**Concept Paper for extending Proximity-1 Blue Books (211.0-B, 211.1-B, 211.2-B) – with inclusion of new frequencies, modulation and coding options**

# Purpose

The purpose of the proposed work is to update the existing Blue Books

* CCSDS 211.0-B, Proximity-1 Space Link Protocol - Data Link Layer;
* CCSDS 211.1-B, Proximity-1 Space Link Protocol - Physical Layer;
* CCSDS 211.2-B, Proximity-1 Space Link Protocol - Coding and Synchronization Sublayer;

in order to add new channels in S-Band, modulation, and coding formats, i.e., increasing the range of functions that Proximity-1 can provide taking into account future Lunar and Martian missions.

Additionally, the possibility of add new channels in K-Band will be investigated either as part of the existing blue books or as separated blue books.

# Key Technical Features

The Blue Books, with respect the current issues, will include:

* S-Band 2025-2110 MHz and 2200-2290 MHz for covering forward (orbit-to-surface) and return (surface-to-orbit) Lunar allocations, possibly extended as 2025-2120 MHz and 2200-2300 MHz for covering also Martian (orbit-to-surface, surface-to-orbit, orbit-to-orbit) allocations;
* Possibly other frequency ranges in K-Band (22/27 GHz) for covering other allocations in the Lunar and Martian regions;
* Bit rates higher than 2048 kbps;
* Spectrally-efficient waveforms to conserve bandwidth,
* High rate coding (greater than 0.5), to further conserve bandwidth;
* Use Version 4 transfer frame format for added flexibility;
* Space Link Protocol adaptations for the new features (e.g., the SET PL EXTENSION).

# Benefits

The proposed extension of the Proximity-1 link will allow bi-directional links in other frequency allocations (in particular those for Lunar and Martian missions), while having higher bit rates and spectral efficiency.

# Requirements of prospective missions

To protect radio astronomy sites from radio interference, limitations are imposed on UHF transmissions at the far side of the Moon. However, missions are allowed to use S-band frequencies, which provide more bandwidth than UHF, everywhere on the Moon. Therefore, it is foreseen that many missions will use the S-band [2025-2110 MHz forward, 2200-2290 MHz return] at the Moon instead of UHF for their proximity communications. Since the same spectrum must be shared among surface-to-relay, surface-to-Earth and orbit-to-Earth users, the 90-MHz S-band allocated bandwidth is anticipated to become oversubscribed quickly, making it difficult for missions to use the spectrum without frequent coordination with each other.

Moreover, since there is no standard defined for K-band proximity (forward: 23.15-23.55, return: 27.0- 27.5 GHz) yet, this is an opportune moment to further extend Proximity-1 to include K-band frequencies by taking advantage of the recommendations made in this concept paper. We note that the need for a K-band proximity standard, is pressing because many of the future missions to the Moon and to Mars are expected to require wideband communications.

**ANNEX 1 – Proposed Charter Modifications**

The charters of RFM, C&S, and SLP WGs do not require any update.

Namely, RFM working group charter reports “Propose changes to Proximity Physical BB (211x1b4) relating to channel frequencies, modulations, and requirements from future Martian/Lunar scenarios”.

The C&S charter instead reports “In order to establish a common framework within which the Agencies may develop standardized services for Telemetry, Telecommand and Proximity-1 links, the CCSDS advocates adoption of a layered systems architecture. Within this approach, the Coding and Synchronization Layer has the purpose of protecting higher layer data units (i.e. "frames") against errors induced during transmission through the physical path to/from a spacecraft.”

The SLP charter reports “This WG develops and adapts wherever possible link layer protocols for new mission environments (proximity communication, formation flying, optical communication, missions utilizing high rate telemetry and telecommand).”

**ANNEX 2 – Proposed CWE Project**

**Title: Proximity-1 Extension for Lunar/Martian missions**

**Document Number:** 211.0-B, 211.1-B, 211.2-B (To be confirmed along the activity)

**Document Type:** Pink Sheets

**Description of Document:** Three Blues Books **(**211.0-B, 211.1-B and 211.2-B) are going to be updated in order to accommodate the extended S-Band Proximity-1 link.

The extension of Proximity-1 in K-Band could be either included in the existing blue books, or as separated blue books.

**Applicable Patents:** -

**Patents Comments:** No patents are known to apply to this Recommended Standard. Information concerning patent rights and licensing for LDPC coding is contained in annex B of 131.0-B.

**Book Editor (estimated resources + Agency Volunteering):** Total resources 3 mm in ESA and 3 mm in NASA. Book editor ESA and NASA

**Prototype 1 (estimated resources + Agency Volunteering):** 6mm+ESA

**Prototype 2 (estimated resources + Agency Volunteering):** 6mm+NASA

**Expected Contributing Agencies:** ESA, NASA

**Expected Monitoring Agencies:** CNES, DLR, UKSA

**Schedule**

**December 2022 – December 2024**

**Total time to complete: 24 months**

|  |  |  |
| --- | --- | --- |
| **Schedule Milestones** | **Forecast** | **Comments** |
| Project Approved | 15 December 2022 |  |
| First draft circulated to WG | April 2023 | Before Spring 23 Meeting |
| First draft comments due | May 2023 | At Spring 23 Meeting |
| Second draft circulated to WG | September 2023 | After Spring 23 Meeting |
| Second draft comments due | October 2023 |  |
| Final WB Submitted to AD for further processing | November 2023 | After Fall 23 Meeting |
| Secretariat Document Processing | March 2024 |  |
| First Prototype Development  | May 2024 |  |
| Second Prototype Development | November 2024 |  |
| First Agency review | April 2024 | Before Spring 24 Meeting |
| RID Resolution | May 2024 | After Spring 24 Meeting |
| Second Agency Review | Not expected |  |
| CMC Approval | December 2024 | Approved by CMC Poll  |