**Concept Paper for defining a Lunar ISN Magenta Book**

# Purpose

The purpose of the proposed work is to create a new Magenta Book entitled “Reference protocol stack architecture for Luna Inter-satellite network”, with the main objective of defining a reference protocol stack for future Lunar missions, by using existing CCSDS standards.

# Key Technical Features

The new Magenta Book will include reference protocol architecture(s) covering the following layers:

* Physical layer,
* Coding & Synchronization layer,
* Data link layer,
* Network layers,

encompassing space user nodes, routing nodes, Earth-space link terminals, and Earth user nodes.

# Benefits

The document will be a specific instance of the content of the SCCS ARD (CCSDS 901.1-M), focused on the Lunar inter-satellite network for communications. The target is to have a short and compact document, suitable for ease and quick consultation from agencies and commercial partners that are planning future Lunar missions.

# Requirements of prospective missions

With the growing interest in the lunar exploration by a number of governmental and private organizations it is expected to have in the near future a large number of lunar missions, as scientific satellites, human outposts, lunar relays, etc.

Because of this, there will be a proliferation of inter-satellite networks that, if not well coordinated, will lead to a quite heterogeneous lunar system architecture.

In this respect, the definition of a Magenta Book will aid entities in having a reference protocol stack architecture for Lunar inter-satellite networks, that could be an enabler for the cross support.

**ANNEX 1 – Proposed Charter Modifications**

In terms of working group, it is expected the support of the followings:

* SLS-RFM,
* SLS-C&S,
* SLS-SLP,
* SIS-DTN,
* SEA-SA

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

Namely, RFM working group charter reports

*Agencies are planning demanding missions to the Moon with links at 2 GHz for low data rates and 22 (the band near 22 GHz)/26 GHz for very high data rates, as well as missions to Mars with 32 GHz trunk links. The 22 (the band near 22 GHz), 26 and 32 GHz frequency bands are not covered by the existing RF and Modulation Blue Book (401.0-B-16). New techniques may be needed for the 2 GHz links to the Moon.*

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).*

The DTN charter reports

*The Delay Tolerant Networking Working Group is specifying the protocols needed to implement the Solar System Internetwork (SSI) concept. These protocols support the portion of the SIS communication domain where large delays, intermittent connectivity, and/or unidirectional communications links may be present.*

The SA charter reports

*The work done in the other Working Groups is focused upon services and protocols provided by specific components of space data systems. In order for these Working Groups to generate standards in such a way that every standard is consistent and coherent with any other standard generated by CCSDS, CCSDS requires a reference architecture that can be used as a common framework by all the Working Groups of CCSDS and also by engineers in the member Agencies who use CCSDS standards to build systems and to provide services. The reference architecture should encompass both informatics and telematics aspects of space data systems and cover all problem areas associated with space data systems (such as organizational, functional, operational and cross support issues).*

**ANNEX 2 – Proposed CWE Projects**

**Title: Reference protocol stack architecture for Luna Inter-satellite links**

**Document Number:** To be assigned by editor

**Document Type:** Magenta Book

**Description of Document:** single Magenta Book providing reference protocol architecture(s) for Lunar inter-satellite networks

**Applicable Patents:** -

**Patents Comments:** -

**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):** N/A

**Prototype 2 (estimated resources + Agency Volunteering):** N/A

**Expected Contributing Agencies:** ESA, NASA

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

**Schedule**

**December 2022 – December 2024**

**Total time to complete: 24 months**

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| **Schedule Milestones** | **Forecast** | **Comments** |
| Project Approved | 15 December 2022 |  |
| Internal WG Review |
| 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  | N/A |  |
| Second Prototype Development | N/A |  |
| 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  |