The Consultative Committee for Space Data Systems

Draft Recommendation for Space Data System Standards

PROXIMITY-1 SPACE LINK PROTOCOL—

DATA LINK LAYER

DRAFT RECOMMENDED STANDARD

CCSDS 211.0-B-3.1

PINK SHEETS

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3.2.2.4 PDU Type ID

3.2.2.4.1 Bit 3 of the Transfer Frame Header shall contain the PDU Type ID.

3.2.2.4.2 The PDU Type ID shall be used to specify whether the Transfer Frame Data field is conveying protocol supervisory data or user data information.

a) Setting the PDU Type ID to '0' indicates that the Transfer Frame Data field contains user data information.

b) Setting the PDU Type ID to '1' indicates that the Transfer Frame Data field contains supervisory protocol data, i.e., control information, used for controlling operations of the Proximity-1 protocol processor. See 3.2.8 for an explanation of when this PDU type must be used.

3.2.2.5 Data Field Construction ID

3.2.2.5.1 Bits 4–5 of the Transfer Frame Header shall contain the Data Field Construction ID (DFC ID).

3.2.2.5.2 The DFC ID shall signal the data field construction rules used to build the U-Frame Data field.

3.2.2.5.3 The four frame data field construction rules are defined in table 3-1.

Table 3-1: U-Frame Data Field Construction Rules

DFC ID	PLTU Type	Frame Data Field Content	Subsection
'00'	Asynchronous	Packets (integer number of unsegmented packets)	3.2.4
'01'	Asynchronous	Segment Data (a complete or segmented packet)	3.2.5
'10'	Reserved for future CCSDS definition.	Reserved for future CCSDS definition.	3.2.6
'11'	Asynchronous	User-defined Data	3.2.7

3.2.2.6 Spacecraft Identifier (SCID)

3.2.2.6.1 Bits 6–15 of the Transfer Frame Header shall contain the SCID.

4.1.2.2 ~~Ordering~~ Frame~~s~~ Selection

~~The following prioritization shall be observed for ordering frames:~~
Each time a frame is to be dispatched to the C&S sublayer, its selection from a series of sources shall be based on the following priority scheme:

a) first priority shall be given to a frame from the MAC queue in the MAC sublayer;

b) second priority shall be given to a PLCW or status report, if U-frame_last_sent is *True*;

c) third priority shall be given to an Expedited frame from the Expedited Frame queue in the I/O sublayer;

d) fourth priority shall be given to a Sequence Controlled frame, first from the Sent queue if required, and then from the Sequence Controlled Frame queue in the I/O sublayer;

e) fifth priority shall be given to a PLCW or status report, if U-frame_last_sent is *False*.

NOTES

1 U-frame_last_sent is set to *True* on session initialization.

2 U-frame_last_sent is set to *False* whenever a PLCW or Status_report is sent.

3 U-frame_last_sent is set to *True* for all other frames sent.

4.2 MEDIUM ACCESS CONTROL (MAC) SUBLAYER

4.2.1 OVERVIEW

The Medium Access Control (MAC) sublayer is responsible for the establishment and termination of each communications session. It is also responsible for any operational changes in the Physical layer configuration made during the data services phase.

Some of the operations performed by the MAC sublayer require a 'handshaking' process between the sending transceiver and the responding transceiver. This handshake is often based upon interpretation of values of the physical layer control signals, i.e., CARRIER_ACQUIRED and BIT_INLOCK_STATUS. Because of the potential for loss of an inter-transceiver control message due to corruption across the space link, MAC control activities require a 'persistence' process to ensure that the expected results of an activity are verified before any other activity is started. This process is generically defined as a persistent activity.

6.2.4.16 Hailing_Data_Rate

Data rate assigned during the Hail Activity. Proximity data rates are defined in the Physical layer.

6.2.4.17 Send_Duration

Send_Duration represents the maximum time that the half duplex transmitter shall transmit data before it relinquishes the Token (transfers to receive).

6.2.4.18 Receive_Duration

Receive_Duration represents the maximum time that the half duplex receiver is anticipating that the sending side shall be transmitting.

6.2.4.19 PLCW_Repeat_Interval

PLCW_Repeat_Interval represents the maximum transmission time between successive PLCWs, even if PLCWs are not required for Sequence Control operations. A zero value represents an infinite time period.

6.3 ELEMENTS AND EVENTS THAT AFFECT STATE STATUS

NOTES

1 The Interval_Clock applies to all timers. It is a frequency (e.g., 100 Hz) that is used for interval timing. It is recommended that the OUTPUT_BIT_CLOCK could be substituted for this clock for counting down the acquisition and tail sequence periods.

2 The following behavior applies to all timers: When the timer counts down to 1, the event associated with the timer occurs. Subsequently, the timer then underflows to zero, which is the inactive state for the timer.

6.3.1 WAIT TIMER (WT) AND ITS ASSOCIATED EVENTS

NOTE – The WAIT TIMER is a down counter. The count-down is enabled only when the timer is non-zero.

The values loaded into the timer shall represent a desired time value consistent with the Interval Clock frequency. The timer shall be loaded with the required MIB parameter value (see state tables), and shall be counted down using the Interval_Clock. The value in the timer shall be counted down until underflow.

6.3.3 PLCW TIMER AND ASSOCIATED EVENTS

The PLCW TIMER shall be used periodically to request the issuance of a PLCW. The PLCW TIMER is a down counter that is driven by the Interval_Clock. When the PLCW Timer=1, the NEED_PLCW variable shall be set *true*. Subsequently, the timer then underflows to zero, which is the inactive state for the timer. The Timer shall be loaded with the value in the PLCW_Repeat_Interval MIB parameter whenever a PLCW is transmitted (see the COP-P State Tables in section 7 for when the NEED_PLCW variable is set to *true*).

NOTE – The PLCW TIMER does not appear in the state transition tables.

6.3.4 OUTPUT FIFO

NOTE – The Output FIFO is a FIFO cache for the storage of bits that are serially output to the Physical layer for radiation.

The FIFO shall be filled with data per the specification defined in table 6-14. The data in the FIFO shall be serially shifted out using the output clock provided by the Physical layer, which is consistent with the physical link data rate. The 'Output FIFO =empty' signals that no data are contained within the FIFO, and more data must be input to the FIFO to keep the output bit stream synchronous.

6.3.5 NO_FRAMES_PENDING

The No_Frames_Pending event shall occur when the Output FIFO becomes empty and there are no frames selectable for output.

6.3.6 DIRECTIVES

6.3.6.1 Local Directives

NOTE – Local directives are sent internally, i.e., not across the Proximity link.

6.3.6.1.1 SET MODE

a) **Connecting-L:** This value shall set the MODE variable to *connecting-listen*.

b) **Connecting-T:** This value shall set the MODE variable to *connecting-transmit* which starts the HAIL activity.

c) **Inactive**: This value shall set the MODE variable to *inactive*, and shall initialize the Proximity-1 control variables described in table 6-6.

d) **Active:** This value shall set the MODE variable to *active*. It is typically used for simplex operations.

Table 6-7: Full Duplex Session Establishment/Data Services State Transition Table

Event No.	Event Causing the Transition (Description)	Starting State (from)	Resulting State (to)	Action(s) in Addition to Tables 6-2, 6-3 and *Comments*
E1	Local Directive - SET MODE *Connecting-L*	S1	S2	
E2	Local Directive - SET MODE *Connecting-T*	S1	S31	- WT=Carrier_Only_Duration - Set PERSISTENCE=*true* - Form and load HAIL Directives into Comm Value Buffer
E3	HAIL Directives Received (Receive SET_TRANSMITTER/ SET_RECEIVER_PARAMETERS Directives)	S2	S41	- WT=Carrier_Only_Duration - Set TRANSMIT = *on* - Set NEED_PLCW=*true* - Set Receiver and Transmitter parameters per HAIL directives - Send Hail_Notification to C&DH
E4	WT=1 Carrier_Only_Duration Timeout	S31	S32	- WT=Acquisition_Idle_Duration - Set MODULATION=*on*
E5	WT=1 Acquisition_Idle_Duration Timeout	S32	S33	- Radiate Hail
E6	Output FIFO=empty	S33	S34	*Hail Radiated* - WT=Tail_Idle_Duration
E7	WT=1 Tail_Idle_Duration Timeout	S34	S35	- WT=Hail_Wait_Duration - Set TRANSMIT = *off*
E8	WT=1 Hail_Wait_Duration Timeout	S35	S31	- WT=Carrier_Only_Duration - Set MODULATION=*off* - Set TRANSMIT = *on* - if CARRIER ONLY RECEIVED, send carrier received notification to C&DH
E9	Valid Transfer Frame Received (or BIT_INLOCK_STATUS=*true*—implementation option. See Hail_Response MIB parameter.)	S35	S41	- Set Transmitter values from Comm Value Buffer - WT=Carrier_Only_Duration - Set MODULATION=*off* - Set PERSISTENCE=*false* - Send Hail_Notification to C&DH
E10	WT=1 Carrier_Only_Duration Timeout	S41	S42	- WT=Acquisition_Idle_Duration - Set MODULATION=*on*
E11	WT=1 Acquisition_Idle_Duration Timeout	S42	S40	*Data Service begins*

NOTE – FOP-P Data operations (7.1) occur within State 40. FARM-P operations (7.2) occur in States 40, 41, 42 and 48 whenever MODE is active and the receiver is on. Comm Value Buffer is the local MAC buffer used for staging the transmit and receive parameters in support of the hailing and COMM_CHANGE directives. Values can be sent in locally or remotely.

Table 6-10: Half Duplex Session Establishment and Data Services (continued)

Event No.	Event Causing the Transition (Description)	Starting State (from)	Resulting State (to)	Action(s) in Addition to Tables 6-2, 6-4 and *Comments*
E34	Output FIFO=empty	S13	S14	***Hail Radiated*** - WT=Tail_Idle_Duration
E35	WT=1 Tail_Idle_Duration Timeout	S14	S36	- WT=Hail_Wait_Duration - Set MODULATION =*off* - Set TRANSMIT = *off*
E36	WT=1 Hail_Wait_Duration Timeout	S36	S11	- Set TRANSMIT = *on* - WT=Carrier_Only_Duration - Set Load HAIL directives to Comm Value Buffer - if CARRIER ONLY RECEIVED, send carrier received notification to C&DH
E37	Valid Transfer Frame Received (or BIT_INLOCK_STATUS = *true*)- implementation option See Hail_Response MIB parameter	S36	S60	- Set Transmitter values per Comm Value Buffer - Set PERSISTENCE=*false* (get ready for next transmit contact) - WT=Receive_Duration - Send Hail_Notification to C&DH
E38	(Transmit Timer Event – End of Send Period) WT=1 Send_Duration Timeout	S50	S50	- Set PERSISTENCE=*true* *Setting* PERSISTENCE *blocks the transmission of data from data services. Now only send from the MAC queue. Therefore, no frames pending will occur.*
E39	No Frames Pending AND. Y=0 .AND. NEED_PLCW is *false*	S50 Y=0	S56	- Form and Load the Token via SET CONTROL PARAMETERS Directive into the MAC queue
E40	WT=1 Carrier_Only_Duration Timeout	S51	S52	- WT=Acquisition_Idle_Duration - Set MODULATION=*on*
E41	(End of Acquire) WT=1 Acquisition_Idle_Duration Timeout	S52	S50	- WT=Send_Duration
E42	No Frames Pending (Y=0)	S56, Y=0	S58	- WT=Tail_Idle_Duration
E43	WT=1 Tail_Idle_Duration Timeout .AND. Y≠2	S58 Y≠2	S62	- WT=Receive_Duration - Set PERSISTENCE=*false* - Set MODULATION =*off* - Switch transmit to receive

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_Interval	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
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

ANNEX D

NOTIFICATIONS TO VEHICLE CONTROLLER

(This annex **is** part of the Recommendation.)

This table summarizes all of the conditions throughout the document under which the vehicle controller is notified from within the protocol.

Number	Condition	Reference
1	RESULT OF PERSISTENT ACTIVITY Notification of the success or failure of a persistent activity.	See 4.2.2, 'Persistent Activity Process'.
2	STATE CONTROL STATUS Status of the Proximity-1 State Control Variables.	See State Tables contained in section 6.
3	INVALID FRAME SOURCE When the SCID field and RECEIVING_SCID_BUFFER disagree, and Test_Source is *true*, then a session violation has occurred and the vehicle controller shall be notified.	See 6.8, 'RECEIVING OPERATIONS'.
4	TIMING SERVICES INSTANCE At the end of receiving the SET CONTROL PARAMETERS (*time sample*) directives, the recipient transceiver notifies its vehicle controller that Proximity time tags and frame sequence numbers are available.	See section 5, 'Proximity-1 Timing Services'.
5	NO CARRIER RECEIVED—HALF DUPLEX	State table 6-10, Event 50.
6	NO DATA TRANSFERRED—HALF DUPLEX	State table 6-10, Event 45.
7	SENDER EXCEEDED PRESCRIBED TRANSMISSION PERIOD—HALF DUPLEX	State table 6-10, Event 44.
8	COP-P LOSS OF SYNCHRONIZATION When FOP-P detects out-of-synchronization condition (SYNCH_TIMER Expires).	See 7.1.3.3, 'FOP-P State Table', Event SE4.
9	CARRIER_LOSS_TIMER UNDERFLOWS	State table 6-9, Event 27.
10	END OF SESSION(# octets received) Notify the vehicle controller of the number of octets received during the session.	State table 6-9, Events E26, E27, E28. State table 6-12, Events E57, E58, E61. State table 6-13, Event E73.
11	CARRIER ONLY RECEIVED Caller notifies vehicle controller that carrier only was detected immediately after the 'Wait for Hail Response' state terminated.	State Table 6-7, Event E8 State Table 6-10, Event E36