Consultative Committee for Space Data Systems

DRAFT RECOMMENDATION FOR SPACE DATA SYSTEM STANDARDS

PROXIMITY-1 SPACE LINK PROTOCOL—

DATA LINK LAYER

CCSDS 211.0-~~B~~P-2.1

~~BLUE BOOK~~PINK SHEETS

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DOCUMENT CONTROL

Document	**Title and Issue**	**Date**	**Status**
CCSDS 211.0-B-1	Proximity-1 Space Link Protocol	October 2002	Superseded
CCSDS 211.0-B-2	Proximity-1 Space Link Protocol—Data Link Layer	April 2003	Current issue (see note)

CCSDS 211.0-P-2.1	Proximity-1 Space Link Protocol—Data Link Layer	November 2003	Current draft update: Changes transmitter and receiver frequency assignments to match the new frequency assignments from 0 through 7 instead of 1 through 8. Defines transmitter modes to be backward compatible with ODY and MEX, and forward compatible with future missions. Updates the frequency tables in the SET PL EXTENSIONS directive to match the proposed channel assignments from 0 to 15 instead of 1 through 16. Changes value in annex C to match ODY implementation. Removes 'UTC' references. Changes the value of RECEIVING_SCID_BUFFER from blank to zero. A zero valued SCID indicates an empty buffer. Specifies that directionality needs to be recorded in the data record for each time tag. Updates reference [F2].

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5 PROXIMITY-1 TIMING SERVICES

5.1 COUPLED NON-COHERENT PROXIMITY TIMING SERVICE

5.1.1 Timing Services are required for Proximity operations in order to provide the following three capabilities:

a) on-board Proximity clock correlation between Proximity nodes;

b) ~~Universal Time Coordinated (UTC)~~ time transfer to a Proximity node;

c) coupled non-coherent time-derived ranging measurements between Proximity nodes.

5.1.2 All three of these capabilities require that MODE is *active* and the transceiver is operating in the Data Services sublayer. Timing Services can occur in full duplex, half duplex, or simplex operations.

NOTE – Timing services can occur concurrently with other data-taking activities. The method utilized to carry out the timing services is specified in 5.2.

5.2 PROXIMITY TIME CORRELATION

5.2.1 OVERVIEW

The same time-tag capture method is used as the basis for all three time services capabilities. The method requires that both the initiating and recipient transceiver shall have the capability of time tagging the trailing edge of the last bit of the Attached Synchronization Marker of every incoming and every outgoing Proximity frame. This method allows for the simultaneous time tagging of transfer frames upon ingress to and egress from a Proximity transceiver (two-way) as well as one-way time tagging depicted in figure 5-1. The time code format is provided in reference [7], i.e., the unsegmented time code of 4 bytes of course time (> 1 sec) and 3 bytes of fine time (< 1 sec). See figure 5-1, Proximity Time Tagging and Time Correlation.

5.2.2 TIME TAG CAPTURE METHOD

The time tag capture method shall be composed of the following steps:

a) The vehicle controller shall issue a SET CONTROL PARAMETERS (*local time tag*) directive to the initiating transceiver, instructing it to capture its local time reference and associated frame sequence numbers over a commanded interval of frames. Upon receipt of this directive, the MAC sublayer shall set the TIME_COLLECTION variable from *inactive* to *collecting data*, indicating that time collection has started.

b) The initiating transceiver shall build and transmit the SET CONTROL PARAMETERS (*Time Sample*) directive. Upon egress of each frame during the commanded interval (based upon the value of Time Sample), the initiating transceiver shall capture the time and frame sequence number of every Proximity frame being radiated. The application processes, which use the collected data, will also require information about any internal signal path delays associated with the radiation process. Once the commanded interval has been reached (the prescribed number of frame time tags have been captured), the MAC sublayer shall set the TIME_COLLECTION variable to *collection complete*, indicating that those times and sequence numbers are available for transfer. Coincidently upon receipt of the SET CONTROL PARAMETERS directive, the recipient transceiver shall identify and decode the directive and capture the subsequent time and frame sequence number of every Proximity frame received over the commanded interval. The recipient transceiver shall also keep track of any internal signal path delays in the process. Upon readout of the collected data set, TIME_COLLECTION shall be set to *inactive*.

c) When the time collection process is completed, both the initiating and remote transceivers shall transfer their captured times, ~~and the~~ associated frame sequence numbers, and direction (indication of whether time tagging was performed upon frame egress or ingress) of every ~~outgoing~~transmitted and ~~every incoming~~received Proximity-1 frame over the commanded interval to their respective vehicle controllers.

d) The vehicle controller (CDS) shall create a Proximity time correlation packet consisting of the series of points (time tag, frame sequence number, time tag direction) it received from its local transceiver collected over the commanded interval. In addition, the internal signal path delays in the transmission and reception chains of the transceiver are required to be known a priori.

NOTES

1 Time tag direction is labeled as either egress or ingress.~~These points represent a series of either all ingress or all egress values.~~

2 The internal delays may have coding and rate components.

3 These time correlation packets need to be processed together.

4 Simultaneous collections of time correlation packets in both directions would increase the accuracy of the processing.

5 By exchanging time correlation packets, either node can compute the correlation between the two Proximity clocks.

6 The REPORT REQUEST Directive (annex A) can be used to initiate a request to the remote transceiver to start up a time tag exchange.

7 A separate TIME COLLECTION variable is required for two-way operations (simultaneous time tagging in both directions).

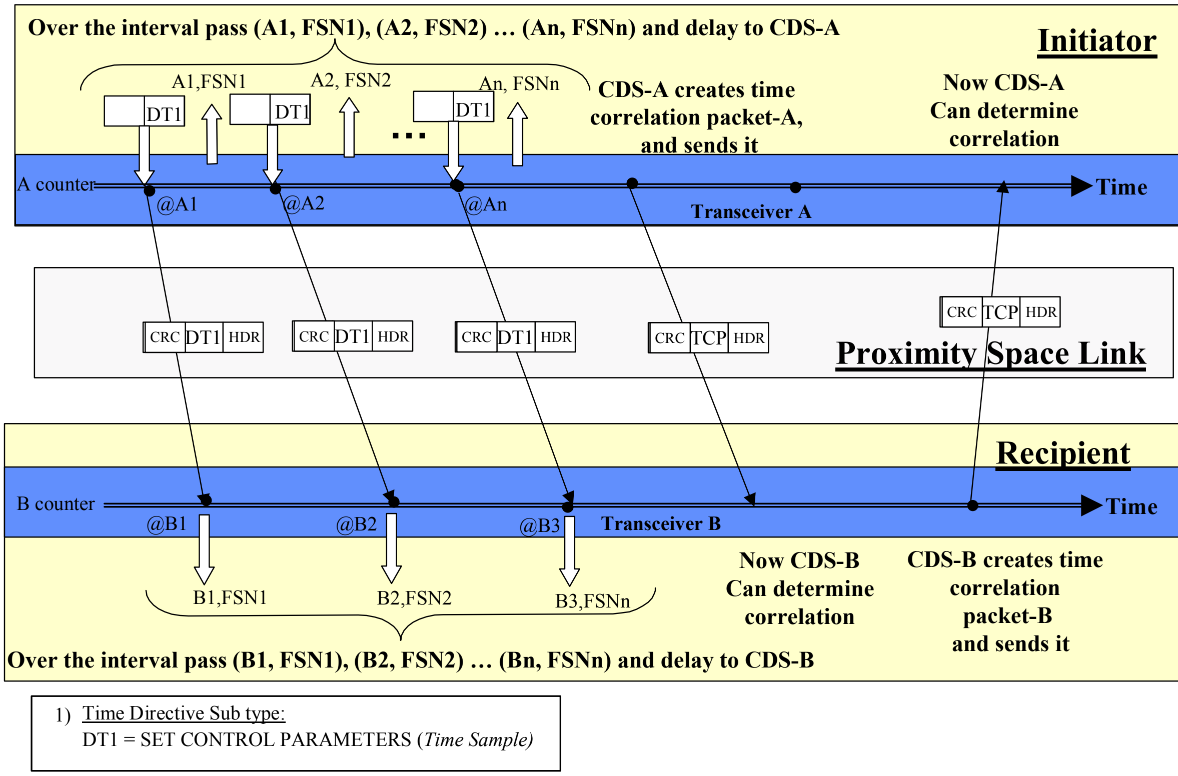

Figure 5-1: Proximity Time Tagging and Time Correlation

5.2.3 TRANSFERRING ~~UTC~~ TIME TO A REMOTE ASSET

NOTE – In order to transfer ~~a UTC equivalent~~ time to a remote asset (i.e., the recipient), the initiator must know the correlation between the initiator's clock and the recipient's clock. It is also assumed that the initiator maintains a correlation between ~~UTC~~ the master clock for the Enterprise and its local Proximity clock.

The method for transferring ~~UTC~~ time to a remote asset shall consist of the following steps:

a) As soon as possible after a Proximity time correlation between the initiator and recipient is completed, the initiator shall build and transmit the TIME DISTRIBUTION (*~~UTC~~ Time Transfer*) directive over the Proximity link. This directive contains the correlation between ~~UTC~~ the Enterprise's master clock and the recipient's clock.

b) The recipient transceiver shall decode the directive and transfer the contents of the directive (~~UTC~~ the Enterprise's master clock to local Proximity clock correlation) to its vehicle controller.

c) The recipient vehicle controller shall apply the correlation in order either to project ~~UTC~~ the Enterprise's master clock values into the future, or to correct past ~~UTC~~ clock values.

NOTE – See figure 5-2, Transferring ~~UTC~~ Time to a Remote Asset.

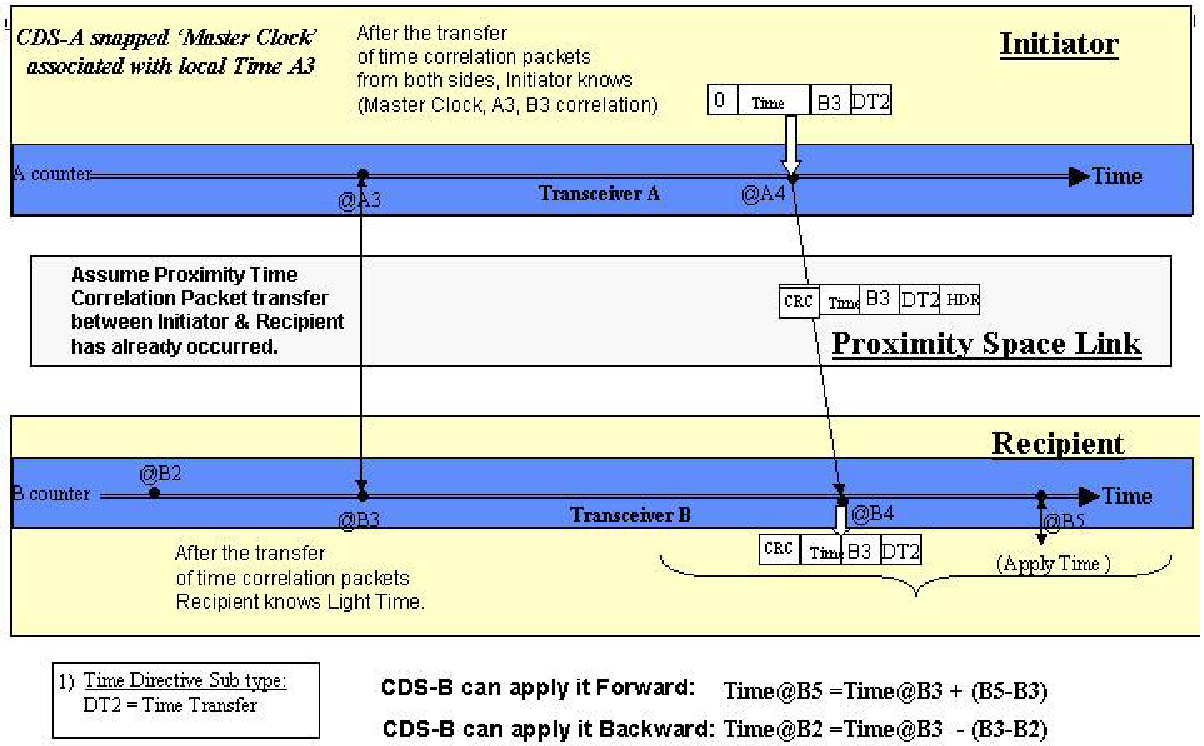

Figure 5-2: Transferring ~~UTC~~ Time to a Remote Asset

6.2.4.2 Test_Source

The Test_Source parameter shall be used to determine whether the received frames whose Source-or-Destination IDs are set to *source* shall be tested for acceptance. Test_Source=*false* means no test shall be performed. Test_Source=*true* means a test shall be performed if the RECEIVING_SCID_BUFFER is non-~~blank~~ zero, i.e., contains a valid SCID. When the RECEIVING_SCID_BUFFER is ~~blank~~zero and Test_Source is *true*, the value of the SCID field in the header of the first received frame whose Source-or-Destination ID is *source* shall be loaded into RECEIVING_SCID_BUFFER.

6.2.4.3 Carrier_Only_Duration

Carrier_Only_Duration represents the time that shall be used to radiate an unmodulated carrier at the beginning of a transmission.

6.2.4.4 Acquisition_Idle_Duration

Acquisition_Idle_Duration represents the time that shall be used to radiate the idle sequence pattern after carrier only to enable the receiving transceiver to achieve bit synchronization and decoder lock.

6.2.4.5 Tail_Idle_Duration

Tail_Idle_Duration represents the time that shall be used to radiate the idle sequence pattern at the end of a transmission to enable the receiving transceiver to process the last transmitted frame (i.e., push the data through the decoders).

6.2.4.6 Carrier_Loss_Timer_Duration

Carrier_Loss_Timer_Duration is the value loaded into the CARRIER_LOSS_TIMER based upon the conditions defined in 6.3.2 (CARRIER_LOSS_TIMER and Associated Events).

6.2.4.7 Comm_Change_Waiting_Period

Comm_Change_Waiting_Period represents the time that the caller will wait for the Comm_Change_Response to the COMM_CHANGE directive.

6.2.4.8 Comm_Change_Response

The acknowledgement by the responder that the persistent activity has been accepted. For the Full Duplex Comm_Change_Response see table 6-8, Events E17 and E20. For the Half Duplex Comm_Change_Response, see table 6-11, Event E68.

Bit 0 … Bit 15

TX Mode 3 bits	TX Data Rate 4 bits	TX Modulation 1 bit	TX Data encoding 2 bits	TX Frequency 3 bits	Directive Type 3 bits
0,1,2	3,4,5,6	7	8,9	10,11,12	13,14,15

Figure A-2: SET TRANSMITTER PARAMETERS Directive

A1.2.2 Directive Type

A1.2.2.1 Bits 13–15 of the SET TRANSMITTER PARAMETERS directive shall contain the Directive Type.

A1.2.2.2 The 3-bit Directive Type field shall identify the type of protocol control directive and shall contain the binary value ‘000’ for the SET TRANSMITTER PARAMETERS directive.

A1.2.3 Transmitter Frequency

A1.2.3.1 General

Bits 10–12 of the SET TRANSMITTER PARAMETERS directive shall be used to set the transmitter frequency of the partnered transceiver to the desired value.

A1.2.3.2 Return Transmitter Frequency (e.g., Orbiter as Initiator; Landed Asset as Responder)

In the context of the forward link, this three-bit field shall define the receive frequency of the Responder. Actual frequency assignments are given in the Physical layer (see reference [9]).

‘000’	‘001’	‘010’	‘011’	‘100’	‘101’	‘110’	‘111’
Ch~~1~~0R	Ch~~2~~1R	Ch~~3~~2R	Ch~~4~~3R	Ch~~5~~4R	Ch~~6~~5R	Ch~~7~~6R	Ch~~8~~7R

A1.2.3.3 Transmitter Data Encoding

Bits 8–9 of the SET TRANSMITTER PARAMETERS directive shall contain the following coding options:

a) ‘00’ = Reserved;

b) ‘01’ = Convolutional Code(7,1/2) (G2 vector inverted) with attached CRC-32 (see reference [8]);

c) ‘10’ = By-pass Convolution Code;

d) ‘11’ = Concatenated (RS(204,188), CC(7,1/2)) Codes.

NOTE – RS(204,188) with CC(7,1/2) code is an ETSI standard. This option is not required for cross support. See reference [F1] for more details.

A1.2.3.4 Transmitter Modulation

Bit 7 of the SET TRANSMITTER PARAMETERS directive shall contain the transmission modulation options:

a) ‘1’ = Non-coherent PSK;

b) ‘0’ = Coherent PSK.

A1.2.3.5 Transmitter Data Rate

A1.2.3.5.1 Bits 3–6 of the SET TRANSMITTER PARAMETERS directive shall contain one of the following transmission data rates (rates in kbps, i.e., powers of 10).

NOTE – Because of the NASA Mars Surveyor Project 2001 Odyssey implementation, there is an added constraint on the use of the values in the Data Rate field for 8, 32, 128, 256 Kbps. Data rate selection is linked to the modulation field value as shown in the tables below. NC indicates non-coherent PSK, and C indicates coherent PSK. R1 through R4 indicate the field is reserved for future definition by the CCSDS.

A1.2.3.5.2 Ordered by Data Rate:

‘1000’	‘1001’	‘0000’	‘0001’	‘1100’	‘0010’	‘0011’	‘1101’	‘0100’	‘0101’	‘0110’	‘0111’	‘1010’	‘1011’	‘1110’	‘1111’
2	4	8 NC	8 C	16	32 NC	32 C	64	128 NC	128 C	256 NC	256 C	R1	R2	R3	R4

A1.2.3.5.3 Ordered by Bit pattern:

‘0000’	‘0001’	‘0010’	‘0011’	‘0100’	‘0101’	‘0110’	‘0111’	‘1000’	‘1001’	‘1010’	‘1011’	‘1100’	‘1101’	‘1110’	‘1111’
8 NC	8 C	32 NC	32 C	128 NC	128 C	256 NC	256 C	2	4	R1	R2	16	64	R3	R4

A1.2.3.6 Transmitter Mode

~~**A1.2.3.6.1** Bits 0–2 of the SET TRANSMITTER PARAMETERS directive shall contain the Transmission Mode options. This field identifies the protocol utilized by the transmitter.~~

~~**A1.2.3.6.2** Bit pattern assignments shall be defined in the MIB.~~

Bits 0–2 of the SET TRANSMITTER PARAMETERS directive shall contain the Transmitter Mode options. This field identifies the data link layer protocol utilized by the transmitter:

a) '000' = Mission Specific;

b) '001' = Proximity-1 Protocol;

c) '010' = Mission Specific;

d) '011' = Mission Specific;

e) '100' = Mission Specific;

f) '101' = Mission Specific;

g) '110' = Reserved by CCSDS;

h) '111' = Reserved by CCSDS.

NOTE – See annex C for NASA Mars Survey Project 2001 Odyssey Orbiter Transmitter Mode mission specific values.

A1.3 SET CONTROL PARAMETERS

A1.3.1 General

A1.3.1.1 The SET CONTROL PARAMETERS directive shall consist of six fields, positioned contiguously in the following sequence (described from least significant bit, bit 15, to most significant bit, bit 0):

a) Directive Type (3 bits);

b) Token (1 bit);

c) Remote No More Data (1 bit);

d) Reserved (2 bits);

e) Duplex (3 bits);

f) Time Sample (6 bits).

A1.3.1.2 This directive is used to set from zero to four control parameters at a time: 1) setting the token for half duplex operations; 2) setting the Remote No More Data condition for session termination in full or half duplex; 3) setting the Duplex parameter; 4) setting the number of time samples to be taken during Timing Services.

NOTE – The structural components of the SET CONTROL PARAMETERS directive are shown in figure A-3.

NOTE – The structural components of the SET RECEIVER PARAMETERS directive are shown in figure A-4.

Bit 0 … Bit 15

RX Mode 3 bits	RX Rate 4 bits	RX Modulation 1 bit	RX Data Decoding 2 bits	RX Frequency 3 bits	Directive Type 3 bits
0,1,2	3,4,5,6	7	8,9	10,11,12	13,14,15

Figure A-4: SET RECEIVER PARAMETERS Directive

A1.4.2 Directive Type

A1.4.2.1 Bits 13–15 of the SET RECEIVER PARAMETERS directive shall contain the Directive Type.

A1.4.2.2 The three-bit Directive Type field shall identify the type of protocol control directive and shall contain the binary value ‘010’ for the SET RECEIVER PARAMETERS directive.

A1.4.3 Receiver Frequency

A1.4.3.1 General

Bits 10–12 of the SET RECEIVER PARAMETERS directive shall be used to set the Receiver frequency of the partnered transceiver to the desired value.

A1.4.3.2 Forward Receive Frequency (e.g., Orbiter as Initiator; Landed Asset as Responder)

In the context of the forward link, this three-bit field shall define the receive frequency of the Responder. Actual frequency assignments are given in the Physical layer (see reference [9]).

‘000’	‘001’	‘010’	‘011’	‘100’	‘101’	‘110’	‘111’
Ch~~1~~0F	Ch~~2~~1F	Ch~~3~~2F	Ch~~4~~3F	Ch~~5~~4F	Ch~~6~~5F	Ch~~7~~6F	Ch~~8~~7F

A1.4.4 Receiver Data Decoding

Bits 8–9 of the SET RECEIVER PARAMETERS directive shall contain the following coding options:

‘00’ = Reserved;

'01' = Convolutional Code(7,1/2) (G2 vector inverted) with attached CRC-32 (see reference [8]);

'10' = By-pass Convolutional Code;

'11' = Concatenated RS(204,188), CC(7,1/2).

NOTE – RS(204,188) with CC(7,1/2) code is an ETSI standard. This option is not required for cross support. See reference [F1] for more details.

A1.4.5 Receiver Modulation

Bit 7 of the SET RECEIVER PARAMETERS directive shall contain the following transmission modulation options:

a) '1' = Non-coherent PSK;

b) '0' = Coherent PSK.

A1.4.6 Receiver Data Rate

A1.4.6.1 Bits 3–6 of the SET RECEIVER PARAMETERS directive shall contain one of the following receiver data rates (rates in kbps, i.e., powers of 10).

NOTE – Because of the NASA Mars Surveyor Project 2001 Odyssey implementation, there is an added constraint on the use of the values in the Data Rate field for 8, 32, 128, and 256 Kbps. Data rate selection is linked to the modulation field value as shown in the tables below ('NC' indicates non-coherent, and c indicates coherent). R1 through R4 indicates the field is reserved for future definition by the CCSDS.

A1.4.6.2 Ordered by Data Rate:

'1000'	'1001'	'0000'	'0001'	'1100'	'0010'	'0011'	'1101'	'0100'	'0101'	'0110'	'0111'	'1010'	'1011'	'1110'	'1111'
2	4	8 NC	8 C	16	32 NC	32 C	64	128 NC	128 C	256 NC	256 C	R1	R2	R3	R4

A1.4.6.3 Ordered by Bit pattern:

'0000'	'0001'	'0010'	'0011'	'0100'	'0101'	'0110'	'0111'	'1000'	'1001'	'1010'	'1011'	'1100'	'1101'	'1110'	'1111'
8 NC	8 C	32 NC	32 C	128 NC	128 C	256 NC	256 C	2	4	R1	R2	16	64	R3	R4

A1.4.7 Receiver Mode

Bits 0–2 of the SET RECEIVER PARAMETERS directive shall contain the Receiver Mode options. ~~Bit pattern assignments shall be defined in the MIB.~~ This field identifies the data link layer protocol utilized by the receiver:

a) ‘000’ = Mission Specific;

b) ‘001’ = Proximity-1 Protocol;

c) ‘010’ = Mission Specific;

d) ‘011’ = Mission Specific;

e) ‘100’ = Mission Specific;

f) ‘101’ = Mission Specific;

g) ‘110’ = Reserved by CCSDS;

h) ‘111’ = Reserved by CCSDS.

NOTE – See annex C for NASA Mars Survey Project 2001 Odyssey Orbiter Receiver Mode mission specific values.

A1.5 SET V(R) DIRECTIVE

A1.5.1 General

The SET V(R) directive shall consist of three fields, positioned contiguously in the following sequence (described from least significant bit, bit 15, to most significant bit, bit 0):

a) Directive Type (3 bits);

b) Spare (5 bits);

c) Receiver Frame Sequence Number (SEQ_CTRL_FSN) (8 bits).

NOTE – The structural components of the SET V(R) directive are shown in figure A-5.

Bit 0 | Bit 15

Receiver Frame Sequence Number SEQ_CTRL_FSN 8 bits	Spare 5 bits	Directive Type 3 bits
0,1,2,3,4,5,6,7	8,9,10,11,12	13,14,15

Figure A-5: SET V(R) Directive

A1.5.2 Directive Type

A1.5.2.1 Bits 13–15 of the SET V(R) directive shall contain the Directive Type.

a) ‘0’ = Channels ~~1~~0 – ~~8~~7 defined in the Frequency Field of the SET TRANSMITTER PARAMETERS and SET RECEIVER PARAMETERS Directives and specifically in the Proximity-1 Physical layer;

b) ‘1’ = Channels ~~9~~8 – ~~16~~15 defined in the Extended Physical Layer Frequency Set defined below.

A1.8.10.2 Forward Link (e.g., Orbiter as Initiator; Landed Asset as Responder)

In the context of the forward link, this three-bit field shall define the receive frequency of the Responder. Actual frequency assignments are given in the Physical layer (see reference [9]).

‘000’	‘001’	‘010’	‘011’	‘100’	‘101’	‘110’	‘111’
Ch~~9~~8F	Ch~~10~~9F	Ch~~11~~10F	Ch~~12~~11F	Ch~~13~~12F	Ch~~14~~13F	Ch~~15~~14F	Ch~~16~~15F

A1.8.10.3 Return Link (e.g., Orbiter as Initiator; Landed Asset as Responder)

In the context of the return link, this three-bit field shall define the transmit frequency of the Responder. Actual frequency assignments are given in the Physical layer (see reference [9]).

‘000’	‘001’	‘010’	‘011’	‘100’	‘101’	‘110’	‘111’
Ch~~9~~8R	Ch ~~10~~9R	Ch~~11~~10R	Ch~~12~~11R	Ch~~13~~12R	Ch~~14~~13R	Ch~~15~~14R	Ch~~16~~15R

A1.8.11 Direction

Bit 0 of the SET PL EXTENSIONS directive shall indicate if the fields in this directive apply to the transmit or receive side of the transceiver.

a) ‘0’ = Transmit side;

b) ‘1’ = Receive side.

A1.9 REPORT SOURCE SPACECRAFT ID

A1.9.1 General

The REPORT SOURCE SPACECRAFT ID is the mechanism by which the local transceiver can provide status of its source spacecraft ID to the remote transceiver across the Proximity link. It shall consist of three fields, positioned contiguously in the following sequence (described from least significant bit, bit 15, to most significant bit, bit 0):

a) Directive Type (three bits);

b) Reserved (three bits);

A2.1.3 The format of the TIME DISTRIBUTION SPDU Data Field shall consist of two fields, positioned contiguously, in the following sequence:

a) TIME DISTRIBUTION directive type (1 octet);

b) Time field (variable: 1 to 14 octets).

NOTE – The structural components of the TIME DISTRIBUTION SPDU Data Field are shown in figure A-10.

Octet: 0	Min: Octet 1 Max: Octet 14
TIME DISTRIBUTION Directive Type 1 octet	Time Field Variable: 1 to 14 octets

Figure A-10: Type 2 SPDU Data Field Contents

A2.2 TIME DISTRIBUTION DIRECTIVE TYPE

A2.2.1 Octet 0 of the TIME DISTRIBUTION SPDU Data Field shall contain the TIME DISTRIBUTION directive type field indicating the function to be performed (if any) with the time contents.

A2.2.2 TIME DISTRIBUTION Types are:

a) '00000000' = NULL;

b) '00000001' = ~~UTC~~ TIME TRANSFER;

c) '00000010' = BROADCAST SPACECRAFT CLOCK TIME;

d) all others = Reserved for CCSDS use.

A2.3 TIME FIELD

Octet 1 through octet 14 shall contain the time value associated with the directive. The time code selected for this field shall comply with the CCSDS Time Code Format Recommendation (reference [7]).

Parameter	Use	Layer
Hail_Wait_Duration	Mandatory. Used in the Hail persistent activity. Session static. See 6.2.4.11.	M
Hailing_Channel	Mandatory. Channel assignment used in the Hail persistent activity during Link Establishment. Session static. See 6.2.4.15.	P,M
Hailing_Data_Rate	Mandatory. Data rate used in the Hail persistent activity during Link Establishment. Session static. See 6.2.4.16.	P,M
Interval_Clock	Mandatory. A frequency (e.g., 100 Hz) that is used for interval timing. Session static. See 6.3.	C
Local_Spacecraft_ID	Mandatory. Used as a frame validation check when Source-or-Destination ID equals *source*. Session static. See 3.2.2.9.3.	M
Maximum_Packet_Size	Mandatory if packets are used. Maximum size of a packet in octets. Used in the segmentation process. Session static. See 4.4.1.1.	I
Persistence_Wait_Time	Mandatory. Defines the maximum amount of time the initiating transceiver stays in persistence until either (1) it receives an acknowledgement from the remote transceiver that the COMM_CHANGE was acted upon, or (2) the wait timer times out. See table 6-8, 'Full Duplex Communication Change State Table'.	M
PLCW_Repeat	Mandatory. Used in COP-P. Session static. See 6.2.4.19.	D
Receive_Duration	Mandatory. Used in Half Duplex Data Services. Session static. See 6.2.4.18.	D
Receiver_Mode	Optional. Used in the SET RECEIVER PARAMETERS Directive. Enterprise-specific. Session static. See A1.4.7.	M
Remote_Spacecraft_ID	Mandatory. Used to address one or several remote spacecraft as opposed to the local spacecraft. Session dynamic. See 3.2.2.9.4.	F,M,D,I

Parameter	Use	Layer
Resync_Local	Mandatory. If Resync_Local equals *false*, it is the responsibility of the local controller to decide how synchronization will be re-established. Otherwise, if *true*, the Sender Node's FOP-P forces synchronization by requesting a SET V(R) persistent activity. Session static. See 7.1.3.2, 'SET V(R) Persistent Activity'.	D
Resync_Lifetime	Mandatory. Used in the FOP-P SET V(R) persistent activity. Session static. See 7.1.3.2.	M,D
Resync_Notification	Mandatory. Used in the FOP-P SET V(R) persistent activity. Session static. See 7.1.3.2.	M,D
Resync_Response	Mandatory. Used in the FOP-P SET V(R) persistent activity. Session static. See 7.1.3.2.	M,D
Resync_Waiting_Period	Mandatory. Used in the FOP-P SET V(R) persistent activity. Session static. See 7.1.3.2.	M,D
Send_Duration	Mandatory. Used in Half Duplex Data Services. Session static. See 6.2.4.17.	D
Synch_Timeout	Mandatory. Defines the value to which the SYNCH_TIMER is initialized or reinitialized. Session static. See 7.1.2.	D
Tail_Idle_Duration	Mandatory. Used in Full, Half Duplex, and Simplex session establishment. Session static. See 6.2.4.5.	M
Test_Source	Mandatory. Used in the verification of the spacecraft ID when the Source-or-Destination ID is *source*. Session static. See 6.2.4.2.	F
~~Transmitter_Mode~~	~~Optional. Used in the SET TRANSMITTER PARAMETERS Directive. Enterprise-specific. Session static. See A1.2.~~	~~M~~
Transmission_Window	Mandatory. Sets the maximum size of the transmission window for the COP-P. Session static. See 7.1.3.3, note 3.	D

C4.1.3 Transmitter Frequency

C4.1.3.1 Bits 10–12 of the SET TRANSMITTER PARAMETERS directive shall be used to set the transmitter frequency of the partnered transceiver to the desired value.

C4.1.3.2 This three-bit field shall contain the value '000' indicating that the Responder's transmit return frequency, 401.585625 MHz, shall be used.

C4.1.4 Transmitter Data Encoding

Bits 8–9 of the SET TRANSMITTER PARAMETERS directive shall contain the following coding options:

a) '00' = Scrambler;

b) '01' = Convolutional Code (7,1/2) without G2 inverter (CRC-32 attached);

c) '10' = By-pass Convolutional Code;

d) '11' = N/A.

C4.1.5 Transmitter Modulation

Bit 7 of the SET TRANSMITTER PARAMETERS directive shall contain the transmission modulation options:

a) '1' = PSK;

b) '0' = PSK Coherent.

C4.1.6 Transmitter Data Rate

Bits 3–6 of the SET TRANSMITTER PARAMETERS directive shall contain the transmission data rate.

'0000'	'0001'	'0010'	'0011'	'0100'	'0101'	'0110'	'0111'	'1000'	'1001'	'1010'	'1011'	'1100'	'1101'	'1110'	'1111'
8 NC	8 C	32 NC	32 C	128 NC	128 C	256 NC	256 C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

NOTE – Rates are in kbps, i.e., powers of 10; C indicates PSK coherent modulation, and NC indicates PSK non-coherent modulation.

C4.1.7 Transmitter Mode

~~C4.1.7.1~~ Bits 0–2 of the SET TRANSMITTER PARAMETERS directive shall contain the Transmission Mode options.~~:~~

a) '000' = Standby;

b) '001' = Sequence Controlled;

c) '010' = Expedited;

d) '011' = Unreliable Bitstream;

e) '100' = Tone Beacon;

f) '101' = Canister Mode.

~~**C4.1.7.2** Bit pattern assignments shall be defined in the MIB.~~

C4.2 SET RECEIVER PARAMETERS DIRECTIVE

C4.2.1 General

The SET RECEIVER PARAMETERS directive shall consist of six fields, positioned contiguously in the following sequence (described from least significant bit, bit 15, to most significant bit, bit 0):

a) Set Directive Type (three bits);

b) Receiver Frequency (three bits);

c) Receiver Data Decoding (two bits);

d) Receiver Modulation (one bit);

e) Receiver Data Rate (four bits);

f) Receiver Mode (three bits).

NOTE – The structural components of the SET RECEIVER PARAMETERS directive are shown in figure C-2.

Bit 0 ... Bit 15

RX Mode 3 bits	RX Rate 4 bits	RX Modulation 1 bit	RX Data Decoding 2 bits	RX Frequency 3 bits	Set Directive Type 3 bits
0,1,2	3,4,5,6	7	8,9	10.11,12	13,14,15

Figure C-2: NASA Mars Surveyor Project 2001 Odyssey SET RECEIVER PARAMETERS Directive

C4.2.2 Set Directive Type

C4.2.2.1 Bits 13–15 of the SET RECEIVER PARAMETERS directive shall contain the Directive Type.

C4.2.2.2 The three-bit Set Directive Type field shall identify the type of protocol control directive and shall contain the binary value '010' for the SET RECEIVER PARAMETERS directive.

C4.2.3 Receiver Frequency

C4.2.3.1 Bits 10–12 of the SET RECEIVER PARAMETERS directive shall be used to set the receiver frequency of the partnered transceiver to the desired value.

C4.2.3.2 This three-bit field shall contain the value ~~'010'~~ '000' indicating that the Responder's receive forward frequency shall be set to 437.1 MHz.

C4.2.4 Receiver Data Decoding

Bits 8–9 of the SET RECEIVER PARAMETERS directive shall contain the following coding options:

a) '00' = Scrambler;

b) '01' = Convolutional Code (7,1/2) without G2 Inverter (CRC-32 attached);

c) '10' = By-pass Convolutional Code;

d) '11' = N/A.

C4.2.5 Receiver Modulation

Bit 7 of the SET RECEIVER PARAMETERS directive shall contain the transmission modulation options:

a) '1' = PSK;

b) '0' = PSK Coherent.

C4.2.6 Receiver Data Rate

Bits 3–6 of the SET RECEIVER PARAMETERS directive shall contain the Receiver Data Rate.

'0000'	'0001'	'0010'	'0011'	'0100'	'0101'	'0110'	'0111'	'1000'	'1001'	'1010'	'1011'	'1100'	'1101'	'1110'	'1111'
8 NC	8 C	32 NC	32 C	128 NC	128 C	256 NC	256 C	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

NOTE – Rates are in kbps, i.e., powers of 10; C indicates PSK coherent modulation, and NC indicates PSK non-coherent modulation.

C4.2.7 Receiver Mode

Bits 0–2 of the SET RECEIVER PARAMETERS directive shall contain the Receiver Mode options.:

a) ‘000’ = Standby;

b) ‘001’ = Sequence Controlled;

c) ‘010’ = Expedited;

d) ‘011’ = Unreliable Bitstream;

e) ‘100’ = Tone Beacon.

~~f) ‘101’ = Canister Mode.~~

C4.3 PROXIMITY LINK CONTROL WORD (PLCW)

C4.3.1 General

C4.3.1.1 The Proximity Link Control Word (PLCW) shall consist of seven fields (see figure C-3), positioned contiguously, and described from least (bit 15) to most significant bit (bit 0) in the following sequence:

a) Report Value (eight bits);

b) Expedited Frame Counter (three bits);

c) Reserved Spare (one bit);

d) PCID (one bit);

e) Retransmit Flag (one bit);

f) SPDU Type Identifier (one bit);

g) SPDU Format ID (one bit).

C4.3.1.2 The PLCW shall be transmitted using the Expedited QOS.

NOTE – At the time of the implementation of the Proximity-1 Protocol for NASA Mars Surveyor Project 2001 Odyssey the PCID field was called VCID. However the functionality of that implementation is equivalent to a Physical Channel ID.

ANNEX E

ABBREVIATIONS AND ACRONYMS

(This annex **is not** part of the Recommendation.)

ARQ	Automatic Repeat Queuing
ASM	Attached Synchronization Marker
BER	Bit Error Rate
C&S	Coding and Synchronization
CCSDS	Consultative Committee for Space Data Systems
CDS	Command and Data Handling System
COP-P	Communication Operations Procedure Proximity
CRC	Cyclic Redundancy Check
CW	Continuous Wave
DFC ID	Data Field Construction Identifier
ETSI	European Telecommunications Standards Institute
FARM-P	Frame Acceptance and Reporting Mechanism Proximity
FIFO	First In First Out
FOP-P	Frame Operations Procedure – Proximity
IPV4	Internet Protocol Version 4
ITU	International Telecommunications Union
MAC	Medium Access Control
MEX	ESA Mars Express Orbiter
MIB	Management Information Base
MSB	Most Significant Bit
NN(R)	Previous acknowledged frame sequence number + 1
N(R)	Last acknowledged frame sequence number +1
N(S)	Frame Sequence Number within the Proximity-1 Frame Header

ODY	NASA Mars Survey Project 2001 Odyssey Orbiter
OSI	Open Systems Interconnection
PC	Physical Channel
PCID	Physical Channel ID
PCM	Pulse Code Modulation
PDU	Protocol Data Unit
P-frame	Supervisory/Protocol Frame
PLCW	Proximity Link Control Word
PLTU	Proximity Link Transmission Unit
PSK	Phase Shift Keyed
QOS	Quality of Service
RF	Radio Frequency
RHCP	Right Hand Circular Polarized
R-S	Reed-Solomon
RX	Receive
SAP	Service Access Point
SCID	Spacecraft Identifier
SCPS-NP	Space Communications Protocol Standards-Network Protocol
SDU	Service Data Unit
SPDU	Supervisory Protocol Data Unit
TCP	Time Correlation Packet
TX	Transmit
U-frame	User Data Frame
UHF	Ultra High Frequency
VE(S)	Value of the next Expedited Frame Sequence Number to be sent
V(S)	Value of the next Sequence Controlled Frame Sequence Number to be sent

ANNEX F

INFORMATIVE REFERENCES

(This annex **is not** part of the Recommendation.)

NOTE – The references in this annex define Physical layer techniques that are not part of the Proximity-1 Physical layer specification. They are included here so that transceivers with an extended Physical Layer can interoperate.

[F1] *Digital Video Broadcasting (DVB); Framing Structure, Channel Coding, and Modulation for 11/12 GHz Satellite Services*. ETSI EN 300 421 V1.1.2 (1997-08). Valbonne: ETSI, 1997.

~~[F2] *Data transmission at 48 kbit/s Using 60-108 kHz Group Band Circuits*. IUT-T Recommendation V.35. Geneva: ITU, October 1984.[1]~~

[F2] *A 48/56/64 kbit/s Data Circuit-terminating Equipment Standardized for Use on Digital Point-to-Point Leased Circuits.* ITU-T Recommendation V.38. Geneva: ITU, October 1996.

[F3] *Performance Characteristics for Intermediate Data Rate Digital Carriers Using Convolutional Encoding/Viterbi Encoding and QPSK Modulation (QPSK/IDR) (Standard A, B, C, E and F Earth Stations)*. Intelsat Earth Station Standard, IESS-308. Rev. 10. Washington, D.C.: Intelsat, February 2000.

~~[1] ITU-T Recommendation V.35 is no longer in force.~~