SLS C&S/RFM/SLP Working Groups
July 2024, intermediate joint meeting

The WGs convened remotely on 23rd July 2024 for doing an intermediate meeting in preparation of CCSDS Fall 2024 technical meetings.
Main objective of the meeting was to re-iterate on the status of the AIs, especially those concerning S-Band proximity-1 extension.

The following three presentations were given as input:

Author	Title	Identifier
NASA	Phase noise analysis on S-Band proximity-1 Hailing Channel – Follow on	SLS-CS_24-10
ESA	S-Band proxy-1 – encoding of carrier frequency	SLS-CS_24-11
NASA	Results of NRZ study	SLS-CS_24-12

Presentation SLS-CS_24-10, done by W. Lee/NASA, was in response to **AI_24_04**. The presentation gave an update of the Phase noise analysis presented in Spring 2024 (see SLS-CS_24-09) taking into account the information provided by ESA concerning the LPF oscillator phase noise mask (assuming that is valid for both transmitter and receiver). It was indicated that with such mask, design guidelines on phase error and variance can be met. However, even if the hailing channel is increased to 2 ksps, the Doppler dynamics up 75 Hz/sec will require proper engineering of the synchronization chain.

Following the presentation:
- The WG agreed to **revise the hailing symbol rate to 2 ksps** (instead of 1 ksps as previously agreed, see Huntsville 2023 MoM, Section 3.1), **but to still keep the 1 ksps as available symbol rate**. This was decided taking in light that vendors are implementing 2 ksps as hailing (See C&S email May 21st 2024) and that 1 ksps shall be maintained for harmonization with the UHF rates;
- ESA took the action (**AI_24_14**) to confirms if hypotheses on phase noise mask and Doppler dynamics are valid. Namely, ESA needs to confirm that phase noise mask is based on measurements done at transmitter RF output, and, if the 75 Hz/sec corresponds to a worst-case scenario of a lander;
- Pending positive confirmation from ESA for the above points, the WG agreed to include the phase noise mask provided by ESA, increased by +3 dB, as an E2E requirement in the Proximity-1 RFM blue book for S-Band links, and to add an informative Note about the required engineering of the synchronization chain (see Slide 7 of the presentation) when operating at low symbol rates;
- W. Lee/NASA took action (**AI_24_15**) to repeat the phase noise analysis for UHF with the mask and Doppler values provided in the current issue of the Blue Book (Figure 3-2 and Section 3.4.5, of 211.1-B-4), to see if the same informative Note should be added for UHF as well.

Presentation SLS-CS_24-11, given by A. Modenini/ESA, was in response to **AI_24_09**, for assessing the number of bits required for encoding the carrier frequency in the S-Band

Proximity-1 directive. Several options with different lengths, fixed and floating point, were analyzed. Finally, the WG decided to go for the float32 since providing the highest flexibility (in precision and ranges), while not being a problem in terms of required bits.
As consequence, the SLP WG will update the Proximity-1 Type 4 directive accordingly.

Presentation SLS-CS_24-12, done by W. Fong/NASA, was in response to **AI_24-01 of SLS RFM WG** (see RFM MoM Spring 2024), but still presented in this meeting for anticipating Fall 2024 activities.
The presentation gave an analysis of the spectral properties of the PCM/PM/NRZ when filtered for meeting the SFCG, ECSS, and NTIA spectral masks, and to limit spectral spikes to -20 dBc. As result it was found that a 2nd order Butterworth with BTs=1.3, with maximum MI=1.26 rad/pk (effective 1.20 rad/pk) gave the best performance and least BER degradation.
The second part of the presentation focused instead on the spectral properties of the PCM/PM/NRZ when in presence of PN ranging. It was found that possible asymmetric PSDs occur if spikes of ranging signal coincide with those of the PCM/PM/NRZ (i.e., chip rate and symbol rate are one multiple of the other). But this can be easily avoided by careful selecting ranging frequencies and rates as normally done for other signals.

For the last part of the meeting, it was raised the question on how to handle the ranging parameters in the Proximity-1 directive, i.e., if should be fixed parameters, or negotiated parameters (e.g. PN or Standard ranging, T2B vs T4b, Mod Index, etc.). It was agreed to have some reserved bytes that could fulfill the purpose once the WG project on ranging will be approved and started.

Finally, a check status was done for the AIs in Annex, where the actioner simply provided a brief status update (see Status in the Annex).

ANNEX: STATUS OF ACTION ITEMS REVIEWED AT THIS MEETING

This annex provides <u>only</u> the AIs that were reviewed at this meeting.
Full list of AIs can be found on CWE (private folder, requires login): https://tinyurl.com/jyrjpz6a

Actions closed during this meeting are cancelled out (with traceability about their closure).
The new AIs are those starting from AI_24_14.

Identifier	AI	Actionee	Status
AI_24_04	~~ESA to check with LPF if possible to provide block diagram information of heterodyning of RF chain and oscillators specs for transmitter and receiver.~~ ~~Given this information, NASA to reiterate analysis for total phase.~~	~~W. Lee~~ ~~N. Maturo~~	Closed SLS-CS_24-10
AI_24_05	To check the need of having an EVM requirement in the Proximity-1 211.1-B, or if this can be considered a specification at unit level	C&S/RFM WGs	On going – to be discussed in London
AI_24_06	~~To draft CWE project for an update of 414.0-B (PN ranging), with the objective of adding space-to-space and one-way ranging~~	~~D. Lee~~	Closed The draft is available the CWE of the RFM WG. 2 protypes are required. NASA will provide one of them, ESA will need to confirm if they can support the second prototype (**AI_24_16**). WG to provide comments (if any) on the draft to D. Lee. If any other agency wants to volunteer for the project, please inform D. Lee. Plan is to have new project to be approved by the WG in London and then must be sent for further approval to the AD.
AI_24_07	~~To check rationale in LNIS for having modulation index range 0.2-1.4, since 0.2 and 1.4 appears not practicable cases~~	~~S. Rodriguez~~	Closed LNIS comment: A mission may need low Mod Index (0.2 to be used in the data channel to use non-regenerative ranging), but LNIS is open to change the lower limit to 0.4 instead of 0.2. Agreed to move to 0.4

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AI_24_08	To provide an updated list of modulation index (in deg) to be supported, taking into account that LPF uses pi/3, and (possibly) input by LNIS (see AI_24_06)	N. Maturo	Update to be provided in London based on the new range 0.4-1.4 (8 values – 3 bits in the directive). To be discussed in London
AI_24_09	~~To provide a proposal for fixed or floating point definition of the channel frequency in S-Band proximity-1~~	~~N. Maturo~~ ~~A. Modenini~~	Closed SLS-CS_24-11
AI_24_10	~~WG to check with vendors if hailing channel is 1 ksps (coded symbol rate) as agreed in Huntsville 2023~~	~~C&S/RFM/SLP WGs~~	Closed. See C&S email May 21st 2024. The hailing 2 ksps (2000 sps) is confirmed, while the lowest supported symbol rate is 1000 sps
AI_24_11	To assess possible incompatibilities of the current S-Band directives for a possible extension to Ka-Band	M. Cosby	On going. To be discussed in London.
AI_24_14	To verify that: • S-Band phase noise mask provided was measured at RF output of LPF, • Doppler dynamics of 75 Hz/sec is the worst-case scenario of a lander.	N. Maturo A. Modenini	New Action
AI_24_15	To repeat analysis for UHF taking into account mask an Doppler as provided in 211.1-B, with the objective to see if same challenges in the synchronization are also for UHF links at low rates	W. Lee	New Action
AI_24_16	ESA (and other member agencies) interested in contributing to the project of space-to-space and one-way ranging (with activities or a prototype) to inform RFM Chair	ESA and other member agencies	New Action

ANNEX: LIST OF PARTICIPANTS

Name	Affiliation
Andrea Modenini	ESA
Dennis Lee	NASA
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