



Moonlight ITT - Moonlight Partnership Project LUNAR COMMUNICATION AND NAVIGATION SYSTEM (LCNS)

Telespazio SpA, Rome, Italy

December 2024

Agenda

A futuristic lunar base on the moon. In the foreground, an astronaut in a white spacesuit stands on the grey, cratered lunar surface. In the background, a large, multi-story lunar base structure is visible. Another astronaut is seen further back near the base. To the right, a lunar rover is partially visible. The Earth is seen in the sky as a large blue and white sphere.

□ LCNS Vision

□ System Architecture & Services

□ LCNS Opportunity & Mission

□ Lunar Scenario & Market

□ Private Public Partnership with ESA

LCNS – Vision

Enable the foundation for a **stable and sustainable future in lunar exploration**, fostering international cooperation and creating **new commercial opportunities** within the Lunar economy

Provide **reliable lunar communication and navigation services**, at the state of art, compliant with **LunaNET specifications** enhancing interoperability and standardization

Lead the **delivery and commercialization of Communication and Navigation services** to support the next generation of institutional and commercial Lunar pioneers

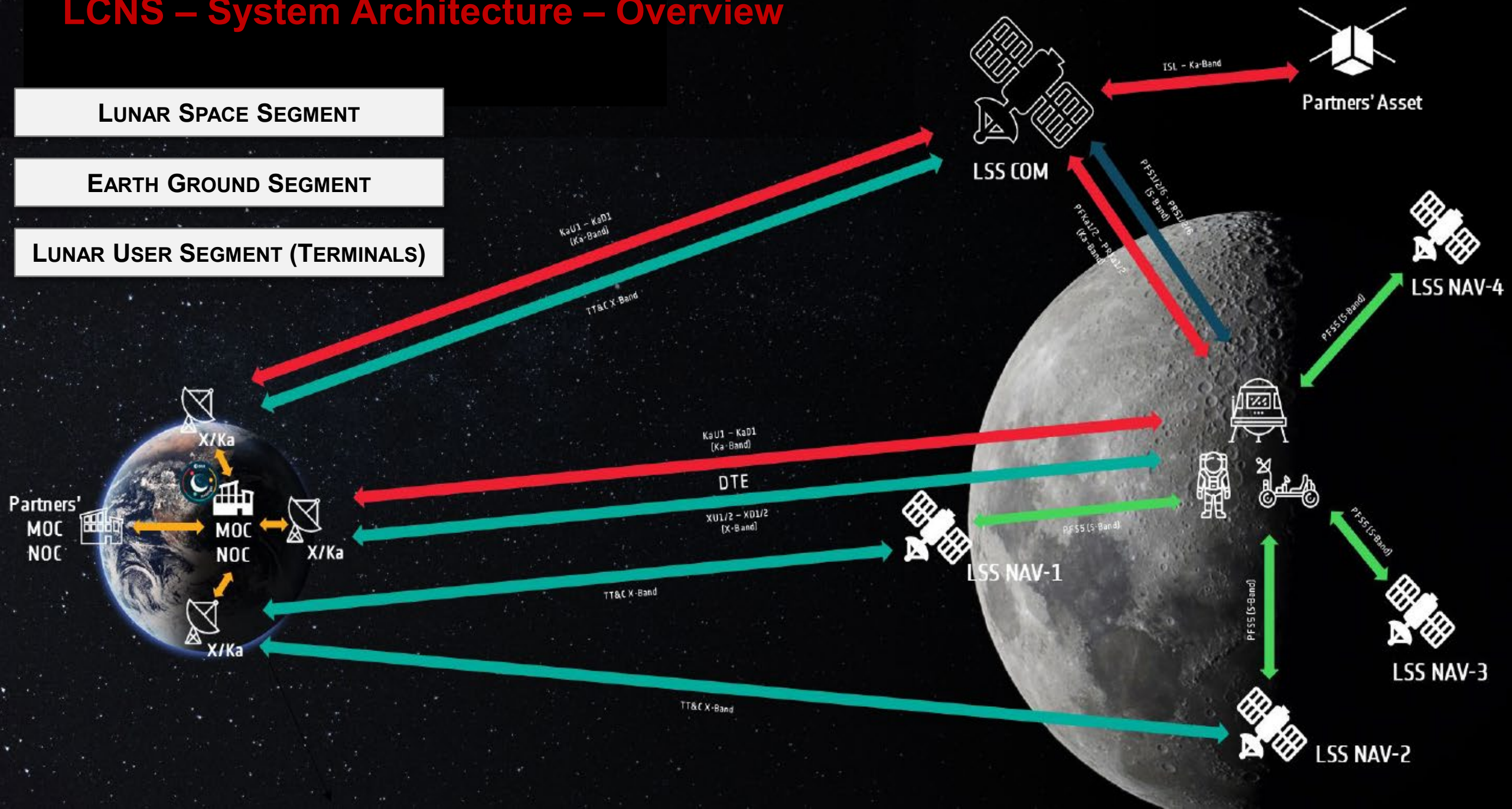


LCNS – System Architecture – Overview

LUNAR SPACE SEGMENT

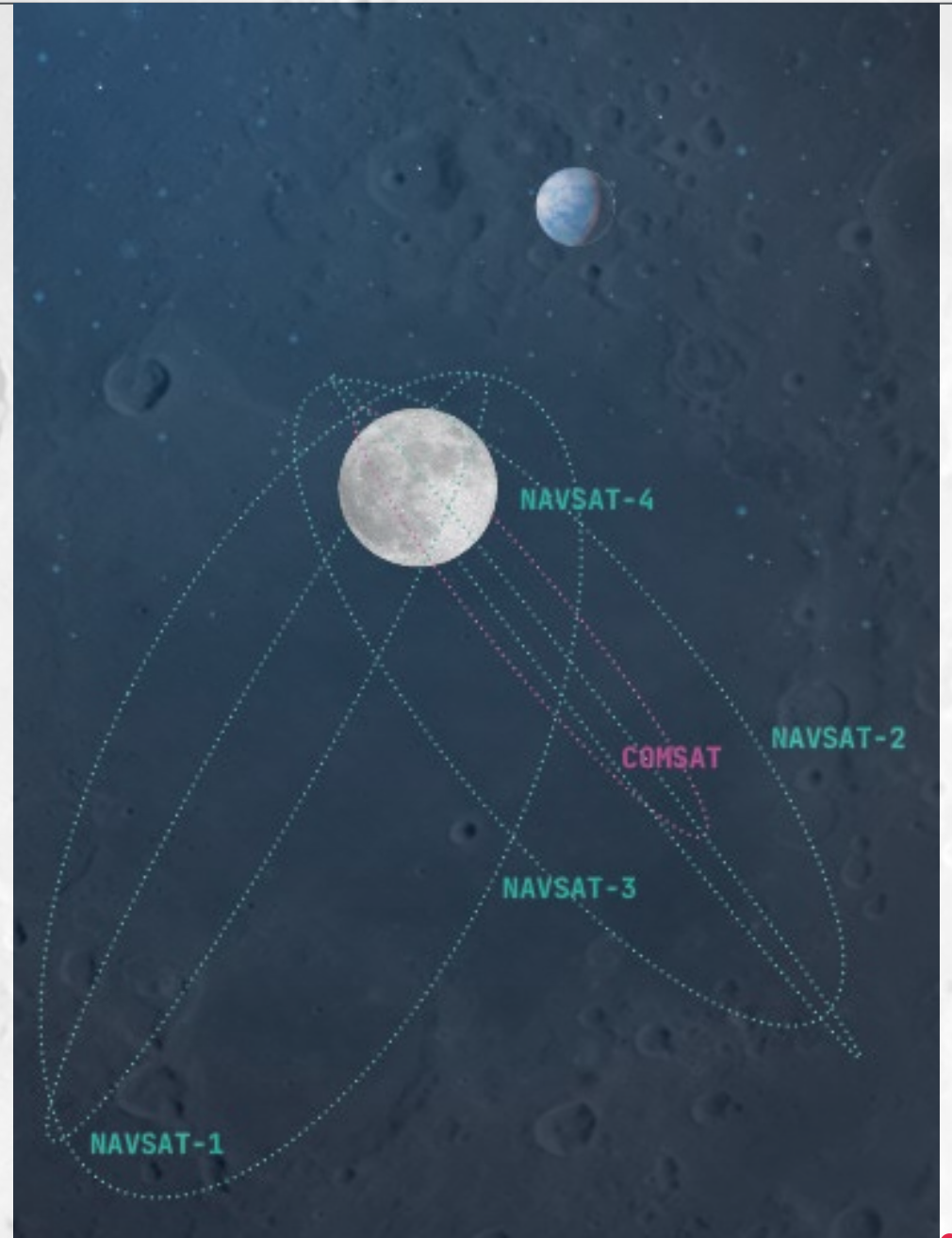
EARTH GROUND SEGMENT

LUNAR USER SEGMENT (TERMINALS)

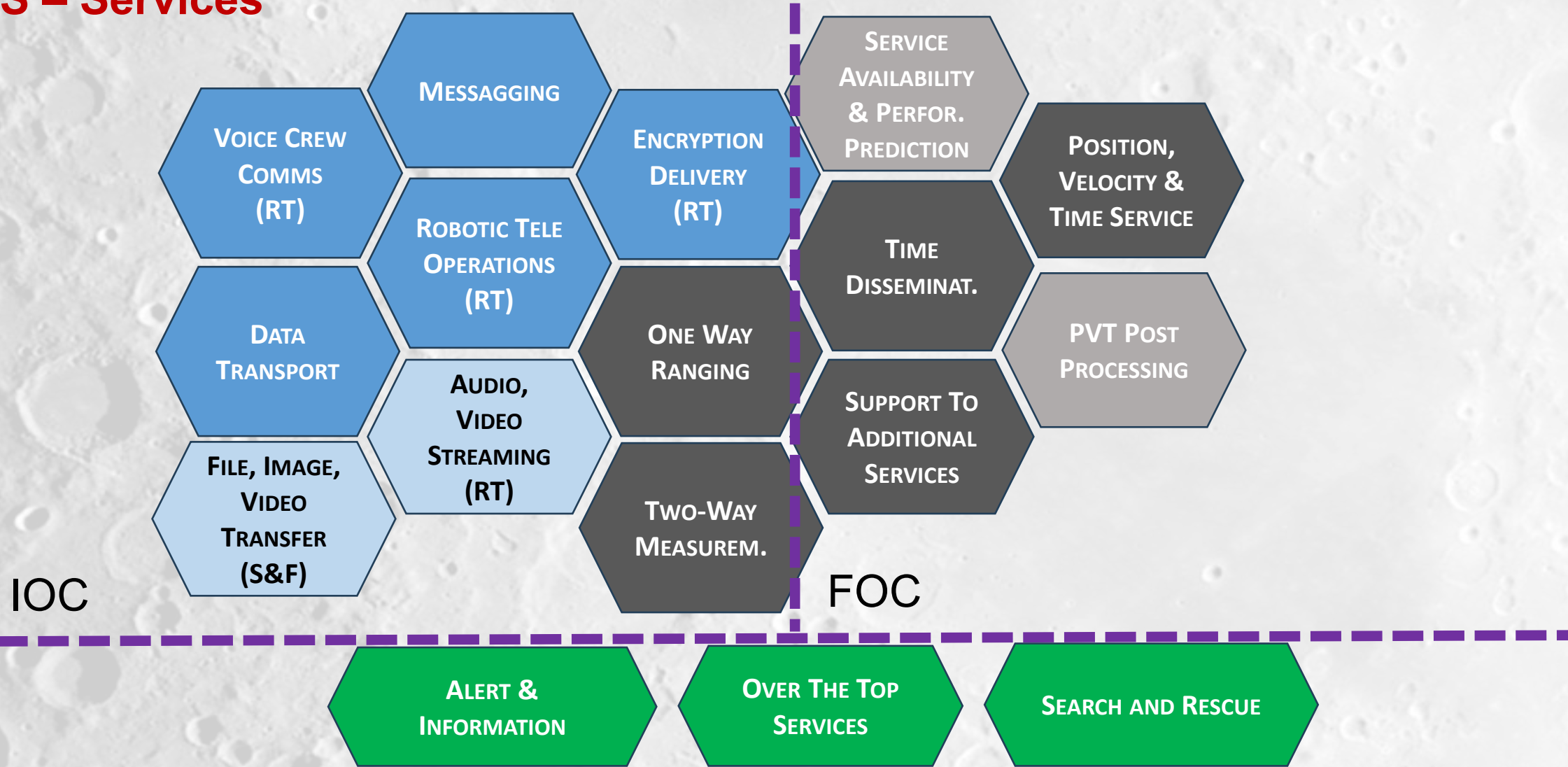


LCNS System – Orbital Configuration

- **Elliptical Lunar Frozen Orbits (ELFOs)** to obtain a constant eccentricity, inclination and argument of pericenter.
- **The NAV satellites** have an orbital period of 24hr and a semi-major axis of about 10000 km.
- **The COM satellite** has an orbital period of 12hr and a semi-major axis of about 6000 km.



LCNS – Services



■ Bi-Directional Com Services
■ Uni-Directional Com Services

■ Real Time Nav Services
■ Non Real Time Nav Services

■ Blended applications



LCNS System – Service capabilities

COMMUNICATION SERVICE CAPABILITIES

The LCNS Services is provided with high availability (>95%) and temporal coverage ~ 16 hours/day (non continuous), with continuous slots of at least 8 hr/day. The following service characteristic are planned to be supported:

- **Data Relay Duplex Service:** Simplex or Full
- **K-band service profile:** Single-Access service with a data-rate up to 60/20 Mbps (Moon-Earth / Earth-Moon)
- **S-band service profile:** Single-Access service with a data-rate up to 1000/100 kbps (Moon-Earth / Earth-Moon)
- **Data Volume:** Non-Real-Time service data volume of 400 GBytes per Earth Day.
- **Delivery Time for Non-Real-Time Data:** Non Real-Time data delivery within 16 hours
- **Availability:** Data Relay Service with an availability of 94% over 30 days
- **QoS for prioritization:** System support Nominal and Critical QoS
- **Latency:** Real time data transferred in less than 5 seconds
- **Maximum number of concurrent sessions:** up to 4 Full-duplex K-band link and 4 Full-Duplex S-band link

A Direct to Earth (DTE) service complement the LCNS data relay services for improving temporal and geometrical coverage.

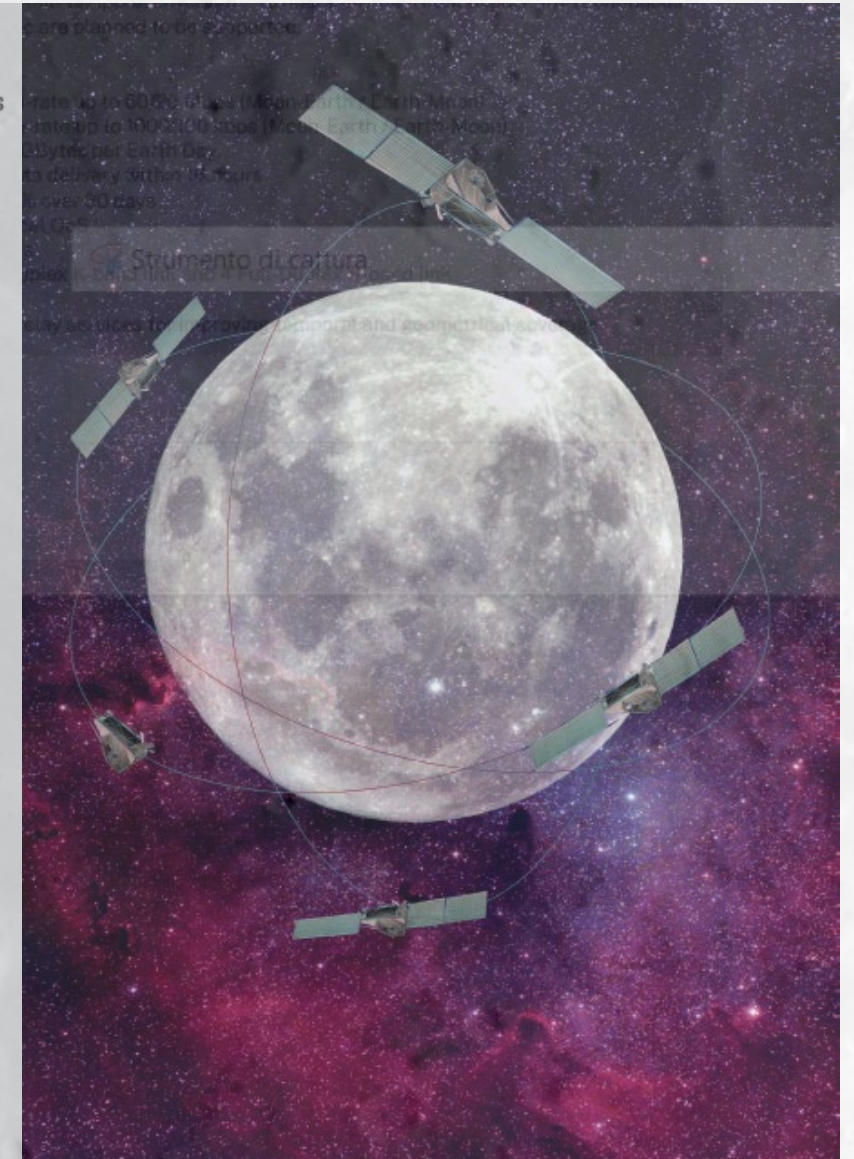
NAVIGATION SERVICE CAPABILITIES

Two categories of navigation services with a minimum availability of 95% over 30 days are provided:

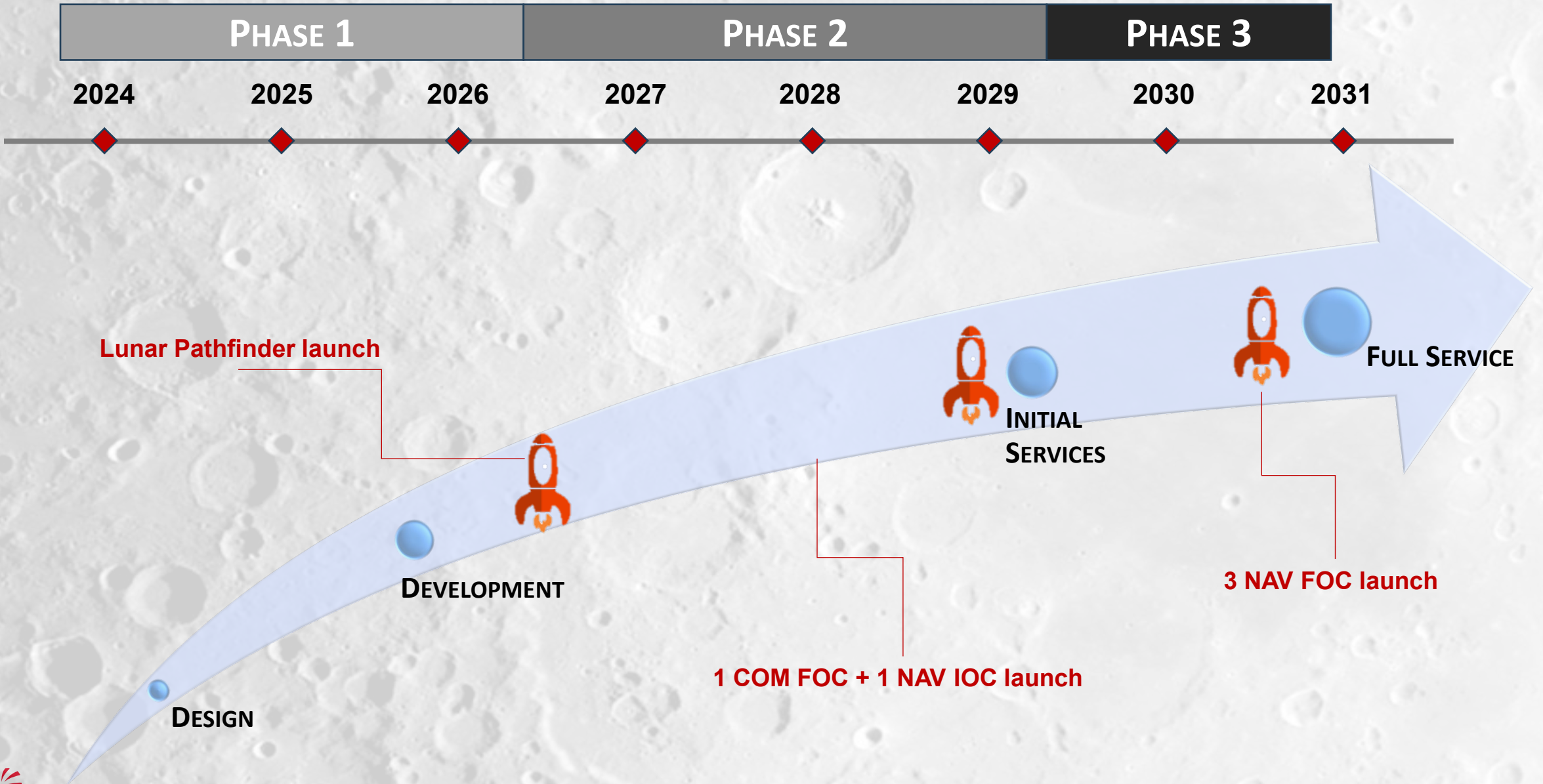
- Real time services:
 - One-Way Ranging (OWR)
 - Position, Velocity and Time (PVT)
 - Time Dissemination Service (TS)
 - Two-Way Measurement (TWM)
 - Navigation Service Availability and Performance Prediction
- Non-real-time services granting highly accurate PVT post processing

The PVT performances, with a 95% confidence on lunar South pole as follows:

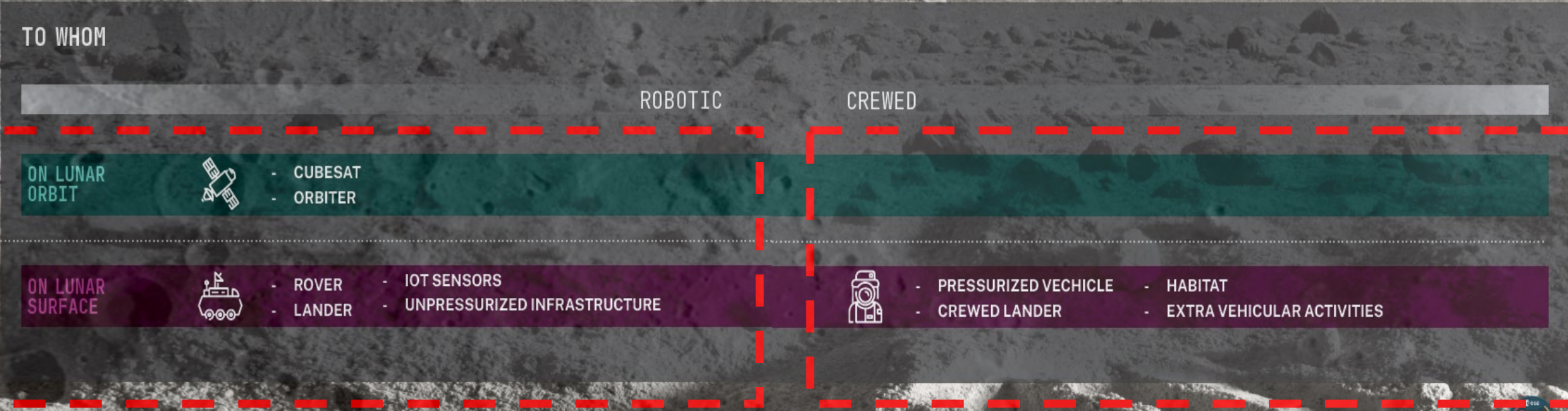
- Horizontal position accuracy < 10 m (static user) to < 50 m (ascending/descending users)
- Vertical position accuracy < 100 m
- Horizontal velocity accuracy ~ 1 m/s (all users)
- Timing accuracy: < 0.4 μ s (static user) to < 15 ms (ascending/descending users)



LCNS – Program Scheduling



LCNS – Main Users



LCNS – Lunar Exploration Opportunity

1

Lunar investment focus on specific assets: orbiters, rovers, transportation...

2

Assets producers have to fulfil their own Lunar Mission Com & Nav needs

3

High asset mass / power (→ high costs) required to realize Lunar Missions

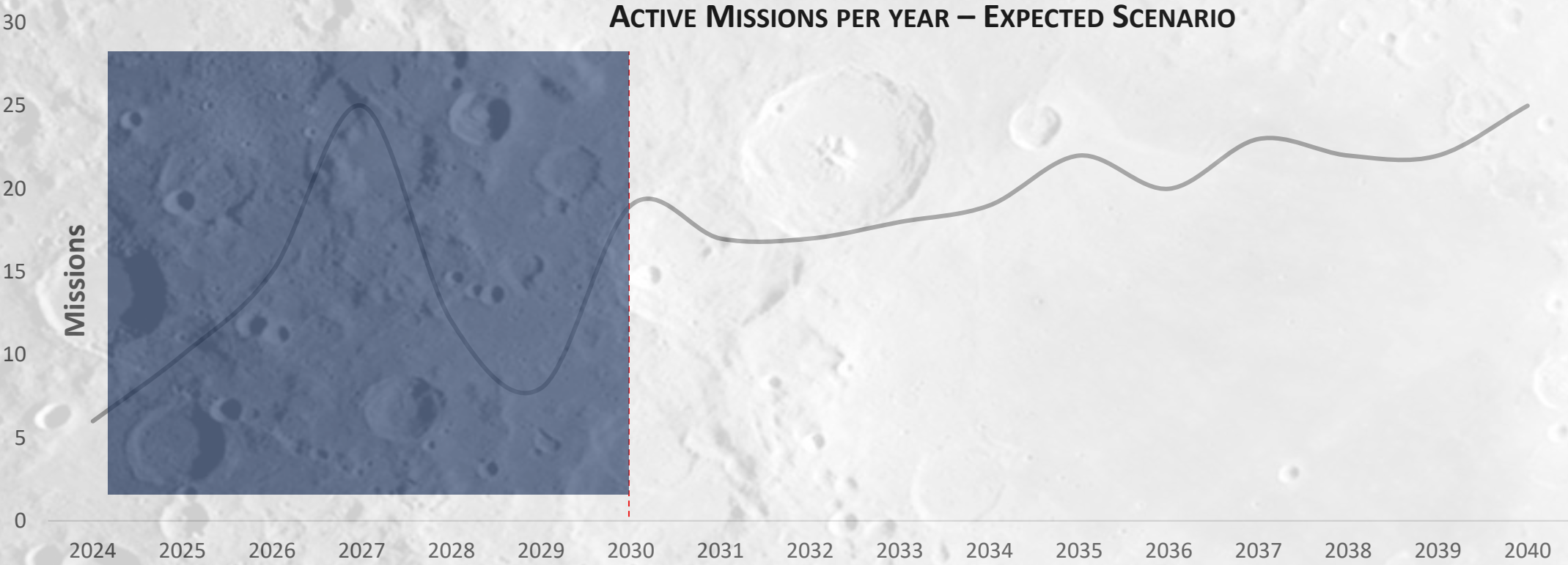
**NOR EFFICIENT
NEITHER EFFECTIVE
LUNAR MISSION
MANAGEMENT ON
USERS SIDE**



Opportunity to aggregate multiple-users demand (institutional and commercial) by providing superior Com and Nav services, in particular for critical mission phases around the Moon and on Lunar surface

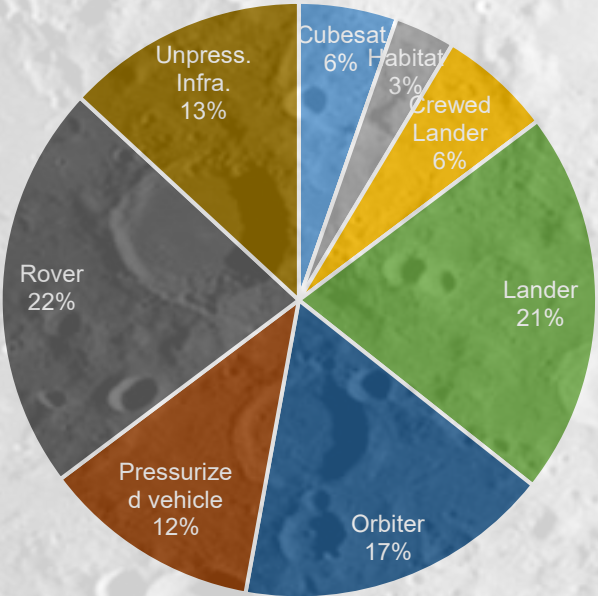


LCNS – Addressable Missions

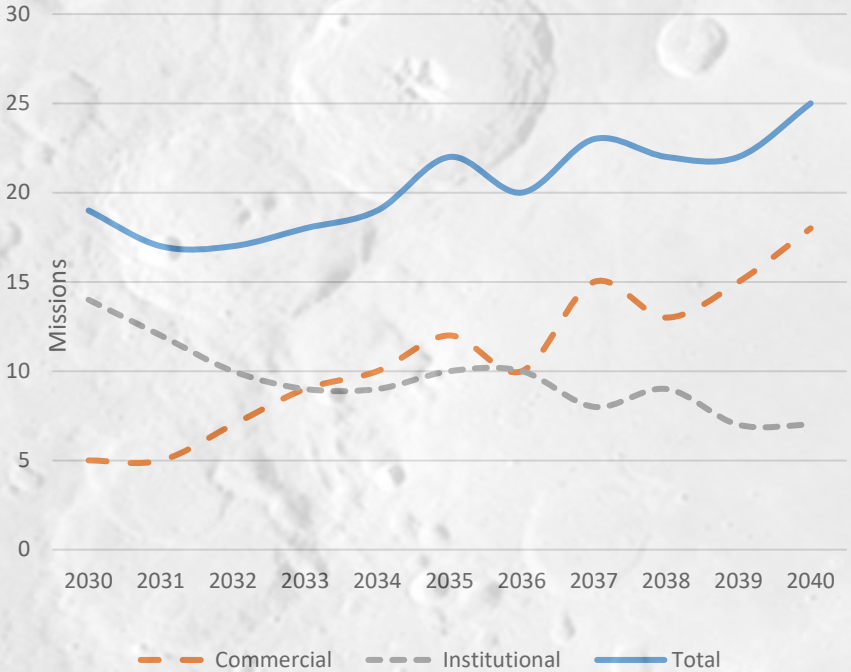


LCNS – Addressable Market

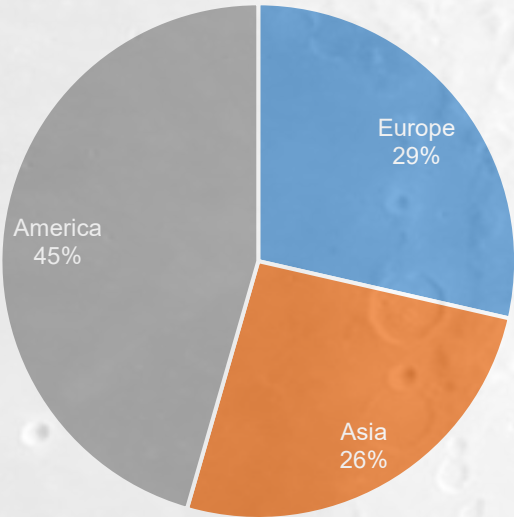
ASSET DISTRIBUTION 2030-40



USER TYPOLOGY 2030-40



GEO AREA 2030-40



LCNS – Business Model Points of Attention

High Demand Risk: Service Offer drives Comm & Nav Demand vs Nav Demand drives Service Offer → Typical Chicken & Egg dilemma

Infrastructure: costly to build and risky to deploy

Mainly Institutional Missions: depending on Agencies budget availability → high potential business volumes but also high revenues uncertainty

**CHALLENGING FOR
A FULL PRIVATE
ENDEAVOUR**

PPP with ESA to pave the way for a sustainable Business Plan and a balanced risk allocation



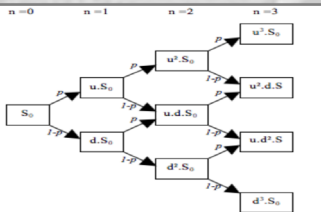
LCNS – PPP key elements & Criticalities



Public intervention to **ensure sustainable private investment**



ESA and Space Agencies Partners as **LCNS anchor customers (*)**



Scalable approach to the Infrastructure building

MAIN CRITICALITIES:

- **GOVERNANCE**
- **INTERNATIONAL AGREEMENTS**
- **INFRASTRUCTURE & LAUNCH COSTS**

(*) LCNS will be interoperable with Lunanet, ESA and NASA data network aiming to provide a "Lunar Internet" for cis-lunar spacecraft and installations



LCNS – Next Steps

- **Engage potential users**
- **Design & Build the Infrastructure**
- **Establish commercial partnerships with Institutional and Commercial players**
- **Fine-tune the Business Case**
- **Engage potential investors**





THANK YOU
FOR YOUR ATTENTION

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