CCSDS 732.1-R-0: DRAFT CCSDS RECOMMENDED STANDARD FOR UNIFIED SPACE DATA LINK PROTOCOL

Responding to CESG comments from Peter Shames

July 21, 2016

Comment 1

1.1 PURPOSE

The purpose of this Recommended Standard is to specify the Unified Space Data Link

Protocol (USLP). This protocol is a Data Link Layer protocol (see reference [1]) to be used over space-to-ground, ground-to-space, or space-to-space communications links by space missions.

Peter’s comment: I hate to say this, but if you are calling this the “Unified Space Data Link Protocol” why isn’t the acronym USDLP?

SLP WG response: Reject comment. CCSDS has for example, Telemetry Space Data Link Protocol, Telecommand Space Data Link Protocol. The abbreviations for these protocols are TM and TC respectively. If we follow previous examples, then USLP need not have every letter present in the acronym. The other important aspect is 5 letters is overkill for this acronym. Also US for USLP would be politically incorrect.

Comment 2

1.4 RATIONALE

The CCSDS believes it is important to document the rationale underlying the

recommendations chosen, so that future evaluations of proposed changes or improvements will not lose sight of previous decisions. The concepts and rationale for the USLP is documented in the USLP Green Book reference [D11].

Peter’s comment (FROM): I would prefer if at least a few sentences of rationale were included here instead of this. Something like: The link layer protocol specified in this document is designed to provide such services across the widest spectrum of domains (near Earth, deep space, proximity) and the widest spectrum of data rates (very high rate RF or optical down to emergency data rates). The intent is to provide one protocol that can cover all of these applications instead of two to four separate protocols. This should both improve performance and reduce costs.

Accepted with modifications:

TO:

The CCSDS believes it is important to document the rationale underlying the

recommendations chosen, so that future evaluations of proposed changes or improvements will not lose sight of previous decisions. USLP was designed to accommodate the broadest spectrum of links (near Earth, deep space, proximity) and the largest spectrum of data rates (very high rate RF or optical down to emergency) in one protocol. See the USLP Green Book reference [D14] for further details.

Comment 3

1.6.1.3 Terms Defined in this Recommended Standard

Peter’s Comment:

Why limit these terms only to Proximity?

Response: Accepted

FROM:

forward link: That portion of a Proximity space link in which the caller transmits and the

responder receives (typically a command link).

return link: That portion of a Proximity space link in which the responder transmits and the caller receives (typically a telemetry link).

TO:

forward link: That portion of a space link in which the caller transmits and the

responder receives (typically a command link).

return link: That portion of a space link in which the responder transmits and the caller receives (typically a telemetry link).

Comment 4

1.6.1.3 Terms Defined in this Recommended Standard

Peter’s Comment:

Define Port too, shows up on pg. 46 in a note, without other intro.

Response: Accepted

FROM:

No definition provided for port.

TO:

Port: The physical element of a Node where a Link is connected. Nodes may have one or more Ports. (note that this definition is consistent with the CCSDS Glossary of terms.)

Comment 5

1.7 References

Peter’s Comment: This spec MUST be updated before the new 16 bit SCIDs can be allocated & used.

Response: This is the job of Tom Gannett and the CCSDS Secretariat. N.B. Tom.

No change.

Comment 6

2.1.1 ARCHITECTURE

The Unified Space Data Link Protocol is a Data Link Layer protocol (see reference [1]) to be used by space missions.

Peter’s Comment:

FROM: The Unified Space Data Link Protocol is a Data Link Layer protocol (see reference [1]) to be used by space missions.

TO: The Unified Space Data Link Protocol is a Data Link Layer protocol (see reference [1]) to be used for all kinds of space communication.

Response: Who uses it has been addressed in the Rationale Section 1.4.

Reject comment.

Comment 7

2.1.2.4 Communications Operations Procedure – 1

Peter’s Comment: The distinction between COP-1 and COP\_P should be made clearer. For instance, can I use COP-P on a long haul link, or vice-versa?

Response:

FROM: Within this document the term, COP refers to both the Communications Operation Procedure-1 (COP-1) reference [9] as well as the Communication Operations Procedure for Proximity links (COP-P) within the Proximity-1 Space Data Link Protocol reference [10].

TO: Within this document the term, COP refers to both the Communications Operation

Procedure-1 (COP-1) reference [9], used in near Earth and Deep Space applications as well as the Communication Operations Procedure for

Proximity links (COP-P) within the Proximity-1 Space Data Link Protocol reference [10]. Please see the USLP Green Book reference [D14] for further details.

Comment 8

2.1.2.4 Communications Operations Procedure – 1

Peter’s Comment: I am left wondering if this isn’t the time to try and come up with a single new, or modified / extended “COP” that meets both need. This would be more in the spirit of the whole USLP concept and would also serve to reduce complexity in this protocol.

Response:

A type of U-COP is a big undertaking that would need resources at the CESG level. I think the idea is worth evaluating but it is outside the scope of this blue book in order to finish this blue book in the proposed time.

Comment 9

2.2.1 Common Features of Services

Peter’s Comment: Which “traffic”? WAN traffic between source & dest?

FROM: The timing of data transfer is determined by the provider in accordance with mission specific rules and may depend on the traffic at the time of transfer.

TO: The timing of data transfer is determined by the provider in accordance with mission specific rules and may depend on the traffic of the data exchange by service provider/lower layers at the time of transfer.

Comment 10

2.2.2.3 Expedited Service – Best Effort Delivery

Peter’s Comment: Might want to explain just how they differ. There is no difference in the data link behavior, but in Reliable mode the receiving end does hold onto the data until the ARQ process completes. Thus this is “expedited” in that the data is delivered when it arrives.

Response: The NOTE correctly addresses a term that is there for historical reasons and because it explains the distinction between Expedited and Sequence Controlled Service. Assuming that the delivery is immediate in reception may not be correct and depend on implementation. I would not update the note with text that may be incorrect.

Comment 11

2.2.2.7 Periodic Service

Periodic service is a special case of synchronous service in which service data units are

transferred at a constant rate. Periodic transfer from service interface to service interface is provided with a specified maximum delay and a specified maximum jitter at the service

interface. There are three cases in which a synchronous service is periodic:

a) If the service is associated with a Virtual Channel (or a Master Channel) and that

Virtual (or Master) Channel produces Transfer Frames at a constant rate, then the

service is periodic.

b) If the service is associated with a Master Channel and there is only one Master

Channel in the Physical Channel, then the service is periodic.

For periodic services, all service data units are sent only once if the user supplies service data units at the same rate as the rate at which the service provider transfers them.

Peter’s Comment: Referring to the last last Sentence above. But otherwise it behaves like the Sync service? Isn’t this same statement true for Synch Service as well?

Response:

The text of this section 2.2.2.7 (periodic service) comes from AOS and TM books. It has 2 flaws:

-          It states 3 cases in which a synchronous service is periodic, but lists only 2 !

-          Case b) assumes that frame length is fixed which is not necessarily the case for USLP.

The last sentence of the subsection is true for both periodic and synchronous services but for synchronous service there is a more specific sentence that discusses the matter.

Therefore, I would suggest:

-          Correct 3rd sentence to : “There is one case in which a synchronous service is periodic: when the service is associated with a Virtual Channel (or a Master Channel) and that Virtual (or Master) channel produces Transfer Frames at a constant rate.”

-          Maintain last sentence as is : “For periodic services, .... transfers them.”

Comment 12

2.2.3.2 MAP Packet (MAPP) Service

Peter’s Comment: Don’t these two sentences say the same thing in different words?

FROM:

The service is unidirectional and asynchronous. If the COP is used, then both Sequence-

Controlled and Expedited service types are provided.

When using a reliable ARQ protocol with USLP, then both Sequence-Controlled and Expedited service types are provided for the MAP Packet Service.

TO:

The service is unidirectional and asynchronous. If a reliable ARQ protocol with USLP is used e.g., COP, then both Sequence-Controlled and Expedited service types are provided

for the MAP Packet Service.

Comment 13

3.3.2.6 Service Type

Peter’s Comment: This is puzzling. If this param signals service type why isn’t it used on receiving end to guide the execution of that service?

FROM:

NOTE – At the receiving end, the Service Type parameter is not used.

TO:

Remove the NOTE. Receiving end also needs to see the Service Type for execution purposes.

\*\* Note to Greg \*\*

Add Section 3.3.3 MAPP Service Primitives

Also replace the term, Section 3.4.2 MCA Service Parameters with MAPA Service Parameters

Comment 14

3.4.3.2.2 Semantics

NOTE – When separate ports are provided for Sequence-Controlled and Expedited

Services, the Service Type parameter is not used in this primitive.

Peter’s Comments:

Define Port too, first shows up here, in a note, without other intro.

Resolution: Added definition of Port in the terms and definitions in Section 1

Comment 15

3.6.3.2 VC\_OCF.request

Peter’s Comment: Shouldn’t this be a “MC\_OCF.request”?

Response:

FROM: 3.6.3.2 VC\_OCF.request

TO: 3.6.3.2 MC\_OCF.request

Comment 16

3.10 COPs Management

Peter’s Comment: Is there any alignment between COP-1 and COP-P directives or other data types? Seems like an opportunity to brings some consistency, or an opportunity to continue to persist inconsistency, which I find troubling. I recognize that these are different protocols, but shouldn’t we try and fix this when / where we can?

Response: A type of U-COP is a big undertaking that would need resources at the CESG level. I think the idea is worth evaluating but it is outside the scope of this blue book in order to finish this blue book in the proposed time.

Comment 17

Figure 4-1: USLP Transfer Frame Structural Components

Peter’s Comment: Is something missing at the top of the figure 4-1

between the dashed lines?

Response: Between the dashed lines at the top of the figure it should say USLP Transfer Frame. Perhaps that is already the case and there was a glitch in printing ??? Tom Gannett to verify. This is consistent with AOS, TM, TC…frame diagram.

Comment 18

4.1.2.2.3.3 The Spacecraft Identifier shall be static throughout all Mission Phases.

NOTE – The Secretariat of the CCSDS assigns Spacecraft Identifiers according to the

procedures in reference [11].

Peter’s Comment: Must update this spec for 16 bit SCIDs.

This is a comment to the CCSDS Secretariat to ensure that ref. document [11] must be updated before USLP becomes an official Blue Book.

No change needed here just book keeping.

Comment 19

4.1.2.3.3 The Source-or-Destination Identifier is interpreted as follows:

Peter’s Comment: Should there at least be a note that says when you use one or the other? Or, to put it another way, how could I use a “Destination SCID” for a return link from S/C to ground, when the ground does not have a SCID?

Response: Since the concept of Source and Destination SCIDs originated in Proximity-1 and there exists green book material for proximity environment uses thereof, it makes sense to add a note to that reference here.

Not all combinations of Source or Destination Identifier makes sense on a given link. CCSDS cannot make everything idiot proof. In the example above, it is an oxymoron for the ground to be assigned a SCID but it makes more sense to use “Source SCID” instead.

FROM: no Note

TO: Note: Although not limited to proximity environments, a discussion of the assignment of source vs. destination Spacecraft ID is provided in reference [D14].

Comment 20

4.1.2.7 Frame Length

Peter’s Comment: Do you need another note here referencing 4.1.1.2?

4.1.1.2 The USLP Transfer Frame length shall be consistent with the specifications contained in references [3], [4], [5], [6], and [7]. The structural components of the USLP Transfer Frame are shown in figure 4-1.

Response: If the user chooses to align the transfer frame with the code block then, yes, the reference to 4.1.1.2 makes sense. If the frame is unaligned to the code block then no, the reference is not necessary.

From:

4.1.2.7.3 The count shall be measured from the first bit of the Transfer Frame Primary Header to the last bit of the Frame Error Control Field (if present), or to the last bit of the Operational Control Field (if present), or to the last bit of the Transfer Frame Data Field (if both the FECF and the OCF is omitted).

NOTES

1 The length count C is expressed as:

C = (Total Number of Octets in the Transfer Frame) – 1

2 The size of this field limits the total number of octets in the Transfer Frame to 65536

octets.

TO:

4.1.2.7.3 The count shall be measured from the first bit of the Transfer Frame Primary Header to the last bit of the Frame Error Control Field (if present), or to the last bit of the Operational Control Field (if present), or to the last bit of the Transfer Frame Data Field (if both the FECF and the OCF is omitted).

NOTES

1 The length count C is expressed as:

C = (Total Number of Octets in the Transfer Frame) – 1

2 The size of this field limits the total number of octets in the Transfer Frame to 65536

octets.

3 See 4.1.1.1

Comment 21

4.1.2.8 Bypass/Sequence Control Flag

Peter’s Comment: This sounds like the FRAME is bypassed entirely, but Note 2 below suggests otherwise. Which is it?

Response: Rejected. There are two different checks going on here. First, the Frame acceptance/rejection check of the FARM in subparagraph b. Then the general frame validation checks (SCID correct etc.) under the NOTE 2. They are 2 different checks. The section is consistent as stated. No Change.

Comment 22

4.1.2.12.5 A resetting of the Virtual Channel Frame Count before reaching the maximum

Virtual Channel Frame Count shall not take place unless it is unavoidable.

Peter’s comment: Is FARM-B only for use in Proximity-1 timing cases, or does it provide sequence count / FARM checks in all cases?

Response: The FARM-B expedited counter is not specific to Prox-1. This is an additional note about Proximity environments.

Comment 23

Protocol Control Command Definition

The Transfer Frame Data Field shall contain any of the following SDUs

determined by management: either an integral number of octets of user data or an integral

number of octets of Protocol Control Command information.

Peter’s comment: Has this (Protocol Control Command) been defined before now? If not, please define it first, then use it.

Response:

FROM: The Transfer Frame Data Field shall contain any of the following SDUs

determined by management: either an integral number of octets of user data or an integral

number of octets of Protocol Control Command information.

TO: The Transfer Frame Data Field shall contain any of the following SDUs

determined by management: either an integral number of octets of user data or an integral

number of octets of Protocol Directives as defined in 4.1.4.2.1.4.3.

Comment 24

4.1.4.1.7 The Virtual Channel ID of an OID Transfer Frame shall be set to the value of ‘all ones’ (i.e., 63 decimal) and a project-specified ‘idle’ pattern shall be inserted into the

Transfer Frame Data Field.

Peter’s Comment: This sounds like a requirement. And it is similar to what was stated in 4.1.2.4.2.

Response: Yes it is a requirement and that is why it is represented as I

Comment 25

Peter’s Comments: think this was already stated a few pages back in 4.1.2.4.2.

Response: It was alluded to in a NOTE to set up the requirement later. I see no reason to change it. It provides good information in that section 4.1.2.4

FROM: VCID 63 is used for transmission of Only Idle Data (OID) Transfer Frames (see

4.1.4.1.6).

TO: VCID 63 is used for transmission of Only Idle Data (OID) Transfer Frames (see

4.1.4.1.7).

Comment 26

Note 4 in 4.1.4.1.7

NOTE 4: OID Transfer Frames are not be sent on Virtual Channels that also carry valid

Packets; it is required that a separate Virtual Channel be dedicated to carry OID

Transfer Frames.

Peter’s comment: This sounds like a requirement. And it is similar to what was stated in 4.1.2.4.2.

Response: Can’t have negative requirements because they can’t be verified. I recommend the following reformulation:

FROM: NOTE 4: OID Transfer Frames are not be sent on Virtual Channels that also carry valid Packets; it is required that a separate Virtual Channel be dedicated to carry OID Transfer Frames.

TO: 4.1.4.1.8 It is required that a separate Virtual Channel be dedicated to carry OID Transfer Frames.

NOTE: OID Transfer Frames are not be sent on Virtual Channels that also carry valid Packets.

Comment 27

4.1.4.2.1.3.5 The TFDZ Construction Rules shall be interpreted as shown in table 4-2 and

specified in 4.1.4.2.1.3.6—4.1.4.2.1.3.13.

Peter’s Comment: This is a compound RQ. Better if it were two separate ones.

Response: Simply it as so. Text trumps tables and figures as the definitive way to express a requirement. So…

FROM: 4.1.4.2.1.3.5 The TFDZ Construction Rules shall be interpreted as shown in table 4-2 and specified in 4.1.4.2.1.3.6—4.1.4.2.1.3.13.

TO: 4.1.4.2.1.3.5 The TFDZ Construction Rules shall be interpreted as specified in 4.1.4.2.1.3.6—4.1.4.2.1.3.13.

Comment 28

NOTE – TFDZ Construction Rules ‘000’ or ‘001’ or ‘010’ apply to fixed-length TFDZs.

‘011’,’100’,’101’,’110’ and ‘111’ apply to variable-length TFDZs.

Peter’s Comment: Move this NOTE to the bottom of Table 4-2: Summary of the TFDZ Construction Rules.

Response: Concurred.

Comment 29

4.1.6.1.2 Frame Error Control Field

4.1.6.1.2 The Frame Error Control Field is optional; its presence or absence shall be

established by management

Peter’s Comment: Why is this “managed” instead of being signaled as the OCF is?

Response: This issue was thoroughly discussed in the SLP WG. Originally FECF was proposed as a signaled field. However, if one includes the FECF Flag in the transfer frame header one has a chicken and egg problem. There could be a CRC error in the frame due to a bit hit in the FECF Flag field. The presence or absence of the FECF would then be questionable, if the FECF Flag field is unreliable, which is being checked by the FECF itself. So the WG rejected this field as signaled and it went back to being managed.

Comment 30

4.1.6.1.3 Note 2: Whether this field should be used on a particular Physical Channel is determined based on the mission requirements for data quality and the selected options for the underlying Synchronization and Channel Coding Sublayer. This field may be

mandatory depending on the selected options for the Synchronization and Channel

Coding Sublayer.

Peter’s Comment: This is a bit obscure. Why not be more explicit about which C&S options require this field.

Response:

FROM: Note 2: Whether this field should be used on a particular Physical Channel is determined based on the mission requirements for data quality and the selected options for the underlying Synchronization and Channel Coding Sublayer. This field may be

mandatory depending on the selected options for the Synchronization and Channel

Coding Sublayer.

TO: Note 2: Whether this field should be used on a particular Physical Channel is determined based on the mission requirements for data quality and the selected options for the underlying Synchronization and Channel Coding Sublayer. This field may be

mandatory depending on the selected options for the Synchronization and Channel

Coding Sublayer as specified in references [3], [6] or [7].

Comment 31

4.2 Protocol Procedures at the Sending End

4.2.1 Overview

Depending on the services actually

used for a real system, not all of the functions may be present in the protocol entity.

Peter’s Comments: This seems like a strange thing to say. The required functions must all be present in the “protocol entity”, but the protocol entity may be implemented by one or more modules, or in S/W of Firmware.

FROM: Depending on the services actually used for a real system, not all of the functions may be present in the protocol entity.

TO: Remove this sentence since it can be misunderstood.

Comment 32

4.2.9.8 When reference [6] is used as the Synchronization and Channel Coding Sublayer,

the All Frames Generation Function may request the Synchronization and Channel Coding Sublayer to perform systematic retransmissions of a data unit as described in 2.4.2, unless the data unit contains a frame carrying service data on the Expedited Service.

Peter’s comment: Is this really “requested” by the AFGF in USLP, and therefore possible to only be intermittently used, or is it a managed parameter for the C&S sub-layer?

Response: USLP follows the logic established in the TC Sync and CC Blue Book. In that book, it states “This Recommended Standard specifies an option for repeated transmissions of Transfer Frames. Annex A contains the service definition for the user in a higher sublayer to request data transfer, including an optional Repetitions parameter for repeated transmissions. In this case, the higher layer is the Data link protocol specification. Note also that only the number of repetitions is the only managed parameter specified in TC Sync & Channel Coding spec.

So the USLP approach is consistent with the existing TC spec in this respect. Reject comment.

Comment 33

4.3.2. MAP Packet Extract Function

Peter’s comment: The sending end describes creation of these frames, top down. Shouldn’t the receiving end describe the deconstruction “bottom up”, starting with the frames and arriving at packets?

Response: The order of the deconstruction is consistent with TM, TC, AOS space data link protocol specifications. Reject comment.

Comment 34

4.3.9.9.1 The TC Channel Coding and Synchronization Recommended Standard

(reference [6]) shall be used as the specification for the Synchronization and Channel Coding Sublayer immediately below this procedure.

Peter’s Response: Earlier sections have asserted that any of several C&S standards can be used. This one (and much of this section) seems to focus only on the TC and not the TM coding. Is this intentional or can the fixed length TM codes also be used? Can slicing be used?

Response: Much of this section is intentionally focused on TC Sync and CC standard due to the specific constraints imposed by that type of coding. So far Slicing has only been applied to the downlink. CCSDS may consider it in the future for TC applications. It does apply to proximity environments already.

Comment 35

Table 5-1: Managed Parameters for a Physical Channel & Table 5-2: master channel & Table 5-3 & Table 5-4

Peter’s comments:

Isn’t there a max size that should be stated for Max transfer frame length, like 65K?

Response: For Maximum transfer frame length for fixed sized frames the specification identifies the maximum size already in Note 2 of 4.1.2.7.3.

So there is no need to duplicate this info in the Managed Parameters. For frames that are variable, we state that the parameter is an integer and that the value is variable.

Comment 36

Table 5-1: Managed Parameters for a Physical Channel & Table 5-2: Master Channel & Table 5-3 & Table 5-4

FROM: Spacecraft ID ….. Integer (allowed value)

TO: Spacecraft ID …. 16-bit Integer (allowed value)

Comment 37

5.5 Managed Parameters for a MAP Channel

Peter’s comment: What about minimum TFDF length and Maximum TFDF length. The value is expressed as Integer.

Response: TFDF length can be either variable or fixed. When fixed, the spec says how large it can be: 4.1.4.1.4 The Transfer Frame Data Field, which shall contain an integral number of octets, may vary in length up to a maximum of 65514 octets. When the TFDF is variable, we only can say that the parameter is an integer and that the value is variable.

Comment 38

6.6.2 ADDITIONAL MANAGED PARAMETERS FOR A VIRTUAL CHANNEL

(Table 6-1:When USLP supports SDLS)

Length of Space Data Link Security Header (octets) Integer

Length of Space Data Link Security Trailer (octets) Integer

Peter’s Comment: What are the ranges of these integer fields?

Response: In Note 2 of Table 6-1 it is stated that “The valid lengths for the Security Header and Security Trailer are specified in reference [14].”

Reference [14] is the SDLS Blue Book.

Comment Rejected.

Comment 39

C2.2.2 USLP Extended Protocol ID (UPID\_Ext)

Peter’s Comment: I have no idea what this registry is or what it is to be used for. If there is just a singular integer field that can be up to 8 bits, what is it used for? Who can assign it? How is assignment responsibility managed? What do these 8 bits signify?

Response: I responded to SANA registration needs in a separate email to SANA. In it, I documented the need for this registry. Here is a copy of my response below:

USLP Extended Protocol ID (UPID\_Ext)

Rational: This new registry will have the same type of structure as other Protocol IDs in CCSDS e.g., Encapsulation Service. It is a unique ID to USLP and therefore it cannot share the name space of an existing protocol ID within the existing SANA registries.

Description: It identifies the CCSDS data link layer recognized Protocol or data contained within the USLP Transfer Frame Data Zone. It is an 8 bit optional field in the USLP Transfer Frame Data Field Header.

Registration Policy

[CCSDSBlue](http://sanaregistry.org/keywords/CCSDSBlue.html)

Review authority

[SLS-SLP](http://cwe.ccsds.org/sls/default.aspx#_SLS-SLP)

Reference

CCSDS 732.1-R-1

Data Type - Integer

| **Protocol Identifier http://sanaregistry.org/r/_support/sort_none.gif** | **Status http://sanaregistry.org/r/_support/sort_none.gif** | **Reference http://sanaregistry.org/r/_support/sort_none.gif** |
| --- | --- | --- |
| 00000000-11111111 | [Unassigned](http://sanaregistry.org/keywords/Unassigned.html) |  |

Comment 40

Annex E: Proximity-1 Variable-length Supervisory Protocol Data Field Formats (Informative Annex)

NOTE 3: The Directive Type field is defined from bits 13 through 15, inclusive, in order to maintain backward compatibility with the NASA Mars Surveyor Project 2001

Odyssey orbiter.

Peter’s Comment: Is this NOTE 3 really essential?

Response:

FROM: NOTE 3: The Directive Type field is defined from bits 13 through 15, inclusive, in order to maintain backward compatibility with the NASA Mars Surveyor Project 2001

Odyssey orbiter.

TO: Remove this note from Annex E

Comment Accepted.