space applications SERVICES
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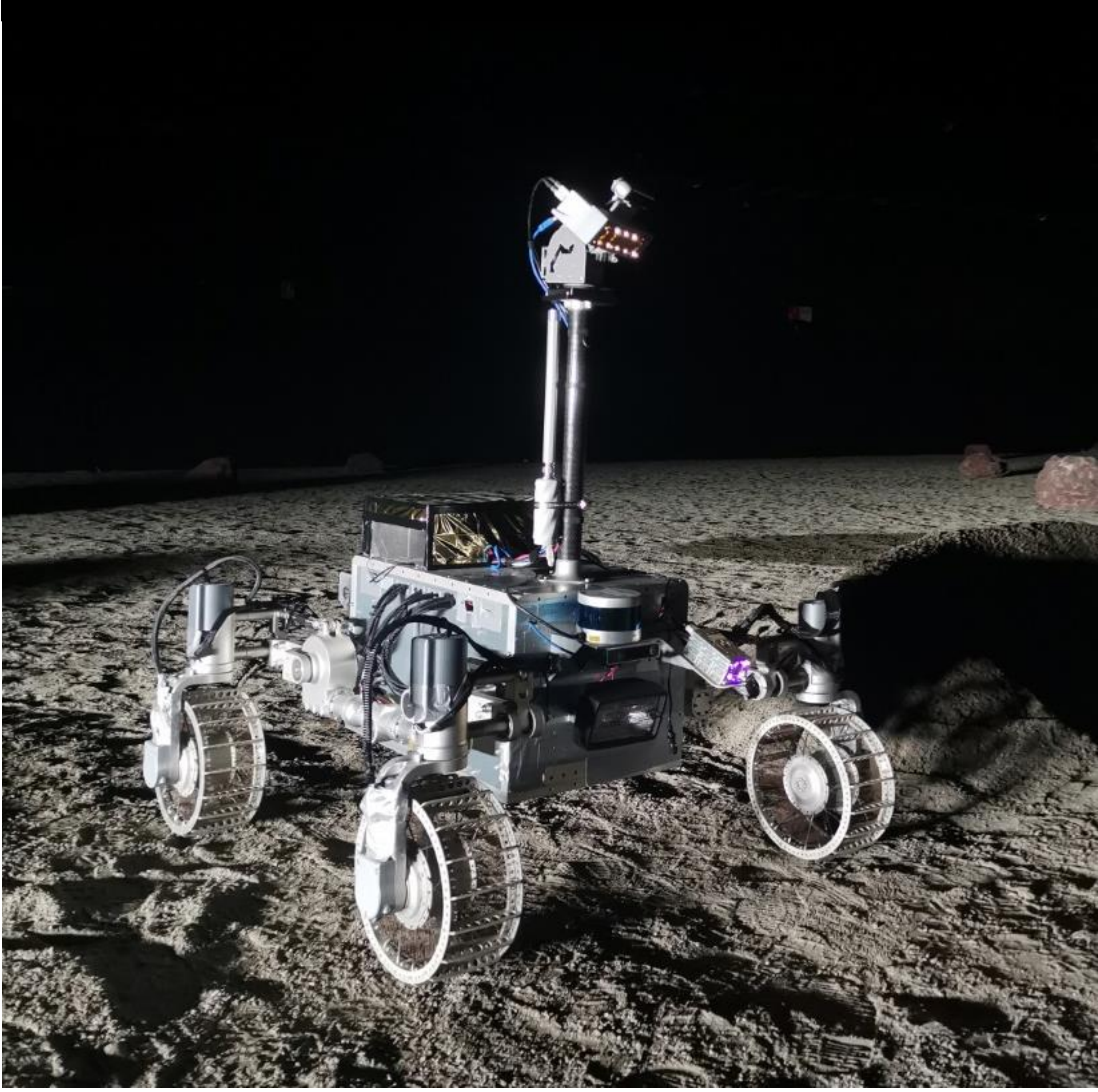
LUVMI-M ROVER

Payload User Guide – Sep 2025

Image: LUVMI-X rendering on the Lunar surface
LUVMI-M is the next generation of the LUVMI rover family



Your Mission, Our Rover

Why Partner With Us?

- **Mobile science platform:** Go beyond static landers with a rover that travels where the science is.
- **Full service delivery:** We handle integration, testing, surface ops, and data return.
- **Heritage you can trust:** 35+ years in space systems, ISS operations, and lunar technologies. Building on 7+ years of ICE Cubes Service for the ISS and extending it now to the lunar surface!
- **Lunar South Pole:** Join a landmark mission to one of the most scientifically valuable locations on the Moon.

Key Payload Specs (Baseline)

Mass	Up to 20 kg
Power	5 V, 12 V, 28 V lines; 30 W for payloads available
Data	100 kbps downlink, 10 kbps uplink (shared)
Thermal	Passive with radiator, supported by heaters where necessary
Mounting	Internal, external, deployable
Location	Attached to rover chassis
Ops Duration	10 – 14 days nominal (extendable w/ upgrades)

How It Works

1. Contact us with your idea or proposal.
2. We will guide you through the integration & interface definition.

2028 Mission Profile

Destination:	Lunar South Pole
Launch Vehicle:	Falcon 9
Lunar Lander:	Nova-C
Environment:	High volatile content, low sun angle

Let's talk: moon@spaceapplications.com

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1 INTRODUCTION

This guide is intended to support commercial, academic and institutional teams interested in mounting payloads on the LUVMI-M lunar rover, with a first mission scheduled for the second half of 2028. Whether your objective is scientific discovery, technology validation or commercial demonstration, this guide gives an overview of the rover's capabilities, payload interface options and the steps to participate.

Space Applications Services and Aerospace Applications North America bring over three decades of experience in delivering operational spaceflight systems, including a well-established commercial payload service on the International Space Station and lunar technology developments under ESA and European Commission programs. With our mobile rover platform, we are extending our scope to the lunar surface by offering a reliable and innovative end-to-end service to deliver your mission to the Moon.

2 LUVMI-M ROVER

2.1 About the LUVMI-M 2028 Mission

LUVMI-M 2028 marks the first lunar mission led by Space Applications Services, in partnership with U.S. lunar transport provider Intuitive Machines. The mission is planned for launch in the second half of 2028 and will touch down at the rim of the Shackleton Crater, one of the Moon's most scientifically valuable locations.

At the core of the mission is LUVMI-M, a compact, mobile rover weighing 20 kg and capable of carrying an equivalent mass of up to 20 kg in scientific or technology demonstration payloads. The rover is designed for a 14-day surface mission, being teleoperated from Space Applications Services' well-established control rooms to traverse up to 5 km across diverse lunar terrain. Its 20 cm wheels, independent drive motors, and ability to climb slopes up to 15° provide reliable mobility in the challenging lunar environment.

2.2 What Makes Our Rover Unique?

LUVMI-M is a compact mobile rover with a flexible platform for lunar surface payloads. Its heritage, 1:1 mass-to-payload mobile ratio and end-to-end integration support distinguish it from static landers and other traditional exploration assets.

LUVMI

The LUVMI rover family was first developed in 2016 and continuously updated to address the growing need for compact, adaptable lunar mobility. By selecting LUVMI-M for your payload, you gain access to a platform whose architecture draws on an established design development and previous test campaigns of ground models.

Surface operations are teleoperated from Space Applications Services' Rover Mission Operations Centre in Brussels. With over 7 years of experience in payload control services on the International Space Station, you can trust our seamless integration and mission control.

The rover supports a wide range of payload types (internal, external or deployable) with flexible power, data and mechanical interfaces, plus optional enhancements tailored to individual payload needs.

Space Applications Services offers full end-to-end support for payload pre-launch activities, as well as post-landing surface operations and data delivery.

2.3 LUVMI-M Subsystems Overview

Navigation
The LUVMI-M rover navigates with a combination of on-board autonomy and teleoperations. Stereo cameras provide a 3D map of the lunar surface, and hazard detection cameras allow for efficient and safe driving.

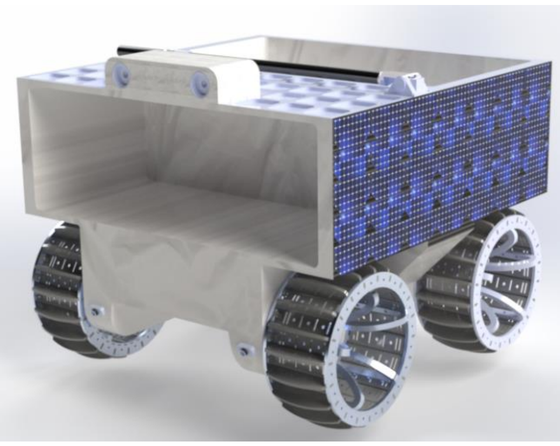
Mobility
LUVMI-M has a top speed of 5 cm/s and can handle slopes of up to 15 degrees. A traverse of multiple kilometers and many payload sites of interest is baselined for each LUVMI-M mission.

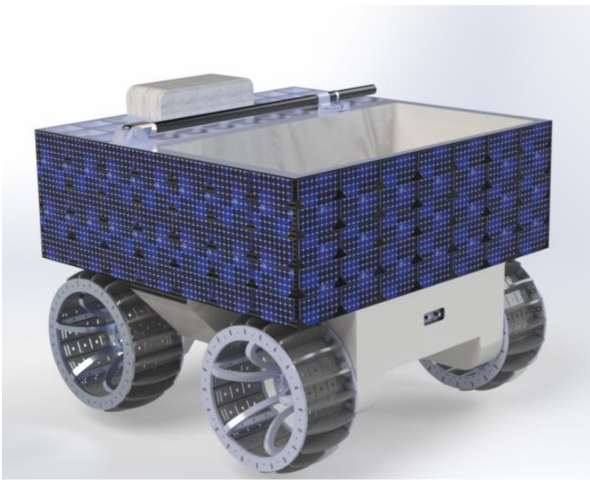
Power
A set of solar panels and batteries sized for extended traverses and payload operations.

Thermal control
Maintains avionics and payloads within operational temperature ranges under the varying conditions of the lunar surface.

Avionics
Supports various data interfaces and includes onboard payload data storage.

Communications
Redundant communication links to the lander and to relay satellites for surface-to-Earth connectivity.



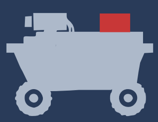


3 PAYLOADS

Your payload travels with reliable connections for power, data, and structure. This chapter summarizes the key rover interfaces. For full technical details, we are happy to help you with any questions via **moon@spaceapplications.com**.

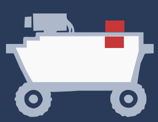
3.1 Payload Hosting Options

LUVMI-M offers flexible payload accommodation to support diverse mission needs:

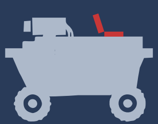


Externally Fixed
Payloads are mounted securely on the rover's exterior frame, allowing direct exposure to the environment.

Internally Hosted
Payloads are installed inside the rover chassis, benefitting from environmental protection and thermal control.



Combined Configurations
Payloads can be split between internal and external locations as needed for operational or integration reasons.



Deployable or Propellable Payloads
Certain payloads may optionally be mounted on mechanisms enabling deployment or limited mobility away from the rover.

For example, if your payload is sensitive to lunar dust and temperature fluctuations, hosting it internally can provide protection and stable thermal conditions. If your payload requires surface deployment for sampling or longer-range sensing, solutions can be integrated within the rover's structure.

3.2 Electrical and Power

LUVMI-M provides standard electrical interfaces designed to support a wide range of lunar payloads. All power lines are protected and independently switchable. Power is supplied through dedicated lines with defined voltage levels and current limits:

Voltage Line	Type	Voltage Range	Max Current
28 V	Unregulated	24 – 33.6 V	4 A
12 V	Regulated	Fixed	4 A
5 V	Regulated	Fixed	4 A

Your payload's power budget changes depending on whether the rover is driving or parked. Here is a quick overview:

Rover State	Typical Available Power	Comments
Stationary	30 W	Short-term peaks allowed
Driving	3 W	Can be continuous or duty-cycled (e.g. 15 W across 20% of the time)

3.3 Data and Communication

Whether your payload's needs are for low-rate telemetry or high-speed data transfer, LUVMI-M supports a suite of standard protocols to stay connected during operations.

Available Protocol	CAN	UART	Ethernet	SpaceWire
Max Data Rate	1 Mbps	10 Mbps	100 Mbps / 1 Gbps	100 Mbps

Data connection for the payloads depends on the operational context. Here is a quick overview of the maximum availability shared by all payloads:

Function	Maximum Availability
Uplink (commands)	10 kbps
Downlink (telemetry)	100 kbps
Downlink during driving	Reduced rate
Onboard storage	400 MB per day

3.4 Thermal Interface

Flexible thermal control options are provided to ensure payloads operate within their required temperature ranges.

Thermal Interface Options	Description
Survival heaters	Thermostat- or thermistor-controlled heaters
Conductive mounting to LUVMI-M	Payload mounting on rover baseplate to establish a thermal path
Isolated mounting	Payload mounting with thermal isolation, for independent temperature control through radiators, MLI or coatings. Recommended for payloads active during rover driving.

If your payload has unique needs with regards to power delivery, data connectivity or thermal management, we encourage you to contact the LUVMI-M team early in the design process.

4 LUNAR ENVIRONMENT

4.1 First Mission: South Polar Landing Site

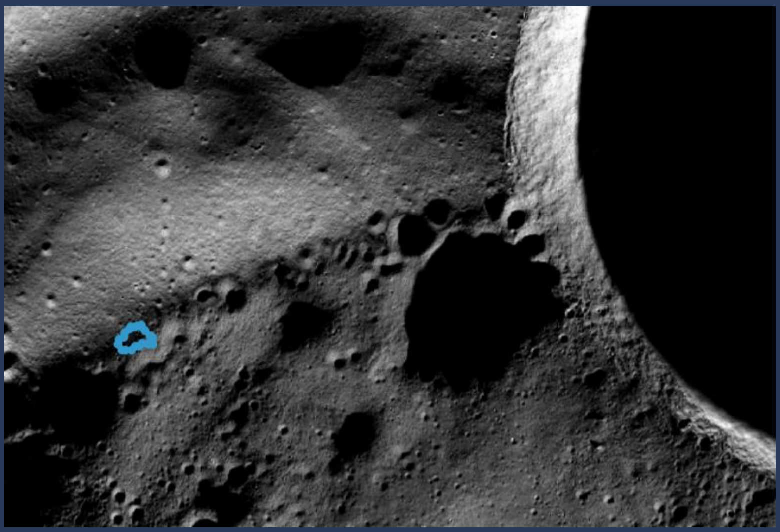
The first LUVMI-M mission in 2028 is set to land on the Shackleton–de Gerlache Ridge, a high-elevation plateau near the lunar South Pole, located at 89.5° S, 137° E. This ridge sits between the Shackleton and de Gerlache craters and offers unique scientific and operational conditions.

Traverse Characteristics

The planned route of 2.5 km circles a peak almost 2,000 meters above the lunar mean radius. This traverse has been designed to maximize exposure to solar illumination for over 70% of the mission time. The slopes of this route are gentle, with a maximum incline of 15°.

Scientific importance

The selected terrain passes small permanently shadowed craters, which are particularly interesting to lunar volatiles studies, of less than 100 meters in diameter. The Shackleton–de Gerlache Ridge was also identified by Spudis et al. (2008)[1] to contain deep crustal materials and possible ejecta from the South Pole-Aitken impact. As such, it promises to contain some of the Moon's oldest surface materials.



Planned route for the LUVMI-M 2028 mission (blue) in reference to the Shackleton crater.

[1] Spudis, Paul D., et al. "Geology of Shackleton Crater and the south pole of the Moon." *Geophysical research letters* 35.14 (2008).

4.2 Mechanical Environments

Payloads experience their highest mechanical loads during launch onboard Falcon 9, including accelerations, vibrations, acoustic pressure, and shocks. These loads vary with payload mass and mounting location on the rover. Space Applications Services will work with customers to define and verify these conditions.

Acceleration	Axial / lateral loads during launch.
Vibration	Sine and random vibrations during launch.
Acoustic	Peak during launch. Maximal expected levels by Nova-C are:

Oct. Freq. (Hz)	25	31.5	63	125	250	500	1,000	2,000	4,000
Acc. Env. (dB)	115	125	130	132	130	125	120	115	110

Shock	During fairing separation, landing, and rover deployment.

Frequency (Hz)	100	1,000	10,000
Shock Response Spectrum (g)	50	1,000	1,000

4.3 Pressure and Humidity Environments

LUVMI-M and its payloads will be exposed to varying pressure and humidity conditions throughout the mission:

Mission Stage	LUVMI-M Pressure	LUVMI-M Humidity
Pre-launch	~101 kPa	50 ± 15% (< 90%)
Launch	< -6.2 kPa/s	50 ± 15%
Transit & Surface Operations	3.2×10^{-5} kPa	0%

Prior to launch, LUVMI-M and its payloads are processed in climate-controlled facilities. However, transport may briefly expose hardware to environments of up to 90% humidity. The most significant pressure change occurs during launch, as payloads undergo rapid depressurization while the vehicle passes through transonic speeds. Afterwards, the payloads are exposed to deep space vacuum for the remainder of the mission.

4.4 Thermal Environment

From pre-launch through to deployment and lunar surface operations, LUVMI-M will experience a broad range of thermal conditions:

Mission Stage	LUVMI-M Temperature Range
Pre-launch and Launch	0 to +27 °C
Transit	-50 to +50 °C
Surface Operations	-100 to 0 °C (2028 mission)

Surface temperatures along the planned traverse vary significantly due to changing illumination and terrain conditions. Payloads should be designed to tolerate these temperature fluctuations or to leverage the rover's own thermal interfaces (see Section 3.4) to maintain operational stability.

4.5 Radiation Environment

LUVMI-M is expected to experience a moderate radiation environment along its trajectory, which includes a brief transit through the Van Allen belts in Low Earth Orbit (LEO), a 7.5-day interplanetary transfer, and 14 days of lunar surface operations.

Amongst these phases, the highest radiation rates occur during the short passage through the Van Allen belts. Across the transfer and surface phases, exposure is mainly from Galactic Cosmic Rays (GCRs). As the LUVMI-M mission date of 2028 is approaching a solar minimum, higher GCR levels are expected, though the probability of intense solar particle events occurring will be lower.

The dose rates across mission phases are estimated as follows:

Mission Stage	Stage Duration	LUVMI-M Radiation Dose Rate*
Transit (LEO)	15 minutes	< 20 rad/day
Transit (interplanetary)	7.5 days	< 0.5 rad/day
Surface Operations	14 days	< 0.25 rad/day
Total Ionizing Dose		< 1 krad

* Values do not include the rates in the case of a major solar particle event.

4.6 Particle and Contaminant Environment

The lunar environment presents unique particulate and contaminant conditions throughout the mission phases:

Pre-launch	Assembly, integration and maintenance activities are guided by Planetary Protection regulations. LUVMI-M and its payloads should be handled in ISO Class 8 cleanrooms or better, following ECSS-Q-ST-70-01 standards.
Transit and Landing	During landing, the lander's engines may release trace amounts of propellant and vent helium pressurant post-touchdown. Additionally, lunar landings cause dust to be lifted, which gradually resettles over a period of hours to days. For sensitive payload components, shielding options can be implemented to provide additional protection.
Surface Operations	Lunar regolith is fine, sharp and electrostatically charged, which can cause it to adhere to external payload surfaces. Payloads mounted externally should assess any vulnerability to these effects.

4.7 Electromagnetic Environment

Payloads must be designed and tested in accordance with MIL-STD-461 or ECSS-E-ST-20-07C (EMC Test Methods). These standards define the limits and test procedures for both emissions and susceptibility of space hardware.

The EMC tests listed below should be followed to properly characterize interference and compatibility:

EMC Test	Referred Standard		Description
Conducted emissions	ECSS-Q-ST-20-07C	MIL-STD-461G (CE102)	Conducted electromagnetic noise from the payload on power / signal lines.
Radiated emissions	ECSS-Q-ST-20-07C	MIL-STD-461G (RE102)	Radiated electromagnetic emissions from the payload.

5 MISSION TIMELINE & OPERATIONS

5.1 Payload Development Roadmap

The timeline below outlines the key milestones towards delivery of the Structural and Thermal Model (STM), the Engineering Qualification Model (EQM), and the Flight Model (FM).

To support the validation of your payload's integration with the rover and lander, early-stage interfaces will be made available from Q1 2026.

Interface Review	Development Model Delivery	Flight Model Delivery	Environment Tests	Launch
ICD agreement between rover and payload	Mechanical, electrical and software model	Payload FM delivery to rover	Rover environmental tests	Payload ready and integrated
Q3 2026	**Q1 2027**	**Q3 2027**	**Q1 2028**	**Q3/Q4 2028**

The integrated rover and payloads will undergo full environmental testing in Q1 2028, including vibration, thermal vacuum, EMC, and RF checks. STM-level test data will support early verification and will be available by Q2 2026.

5.2 Launch and Surface Operations

The LUVMI-M mission follows a multi-phase profile, beginning with launch and ending with surface operations on the Moon. The key phases are outlined below:

Launch & Transit

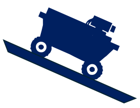
After integration on the lander, the rover will remain powered down through launch. The transit to the Moon is expected to last approximately 7 – 8 days. During this phase, limited power-up windows may be allocated for payload or heater activation, subject to mission constraints.

Lunar Descent & Landing

The lander will execute the descent and soft landing at the Shackleton-de Gerlache Ridge. LUVMI-M and its onboard payloads will remain mechanically stowed until deployment is triggered post-landing.

Rover Deployment & Surface Mission

Once on the lunar surface, the mission is structured into three sequential operational phases:



Egress & Commissioning (0.5 days): Deployment from the lander garage, commissioning, mobility tests, and initial payload health verification.

Local Exploration (3 days): Scientific operations at sites within the lander vicinity (< 1,000 m).

Extended Traverse (7 – 10 days): The rover traverses up to 5 km and performs scientific operations outside the lander vicinity.

Real-time communication with up to 5 seconds latency is maintained during surface operations, depending on the communication windows provided by the IM-lander for local exploration and relay satellite services for extended traverses. Operations are performed by Space Applications Services operators or payload operators present at the Space Applications Services Control Centre in Brussels.

Outside these communication windows, payloads can be activated via pre-programmed, time-tagged telecommands. Data and telemetry will then be stored onboard and downlinked to the Control Centre during the next communication window. This is only possible for payloads that are non-disruptive and with a low risk associated with their non-supervised operation.

6 HOW TO JOIN?

6.1 How to Propose a Payload?

Interested in flying your payload on LUVMI-M? Simply start by filling out our questionnaire. Let us understand your payload's basics and how we can support you. For more detailed technical information and integration requirements, we are happy to provide the Interface Control Document upon request.

Do you have questions or want to chat about your ideas? The LUVMI-M team is here to help and guide you. Contact us at **moon@spaceapplications.com**.

6.2 Engineering Support Provided

As the payload developer, customers have the choice of how much engineering support is required for their payload.

Customers have the option to request end-to-end LUVMI-M services while performing their own payload development. Engineering support from Space Applications Services may consist of:

- Guidance during the payload development and testing
- Interface testing with the rover
- Safety and flight certification
- Software security
- Payload integration activities towards the LUVMI-M rover
- Integration contact towards Intuitive Machines,
- Pre-launch preparation activities
- Operational setup activities
- Data delivery

Alternatively, customers have the option of defining the scientific / technical requirements for their payloads, while we take care of design, development and testing activities in addition to the above-described end-to-end service.