Purpose – For Lunar, the CCSDS plans on defining Prox-1 directives for S-band and maybe K-band. I would like to get your thoughts on my ideas below for expanding these Prox-1 directives. I don’t know all the values for all the parameters yet, but I do know that Lunar operations plans to add the rate 2/3 LDPC k=4096 code and OQPSK and GMSK modulations.

Principles to adhere to for this change:

1. Use one comprehensive “composite” directive instead of several 16 bit length ones. Backward compatible with the current Variable length SPDU structure.
2. Make the directive set useable for more than just S-band (Lunar) i.e., make it multi-frequency compatible, and backward compatible with the original UHF directives in Prox-1.
3. Use 32 bit single precession values each for specific frequency and symbol rate (allows missions more flexibility) then there is no reason to use managed parameters for these fields anymore.
4. Replace SET PL\_Extensions directive with the more generic **Type 8 SPDU for Experimental Extensions** for the use case where an agency has experimental orange book parameters that they would like to experiment with before they perhaps are standardized. – maybe … not sure yet

Architecture:

1.**Directives as building blocks** of size 16 bits Currently, a variable length SPDU contains a) can be composed of up to a maximum of seven 16-bit discrete, self-delimiting and self-identifying directives. The currently defined Prox-1 directive set uses 16-bit directives that can be appended one after the other ex. SET TRANSMITTER PARAMETERS followed by SET RECEIVER PARAMETERS.

2. We could do **modify building blocks** similar to one above, to enlarge some of the directives from 32 bits in length and keep others the same of 16 bits in length. If we were to live with the current constraint of the 15 bytes available for the data portion of the SPDU, then a maximum of three, 32-bit directives and one, 16-bit directive would fit.

3. **One comprehensive directive.** The enterprise can define the size of this ‘one and done’ directive. It would contain all the 5 critical communication parameters needed to establish the link, and move onto the working channel. These parameters are: Frequency, Symbol Rate, MODCOD (modulation & coding), data link layer protocol. Current thinking puts the total directive size at 13 bytes (104 bits), well within the maximum size of the variable length SPDU data field. This is the proposed modified Type 3 SPDU.

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These directives are fixed length SPDUs.

1. a ‘1’ in the SPDU Format ID field and a 0’ in the SPDU Type Identifier field identifies the SPDU as a 16 bit PLCW. Note: Currently used in proximity operations at Mars.
2. a ‘1’ in the SPDU Format ID field and a 1’ in the SPDU Type Identifier field identifies the SPDU as a 32 bit PLCW. Note: Previously, this SPDU was reserved by CCSDS. The specification will be modified from both fixed SPDU types being 16 bits long, to this new arrangement.

The 32 bit PLCW including the SPDU header shall consist of seven fields positioned contiguously in the following sequence (described from least significant bit, Bit 15, to most significant bit, Bit 0—  
see figure 3-5):

1. Report Value (16 bits);
2. Expedited Frame Counter (3 bits);
3. PCID (1 bit);
4. Retransmit Flag (1 bit);
5. Reserved Spares (9 bits);
6. SPDU Type Identifier (1 bit);
7. SPDU Format ID (1 bit).

Note: This PLCW shall be transmitted using the Expedited QoS.

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Table 3‑6 : Variable-Length Supervisory Protocol Data Unit

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable-Length SPDU** | **SPDU Header (1 octet, fixed)** | | | **SPDU Data Field (0-15 octets)** |
|  | Format ID   (Bit 0) | SPDU Type Identifier  (Bits 1,2,3) | Length of SPDU Data Field (Bits 4,5,6,7) | (Contains 1 or more protocol objects, i.e., directives, reports) |
| Type 1 | ‘0’ | ‘000’ | Length in Octets | Directives/Reports (see note) |
| Type 2 | ‘0’ | ‘001’ | " | Time Distribution PDU |
| Type 3 | ‘0’ | ‘010’ | " | Session Establishment and Status Directive PDU |
| Type 4 | ‘0’ | ‘011’ | " | Reserved for Lunar Pathfinder Use - TBD |
| Type 5 | ‘0’ | ‘100’ | " | Reserved for CCSDS Use |
| Type 6 | ‘0’ | ‘101’ | " | Reserved for CCSDS Use |
| Type 7 | ‘0’ | ‘110’ | " | Reserved for CCSDS Use |
| Type 8 | ‘0’ | ‘111’ | " | Reserved for CCSDS Use |
| NOTE – Directives and Reports can be multiplexed within the SPDU Data Field. | | | | |

B3 SPDU TYPE 3: Session Establishment and Status Composite Directive (Session\_EST\_and\_Status)

B3.1 Overview

The Session\_EST\_and\_Status directive is the mechanism by which initial (hailing) as well as additional (working) Physical Layer and Coding & Synchronization parameters can be enabled or disabled. The Composite directive is defined as the new Type 3 Variable length SPDUs in Table 3-6 (p. 3-15) in CCSDS 211.0-B-6. SPDU Type Identifier is ‘010’. This directive is transferred across the Proximity link from the local transceiver to the remote transceiver.

B3.2 General

The Session\_EST\_and\_Status directive shall consist of ten fields, positioned contiguously in the following sequence (described from least significant bit, Bit 103, to most significant bit, Bit 0):

1. Demand/Query (1 bit);
2. Link Direction (1 bit);
3. Query Response (1 bit);
4. MODCOD (21 bits);
5. Symbol Rate (32 bits);
6. Carrier Frequency (32 bits);
7. Link Status/Request Link Status (1 bit);
8. Decoded Transfer Frame Rate (7 bits);
9. Link SNR (6 bits);
10. Spares (2 bits).

NOTE – The structural components of the SESSION\_EST\_AND\_STATUS directive are shown in figure B-TBD.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Bit 0 | |  | | |  | |  | | |  | Bit 15 | |
| Demand/Query  1 bit | Link Direction  1 bit | | Query Response  1 bit | MODCOD    21 bits | | Symbol  Rate  32 bits | Carrier Freq.  32 bits | Link Status/  Request Link Status  1 bit | Decoded  Transfer Frame  Rate  7 bits | | Link  SNR    6 bits | Spares  2 bits |
| 0 | 1 | | 2 | 3-23 | | 24-55 | 56-87 | 88 | 89-95 | | 96-101 | 102-103 |

Figure B‑TBD : SESSION\_EST\_AND\_STATUS Directive

B3.3 Directive Format

B3.3.1 Demand/Query

Bit 0 of the SESSION\_EST\_AND\_STATUS directive shall contain either a Demand Hail or a Query to negotiate the hail between the caller and the responder.

1. ‘0’ = Demand Hail (Command);
2. ‘1’ = Query (Link Negotiation).

B3.3.2 Link Direction

Bit 1 of the SESSION\_EST\_AND\_STATUS directive shall indicate the link direction (Forward direction defined by Hail):

1. ‘0’ = Return Link;
2. ‘1’ = Forward Link.

B3.3.3 Query Response

Bit 2 of the SESSION\_EST\_AND\_STATUS directive shall indicate whether the negotiated hail (query) was accepted or rejected by the responder.

1. ‘0’ = ACK;
2. ‘1’ = NACK.

B.3.3.4 MODCOD (Modulation & Coding & Link Layer Protocol)

Bits 3-23 of the SESSION\_EST\_AND\_STATUS directive shall indicate the type of modulation, coding, interleaving, randomization, and data link layer protocol used. See Example Only Table below. NB. The real table needs to be completed by RF&MOD and C&S WGs

|  |  |
| --- | --- |
| ModCod Value | ModCod Name |
| 1001 | TC Synch & Coding: BCH, BPSK, TC Space |
| 1002 | TC Synch & Coding: BCH, BPL, TC Space |
| 1003 | TC Synch & Coding: LDPC(128,64), BPL, TC Space |
| 1004 | TC Synch & Coding: LDPC(512,256), BPL, TC Space |
| 1005 | TC Synch & Coding: LDPC(128,64) w/tail, BPL, TC Space |
| 1006 | TC Synch & Coding: BCH, BPSK, AOS |
| 1007 | TC Synch & Coding: BCH, BPL, AOS |
| 1008 | TC Synch & Coding: LDPC(128,64), BPL, AOS |
| 1009 | TC Synch & Coding: LDPC(512,256), BPL, AOS |
| 1010 | TC Synch & Coding: LDPC(128,64) w/tail, BPL, AOS |
| 1101 | TM Synch & Coding: No coding, OQPSK |
| 1102 | TM Synch & Coding: Conv Code, OQPSK |
| 1103 | TM Synch & Coding: Concat (CC & RS), OQPSK, I=4 |
| 1201 | Prox1 Synch & Coding: Convolutional, BPL |
| 1202 | Prox1 Synch & Coding: Convolutional, BPL |
| 1203 | Prox1 Synch & Coding: LDPC(6144,4096), BPL |
| 1204 | Prox1 Synch & Coding: LDPC(6144,4096), GMSK |
|  |  |
|  |  |
|  |  |
|  |  |

B3.3.5 Symbol Rate

Bits 24-55 of the SESSION\_EST\_AND\_STATUS directive shall indicate the symbol rate in symbols per second (provides Hz to TeraHz resolution) Single Precision.

B3.3.6 Frequency

Bits 56-87 of the SESSION\_EST\_AND\_STATUS directive shall indicate the carrier frequency in Hz (provides Hz to TeraHz resolution) Single Precision.

B3.3.7 Link Status/Request Link Status

Bit 88 of the SESSION\_EST\_AND\_STATUS directive shall indicate that this is a link status report or a request for a link status report.

1. ‘0’ = Transmitting a Link Status Report;
2. ‘1’ = Requesting that a Link Status Report be Transmitted.

B3.3.8 Decoded Transfer Frame Rate

Bits 89-95 of the SESSION\_EST\_AND\_STATUS directive shall contain the Decoded Transfer Frame Rate reported as a percentage of total number of transfer frames received during this link session.

B3.3.9 Link SNR

Bits 96-101 of the SESSION\_EST\_AND\_STATUS directive shall contain the link Signal-to-Noise (SNR) ratio i.e., Eb/No in dB Hz.

B3.3.9 Spares

Bits 102-103 of the SESSION\_EST\_AND\_STATUS directive shall contain CCSDS reserved spare bits.

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TBD – TBD – TBD:

Type 8 SPDU for Experimental Extensions (acknowledgement: Ken Peters – NASA/JPL)

These are Experimental Extension directives, supporting up to 16 directives, each 32 bits in length. SPDU Type Identifier is ‘111’. SCID would “automatically” provide a unique value for a project to use when creating its own extensions, without having to go through some separate process to get another ID.

Type 8 SPDU directive SET EXTENSION DICTIONARY (32 bits):

Bit 0-3: Directive Type (4 bits) – Provides maximum of 16 directives; value= ‘0000’

Bit 4-5: Reserved (‘00’) – align following fields with octets for human decodability

Bit 6-15: SCID – SCID of the spacecraft who initially defined the particular extension dictionary (other spacecraft could use this dictionary also, if they support the same extensions, they would put in this field the original spacecraft’s SCID, not their own SCID, unless they make changes to the dictionary).

Bit 16-23: Dictionary major version (of this SCID-defined dictionary)

Bit 24-31: Dictionary minor version (of this SCID-defined dictionary)

One would send an initial SET EXTENSION DICTIONARY directive to select the extension dictionary to use for interpreting all subsequent Type 8 SPDUs (until possibly receiving another SET EXTENSION DICTIONARY directive). Then all other Type 8 SPDUs with Directive types 1-15 would be defined however the initial project decided to define them for its needs (it would not have to define all the types, just however many directives it needs).

**Annex A – Current Prox-1 variable length SPDUs**

Table ‑6 : Variable-Length Supervisory Protocol Data Unit

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variable-Length SPDU** | **SPDU Header (1 octet, fixed)** | | | **SPDU Data Field (0-15 octets)** |
|  | Format ID   (Bit 0) | SPDU Type Identifier  (Bits 1,2,3) | Length of SPDU Data Field (Bits 4,5,6,7) | (Contains 1 or more protocol objects, i.e., directives, reports) |
| Type 1 | ‘0’ | ‘000’ | Length in Octets | Directives/Reports (see note) |
| Type 2 | ‘0’ | ‘001’ | " | Time Distribution PDU |
| Type 3 | ‘0’ | ‘010’ | " | Status Reports |
| Type 4 | ‘0’ | ‘011’ | " | Reserved for CCSDS Use |
| Type 5 | ‘0’ | ‘100’ | " | Reserved for CCSDS Use |
| Type 6 | ‘0’ | ‘101’ | " | Reserved for CCSDS Use |
| Type 7 | ‘0’ | ‘110’ | " | Reserved for CCSDS Use |
| Type 8 | ‘0’ | ‘111’ | " | Reserved for CCSDS Use |
| NOTE – Directives and Reports can be multiplexed within the SPDU Data Field. | | | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | |  | | | | | |  | | | | |  | | |  | | **Directive**  **Type**  **3 bits (**13,14,15) |
| Mode (0,1,2) | | | Data Rate (3,4,5,6) | | | | | | Modulation (7) | | | | | Data Encoding (8,9) | | | Frequency (10,11,12) | | ‘000’ = Set Transmitter Parameters |
| Time Sample  (0,1,2,3,4,5) | | | | | Duplex  (6,7,8) | | Reserved (9,10) | | | | Remote No More Data  (11) | | | | | | Token  (12) | | ‘001’ = SET CONTROL PARAMETERS |
| Mode (0,1,2) | | | Data Rate (3,4,5,6) | | | | | | Modulation (7) | | | | | Data Decoding (8,9) | | | Frequency (10,11,12) | | ‘010’ = Set Receiver Parameters |
|  | Receiver Frame Sequence Number (SEQ\_CTRL\_FSN) (0,1,2,3,4,5,6,7) | | | | | | | | | | |  | | Reserved  (8,9,10,11,12) | | | | | ‘011’ = Set V(R) |
| Reserved (0,1,2) | | | Status Report Request (3,4,5,6,7) | | | | | | Time-Tag Request  (8,9,10) | | | | | PCID 0 PLCW Request  (11) | | | PCID 1 PLCW Request (12) | | ‘100’ = Report Request |
|  | | | | | | | |  | | | | | | |  | |  | | ‘101’ = Reserved |
| Direction  (0) | | Freq Table (1) | | Rate Table  (2) | | Carrier Mod  (3,4) | | | | Data Mod (5,6) | | | Mode Select (7,8) | | | scrambler (9,10) | Diff.  Encoding (11) | R-S Code (12) | ‘110’ = SET PL  EXTENSIONS |
| Source Spacecraft ID (0,1,2,3,4,5,6,7,8,9) | | | | | | | | | | | | | Reserved  (10,11,12) | | | | | | ‘111’ = Report Source SCID |

Figure B‑1 : Type 1 SPDU Data Field Contents