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. 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.
2. Use Tables for frequencies and data rates (allows missions more flexibility)
3. Define a channel number index into the frequency tables … same for data rate tables
4. Front load the directive type as bit 0 instead of the last bit in the directive. (Note: we were forced to do it the wrong way by CE Mars 98 design)
5. Use one directive for SET TRANSMITTER PARAMETERS, SET RECEIVER PARAMETERS like Electra does (SET PL\_EXT) but rename it: SET TRANSCEIVER PARAMETERS.
6. 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.

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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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These directives are variable length and can accommodate up to 16 octets of directive size. They are to be defined as the new Type 4 Variable length SPDUs in Table 3-6 (p. 3-15) in CCSDS 211.0-B-6. SPDU Type Identifier is ‘011’.

1. New SET TRANSCEIVER PARAMETERS directive (32 bits):
* Bit 0-3: Directive Type (4 bits) – Provides maximum of 16 directives; value= ‘0000’
* Bit 4: Transceiver Side (1 bit) – Set up the Receiver or the Transmitter
* Bit 5: Frequency Table – 0 = Default; 1 = Extended
* Bit 6-10: Frequency Channel Number – Up to 32 frequency assignments are available per table
* Bit 11: Data Rate Table - 0 = Default; 1 = Extended
* Bit 12-16: Data Rate - Up to 32 data rate assignments are available per table
* Bit 17: Modulation/Coding (Mod/Cod) Table - 0 = Default; 1 = Extended
* Bit 18-21: ModCod – Up to 16 modulation/coding assignments per ModCod table

Coding (accommodates new LDPC rate 2/3 code k=4096, reserved bits)

Carrier Modulation – (accommodates new OQPSK and GMSK)

* Bit 22-23: Bit Data Format – NRZ-L, Bi-Phase-L, …
* Bit 24: Protocol Mode – 0 = Prox-1; 1= No Protocol (Raw mode)
* Bit 25-26: Carrier Suppression – 0 = Suppressed Carrier; 1 = Residual Carrier, reserved bits
* Bit 27: Transceiver Coherency – 0 = Coherent; 1 = Non-coherent
* Bit 28-31: Spares

1. SET CONTROL PARAMETERS directive (16 bits)
* Bit 0-3: Directive Type (4 bits) – Provides maximum of 16 directives; value=’0001’
* Bit 4-9: Time Sample (6 bits) –
* Bit 10-12: Duplex (3 bits) –
* Bit 13: Remote No More Data (1 bit) –
* Bit 14: Token (1 bit) –
* Bit 15: Reserved
1. SET V(R) (COP command) (32 bits)
* Bit 0-3: Directive Type (4 bits) – Provides maximum of 16 directives; value=’0010’
* Bit 4-19: Receiver Frame Sequence Number (16 bits)
* Bit 20-31: Reserved
1. REPORT REQUEST directive (16 bits)
* Bit 0-3: Directive Type (4 bits) – Provides maximum of 16 directives; value=’0011’
* Bit 4-8: Status Report Request Type (5 bits)
* Bit 9-11: Time Tag Report Request Type (3 bits)
* Bit 12: PCID 0: PLCW Request (1 bit)
* Bit 13: PCID 1: PLCW Request (1 bit)
* Bit 14-15: Reserved
1. REPORT SOURCE SPACECRAFT ID directive (32 bits)
* Bit 0-3: Directive Type (4 bits) – Provides maximum of 16 directives; value=’0100’
* Bit 4-19: Source Spacecraft ID – Provides for Version 3 & Version 4 SCID values
* Bit 20-31: Reserved

Directive Types ‘0101’ through ‘1110’ are CCSDS reserved

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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).

Some Questions

Question (1): Do we need to keep and maintain the specific and unique parameters in the SET PL\_EXTENSIONS Directive for Lunar operations and beyond ?

Question (2): What do you think about the names of these parameters ? Descriptive enough ?

Your thoughts ?

Question (3): Can we simplify the SET TRANSCEIVER PARAMETERS directive? In DVBS2, they use “modcod” as a combination of modulation and coding into a single unique identifier. Thus, a link can be established with three parameters. Do we need the other parameters or not ?

1. Carrier Frequency
2. Symbol Rate
3. ModCod value