ESA Moonlight Initiative

Moderator: Mike Snell
IPNSIG

Presenter: David Gomez Otero
European Space Agency
Europe’s new era of exploration

Regular and substantial robotic access during the 2030s enabling European-led scientific and logistic activities

Reliable and visible partner for sustainable exploration of the Moon

Ambition of the first European on the surface before 2030
The lunar Economy

Key Markets Driving the Return to the Moon are Science & Technology Development, Asset Transportation, and Pre-human Robotic Exploration - Totalling 62% Of the Entire Market Missions

The Fundamental Building Blocks for the Moon Market Started with the Objective of Building a Sustainable Presence of Humans, However as we Dive Into the Early Years of the Missions - it is Clear that the Need for Science and Technology Development, Transportation of Payloads, and Transmitting Data and Communication Back to Earth is Becoming a Clear Winner in the Picture.

Mission Launches Per Year

2021
2031

Science & Tech
Transportation
Robotics
Manned

The 251+ Missions Expected Over the Next 10 Years Will Activate the $100 Billion Moon Economy

NSR Report April 2022

NSR
NORTHERN SKY RESEARCH
An Analyst Mission Company

Northern Sky Research, One Minuteman Place, Suite 400, Cambridge, MA, 02138, 1-877-624-7743

+ THE EUROPEAN SPACE AGENCY
To enable the delivery of **Communications** and **Navigation Services** that will support the current and next generations of institutional and commercial Lunar explorers.
LunaNet Interoperability Specification Document
Version 4
LUNAR PATHFINDER
Low-rate satellite communications service + Moon GNSS Receiver

Development

Pathfinder Service

Q1 2025

MOONLIGHT CONSTELLATION
High-data rate satellite Lunar Communications and Navigation Service (LCNS)

Design
Development
Initial Services

2020 2021 2022 2023 2024 2025 2026 2027 2028
LCNS Implementation Steps

- Kick off of phase A/B1 on April 2021
- Industrial teams include satellite operators (potential service providers) and large system (space & ground) integrators
- December 2022: Open Invitation to Tender (ITT) for the full implementation (subject to CM22 approval)
LCNS next Steps

- Preparations for the full implementation subject to approval in Ministerial Council Nov 2022
- Request for Information (RFI) for Phase B2/C/D/E released in October 2022 (already closed) including draft Service CONOPS and Requirements (For Information):

- Invitation to tender planned for December 2022 (pending programme approval)
- Planned study for Lunar downstream applications (Intended December 2022)

https://business.esa.int/funding/intended-tender/lunar-economy-applications
LCNS Service offer

**COMMS**
- Data Relay
  - Real Time / non-Real Time
  - High/Low Data Rates
  - High/Low Priority
  - Critical/Nominal
- Messaging
  - Messages

**NAVIGATION**
- Real Time
  - One Way Ranging
  - Position and Velocity
  - Time Dissemination
  - Two Way Ranging
- Non Real Time
  - Post Processing PVT

**OTHERS**
- Search and Rescue
- Alert and Newsfeed
- Third Party Payloads
- Over the Top Services
LCNS Top Level Architecture
LCNS Service Requirements

- Commercial & Institutional Missions
- Open Interface
- Interoperability
- Beyond 2026/27
- Scalability
- Regulations

Support all Mission Phases

200Km Service Volume [upto 70,000Km best effort]

South Pole Coverage [Global coverage best effort]
LCNS Initial Mission Assumptions

- **High DataRate (KBand)**
  - Upto 200Mbps/user

- **Low DataRate (Sband)**
  - Upto 1Mbps/user

- **Security functions**
  - Slotted Real time services

- **Position accuracy**
  - Orbiters: 100m
  - Landing: 50m
  - Surface: 10m

- **Compatible with Earth GNSS**

- **Precise timing (sub µs)**

- **Velocity accuracy**
  - Landing: 1 m/s
  - Surface: 1 m/s
Towards Solar System Internetworking

- CCSDS Report in SSI Architecture
- IOAG Lunar Communications Architecture
- LunaNet Interoperability Framework

BUT: where and how to start?
A network in steps

- Similarly to Terrestrial networks, the Lunar Internet will grow gradually
- However we should leverage know-how of decades of Mobile networks and SATCOM systems
- Need to change paradigm:

**Today**
- COMMs is part of the mission
- Bespoke Equipments
- Each Mission has its own E2E infrastructure

**Future**
- COMMs as a 3rd party service (commodity)
- Pay as you Go / Monthly fees
- Universal User terminal

Image Credit: 3GPP
Network approach in Moonlight

**IOC (Initial Operational Capabilities)**
- Basic Relay Connectivity
- Pre-Scheduled contacts
- Point2Point
- Basic routing
- Limited flexibility
- DTN Compatible
- “Network trials”

**FOC (Full Operational Capabilities)**
- Network approach
- Routing Capabilities
- Higher Flexibility
- End-to-end native DTN/BP7v
- User Initiated Services
- Messaging Services

**Next Gen**
- On Demand services
- Dynamic Resource Allocation
- Automatised management
- Roaming support
Challenges ahead

- User hailing
- Signalling and control planes “always on”
- User paging, tracking and monitoring
- Dynamic resource management
- Roaming across service/network providers
- Network governance
- Mobility Management

Who are we? Lunar Missions!
What do we want? COMMS!
When do we need them? Any time, Anywhere!
moonlight@esa.int

Moonlight Website

Draft Service Reqs. (RFI)
Academy materials at:
https://ipnsig.org/ipnsig-academy-events/

Any questions to:
secretariat@ipnsig.org
IPNSIG Academy – Program for 2022-2023

Links to recordings - https://ipnsig.org/ipnsig-academy-events/

1. Yosuke Kaneko 100+ Years Vision [May 18]
2. Vinton G. Cerf DTN Overview [June 1]
3. Oscar Garcia DTN Projects Work [July 13]
4. Scott Burleigh SSI Architecture Study [Aug 3]
5. Lara Suzuki DTN Live Demonstration [Sep 7]
7. David Gomez Otero ESA Moonlight Overview [Nov 2]
8. Ed Birrane IETF Standardization Efforts [Dec 7]
10. Laura DeNardis Interplanetary Internet Governance [Feb 1]
11. Scott Pace Space Policy, Perspective on IPN Governance [Mar 1]
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Thank you.
You will be redirected to a short survey.

https://www.surveymonkey.com/r/8HDP8PT