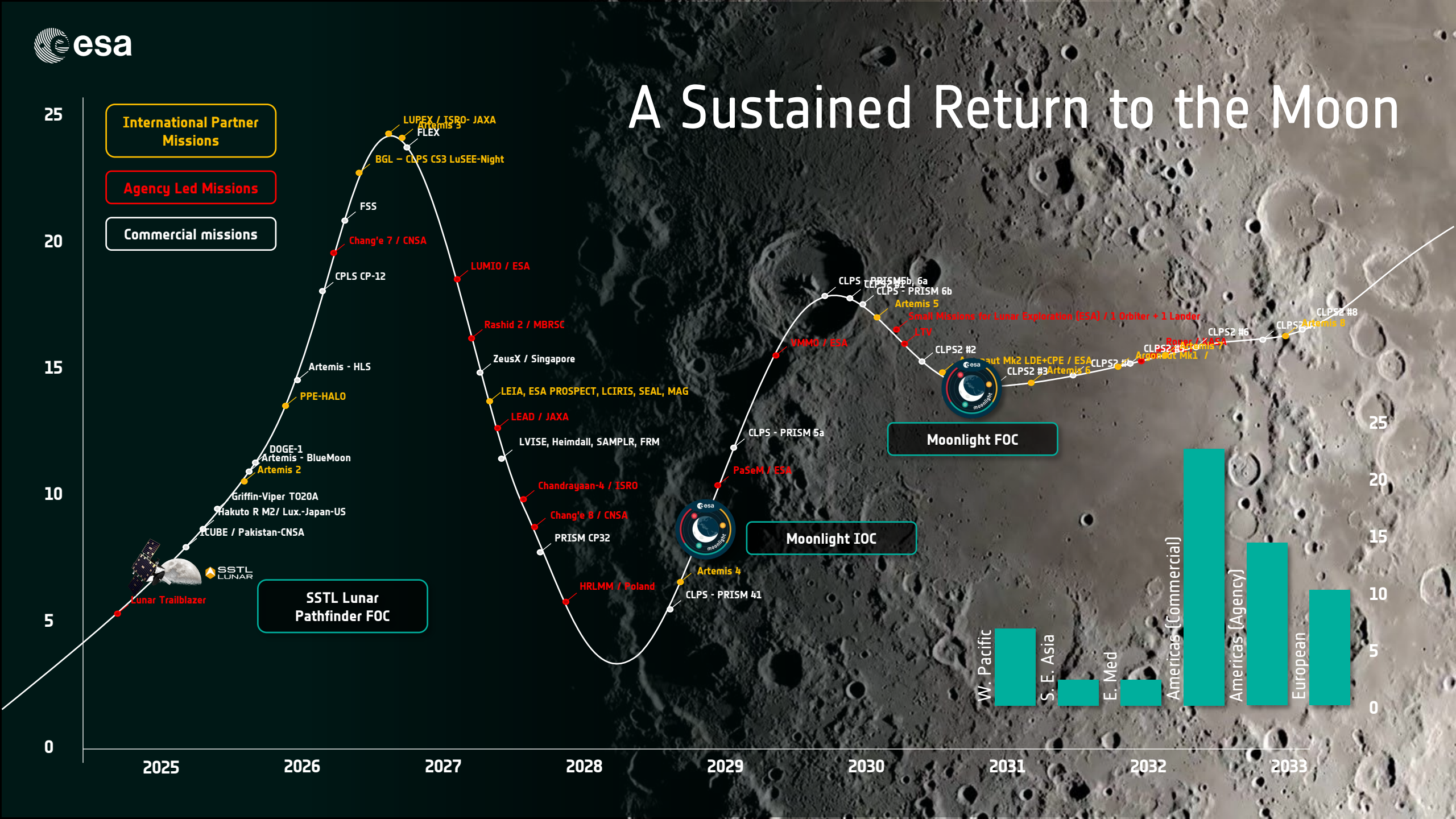
# The Moonlight Programme


esa

# A Sustained Return to the Moon

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400+
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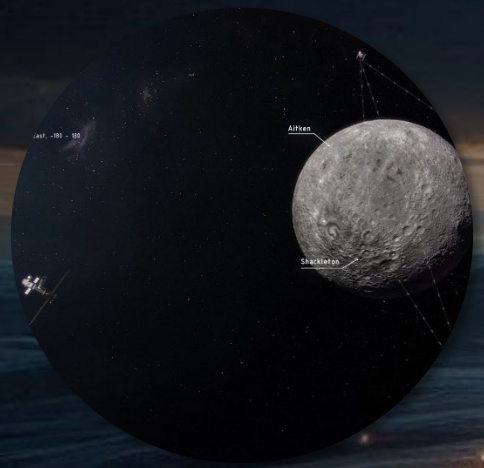
NASA
JAXA
CLPS
COMMERCIAL LUNAR PAYLOAD SERVICES
इसरो ISRO
Planned missions to the moon in the next 10 years

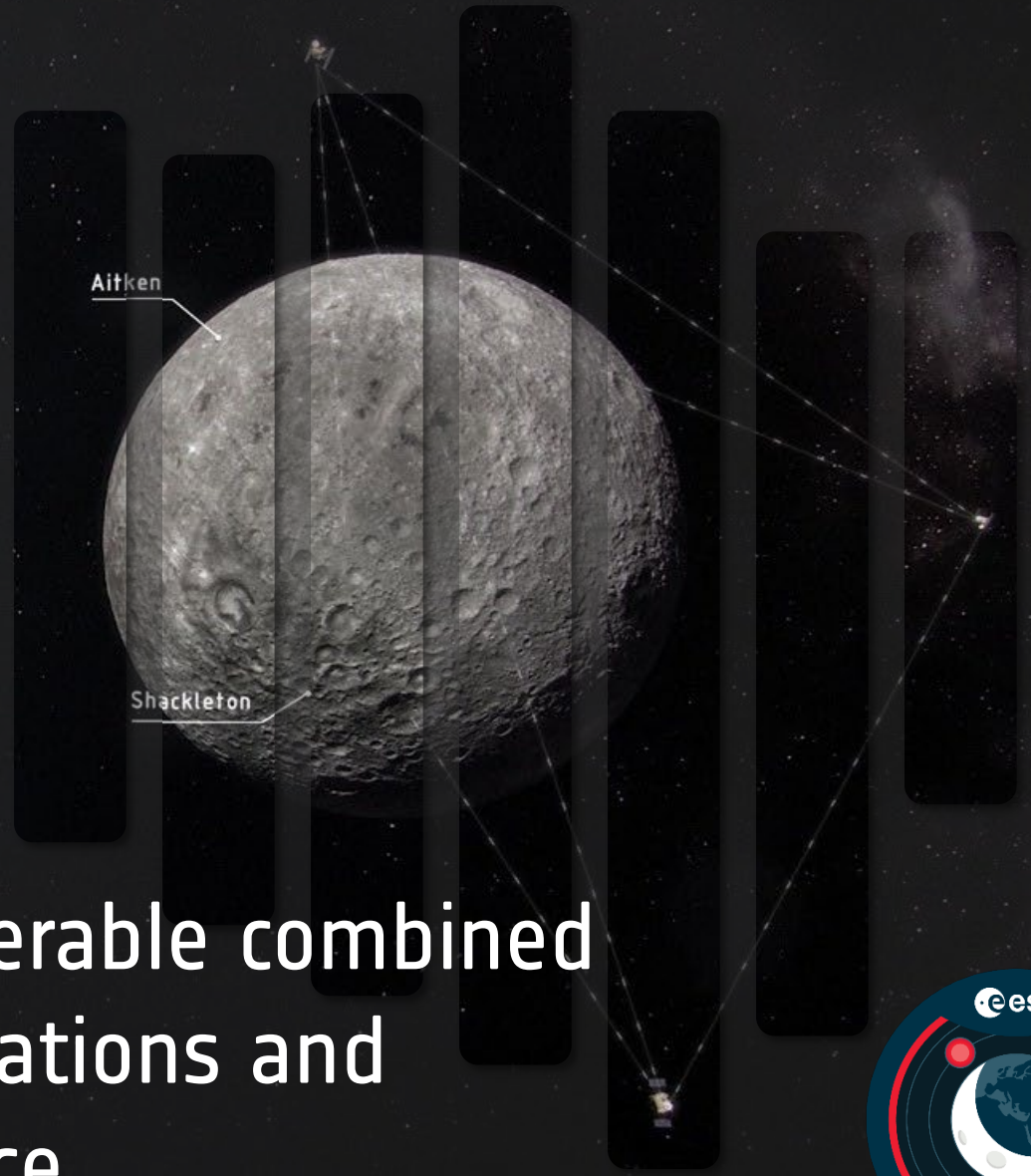




# Dedicated cislunar COM and NAV infrastructure connecting the Earth to the Moon

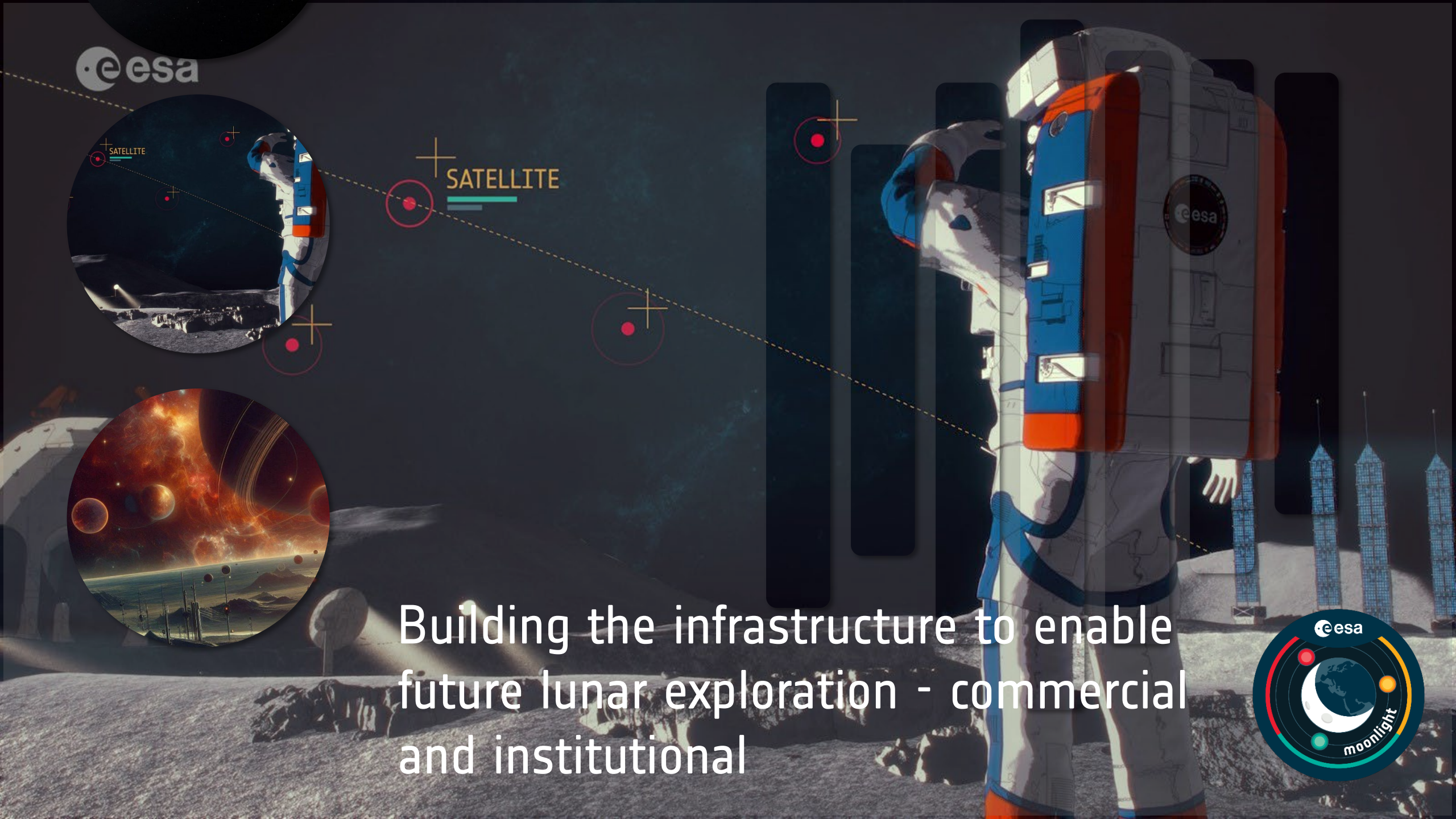
esa moonlight






# The first interoperable combined Lunar Communications and Navigation Service

moonlight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SATELLITE
SATELLITE
Building the infrastructure to enable future lunar exploration - commercial and institutional
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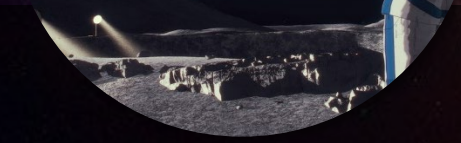
moonlight



# Laying the foundations for solar system wide communication and navigation

# Benefits to Users

### Reduced operational costs
- Optimised ground station operations
- Reduced need for backhaul of aggregated comms data

### Smaller, less power hungry terminals
- Greater SWAP properties vs systems required for DTE

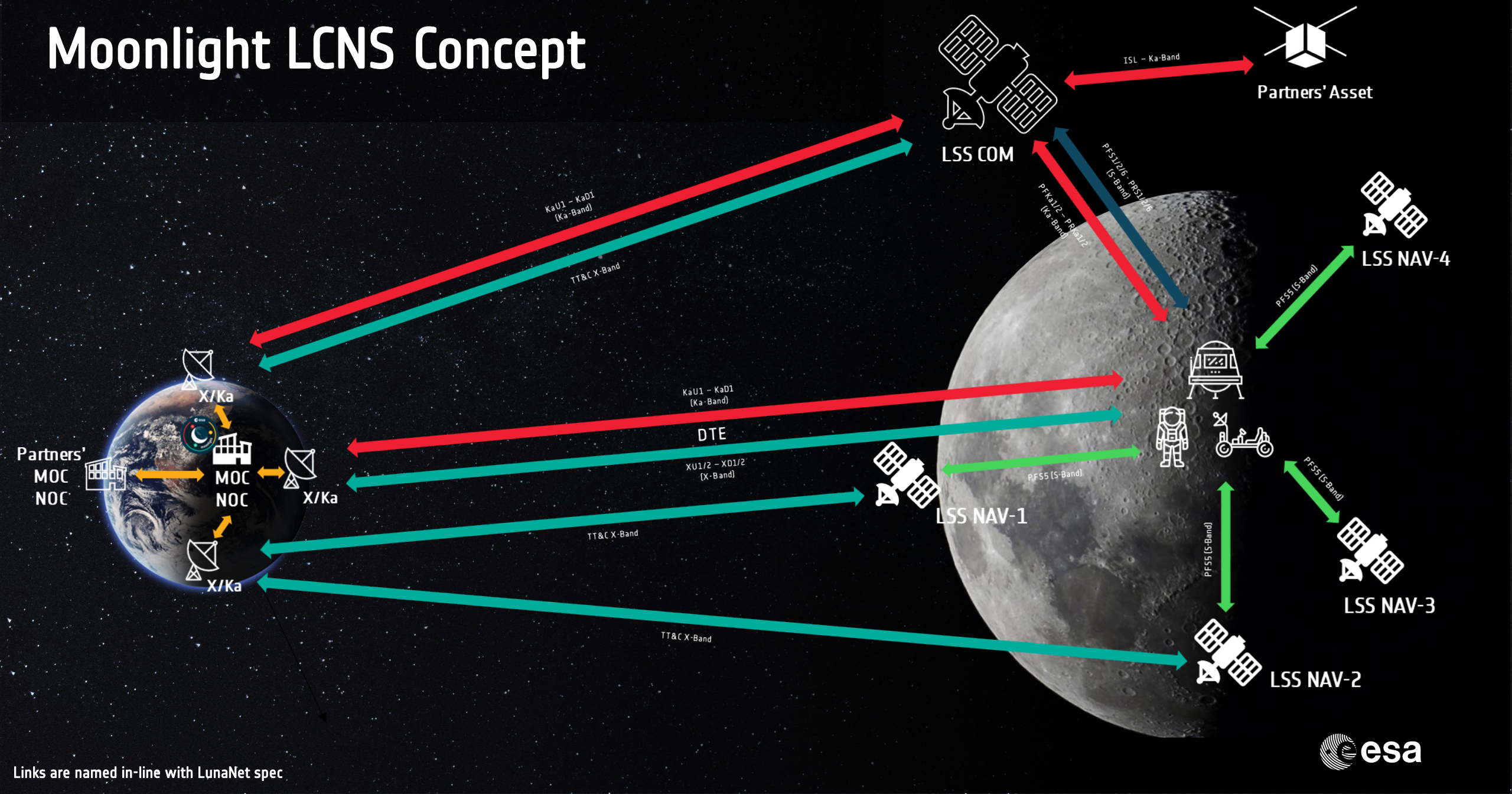
### Enhanced communication performance
- Improved data rate for comms vs achievable through DTE
- Increased data volume for same terminal

### Improved Probability of Success
- Improve the landing accuracy of landers improving mission success
- Greater accuracy opens new domains of access

### Improved exploration capabilities
- Solves line of sight issue – can operate on lunar far side
- Can operate independent of surface relay (lander)

### Interoperability
- Flexible integration with the rest of the lunar ecosystem (e.g. LunaNet and Lunar Gateway)

# Moonlight LCNS Concept



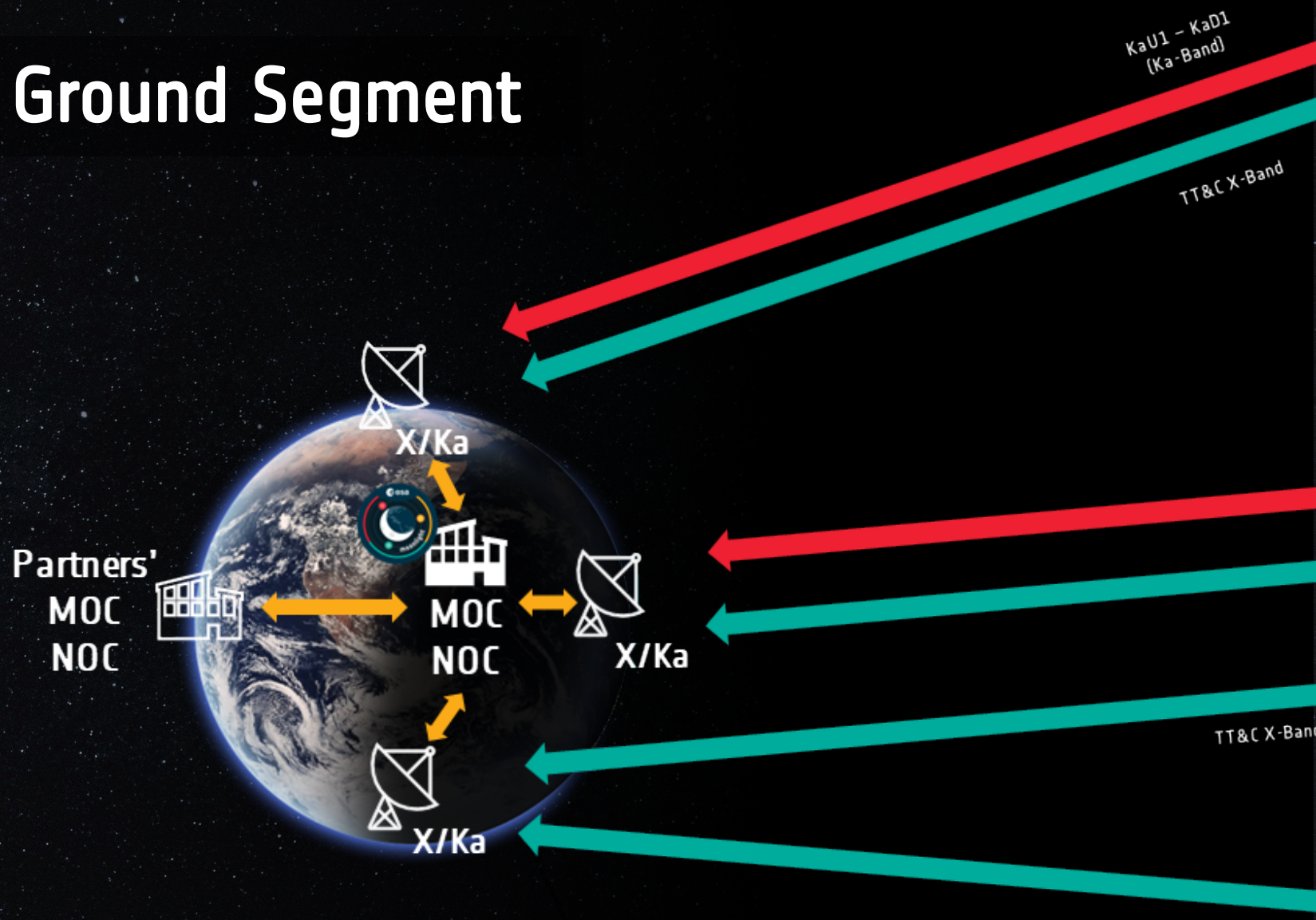

Links are named in-line with LunaNet spec

# Moonlight LCNS Earth Ground Segment

Moonlight industry owned and operated MOC and NOC

X/Ka Band Ground Stations

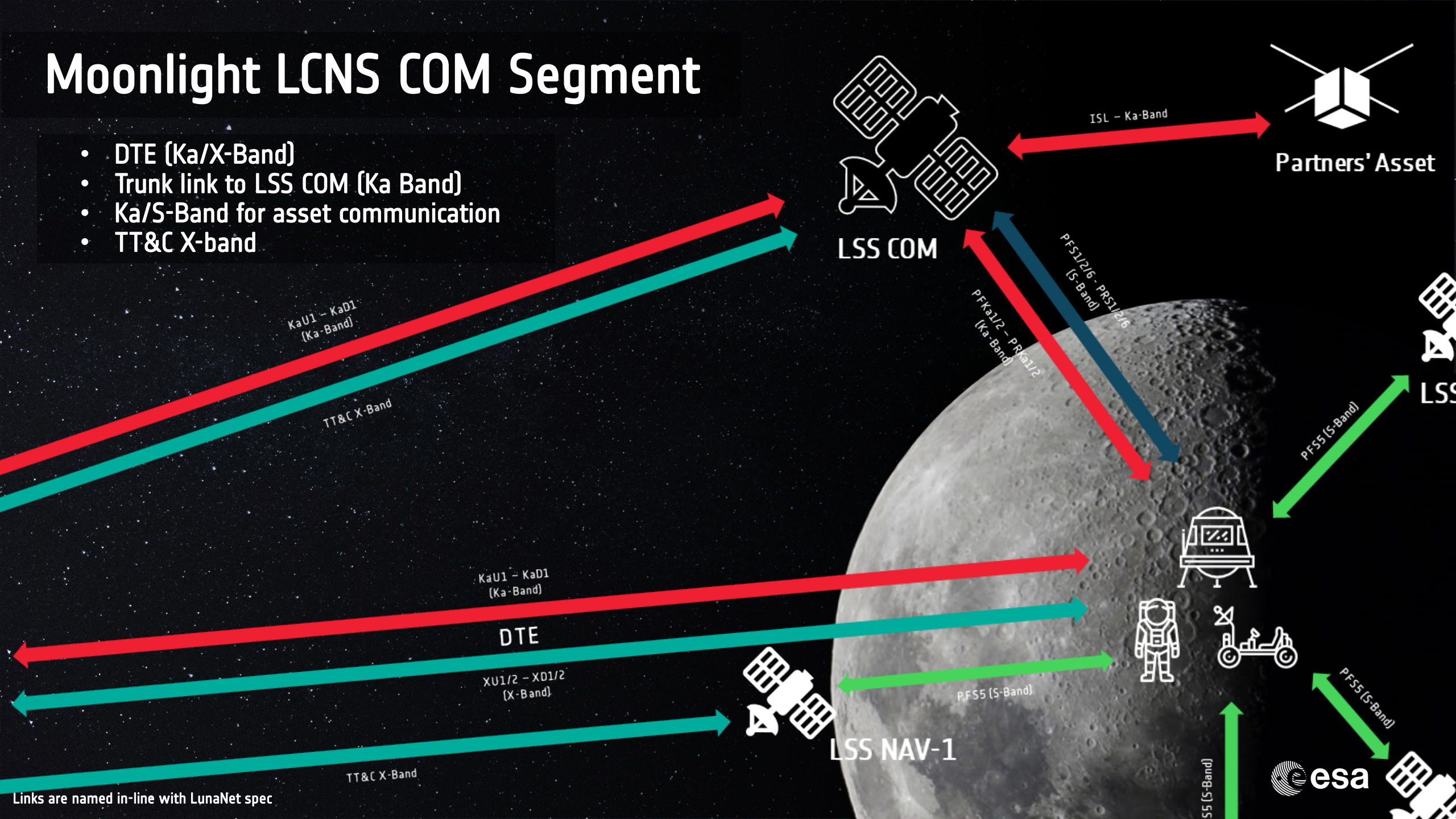
Direct links to Partners' MOC and NOC




Links are named in-line with LunaNet spec

# Moonlight LCNS COM Segment

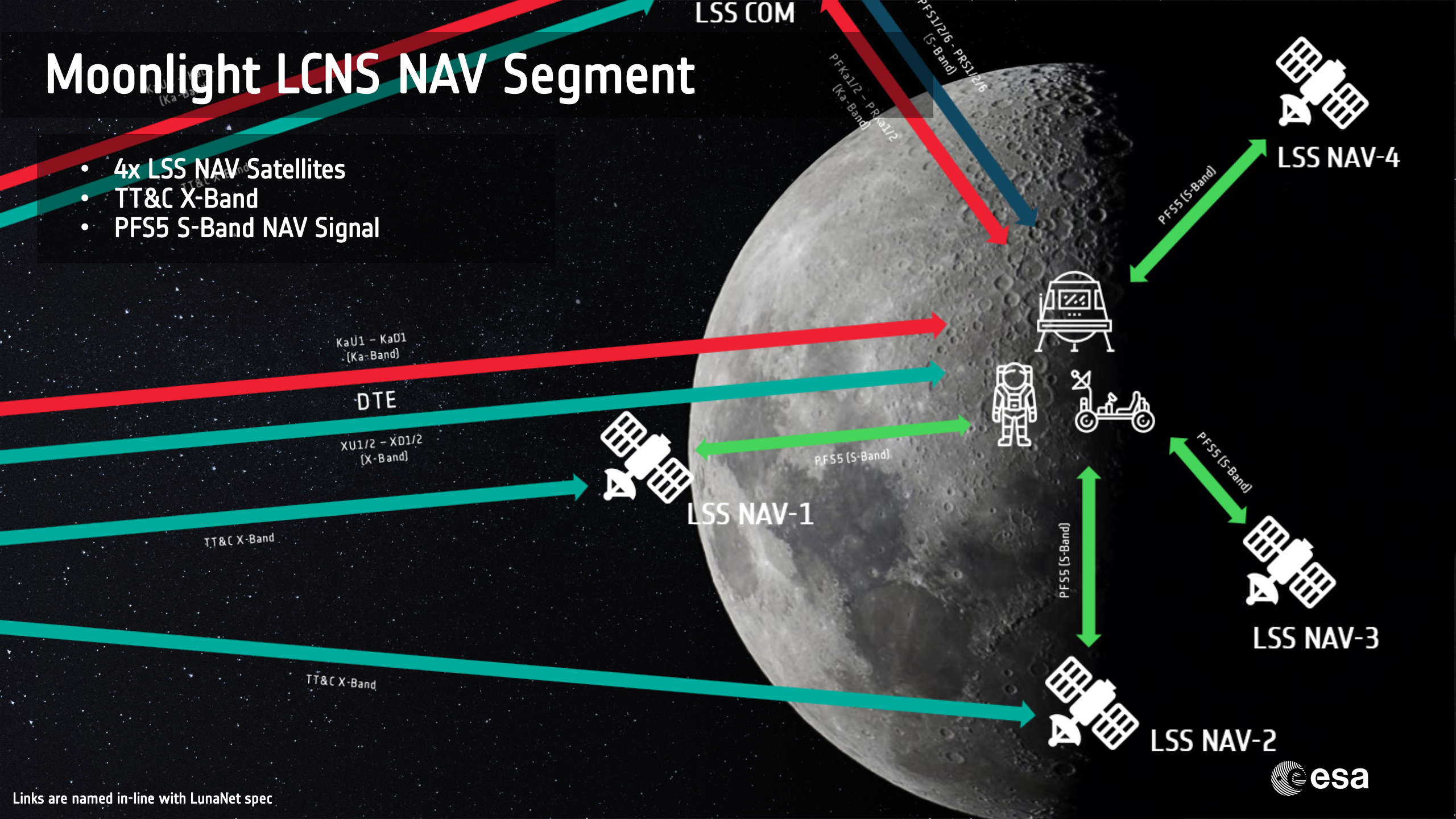
- DTE (Ka/X-Band)
- Trunk link to LSS COM (Ka Band)
- Ka/S-Band for asset communication
- TT&C X-band



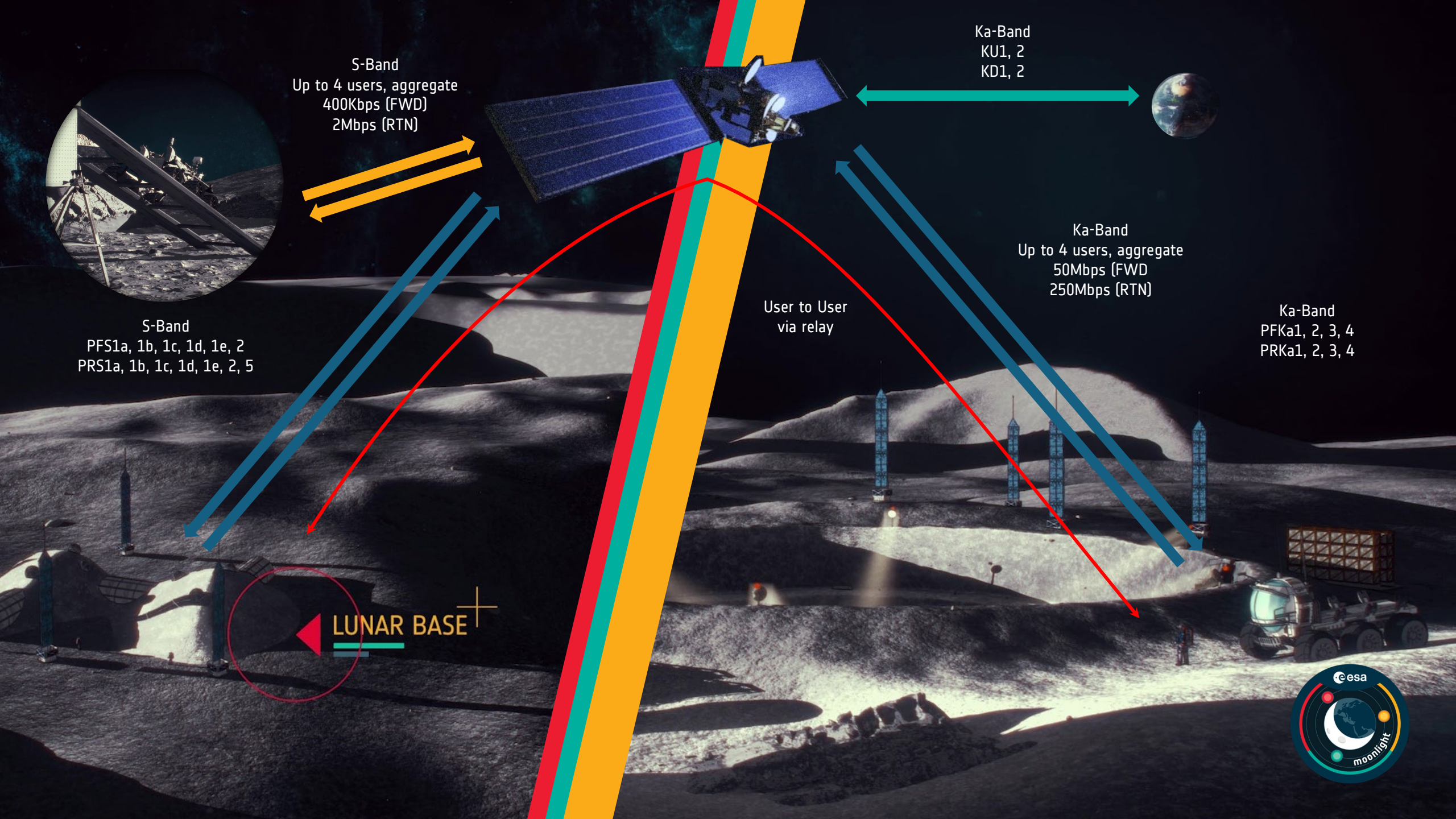

Links are named in-line with LunaNet spec

# Moonlight LCNS NAV Segment

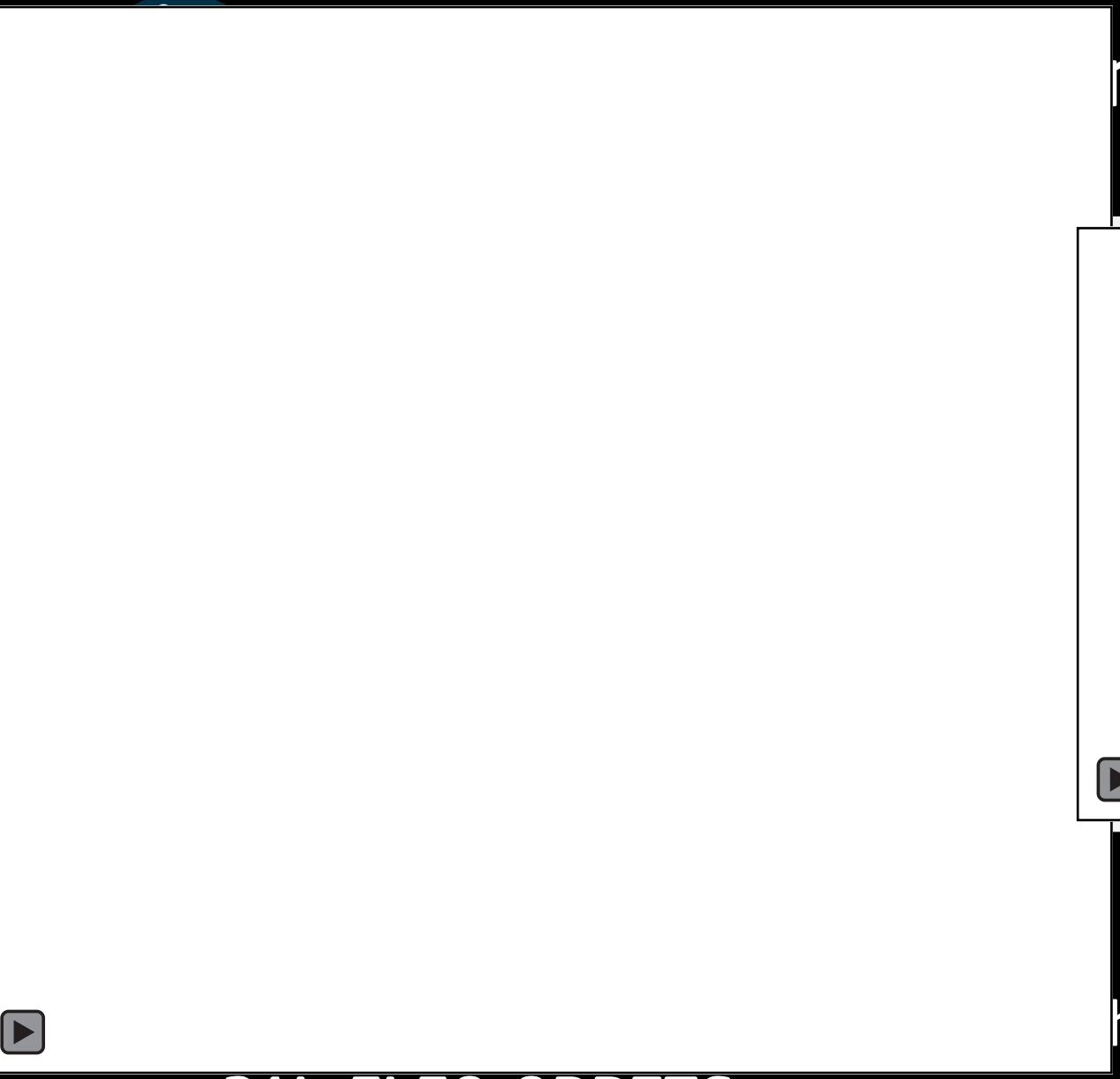
- 4x LSS NAV Satellites
- TT&C X-Band
- PFS5 S-Band NAV Signal



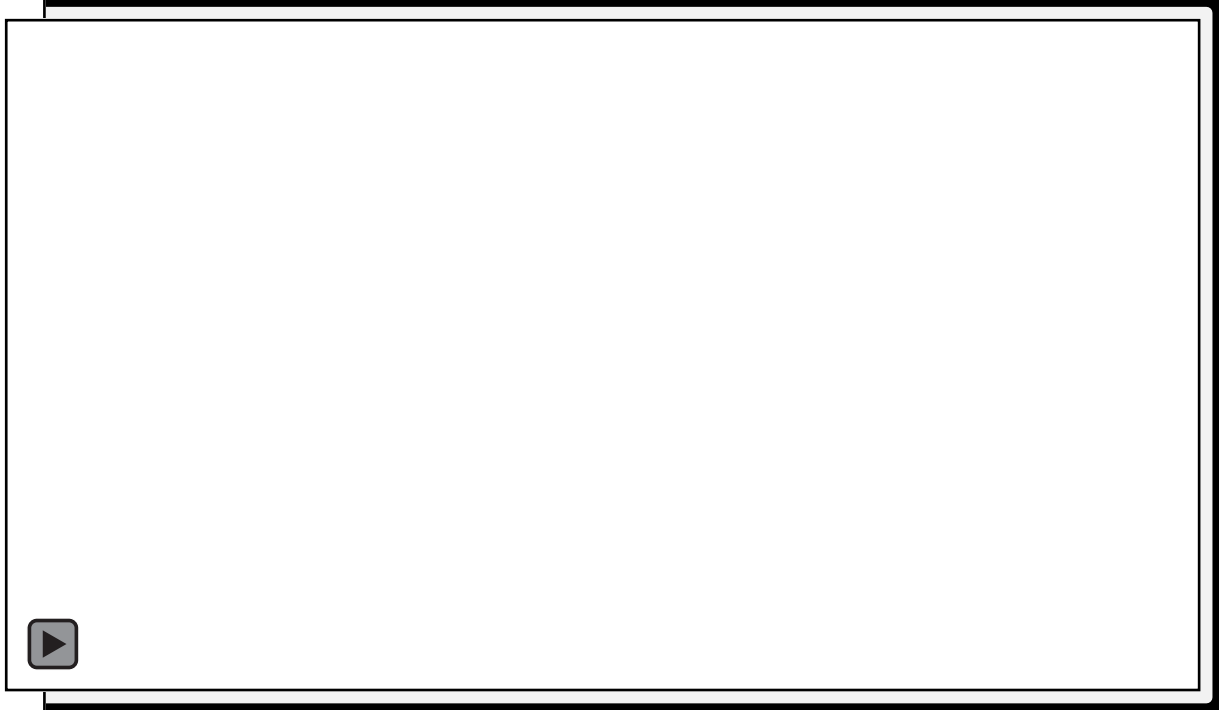

Links are named in-line with LunaNet spec


S-Band
Up to 4 users, aggregate
400Kbps (FWD)
2Mbps (RTN)
Ka-Band
KU1, 2
KD1, 2
S-Band
PFS1a, 1b, 1c, 1d, 1e, 2
PRS1a, 1b, 1c, 1d, 1e, 2, 5
User to User
via relay
Ka-Band
Up to 4 users, aggregate
50Mbps (FWD
250Mbps (RTN)
Ka-Band
PFKa1, 2, 3, 4
PRKa1, 2, 3, 4
LUNAR BASE
esa
moonlight

n lunar orbit



24h ELFO ORBITS

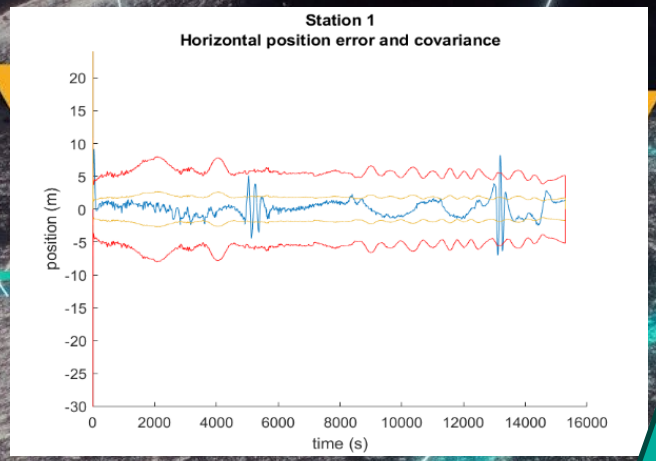


A minimum of
hours of continuous PNT service at South
Pole every 24 h

# Moonlight LCNS High-level PNT Performances

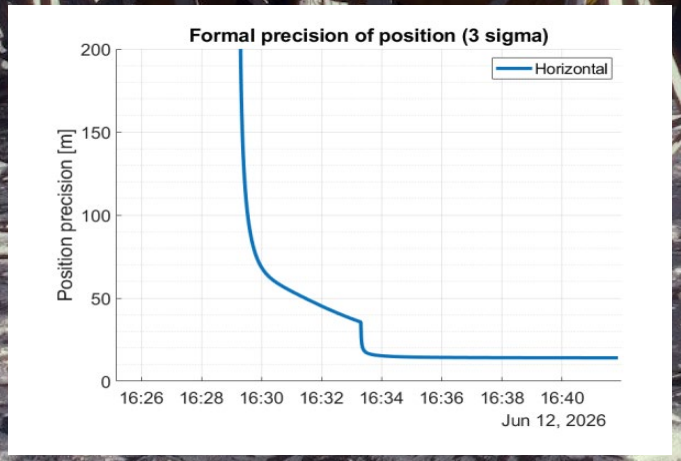
Real time < 10 m (95%)
Post-processing < 3 m (95%)
Estimated Real time: 3-5 meters

## *Surface Rover*



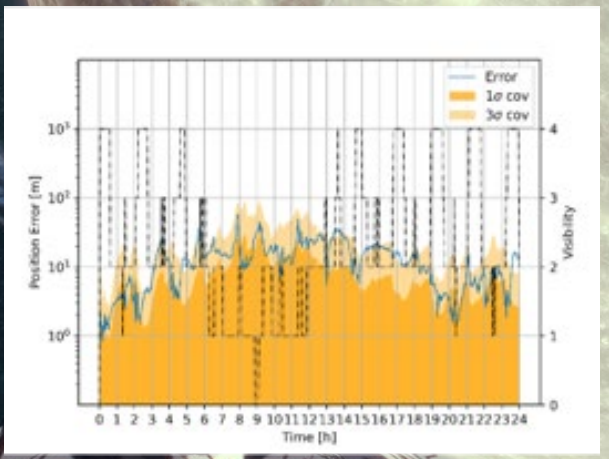

< 50 m (95%) Landing accuracy
Estimated: ~20 meters

## *Luna Lander*

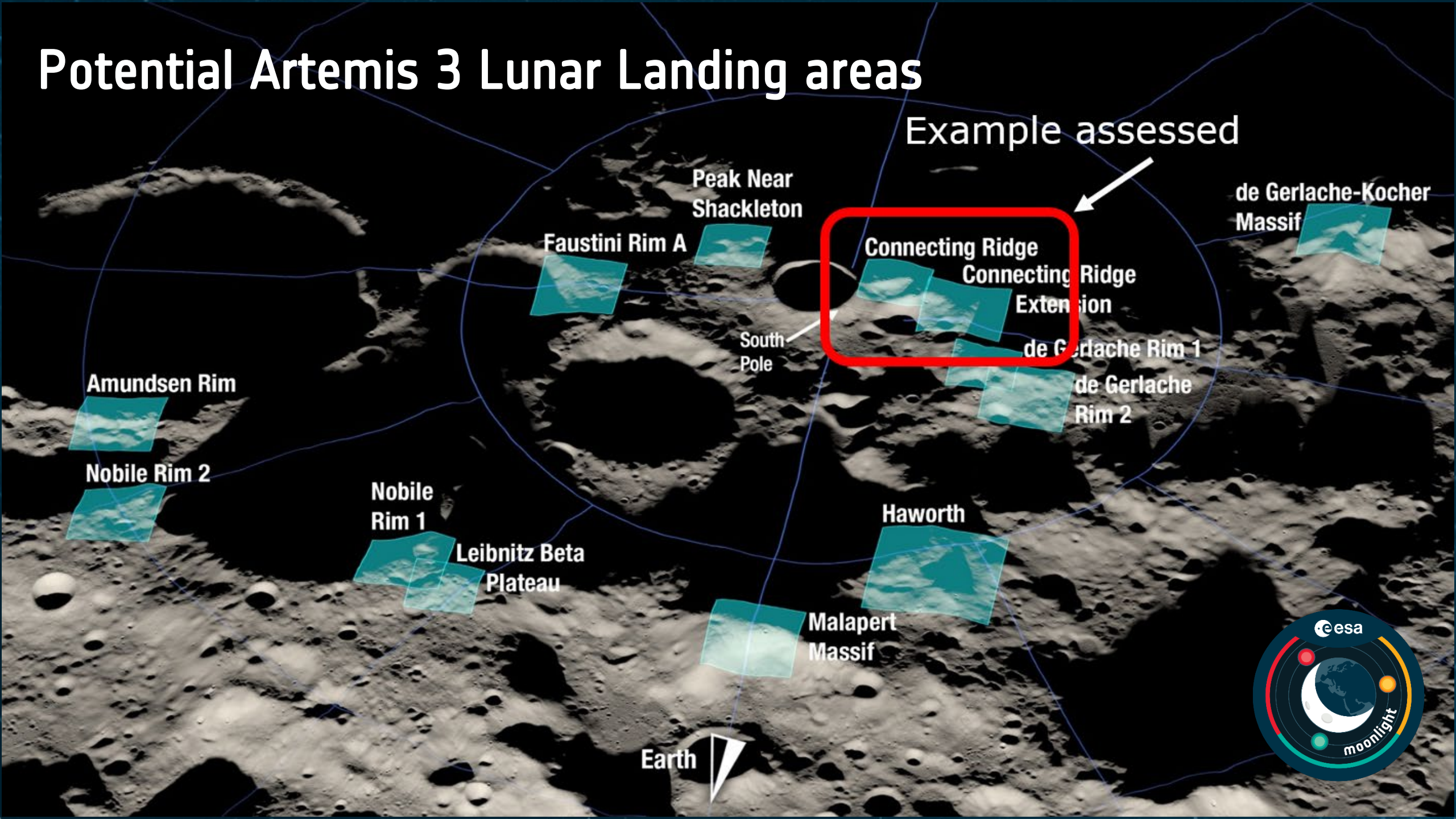



## *Luna orbiter*

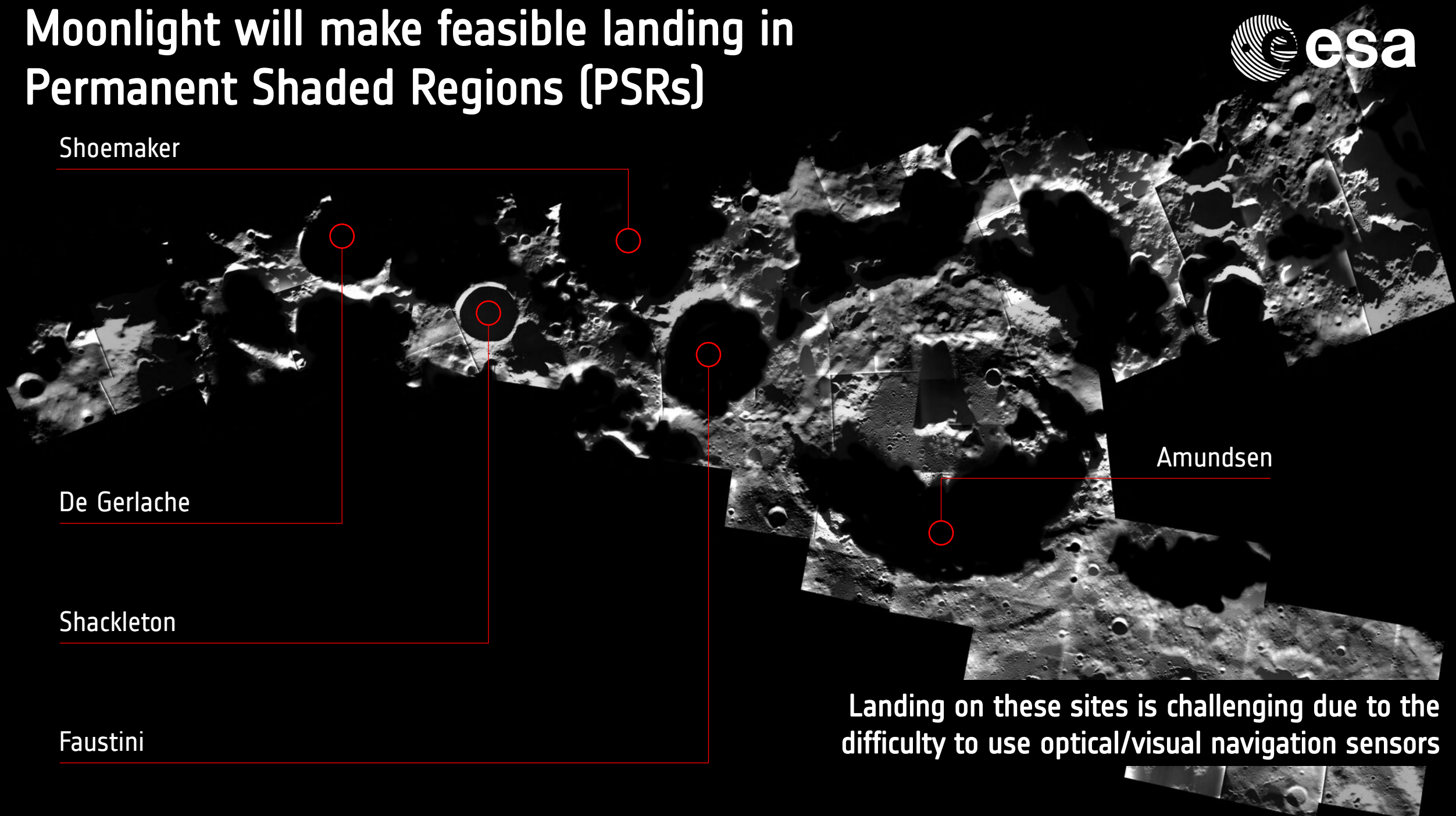
Real time < 100 m (95%)
LLO accuracies
Estimated: 30-60 meters



# Potential Artemis 3 Lunar Landing areas



# Moonlight will make feasible landing in Permanent Shaded Regions (PSRs)

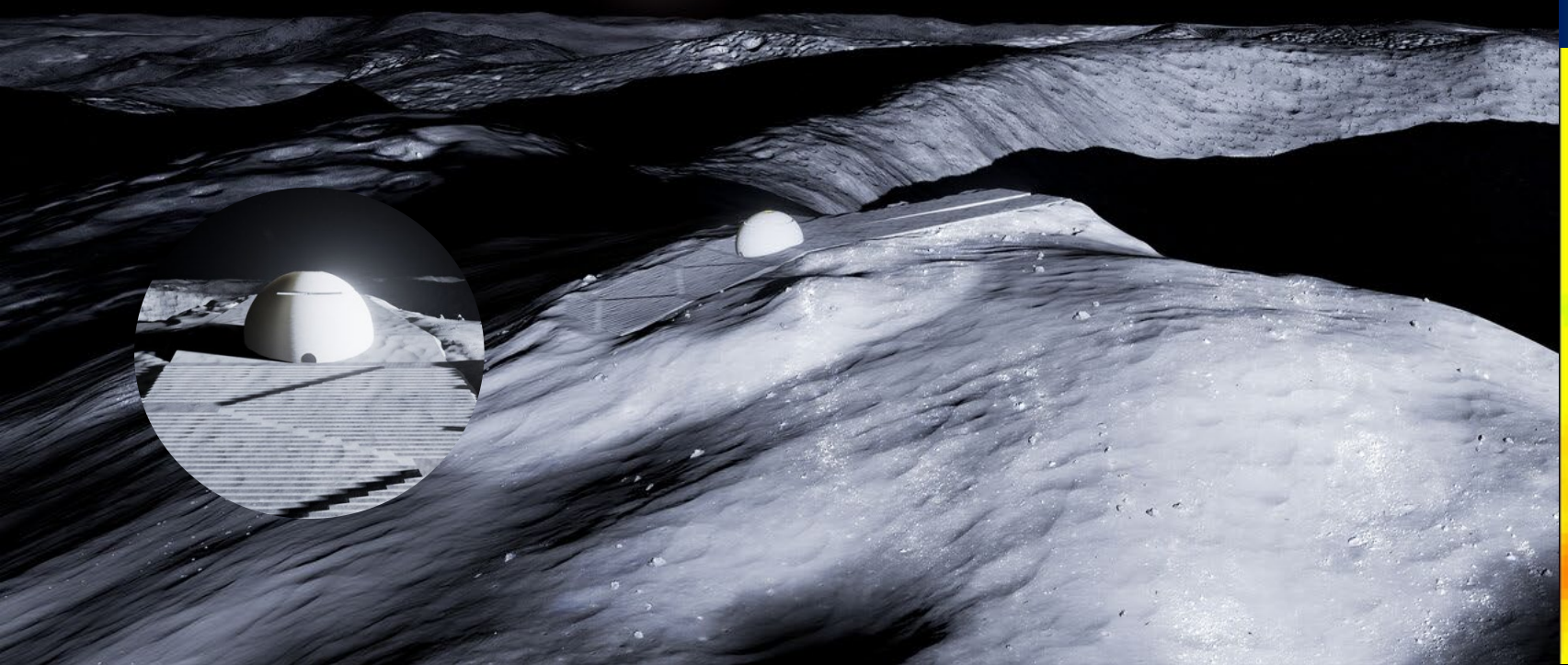


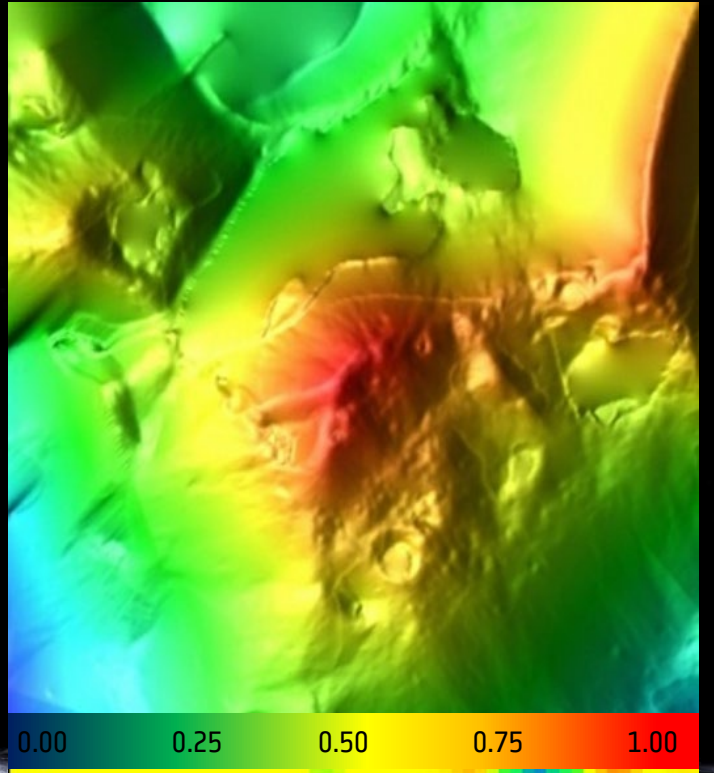

**Landing on these sites is challenging due to the difficulty to use optical/visual navigation sensors**

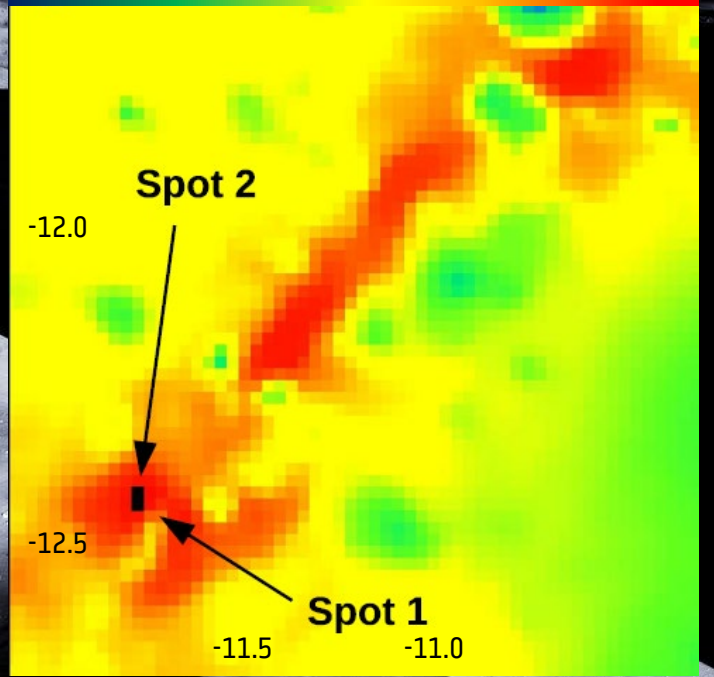
# Moonlight will make feasible landing in Peaks of Eternal Light (PEL) regions

Over 20 years, the longest continuous periods in darkness are typically only 3-5 days.

Landing accuracies required < 50 metres





# Moonlight LCNS Commercial Model

Moonlight commercially owned and operated lunar COM-NAV service

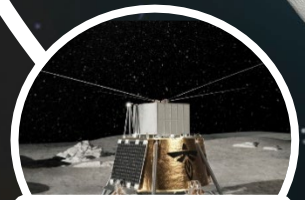
ESA supporting infrastructure development, service anchor customer

International Cooperation through barter exchanges of procured services

Commercial service directly available to Gov agencies

Commercial

ESA Missions



Gov. Missions

# The ESA Moonlight Ecosystem

## Lunar Pathfinder

COM satellite (S-Band)
3 Hosted Payload Experiments
- Radiation Monitor
- Laser Retro-Reflect
- GNSS Weak Signal Detection

SSTL LUNAR

## Moonlight Lunar COM and NAV System (LCNS)

COM Satellite (Ka & S-Band)
4x NAV Satellites
High Data Rate

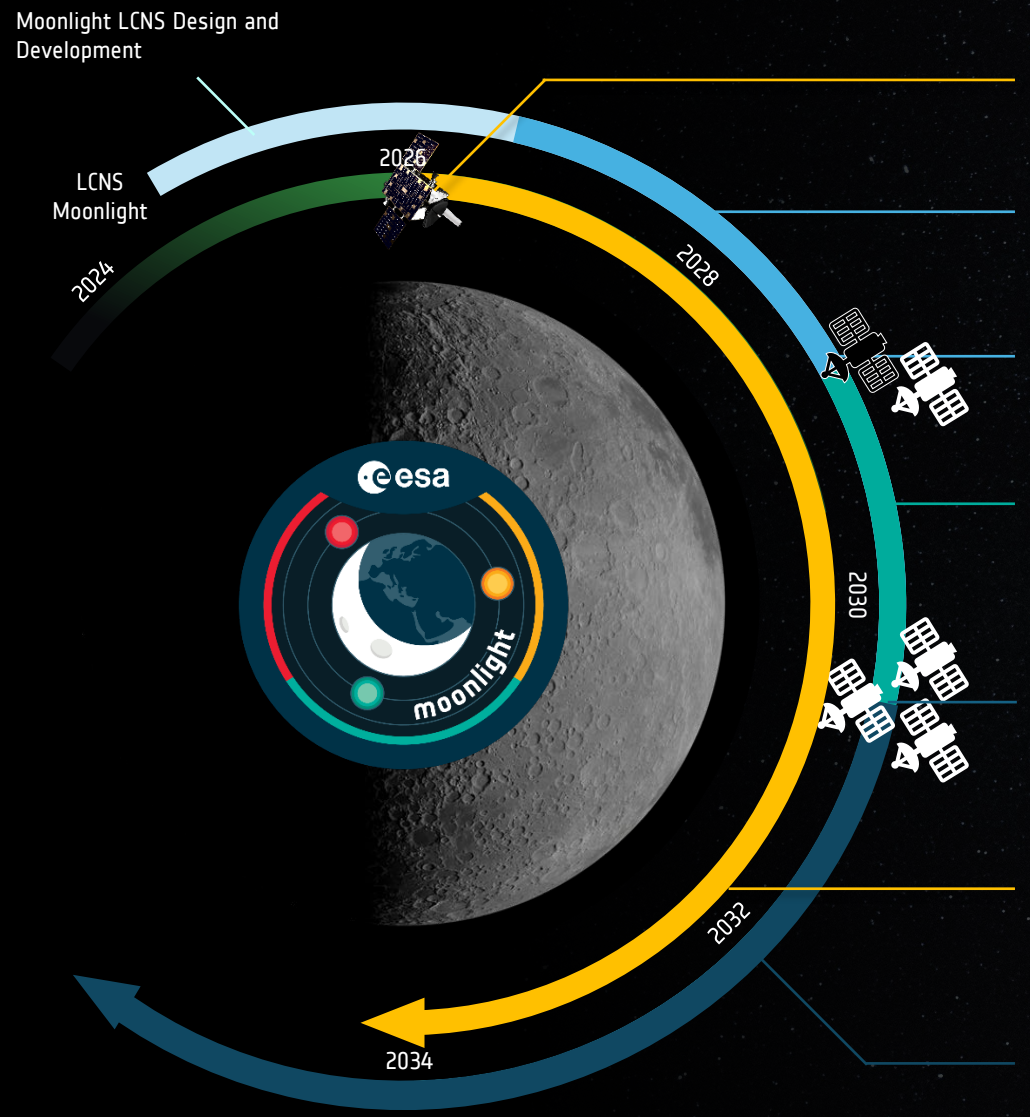
TELESPAZIO
a LEONARDO and THALES company

Commercial

ESA Missions

Gov. Missions

# The Road to Moonlight




SSTL Lunar Pathfinder Launch COM and NAV Demo, Commercial Service

Moonlight LCNS Manufacture, Assembly and Test

Moonlight LCNS IOC Launch (1x COM, 1x NAV)

Moonlight LCNS NAV Satellite Manufacture, Assembly and Test

Moonlight LCNS FOC Launch (3x NAV)

SSTL Lunar Pathfinder Decommissioning

Moonlight LCNS Service Delivery

## Phase 1

Design and development to CDR
- COM
- NAV
- User Terminal
- Ground Segment

LLI Procurement

## Phase 2

Manufacture, Test Launch for IOC
- 1x COM Satellite
- 1x Nav Satellite
- User Terminal for Service Validation

Implement and Test
- Ground Segment

## Phase 3

Manufacture, Test Launch for FOC
- 3x NAV Satellite

Implement and Test
- Ground Segment Complement

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