CCSDS SLS Triple Joint (SLP, RFM, CS) WG Meeting Minutes

Spring 2025 Meeting APL, Laurel, MD, USA

Wednesday, June 11, 2025

1. Attendees: Greg Kazz (NASA-JPL), Matt Cosby (UKSA), Shannon Rodriguez (NASA-GSFC), Wing Lee (NASA-GSFC), Wai Fong (NASA-GSFC), Clement Leclerc (CNES), Ken Andrews (NASA-JPL), Mazen Shihabi (NASA-JPL), Stefano Petri (ESA), Jorge Quintanilla (ESA), Guillon Herve (CNES, online), Amanuel Gedda (DLR, online), Lee Stabkin (NASA), Natalya Stepanova (NASA), Victor Sank (NASA), Sami Asmar (NASA-JPL), Nicola Maturo (ESA), Ignacio Aguilar (ESA), Clemens Heese (ESA), Brice Dellandrea (ESA, online)
2. Number of Atendees based upon Agency: (20 Total)

2, CNES 6, ESA 10, NASA 1, UKSA 1,DLR

All the files mentioned in these meeting minutes are found on the SLP WG CWE under the following URL:

[https://tinyurl.com/CCSDS2025](https://urldefense.us/v3/__https:/tinyurl.com/CCSDS2025__;!!PvBDto6Hs4WbVuu7!Kj0fZjWMnrkr9wBDNg8m9gPb2-Rj4X6eN2RFpwExJ6QUR0C0S2dWY5bWWuPmsnTBubxYbfuEQeL5eFX9Qn2WoucqRssmoWB_$) - (and once again… don’t forget to login, otherwise you will see a blank page)

1. Meeting Agenda

Joint SLP/C&S/RFM meeting, Wednesday June 11, 2025 – starting at 8:45

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| Chair: Greg Kazz | Author | | Agenda Topic | | Estimated time allocation in minutes | | REMARKS |
| 1 | | ESA/N. Maturo | | Pink books for Proximity-1 RFM and C&S | | 30 | |
| 2 | | ESA/B. Dellandrea | | Ka-Band Prox-1 extension – ESA inputs | | 30 | |
| 3 | | ESA/S. Petri | | Prox-1 - Common sharing of hailing | | 30 | |
| 4 | | ESA/S. Petri | | 235.1 use for Lunanet - protocol stack and AOS compatibility | | 30 | |
| 5 | | SLP WG / G. Kazz | | Changes to Generic Session Control Book affecting Proximity-1 S-Band | | 30 | |
| 6 | | ESA/S. Petri | | Modcods for 235.1 - Reserve fields | | 30 | |
| 7 | | NASA/S. Rodriguez & M. Shihabi | | Ka-Band Prox-1 extension – new project proposal | | 60 | |
| 8 | | NASA/W. Lee | | Proximity-1 Links randomizer | | 30 | |
| TOTAL hours | | | | 4.5 | | | |

1. Pink books for Proximity-1 RFM and C&S – Nicola Maturo (ESA)

Nicola Maturo spoke to the updates to both the Prox-1 C&S (211.2-B) and the Prox-1 RFM (211.1-B) books due to the addition of the Lunar S-band interfaces.

Items covered concerning the Prox-1 RFM (211.1-B) were :

* ACTION: Nicola took the action to Modified Figure 1-1 slightly to include the “symbol rate equivalent” text after the Bi-Phase block in the diagram. Also fix the R (sub b) to R (sub d) as well.
* Confirmed again that 8000 sps is the hailing rate for Mars.
* ACTION: Added filtering due to the spectrum constraints for Bi-Phase modulation at S-band. Is Butterworth filtering really necessary in the Bi-Phase-L case ? This action was assigned to both Andrea Modenini and Dennis Lee to examine section 5.1.6.2.6 in 211.1-B.
* The note in Section 5.2.4 Discrete Spurious Spectrial Lines was slightly modified by Nicola.
* New information added for Section 5.2.4.1 Filtered Bi-Phase L. This constraints spurios lines below -20dBc. Nicola took the action to add the 4KHz BW normalized symbol rate to this section.
* Note that the ECSS calls out a violation of spectral lines. Note that so far in 211.1-B, the maxium symbol rate for Bi-Phase-L has not been specified. At the meeting, it was mentioned that it could go as high as 150Ksps.

Items covered concerning the Prox-1 C&S(211.2-B) were:

* ACTION: Nicola M. to update Figure 1-2 similar to the RFM Figure 1-1.
* ACTION: Greg Kazz took the action to update the 235.1-W book to add an extra bit (going to 3 bit field) to the transceiver mode parameter in Annex E, Link\_Establishment&Control directive for more potential protocol growth.

1. K/Ka-bands Proximity-1 Extension – Brice Dellandria/Daniel Pettitt/Stefano Petri (ESA)

Brice (who was remote online) spoke to a way forward for the use of the Proximity-1 hailing and working channels at K/Ka bands. The key points of the discussion are captured below:

* The spectrum available at K/Ka band was reported as 200MHz available on both the Forward and Return Links single access over a 500MHz total band allocated to space-to-space lunar coms (23-23.5 + 27-27.5). Their conclusion was that it is unlikely that anyone would need a wider than 200 MHz bandwidth at K-band for single access communication use. In addition, the lowest SNR comm signal is filtered BPSK 1 Msps using LDPC ½ (32768, 16384). Their recommendation is to use that modcod for hailing with a 2 MHz BW.
* The link dynamics (doppler frequency range and dopper rate) were provided.
* K-band pointing conditions were examined. Their conclusion was HGA to HGA communication would not be sufficient. As an alternative, LGA/MGA K-band antenna shall be used for hailing prior to HGA communication on the working channel or alternatively, hailing would be carried out at S-band first, and then move on to K-band working channel.
* The whole point of adding K-band is to increase data volume, currently envisioned for the return data link. Brice pointed out in this case that implementations could focus on providing a high capacity transmitter vs a transceiver. To this point, Ignacio Aguilar questioned if the future may bring both forward and return links in more balance that the current asymmetric Proximity-1 data links at Mars.
* COP-P service would be strained due to the very high return data rates. Therefore, the authors proposed to consider an S-band full duplex TTC and a Ka-band simplex return combination. Greg Kazz mentioned that higher order protocols providing selective repeat ARQ could replace COP-P. However, as Brice pointed out, COP-P for Prox-1 has advantages including ease of implementation and heritage.

1. K/Ka band Prox-1 Ext. new project proposal – Shannon Rodriguez (NASA-GSFC)/Mazen Shihabi (NASA-JPL)

Shannon Rodriquez presented the current state of the proposal from the NASA side to move into K/Ka band for Proximity-1 operations. She was joined by Mazen Shihabi who provided addition information on this topic. No K/Ka band frequency channelization scheme has been proposed to date. Unclear at this time, if one is needed or not. Lunar Comm and Nav Systems (LCRNS) is specifying maxium Prox-1 K/Ka band symbol rate to be 100 Msps. There still are many open questions that need answers before a CCSDS position on K/Ka – band standardization can take place. The questions that Shannon raised were:

* LDPC Codes in LNIS are bigger for code rate ½, 2/3 and 4/5 than what we defined for S-band Prox-1 codes. ​
* Performance vs complexity​ trade off
* At FER = 1e-5, gain ~1.1dB going from information block size of 1k to 16k. ​
* Do we need to apply SFCG mask to these Ka-band proximity links?​
* Do we leave prox-1 bandwidth and non prox-1 proximity bandwidth separated as we are doing in S-band?​
* Do we channelize the proximity-1 band? ​
* Protocol can give ability to use adjacent channels for rates higher than one channel.​
* Do we hail on S-band or Ka-band?​
* Beamwidth considerations​
* Hailing Channels for Ka-band are not currently identified in SFCG​
* Performance would be much different for Mars in comparison to Lunar.​

Mazen similarly made many good points. His first point was that the need for a standard approach to K/Ka bands lunar proximity communications is urgent. Inaction will force individual relay missions to adopt their own signaling format, which could create significant interoperability problems in the future.​ Another point is that CCSDS should strive to reuse as much of the Lunar K/Ka band Proximity-1 standard for future Mars operations as well. Currently, Mars Proximity-1 operations is limited to UHF band only. However, the 211.0-B and the emerging 235.1 books are written from a frequency agnostic point of view. Mazen also acknowledged alternative methods of hailing and moving onto a working channel. The options addressed were:

* Low data rate users hail on S-band and work on S-band
  + Multipath losses are higher at S-band at lower elevations. Advantage is one would not need to rehail on a separate frequency band.
* High data rate users hail on Ka-band
* Hail on S-band and move to a working channel on Ka-band. In this case the FWD link (assuming it is a much lower data rate) could provide the ARQ messages during the working session at S-band, while the return link (much higher rate) would operate at Ka-band.
* Another alternative is to move from Frequency Division to CDMA to solve hailing collisions.

It was noted that the future K-band/S-band directive set must support the switch to K-band frequencies starting from hailing at S-band. Currently, this approach is possible because the frequency field is independent of Channel bin assignment i.e., it is a fp number that can be dialed in by the user.

* In order to support higher data rates, higher order spectrally efficient modulations will be necessary e.g., 8PSK, 16 APSK, and 32 APSK​ to conserve BW.

Once the link is established and communication occurs over the working channel, if communication breaks down, Proximity-1 has a built in rehailing mechanism. We would have to ensure that in the hybrid, S-band hailing/K-band working channels, that a return to S-band to rehail would provide a reliable path to link reestablishment.

The following are my notes taken during this discussion:

* Can the Prox-1 state machine handle hailing and working frequency assignment across multiple bands ? I believe the answer is yes, as long as the radios can dial in the desired frequency assignments. Nothing to preclude using frequencies across multiple frequency bands. Unlike S-band, no center frequency channel assignment would be defined.
* If 200 MHz is supplied in K band, each assigned 1 Msps, then up to 200 users could be supported. Up to 400 users could be supported if dual polarization used. For S-band, 8 users (single Polarization) and 16 users (dual polarization) are envisioned.
* Question was raised if a proximity radio could jump 200 MHz to cover the entire K-band envisioned ? The ACTION was given to the RFM WG to ask radio vendors if this was possible and desireable. If the radios cannot cover the entire 200 MHz than what sections of the BW could they cover ?
* Is a 3rd S-band hailing channel needed ? ACTION: Assigned to the RFM WG. Also are there any other impacts on any other WG ?
* Brice Dellandrea pointed out that new MODCODs for K/Ka band will be needed.
* Shannon pointed out that 8 PSK and 16 PSK will probably be no problem to add. However both LNIS and CCSDS will need to agree on MODCODs. ACTION on Stefano Petri to help resolve the disparity between what MODCODs LNIS wants vs what NASA wants. For example, BPSK is inefficient to use at K-band, but LNIS is specifying it.

1. Prox-1 - Common sharing of hailing – Stefano Petri (ESA)

Stefano presented briefly on the current protocol stack envisioned for LNIS version 5. The data link protocol layer is supported by either CCSDS AOS or USLP. However the physical layer is supported by a LNIS waveform. The coding sublayer is supported by CCSDS TM Sync & CC. On the other hand, the ESA and NASA missions are using the Prox-1 RFM and CS recommendations along with USLP. It is important to note that the LNIS choice of protocol stack makes these missions automatically not LNIS-compliant and fragments our Lunar relays offer​

In order to achieve the convergence of LNIS and Prox-1, LNIS would use USLP supportby Prox-1 C&S underneath. ICSIS also would be covered by this protocol stack on the AOS/TM C&S option (Gateway-like session establishment procedures would still diverge).

The 2nd part of Stefano’s presentation covered 235.1 use for Lunanet - protocol stack and AOS compatibility. This material was reviewed in the SLP WG meeting earlier on Tuesday. There, Stefano presented his vision of multiplexing AOS U-Frames along with USLP P-Frames on the Proximity-1 space data link using the Generic Session Control. The result was that in order to keep the data link synchronous to meet the fixed AOS transfer frame format requirement, the USLP P-frames are also required to maintain the same fixed length as the AOS U-frames. Since the P-frames only carry a relatively small amount of data to transmit one or more P-Frames, padding must fill out the remainder of the USLP P-frame. This required some extra thinking on our part to come up with a method to pad the remainer of this P-frame. The idea was to define a new variable length directive that would include the length of the directive along with the padding inside of it. The problem however was that it would be impossible to keep the existing SPDU format (maximum size of 15 x 16 octets for the data field) but pad a USLP P-frame whose maximum size could be up to 65,536 octets. We knew apriori that it would be difficult to retrofit the AOS protocol to handle this case. Therefore it was decided at this meeting by the SLP WG to generate the following constraints on the use of AOS transfer frames over the Proximity-1 data link in lieu of the padding directive:

a) SPDUs (P-frames) shall only be transmited over Version-3 or Version-4 frames.

b) AOS (Version-2) transfer frames can only be transmitted as U-frames.

c) Transfer frames in general with different transfer frame version numbers cannot be multiplexed across the Proximity-1 data link, once the link has been established.

It was noted that LNIS may not appreciate this solution offered by CCSDS for AOS data frames over the proximity-1 link.

1. MODCODs for CCSDS 235.1 Generic Session Control Book

We as a collective group modified some of the modulation and coding fields in 235.1 book to include additional modulation and coding types to align the specification better with LNIS. The minimum symbol rate was lowered to 500 sps (from 1000 sps). The maximum S-band symbol rate continues to be 4, 096,000 sps.

1. CCSDS 235.1

Consensus was achieved at this meeting to move ahead and publish the 235.1 as a RED-1 book so that it can appear for the 1st agency review before the Fall Meeting.

END