or acknowledgement from the VSS user in time for the scheduled reservation, the station shall send a general failure (see Section 1.3.20) with cause code 7E hex or FE hex.

If a response is received, the VSS shall inform the VSS user.

1.3.21 Retransmission procedures

After transmitting a burst containing a reservation for a peer station (i.e., unicast request reservation, directed request reservation, information transfer request reservation) and not receiving a response by the expected slot, a station shall either retransmit the request or inform the VSS user if Q5num attempts have already been made or if more than Q5wait seconds have elapsed since the VSS user initiated the request.

Note.— If Q5num = 1, no re-transmission is attempted and hence parameters Q5max, Q5min, Q5mult, Q5exp are not used.

The re-transmitting station shall wait for Q5min + *min*(U(x), Q5max) seconds before attempting to retransmit the burst, where:

U(x)	is a uniform random number generated between 0 and x;
x	= Q5mult * $Q5exp^{retrans}$ / (1-u);
u	is a measurement of channel utilization with a range of value from 0 to 1, with 1 corresponding to a channel that is 100 percent occupied. Channel utilization is the number of slots occupied in the last minute (see 1.2.4.3);
retrans	is the number of times that a burst has been retransmitted.

1.4 DLS SUBLAYER

NOTE: This section is subject to replacement by a new section when the development of the new DLS protocol is complete and validated.

The DLS shall support bit-oriented simplex air/ground (A/G) communications using the aviation VHF link control (AVLC) protocol with the modifications described in this section.

1.4.1 Services

The DLS services for AVLC shall conform to the *VDL Mode 2 Technical Manual,* Section 5.3.2 and shall support unicast connectionless services.

Note 1.— Connectionless services can be used for both air-ground and air-air communications.

1.4.2 AVLC DLS protocol specification

VDL Mode 4 shall support AVLC frames that are supported by the VDL Mode 2 Technical Manual, Section 5.3.3 except that the TEST frame shall not be used, and except as modified in Section 1.4.2.1. A station shall also implement the VDL Mode 4 specific DLS burst formats described below.

Note 1.— VDL Mode 4 can support the same DLS protocol as VDL Mode 2 and, in addition, provides a specific protocol in which frames are transferred using special burst formats which can take advantage of the VDL Mode 4 reservation protocols to minimize the need for random channel access.

Note 2.— The TEST frame (ISO 7809 Option 12) is not supported in VDL Mode 4 and therefore the TEST frame is considered an invalid frame and procedures for handling this are defined in ISO 4335 (i.e. generation of FRMR).

1.4.2.1 Station address encoding

1.4.2.1.1 Address type

The address type field is described in Table 1-55.

Table 1-55. Address type field encoding

Bit encoding			Description type	Bits 1 to 24
27	26	25		
0	0	0	Mobile	Non-unique identity
0	0	1	~~Mobile~~Aircraft	24-bit ICAO address
0	1	0	~~Reserved~~Ground vehicles	~~Future use~~Nationally administered address space
0	1	1	Reserved	Future use
1	0	0	Ground station	ICAO-administered address space
1	0	1	Ground station	ICAO-delegated address space
1	1	0	Reserved	Future use
1	1	1	All stations broadcast	All stations

1.4.2.1.2 Non-unique identity address

A mobile station using the non-unique identity address shall randomly choose a 24-bit address. The non-unique identity address of all zeros shall not be used. The non-unique identity address of all ones shall be used for broadcast applications only. All radio units located at a station shall use the same non-unique identity address.

If the station detects that another station is using the same random address, it shall stop transmitting on the current address; it shall then randomly select a new address. It shall use this new address in subsequent transmissions.

Note 1.— Processing of ambiguous data resulting from use of the non-unique address is an end system issue.

When using VDL Mode 4 for ATS applications, aircraft shall use the unique 24-bit ICAO address.

Note 2.— In this case bits 25, 26, and 27 of the full 27-bit address will be 1, 0, and 0 respectively, as is defined in Table 1-55~~It is anticipated that this will be limited to aircraft not receiving or requesting an ATSC service~~.

1.4.2.1.3 **Broadcast address encoding**

The broadcast addresses shall be encoded as in the VDL Mode 2 Technical Manual Table 5-3 except:

a) the broadcast destination of all mobiles that use non-unique identity addresses shall be encoded as type field = 000 binary and specific address field = all ones; and

b) the broadcast destination of type field = 001 binary and specific address field = all ones shall apply to all mobiles.

1.4.2.1.4 **Other address types**

Other address types shall conform to the VDL Mode 2 Technical Manual Sections 5.3.3.3.5 to 5.3.3.3.7 and Section 5.3.3.4.

1.4.2.2 **DLS burst formats**

DLS bursts shall be encoded using the burst format defined in Section 1.3.2 with the information field content as defined below.

1.4.2.2.1 **Request to send burst**

A DLS station shall transmit the request to send (RTS) burst defined in Table 1-56 with VSS user supplied QoS and reservation parameters to make a request to send information over a point-to-point connection.

Table 1-56. RTS burst format

Description	Octet	Bit Number							
		8	7	6	5	4	3	2	1
burst id	5	res	0	1	0	0	0	0	1
N(s) (nsf)	6	nsf_7	nsf_6	nsf_5	nsf_4	nsf_3	nsf_2	nsf_1	nsf_0
priority (p_a) and length (lg_a) for frame a	7	p_{a2}	p_{a1}	res	lg_{a5}	lg_{a4}	lg_{a3}	lg_{a2}	lg_{a1}
priority (p_b) and length (lg_b) for frame b	8	p_{b2}	p_{b1}	res	lg_{b5}	lg_{b4}	lg_{b3}	lg_{b2}	lg_{b1}
priority (p_c) and length (lg_c) for frame c	9	p_{c2}	p_{c1}	res	lg_{c5}	lg_{c4}	lg_{c3}	lg_{c2}	lg_{c1}
priority (p_d) and length (lg_d) for frame d	10	p_{d2}	p_{d1}	res	lg_{d5}	lg_{d4}	lg_{d3}	lg_{d2}	lg_{d1}
priority (p_e) for extra information extra information included (ei)	11	p_{e2}	p_{e1}	res	ei	in_{12}	in_{11}	in_{10}	in_9
extra information (in)	12	in_8	in_7	in_6	in_5	in_4	in_3	in_2	in_1

The N(s) field (nsf) shall declare the sequence number of the information (INFO) frames needing to be transmitted to the destination. Bit nsf_j shall be set to 1 if N(s) = j needs to be transmitted. The station shall be able to request the transfer of up to four INFO frames.

The four sets of priority/length (p_{1-d} /lg_{1-d}) fields shall be assigned to INFO frames in the order in which they need to be transmitted. The 'd' field shall only be used if 4 bits in the N(s) field are set to 1 (otherwise it shall be set to all zeros); the 'c' field shall only be used if at least 3 bits in the N(s) field are

set to 1; etc. The priority field shall be set to the priority of the INFO frame as defined in Table 1-10. The length field shall be set to min((31 + length of frame in octets) / 32, 32) - 1.

If the nsf byte is non-zero (the RTS burst is being used to request transmission of one or more INFO frames) and if there are further INFO frames to be transmitted to this destination, then the ei bit shall be set to 1, the priority for the extra information field (pe) shall be set to the maximum priority of the outstanding INFO frames (that is, the INFO frames after the first four in the transmit queue), and the extra information field (in) shall be set to zero. If the nsf byte is zero (the RTS burst is being used to request transmission of a UI frame), then the ei bit shall be set to 1, pe shall be set to the priority of the UI frame to be transmitted, and in shall be set to min(31+ length of UI frame in octets)/32, 32) –1. If no extra information needs to be transmitted, then the ei bit shall be set to zero.

Note 1.— The unicast reservation burst contains the destination address.

Note 2.— N(s) takes on the values 0 through 7 inclusive, per ISO 4335.

1.4.2.2.2 Compressed frame burst

A DLS station shall transmit the compressed frame burst defined in Table 1-57 with the VSS user supplied QoS and reservation parameters.

Table 1-57. Compressed frame burst format

Description	Octet	Bit Number							
		8	7	6	5	4	3	2	1
burst id, command/response (c/r) status bit	5	c/r	0	1	1	0	0	0	1
link control field	6	per VDL Technical Manual Mode 2							
information	7								
	8								
	9								
	10								

The command/response (c/r) status bit, link control field and the information field shall be defined and encoded as per the VDL Mode 2 Technical Manual Sections 5.3.3.3.2, 5.3.3.5 and 5.3.3.6 respectively. The air/ground status (VDL Mode 2 Technical Manual Section 5.3.3.3.1) shall be derived from the altitude field of the synchronization burst message (see Section 1.5.2).

Note.— The information field may continue past octet 10.

1.4.3 DLS system parameters

The DLS sublayer timers and parameters shall conform to the VDL Mode 2 Technical Manual Section 5.3.4, except that Table 1-58 below shall define the DLS system parameter default values and N3 shall be as defined in Table 1-59.

Table 1-58. Data link service system parameters

Symbol	Parameter name		Mode 4 default
T1min	Delay before retransmission	minimum	Q5min
T1max		maximum	Q5max
T1mult		multiplier	Q5mult
T1exp		exponent	Q5exp
T2	Delay before acknowledgement		54 msec
T3min	Link initialization time	minimum	T1min + 5 sec
T3max		maximum	T1max
T3mult		multiplier	T1mult
T3exp		exponent	T1exp
T4	Maximum delay between transmissions	mobile	As VDL Mode 2 Technical Manual Table 5-5
		ground	As VDL Mode 2 Technical Manual Table 5-5
N1	Maximum number of bits in any frame		As VDL Mode 2 Technical Manual Table 5-5
N2	Maximum number of transmissions		As VDL Mode 2 Technical Manual Table 5-5
kw	Window size		As VDL Mode 2 Technical Manual Table 5-5

Table 1-59. VDL Mode 4 DLS parameters

Symbol	Parameter name	Minimum	Maximum	Default	Increment
N3	Maximum length of DLS transmission	2 octets	16384 octets	86	1 octet

1.4.3.1 Parameter N3 (maximum length of DLS transmission)

The parameter N3 shall be the maximum size in octets of a transmission (comprising one or more Compressed Frames) that shall use the short transmission procedures defined in Section 1.4.4.3.

Note.— A slot (GFSK) can contain 32 octets of data. The last slot in a sequence should only contain 24 octets to allow for propagation guard time. Allowing an average 0.5 octet/slot for bit stuffing, 1 slot could contain 23 octets of data including flags and reservation blocks. 2 slots could contain 54 octets. 3 slots could contain 86 octets, etc.

1.4.4 DLS procedures

DLS procedures shall conform to the VDL Mode 2 Technical Manual Sections 5.3.5 to 5.3.11 except as noted below.

1.4.4.1 Setting of retransmission parameters

For all DLS bursts, quality of service parameters Q5min, Q5max, Q5mult, Q5exp and Q5num shall be set to T1min, T1max, T1mult, T1exp and N2 respectively.

Note.— Retransmission of DLS frames is handled in VSS.

1.4.4.2 Selection of transmission procedures

After the MAC layer authorizes a random transmission, the station shall calculate the total length in octets of the sequence of compressed frame bursts required to contain the frames queued for transmission using the short transmission procedures defined in Section 1.4.4.3. The total length shall include the length of any reservation fields contained within the compressed frame bursts, together with any flags. If the total length is less than or equal to N3, then the station shall use short transmission procedures (Section 1.4.4.3) to transmit the queued data. Otherwise, the station shall use the long transmission procedures (Section 1.4.4.4).

1.4.4.3 Short transmission procedures

After the selection of a short transmission procedure, the station shall transmit one or more compressed frame bursts containing the frames queued for transmission with QoS parameters as defined in Table 1-60. At least one burst for each destination shall contain a unicast request reservation field with the parameters in Table 1-60.

Note.— If the responder VSS sublayer has not received a response from the VSS user in the scheduled reservation it can send a general failure (see Section 1.3.20) with error type 7E hex or FE hex and a unicast request reservation (with itself as the transmitter) according to the procedures of Section 1.3.19.2.

If a response is not received from the peer, the station shall retransmit the unicast request according to the procedures of Section 1.3.9.

Table 1-60. Short transmission compressed frame burst parameters

Symbol	Parameter name	Default
V32	Minimum response delay	T2 * M1 / 60 slots
V33	Maximum response delay	(5 sec) * M1 / 60 slots
V34	Source/destination control	0
V35	Broadcast control	0
V36	Length of reserved block	1 slot
Q1	Priority	highest priority of user data frames
Q2a	Slot selection range constraint for level 1	150 NMI
Q2b	Slot selection range constraint for level 2	150 NMI
Q2c	Slot selection range constraint for level 3	0 NMI
Q2d	Slot selection range constraint for level 4	300 NMI
Q3	Replace queued data	TRUE
Q4	Number of available slots	3

1.4.4.3.1 Recommendation

When possible and applicable, the response offset subfield of the short transmission compressed frame bursts should be assigned to slots contiguous to other reservations.

1.4.4.4 Long transmission procedures

1.4.4.4.1 Request to send

After the selection of a long transmission procedure, the station shall transmit one RTS burst to each unique destination in the transmit queue with QoS parameters as defined in Table 1-61. Each burst shall contain a unicast request reservation field with the parameters in Table 1-61. If a response is not received, the station shall retransmit the unicast request according to the procedures of Section 1.3.14.

Table 1-61. Long transmission RTS burst parameters

Symbol	Parameter name	Default
V32	Minimum response delay	T2 * M1 / 60 slots
V33	Maximum response delay	(5 sec)* M1 / 60 slots
V34	Source/destination control	0
V35	Broadcast control	0
V36	Length of reserved block	1 slot
Q1	Priority	highest priority of user data frames
Q2a	Slot selection range constraint for level 1	150 nmi
Q2b	Slot selection range constraint for level 2	150 nmi
Q2c	Slot selection range constraint for level 3	0 nmi
Q2d	Slot selection range constraint for level 4	300 nmi
Q3	Replace queued data	TRUE
Q4	Number of available slots	3

1.4.4.4.2 Recommendation

When possible, the response offset subfield of each RTS burst should be assigned to slots that are not contiguous to other reservations.

1.4.4.4.3 Response to RTS

If the responder does not support the DLS, then it shall transmit a general failure (see Section 1.3.20) with an error type of 80 hex, with the QoS parameters as defined in Table 1-62.

If the length subfield for frame a (lg_a) in the RTS is not equal to zero then the following procedures shall apply. If the responder does not have a link with the sender, then the responder shall send a disconnected mode (DM) response. If the RTS contained a protocol error (e.g., one of the listed N(s)'s is illegal), then the responder shall transmit a frame reject (FRMR). Otherwise, the responder shall determine whether the entire RTS can be accommodated within a single information transfer of length equal to the sum of lg_x for x = a, b, c, d, e or whether only a subset of the request can be reserved. It shall then transmit a supervisory response frame (i.e., either a receive ready (RR) or selective reject (SREJ)) in a compressed frame burst. If all of the INFO frames in the RTS are being acknowledged and there is no outstanding extra information frame to be sent, then the response burst reservation field (see Section 1.3.18.1) shall be included. Otherwise, an information transfer request reservation field shall be included and transmitted with the parameters in Table 1-63, indicating the number of slots reserved for transfer of the INFO and extra information frames.

Note 1.— lg_a not equal to zero corresponds to the case where the RTS is being used to request the transfer of at least one INFO frame.

If the length subfield for frame a (lg_a) in the RTS is equal to zero then the responder shall transmit a general confirm with r-mi = RTS including an information transfer reservation field with lg set equal to the total length of the extra information frames that are to be transferred.

Note 2.— lg_a equal to zero corresponds to the case where there are no INFO frames to be sent and the RTS is being used to request the transfer of extra information frames only.

If the channel is too busy (either the responder cannot find a sufficiently large series of contiguous slots or the priority is too low for the channel utilization), then the responder shall transmit either a general confirm including a unicast reservation with V34 = 1 indicating when the responder will transmit an information transfer request in response to the RTS or a general failure (see Section 1.3.20) with error type = 01 hex.

Note 3.— If the responder sends a general failure (see Section 1.3.20) the sender can retransmit the RTS after the timeout defined by the back-off delay or in the slot reserved by the destination.

Table 1-62. General response to RTS parameters

Symbol	Parameter name	Default
Q1	Priority	2
Q2a	Slot selection range constraint for level 1	150 nmi
Q2b	Slot selection range constraint for level 2	150 nmi
Q2c	Slot selection range constraint for level 3	0 nmi
Q2d	Slot selection range constraint for level 4	300 nmi
Q3	Replace queued data	TRUE
Q4	Number of available slots	3

Table 1-63. Response to RTS compressed frame burst parameters

Symbol	Parameter name	Default
V42	Length of information transfer	Sufficient to included requested INFO/UI frames
V43	Minimum information transfer delay	T2 * M1 / 60 slots
V44	Maximum information transfer delay	(5 sec) * M1 / 60 slots
V45	Minimum response delay	T2 * M1 / 60 slots
V46	Maximum response delay	(5sec) * M1 / 60 slots
Q1	Priority	Highest priority in the RTS for which a reservation has been made
Q2a	Slot selection range constraint for level 1	150 nmi
Q2b	Slot selection range constraint for level 2	150 nmi
Q2c	Slot selection range constraint for level 3	0 nmi
Q2d	Slot selection range constraint for level 4	300 nmi
Q3	Replace queued data	TRUE
Q4	Number of available slots	3

A station receiving a burst addressed to it with an information transfer request reservation field shall first determine what frames have been acknowledged, and then transmit as many frames as can fit in the

allocated reservation. If the priority of any frames identified in field ‘e’ is higher than the priority of all frames identified in frames ‘a’, b’, ‘c’, and ‘d’ it shall first transmit any frames in field ‘e’ followed by ‘a’, ‘b’, ‘c’, and ‘d’; otherwise it shall first transmit the ‘a’ frame followed by ‘b’, ‘c’, and ‘d’ frames, and then finally any frames identified in the field ‘e’. If the station has nothing to transmit (e.g., after a reset), it shall not transmit.

1.4.4.4.4 Acknowledging the data

A station which transmitted an information transfer request reservation field (and consequently has a reservation for a response) shall transmit in the reserved slot a response supervisory frame (either an RR or SREJ) to acknowledge transfer (or non-transfer) of INFO frames and a UA to acknowledge a UI.

If at least one frame but not all of the frames which were identified in the RTS have been received correctly (including the extra information frames), then the station shall include an information transfer request reservation field with the parameters in Table 1-64 indicating the number of slots reserved for transfer of the outstanding INFO and extra information frames.

Note.— This requirement is to prevent the responder from having to implement an N2 procedure, as defined in the VDL Mode 2 Technical Manual Section 5.3.4.6, after having received an RTS.

Table 1-64. Acknowledgement compressed frame burst parameters

Symbol	Parameter name	Default
V42	Length of information transfer	Sufficient to included requested INFO/UI frames
V43	Minimum information transfer delay	T2 * M1 / 60 slots
V44	Maximum information transfer delay	(5 sec) * M1 / 60 slots
V45	Minimum response delay	T2 * M1 / 60 slots
V46	Maximum response delay	(5 sec) * M1 / 60 slots
Q1	Priority	2
Q2a	Slot selection range constraint for level 1	150 nmi
Q2b	Slot selection range constraint for level 2	150 nmi
Q2c	Slot selection range constraint for level 3	0 nmi
Q2d	Slot selection range constraint for level 4	300 nmi
Q3	Replace queued data	TRUE
Q4	Number of available slots	3

1.4.4.5 Support for unicast connectionless services

Consistent with ISO 4335, a unicast UI shall be transmitted to transfer connectionless, point-to-point data. A unicast UA shall acknowledge receipt of a unicast UI.

Note.— This is contrary to the VDL Mode 2 Technical Manual Section 5.3.11.5 which uses UI frames solely for broadcast.

1.4.4.6 Supervisory data

Supervisory data shall be added to pending communications data where possible.

1.5 LINK MANAGEMENT ENTITY SUBLAYER

NOTE: Changes will be introduced in this section when the development of the new DLS protocol is complete and validated.

1.5.1 Services

The services of the LME shall conform to the VDL Mode 2 Technical Manual Section 5.4.1 except as specified below.

1.5.1.1 Link provision

Each ground and mobile LME shall monitor all transmissions (both DLS and VSS) from its peer's stations to maintain a reliable link between some ground station and the mobile while the mobile is in coverage of an acceptable ground station in the ground system.

1.5.2 Synchronization burst format

All VDL Mode 4 stations shall transmit synchronization bursts to support link management.

1.5.2.1 Fixed and variable data fields

The synchronization burst shall consist of two portions: a fixed data field containing information that must be sent with each synchronization burst and a variable data field containing additional system management information that does not need to be included in each synchronization burst.

Note 1.— The variable data field can also include VSS user specific information.

Note 2.— The fixed data field contains 55 bits of data consisting of bits 2 through 8 of octet 5 and all of octets 6 through 11 inclusive (the fixed data field begins after the source address and message identification fields which consist of the first four octets and bit 1 of octet 5). The variable portion contains 54 bits of data consisting of octets 12 through 17 and bits 3 through 8 of octet 18.

Note 3.— Certain variable information fields have been assigned and are described in Section ~~C~~3.

1.5.2.2 Fixed data field format

Stations shall have fixed data fields as defined in Table 1-65.

Table 1-65. Synchronization burst format

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
~~autonomous/directed flag (a/d)~~TCP change flag (tc) baro/geo altitude (b/g) CPR Format even/odd (cprf) position uncertainty (nucp)	5	$nucp_4$	$nucp_3$	$nucp_2$	$nucp_1$	cprf	b/g	~~a/d~~tc	0
latitude (lat)	6	lat_8	lat_7	lat_6	lat_5	lat_4	lat_3	lat_2	lat_1
base altitude (balt)	7	$balt_{12}$	$balt_{11}$	$balt_{10}$	$balt_9$	lat_{12}	lat_{11}	lat_{10}	lat_9
	8	$balt_8$	$balt_7$	$balt_6$	$balt_5$	$balt_4$	$balt_3$	$balt_2$	$balt_1$
longitude (lon)	9	lon_8	lon_7	lon_6	lon_5	lon_4	lon_3	lon_2	lon_1
time figure of merit (tfom)	10	$tfom_2$	$tfom_1$	lon_{14}	lon_{13}	lon_{12}	lon_{11}	lon_{10}	lon_9
data age (da) information field ID (id)	11	da_4	da_3	da_2	da_1	id_4	id_3	id_2	id_1
ID extension 1 (id1) ID extension 2 (id2)	12	$id1_4$	$id1_3$	$id1_2$	$id1_1$	$id2_4$	$id2_3$	$id2_2$	$id2_1$
ID extension 3 (id3)	13	$id3_4$	$id3_3$	$id3_2$	$id3_1$	in_k			
information field (in)	14								
	15			. . . . .					
	16								
	17	in_{14}	in_{13}	in_{12}	in_{11}	in_{10}	in_9	in_8	in_7
	18	in_6	in_5	in_4	in_3	in_2	in_1		

. . . . . Denotes variable length field

Note.— Mobile and ground stations are identified by the address type field in the 27-bit code (see Section 1.4.2.1).

The subfields shall be computed as defined in Table 1-66.

Table 1-66. Synchronization burst field encoding(fixed data field)

Subfield	Range	Encoding	Notes
~~autonomous/ directed (a/d)~~TCP change flag (tc)	Boolean	~~0 = autonomous slot selection (including directed rate),~~ ~~1 = directed slot selection or ground station transmission~~(see Section 3.6)	~~Identifies whether the synchronization burst is an autonomous or directed burst~~
time figure of merit (tfom)	0 to 3	0 = primary certified 1 = primary/non-certified 2 = secondary 3 = tertiary	(see Section 1.2.3)
position navigation uncertainty category (nucp)	0 to 9	See Table 1-67	
latitude (lat)	-90 to + 90°	12-bit low-resolution encoding according to the CPR encoding algorithm adapted for VDL Mode 4, as described in Section 4	The 12-bit CPR encoding provides position to a resolution of approximately ±140 m, within a segment (patch) of approximately 600 nmi
longitude (lon)	-180° to + 180°	14-bit low-resolution encoding according to the CPR encoding algorithm adapted for VDL Mode 4, as described in Section 4	The 14-bit CPR encoding provides position to a resolution of approximately ±120 m, within a segment (patch) of approximately 600 nmi
CPR format even/odd	0 to 1	0 = even 1 = odd The CPR flag shall apply to all CPR encoded sub-fields included in the synchronisation burst	
base altitude (balt)	0 to 4095	Base altitude is reported as specified in Table 1-68	
baro/geo altitude (b/g)	0 to 1	0 = barometric 1 = geometric	Indicates whether barometric or geometric base altitude is reported
data age (da)	0 to 15	See Table 1-69	
information field ID (id)	0 to 15	As defined by application standards. Some values for the information field ID are pre-reserved and defined in Section 3	Provides the information field identity contained in the variable data field (see Section 1.5.2.3)
ID extension	0 to 15	See below	Provides a means of increasing the number of variable fields that can be accommodated
information field (in)	-	As defined by application standards	The information field contained in the variable data field (see Section 1.5.2.3)

The TCP change flag (tc) shall be encoded as defined in Section 3.6 if the message ID (see Table 1-6) indicates that the burst is a directed synchronisation burst. Otherwise it shall be reserved for future definition and set equal to 1.

The information field ID (id) and ID extension (idn) subfields shall provide addresses for information fields (in) as follows:

1. An information field ID (id) equal to F hex shall indicate that no information field is present.
2. An information field ID (id) subfield equal to 0 hex to 9 hex or B hex to E hex shall indicate one of 14 information fields of length 54 bits.
3. ID extension 1 (id1) subfield shall only be present if the information field ID (id) is equal to A hex. An ID extension 1 (id1) subfield equal to 0 hex to 9 hex or B hex to F hex shall indicate one of 15 information fields of length 50 bits.
4. ID extension n (idn) subfield shall only be present if the ID extension n-1 (idn-1) subfield is equal to A hex. An ID extension n (idn) subfield equal to 0 hex to 9 hex or B hex to F hex shall indicate one of 15 information fields of length 54 – 4n bits.

The station shall encode its navigation uncertainty category of position (nucp) in accordance with Table 1-67.

Table 1-67. Encoding of position navigation uncertainty category (nucp)

nucp	Required Navigation Performance (RNP) class	Horizontal Protection Limit (HPL) (0.9999999 integrity bound) (nmi)	Horizontal error (nmi unless otherwise stated)	Vertical error (ft)
			Horizontal and vertical errors are 95% numbers.	
0	N/A	N/A	N/A	N/A
1	RNP-10	<20	<10	reserved
2	RNP-5	<10	<5	reserved
3	RNP-1	<2	<1	reserved
4	RNP-0.5	<1	<0.5	reserved
5	e.g., NPA, DME-DME	<0.5	<0.25	reserved
6	e.g., GPS-SPS	<0.2	<0.1	reserved
7	e.g., GNSS (no SA)	<0.1	<0.05	reserved
8	e.g., SBAS	reserved	<10m	<15m
9	e.g., GBAS	reserved	<3m	<4m

The station shall encode base altitude in accordance with Table 1-68.

Table 1-68. Base altitude encoding

Actual base altitude of transmitting station (feet)	Transmitted value of altitude	Decoded base altitude (feet) (geo = WGS84 height except as noted)
Unknown	0	altitude unknown
altitude < -1 305	1	less than -1 300
-1 305 ≤ altitude < -1 295	2	-1 300
-1 295 ≤ altitude < -1 285	3	-1 290
↓	↓	↓
-15 ≤ altitude < -5	131	-10
-5 ≤ altitude < 5	132	0
5 ≤ altitude < 15	133	10
↓	↓	↓
7 995 ≤ altitude < 8 005	932	8 000
8 005 ≤ altitude < 8 015	933	8 010
8 015 ≤ altitude < 8 037.5	934	8 025
8 037.5 ≤ altitude < 8 062.5	935	8 050
8 062.5 ≤ altitude < 8 087.5	936	8 075
↓	↓	↓
71 912.5 ≤ altitude < 71 950	3 490	71 925
71 950 ≤ altitude < 72 050	3 491	72 000
72 050 ≤ altitude < 72 150	3 492	72 100
72 050 ≤ altitude < 72 250	3 493	72 200
72 250 ≤ altitude < 72 350	3 494	72 300
72 350 ≤ altitude < 72 450	3 495	72 400
↓	↓	↓
129 950 ≤ altitude < 130 050	4 072	130 000
130 050 ≤ altitude	4 073	more than or equal to 130 100
	4 074 to 4 094	reserved
station on ground	4 095	station at 0 AGL

The data age (da) subfield shall be encoded based on the report latency which shall be the difference between the time of validity of the horizontal position data (latitude and longitude) and the time of transmission, in accordance with Table 1-69.

Table 1-69. Report latency encoding and decoding

Report latency (msec)	Transmitted value of data age (da)	Decoded latency (msec)
difference < 100	0	50
100 ≤ difference < 200	1	150
200 ≤ difference < 300	2	250
↓	↓	↓
900 ≤ difference < 1 000	9	950
1 000 ≤ difference < 1 200	10	1 100
1 200 ≤ difference < 1 500	11	1 350
1 500 ≤ difference < 2 000	12	1 750
2 000 ≤ difference < 3 000	13	2 500
3 000 ≤ difference < 4000	14	3 500
4 000 ≤ difference or unknown	15	unknown

If the report latency is greater than 4 seconds, then nucp shall be set to 0.

1.5.2.3 Variable data field format

The variable data field shall be available to carry additional information as may be required by another VSS user or application. The content and format of the variable data field shall be identified by the information field ID (id). The format of the variable data field corresponding to a given id shall be as specified in the appropriate application standard.

Note.— Up to 15 different information fields can be addressed. Information fields 1 to 9 are given priority over other information fields (see Section 1.5.6.1.1). Further short information fields may be addressed with the use of the extension field ID of 10 (see Section 1.5.2.2).

1.5.2.4 Synchronization burst request

To request that a station transmit a synchronization burst with a specific information field, a station shall transmit a general request burst to the appropriate application process as defined in Section C.4.

1.5.3 Request to send exchange identity (XID) burst formats

1.5.3.1 Request to send XID burst

An LME shall transmit the request to send XID (RTX) burst defined in Table 1-70 with VSS user supplied QoS and reservation parameters to make a request to send an XID to a peer LME.

Table 1-70. RTX burst format

Description	Octet	Bit Number							
		8	7	6	5	4	3	2	1
burst id	5	res	1	0	0	0	0	0	1
priority of XID (px)	6	px_2	px_1	res	res	lx_{12}	lx_{11}	lx_{10}	lx_9
length of XID (lx)	7	lx_8	lx_7	lx_6	lx_5	lx_4	lx_3	lx_2	lx_1
connection management parameter (cx)	8	cx_8	cx_7	cx_6	cx_5	cx_4	cx_3	cx_2	cx_1
XID sequence number parameter (seq)	9	seq_8	seq_7	seq_6	seq_5	seq_4	seq_3	seq_2	seq_1
RTX retransmission count (cnt)	10	res	res	res	res	cnt_4	cnt_3	cnt_2	cnt_1

The priority of XID subfield (px) shall be the priority of the XID as defined in Table 1-10. The length of XID subfield (lx) shall be set to min((31 + length of frame in octets) / 32, 32) - 1. The connection management subfield (cx) shall be set equal to the value of the connection management parameter. The XID sequence parameter (seq) shall be set equal to the value of the XID sequence parameter. The retransmission count (cnt) shall be set equal to the 0 on the first transmission of a new RTX, and the cnt field shall be incremented by one for every subsequent retransmission.

Note.- An XID is a system management Protocol Data Unit (PDU).

1.5.3.2 XID burst

XID data shall be contained within either a compressed frame burst (see Table 1-57) or, for broadcast transmission of VDL Mode 4 private parameters only, shall alternatively use the compressed XID burst defined in Table 1-71.

Table 1-71. Compressed XID burst format

Parameter field	Octet	Bit position within octet							
		8	7	6	5	4	3	2	1
message ID, directory of services flag (dos)	5	dos	0	1	1	1	1	0	1
information field	6	in_k							
	7 - n-5			.....					
	n-4								
	n-3						in_1		

. . . . . Denotes variable length field

A value for the directory of services (dos) flag equal to 1 shall indicate that the XID parameter DOS message (see Section 1.5.4.4.2) is present in the burst. Otherwise the XID parameter DOS message shall be absent.

The following conditions shall apply to the use of the compressed XID burst:

1. The XID shall contain VDL Mode 4 private parameters only.
2. The XID shall be broadcast from a ground station.
3. The c/r flag shall be absent from the burst and its value shall be assumed to be equal to 0.
4. The link control field shall not be transmitted and its value shall be assumed to be equal to AF_{hex}.
5. The Format Identifier shall not be transmitted, and its value shall be assumed to be equal to 82_{hex}.
6 The group ID shall not be transmitted and its value shall be assumed to be equal to $F0_{hex}$.
7 The VDL Mode 4 private parameter set identifier shall not be transmitted and its value shall be assumed to be equal to 00_{hex}.
8 If present, XID parameter DOS message shall always appear last.
9 For XID parameter DOS message, the parameter length shall be absent and the DOS message parameter shall end at the end of the information field.

1.5.4 Exchange identity (XID) parameter formats

The XID parameter formats shall conform to the VDL Mode 2 Technical Manual Section 5.4.2 except that the modulation support, aircraft location, autotune frequency, frequency support list, and ground station location parameters (VDL Mode 2 Technical Manual Sections 5.4.2.5.1, 5.4.2.5.4, 5.4.2.6.1, 5.4.2.7.1, 5.4.2.7.8, respectively) shall never be sent. Any requirements for the transmission of the modulation support, autotune frequency or frequency support list shall be interpreted as requiring the transmission of the related VDL Mode 4 private parameter defined below. The use of each of the parameter subsets (general purpose information, aircraft-initiated information, ground-based initiated information, and ground-based initiated modification) shall be as defined in the VDL Mode 2 Technical Manual Section 5.4.2.

1.5.4.1 General purpose information private parameters

1.5.4.1.1 VDL Mode 4 private parameter set identifier

The VDL Mode 4 parameter set is identified by the ISO IA5 character capital ‘S’ encoded as per Table 1-72. This parameter shall be included whenever any of the VDL Mode 4 private parameters are to be sent. It shall be the first private parameter sent as per ISO 8885.

Table 1-72. VDL Mode 4 private parameter set identifier parameter encoding

Field	Bit Position								Notes
Parameter ID	0	0	0	0	0	0	0	0	Parameter set identifier
Parameter length	0	0	0	0	0	0	0	1	
Parameter value	0	1	0	1	0	0	1	1	Character S

1.5.4.2 Modulation support parameter

This parameter defines a list of modulation schemes that are supported. This parameter shall be sent on link establishment. It shall be encoded as shown in Table 1-73 and 1-74.

Table 1-73. Modulation support list encoding

Field	Bit Position								Notes
Parameter ID	1	0	0	0	0	0	0	1	Modulation support list
Parameter length	n_8	n_7	n_6	n_5	n_4	n_3	n_2	N_1	
Parameter value					m_4	m_3	m_2	M_1	Mode

Table 1-74. Modulation encoding

Encoding	Meaning
0 to 1	Reserved
2	VDL Mode 2
3	VDL Mode 3
4	VDL Mode 4 (GFSK modulation)
5 to F	Reserved

1.5.4.3 Ground-initiated modification private parameters

1.5.4.3.1 N3 parameter

This parameter defines the value of N3 that an aircraft shall use, encoded as a 16-bit unsigned integer as per Table 1-75.

Table 1-75. N3 parameter encoding

Field	Bit position								Notes
Parameter ID	0	1	0	0	0	0	0	0	N3 parameter
Parameter length	0	0	0	0	0	0	1	0	
Parameter value	n_{16}	n_{15}	n_{14}	n_{13}	n_{12}	n_{11}	n_{10}	n_9	
	n_8	n_7	n_6	n_5	n_4	n_3	n_2	n_1	

1.5.4.3.2 VS1 parameter

This parameter defines the value of VS1 that an aircraft shall use, encoded as a 4-bit unsigned integer as per Table 1-76.

Table 1-76. VS1 parameter encoding

Field	Bit position								Notes
Parameter ID	0	1	0	0	0	0	0	1	VS1 parameter
Parameter length	0	0	0	0	0	0	0	1	
Parameter value	0	0	0	0	n_4	n_3	n_2	n_1	

1.5.4.3.3 VS2 parameter

This parameter defines the value of VS2 in dB that an aircraft shall use, encoded as a 6-bit unsigned integer as per Table 1-77.

Table 1-77. VS2 parameter encoding

Field	Bit position								Notes
Parameter ID	0	1	0	0	0	0	1	0	VS2 parameter
Parameter length	0	0	0	0	0	0	0	1	
Parameter value	0	0	n_6	n_5	n_4	n_3	n_2	n_1	

1.5.4.3.4 Q4 parameter

This parameter defines the value of Q4 that an aircraft shall use, encoded as a 5-bit unsigned integer as per Table 1-78.

Table 1-78. Q4 parameter encoding

Field	Bit position								Notes
Parameter ID	0	1	0	0	0	0	1	1	Q4 parameter
Parameter length	0	0	0	0	0	0	0	1	
Parameter value	0	0	0	n_5	n_4	n_3	n_2	n_1	

1.5.4.3.5 VS4 parameter

This parameter defines the value of VS4 in nmi that an aircraft shall use, encoded as a 7-bit unsigned integer as per Table 1-79.

Table 1-79. VS4 parameter encoding

Field	Bit Position								Notes
Parameter ID	0	1	0	0	0	1	0	0	VS4 parameter
Parameter length	0	0	0	0	0	0	0	1	
Parameter value	0	n_7	n_6	n_5	n_4	n_3	n_2	n_1	

1.5.4.3.6 m2 filter parameters

Table 1-80 defines the values of parameters used for the m2 filter that an aircraft shall use. M2inc is encoded as an 8-bit unsigned integer. M2limit is encoded as a 16-bit unsigned integer.

Table 1-80. m2 filter parameter encoding

Field	Bit position								Notes
Parameter ID	0	1	0	0	0	1	0	1	m2 filter parameters
Parameter length	0	0	0	0	0	0	1	1	
M2inc parameter value	i_8	i_7	i_6	i_5	i_4	i_3	i_2	i_1	M2inc
M2limit parameter value	l_{16}	l_{15}	l_{14}	l_{13}	l_{12}	i_{11}	i_{10}	l_9	M2limit
	l_8	l_7	l_6	l_5	l_4	l_3	l_2	l_1	

1.5.4.3.7 CG1 filter parameters

Table 1-81 defines the values of parameters used for the CG1 filter that an aircraft shall use. CG1_plea is encoded as an 8-bit unsigned integer. CG1_range is encoded as an 8-bit unsigned integer. TG6 is encoded as an 8-bit unsigned integer. CG1_inc is encoded as an 8-bit unsigned integer. 1/CG1_decay is encoded as an 8-bit unsigned integer. CG_limit is encoded as a 16-bit unsigned integer.

Table 1-81. CG1 filter parameter encoding

Field	Bit position								Notes
Parameter ID	0	1	0	0	0	1	1	0	CG1 filter parameters
Parameter length	0	0	0	0	0	1	1	1	
CG1_plea parameter value	p_8	p_7	p_6	p_5	p_4	p_3	p_2	p_1	CG1_plea
CG1_range parameter value	r_8	r_7	r_6	r_5	r_4	r_3	r_2	r_1	CG1_range
TG6 parameter value	t_8	t_7	t_6	t_5	t_4	t_3	t_2	t_1	TG6
CG1_limit parameter value	l_{16}	l_{15}	l_{14}	l_{13}	l_{12}	i_{11}	i_{10}	l_9	CG1_limit
	l_8	l_7	l_6	l_5	l_4	l_3	l_2	l_1	
CG1_inc parameter value	i_8	i_7	i_6	i_5	i_4	i_3	i_2	i_1	CG1_inc
1/CG1_decay parameter value	d_8	d_7	d_6	d_5	d_4	d_3	d_2	d_1	1/CG1_decay

1.5.4.3.8 Autotune frequency parameter

This parameter defines the frequency and modulation scheme that an aircraft LME shall use to reply to a ground station listed in the replacement ground station parameter. This parameter shall be sent by a ground LME when an autotune is required. The parameter shall be encoded as a 16-bit field as per Table 1-82. The modulation subfield (m bits) shall be defined as per Table 1-74. The frequency subfield (f bits) shall be defined as per Table 1-30.

Table 1-82. Autotune parameter encoding

Field	Bit position								Notes
Parameter ID	0	1	0	0	0	1	1	1	Autotune frequency
Parameter length	0	0	0	0	0	0	1	0	
Parameter value	m_4	m_3	m_2	m_1	f_{12}	f_{11}	f_{10}	f_9	
	f_8	f_7	f_6	f_5	f_4	f_3	f_2	f_1	

1.5.4.3.9 Maximum number of missed reservations parameter

This parameter defines the number of consecutive missed reservations that will be used to determine a station is unreachable. This parameter shall be sent by a ground LME, as required, to adjust the timeliness of the LEAVE event. The parameter shall be encoded as an 8-bit field as per Table 1-82a. The parameter (G1) shall be defined as per Table 1-89.

Table 1-82a. G1 parameter encoding

Field	Bit position								Notes
Parameter ID	0	1	0	0	1	0	0	0	Autotune frequency
Parameter length	0	0	0	0	0	0	0	1	
Parameter value	$G1_8$	$G1_7$	$G1_6$	$G1_5$	$G1_4$	$G1_3$	$G1_2$	$G1_1$	

Note: The range of the G1 counter is 1 to 255. The value of 0 (G1=0) is invalid.

1.5.4.4 Ground-initiated information private parameters

1.5.4.4.1 Frequency support list

This parameter, encoded per Table 1-83, shall provide the mode, frequency, ground station address information and the relative location of the ground station listed. The location shall be encoded as an offset relative to the position of the source station: easterly offset (eo) (west is negative)and northerly offset (no) (south is negative) shall each be 8 bit parameters with a resolution of 4 nmi encoded using two's complement math. The mode shall be encoded per Table 1-74 and the frequency shall be encoded per 1-30. The usage of this parameter is defined in the VDL Mode 2 Technical Manual Section 5.4.2.7.1.

Table 1-83. Frequency support list encoding

Field	Bit position								Notes
Parameter ID	1	1	0	0	0	0	0	0	frequency support list
Parameter length	n_8	n_7	n_6	n_5	n_4	n_3	n_2	n_1	
Parameter value	m_4	m_3	m_2	m_1	f_{12}	f_{11}	f_{10}	f_9	mode/frequency
	f_8	f_7	f_6	f_5	f_4	f_3	f_2	f_1	
	g_{27}	g_{26}	g_{25}	g_{24}	g_{23}	g_{22}	0	0	ground station identification
	g_{21}	g_{20}	g_{19}	g_{18}	g_{17}	g_{16}	g_{15}	0	
	g_{14}	g_{13}	g_{12}	g_{11}	g_{10}	g_9	g_8	0	
	g_7	g_6	g_5	g_4	g_3	g_2	g_1	0	
	eo_8	eo_7	eo_6	eo_5	eo_4	eo_3	eo_2	eo_1	easterly offset
	no_8	no_7	no_6	no_5	no_4	no_3	no_2	no_1	northerly offset

1.5.4.4.2 Directory of service (DOS) message

The directory of service message shall be encoded as defined in Table 1-84.

Table 1-84. Directory of service message encoding

Field	Bit position								Notes
	8	7	6	5	4	3	2	1	
parameter ID	1	1	0	0	0	1	0	1	DOS message
Parameter length	n_8	n_7	n_6	n_5	n_4	n_3	n_2	n_1	
parameter value	gsc	ai_3	ai_2	ai_1	ent_4	ent_3	ent_2	ent_1	entry number (ent), **current channel subfield** additional service info (ai); GSC flag (gsc)
	si_8	si_7	si_6	si_5	si_4	si_3	si_2	si_1	service information (si)
	res	res	res	res	$anum_4$	$anum_3$	$anum_2$	$anum_1$	application number (anum) res field absent if anum field is absent.
	a_{18}	a_{17}	a_{16}	a_{15}	a_{14}	a_{13}	a_{12}	a_{11}	application 1 (a_1)
					to				
	a_{k8}	a_{k7}	a_{k6}	a_{k5}	a_{k4}	a_{k3}	a_{k2}	a_{k1}	application k (a_k)
	gsc	ai_3	ai_2	ai_1	f_{12}	f_{11}	f_{10}	f_9	**channel subfield:** additional service info (ai); GSC flag (gsc)
	f_8	f_7	f_6	f_5	f_4	f_3	f_2	f_1	frequency (f)
	si_8	si_7	si_6	si_5	si_4	si_3	si_2	si_1	service information (si)
	res	res	res	res	$anum_4$	$anum_3$	$anum_2$	$anum_1$	application number (anum)
	a_{18}	a_{17}	a_{16}	a_{15}	a_{14}	a_{13}	a_{12}	a_{11}	application 1 (a_1)
					to				
	a_{k8}	a_{k7}	a_{k6}	a_{k5}	a_{k4}	a_{k3}	a_{k2}	a_{k1}	application k (a_k)
	sit_6	sit_5	sit_4	sit_3	sit_2	sit_1	x	x	service information type (sit)

Note.— Bits denoted "x" may be used within the reservation field.

The current channel subfield shall always be present. 1, 2 or more other channel subfields (channel 1, channel 2 etc) shall be added as required in a continuous bit sequence. The contents of the channel subfields shall be determined by the ai subfield as defined in Table 1-85. The service information type (sit) subfield shall follow the last channel subfield.

The subfields within each channel subfield shall be computed as defined in Table 1-85.

Table 1-85. Directory of service message subfield encoding

Subfield	Range	Encoding	Notes
entry number (ent)	0 – 15	ent = entry number of Directory of Services message	up to 16 different DOS messages can be accommodated associated with each ground station transmitting DOS messages.
frequency (f)		See Table 1-30 Absent in current channel subfield	indicates the channel on which the DOS service is provided
GSC flag (gsc)	0 – 1	set to 1 if channel is a GSC	
additional service information (ai)	0 – 7	bit 1: set to 1 if si field included bit 2: set to 1 if anum field present. bit 3: set to 1 if application (a) subfield(s) present	
service information type (sit)	0 – 63	Defines services indicated by each bit in the service information field. As defined by application standards	
service information (si)	Contains 8 single bit flags	Bits indicate the services provided on the indicated channel. bit set if service is available Meaning of bits defined by application standards. field absent if ai bit 0 = 0	
application number (anum)	0 – 15	Indicates the number of application fields present. field absent if ai bit 1 = 0	
application (a)	0 – 255	Identifies a single service defined by application standards field absent if ai bit 2 = 0 if ai bit 1 = 0 and ai bit 2 ≠ 0, only one application subfield shall be present	

Each DOS message shall override any previous DOS message from the same ground station with the same entry number (ent).

The upper bit of the application field shall be used as an extension field, so that a 0 indicates a one byte field and a 1 indicates that the ID continues in the next byte.

Application fields shall be allocated as defined in Table 1-86.

Table 1-86. Allocation of application fields

Encoding (decimal equivalent)	Allocation
0 - 31	reserved for future allocation by ICAO
32 - 63	reserved for private allocation by service provider
64 –127	reserved for future allocation by ICAO delegated authority
128 – 255	reserved for future use (extension of application field)

Service information type (sit) fields shall be allocated as defined in Table 1-87.

Table 1-87. Allocation of service information type fields

Encoding (decimal equivalent)	Allocation
0 – 31	reserved for future allocation by ICAO
32 – 47	reserved for private allocation by service provider
48 –63	reserved for future allocation by ICAO delegated authority

1.5.5 LME timers and parameters

The LME shall conform to the VDL Mode 2 Technical Manual Section 5.4.3, except that Table 1-88 below shall define the VDL Mode 4 management entity system parameter default values and G1 shall be as defined in Table 1-89.

Table 1-88. Management entity system parameters

Symbol	Parameter name	Mode 4 default
TG1 (air only)	Minimum frequency dwell time	Not required
TG2	Maximum idle activity time	3 minutes
TG3 (ground only)	Maximum time between transmissions	Not required
TG4 (ground only)	Maximum time between GSIFs	Not required
TG5	Maximum link overlap time	As VDL Mode 2 Technical Manual Section 5.4.3

Table 1-89. System management parameters

Symbol	Parameter name	Minimum	Maximum	Default	Increment
G1	Maximum number of missed reservations	1	~~15~~255	3	1

1.5.5.1 Counter G1 (maximum number of missed reservations)

~~Counter~~Parameter G1 shall be the maximum number of missed reservations before a station assumes that a peer station is unreachable. Counter G1 shall be set to zero when a transmission is received from a peer station. Counter G1 shall be incremented when no transmission is received from a peer station for which there was a prior reservation if G1 has not been incremented in the previous five seconds, except that a station shall not increment G1 when the prior reservation was made by a station other than the peer station. When counter G1 exceeds the maximum number of missed reservations (the value of parameter G1), the peer station shall be marked as unreachable in the peer entity contact table (PECT) (see Section 1.5.6.2), and links to the peer station cancelled. There shall be one Counter G1 per peer station. Stations marked as unreachable shall be retained in the PECT for a period of time not less than 60 minutes.

Note 1.— The reason that G1 is not incremented when no response is heard in a slot that another station reserved for its peer is the possibility that the reservation itself was lost and thus no reliable inference can be made on the reachability of the peer station.

Note 2.— PECT entries are retained for a period of time in order to stabilize acquisition and track re-initialization performance for stations at the limits of coverage, and also to support potential search and rescue applications that may be developed in the future. Reservations for unreachable stations are retained in the reservation table and allowed to expire normally. These reservations represent real transmissions that may be expected to occur at the indicated times.

Note 3.— The timeliness of the generation of leave events depends on the value of the G1 counter and the number of reservations known to have been made by a station within a time interval. If the G1 counter is set to a low value then a leave event may be generated when a string of messages closely spaced in time is lost due to aircraft banking, antenna shadowing effects and interference. A ground station can readjust the G1 counter with the XID parameter defined in section 1.5.4.3.9 in order to minimise the likelihood of a leave event false alarm.

1.5.6 LME procedures

The LME procedures shall conform to the VDL Mode 2 Technical Manual Section 5.4.4, except that the aircraft location and ground location private parameters shall not be included in any XID and synchronization burst procedures shall be used as defined below.

Note.— Aircraft location and ground location are included as source addresses in the burst format.

1.5.6.1 Synchronization burst procedures

All stations shall transmit the appropriate synchronization burst defined in Section 1.5.2 depending on whether it is a mobile station or a ground station with the QoS and either the periodic broadcast or incremental broadcast parameters defined in Table 1-90. The values of the subfields shall be the latest available data that can be obtained by the station at the start of the slot immediately preceding the first slot of the intended transmission. Where time is used to calculate fields in the transmission, it shall be the time associated with the latitude and longitude data contained in the transmission.

A station transmitting a synchronization burst in a slot assigned by another station shall set the a/d bit to 1; otherwise, the station shall set the a/d bit to 0.

Table 1-90. Synchronization burst parameters

Symbol	Parameter name		Default
TV11min	Reservation	minimum	4

Symbol	Parameter name		Default
TV11max	Hold timer	maximum	8
V11	Nominal periodic rate		6
V12	Periodic dither range		0.1
V21	Nominal rate		100
V22	Max Dither range		31
Q1	Priority		As per information field
Q2a	Slot selection range constraint for level 1		150nmi
Q2b	Slot selection range constraint for level 2		150nmi
Q2c	Slot selection range constraint for level 3		0nmi
Q2d	Slot selection range constraint for level 4		300nmi
Q3	Replace queued data		TRUE
Q4	Number of available slots		3

1.5.6.1.1 Transmission of synchronization bursts supporting applications

A station shall transmit synchronization bursts in accordance with a request from a peer station as described in 1.5.2.4, at the specified rate, and containing the information field corresponding to the requested information field ID (r-id).

The station shall transmit additional synchronization bursts required to meet the demands of any application. In the event that an application request requiring the transmission of synchronization bursts is delivered by means of a directed request, the required bursts shall be transmitted in the slots reserved by the directed request protocol.

Note.— The interaction between the LME and the application of specific requirements for transmission of synchronization bursts is a local issue.

1.5.6.1.2 Mobile stations

Whenever mobile stations are not directed to transmit synchronization bursts on any frequency, they shall transmit mobile synchronization bursts on all GSCs which they can receive at least once per M1 slots. When transmitting autonomously on the GSCs, mobile stations shall use the standard parameters defined in Table 1-66.

Note.— Upon termination of all directed synchronization burst transmissions on a channel(s) other than the GSCs, mobile stations may employ the network entry procedures as described in Section 1.5.6.3 to quickly enter the GSC network(s).

1.5.6.1.3 Ground stations

1.5.6.1.3.1 Recommendation

A set of ground stations should ensure that sufficient synchronisation bursts are available to support the derivation of secondary timing.

Note.— To optimize the secondary navigation calculations, the transmissions from the various ground stations should all be in contiguous slots so that aircraft movement does not add additional error.

1.5.6.1.4 Procedures for conflict resolution

For the purposes of assessing whether another reservation conflicts with a reservation for a synchronization burst, the station shall apply the procedures defined in Section 1.3.6.5 except that the default quality of service parameters defined in Table 1-91 shall be applied to the synchronization burst reservation.

Table 1-91. Synchronization burst parameters for conflict resolution

Symbol	Parameter name	Default
Q1	Priority	As per information field
Q2a	Slot selection range constraint for level 1	150nmi
Q2b	Slot selection range constraint for level 2	150nmi
Q2c	Slot selection range constraint for level 3	75nmi
Q2d	Slot selection range constraint for level 4	300nmi

Note.— These default parameters place a tighter constraint at level 3 than the defaults for original slot selection, which would always result in a slot being selected. The tighter constraint forces the stream to dither to find slots that might be available at higher levels and hence reduces the probability of slot conflict.

1.5.6.2 Peer entity contact Table (PECT)

Every station shall maintain a table of all known stations. For each station, the table shall include the type of the station, a copy of the last of each type of broadcast burst, the time of the last transmission and a G1 counter. The ability to reach a peer station shall be assumed lost after G1 missed reservations.

1.5.6.3 Network entry protocol specifications

1.5.6.3.1 Network entry parameters

The network entry protocol shall implement the system parameters defined in Table 1-92.

Table 1-92. Plea parameters

Symbol	Parameter name	Minimum	Maximum	Recommended default	Increment
CG1_plea	Minimum pool size of peer stations for plea	1	256	2	1
CG1_range	Maximum range for exposure filter	0 nmi	255 nmi	100 nmi	1 nmi
TG6	Maximum delay for plea response	0.1 sec	16 sec	2 sec	0.1 sec
CG1_limit	Exposure filter threshold	1	65 536	2 000	1
CG1_inc	Exposure filter unknown station increment	1	256	MAX(MIN(5*(V11-1), 256), 1)	1
CG1_decay	Decay rate for CG1 filter	1/256	1	247/256	0
CG1_reach	Maximum unreachability time	1 minute	15 minutes	3 minutes	1 minute
TG7	Minimum time delay for plea	1 slot	255 slot	75 slot	1 slot

Note.— There is a separate CG1 filter for each channel which implements the exposure filter.

1.5.6.3.1.1 Parameter CG1_plea (minimum pool size of peer stations for plea)

CG1_plea shall define the minimum number of viable peer stations which must be identified before a plea can be issued. The plea target is selected uniformly from a set of CG1_plea viable peer stations.

1.5.6.3.1.2 Parameter CG1_range (maximum range for exposure filter)

CG1_range shall define the threshold beyond which newly-identified peer stations are disregarded for purposes of determining “exposure”.

Note 1.— This digital filter is intended to trigger network re-entry in cases where a station identifies a large number of new peer stations in a short period of time (e.g., during climb-out from an airport, or when crossing a mountain range). Conversely, since it is normal for new stations to be identified at great range, stations at great range should not be included in the determination of when a station has become “exposed”.

Note 2.— If range cannot be determined (i.e., because a station is not aware of its own location), it is set to a default value of 0. Therefore, unless a service provider has specifically reset CG1_range = 0 by a previous command detected by the station, all newly identified peer stations will increment the value of the filter.

1.5.6.3.1.3 **Parameter TG6 (maximum delay for plea response)**

TG6 shall specify the maximum allowed time interval between receiving a plea and transmitting a plea response. A station receiving a plea shall attempt to respond as quickly as possible. If a response cannot be generated in TG6 seconds, the station shall purge the plea and not respond.

Note.— This is intended to avoid creating reservations that will not be used.

1.5.6.3.1.4 **Parameter CG1_limit (exposure filter threshold)**

When CG1 is greater than or equal to CG1_limit, the station shall consider itself "exposed" (i.e., it has recently detected a large number of users which were not previously in its PECT, indicating that its reservation table may be incomplete). Consistent with the requirements of Section 1.5.6.3, the station shall then reset CG1 = 0, and perform network entry, on the affected channel.

1.5.6.3.1.5 **Parameter CG1_inc (exposure filter unknown station increment)**

CG1_inc shall be the value by which CG1 is incremented each time a station which has been unreachable for at least CG1_reach minutes or a previously unknown peer station is detected with a station-to-station range less than or equal to CG1_range, or with station-to-station range which is indeterminate.

1.5.6.3.1.6 **Parameter CG1_decay (decay rate for CG1 filter).**

CG1_decay shall be the per second decay rate for CG1.

1.5.6.3.1.7 **Recommendation**

CG1_decay should be selected such that CG1 represents an approximate metric for the uncertainty in reservation information associated with newly detected stations.

1.5.6.3.1.8 Parameter CG1_reach

CG1_reach shall be the maximum allowed time between two successfully received transmissions from a peer station without increase the CG1_filter.

1.5.6.3.1.9 Parameter TG7 (minimum time delay for plea)

TG7 shall be the minimum time delay, measured in slot intervals, between the initiation of network entry procedures and the issuance of the first plea on the channel, and also the retry interval between successive examinations of the pool of viable peer stations for ple1. TG7 shall be set when a station tunes to a new frequency on which it has less than nr reservations for synchronization bursts over the next M1 slots; or, upon expiration, if there are no viable peer stations for ple1.

TG7 shall be cleared when the number of reservations for synchronization bursts, over the next M1 slots, equals or exceeds nr; or, when the station has monitored the frequency for M1 slots since the initiation of network entry procedures. Upon expiration of TG7, the station shall transmit a plea if a viable peer station exists.

1.5.6.3.2 **Conditions for application of network entry procedures**

When entering the network, a VSS user shall apply at least one of the network entry procedures defined in Sections 1.5.6.3.3, 1.5.6.3.4 or 1.5.6.3.5, under any of the conditions identified in Table 1-93, on the indicated channels.

Table 1-93. Conditions for network entry

Condition	Channel(s)
Power ON	Global signalling channels
m2 is greater than or equal to M2_limit (see Section 1.2.2.2). *Note.— The m2 test addresses retuning as well as short periods of receiver non-performance for reasons such as receiver deactivation or desensitization in a single-antenna configuration during transmission on another channel.*	Any channel on which the station intends to transmit synchronization bursts in autonomous mode
CG1 is greater than or equal to CG1_limit.	Any channel on which the station intends to transmit synchronization bursts in autonomous mode

The events affecting the value of the CG1 filter are defined in Table 1-94.

Table 1-94. Asynchronous events affecting value of management filter CG1

Events	Values of CG1
Station detects a synchronization burst from a station which has been unreachable on the channel for at least CG1_reach minutes or a previously unknown station at a station-to-station range which can either be calculated as less than CG1_range, or is indeterminate.	$CG1_{new} = CG1_{old} + CG1\_inc$
Station detects a synchronization burst from a station which has been unreachable on the channel for less than CG1_reach minutes or a previously unknown station at a station-to-station range which can be calculated as greater or equal to CG1_range	$CG1_{new} = CG1_{old}$
Once per second	$CG1_{new} = truncate(CG1_{old} * CG1\_decay)$

If CG1 >= CG1_limit, CG1 shall be reset to 0.

Following successful application of the network entry procedures of this section on a given channel, yielding (60/nr) reservations, nr = nominal rate, a station shall not re-apply the procedures of this section, on that channel, for a period of M1 slots.

1.5.6.3.3 Network entry using plea/response procedures

1.5.6.3.3.1 Plea transmission procedures

A station desiring to transmit synchronization bursts on a VDL Mode 4 channel, which has been tuned to the channel for at least TG7 slots but which is prevented from transmission by lack of a valid reservation table, shall identify a set of peer stations S with the highest reported altitudes. The size of S, S_count, shall be defined by

S_count = min((number of viable peer stations identified), CG1_plea)

and a peer station shall be considered viable if it is a mobile station which is known to have transmitted a synchronization burst on the channel on the normal slot boundary with the a/d bit set = 0, or if it is a ground station which is known to have transmitted a synchronization burst on the channel. If S_count is equal to zero, the TG7 timer shall be reset. If S_count is greater than 0, the station shall transmit a plea to a peer station selected randomly from S. The plea shall be transmitted using the response reservation encoding in Section 1.3.18.1 (the destination address bits being set to the address of the selected peer station), with transmission starting on the delayed burst slot boundary of an unoccupied slot. The station shall continue to transmit plea requests, using the Q5 parameters specified in Table 1-95, until one of the following conditions is satisfied:

a) it receives a plea response directed reservation request;

b) it receives an autotune directed reservation request;

c) it creates the necessary number of synchronization burst streams for the channel.

Table 1-95. Plea burst parameters

Symbol	Parameter name		Default
Q1	Priority		2
Q2a	Slot selection range constraint for level 1		150 nmi
Q2b	Slot selection range constraint for level 2		150 nmi
Q2c	Slot selection range constraint for level 3		0 nmi
Q2d	Slot selection range constraint for level 4		300 nmi
Q3	Replace queued data		TRUE
Q4	Number of available slots		2
Q5num	VSS retransmission parameters	number of attempts	1
Q5wait		maximum time to wait for a reply	3 seconds

On each transmission of a plea request, the set S shall be rebuilt and the destination shall be selected randomly from the set.

A network entry burst (defined in Table 1-6) shall have length n ≤ 11 octets excluding frame flags and bit stuffing and shall have a priority of 2. The information field, if present, shall be set to 0 on transmit and shall be ignored on receive.

Note 1.— A station may consider its reservation table for a channel invalid, for the purpose of selecting slots for synchronization bursts, if it has been tuned to a channel for less than M1 slots or if the conditions for rapid network entry, defined in Table 1-93, are satisfied.

Note 2.— If the station has less than nr reservations for synchronization bursts over the next M1 slots at the time the last directed reservation is executed, it may repeat the plea transmission procedure in order to generate additional reservations. The TG7 timer will not be running, and is not required, in this scenario.

Note 3.— In the event that a station issues multiple pleas and receives multiple responses, the final plea/response interaction could result in a total number of synchronization burst streams per M1 slots which exceeds nr. In this case the station would be required to cancel some of the reservations and shift individual nominal slots (or sets of nominal slots) in order to form a periodic sequence of synchronization bursts in time, in accordance with paragraph 1.3.10.5.1.

1.5.6.3.3.2 Plea response transmission procedures

Upon receiving a network entry burst with a response reservation addressed to itself (i.e., a plea) , a station shall take the following actions. If the station has observed the given frequency for at least the previous 60 seconds, and has not initiated a network entry or re-entry procedure within the previous 60 seconds, it shall transmit a synchronization burst request with a plea response reservation containing: min(12, number of reservations required to allow one minute of transmissions at the default synchronization burst rate for this channel) reservations or else if the transmission rate is not known once per 10 second reservations. These reservations shall be identified as follows:

a) unexpired reservations from any prior plea response addressed to the requesting station;

b) any periodic reservations for the requesting station, not otherwise contained in a prior plea response and which a) do not conflict with other known reservations, and b) can be appended to a possible list of reservations in accordance with item (1) above (considering the encoding constraints of the plea response);

c) additional reservations as required, using the selection parameters of Table 1-96.

Otherwise the station shall ignore the burst.

If the station cannot transmit the plea response within TG6 seconds of receiving the plea, the plea response shall be purged and not transmitted.

Table 1-96. Plea response parameters

Symbol	Parameter name	Default
Q1	Priority	2
Q2a	Slot selection range constraint for level 1	150 nmi
Q2b	Slot selection range constraint for level 2	150 nmi
Q2c	Slot selection range constraint for level 3	0 nmi
Q2d	Slot selection range constraint for level 4	300 nmi
Q3	Replace queued data	TRUE
Q4	Number of available slots	3

1.5.6.3.3.3 Recommendation

The station should attempt to transmit the plea response as soon as possible following the plea (while still selecting the transmit slot randomly). The first reservation contained in the plea response should occur as soon as possible in time following the plea response, but not sooner than V52 slots. This supports rapid network entry while still providing sufficient time for the station entering the network to plan for, and

form, its first synchronization burst. The station should attempt to reserve slots which are currently unreserved, and which are related to available slots for which the plea recipient can transmit BND reservations.

Note.— The constraints on transmission time avoid possible race conditions and conflicting reservation sets associated with multiple exchanges of pleas and plea responses. The requirement to include unexpired reservations, if known, minimizes the likelihood of wasted channel resources in the case where a station fails to hear its requested plea response, but other station(s) in the airspace heard it and allocated the appropriate slots.

1.5.6.3.3.4 **Plea response reception procedures**

A station receiving a plea response shall transmit in the reserved slots.

Note.— If the station has not yet declared/transmitted an existing set of periodic reservations for all required synchronization bursts on the given frequency, it may use the reservation fields in the slots reserved by the plea response to set up these periodic streams using periodic reservations (if it has been listening to the channel for at least 60 seconds) or BND reservations (if it has been listening to the channel long enough to use the BND reservation, but not long enough for a periodic reservation). A station may also transmit a null reservation (See Section 1.3.9) or a periodic cancellation (see Section 1.3.10.5.9) in the slots reserved by the plea response. See Section 1.3.10.5.1 for requirements regarding transmissions after the first M1 slots.

1.5.6.3.4 **Network entry via BND**

A station intending to initiate synchronization burst transmissions on a channel, which has insufficient reservations for its intended number of synchronization burst streams, and which cannot make periodic reservations, shall transmit a series of delayed network entry bursts with BND reservations. The number per minute of delayed network entry bursts with BND reservations shall be equal to or less than the intended number of synchronization burst streams per minute. The station shall stop transmitting delayed network entry bursts with a BND reservation if it has set up the required number of streams or it receives a plea response or a directed reservation request. If it receives a plea response or directed reservation request, and thus does not require the reservations created by previous BND transmissions, it shall include a no reservation field in the synchronization bursts transmitted in the unnecessary slots. At most one delayed network entry burst using a BND broadcast reservation shall be made per intended stream.

A station which has reservations for synchronization burst transmissions and which intends to continue operations on the channel, but which is unable to make periodic reservations, shall use BND reservations in lieu of periodic reservations.

A network entry burst (defined in Table 1-6) shall have length $n \leq 11$ octets excluding frame flags and bit stuffing and shall have a priority of 2. The information field, if present, shall be set to 0 on transmit and shall be ignored on receive.

Note.— A station may be temporarily unable to make periodic reservations if its existing reservations are due to a recently received plea response, or if it determines that it has become "exposed" (i.e., CG1 exceeded CG1_limit within the previous 60 seconds).

1.5.6.3.5 **Network entry by full-slot random transmission or plea-to-self**

In the event that a station has listened to a channel for a full minute prior to net entry, a station shall use one of two procedures to begin transmitting synchronization bursts:

a) use default random transmission protocols with combined periodic/incremental reservation types to place each new periodic reservation and to simultaneously reserve the next selected slot in the same superframe for the transmission containing the next periodic reservation, or

b) use default random transmission protocols to transmit a plea response addressed to itself, followed by synchronization bursts with periodic reservations in the reserved slots (note: these may be affected by other reservations detected after transmission of the plea response).

Note.— These default procedures may also be used when a station reverts to autonomous operations after a period of directed operations on the GSC(s), such that the station has a valid reservation table at the time of reversion to autonomous mode.

1.5.7 XID frame types

The aircraft and ground LMEs shall use the XID frame types defined in the VDL Mode 2 Technical Manual Tables 5-46 a, b and c with the additions detailed in Table 1-97.

Table 1-97. XID parameters

			GSIF	**Air initiated link establishment**		**Link parameter modification**	
	Source address		**Ground station**	**Aircraft**	**New ground station**	**Current ground station**	**Aircraft**
	Destination address		**All aircraft**	**Proposed ground station**	**Aircraft**	**Aircraft**	**Current ground station**
XID parameters	GI hex	PI hex		GSIF (P=0)	XID_CMD_LE (P=1)	XID_RSP_LE (F=1)	XID_CMD_LPM (P=1)
Private parameters							
Parameter set ID	F0	00	M	M	M	M	M
N3 parameter	F0	40	O	N/A	O	O	N/A
VS1 parameter	F0	41	O	N/A	O	O	N/A
VS2 parameter	F0	42	O	N/A	O	O	N/A
Q4 parameter	F0	43	O	N/A	O	O	N/A
VS4 parameter	F0	44	O	N/A	O	O	N/A
m2 filter parameters	F0	45	O	N/A	O	O	N/A
CG1 filter parameters	F0	46	O	N/A	O	O	N/A
Autotune parameter	F0	47	O	N/A	~~O~~O	O	N/A
G1 parameter	F0	48	O	N/A	O	O	N/A
Frequency support	F0	C0	O	N/A	O	O	N/A
Directory of service message	F0	C3	O	N/A	O	O	N/A

			Ground initiated handoff		Air initiated handoff	
	Source address		**Proposed ground station**	**Aircraft**	**Aircraft**	**New ground station**
	Destination address		**Aircraft**	**New ground station**	**Proposed ground station**	**Aircraft**
XID parameters	GI hex	PI hex	XID_CMD_HO (P=1)	XID_RSP_HO (F=1)	XID_CMD_HO (P=1)	XID_RSP_HO (F=1)

Private parameters

Parameter set ID	F0	00	M	M	M	M
N3 parameter	F0	40	O	N/A	N/A	O
VS1 parameter	F0	41	O	N/A	N/A	O
VS2 parameter	F0	42	O	N/A	N/A	O
Q4 parameter	F0	43	O	N/A	N/A	O
VS4 parameter	F0	44	O	N/A	N/A	O
m2 filter parameters	F0	45	O	N/A	N/A	O
CG1 filter parameters	F0	46	O	N/A	N/A	O
Autotune parameter	F0	47	O	N/A	N/A	O
G1 parameter	F0	48	O	N/A	N/A	O
Frequency support	F0	C0	O	N/A	N/A	O
Directory of service message	F0	C3	O	N/A	N/A	O

			Air requested handoff	**Ground requested handoff**	**Ground requested broadcast**	**Link connection rejection**
	Source address		**Aircraft**	**Current ground station**	**New ground station**	**Any station**
	Destination address		**Current or proposed ground station**	**Aircraft**	**All aircraft**	**Any station**
XID parameters	GI hex	PI hex	XID_CMD_HO (P=0)	XID_CMD_HO (P=0)	XID_CMD_HO (P=0)	XID_RSP_LCR XID_CMD_LCR

Private parameters

Parameter set ID	F0	00	M	M	M	M
N3 parameter	F0	40	N/A	O	O	N/A
VS1 parameter	F0	41	N/A	O	O	N/A
VS2 parameter	F0	42	N/A	O	O	N/A
Q4 parameter	F0	43	N/A	O	O	N/A
VS4 parameter	F0	44	N/A	O	O	N/A
m2 filter parameters	F0	45	N/A	O	O	N/A
CG1 filter parameters	F0	46	N/A	O	O	N/A
Autotune parameter	F0	47	N/A	O	O	N/A
G1 parameter	F0	48	N/A	O	O	N/A
Frequency support	F0	C0	N/A	O	O	N/A
Directory of service message	F0	C3	N/A	O	O	N/A

1.5.8 XID transmission procedures

1.5.8.1 Request to send

To send an XID to a specific peer station using the long transmission procedures, an LME shall transmit an RTX burst as defined in Table 1-70. Each burst shall contain a unicast request reservation field with the parameters in Table 1-98. If a response is not received, the station shall retransmit the unicast request according to the procedures of Section 1.3.14.

Any General Response (either confirm or failure) sent in response to this RTX (that is, with id=RTX or compressed frame) other than a General Failure with error type 80 hex shall include the connection management parameter (octet 8 of the request) in the first octet of the user parameter field (octet 10 of the response), the XID sequence parameter (octet 9 of the request) in the second octet of the user parameter field (octet 11 of the response), and the RTX retransmission count (octet 10 of the request) in the third octet of the user parameter field (octet 12 of the response).

Note 1.— A ground station may use fixed transmission procedures to support long XID transmissions as well as broadcast XIDs. These transmissions may be augmented as appropriate with periodic reservations and block messages, to eliminate the potential for garble and also to indicate future intent

Note 2.— Short transmission procedures (See Section 1.4.4.3) can also be used when applicable.

Table 1-98. Long transmission RTX burst parameters

Symbol	Parameter name	Default
V32	Minimum response delay	T2 * M1 / 60 slots
V33	Maximum response delay	5 * M1 / 60 slots
V34	Source/destination control	0
Q1	Priority	highest priority of user data frames
Q2a	Slot selection range constraint for level 1	150 nmi
Q2b	Slot selection range constraint for level 2	150 nmi
Q2c	Slot selection range constraint for level 3	0 nmi
Q2d	Slot selection range constraint for level 4	300 nmi
Q3	Replace queued data	TRUE
Q4	Number of available slots	3

1.5.8.2 Recommendation

When possible, the response offset subfield of each RTX burst should be assigned to slots that are not contiguous to other reservations

1.5.8.3 Response to RTX

If the responder does not support the LME, then it shall transmit a general failure (see Section 1.3.20) with an error type of 80 hex, but no other parameters, using the QoS parameters as defined in Table 1-99. If the most recent XID that the responder has received from the source has the same XID sequence number, it shall transmit a General Confirm with id=compressed frame (with the c/r bit set to response) per Section 1.5.8.4. Otherwise, the responder shall transmit a general confirm with id = RTX including an information transfer reservation field with lg set equal to the length of the XID and QoS parameters as defined in Table 1-100.

If the channel is too busy (either the responder cannot find a sufficiently large series of contiguous slots or the priority is too low for the channel utilization), then the responder shall transmit either a general confirm including a unicast reservation with V34 = 1 indicating when the responder will transmit an information transfer request in response to the RTX or a general failure with error type = 01 hex.

Note 1.— If the responder sends a general failure the sender can retransmit the RTX after the timeout defined by the back-off delay or in the slot reserved by the destination.

Table 1-99. General response to RTX parameters

Symbol	Parameter name	Default
Q1	Priority	2
Q2a	Slot selection range constraint for level 1	150 nmi
Q2b	Slot selection range constraint for level 2	150 nmi
Q2c	Slot selection range constraint for level 3	0 nmi
Q2d	Slot selection range constraint for level 4	300 nmi
Q3	Replace queued data	TRUE
Q4	Number of available slots	3

Table 1-100. Response to RTX compressed frame burst parameters

Symbol	Parameter name	Default
V42	Length of information transfer	Sufficient to include requested INFO/UI frames
V43	Minimum information transfer delay	T2 * M1 / 60 slots
V44	Maximum information transfer delay	5 * M1 / 60 slots
V45	Minimum response delay	T2 * M1 / 60 slots
V46	Maximum response delay	5 * M1 / 60 slots
Q1	Priority	highest priority in the RTS for which a reservation has been made
Q2a	Slot selection range constraint for level 1	150 nmi
Q2b	Slot selection range constraint for level 2	150 nmi
Q2c	Slot selection range constraint for level 3	0 nmi
Q2d	Slot selection range constraint for level 4	300 nmi
Q3	Replace queued data	TRUE
Q4	Number of available slots	3

A station receiving a general confirm of an RTX burst addressed to it with an information transfer request reservation field shall transmit the XID in a compressed frame burst format in the reserved slots.

A station not receiving a response to the RTX shall increment the retransmission count field and shall retransmit the RTX using the parameters in Table 1-101 and the procedures of Section 1.3.21.

Note 2.- The process of receiving an XID (i.e., receiving an RTX, etc.) is independent of the process of sending an XID (i.e., sending an RTX, etc.).

Table 1-101. RTX retransmission parameters

Symbol	Parameter Name		Default
Q5min	RTX retransmission parameters	Minimum	0
Q5max		Maximum	5 s
Q5mult		Multiplier	1
Q5exp		Exponent	1.5
Q5num		number of attempts	4
Q5wait		maximum time to wait for a reply	60 s for XID_CMD and 5 s for XID_RSP

Note 3.- Q5wait is 5 seconds for an XID_RSP since the XID_CMD will be retransmitted after T3 seconds (5 seconds plus the T1 timer) and so a second XID_RSP is going to be generated. Retransmission of an RTX is handled only by LME.

1.5.8.4 Acknowledging the data

A station which transmitted an information transfer request reservation field (and consequently has a reservation for a response) shall transmit in the reserved slot a general response burst with id set to compressed frame burst (with c/r bit set to response) with a response reservation type. If it received the XID, it shall send a general confirm; otherwise it shall send a general failure.

Note.— The use of a general confirm as a technical acknowledgement works because only XIDs will be acknowledged with this method and only one XID may be outstanding. The T3 timer is still required to verify the receipt of a response to an XID_CMD.

A station that receives a General Confirm with id of compressed frame shall consider the XID to have been delivered. A station that receives a General Failure with id of compressed frame and a retransmission count parameter that matches the most recently transmitted RTX shall retransmit the RTX using the parameters in Table 1-101 and the procedures of Section 1.3.21.

2. SECTION VDL MODE 4 MOBILE SUBNETWORK DEPENDENT CONVERGENCE FUNCTION (SNDCF)

The VDL Mode 4 shall support the Frame Mode SNDCF as defined in ICAO Doc 9705 Edition 3, section 5.7.8. To support the interface, VDL Mode 4 shall:

(1) generate a Join event upon reception of an XID_RSP_LE or an XID_RSP_HO.

(2) generate a Leave event whenever either the link is terminated, or the link is abandoned.
Note 1.— A link can be terminated for a variety of reasons including a station becoming unreachable as defined in Section 1.5.5.1, protocol exchanges and link timeouts (e.g. expiration of the TG2 or the TG5 timer). A link is abandoned when the TM2 timer indicates that the frequency is congested and the LME enters frequency recovery mode trying to find a less congested frequency and the VDL 4 station does not have a spare receiver to monitor both the old and the new channel.

(3) provide a data transfer service as defined in Section 1.4.

Note 2.— The timeliness of the generation of leave events depends on the value of the G1 counter and the number of reservations known to have been made by a station within a time interval.

~~2.SECTION SUBNETWORK LAYER PROTOCOLS AND SERVICES~~

~~The Subnetwork layer shall conform to the VDL Mode 2 Technical Manual Section 6 except as described below:~~

~~During link establishment, an airborne station shall establish an SVC for each of the priority layers levels (as defined in Table 1A-10) that it expects to use over the link, using the priority facility of ISO 8208.~~

~~*Note. The priority facility was added to ISO 8208 after the date of issue cited by VDL Mode 2.*~~

~~If a CALL REQUEST or CALL CONFIRMATION with a priority facility containing a value other than 0, 1 or 2 is received, a CLEAR REQUEST containing a diagnostic specifying the illegal parameter value shall be sent.~~

~~Data shall be transferred over the SVC with the highest negotiated priority not greater than the priority of the data packet. If no SVC has been established equal to or less than the priority of the data packet, then the data packet shall be discarded.~~

3.SECTION ADDITIONAL MATERIAL FOR ADS-B APPLICATIONS

3.1 INTRODUCTION

Note.— This section defines the additional requirements for VDL Mode 4 supporting ADS-B services.

3.2 ACRONYMS, ABBREVIATIONS AND PARAMETER SYMBOLS

Note.— Other acronyms, abbreviations and parameter symbols have been listed in previous sections of these SARPs.

The following acronyms and abbreviations are introduced in this section as they are defined below.

Acronym	***Description***
MASPS	Minimum aviation system performance standards

Note.— The following parameter symbols are introduced in this section as they are defined below. Other parameters have been listed in previous sections of these SARPs.

Table 3-1. Summary of parameter symbols for ADS-B applications

Parameter	Name	Section or table defined in
ac	Aircraft category	Table 3-11
altr	Altitude rate	Table 3-11
app	Application specific data	Table 3-~~34~~35
auto	Autonomous information	Table 3-21
aux	Auxiliary parameters	Table 3-21
bgo	Baro/geo offset	Table 3-11
br/gr	Baro rate/geo rate offset	Table 3-11
csid	Command set ID	Table 3-27
csl	Call sign left	Table 3-11
csr	Call sign right	Table 3-11
day	Universal coordinated time (UTC) day subfield	Table 3-11
dc	Directory count	Table 3-27
fc	Frequency count	Table 3-27
frq	Frequency index	Table 3-~~42~~39
gs	Ground speed	Table 3-11
gt	Ground track	Table 3-11
h	UTC hour	Table 3-11
ido	Individual offset	Table 3-29

Parameter	Name	Section or table defined in
lat4	4-bit latitude offset	Table 3-11
lat6	6-bit latitude offset	Table 3-11
lat8	8-bit latitude offset	Table 3-11
len	Length	Table 3-~~34~~35
lg	Parameter group length	Table 3-21
lon4	4-bit longitude offset	Table 3-11
lon6	6-bit longitude offset	Table 3-11
lon8	8-bit longitude offset	Table 3-11
mb	More bit	Table 3-~~34~~35
mid	Message ID	Table 3-~~34~~35
min	UTC minute	Table 3-11
mon	UTC month	Table 3-11
NES	Number of elements in script	3.7.2.1
no	TCP number	Table 3-11
nsd	Non-standard definition	Table 3-~~42~~39
NTM	Number of transmissions per minute	3.7.2.1
nucr	Rate uncertainty	Table 3-11
pid	Patch ID	Table 3-11
pos	Maximum sleep position	Table 3-21
r-b/a	Requested baro/geo altitude	Table 3-21
rcv	Must receive	Table 3-~~40~~37
r-id	Requested information ID subfield	Table 3-21
rpt	Repeat count	Table 3-~~42~~39
sc	Script count	Table 3-27
sec	UTC second	Table 3-11
sleep	Autonomous monitoring	Table 3-21
slt	Slot	Table 3-11
snr	Secondary reporting rate	Table 3-21
sr	Script rate	Table 3-27
st	Status	Table 3-11
styp	Script duration type	Table 3-27
tc	Transmission definition count	Table 3-27
tind	Turn indication	Table 3-11
ttg	Time to go	Table 3-11
txd	Transmission definition index	Table 3-~~42~~39
typ	TCP type	Table 3-11

Parameter	Name	Section or table defined in
vel	Maximum sleep velocity	Table 3-21
yr	UTC year	Table 3-11

3.3 INFORMATION FIELD FORMATS

Table 3-2 defines the information field formats that have been assigned for use by the ADS-B application.

Table 3-2. ADS-B information fields

Information field ID (id)	ID extension 1 (id1)	ID extension 2 (id2)	Information field name
0 hex	not present	not present	Basic
1 hex	not present	not present	High dynamic
2 hex	not present	not present	Full position
3 hex	not present	not present	Basic ground
4 hex	not present	not present	UTC time
5-7 hex	not present	not present	Available for future use
8 hex	not present	not present	Two slot TCP
9 hex	not present	not present	Single slot TCP
A hex	0 hex	not present	Available for future use
A hex	1 hex	not present	Aircraft data (call sign, category, status)
A hex	2 – 9 hex	not present	Available for future use
A hex	A hex	0 hex	High resolution
A hex	A hex	1 - 9 hex	Available for future use
A hex	A hex	A hex	Extension (available for future use via further ID extension fields)
A hex	A hex	B – F hex	Available for future use
A hex	B – F hex	not present	Available for future use
B – E hex	not present	not present	Available for future use
F hex	not present	not present	No information field provided

For each information field, data shall be encoded as defined in Tables 3-3 to 3-10.

Table 3-3. Information field 0 hex — Basic

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
information field ID	11	x	x	x	x	0	0	0	0
rate uncertainty (nucr) 6-bit latitude offset (lat6)	12	$nucr_2$	$nucr_1$	$lat6_6$	$lat6_5$	$lat6_4$	$lat6_3$	$lat6_2$	$lat6_1$
6-bit longitude offset (lon6) baro rate/geo rate (br/gr)	13	$nucr_3$	br/gr	$lon6_6$	$lon6_5$	$lon6_4$	$lon6_3$	$lon6_2$	$lon6_1$
baro/geo offset (bgo)	14	$altr_9$	bgo_7	bgo_6	bgo_5	bgo_4	bgo_3	bgo_2	bgo_1
altitude rate (altr)	15	$altr_8$	$altr_7$	$altr_6$	$altr_5$	$altr_4$	$altr_3$	$altr_2$	$altr_1$
ground speed (gs)	16	gs_8	gs_7	gs_6	gs_5	gs_4	gs_3	gs_2	gs_1
ground track (gt)	17	gs_{11}	gs_{10}	gs_9	gt_5	gt_4	gt_3	gt_2	gt_1
	18	gt_{11}	gt_{10}	gt_9	gt_8	gt_7	gt_6		

Note.— "x" denotes part of fixed data field.

Table 3-4. Information field 1 hex — High dynamic

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
information field ID	11	X	x	x	x	0	0	0	1
baro rate/geo rate (br/gr), baro/geo offset (bgo)	12	br/gr	bgo_7	bgo_6	bgo_5	bgo_4	bgo_3	bgo_2	bgo_1
altitude rate (altr)	13	$altr_8$	$altr_7$	$altr_6$	$altr_5$	$altr_4$	$altr_3$	$altr_2$	$altr_1$
rate uncertainty (nucr)	14	$altr_9$	$nucr_3$	$nucr_2$	$nucr_1$	gs_{12}	gs_{11}	gs_{10}	gs_9
ground speed (gs)	15	gs_8	gs_7	gs_6	gs_5	gs_4	gs_3	gs_2	gs_1
4-bit longitude offset (lon4), 4-bit latitude offset (lat4)	16	$lon4_4$	$lon4_3$	$lon4_2$	$lon4_1$	$lat4_4$	$lat4_3$	$lat4_2$	$lat4_1$
ground track (gt)	17	gt_8	gt_7	gt_6	gt_5	gt_4	gt_3	gt_2	gt_1
	18	gt_{12}	gt_{11}	gt_{10}	gt_9	res	res		

Note.— "x" denotes part of fixed data field.

Table 3-5. Information field 2 hex — Full position

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
information field ID	11	X	x	x	x	0	0	1	0
6-bit latitude offset (lat6)	12	pid_{10}	pid_9	$lat6_6$	$lat6_5$	$lat6_4$	$lat6_3$	$lat6_2$	$lat6_1$
patch ID (pid)	13	pid_8	pid_7	pid_6	pid_5	pid_4	pid_3	pid_2	pid_1
baro/geo offset (bgo)	14	gt_{11}	bgo_7	bgo_6	bgo_5	bgo_4	bgo_3	bgo_2	bgo_2
6-bit longitude offset (lon6)	15	gt_{10}	gt_9	$lon6_6$	$lon6_5$	$lon6_4$	$lon6_3$	$lon6_2$	$lon6_1$
ground track (gt)	16	gt_8	gt_7	gt_6	gt_5	gt_4	gt_3	gt_2	gt_1
ground speed (gs)	17	gs_8	gs_7	gs_6	gs_5	gs_4	gs_3	gs_2	gs_1
rate uncertainty (nucr)	18	gs_{11}	gs_{10}	gs_9	$nucr_3$	$nucr_2$	$nucr_1$		

Note.— "x" denotes part of fixed data field.

Table 3-6. Information field 3 hex — Basic ground

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
information field ID	11	~~X~~x	x	x	x	0	0	1	1
UTC hours (h)	12	~~R~~res	res	res	h_5	h_4	h_3	h_2	h_1
UTC minute (min)	13	pid_{10}	pid_9	min_6	min_5	min_4	min_3	min_2	min_1
patch ID (pid)	14	pid_8	pid_7	pid_6	pid_5	pid_4	pid_3	pid_2	pid_1
baro/geo offset (bgo)	15	~~R~~res	bgo_7	bgo_6	bgo_5	bgo_4	bgo_3	bgo_2	bgo_1
slot (slt)	16	slt_8	slt_7	slt_6	slt_5	slt_4	slt_3	slt_2	slt_1
4-bit longitude offset (lon4), 4-bit latitude offset (lat4)	17	$lon4_4$	$lon4_3$	$lon4_2$	$lon4_1$	$lat4_4$	$lat4_3$	$lat4_2$	$lat4_1$
UTC second (sec)	18	sec_6	sec_5	sec_4	sec_3	sec_2	sec_1		

Note.— "res" denotes currently unused. "x" denotes part of fixed data field.

Table 3-7. Information field 4 hex — UTC time

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
information field ID	11	X	x	x	x	0	1	0	0
UTC day (day)	12	~~R~~res	res	res	day_5	day_4	day_3	day_2	day_1
UTC year (yr)	13	yr_8	yr_7	yr_6	yr_5	~~Y~~yr_4	yr_3	yr_2	yr_1
UTC hours (h), UTC month (mon)	14	h_4	h_3	h_2	h_1	mon_4	mon_3	mon_2	mon_1
UTC minute (min)	15	res	h_5	min_6	min_5	min_4	min_3	min_2	min_1
slot (slt)	16	slt_8	slt_7	slt_6	slt_5	~~S~~slt_4	slt_3	slt_2	slt_1
4-bit longitude offset (lon4), 4-bit latitude offset (lat4)	17	$lon4_4$	$lon4_3$	$lon4_2$	$lon4_1$	~~L~~$lat4_4$	$lat4_3$	$lat4_2$	$lat4_1$
UTC second (sec)	18	sec_6	sec_5	sec_4	sec_3	~~S~~sec_2	sec_1		

Note.— "res" denotes currently unused. "x" denotes part of fixed data field.

Table 3-8a. Information field 8 hex — Two slot TCP

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
information field ID	11	x	x	x	x	1	0	0	0
TCP latitude (lat)	12	lat_8	lat_7	lat_6	lat_5	lat_4	lat_3	lat_2	lat_1
	13	$balt_{12}$	$balt_{11}$	$balt_{10}$	$balt_9$	lat_{12}	lat_{11}	lat_{10}	lat_9
base altitude (balt)	14	$balt_8$	$balt_7$	$balt_6$	$balt_5$	$balt_4$	$balt_3$	$balt_2$	$balt_1$
longitude (lon)	15	lon_8	lon_7	lon_6	lon_5	lon_4	lon_3	lon_2	lon_1
	16	ttg_6	ttg_5	lon_{14}	lon_{13}	lon_{12}	lon_{11}	lon_{10}	lon_9
time to go (ttg)/TCP type (typ)	17	ttg_4	ttg_3	ttg_2	ttg_1	typ_4	typ_3	typ_2	typ_1
TCP+1 latitude (lat)	18	lat_8	lat_7	lat_6	lat_5	lat_4	lat_3	lat_2	lat_1
	19	$balt_{12}$	$balt_{11}$	$balt_{10}$	$balt_9$	lat_{12}	lat_{11}	lat_{10}	lat_9
base altitude (balt)	20	$balt_8$	$balt_7$	$balt_6$	$balt_5$	$balt_4$	$balt_3$	$balt_2$	$balt_1$
longitude (lon)	21	lon_8	lon_7	lon_6	lon_5	lon_4	lon_3	lon_2	lon_1
	22	ttg_6	ttg_5	lon_{14}	lon_{13}	lon_{12}	lon_{11}	lon_{10}	lon_9
time to go (ttg)/TCP type (typ)	23	ttg_4	ttg_3	ttg_2	ttg_1	typ_4	typ_3	typ_2	typ_1
TCP+2 latitude (lat)	24	lat_8	lat_7	lat_6	lat_5	lat_4	lat_3	lat_2	lat_1
	25	$balt_{12}$	$balt_{11}$	$balt_{10}$	$balt_9$	lat_{12}	lat_{11}	lat_{10}	lat_9
base altitude (balt)	26	$balt_8$	$balt_7$	$balt_6$	$balt_5$	$balt_4$	$balt_3$	$balt_2$	$balt_1$
longitude (lon)	27	lon_8	lon_7	lon_6	lon_5	lon_4	lon_3	lon_2	lon_1
	28	ttg_6	ttg_5	lon_{14}	lon_{13}	lon_{12}	lon_{11}	lon_{10}	lon_9
time to go (ttg)/TCP type (typ)	29	ttg_4	ttg_3	ttg_2	ttg_1	typ_4	typ_3	typ_2	typ_1
TCP+3 latitude (lat)	30	lat_8	lat_7	lat_6	lat_5	lat_4	lat_3	lat_2	lat_1
	31	$balt_{12}$	$balt_{11}$	$balt_{10}$	$balt_9$	lat_{12}	lat_{11}	lat_{10}	lat_9
base altitude (balt)	32	$balt_8$	$balt_7$	$balt_6$	$balt_5$	$balt_4$	$balt_3$	$balt_2$	$balt_1$
longitude (lon)	33	lon_8	lon_7	lon_6	lon_5	lon_4	lon_3	lon_2	lon_1
	34	ttg_6	ttg_5	lon_{14}	lon_{13}	lon_{12}	lon_{11}	lon_{10}	lon_9
time to go (ttg)/TCP type (typ)	35	ttg_4	ttg_3	ttg_2	ttg_1	typ_4	typ_3	typ_2	typ_1
call sign left (csl)	36	csl_8	csl_7	csl_6	csl_5	csl_4	csl_3	csl_2	csl_1

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
	37	csl_{16}	csl_{15}	csl_{14}	csl_{13}	csl_{12}	csl_{11}	csl_{10}	csl_{9}
	38	res	res	res	csl_{21}	csl_{20}	csl_{19}	csl_{18}	csl_{17}
call sign right (csr)	39	csr_{8}	csr_{7}	csr_{6}	csr_{5}	csr_{4}	csr_{3}	csr_{2}	csr_{1}
	40	csr_{16}	csr_{15}	csr_{14}	csr_{13}	csr_{12}	csr_{11}	csr_{10}	csr_{9}
status (st)	41	st_{3}	st_{2}	st_{1}	csr_{21}	csr_{20}	csr_{19}	csr_{18}	csr_{17}
current patch ID (pid)	42	pid_{8}	pid_{7}	pid_{6}	pid_{5}	pid_{4}	pid_{3}	pid_{2}	pid_{1}
6-bit latitude offset (lat6)	43	pid_{10}	pid_{9}	$lat6_{6}$	$lat6_{5}$	$lat6_{4}$	$lat6_{3}$	$lat6_{2}$	$lat6_{1}$
rate uncertainty (nucr), 6-bit longitude offset (lon6), baro rate/geo rate (br/gr)	44	$nucr_{3}$	br/gr	$lon6_{6}$	$lon6_{5}$	$lon6_{4}$	$lon6_{3}$	$lon6_{2}$	$lon6_{1}$
aircraft category (ac)	45	$altr_{9}$	$nucr_{2}$	$nucr_{1}$	ac_{5}	ac_{4}	ac_{3}	ac_{2}	ac_{1}
altitude rate (altr)	46	$altr_{8}$	$altr_{7}$	$altr_{6}$	$altr_{5}$	$altr_{4}$	$altr_{3}$	$altr_{2}$	$altr_{1}$
ground speed (gs)	47	gs_{8}	gs_{7}	gs_{6}	gs_{5}	gs_{4}	gs_{3}	gs_{2}	gs_{1}
ground track (gt)	48	gs_{11}	gs_{10}	gs_{9}	gt_{5}	gt_{4}	gt_{3}	gt_{2}	gt_{1}
	49	gt_{11}	gt_{10}	gt_{9}	gt_{8}	gt_{7}	gt_{6}	res	res

Note.— "res" denotes currently unused. "x" denotes part of fixed data field.

Table 3-8b. Information field 9 hex — Single slot TCP

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
information field ID	11	x	x	x	x	1	0	0	1
base altitude (balt)	12	$balt_{8}$	$balt_{7}$	$balt_{6}$	$balt_{5}$	$balt_{4}$	$balt_{3}$	$balt_{2}$	$balt_{1}$
TCP number (no)	13	$balt_{12}$	$balt_{11}$	$balt_{10}$	$balt_{9}$	~~N~~no_{2}	no_{1}	pid_{10}	pid_{9}
patch ID (pid)	14	pid_{8}	pid_{7}	pid_{6}	pid_{5}	~~P~~pid_{4}	pid_{3}	pid_{2}	pid_{1}
latitude (lat)	15	lat_{8}	lat_{7}	lat_{6}	lat_{5}	~~L~~lat_{4}	lat_{3}	lat_{2}	lat_{1}
longitude (lon)	16	lat_{12}	lat_{11}	lat_{10}	lat_{9}	~~L~~lon_{14}	lon_{13}	lon_{12}	lon_{11}
	17	lon_{10}	lon_{9}	lon_{8}	lon_{7}	~~L~~lon_{6}	lon_{5}	lon_{4}	lon_{3}
time to go (ttg)	18	ttg_{6}	ttg_{5}	ttg_{4}	ttg_{3}	~~T~~ttg_{2}	ttg_{1}		

Note.— "res" denotes currently unused. "x" denotes part of fixed data field.

Table 3-9. Information field A1 hex — Aircraft data

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
information field ID	11	x	x	x	x	1	0	1	0
aircraft category (ac)	12	0	0	0	1	ac_4	ac_3	ac_2	ac_1
status (st)	13	ac_5	st_3	st_2	st_1	csl_{12}	csl_{11}	csl_{10}	csl_9
call sign left (csl)	14	csl_8	csl_7	csl_6	csl_5	csl_4	csl_3	csl_2	csl_1
	15	csl_{20}	csl_{19}	csl_{18}	csl_{17}	csl_{16}	csl_{15}	csl_{14}	csl_{13}
call sign right (csr)	16	csl_{21}	csr_7	csr_6	csr_5	csr_4	csr_3	csr_2	csr_1
	17	csr_{15}	csr_{14}	csr_{13}	csr_{12}	csr_{11}	csr_{10}	csr_9	csr_8
	18	csr_{21}	csr_{20}	csr_{19}	csr_{18}	csr_{17}	csr_{16}		

Table 3-10. Information field AA0 hex — High resolution

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
information field ID	11	x	x	x	x	1	0	1	0
	12	1	0	1	0	0	0	0	0
rate uncertainty (nucr)	13	res	$nucr_3$	$nucr_2$	$nucr_1$	Gs_{12}	gs_{11}	gs_{10}	gs_9
ground speed (gs)	14	gs_8	gs_7	gs_6	gs_5	Gs_4	gs_3	gs_2	gs_1
8-bit longitude offset (lon8)	16	$lon8_8$	$lon8_7$	$lon8_6$	$lon8_5$	$Lon8_4$	$lon8_3$	$lon8_2$	$lon8_1$
8-bit latitude offset (lat8)	17	$lat8_8$	$lat8_7$	$lat8_6$	$lat8_5$	$Lat8_4$	$lat8_3$	$lat8_2$	$lat8_1$
ground track (gt)	18	gt_8	gt_7	gt_6	gt_5	Gt_4	gt_3	gt_2	gt_1
turn indication (tind)	18	gt_{12}	gt_{11}	gt_{10}	gt_9	$tind_2$	$tind_1$		

Note.— "res" denotes currently unused. "x" denotes part of fixed data field.

The values of the information field subfields shall be as defined in Table 3-11.

Table 3-11. Information field encoding (variable data field)

Subfield	Range	Encoding	Notes
rate navigation uncertainty category (nucr)	0-4	Values 0, 1, 2, 3, 4 in accordance with the five nucr categories specified for ADS-B MASPS by RTCA/DO-242	
4-bit latitude (lat4)	-	A high-resolution component to enhance the 12-bit low-resolution encoding transmitted in the fixed part (see Table 1-66). Encoding of this high-resolution component is described in Section 4.6	
6-bit latitude (lat6)	-	See note above	
8-bit latitude (lat8)	-	See note above	
4-bit longitude (lon4)	-	A high-resolution component to enhance the 14-bit low-resolution encoding transmitted in the fixed part (see Table 1-66). is described in Section 4.6	
6-bit longitude (lon6)	-	See note above	
8-bit longitude (lon8)	-	See note above	
baro/geo offset (bgo)	0-127	bgo = barometric - geometric altitude Encoding as in Table 3-12 below	
baro rate/geo rate (br/gr)	Binary	0 = altitude rate is barometric altitude rate 1 = altitude rate is geometric altitude rate	
altitude rate (altr)	-32 100 fpm to +32 100 fpm	Bit $altr_9$ encodes the sign of altitude rate of change with 0 = climb and 1 = descend. $altr_9$ shall be set to 0 if the magnitude of altitude rate is unknown Bits $altr_8$ ... $altr_1$ encode the magnitude of altitude rate of change as specified in Table 3-14.	
ground speed (gs)	0 to ≥ 11 256 knots	Encoding as in Table 3-13	Range is 0 to 3069 knots for 11 bits and 0 to 11 256 for 12 bits. Resolution steps from 1 knot to 4 knots. Note that bit 12 is only available in the high dynamic variable part.
ground track (gt)	0° to 359.912°	due North ± $½^{N+1}$ degrees coded as 0 and decoded as due North Resolution is $360/2^N$ degrees	Ground track is the same as true track. N is the number of bits (either 11 or 12) assigned in the variable field for ground track.
turn indication (tind)	0 – 3	0 = Unknown, 1 = Left, 2 = Right and 3 = Straight	The threshold between straight and turning is an

Subfield	Range	Encoding	Notes
			operational issue that will be specified elsewhere.
patch ID (pid)	-	Encoding is described in Section 4.8	
TCP type (typ)	0 – 15	Reserved for future definition	
UTC year (yr)	1-255	current year - 1970, 0= N/A	
UTC month (mon)	1-12	integer months	
UTC day (day)	1-31	integer days, 00= N/A	
UTC hours (h)	0-23	integer hours	
UTC minute (min)	0 to 59	integer minutes	
UTC second (sec)	0 to 60	integer seconds	Seconds run up to 60 to allow for leap seconds
slot (slt)	0 to 255	integer slots, 0 indicates the first slot in the second frame	
TCP number (no)	0 – 3	0 = current 1 = next 2 = next + 1 3 = next + 2	
TCP time to go (ttg)	0 – 63	Indicates the time to reach the indicated TCP from either the current position (no – 0) or from the previous TCP (no = 1, 2 or 3). Encoding as in Table 3-17	
call sign left (csl), call sign right (csr)		Encoding for call sign: 1) Call sign shall be left justified 2) Only valid characters are 1-Z, 0 – 9 and null: Assign 1- Z = 0 – 25, 0 – 9 = 26 – 35, null = 36 3) Call sign shall be an eight character string "c_1, c_2, c_3, c_4, c_5, c_6, c_7, c_8" 4) csl = $c_1\ 36^3 + c_2\ 36^2 + c_3\ 36 + c_4$ 5) csr = $c_5\ 36^3 + c_6\ 36^2 + c_7\ 36 + c_8$	
aircraft category (ac)	0 – 31	Encoding as in Table 3-15	
status (st)	0 – 7	Encoding as in Table 3-16	

For information field 9 hex, TCP, the encoding of the base altitude (balt) shall be as defined in Table 1-68 and the patch ID, latitude and longitude subfields shall be encoded as described in Section 4, except that the lowest two bits of the longitude subfield shall be omitted from the transmission and assumed equal to 01 binary.

Note.— For TCP transmission, position encoding shall use the Patch ID encoding described in Section 4.8. The longitude subfield is truncated by two bits. This means that the available resolution will be +/- 150m except at high latitudes where the resolution will increase to +/- 450m.

The encoding of the baro/geo offset subfield shall be as defined in Table 3-12.

Table 3-12. Baro/geo offset encoding (variable data field)

Barometric/geometric altitude offset of transmitting station (ft)		Transmitted value of bgo	Decoded offset (ft)	
base alt ≤ 24 012.5	24 012.5 < base alt		base alt ≤ 24 012.5	24 012.5 < base alt
bgo < -2 075	bgo < -5 050	1	< -2 075	< -5 050
-2 075 ≤ bgo < -2 025	-5 050 ≤ bgo < -4 950	2	-2 050	-5 000
-2 025 ≤ bgo < -1 975	-4 950 ≤ bgo < -4 850	3	-2 000	-4 900
-1 975 ≤ bgo < -1 925	-4 850 ≤ bgo < -4 750	4	-1 950	-4 800
-1 925 ≤ bgo < -1 875	-4 750 ≤ bgo < -4 650	5	-1 900	-4 700
-1 875 ≤ bgo < -1 825	-4 650 ≤ bgo < -4 550	6	-1 850	-4 600
↓	↓	↓	↓	↓
3 975 ≤ bgo < 4 025	7 050 ≤ bgo < 7 150	123	4 000	7 100
4 025 ≤ bgo < 4 075	7 150 ≤ bgo < 7 250	124	4 050	7 200
4 075 ≤ bgo < 4 125	7 250 ≤ bgo < 7 350	125	4 100	7 300
bgo ≥ 4 125	bgo ≥ 7 350	126	> 4 125	> 7 350
reserved		127	error	
offset unknown		0	offset unknown	

Note.— The encoding of the ground speed subfield shall be as defined in Table 3-13.

Table 3-13. Ground speed encoding (variable data field)

Actual speed over ground of transmitting station (knots)	Transmitted value of gs (decimal equivalent of field)	Decoded speed over ground (knots)
unknown	0	unknown
0 ≤ speed < 0.5	1	0
0.5 ≤ speed < 1.5	2	1
1.5 ≤ speed < 2.5	3	2
2.5 ≤ speed < 3.5	4	3
3.5 ≤ speed < 4.5	5	4
↓	↓	↓
1 021.5 ≤ speed < 1 022.5	1 023	1 022
1 022.5 ≤ speed < 1 024	1 024	1 023
1 024 ≤ speed < 1 026	1 025	1 025
1 026 ≤ speed < 1 028	1 026	1 027
↓	↓	↓
3 068 ≤ speed < 3 070	2 047	3 069
3 070 ≤ speed < 3 074	2 048	3 072
3 074 ≤ speed < 3 078	2 049	3 076
3 078 ≤ speed < 3 082	2 050	3 080
↓	↓	↓
11 250 ≤ speed < 11 254	4 093	11 252
11 254 ≤ speed < 11 258	4 094	11 256
11 258 ≤ speed	4 095	more than or equal to 11 258

Note.— The time over which the ground speed is computed is station dependent.

The encoding of the magnitude part of the altitude rate subfield (bits 1 to 8) shall be as defined in Table 3-14.

Table 3-14. Altitude rate magnitude encoding and decoding

Actual altitude rate of transmitting station (fpm)	Transmitted decimal value of $altr_8$ ... $altr_1$	Decoded magnitude of altitude rate (fpm)
unknown	0	unknown
|arate| < 50	1	0
50 ≤ |arate| < 150	2	100
150 ≤ |arate| < 250	3	200
250 ≤ |arate| < 350	4	300
↓	↓	↓
19 950 ≤ |arate| < 20 050	201	20 000
20 050 ≤ |arate| < 20 300	202	20 200
20 300 ≤ |arate| < 20 500	203	20 400
↓	↓	↓
29 900 ≤ |arate| < 30 100	251	30 000
30 100 ≤ |arate| < 30 500	252	30 250
30 500 ≤ |arate| < 31 000	253	30 750
31 000 ≤ |arate| < 32 000	254	31 500
32 000 ≤ |arate|	255	more than or equal to 32 000

Note.— The quantization step size of altr (100 fpm) is equivalent to a one sigma error of 0.5 fps.

The encoding of the aircraft category subfield shall be as defined in Table 3-15.

Table 3-15. Aircraft category encoding

Encoded value	Aircraft/vehicle category	Comments
0	light a/c	7000 kgs (15500 lbs) or less
1	reserved	
2	medium a/c	more than 7000 kgs (15500 lbs) and less than 136000 kgs (300000 lbs)
3	reserved	
4	heavy a/c	136000 kgs (300000 lbs) or more
5	highly manoeuvrable and high speed	>5g acceleration capability and >400 knots
6, 7, 8	reserved	
9	rotorcraft	
10	glider/sailplane	
11	lighter than air	
12	unmanned aerial vehicle	
13	space/transatmospheric vehicle	
14	ultra -light/hang-glider/ para -glider	
15	parachutist/skydiver	
16, 17, 18	reserved	
19	surface vehicle — emergency vehicle	
20	surface vehicle — service vehicle	
21	fixed ground or tethered obstruction	
22, 23	reserved	
24, 25, 26, 27, 28, 29, 30	reserved	
31	unknown	

The encoding of the aircraft status subfield shall be as defined in Table 3-16.

Table 3-16. Aircraft status (emergency/priority status) encoding

Encoded value	Status
0	no emergency/not reported
1	general emergency
2	lifeguard/medical
3	minimal fuel
4	no communications
5	unlawful interference
6, 7	reserved

The encoding of the time to go (ttg) subfield shall be as defined in Table 3-17.

Table 3-17. Time to go subfield encoding

Actual time to go (minutes)	Transmitted decimal value of ttg	Decoded magnitude of time to go (minutes)
unknown	0	No time to go information available
time to go < 0.125	1	0
0.125 ≤ time to go < 0.375	2	0.25
0.375 ≤ time to go < 0.625	3	0.5
↓	↓	↓
15.375 ≤ time to go < 15.625	62	15.5
15.625 ≤ time to go	63	more than or equal to 15.625

3.4 ADS-B REQUEST

3.4.1 ADS-B request format

To request that a station transmit an ADS-B report consisting of a synchronization burst , a station shall transmit a general request burst with r-mi$_1$ = 0, and shall include the auxiliary information as shown in Tables 3-18, 3-19 and 3-20, as appropriate given the values of the sleep and auto bits in octet 6. The information subfields shall be encoded according to Table 3-21. Parameter blocks shall be included only if the respective parameter flag bit is 1 and shall be included in the order (most significant to least significant) of the parameter flag bits. The parameter flag sub-field shall consist of bits 8 through 3 of octet 6.

3.4.2 Sleep mode

If the requesting station desires the responding station to respond at one specified rate as a default, but a different specified rate in the event certain position or velocity deviation thresholds are exceeded, the

requesting station shall set the sleep bit = 1 and octets 7-8 in Table 3-19 shall be sent. Otherwise, the sleep bit shall be set = 0 and octets 7-8 in Table 3-19 shall not be sent.

Note.— The default reporting rate is defined by the reservation data. The contingency reporting rate, in the event that certain position or velocity deviation thresholds are exceeded, is defined by the snr field described here.

3.4.3 Automatic selection of variable information fields

If the requesting station desires the responding station to respond with synchronization burst variable parts selected autonomously by the responding station, the requesting station shall set the auto bit = 0 and octet k in Table 3-20 shall not be sent. Otherwise, the station shall set the auto bit = 1 and the desired variable part ID shall be encoded as indicated in Table 3-20.

Note 1.— The value of k = 7 if the sleep bit = 0 (implying that the auxiliary information for sleep mode is not transmitted), and is 9 if the sleep bit = 1.

Note 2.— The r-id field, which is variable-length, should be encoded in the minimum length allowed. Then, for r-id selections supported within 4 bits, the parameter set enabled by the auto bit fits in a single octet and the overall ADS-B request, with sleep parameters and requested variable part identification, fits in a single message of length = 20 octets.

Table 3-18. ADS-B request bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
r-mi$_1$ (bit 8 = 0), burst ID	5	0	0	0	0	0	0	0	1
autonomous monitoring (sleep),	6	sleep	auto	res	res	res	res	r-b/a$_2$	r-b/a$_1$
autonomous information (auto), requested base altitude (r-b/a), auxiliary information (aux) auxiliary information as required	7 to m	see Tables 3-19 and 3-20							

Table 3-19. ADS-B request bit encoding for sleep mode parameters when sleep bit = 1

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
secondary reporting rate (snr), maximum sleep velocity (vel)	7	snr$_4$	snr$_3$	snr$_2$	snr$_1$	vel$_4$	vel$_3$	vel$_2$	vel$_1$
maximum sleep position (pos)	8	pos$_8$	pos$_7$	pos$_6$	pos$_5$	pos$_4$	pos$_3$	pos$_2$	pos$_1$

Table 3-20. ADS-B request bit encoding for auto parameters when auto bit = 1

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
length (lg), auxiliary data (aux), requested information field ID (r-id) (included if auto = 0)*	k	lg_2	lg_1	aux_2	aux_1	$r\text{-}id_4$	$r\text{-}id_3$	$r\text{-}id_2$	$r\text{-}id_1$

* The r-id field may continue into additional octets depending on the variable part requested.

Table 3-21. ADS-B request field encoding

Subfield	Range	Encoding	Out of Scale	Notes
sleep	Boolean	0 = no sleep mode; 1 = sleep mode	n/a	if 1, additional information describing sleep mode parameters is provided as a first additional information subfield starting in octet 7.
autonomous information (auto)	Boolean	0 = autonomously select transmitted information field 1 = provide requested information field only	n/a	if 1, additional information describing requested information is provided as an additional information subfield starting in octet 7 (if sleep = 0 implying lack of sleep mode parameters), or octet 9 (if sleep = 1).
requested information ID (r-id)	Binary; variable length	See Table 3-2	A value not contained in Table 3-2.	Requests the information field identity contained in the variable data field
maximum sleep velocity (vel)	1 to 15 knots	integer knots	0= ignore	
maximum sleep position (pos)	1 to 255 metres	integer metres	0= ignore	
secondary reporting rate (snr)	same as nr	n/a	n/a	
parameter group length (lg)	0 – 3	Binary	n/a	Indicates number of additional octets in parameter group (e.g., a parameter group comprising a single octet is encoded as 0)
auxiliary parameters (aux)	0 – 3	If r-id = 0 or 1, then: 00 = baro rate; 01 = geo rate 10 = reserved 11 = don't care.	Error if r-id and aux pairing is not listed as a valid encoding in this table.	Interpretation depends on value of r-id field. Unassigned values are reserved.

Subfield	Range	Encoding	Out of Scale	Notes
		If r-id = 9_{hex}, then: 00 = current TCP; 01 = next TCP, 10 = next + 1 TCP, 11 = next + 2 TCP.		If r-id $\notin \{0, 1, 9\}_{hex}$, aux = 00.
requested base altitude (r-b/a)	0 – 3	0 = report either barometric or geometric 1 = report barometric or, if not available, report geometric 2 = report geometric or, if not available, report barometric 3 = reserved for future use		

Note 3.— As an example, an ADS-B request for an aircraft off the airport movement area, which is stopped, could potentially be sent with the encoding of Table 3-22. This encoding imposes sleep mode with wakeup parameters vel = 4 kts and pos = 10 m, and requests the high-resolution variable part. The snr field indicates that the station should transmit once per second in the event that the velocity or position deviation thresholds are exceeded.

Table 3-22. Example ADS-B request bit encoding for sleep mode with request for high-precision variable part

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
$r\text{-}mi_1$ (bit 8 = 0), burst ID	5	0	0	0	0	0	0	0	1
autonomous monitoring (sleep), autonomous information (auto), requested base altitude (r-b/a)	6	sleep (1)	auto (1)	res (0)	res (0)	res (0)	res (0)	$r\text{-}b/a_2$	$r\text{-}b/a_1$
secondary reporting rate (snr), maximum sleep velocity (vel)	7	snr_4 (1)	snr_3 (1)	snr_2 (0)	snr_1 (1)	vel_4 (0)	vel_3 (1)	vel_2 (0)	vel_1 (0)
maximum sleep position (pos)	8	pos_8 (0)	pos_7 (0)	pos_6 (0)	pos_5 (0)	pos_4 (1)	pos_3 (0)	pos_2 (1)	pos_1 (0)
requested information field ID (r-id) (included if auto = 0)	9	lg_2 (0)	lg_1 (0)	aux_2 (0)	aux_1 (0)	$r\text{-}id_4$ (1)	$r\text{-}id_3$ (0)	$r\text{-}id_2$ (1)	$r\text{-}id_1$ (0)

3.5 DEFAULT ADS-B REPORTING

In the absence of an ADS-B request from a peer station or a request from the ADS-B application in the station, the station shall transmit at least 12 synchronization bursts per minute averaged over the two GSCs.

3.6 ADS-B PROCEDURES

A station issuing an ADS-B request (see Section C.4) shall set the auto bit to 0 and include the r-id field when requesting a specific information field. A requesting station shall set the auto bit to 1 and not include the r-id field when it desires that the responding unit determine which information field is the most important at any point in time. The sleep bit shall be set to 0 when requesting a single response (e.g. via a unicast request reservation); the vel, pos and rate fields shall be included in the transmitted request and ignored by the receiving station when the sleep bit is set to 0. A station requesting the time synchronization information field (information field ID 2) shall only transmit a request to a station that has announced that it is operating with a primary time source (tfom = 0 or 1).

A requesting station shall set the sleep bit to 1 when it wants the responding station to transmit a synchronization burst in directed slots at one rate, but transmit at a higher rate under certain circumstances. If the sleep bit is set to 1, a station shall monitor its position and velocity to determine if the station has exceeded either of two thresholds: (a) moving more than pos metres from the position reported in the last directed report or (b) moving more than vel knots. If pos is zero, then the position test shall be ignored. If vel is zero, then the velocity test shall be ignored. A station which exceeded either the position or velocity threshold, shall begin to transmit autonomously using the incremental broadcast procedures until one of the following occurs:

a) it receives a directed request reservation for the frequency on which it is transmitting autonomously with the or bit set to 1 (both the autonomous incremental transmissions and the directed periodic transmissions shall be affected);

b) it is transmitting autonomous synchronization bursts because it exceeded the position threshold, but not the velocity threshold, and it subsequently transmitted a directed synchronization burst (in this case, the station shall not make an incremental reservation past the slot in which it will transmit the directed synchronization burst);

c) it is transmitting autonomous synchronization bursts because it exceeded the velocity threshold, and it subsequently transmitted a directed synchronization burst after its velocity had subsided below the threshold.

Note.— Note that the procedures for sleep mode apply to vertical as well as horizontal movement.

Information fields 0, 1, 2, 3, 4 and AA1 hex shall have priority over other information fields.

A station which is transmitting directed synchronisation bursts which, as part of a regular periodic series of synchronisation bursts, include the two slot TCP variable part defined in Table 3-8a, shall indicate when there is a change to any of its TCPs by setting the TCP change flag (see ~~s~~Section ~~1.3.2.6~~1.5.2.2) to zero in all directed synchronisation bursts transmitted by the station.

When a mobile has set its TCP change flag to 0, only ground stations shall be allowed to respond by issuing an ADS-B request burst requesting that the mobile transmit a synchronisation burst containing the two slot TCP variable part.

The station shall set the TCP change flag to 1 when it has transmitted updated TCP information using the two slot TCP variable part.

A station which is transmitting directed synchronisation bursts which do not include the two slot TCP variable part in the regular periodic series of synchronisation bursts, shall set the TCP change flag to 1.

3.7 XID PARAMETERS

3.7.1 Directory of service (DOS) message

Directory of service information shall be transmitted using the XID parameter DOS message defined in Section 1.5.4.4.2.

The application fields shall be encoded as defined in Table 3-23.

Table 3-23. Encoding of application fields

Encoding (decimal equivalent)	Implied meaning
0	ADS-B
1	TIS-B
2	Secondary navigation capability
3	FIS-B

The service information (si) field for service information type (sit) field equal to hex 00 shall be as defined in Table 3-24.

Table 3-24. Encoding of service information field for sit = hex 00

Service information (si) field bit number	Service	Equivalent application field (see Table 3-23)
1	ADS-B	0
2	TIS-B	1
3	Secondary navigation capability	2
4	FIS-B	3
5 - 8	reserved	

3.7.2 Channel management XID Parameter

The channel management XID parameter shall be divided into component blocks as described in Table 3-25. A station that matches a destination ID in a channel management XID parameter, or is contained in a defined region in a channel management XID parameter, shall not process subsequent channel management XID parameters with the same command set ID in the same XID. A station receiving a channel management XID parameter with a script that matches an active command set shall update the script duration but otherwise not modify its transmissions.

Note.- If the destination block is an implied broadcast (dc = 0 per Table 3-27), it is considered to match the receiving station's ID.

Table 3-25. Component blocks of channel management XID

Blocks	Description
Header block	Contains the XID header and the non-repetitive information for each of the sub-elements.
Destination block	Contains a list of zero or more destinations or a geographic region, along with the timeout and slot offset from the current slot to the start of the script (zero destinations included implies broadcast.)
Transmission definition block	Contains from 0 to 15 transmission definitions in an unordered list. Each definition describes a particular desired transmission (one not already specified in SARPs) and all relevant options. The location of a particular transmission block in this list defines an implicit pointer used in the script block (i.e., thereby specifying a particular message).
Frequency block	Contains from 1 to 7 frequencies in an ordered list and optional sleep parameters to use on each frequency. The location of a particular frequency block in this list defines an implicit pointer used in the script block (i.e., thereby specifying a particular frequency).
Parameter block	Contains QOS and other transmission parameters to use with the elements of this script.
Script block	Contains a repeat rate and from 1 to N script elements in an ordered list. Each script element consists of an optional repeat count, a frequency block pointer, and a transmission block pointer.

3.7.2.1 Header block encoding

The channel management XID parameter header block shall be encoded as defined in Table 3-26 with subfield encodings as defined in Table 3-27.

Table 3-26. Header block bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
XID parameter ID	1	0	1	0	0	1	0	0	0
XID length	2	n_8	n_7	n_6	n_5	n_4	n_3	n_2	n_1
directed timeout (dt)	3	dt_4	dt_3	dt_2	dt_1	do_{12}	do_{11}	do_{10}	do_9
directed offset (do)	4	do_8	do_7	do_6	do_5	do_4	do_3	do_2	do_1
~~directory~~destination count (dc)	5	dc_8	dc_7	dc_6	dc_5	dc_4	dc_3	dc_2	dc_1
command set ID (csid), transmission definition count (tc)	6	$csid_4$	$csid_3$	$csid_2$	$csid_1$	tc_4	tc_3	tc_2	tc_1
frequency count (fc), script duration type (styp), script rate (sr)	7	fc_3	fc_2	fc_1	styp	sr_4	sr_3	sr_2	sr_1
transmit parameter count (pc)	8	res	res	pc_6	pc_5	pc_4	pc_3	pc_2	pc_1
script count (sc)	9	sc_8	sc_7	sc_6	sc_5	sc_4	sc_3	sc_2	sc_1

Table 3-27. Header block field encoding

Subfield	Encoding	Notes
directed timeout (dt)	See Table 1-35	
directed offset (do)	0 or 2 to $2^{12} - 1$ do = 1: invalid	do = 0 implies directed rate reservation. do >1 implies directed slot reservation. For do >1, do = the first slot in which to transmit.
destination count (dc)	0-255	Number of ~~destination addresses that follow~~bytes in the destination block. 0 implies broadcast.
command set ID (csid)	0-~~15~~14 : valid csid identifiers 15 : cancel all prior commands	ID specifying this command~~*~~ (See Note 1)
transmission definition count (tc)	0-15	The number of elements in the transmission definition block.
frequency count (fc)	0 : no freq listed (csid = 15) 1-7 : number of frequencies	The number of elements in the frequency block.
script duration type (styp)	styp = 0: interpret sr as the number of times the entire script repeats per minute; styp = 1: interpret sr as the number of minutes until script repeats.	
script rate (sr)	0-15. Interpreted based on styp. For styp = 0, sr is encoded per Table 1-33. For styp = 1, sr is encoded as minutes between 2 (encoded as 0) and 17 minutes.	
script count (sc)	1 (encoded as 0) – 256	Number of bytes in script block.
transmit parameter count (pc)	0 - 63	Number of bytes in the transmit parameter block.

Note 1.- The command set ID allows a ground station to uplink several (up to ~~16~~15) separate commands to each aircraft or set of aircraft (including all aircraft in view) which are each processed separately. A transmission with csid = x overrides operations specified in a previous transmission with csid = x, but does not affect operations dictated by previous transmissions with csid ¹ x. Hence a ground station can command multiple sets of messages (each set containing various types of transmissions), and the transmissions can have different report periods from one set to another. An example is a sequence of sync bursts on two or more frequencies defined by command set csid = 0, and a separate sequence of TCPs on the same or different frequency(ies) defined by command set csid = 1. The use of different command sets allows directed-slot operation for both command sets even though the two sets of commanded transmissions may have different burst lengths (e.g., one slot for sync bursts and two slots for TCPs).

The number of elements in the script (total number of transmissions over one repeat cycle) shall be designated NES. The number of transmissions per minute shall be designated NTM. A repeat cycle can be less than a sub-multiple of one minute, exactly one minute, or multiple minutes.

Note 2.- The NES can be greater than sc because of the repeat capability.

Note 3.- The length of a single channel management XID parameter is limited by ISO 8885 to 255 bytes.

3.7.2.2 **Destination block encoding**

The destination block shall consists of zero destinations (a broadcast), one or more addressed destinations, or a regional definition, as defined in the following sections. ~~A directory count (dc) of zero (i.e., in the header) indicates that the transmission is a broadcast and incumbent upon all listeners. If one or more addresses are included in the block, and none of them match the receiver, then further processing of the request shall terminate.~~

3.7.2.2.1 Broadcast destination

If the destination count (dc) in the header block is zero, then the channel management XID parameter shall applies to all stations.

3.7.2.2.2 Addressed destination

If bit 8 of octet 1 of the destination block is a zero, then the destination block shall consists of one or more addresses per Table 3-28 with encodings defined in Table 3-29. If none of the addresses matches the receiver, then further processing of this parameter shall terminate.

Note.- The individual offset for the first destination is limited to 0-15 and not 0-31.

Table 3-28. Addressed ~~D~~destination block bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
individual offset (ido)	1	ido_5	ido_4	ido_3	ido_2	ido_1	d_{27}	d_{26}	d_{25}
destination address (d)	2	d_{24}	d_{23}	d_{22}	d_{21}	d_{20}	d_{19}	d_{18}	d_{17}
	3	d_{16}	d_{15}	d_{14}	d_{13}	d_{12}	d_{11}	d_{10}	d_9
	4	d_8	d_7	d_6	d_5	d_4	d_3	d_2	d_1

Table 3-29. Addressed ~~D~~destination block field encoding

Subfield	Encoding	Notes
individual offset (ido)	Per Section 1.4.2.1	
destination address (d)	0-31	See description of usage below.

3.7.2.2.1 **Directed rate operations**

If the directed offset is set equal to 0, then the addressed stations shall operate in directed rate mode. The individual offset parameter ido shall be set to 0 on transmit for each addressed station.

All stations that are not individually addressed shall operate in directed rate mode.

3.7.2.2.2 **Directed slot operations**

If the directed offset is not set equal to 0, then the addressed stations shall operate in directed slot mode. The individual offset parameter ido for each addressed station shall be set to the number of slots by which the transmissions of that station are to be offset from do after the first slot of the XID command.

A station transmitting a channel management XID parameter for which the directed offset is not set equal to 0 shall first ensure that the slots which will be used by addressed stations have first been reserved using block reservation protocols (see section 1.3.17) or ground quarantine (see section 1.3.6.4).

Note.- Directed slot operation is announced by setting bit 1 of octet 1 of the transmitted burst = 1.

3.7.2.2.3 Regional multicast

If bit 8 of octet 1 of the destination block is a one, then the destination block shall consists of a regional multicast per Table 3-30 with encodings defined in Table 3-31. Stations operating in directed-slot mode shall not process regional multicast commands. A station shall determine that it is in the defined region if Condition 1 is true and either Condition 2a or Condition 2b is true:

Condition 1: altitude compliance

- the station altitude (using baro altitude if available, otherwise geo altitude) is greater than or equal to the lower altitude and less than or equal to the upper altitude

Condition 2a: radial range compliance when there is at least one vertex *k* with radial *k* less than or equal to the station's radial from the center of the defined region

- the station distance from the center of the region, assuming a spherical Earth, is less than or equal to the distance *k* associated with the vertex *k* having greatest radial *k* less than or equal to the station's radial from the center of the defined region, or

Condition 2b: radial range compliance when there is no vertex with radial *k* less than or equal to the station's radial from the center of the defined region

- the station distance from the center of the region, assuming a spherical Earth, is less than or equal to the distance k_{vc} associated with the last vertex in the list.

If the station is not in the defined region, then further processing of this parameter shall terminate.

Note.- The (radial, range) pairs may be parsed in a clockwise direction around the defined center of the region. Each range applies at its associated radial, and in a clockwise direction until another radial is encountered.

Table 3-30. Regional multicast block bit encoding

Description		Octet	Bit number							
			8	7	6	5	4	3	2	1
vertex count (vc)		1	0	res	lon_{14}	lon_{13}	vc_4	vc_3	vc_2	vc_1
center latitude (lat, lat4)		2	lon_8	lon_7	lon_6	lon_5	lon_4	lon_3	lon_2	lon_1
		3	lon_{12}	lon_{11}	lon_{10}	lon_9	lat_{12}	lat_{11}	lat_{10}	lat_9
center longitude (lon, lon4)		4	lat_8	lat_7	lat_6	lat_5	lat_4	lat_3	lat_2	lat_1
		5	$lon4_4$	$lon4_3$	$lon4_2$	$lon4_1$	$lat4_4$	$lat4_3$	$lat4_2$	$lat4_1$
lower altitude (lalt)		6	$lalt_8$	$lalt_7$	$lalt_6$	$lalt_5$	$lalt_4$	$lalt_3$	$lalt_2$	$lalt_1$
upper altitude (ualt)		7	$ualt_8$	$ualt_7$	$ualt_6$	$ualt_5$	$ualt_4$	$ualt_3$	$ualt_2$	$ualt_1$
vertex 1	radial 1 (r_1)	8	$r_{1,8}$	$r_{1,7}$	$r_{1,6}$	$r_{1,5}$	$r_{1,4}$	$r_{1,3}$	$r_{1,2}$	$r_{1,1}$
	distance 1 (d_1)	9	$d_{1,8}$	$d_{1,7}$	$d_{1,6}$	$d_{1,5}$	$d_{1,4}$	$d_{1,3}$	$d_{1,2}$	$d_{1,1}$
vertex 2	radial 2 (r_2)	10	$r_{2,8}$	$r_{2,7}$	$r_{2,6}$	$r_{2,5}$	$r_{2,4}$	$r_{2,3}$	$r_{2,2}$	$r_{2,1}$
(as needed)	distance 2 (d_2)	11	$d_{2,8}$	$d_{2,7}$	$d_{2,6}$	$d_{2,5}$	$d_{2,4}$	$d_{2,3}$	$d_{2,2}$	$d_{2,1}$

Table 3-31. Regional multicast block field encoding

Subfield	Encoding	Notes
center latitude (lat, lat4) center longitude (lon, lon4)	lat, lon, lat4, lon4 are CPR encoded per Section 4.	Sent using type=0, reference position is location of station transmitting this XID.
lower altitude (lalt) upper altitude (ualt)	0: alt = -1 500 feet 1: alt = -1 250 feet 2-254: 250ft linear increments up to 63 500 feet 255: no upper limit	Station only matches the broadcast if its altitude (baro if available, otherwise geo) is between lower and upper altitudes. Altitude code 255 is not valid for lower altitude.
distance (d)	See table 3-32.	Vertex blocks are listed in monotonically increasing radial order (clockwise around center).
radial (r)	due North coded as 0. Resolution is 360/256 degrees, linear	

Table 3-32. Vertex distance encoding

Transmitted value of distance (decimal equivalent of field)	Within region if:
0	distance < 0.5 nmi
1	distance < 1.0 nmi
↓	↓
59	distance < 29.5 nmi
60	distance < 30 nmi
61	distance < 31 nmi
↓	↓
89	distance < 59 nmi
90	distance < 60 nmi
91	distance < 62 nmi
↓	↓
119	distance < 118 nmi
120	distance < 120 nmi
121	distance < 124 nmi
↓	↓
254	distance < 656 nmi
255	distance < 660 nmi

Note. – As indicated in Section 3.7.2.2.2.1, a station that matches the regional broadcast filter operates per the directed rate mechanism.

3.7.2.3 Channel management XID reception procedures

Upon receipt of a channel management XID command that is determined to apply to the station due to an ID or regional match, the station shall establish NTM streams. If styp = 0, then NTM shall equal NES * nr (where nr is the result of looking up the encoded sr in Table 1-33). If styp = 1, then NTM shall equal NES / (2 + sr). If styp=1 and NES is not a multiple of (2 + sr), then periodic streams cannot be defined according to the indicated script, the message shall be judged invalid, and the entire XID parameter shall be discarded without further processing.

The receiving station shall update its reservation table and carry out the actions as specified in Table 3-~~30~~33. The mth individual offset ido_m shall correspond to the mth destination address matching that of the receiving station.

Note.- The station is only required to update its reservation table with the reservations that require transmission by the station. Slot selections by other stations commanded in directed-rate mode are unknown at the time the command is processed. Reservations for other stations commanded in directed-slot mode are known in principle, but are required to be located in blocked or quarantined slots according to 3.7.2.2.2.2. Hence there is no operational need to record these reservations at the time the command is processed.

Table 3-~~30~~33. Action on receipt of a channel management XID

Directed offset (do)	Directed timeout (dt)	Action
0	any	See 1.3.16.5.2.
1	any	Invalid
do > 1	dt < 15	Reserve the following slots for the destination to broadcast: for j equal to 0 to 3 and k equal to 0 to NTM - 1, the slots equal to truncate (do + ido_m + (k * M1/NTM) + j * M1) through (lg + truncate (do + ido_m + (k * M1/NTM) + j * M1)) after the first slot of the received burst
do > 1	dt = 15	Reserve the following slots for the destination to broadcast: for k equal to 0 to NTM - 1, the slots equal to truncate (do + ido_m + (k * M1/NTM)) through (lg + truncate (do + (k * M1/NTM))) after the first slot of the received burst

Upon receipt of a burst containing an autotune reservation (pr_flag = 0), the station shall update its reservation table and carry out the actions as specified in Table 1-39.

3.7.2.3.1 **Response to a channel management XID with do = 0**

If the directed offset subfield is equal to 0, the responder station shall operate autonomously using the periodic broadcast procedures with the nominal periodic rate (V11) set to NTM in the autotune reservation transmission for the next dt * M1 slots, with the ~~first two bits of the message ID field set to "00"~~a/d bit set equal to 0. The nominal slots shall be spaced such that the nominal slot for the kth element identified in the script occurs

truncate ((k-1)*M1/NTM) slots

after the nominal slot for the first element identified in the script. The first transmission made in accordance with the received channel management XID command shall occur within 4500 slots of the start of the received command.~~Upon cessation of directed transmissions, the responder shall resume default autonomous behaviour on the GSCs, reserving new slots as required.~~

3.7.2.3.2 **Response to a channel management XID with do > 1**

On receipt of an XID command with the mth destination address matching that of the receiving station and with the directed offset subfield (do) greater than 1, the responder station shall begin the transmission of the first script element at $T0_m$ slots after the first slot of the XID command where $T0_m$ = do + ido_m. Subsequent transmission slots shall be spaced such that the slot for the kth element identified in the script occurs

truncate ((k-1)*M1/NTM) slots

after the specified slot for the first element identified in the script. The a/d bit shall be set equal to 1.

3.7.2.3.3 Setting of TV11 timer

Upon receipt of a channel management XID command the station shall set the TV11 timer (see Section 1.3.10.2.1) equal to the value of the directed timeout (dt) subfield for each of the slots indicated in the XID transmission. The responder station shall transmit in each of the reserved slots. Each response burst shall contain the periodic broadcast reservation field with the periodic offset (po) subfield set to 0 and the periodic timeout (pt) subfield set to min(3, TV11-1). After transmission, the timer TV11 shall be decremented. When TV11 reaches zero, the responder shall not transmit a response to the directed request. Upon cessation of directed transmissions, the responder shall resume default autonomous behaviour on the GSCs, reserving new slots as required.

3.7.2.3.4 Sharing streams

If styp = 1, then the transmissions in successive minutes shall share streams with those script elements that are NTM (modulo NES) apart. If all of the elements that share a stream are not transmitted on the same frequency, then the message shall be judged invalid and the entire XID parameter shall be discarded. If all of the elements that share a stream are not of the same length, then a basic sync burst shall be transmitted for all elements in that stream.

If a station receives a plea request, it shall use NTM as the default reporting rate for the frequency to construct the plea response.

3.7.2.4 Cancellation of channel management XID command

A station shall cancel a channel management XID command with known csid by transmitting a channel management XID with the directed timeout subfield set to 15, the directed offset (do) set to the offset from the first slot of the cancellation XID to the first slot for which the reservation shall be cancelled, and all other subfields set to the same values as in the original ~~burst~~channel management XID command to be cancelled.

A station shall cancel the set of all channel management XID commands for a station or set of stations by transmitting a channel management XID with csid = 15.

A receiving station that is commanded to cancel all reservations for sync burst transmission shall revert to default sync burst operations.

3.7.2.5 Cancellation of autonomous streams

If the responder was transmitting autonomously the VSS user data for which a channel management XID command was received, then it shall cancel its existing reservations in accordance with paragraph 1.3.10.5.9, and operate in accordance with the parameters of the XID command.

3.7.2.5.1 Command set ID parameter

A station that receives a channel management XID parameter with csid = 0 shall terminate any previous default sync burst operations and initiate operations in accordance with the current XID parameter.

A station that receives a channel management XID parameter with csid matching a previously-received channel management XID parameter shall terminate any previous operations commanded by the previous XID parameter and initiate operations in accordance with the current XID parameter.

A station that does not receive a new XID parameter block with csid = 0 within (dt * M1) slots, with dt as specified in the XID parameter block with csid = 0, shall revert to default sync burst operations.

A station that receives a new XID parameter block with csid = 15 shall cancel all reservations for transmission associated with the previously-received channel management XID commands and revert to default sync burst operations.

A station that does not receive a new XID parameter block with csid > 0 within (dt * M1) slots, with dt as specified in the XID parameter block with csid > 0, shall terminate the operations indicated in the associated XID parameter block.

3.7.2.6 Transmission block encoding

3.7.2.6.1 Transmission block definitions in SARPs

The SARPs contain the following ordered list of standard transmission blocks (id = 0 through 15) which can be referenced by id without explicitly describing the referenced formats in the uplink XID. If a station receives an XID parameter containing a standard transmission definition (id = 0 through 15) that it does not recognize, it shall transmit a basic sync burst.

Table 3-34. Transmission block definitions in SARPs

Encoding	Transmission definition
0	Sync burst with baro altitude, no sleep parameters, basic variable field, baro alt rate
1	Sync burst with geo altitude, no sleep parameters, basic variable field, geo alt rate
2	Sync burst with baro altitude, no sleep parameters, full position variable field, baro alt rate
3	Sync burst with baro altitude, no sleep parameters, aircraft data variable field
4 – 15	reserved

3.7.2.6.2 Transmission block definitions not predefined in SARPs

The XID can contain explicit definitions of transmission blocks (i.e., if a desired transmission block is not predefined in Table 3-34~~contained in the ordered list in SARPs but is still describable using internationally standardized elements~~). Zero to fifteen such transmission blocks can be defined in the transmission block definition section (as indicated by the tc field) and shall be encoded as defined in Tables 3-~~31~~35 and 3-~~33~~37.

Table 3-~~31~~35. Sync burst block bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
Boolean ID (id)	1	id_4	id_3	id_2	id_1	aux	b/g	res	0
ID-extension (if required)	2	$id1_4$	$id1_3$	$id1_2$	$id1_1$	$id2_4$	$id2_3$	$id2_2$	$id2_1$

Table 3-~~32~~36. Sync burst block field encoding

Subfield	Encoding	Notes
baro/geo selection (b/g)	b/g = 0: send baro b/g = 1: send geo	If the preferred altitude encoding is not available, then send the other if it is available.
variable field ID (and extensions)	Per Table 3-2	Octet 2 is only included when necessary
auxiliary selection (aux)	For those variable fields with a selection (e.g, basic, high dynamic, TCP), send selection = aux.	If the requested data is not available, but the alternate is, then send the alternate. As an example, for the basic variable field, aux=0 means send baro rate.

If the mobile is travelling greater than 3069 knots (i.e., bit gs_{12}=1), then the mobile shall transmit a high dynamic variable field whenever it otherwise would have transmitted a basic, full position, or high resolution variable field.

Table 3-~~33~~37. Non-sync burst block bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
message ID (mid), more bit (mb)	1	mb	mid_7	mid_6	mid_5	mid_4	mid_3	mid_2	mid_1
length (len), application specific (app)	2	app	app	app	app	len_4	len_3	len_2	len_1

Note.– Octets 3 through len+2 are all application specific.

Table 3-~~34~~38. Non-sync burst block field encoding

Subfield	Encoding	Notes
application specific data (app)		Defined by the application specified by the message ID
length (len)	0-15	Number of bytes following the length (i.e., an application requiring only 4 bits of parameters would encode a 0 for length)
message ID (mid)	Per Table 1-6	
more bit (mb)	mb = 0: octet 2 not included mb = 1: octet 2 (and possibly more follow)	

Whenever the mobile cannot transmit the requested information (either a new message ID, variable field, or other option was defined that the mobile does not understand or the mobile does not have the requested information), then the mobile shall transmit a sync burst with a basic variable field.

3.7.2.7 Frequency block encoding

~~One~~ Zero to seven frequencies are included in the frequency block section (as indicated by the fc field). A single frequency shall be encoded as defined in Table 3-39 with subfield encodings as defined in Table 3-40:

Table 3-39. Frequency block bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
flags	1	sleep	auto	rcv	res	f_{12}	f_{11}	f_{10}	f_9
freq	2	f_8	f_7	f_6	f_5	f_4	f_3	f_2	f_1

Table 3-40. Frequency block field encoding

Subfield	Encoding	Notes
frequency (f)	Per Section 1.3.15.1	
must receive (rcv)	rcv = 0: reception on this frequency is optional rcv = 1: reception on this frequency is mandatory	As the list is ordered in priority, a station receiving a list with a frequency with rcv=0 before a frequency with rcv=1 shall discard the entire XID parameter.
sleep and auto	Per section 3.4.3	If the respective bit is set, then the respective block is appended per Section 3.4.3

The list of frequencies is ordered. A station with k available receivers shall monitor the first min(k, number of mandatory frequencies) frequencies in the frequency list.

3.7.2.7.1 Recommendation~~.~~

A station with spare receivers should monitor the remaining frequencies in the list.

3.7.2.8 Transmission parameter block definition

The station shall transmit all of the streams defined in the script using the parameters defined in Table 3-41 with subfield encodings as defined in Section 1 for the appropriate variable. The station shall use the first transmit parameter count (pc) octets from Table 3-41 instead of the default values for those parameters. If pc is greater than the length of Table 3-41, then the station shall ignore all octets beyond the length. These parameters shall be ignored for directed slot operations.

Note.– pc would be greater than the length of Table 3-41 if more parameters were added after the software was released.

Table 3-41. Transmission parameter block bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
Q1, Q4	1	$Q1_2$	$Q1_1$	res	$Q4_5$	$Q4_4$	$Q4_3$	$Q4_2$	$Q4_1$
Q2a	2	$Q2a_8$	$Q2a_7$	$Q2a_6$	$Q2a_5$	$Q2a_4$	$Q2a_3$	$Q2a_2$	$Q2a_1$
	3	$Q2a_{12}$	$Q2a_{11}$	$Q2a_{10}$	$Q2a_9$	$Q2b_{12}$	$Q2b_{11}$	$Q2b_{10}$	$Q2b_9$
Q2b	4	$Q2b_8$	$Q2b_7$	$Q2b_6$	$Q2b_5$	$Q2b_4$	$Q2b_3$	$Q2b_2$	$Q2b_1$
Q2c	5	$Q2c_8$	$Q2c_7$	$Q2c_6$	$Q2c_5$	$Q2c_4$	$Q2c_3$	$Q2c_2$	$Q2c_1$
	6	$Q2c_{12}$	$Q2c_{11}$	$Q2c_{10}$	$Q2c_9$	$Q2d_{12}$	$Q2d_{11}$	$Q2d_{10}$	$Q2d_9$
Q2d	7	$Q2d_8$	$Q2d_7$	$Q2d_6$	$Q2d_5$	$Q2d_4$	$Q2d_3$	$Q2d_2$	$Q2d_1$
TV11min, TV11max	8	$TV11min_4$	$TV11min_3$	$TV11min_2$	$TV11min_1$	$TV11max_4$	$TV11max_3$	$TV11max_2$	$TV11max_1$
V11	9	res	res	$V11_6$	$V11_5$	$V11_4$	$V11_3$	$V11_2$	$V11_1$
V12	10	res	$V12_7$	$V12_6$	$V12_5$	$V12_4$	$V12_3$	$V12_2$	$V12_1$
VS2	11	res	res	$VS2_6$	$VS2_5$	$VS2_4$	$VS2_3$	$VS2_2$	$VS2_1$
VS4	12	res	$VS4_7$	$VS4_6$	$VS4_5$	$VS4_4$	$VS4_3$	$VS4_2$	$VS4_1$

3.7.2.9 Script block definition

The channel management XID parameter script shall be encoded as defined in Table 3-~~41~~ 42 with subfield encodings as defined in Table 3-~~42~~43.

The script block shall contain one or more script elements. There are two types of script elements as defined in Table 3-42. A transmitting station shall not transmit a script block with two consecutive octets having bits 6-8 equal to "111". A receiving station shall discard a channel management XID command containing a script block with two consecutive octets having bits 6-8 equal to "111".

Table 3-~~41~~42. Script block bit encoding

Description	Octet	Bit number							
		8	7	6	5	4	3	2	1
freq index (frq), transmission definition index (txd)	1	frq_3	frq_2	frq_1	nsd	txd_4	txd_3	txd_2	txd_1
					or				
repeat count (rpt)	1	1	1	1	rpt_5	rpt_4	rpt_3	rpt_2	rpt_1
freq index (frq), non-standard definition (nsd), transmission definition index (txd)	2	frq_3	frq_2	frq_1	nsd ~~txd1~~	txd_4	txd_3	txd_2	txd_1

Table 3-~~42~~43. Script block field encoding

Subfield	Encoding	Notes
frequency index (frq)	0-6 : integer index into freq block 7 : repeat flag (second octet with freq index follows)	The offset from the beginning of the frequency list. (An encoding of 0 refers to the first element in the frequency block.)
Non-standard definition (nsd)	nsd = 0: defined in SARPs per Table 3-34. nsd = 1: defined in XID transmission definition list (see Section 3.7.2.6.2)	
Transmission definition index (txd)	0-15	The offset from the beginning of the transmission definition list (An encoding of 0 refers to the first element in the list.)
Repeat count (rpt)	3 (encoded as 0) to 34	The number of times to repeat the frequency~~/vfd~~ and (nsd, txd) listed in octet 2.

4.SECTION DEFINITIONS FOR COMPACT POSITION REPORTING

4.1 INTRODUCTION

Note.— This section provides the definition of the compact position reporting (CPR) encoding scheme to be used by VDL Mode 4 stations.

4.2 PARAMETER SYMBOLS, DATA TYPES, CONSTANTS AND VARIABLES

4.2.1 Parameter symbols

Note.— The following parameter symbols are introduced in this section as they are defined below. Other parameters have been listed in previous sections of these SARPs.

Table 4-1. Summary of parameter symbols for CPR

Parameter	Name	Section or table defined in
TR1	Maximum age for use in global decode	4.10.2.1
TR2	Maximum time between global updates	4.10.2.2

4.2.2 Data types

All calculations in this section shall use signed integers.

Note.— Division is therefore considered to be integer division (the result of a division is truncated to an integer).

Results of calculations to perform encoding and decoding shall match the results when performed with 64-bit signed integer operations.

4.2.3 Constants

Constants used in the description of CPR shall have the values defined in Table 4-2.

Table 4-2. Constants used in CPR calculations

Type	Name	Value	Description
Integer	LAT_Z	9	Number of zones from 0° to 90° latitude.
Integer	MAX_C	2^{51}	Maximum value for longitude and latitude.
Integer	MAX_C	2^{12} -1	Maximum transmitted latitude value.
Integer	MAX_T^{lon}	2^{14} -1	Maximum transmitted longitude value.

4.2.4 Variables

Note 1.— CPR calculations convert between three representations of a station's position: 1) The external representation of latitude and longitude which is meaningful to applications. 2) The internal representation which provides an integer representation of the position. 3) The link representation which is the encoded position. Tables 4-3 and 4-4 divide the variables and functions used in the CPR calculations into these three categories.

Variables used in CPR calculations shall have the type and range restrictions defined in Table 4-3. [A,B] shall mean greater than or equal to A and less than or equal to B. [A,B) shall mean greater than or equal to A and less than B.

Table 4-3. Variables used in CPR calculations

Type	Name	Range	Description
External representation			
Real	*latitude*	[0,90], [270, 360)	The input latitude Note that a latitude of [-90,0) maps to [270,360).
Real	*longitude*	[0,360)	The input longitude.
Internal representation			
Integer	$type$, $type_{last}$	0 or 1	The type of CPR (0 = even, 1 = odd).
Integer	$clat_{in}$, $clon_{in}$	$[0, MAX_C]$	Latitude and longitude to be encoded.
Integer	tmp_n	$[0, MAX_C]$	Temporary variable number *n*. Only used to make expressions and functions more readable.
Integer	$clat_{ref}$, $clon_{ref}$	$[0, MAX_C]$	Reference latitude and longitude for local decoding.
Integer	x		Any integer.
Integer	pos_1, pos_2	$[0, MAX_C]$	A latitude or longitude.
Integer	$clat_{dec}$, $clon_{dec}$	$[0, MAX_C]$	Decoded latitude and longitude.
Integer	$bits$	3, 5 or 7	Number of bits for the magnitude offset.
Integer	lat_{offs}, lon_{offs}	[0, 2^{bits} -1]	Latitude and longitude offset.
Integer	s_{lat}, s_{lon}	0 or 1	Sign of the latitude and longitude offset.
Integer	lat_p	[0, 18]	The latitude patch.
Integer	lon_p	[0, 35]	The longitude patch.
Link representation			
Integer	*cprf*	0 or 1	CPR format even/odd.
Integer	*lat*	$[0, MAX_T^{lat}]$	Encoded latitude.
Integer	*lon*	$[0, MAX_T^{lon}]$	Encoded longitude.
Integer	lat_{ref}, lat_0, lat_1	$[0, MAX_T^{lat}]$	Encoded latitude.
Integer	lon_{ref}, lon_0, lon_1	$[0, MAX_T^{lon}]$	Encoded longitude.
Integer	*lat4, lat6, lat8*	$[0, 2^{bits+1} - 1]$	Encoded latitude offset.
Integer	*lon4, lon6, lon8*	$[0, 2^{bits+1} - 1]$	Encoded longitude offset.
Integer	*pid*	[0, 179]	Encoded patch ID.

Note 2.— All CPR computations use integer-valued longitude and latitude (in the range $[0, MAX_C]$, *where each step is* $\frac{360}{MAX_C + 1} \approx 0.1598721155 \times 10^{-12}$ *degrees). The conversion from arbitrary-precision real numbers is detailed in the following sections.*

4.2.5 Functions

Functions used in CPR shall have the input parameters and return values defined in Table 4-4.

Note.— The detailed definitions for the functions are given in the following sections.

Table 4-4. Input parameters and return values for functions used in CPR calculations

Type	Name	Description
Function returns value in internal representation		
Integer	*nz (type)*	Number of zones depending on the type (odd/even) of CPR format.
Integer	*dlat (type)*	Latitude patch size for type *type*.
Integer	*nl* ($clat_{dec}$, *type)*	Looks up the value in the transition level table 4-5.
Integer	*dlon* ($clat_{dec}$, *type)*	Longitude patch size at latitude $clat_{dec}$ for type *type*.
Integer	lat_{offs} (*lat*, lat_{ref})	Latitude zone offset.
Integer	lon_{offs} (*lon*, lon_{ref})	Longitude zone offset.
Integer	dec_{lat} ($clat_{ref}$, *lat*, lat_{ref}, *type)*	Local latitude decoding.
Integer	dec_{lon} ($clat_{dec}$, $clon_{ref}$, *lon*, lon_{ref}, *type)*	Local longitude decoding.
Integer	lat_{seg} (lat_0, lat_1, $type_{last}$)	Latitude segment for global decoding.
Integer	lon_{seg} (lon_0, lon_1, $clat_{dec}$, $type_{last}$)	Longitude segment for global decoding.
Integer	$globalDec_{lat}$ (lat_0, lat_1, $type_{last}$)	Global latitude global.
Integer	$globalDec_{lon}$ (lon_0, lon_1, $clat_{dec}$, $type_{last}$)	Global longitude global.
Integer	*fix (x)*	Converts negative co-ordinates to positive.
Integer	*lookup* ($clat_{in}$, *type)*	The value that corresponds to $clat_{in}$ and *type* in the transition level table.
Integer	*diff* (pos_1, pos_2)	The (shortest) distance between pos_1 and pos_2.
Integer	*sign* (pos_1, pos_2)	The sign of *diff* (pos_1, pos_2).
Integer	$offset_{dec}^{lat}(lat_{offs}, s_{lat}, bits, type)$	Calculates the true offset for the latitude offset given in *bits* bits.
Integer	$offset_{dec}^{lon}(clat_{dec}, lon_{offs}, s_{lon}, bits, type)$	Calculates the true offset for the longitude offset given in *bits* bits.
Integer	$fullDec_{lat}$ (*lat*, lat_p, *type)*	Decodes full position latitude.
Integer	$fullDec_{lon}$ ($clat_{dec}$, *lon*, lon_p, *type)*	Decodes full position longitude.
Function returns value in link representation		
Integer	enc_{lat} ($clat_{in}$, *type)*	Returns the CPR encoded value for $clat_{in}$ using type *type*.
Integer	enc_{lon} ($clat_{dec}$, $clon_{in,}$ *type)*	Returns the CPR encoded value for $clon_{in}$ using type *type*.
Integer	$offset_{enc}^{lat}(clat_{in}, clat_{dec}, bits, type)$	The difference between $clat_{in}$ and $clat_{dec}$ expressed using *bits* bits.
Integer	$offset_{enc}^{lon}(clat_{dec}, clon_{in}, clon_{dec}, bits, type)$	The difference between lon_{in} and $clon_{dec}$ expressed using *bits* bits.
Integer	enc_{patch} (lat_p, lon_p)	Encode the patch id.

4.2.6 Patch constants

4.2.6.1 Transition table

The function *lookup($clat_{in}$, type)* shall return the value in the number of zones (even or odd, depending on *type*) column in Table 4-5 for which the $clat_{in}$ value satisfies the restriction in the Range(integer) column.

Note.- The table is symmetrical for latitudes in the range $\left[3 \cdot \lfloor MAX_C/4 \rfloor, MAX_C\right]$ *(i.e. [–90, 0) degrees). This means that for latitude the range 0 – 90 degrees is mapped to* $0 - \lceil MAX_C/4 \rceil$ *and -90 – 0 = 270 – 360 is mapped to* $3 \cdot \lfloor MAX_C/4 \rfloor - MAX_C$.

Table 4-5. Transition table for *lookup* function

Range (degrees)	Range (integer)	Number of zones Even	Number of zones Odd
<13.518674176405572	<84559299976949	35	34
[13.518674176405572,19.162797152134097)	[84559299976949,119863286269066)	34	33
[19.162797152134097,23.5247169626056)	[119863286269066,147147092426093)	33	32
[23.5247169626056,27.228512609375226)	[147147092426093,170314332279771)	32	31
[27.228512609375226,30.51543280332421)	[170314332279771,190874016391806)	31	30
[30.51543280332421,33.50899730287358)	[190874016391806,209598760787195)	30	29
[33.50899730287358,36.28248037044658)	[209598760787195,226946895939473)	29	28
[36.28248037044658,38.883571527761575)	[226946895939473,243216719782307)	28	27
[38.883571527761575,41.34536944123708)	[243216719782307,258615264457015)	27	26
[41.34536944123708,43.691961273699334)	[258615264457015,273293195154609)	26	25
[43.691961273699334,45.941527811563425)	[273293195154609,287364232684706)	25	24
[45.941527811563425,48.10819571981785)	[287364232684706,300916739329498)	24	23
[48.10819571981785,50.20320392571675)	[300916739329498,314021014573143)	23	22
[50.20320392571675,52.23567067731592)	[314021014573143,326734093052511)	22	21
[52.23567067731592,54.213116139057256)	[326734093052511,339103013392294)	21	20
[54.213116139057256,56.14182888275907)	[339103013392294,351167110605961)	20	19
[56.14182888275907,58.02712896497076)	[351167110605961,362959661644475)	19	18
[58.02712896497076,59.87356014060077)	[362959661644475,374509087692437)	18	17
[59.87356014060077,61.68503184003544)	[374509087692437,385839842234890)	17	16
[61.68503184003544,63.46492412462716)	[385839842234890,396973067553844)	16	15
[63.46492412462716,65.2161639281094)	[396973067553844,407927071618287)	15	14
[65.2161639281094,66.9412773021877)	[407927071618287,418717654880330)	14	13
[66.9412773021877,68.6424192797632)	[418717654880330,429358297069654)	13	12
[68.6424192797632,70.32137954962614)	[429358297069654,439860192688716)	12	11
[70.32137954962614,71.97955727480327)	[439860192688716,450232093501524)	11	10
[71.97955727480327,73.61788995824008)	[450232093501524,460479863588517)	10	9
[73.61788995824008,75.23670452702919)	[460479863588517,470605547878490)	9	8
[75.23670452702919,76.83542194177753)	[470605547878490,480605524480339)	8	7
[76.83542194177753,78.41195676510516)	[480605524480339,490466748984332)	7	6
[78.41195676510516,79.9614066817654)	[490466748984332,500158557411138)	6	5
[79.9614066817654,81.47284075679195)	[500158557411138,509612576768200)	5	4
[81.47284075679195,82.91989876526003)	[509612576768200,518663923862256)	4	3
[82.91989876526003,84.22404437738102)	[518663923862256,526821353991124)	3	2
[84.22404437738102,84.99999999999986)	[526821353991124,531674956009016)	2	1
≥ 84.99999999999986	≥ 531674956009016	1	1

4.2.6.2 Patch size functions

The size of a latitude and longitude patch shall be:

$$nz(type) = 4 \cdot LAT_Z - type$$

$$dlat(type) = \frac{MAX_C}{nz(type)}$$

$$nl(clat_{in}, type) = \begin{cases} lookup(clat_{in}, type) & \text{if } clat_{in} < MAX_C/2 \\ lookup(MAX_C - clat_{in}, type) & \text{else} \end{cases}$$

$$dlon(clat_{in}, type) = \frac{MAX_C}{nl(clat_{in}, type)}$$

4.3 FIXED DATA FIELD POSITION ENCODING

4.3.1 General

Given an arbitrary position *latitude* and *longitude* and a desired *type* (odd or even), the *lat*, *lon* and *cprf* sub-fields in the fixed data field of the synchronization burst shall be set to the value of $enc_{lat}()$ and $enc_{lon}()$ computed as defined below.

4.3.2 Input parameters

latitude = latitude to be encoded.
longitude = longitude to be encoded.
type = type of encoding (odd or even).

4.3.3 Calculations

4.3.3.1 Latitude

$$clat_{in} = \frac{(latitude) \cdot (MAX_C + 1)}{360}$$

$$lat = enc_{lat}(clat_{in}, type) = \frac{\left(nz(type) \cdot \mathrm{mod}(clat_{in}, dlat(type)) + \frac{MAX_C}{2 \cdot MAX_T^{lat}} \right)}{\left(\frac{MAX_C}{MAX_T^{lat}} \right)}$$

4.3.3.2 Longitude

$$clon_{in} = \frac{(longitude) \cdot (MAX_C + 1)}{360}$$

$$lon = enc_{lon}(clat_{dec}, clon_{in}, type) = \frac{\left(nl(clat_{dec}, type) \cdot \bmod(clon_{in}, dlon(clat_{dec}, type)) + \frac{MAX_C}{2 \cdot MAX_T^{lon}} \right)}{\left(\frac{MAX_C}{MAX_T^{lon}} \right)}$$

Note.— $clat_{dec}$ = dec_{lat} (latitude, lat, lat, type) as defined in Section 4.4.3.2.

4.4 FIXED DATA FIELD POSITION LOCAL DECODING

4.4.1 General

When the position report processing state machine (see Section 4.10.3.2) indicates that local decoding shall be performed, then the fixed data field position shall be decoded using a single position report and an unambiguous global reference location. The calculation shall return the *latitude*, *longitude* and *type* sub-fields.

Note.— Local decoding uses a single report from the target and a reference location which can be either the receiver's position (if only one type of report has been received from a target) or the last decoded position for the target (if the target's unambiguous global position is known).

4.4.2 Input parameters

$clat_{\text{ref}}$ = reference latitude.
$clon_{ref}$ = reference longitude.
lat = CPR encoded latitude to be decoded.
lon = CPR encoded longitude to be decoded.
cprf = CPR format even/odd.

4.4.3 Calculations

4.4.3.1 Supporting function

$$fix(x) = \begin{cases} x + 1 + MAX_c & \text{if } x < 0 \\ x & \text{else} \end{cases}$$

4.4.3.2 Latitude

$$type = cprf$$

$$lat_{ref} = enc_{lat}(clat_{ref}, type)$$

$$lat_{offs}(lat, lat_{ref}) = \begin{cases} 1 \ \ if \ \ (lat_{ref} - lat) > \frac{MAX_T^{lat}}{2} \\ -1 \ \ if \ \ (lat_{ref} - lat) < -\frac{MAX_T^{lat}}{2} \\ 0 \ \ \ else \end{cases}$$

$$tmp_1 = dlat(type) \cdot \left(\frac{clat_{ref}}{dlat(type)} + lat_{offs}(lat, lat_{ref}) \right)$$

$$clat_{dec} = dec_{lat}(clat_{ref}, lat, lat_{ref}, type) = fix\left(\frac{\left(\left(\frac{MAX_C}{MAX_T^{lat}} \right) \cdot lat \right)}{nz(type)} + tmp_1 \right)$$

$$latitude = \frac{\left(clat_{dec} + offset_{dec}^{lat}(lat_{offs}, s_{lat}, bits, type) \right) \cdot 360}{(MAX_C + 1)}$$

Note.— $offset_{dec}^{lat}(lat_{offs}, s_{lat}, bits, type)$ is defined in Section 4.7.3.1.

4.4.3.3 **Longitude**

$$lon_{ref} = enc_{lon}(clat_{dec}, clon_{ref}, type)$$

$$lon_{offs}(lon, lon_{ref}) = \begin{cases} 1 \ \ if \ (lon_{ref} - lon) > \frac{MAX_T^{lon}}{2} \\ -1 \ \ if \ (lon_{ref} - lon) < -\frac{MAX_T^{lon}}{2} \\ 0 \quad else \end{cases}$$

$$tmp_2 = dlon(clat_{dec}, type) \cdot \left(\frac{clon_{ref}}{dlon(clat_{dec}, type)} + lon_{offs}(lon, lon_{ref}) \right)$$

$$clon_{dec} = dec_{lon}(clat_{dec}, clon_{ref}, lon, lon_{ref}, type) = fix\left(\frac{\left(\left(\frac{MAX_C}{MAX_T^{lon}} \right) \cdot lon \right)}{nl(clat_{dec}, type)} + tmp_2 \right)$$

$$longitude = \frac{\left(clon_{dec} + offset_{dec}^{lon}(clat_{dec}, lon_{offs}, s_{lon}, bits, type) \right) \cdot 360}{(MAX_C + 1)}$$

Note.— $offset_{dec}^{lon}(clat_{dec}, lon_{offs}, s_{lon}, bits, type)$ is defined in Section 4.7.3.2.

4.5 FIXED DATA FIELD POSITION GLOBAL DECODING

4.5.1 General

When the position report processing state machine (see Section 4.10.3.2) indicates that global decoding shall be performed, then the fixed data field position shall be decoded using the most recently received odd and even fixed data field positions. The calculation shall return the *latitude*, *longitude* and *type* fields.

Note.— The global decoding is guaranteed to succeed if the target has travelled less than 8.4 nmi between the odd and even position report and if the target has not crossed any transition latitude between the reports.

4.5.2 Input parameters

lat_0 = even CPR encoded latitude to be decoded.
lon_0 = even CPR encoded longitude to be decoded.
lat_1 = odd CPR encoded latitude to be decoded.
lon_1 = odd CPR encoded longitude to be decoded.
cprf = type of encoding (odd or even) for the most recent of the two CPR reports.

4.5.3 Transition level straddling

If, $nl(globalDec_{lat}(lat_0, lat_1, 1, 0) \neq nl(globalDec_{lat}(lat_0, lat_1, 0),0)$ then decoding as defined in 4.10.3.3 shall be computed instead of a global decode.

Note.— This situation occurs when the target has straddled a transition latitude.

4.5.4 Calculations

4.5.4.1 Latitude

$$type_{last} = cprf$$

$$tmp_3 = \frac{\left(lat_0 \cdot nz(1) + 2 \cdot nz(type_{last}) \cdot MAX_T^{lat} + \frac{MAX_T^{lat}}{2} - lat_1 \cdot nz(0) \right)}{MAX_T^{lat}}$$

$$lat_{seg}(lat_0, lat_1, type_{last}) = \mathrm{mod}(tmp_3, nz(type_{last}))$$

$$tmp_4 = lat_{seg}(lat_0, lat_1, type_{last}) \cdot dlat(type_{last})$$

$$clat_{dec} = globalDec_{lat}(lat_0, lat_1, type_{last}) = tmp_4 + \frac{\left(\left(\frac{MAX_C}{MAX_T^{lat}} \right) \cdot lat_{type_{last}} \right)}{nz(type_{last})}$$

4.5.4.2 Longitude

$$tmp_5 = \frac{\left(lon_0 \cdot nl(clat_{dec},1) + 2 \cdot nl(clat_{dec}, type_{last}) \cdot MAX_T^{lon} + \frac{MAX_T^{lon}}{2} - lon_1 \cdot nl(clat_{dec},0) \right)}{MAX_T^{lon}}$$

$$lon_{seg}(lon_0, lon_1, clat_{dec}, type_{last}) = \mathrm{mod}(tmp_5, nl(clat_{dec}, type_{last}))$$

$$tmp_6 = lon_{seg}(lon_0, lon_1, clat_{dec}, type_{last}) \cdot dlon(clat_{dec}, type_{last})$$

$$clon_{dec} = globalDec_{lon}(lon_0, lon_1, clat_{dec}, type_{last}) = tmp_6 + \frac{\left(\left(\frac{MAX_C}{MAX_T^{lon}} \right) \cdot lon_{type_{last}} \right)}{nl(clat_{dec}, type_{last})}$$

4.6 INFORMATION FIELD OFFSET ENCODING

4.6.1 General

Given a position and its fixed data field encoding (see Section 4.3), a high resolution offset encoding of size *bits* together with an additional bit indicating the sign of the offset shall be computed as defined below. The offset shall be encoded in the sub-fields lat4, lon4 (for *bits* = 3), lat6, lon6 (for *bits* = 5) or lat8, lon8 (for bits = 7) dependent on which synchronization burst variable part is to be transmitted (see Section 3).

4.6.2 Input parameters

$clat_{in}$ = latitude to be encoded.
$clon_{in}$ = latitude to be encoded.
lat = the CPR encoded latitude (see Section 4.3).
lon = the CPR encoded longitude (see Section 4.3).
type = type of CPR (odd or even).
bits = number of bits in magnitude of the offset.

4.6.3 Calculations

4.6.3.1 Supporting functions

$$diff(pos_1, pos_2) = \begin{cases} pos_1 - pos_2 - MAX_C - 1 & \text{if } pos_1 > pos_2 + MAX_C / 2 \\ pos_1 - pos_2 + MAX_C + 1 & \text{if } pos_2 > pos_1 + MAX_C / 2 \\ pos_1 - pos_2 & \text{else} \end{cases}$$

$$sign(pos_1, pos_2) = \begin{cases} 1 & \text{if } diff(pos_1, pos_2) \geq 0 \\ 0 & \text{else} \end{cases}$$

4.6.3.2 **Latitude**

$$lat = enc_{lat}(clat_{in}, type)$$
$$clat_{dec} = dec_{lat}(clat_{in}, lat, lat, type)$$

$$tmp_7 = \frac{MAX_C}{2 \cdot nz(type) \cdot MAX_T^{lat} \cdot (2^{bits} - 1)}$$

$$offset_{enc}^{lat}(clat_{in}, clat_{dec}, bits, type) = \frac{\left| diff(clat_{in}, clat_{dec}) \right| + \frac{tmp_7}{2}}{tmp_7}$$

$$lat4(bits\ 1 to\ 3) = offset_{enc}^{lat}(clat_{in}, clat_{dec}, 3, type)$$

$$lat6(bits\ 1 to\ 5) = offset_{enc}^{lat}(clat_{in}, clat_{dec}, 5, type)$$

$$lat8(bits\ 1 to\ 7) = offset_{enc}^{lat}(clat_{in}, clat_{dec}, 7, type)$$

$$lat4(bit\ 4) = lat6(bit\ 6) = lat8(bit\ 8) = sign(clat_{in}, clat_{dec})$$

4.6.3.3 **Longitude**

$$lon = enc_{lon}(clat_{dec}, clon_{in}, type)$$

$$clon_{dec} = dec_{lon}(clat_{dec}, clon_{in}, lon, lon, type)$$

$$tmp_8 = \frac{MAX_C}{2 \cdot nl(clat_{dec}, type) \cdot MAX_T^{lon} \cdot (2^{bits} - 1)}$$

$$offset_{enc}^{lon}(clat_{dec}, clon_{in}, clon_{dec}, bits, type) = \frac{\left| diff(clon_{in}, clon_{dec}) \right| + \frac{tmp_8}{2}}{tmp_8}$$

$$lon4(bits 1 to 3) = offset_{enc}^{lon}(clat_{dec}, clon_{in}, clon_{dec}, 3, type)$$

$$lon6(bits 1 to 5) = offset_{enc}^{lon}(clat_{dec}, clon_{in}, clon_{dec}, 5, type)$$

$$lon8(bits 1 to 7) = offset_{enc}^{lon}(clat_{dec}, clon_{in}, clon_{dec}, 7, type)$$

$$lon4(bit\ 4) = lon6(bit\ 6) = lon8(bit\ 8) = sign(clon_{in}, clon_{dec})$$

4.7 INFORMATION FIELD OFFSET DECODING

4.7.1 General

To decode the information field latitude and longitude offsets, the offset values defined below shall be added to the position from the fixed data field position decoding (either local or global) to determine the actual target position.

4.7.2 Input parameters

lat4, lat6, lat8 = received latitude offset.
lon4, lon6, lon8 = received longitude offset.
type = type of encoding (odd or even).
$clat_{dec}$ = the target's decoded latitude (see Section 4.4.3.2)

4.7.3 Calculations

4.7.3.1 Latitude

$$bits = \begin{cases} 3 & if\ lat4, lon4\ provided\ as\ input \\ 5 & if\ lat6, lon6\ provided\ as\ input \\ 7 & if\ lat8, lon8\ provided\ as\ input \end{cases}$$

$$lat_{offs} = \begin{cases} lat4(bits1to3) & if\ lat4, lon4\ provided\ as\ input \\ lat6(bits1to5) & if\ lat6, lon6\ provided\ as\ input \\ lat8(bits1to7) & if\ lat8, lon8\ provided\ as\ input \end{cases}$$

$$s_{lat} = \begin{cases} lat4(bit\ 4) & if\ lat4, lon4\ provided\ as\ input \\ lat6(bit\ 6) & if\ lat6, lon6\ provided\ as\ input \\ lat8(bit\ 8) & if\ lat8, lon8\ provided\ as\ input \end{cases}$$

$$tmp_9 = \frac{MAX_C}{2 \cdot nz(type) \cdot MAX_T^{lat} \cdot (2^{bits} - 1)}$$

$$offset_{dec}^{lat}(lat_{offs}, s_{lat}, bits, type) = \begin{cases} lat_{offs} \cdot tmp_7 & \text{if } s_{lat} = 1 \\ -lat_{offs} \cdot tmp_7 & \text{if } s_{lat} = 0 \end{cases}$$

Note.— tmp_7 is defined in Section 4.6.3.2.

4.7.3.2 Longitude

$$lon_{offs} = \begin{cases} lon4(bits1to3) & if\ lat4, lon4\ provided\ as\ input \\ lon6(bits1to5) & if\ lat6, lon6\ provided\ as\ input \\ lon8(bits1to7) & if\ lat8, lon8\ provided\ as\ input \end{cases}$$

$$s_{lon} = \begin{cases} lon4(bit\ 4) & if\ lat4, lon4\ provided\ as\ input \\ lon6(bit\ 6) & if\ lat6, lon6\ provided\ as\ input \\ lon8(bit\ 8) & if\ lat8, lon8\ provided\ as\ input \end{cases}$$

$$tmp_{10} = \frac{MAX_C}{2 \cdot nl(clat_{dec}, type) \cdot MAX_T^{lon} \cdot (2^{bits} - 1)}$$

$$offset_{dec}^{lon}(clat_{dec}, lon_{offs}, s_{lon}, bits, type) = \begin{cases} lon_{offs} \cdot tmp_8 & \text{if } s_{lon} = 1 \\ -lon_{offs} \cdot tmp_8 & \text{if } s_{lon} = 0 \end{cases}$$

Note.— tmp_8 is defined in Section 4.6.3.3.

4.8 PATCH ID ENCODING

4.8.1 General

When a station sends an unambiguous global position in a single message, then it shall transmit the value of $enc_{patch}()$ as the patch ID (pid).

4.8.2 Input parameters

$clat_{in}$ = latitude to encode.
$clon_{in}$ = longitude to encode.
type = type of encoding (odd or even).

4.8.3 Calculations

$$lat_p = \begin{cases} \dfrac{clat_{in}}{dlat(type)} & \text{if } 0 \le clat_{in} \le \frac{MAX_C}{4} \\ \dfrac{clat_{in}}{dlat(type)} - 16 & \text{if } clat_{in} > \frac{MAX_C}{4} \end{cases}$$

$$lat = enc_{lat}(clat_{in}, type)$$

$$clat_{dec} = dec_{lat}(clat_{in}, lat, lat, type)$$

$$lon_p = \frac{clon_{in}}{dlon(clat_{dec}, type)}$$

$$pid = enc_{patch}(lat_p, lon_p) = 36 \cdot lat_p + lon_p$$

4.9 PATCH ID DECODING

4.9.1 General

The patch ID decoding shall use the received patch ID , lat and lon subfields and decode this to a position in latitude and longitude, which is globally unambiguous.

4.9.2 Input parameters

lat = CPR latitude to decode.
lon = CPR longitude to be decode.
type = type of encoding (odd or even).
pid = encoded patch id

4.9.3 Calculations

4.9.3.1 Latitude

$$lat_p = \begin{cases} \dfrac{pid}{36} & \text{if } 0 \le pid \le 359 \\ \dfrac{pid}{36} + 16 & \text{if } pid > 359 \end{cases}$$

$$fullDec_{lat}(lat, lat_p, type) = \frac{\left(\left(\dfrac{MAX_C}{MAX_T^{lat}}\right) \cdot lat\right)}{nz(type)} + dlat(type) \cdot lat_p$$

4.9.3.2 Longitude

$$lon_p = \mathrm{mod}(pid, 36)$$

$$clat_{dec} = fullDec_{lat}(lat, lat_p, type)$$

$$fullDec_{lon}(clat_{dec}, lon, lon_p, type) = \frac{\left(\left(\dfrac{MAX_C}{MAX_T^{lon}}\right) \cdot lon\right)}{nl(clat_{dec}, type)} + dlon(clat_{dec}, type) \cdot lon_p$$

4.10 POSITION REPORT PROCESSING

4.10.1 Services

The PECT (see Section 4.10.3.1) shall maintain sufficient history of received targets to enable unambiguous global position to be determined.

4.10.2 Position report parameters

The position report parameters shall be as defined in Table 4-6.

Table 4-6. Position report processing parameters

Symbol	Parameter name	Minimum	Maximum	Default	Increment
TR1	Maximum age for use in global decode	1 sec	60 sec	30 sec	1 sec
TR2	Maximum time between global updates	1 sec	240 sec	60 sec	1 sec

4.10.2.1 Parameter TR1 (maximum age for use in global decode)

The parameter TR1 shall be the maximum age of a report for its use in a global decode. The timer shall be started (or restarted) as defined in Table 4-7. If it expires the report shall not be valid for use in a global decode.

4.10.2.2 Parameter TR2 (maximum time between global updates)

The parameter TR2 shall be the maximum time between global updates. The timer shall be started (or restarted) as defined in Table 4-7.

4.10.3 Position report processing procedures

4.10.3.1 Position report processing state machine

For each station maintained in the PECT (see Section 1.5.6.2), the station shall maintain the record of the last received position report and a position report processing state machine with the following states:

a) State 1 shall indicate that no position report has been received and represents the initial state of the position report processing state machine;

b) State 2 shall indicate that a position report has been received but that no position has been decoded;

c) State 3 shall indicate that a position report has been received and that a local position has been decoded;

d) State 4 shall indicate that a position report has been received and that a global position has been decoded.

4.10.3.2 Position report processing state machine transitions

On receipt of a position report, the station shall update its state machine as defined in Table 4-7 and report target position quality to the application.

Note 1.— State transitions depend on:

a) *the initial state;*

b) the type (even or odd) of the last received position report;

c) the type of received position report (even/odd/with patch ID/without patch ID);

d) whether the station has knowledge of its own position;

e) the state of timers TR1 and TR2.

Note 2.— The station carries out the actions defined as "C=" in Table 4-7:

a) C = GL: carry out global decoding as defined in Section 4.5 if there is no patch ID, or as defined in E9 if there is a patch ID;

b) C = L1: carry out local decoding using own position as reference, as defined in Section 4.4;

c) C = L2: carry out local decoding using the last known position of the transmitting station as reference, as defined in Section 4.4;

d) C = NO: no decode is carried out.

Note 3.— The station restarts timers TR1 and TR2 as indicated in Table 4-7:

a) *resTR1: restart timer TR1;*

b) resTR2: restart timer TR2.

Note 4.— The state machine enters the state indicated as "N=" in Table 4-7 and reports the target position quality to the application:

a) *if the final state is 1 or 2, the station indicates a target position quality of "none";*

b) if the final state is 3, the station indicates a target position quality of "local";

c) if the final state is 4, the station indicates a target position quality of "global".

Table 4-7. State transitions for position report processing

In State				**1**	**2**		**3**		**4**	
Last report				**None**	**Even**	**Odd**	**Even**	**Odd**	**Even**	**Odd**
Target position quality				**None**	**None**	**None**	**Local**	**Local**	**Global**	**Global**
Received position report type	**Own Posi-tion**	**Timers (exp = expired)**								
		TR1	**TR2**							
Even or odd with patch ID	not appli-cable	not appli-cable	not appli-cable	N= 4 C= GL resTR1 resTR2	N= 4, C= GL resTR1, resTR2		N= 4, C= GL resTR1, resTR2		N= 4, C= GL resTR1, resTR2	
Even	Yes	Not exp	Not exp	N= 3 C= L1 ResTR1	N= 3 C= L1 resTR1	N= 4 C= GL resTR1 resTR2	N= 3 C= L1 resTR1	N= 4 C= GL resTR1 resTR2	N= 4 C= L2 resTR1	N= 4 C= GL resTR1 resTR2
			Exp						N= 3 C= L1 resTR1	
		Exp	Not exp			N= 3 C= L1 resTR1		N= 3 C= L1 resTR1	N= 4, C= L2, resTR1	
			Exp						N= 3, C= L1, resTR1	
	No	Not exp	Not exp	N= 2 C= NO ResTR1	N= 2 C= NO resTR1	N= 4 C= GL resTR1 resTR2	N= 2 C= NO resTR1	N= 4 C= GL resTR1 resTR2	N= 4 C= L2 resTR1	N= 4 C= GL resTR1 resTR2
			Exp						N= 2 C= NO resTR1	
		Exp	Not exp			N= 2 C= ~~L1~~NO resTR1		N= 2 C= NO resTR1	N= 4, C= L2, resTR1	
			Exp						N= 2, C= NO, resTR1	
Odd	Yes	Not exp	Not exp	N= 3 C= L1 ResTR1	N= 4 C= GL resTR1 resTR2	N= 3 C= L1 resTR1	N= 4 C= GL resTR1 resTR2	N= 3 C= L1 resTR1	N= 4 C= GL resTR1 resTR2	N= 4 C= L2 resTR1
			Exp							N= 3 C= L1 resTR1
		Exp	Not exp		N= 3 C= L1 resTR1		N= 3 C= L1 resTR1		N= 4, C= L2, resTR1	
			Exp						N= 3, C= L1, resTR1	
	No	Not exp	Not exp	N= 2 C= NO ResTR1	N= 4 C= GL resTR1 resTR2	N= 2 C= NO resTR1	N= 4 C= GL resTR1 resTR2	N= 2 C= NO resTR1	N= 4 C= GL resTR1 resTR2	N= 4 C= L2 resTR1
			Exp							N= 2 C= NO resTR1
		Exp	Not exp		N= 2 C= ~~L1~~NO resTR1		N= 2 C= NO resTR1		N= 4, C= L2, resTR1	
			Exp						N= 2, C= NO, resTR1	

4.10.3.3 State machine transitions for transition level straddling

When a position report is received from a station which fulfils:

a) the conditions for the initial state, last received report type, received report type, own position and timer states defined in Table 4-8;

b) the conditions defined in Section 4.5.3 are met (because the station has crossed a transition latitude),

the receiving station shall update its state machine as defined in Table 4-8 and report the target position quality to the application. Otherwise the station will process the report as defined in Section 4.10.3.2.

Table 4-8. State transitions for position report processing (transition level straddling)

In State				**1**	**2**		**3**		**4**	
Last report				**None**	**Even**	**Odd**	**Even**	**Odd**	**Even**	**Odd**
Target position quality				**None**	**None**	**None**	**Local**	**Local**	**Global**	**Global**
Received position report type	Own Posi-tion	Timers (exp = expired)								
		TR1	TR2							
Even	Yes	Not exp	Not exp	See Table 5-7	See Table 5-7	N= 3 C= L1 resTR1	See Table 5-7	N= 3 C= L1 resTR1	See Table 5-7	N= 4 C= L2 resTR1
			Exp							N=3 C= L1 res TR1
	No	Not exp	Not exp			N= 2 C= NO resTR1		N= 2 C= NO resTR1		N= 4 C= L2 resTR1
			Exp							N= 2 C= NO resTR1
Odd	Yes	Not exp	Not exp	See Table 5-7	N= 3 C= L1 resTR1	See Table 5-7	N= 3 C= L1 resTR1	See Table 5-7	N= 4 C= L2 resTR1	See Table 5-17
			Exp						N=3 C=L1 resTR1	
	No	Not exp	Not exp		N= 2 C= NO resTR1		N= 2 C= NO resTR1		N= 4 C= L2 resTR1	
			Exp						N= 2 C= NO resTR1	

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