



ASTROBOTIC

Astrobotic's Space Logistics Services: Making the Moon Accessible to the World

FISO Telecon

November 30th, 2022

Astrobotic Technology, Inc.

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WHY THE MOON

FUEL DEPOTS



MINING



MANUFACTURING



EXPLORATION & RESEARCH



LIVING OFF THE LAND



MULTI-PLANET SPECIES



ASTROBOTIC BY THE NUMBERS

2007

Founded (spun out of CMU Robotics)

206

Employees

50+

NASA lunar-related contracts

2

Lunar lander missions booked

2

Lunar rover mission booked

25+

Commercial + defense contracts

\$425M+

In customer-awarded space robotic work

Astrobotic is the largest CLPS provider and the only U.S. company with awarded lander and rover missions to the Moon



200+ EMPLOYEES

**1000+ YEARS COMBINED EXPERIENCE
IN SPACE, ROBOTICS, & AERONAUTICS**

~HALF WITH ADVANCED DEGREES

We draw talent from the best of the space industry
and beyond (e.g., robotics, nuclear, micro-e)



Pictured: Approximately ~50% of current staff

ASTROBOTIC FACILITIES

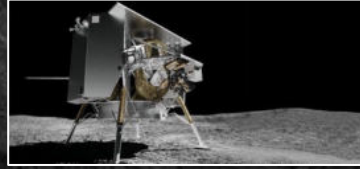


- 47,000 square foot facility completed in August 2021.
- Astrobotic HQ can host four concurrent spacecraft developments and has an adjoining mission control center (available for your mission if needed).

DELIVERY

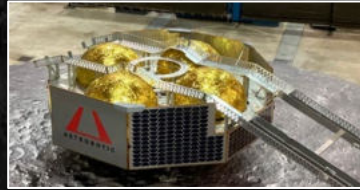
Peregrine Lander

Surface payload: 120 kg



Griffin Lander

Surface payload: 500 kg



MOBILITY

CubeRover[®]

Surface payload: Up to 24 kg



Polaris Rover

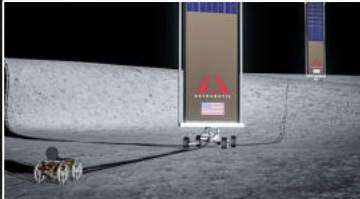
Surface payload: 90 kg



POWER

LunaGrid[®]

Provides 10s of kW of power



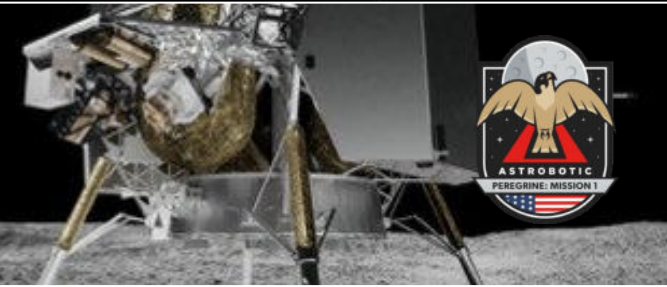
TEST

Xodiac

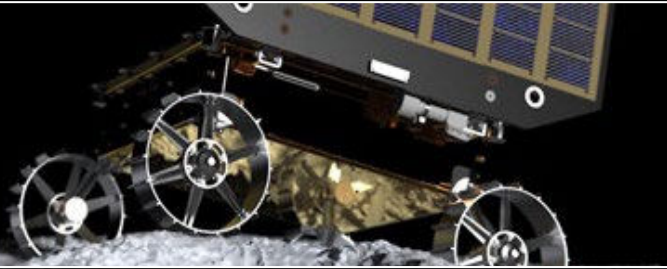
Suborbital testing to 300 m



Peregrine Mission One Q1 2023



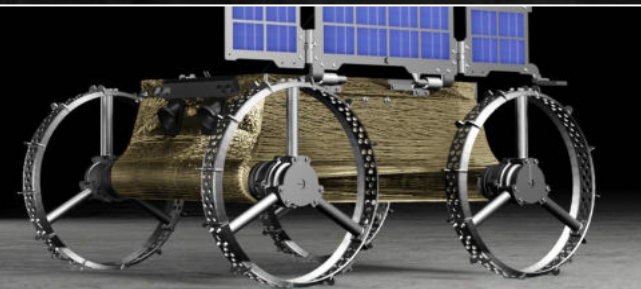
MoonRanger Q4 2023



Griffin Mission One Q4 2024

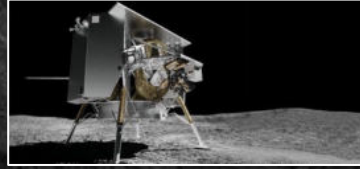


Night Rider Q4 2025



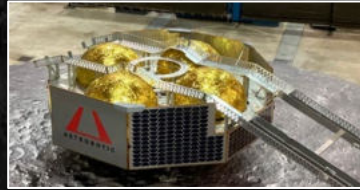
Peregrine Lander

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CubeRover®

Surface payload: Up to 24 kg



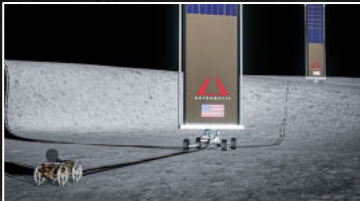
Polaris Rover

Surface payload: 90 kg



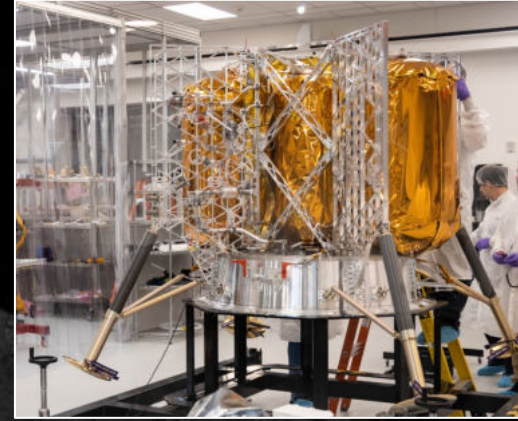
LunaGrid®

Provides 10s of kW of power

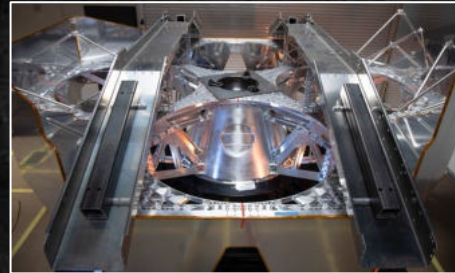


Xodiac

Suborbital testing to 300 m



PEREGRINE MISSION ONE



GRIFFIN MISSION ONE



ASTROBOTIC MANIFEST



MISSION ONE **PEREGRINE** Q1 2023

LANDING SITE: LACUS MORTIS

**16 customers
from 6 countries**

**\$79.5M
NASA award**

PEREGRINE MISSION ONE

DHL



PULI



DYMON



AEM



ASTROSCALE



ATLAS



ELYSIUM



LM1



SPACEBIT



MOONARTS



DHL MOONBOX



ARCH FOUNDATION



CANADENSYS



CARNEGIE MELLON



ASTROBOTIC



NASA



PEREGRINE LANDER

Top-Mounted
Solar Panel

Medium
Gain Antenna

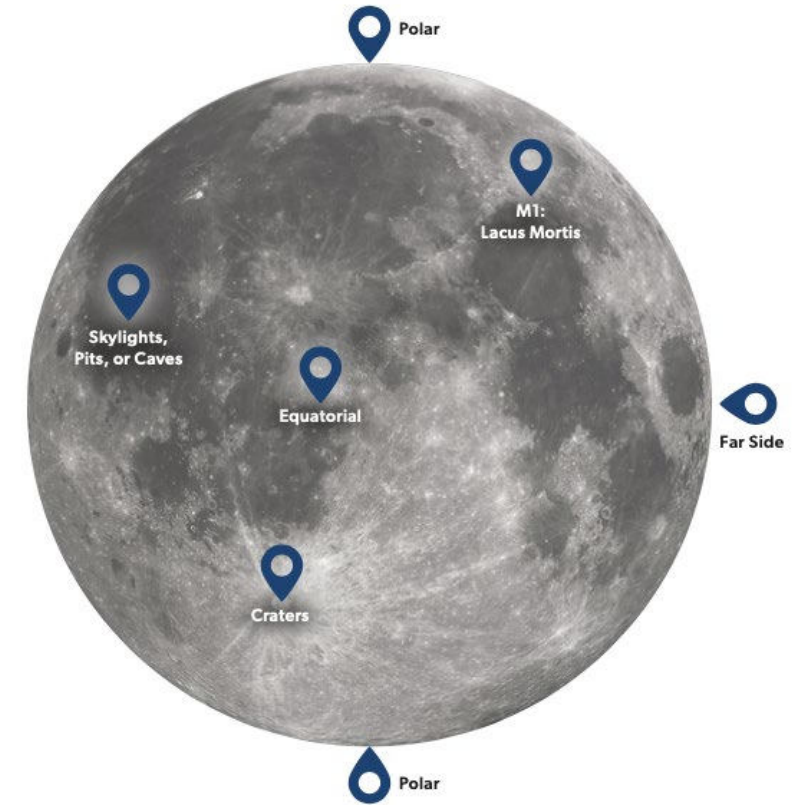
Side-Mounted
Radiators



Propellant Tanks

Payload
Mounting Decks

Attitude Control
Thrusters

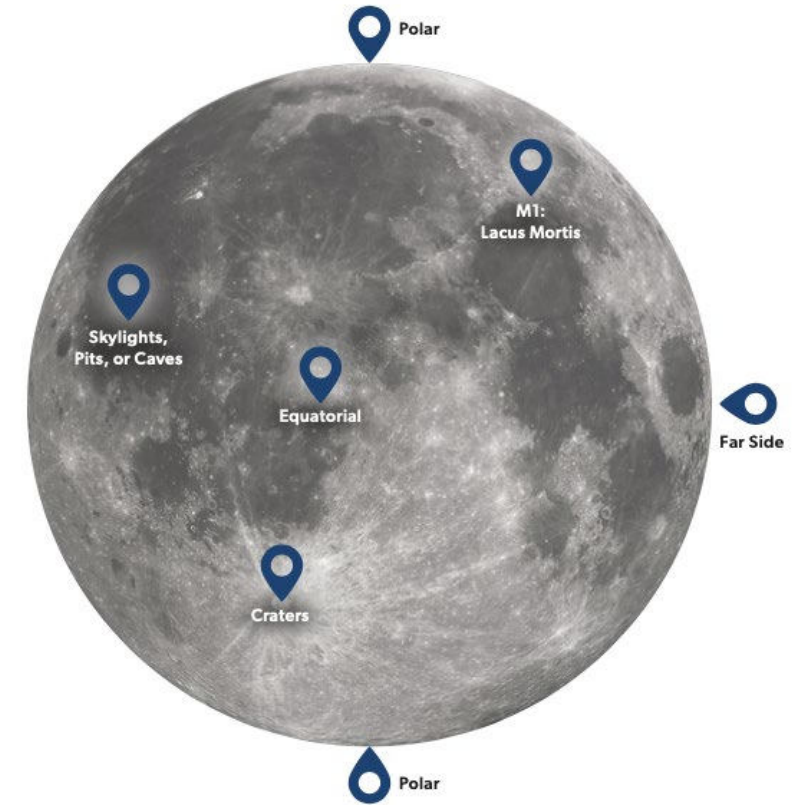
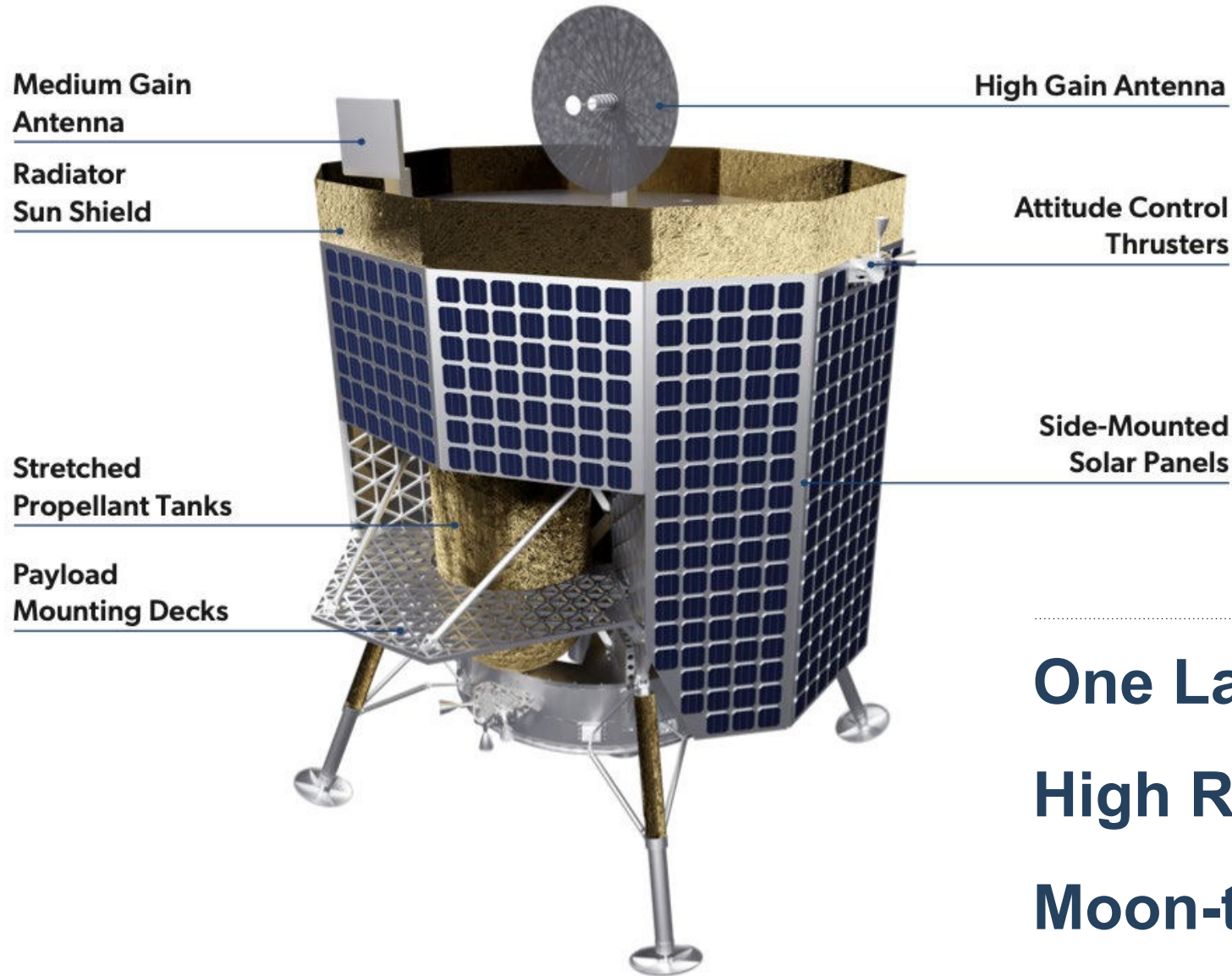


One Lander, Any Mission

High Reliability, Low Complexity

Moon-tested in 2021

PEREGRINE LANDER



One Lander, Any Mission

High Reliability, Low Complexity

Moon-tested in 2021

ASTROBOTIC MANIFEST

MISSION THREE

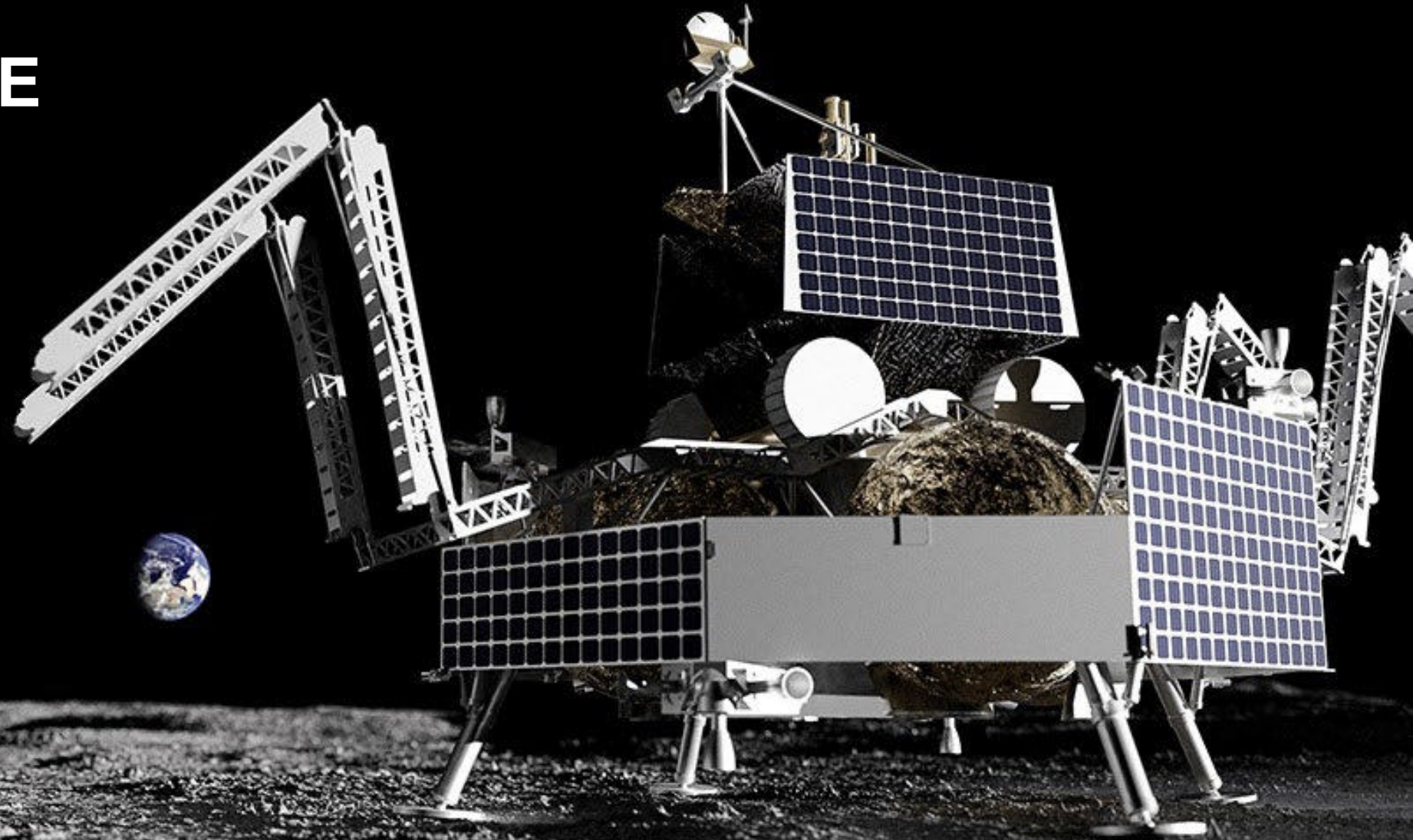
GRIFFIN

Q4 2024

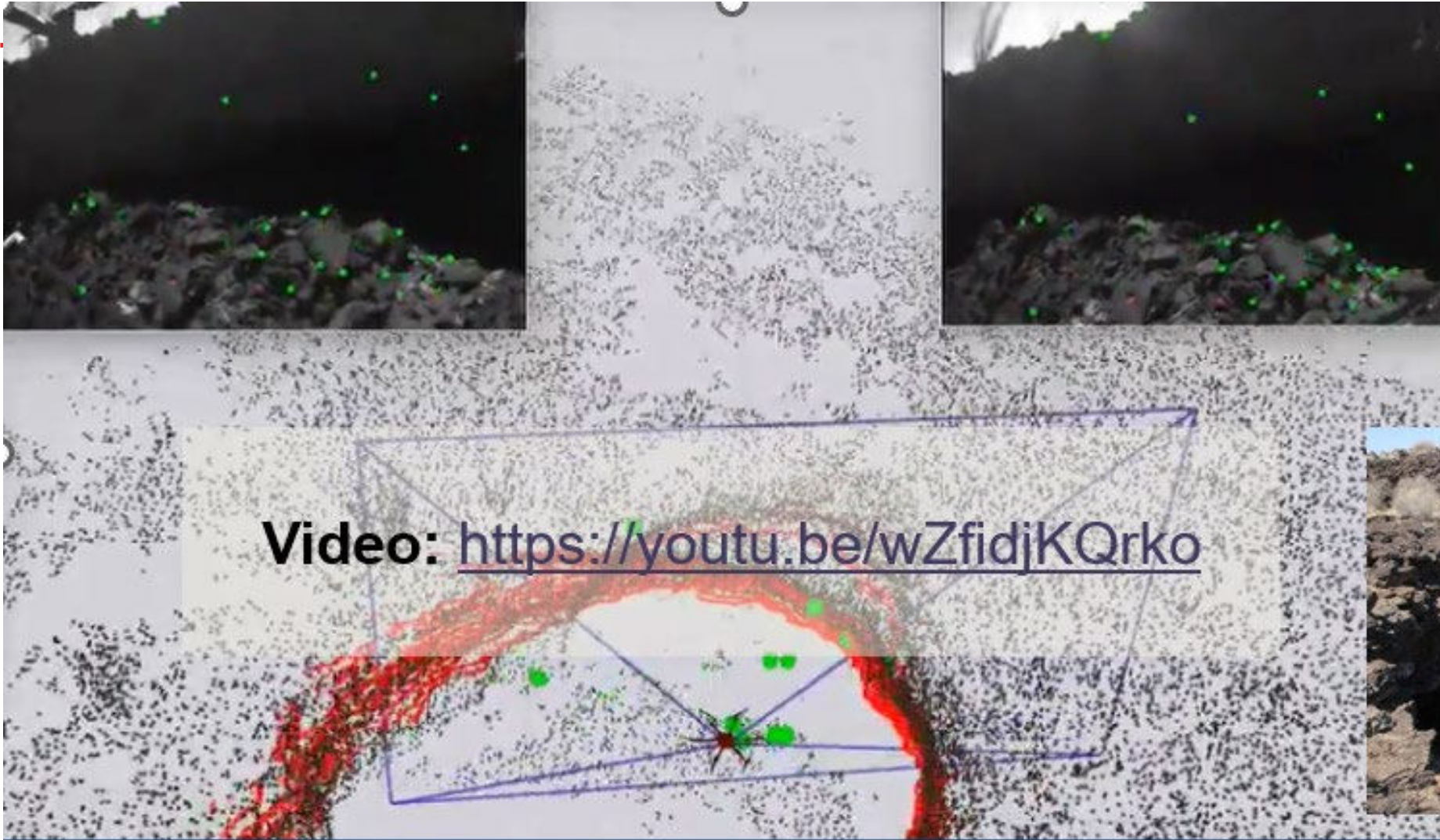
LANDING SITE: SOUTH POLE

Carrying the
NASA VIPER
rover

\$199.5 million
NASA award



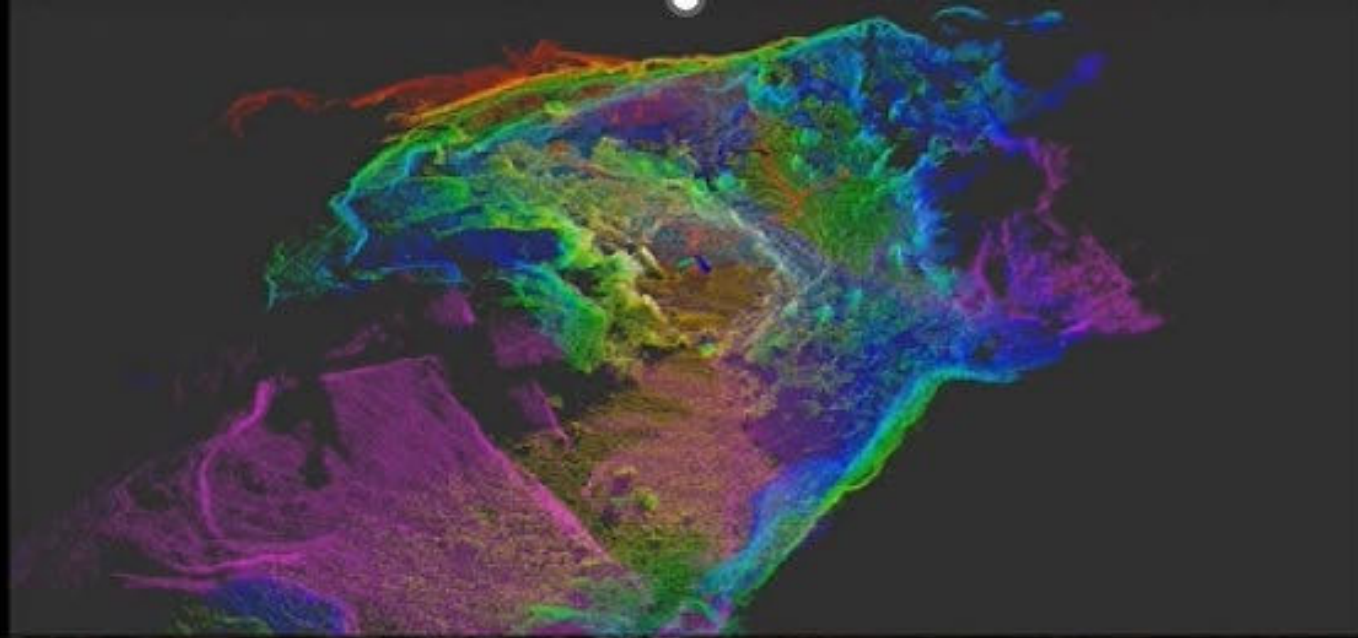
POTRILLO VOLCANIC FIELDS, NEW MEXICO

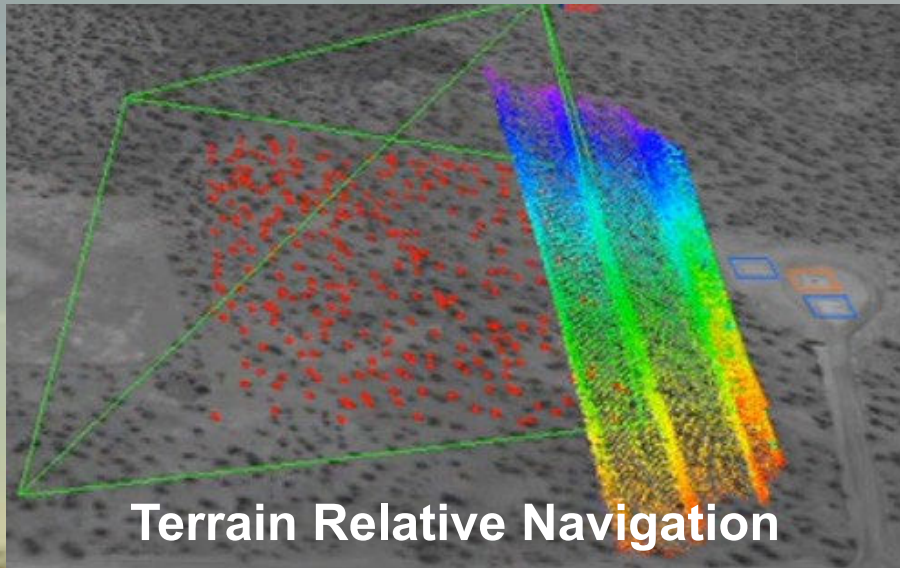
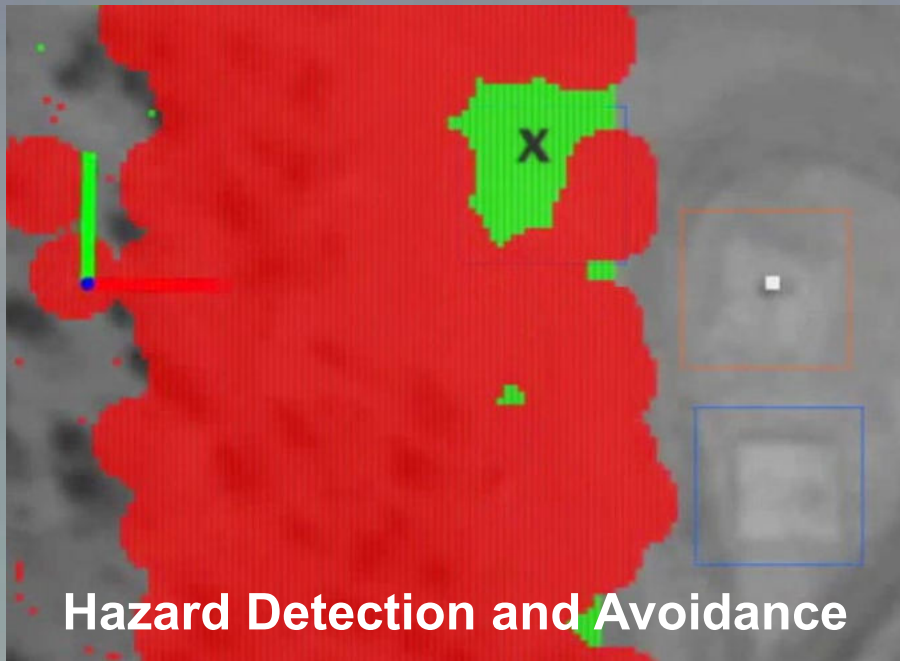


AstroNav Real-time LiDAR/Vision Flight in Volcanic Pit

Rapps Cave, West Virginia

2x Speed





TRL 6 Terrain Relative Navigation (TRN) and Hazard Detection & Avoidance (HD&A) (Flight Opportunities Program, Mojave, CA)

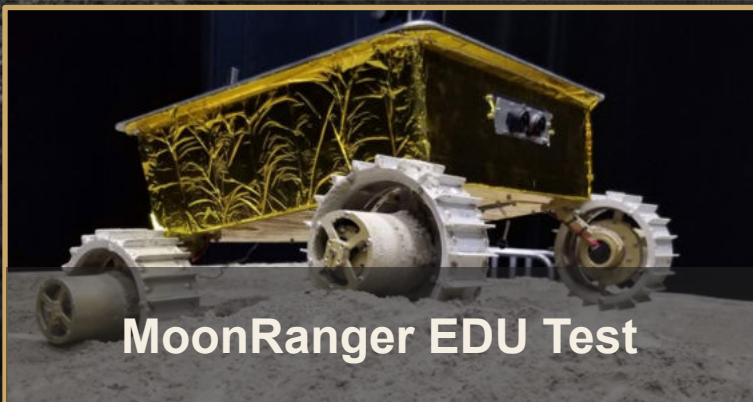
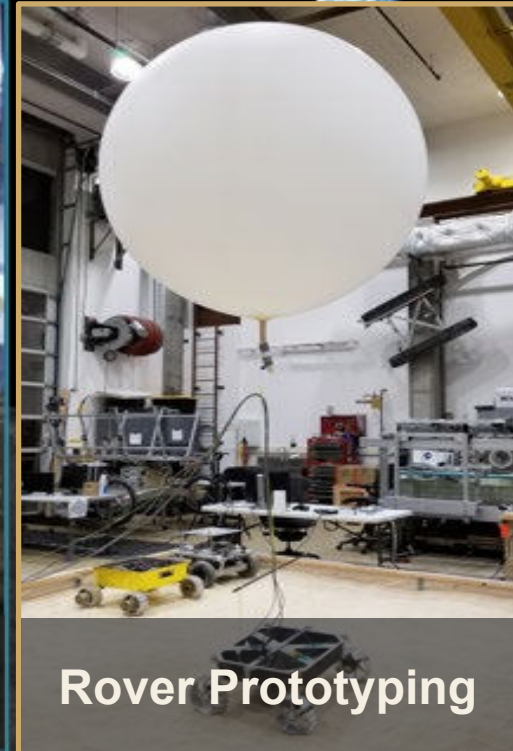
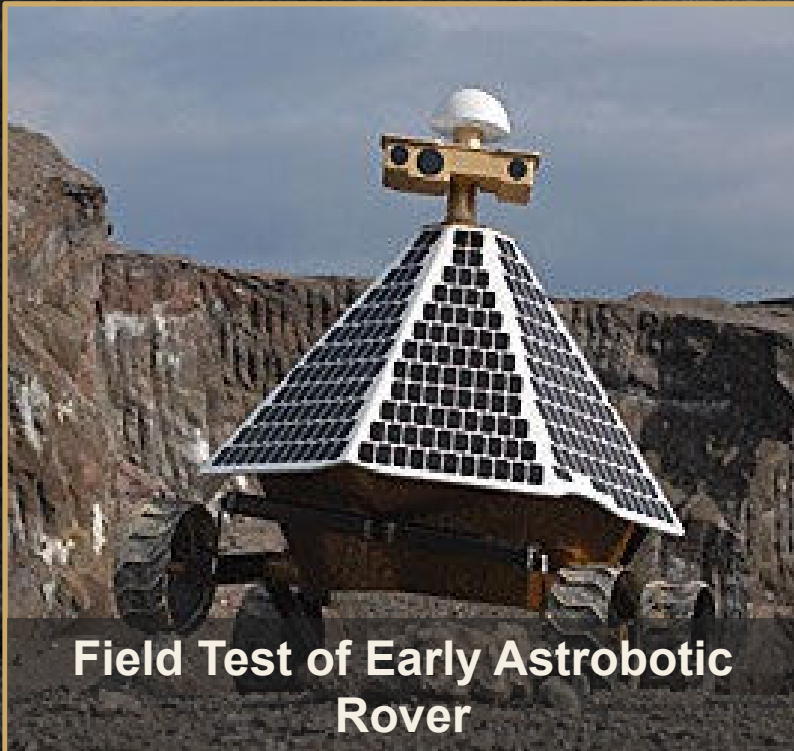
Video: <https://youtu.be/53hLiOWHByQ>

SBIR Sequential Phase II Award

- **Designed to survive the lunar night**
- **Communication with lunar orbital assets**
- **2025 flight on Astrobotic's lander**
- **1U with 1 kg of payload capacity available on board**



ROVER HERITAGE: PRIOR WORK



Polaris

Mobility as a Service

System Specifications

Mass: 300 kilogram

Payload Capacity: 90 kilogram

Dimensions: 1.7 m x 1.1 m x 1.7 m

Rechargeable Battery: 960 Wh

Comms: 1.5 Mbps direct-to-Earth (stationary),
600 kbps (roving)

Control: Teleoperation with safeguarding

Drivetrain: 4-wheel skid steer

Nominal Speed: 10 cm/s

Flexible multi-mission bus

Technical Maturity

Peregrine Lander avionics, power,
communications, and interfaces

Red Rover rocker suspension for slope
climbing and long distance traverse

CubeRover system engineering and
development

Compatible with Astrobotic's Griffin Lander



CubeRover

Mobility as a Service

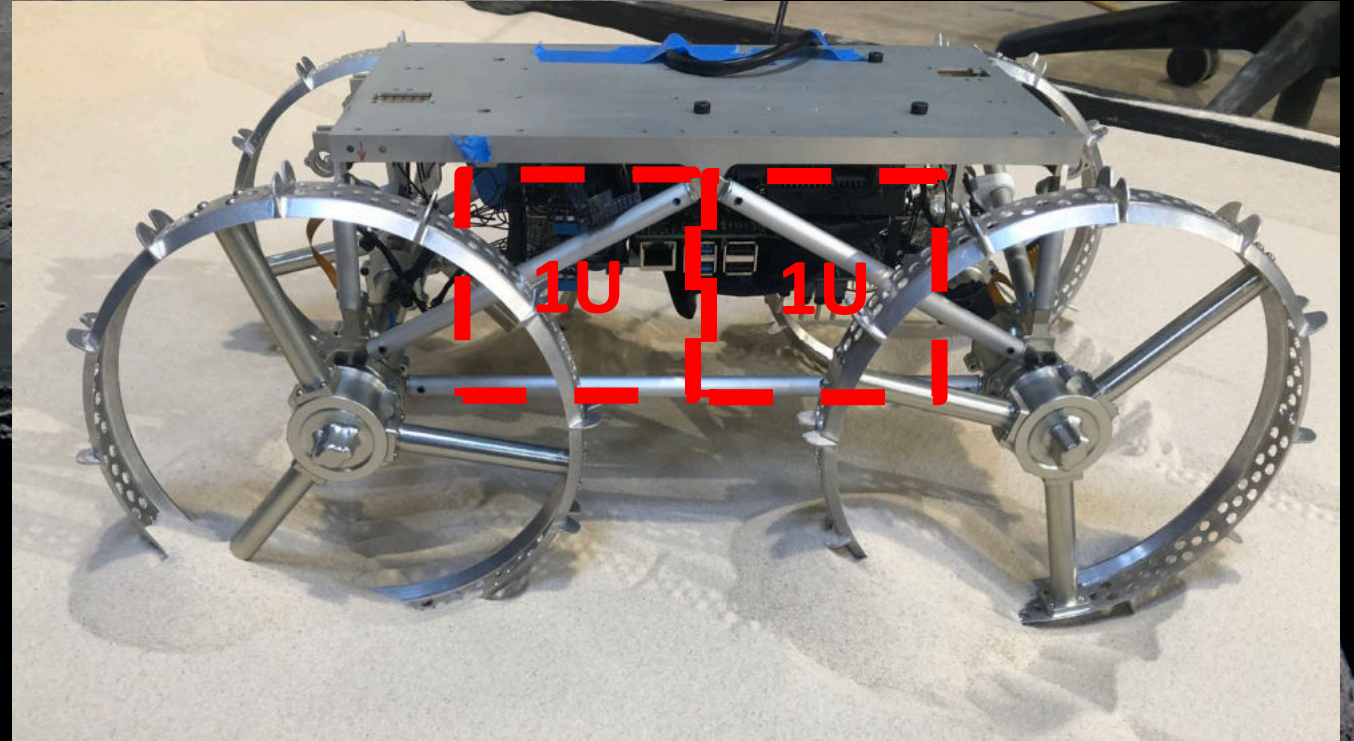
Astrobotic offers *Mobility-As-A-Service* on CubeRovers for payloads on the lunar surface. Service on CubeRovers includes payload integration onto a CubeRover, launch and landing on the Moon via Astrobotic's lander, along with directed control of the CubeRover on the Moon for payload operations. CubeRovers are also offered as a standalone products to support robust payload customer needs.



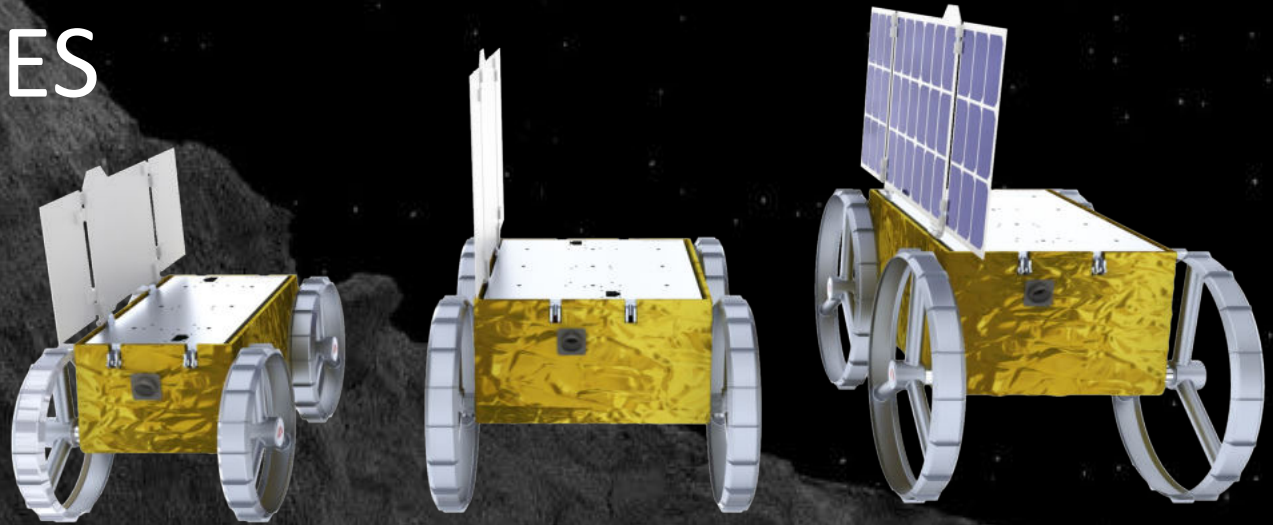
CUBEROVER LEVERAGES THE CUBESAT SIZE STANDARD

CubeRovers leverage the CubeSat standard for payload volume and mass, such that:

- Each “U” can accommodate a 10 x 10 x 10 cm payload that weighs up to 1 kg.
- For example, a 2U CubeRover has a payload bay that can accommodate two 1U CubeSats (20 x 10 x 10 cm and up to 2 kg)
- CubeRovers are available in many sizes: 2U, 4U, and 6U are available today.



CUBEROVER SERVICES



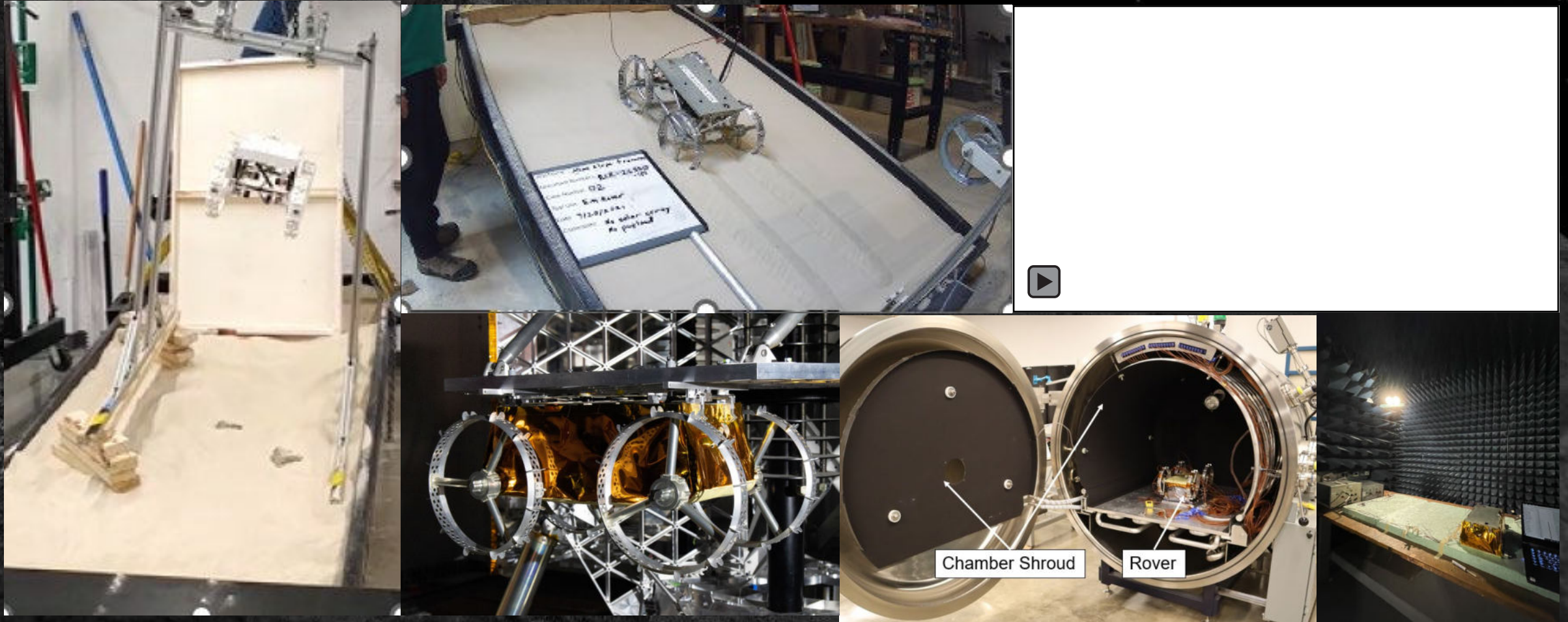
CUBEROVER SPECS	2U	4U	6U
Rover Mass	4.6 kg	8 kg	10.6 kg
Payload Capacity	Up to 2 kg	Up to 4 kg	Up to 6 kg
Guaranteed Payload Envelope	20 x 10 x 10 cm	20 X 20 X 10 cm	30 X 20 X 10 cm
Non-Standard Payload Envelope	Additional 2100cm ³ internal and 910cm ³ external volume available	Additional 3900cm ³ internal and 1768cm ³ external volume available	Additional 5700cm ³ internal and 2625cm ³ external volume available
Payload Nominal Power Services	100 Wh +	150 Wh +	200 Wh +
Payload Power Interface	28 Vdc		
Payload Thermal Environment	-20C to 60C		
Payload Wired Interface	RS-422		
Payload Comms Services	10 kbps per kilogram		
Payload Wireless Standard	WLAN 802.11n		
Payload Data Storage	32 Gb +		
Nominal Speed	4 cm/s		
Mission Duration	8 Earth days		

Non-standard services can be made available upon request.

CUBEROVER USES

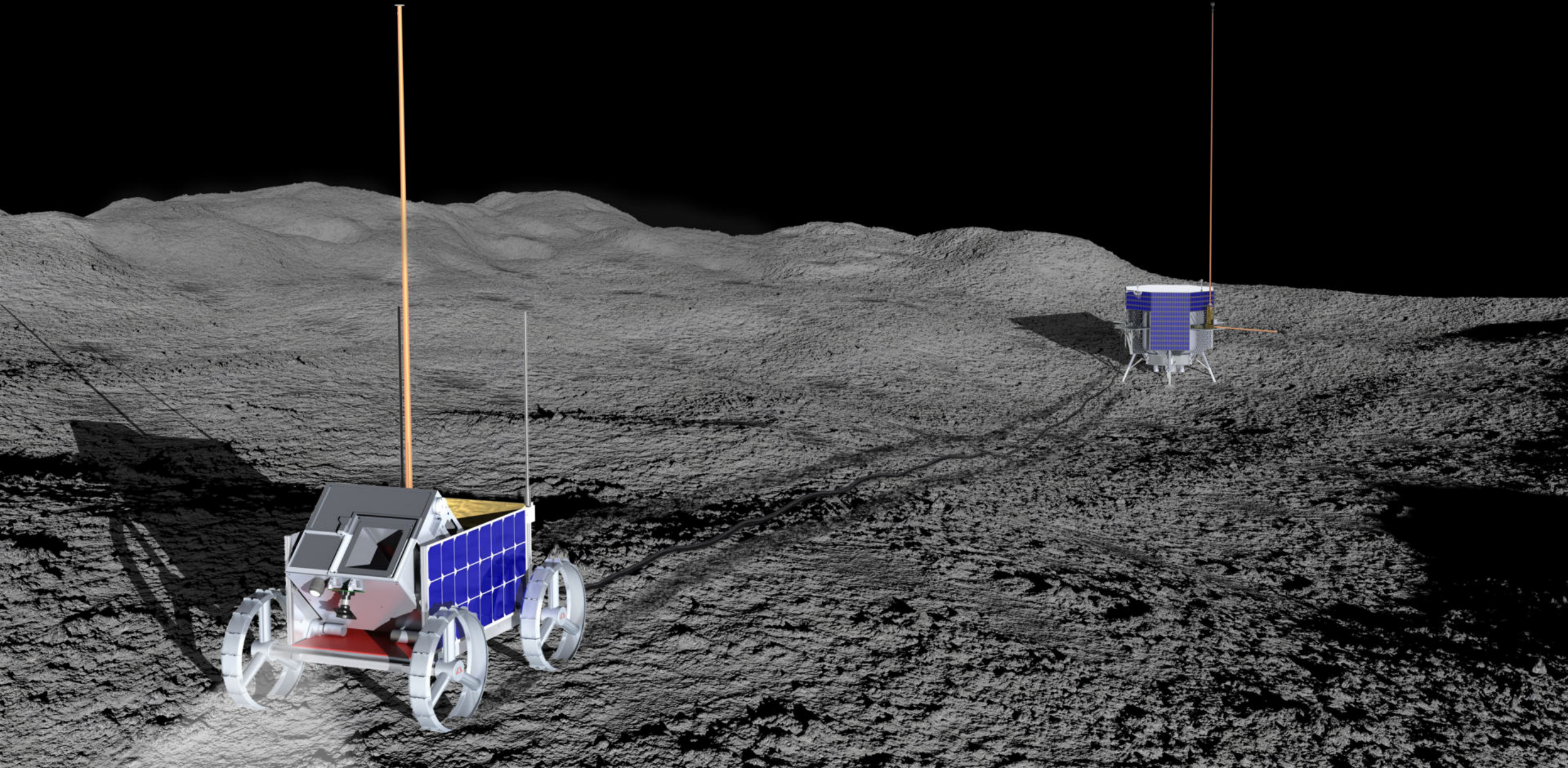
APPLICATION EXAMPLES		INSTRUMENT EXAMPLES
IN-SITU RESOURCE UTILIZATION		SPECTROMETER
SWARMING		NEUTRON DETECTOR
SCOUTING		GRAVIMETER
PROSPECTING		RETROREFLECTOR
TECHNOLOGY DEMONSTRATION		PENETROMETER
MARSUPIAL MISSIONS		MAGNETOMETER
BIOLOGICAL SCIENCES		ELECTROMETER
ENVIRONMENTAL MONITORING		GROUND PENETRATING RADAR

CUBEROVER MATURITY

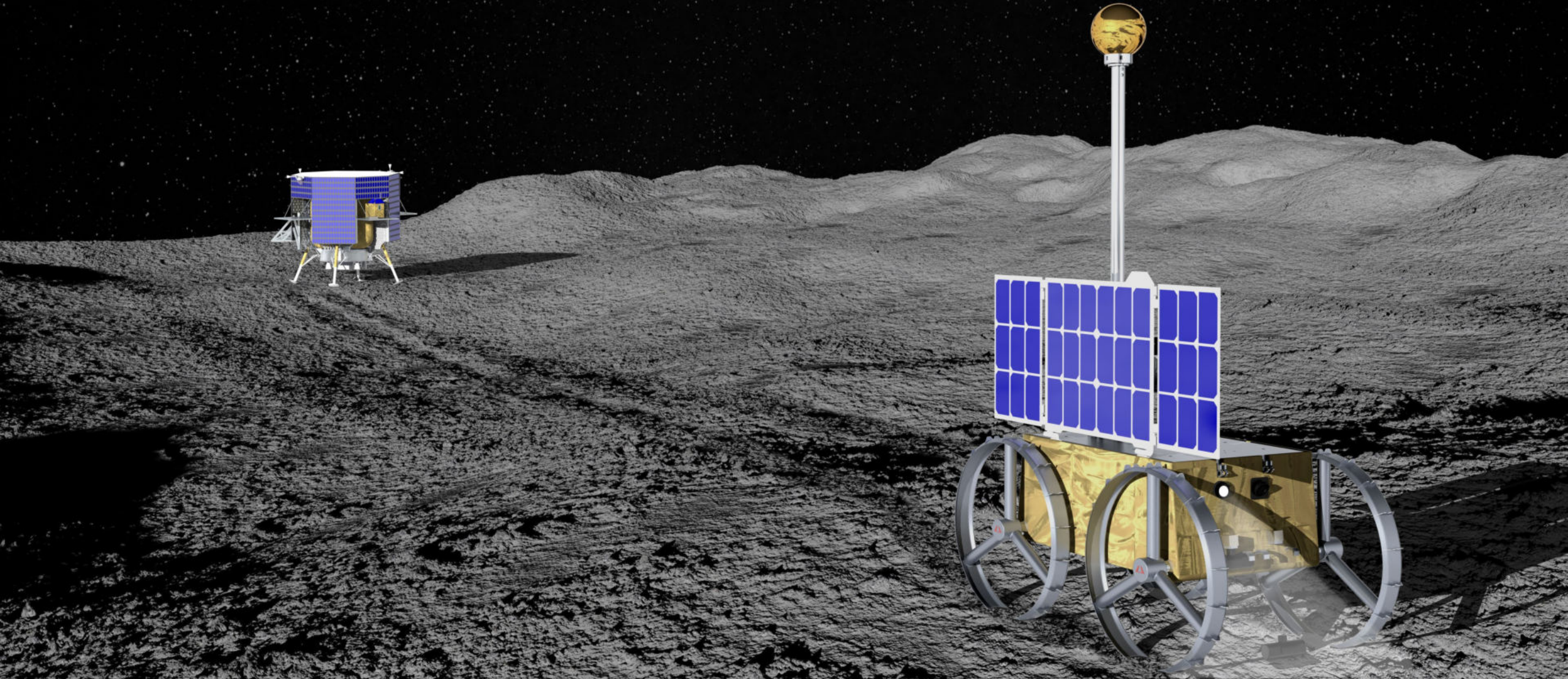


Patent pending stowage and deployment design.

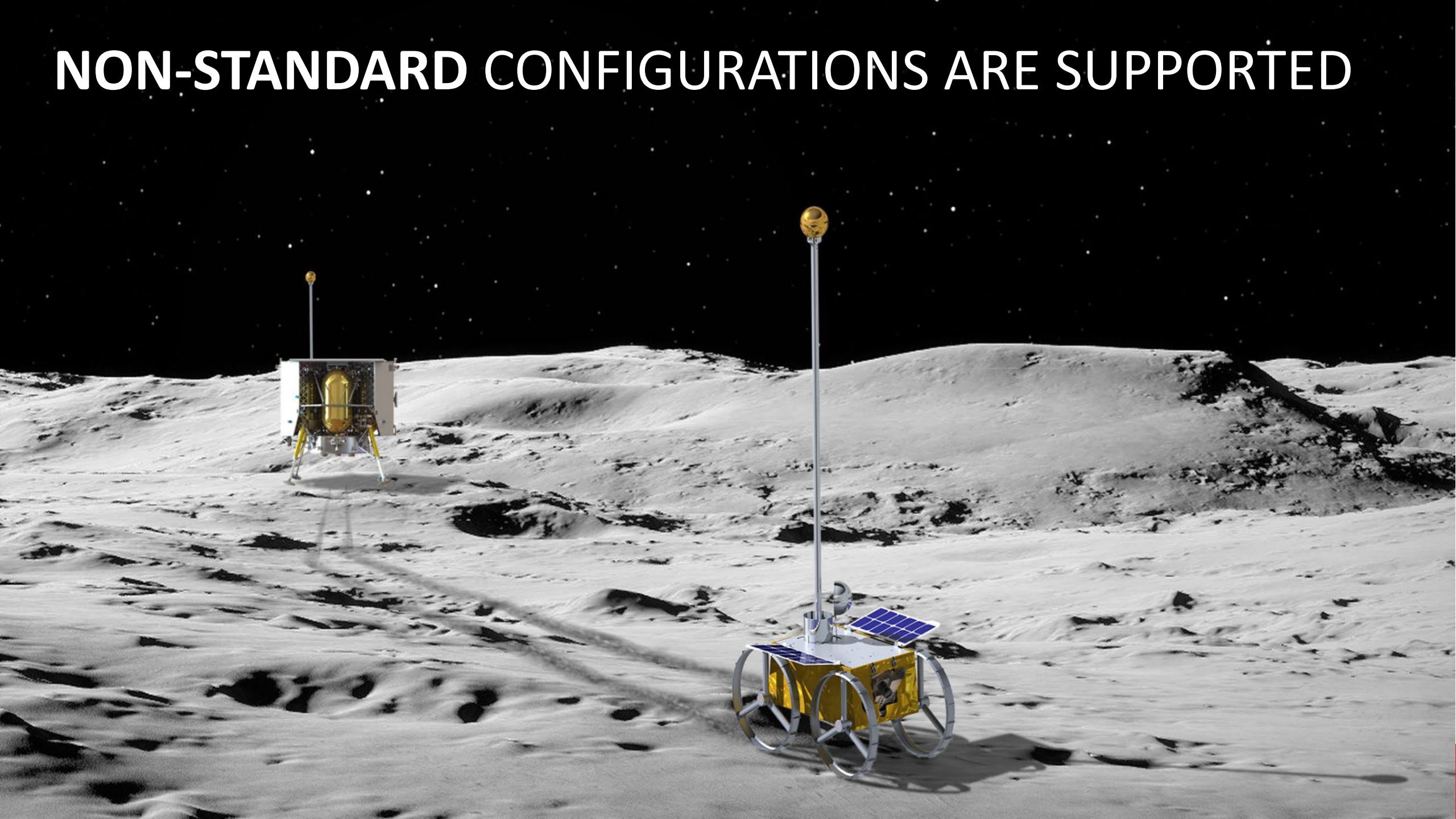
NON-STANDARD CONFIGURATIONS ARE SUPPORTED



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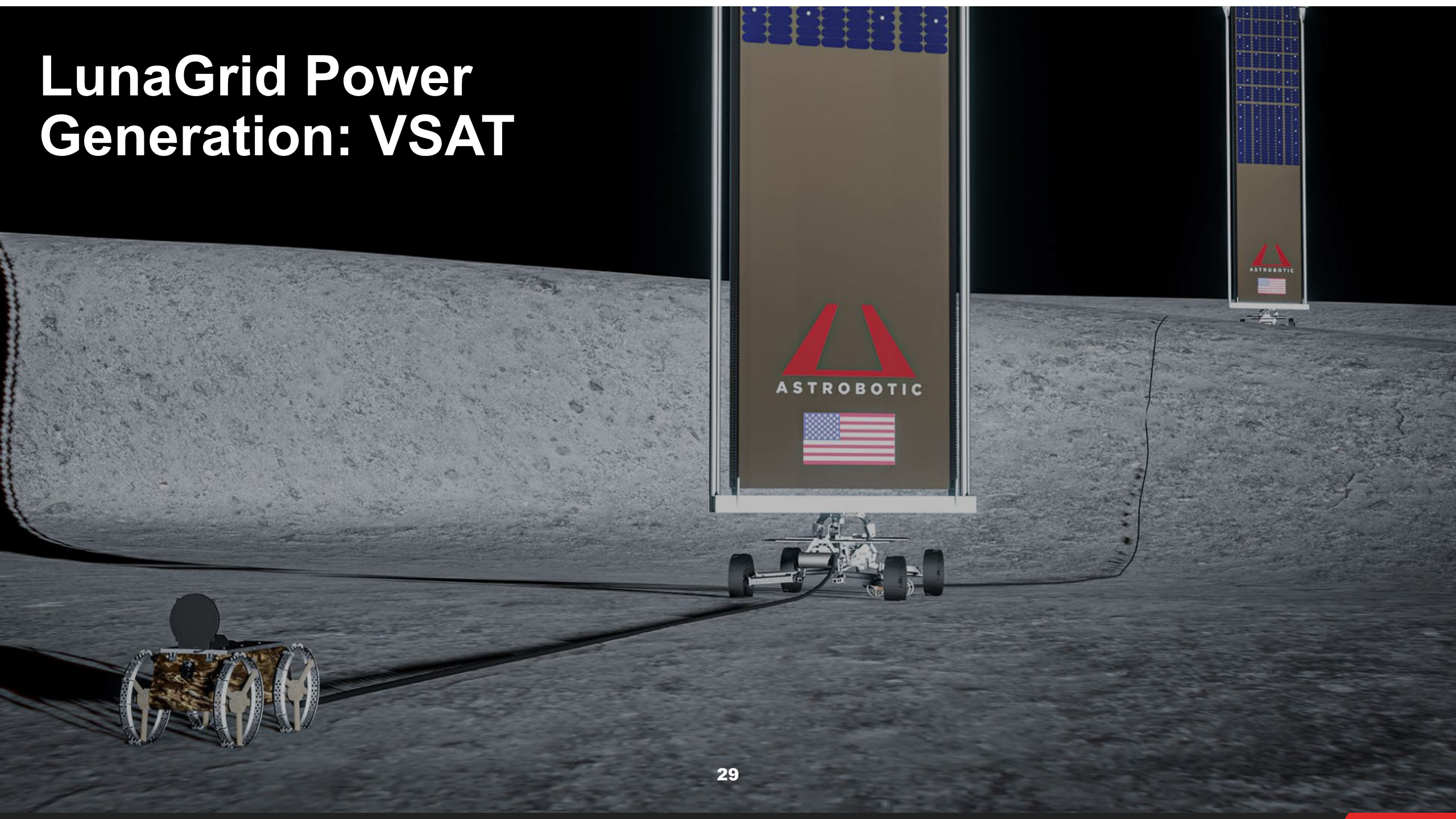
INTRODUCING LUNAGRID



Everything on the Moon depends on power.

LunaGrid (patent pending) is a complete power generation and distribution service that survives the lunar night and delivers tens of kilowatts of continuous power to surface assets for multi-year operations starting in 2026.

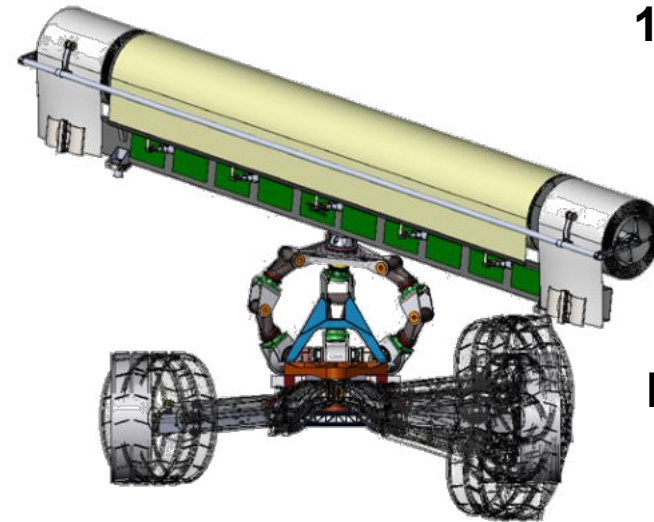
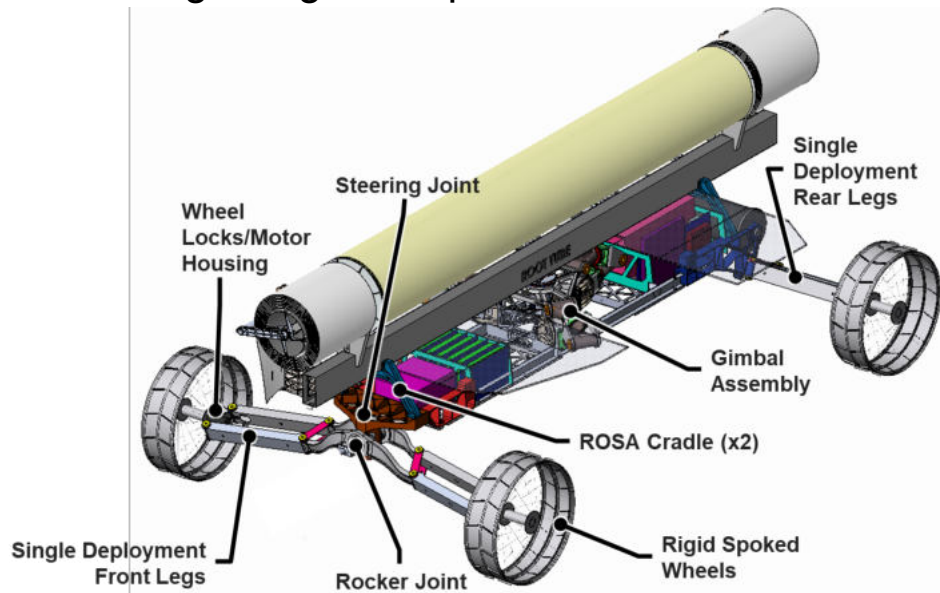
LunaGrid Power Generation: VSAT



VSAT

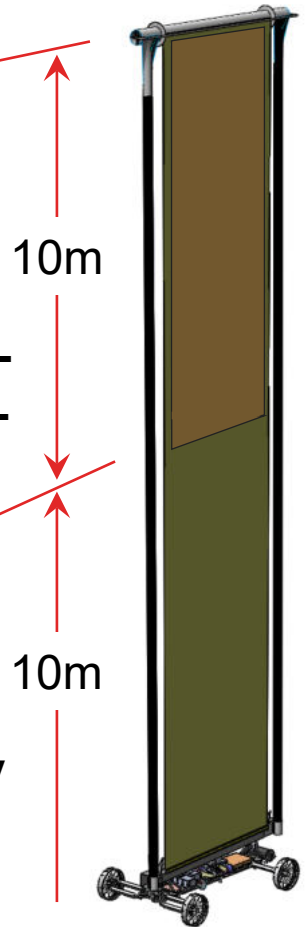
Contract Requirements:

- Autonomous deployment, retraction, and mobility to new Lunar surface sites
- Minimum of 10 deployment / retraction cycles
- 10kW beginning of life power
- 10m mast height to bottom of solar array blanket
- 15° incline terrain stability
- Adaptable to changes in illumination
- Adaptable to multiple mission architectures



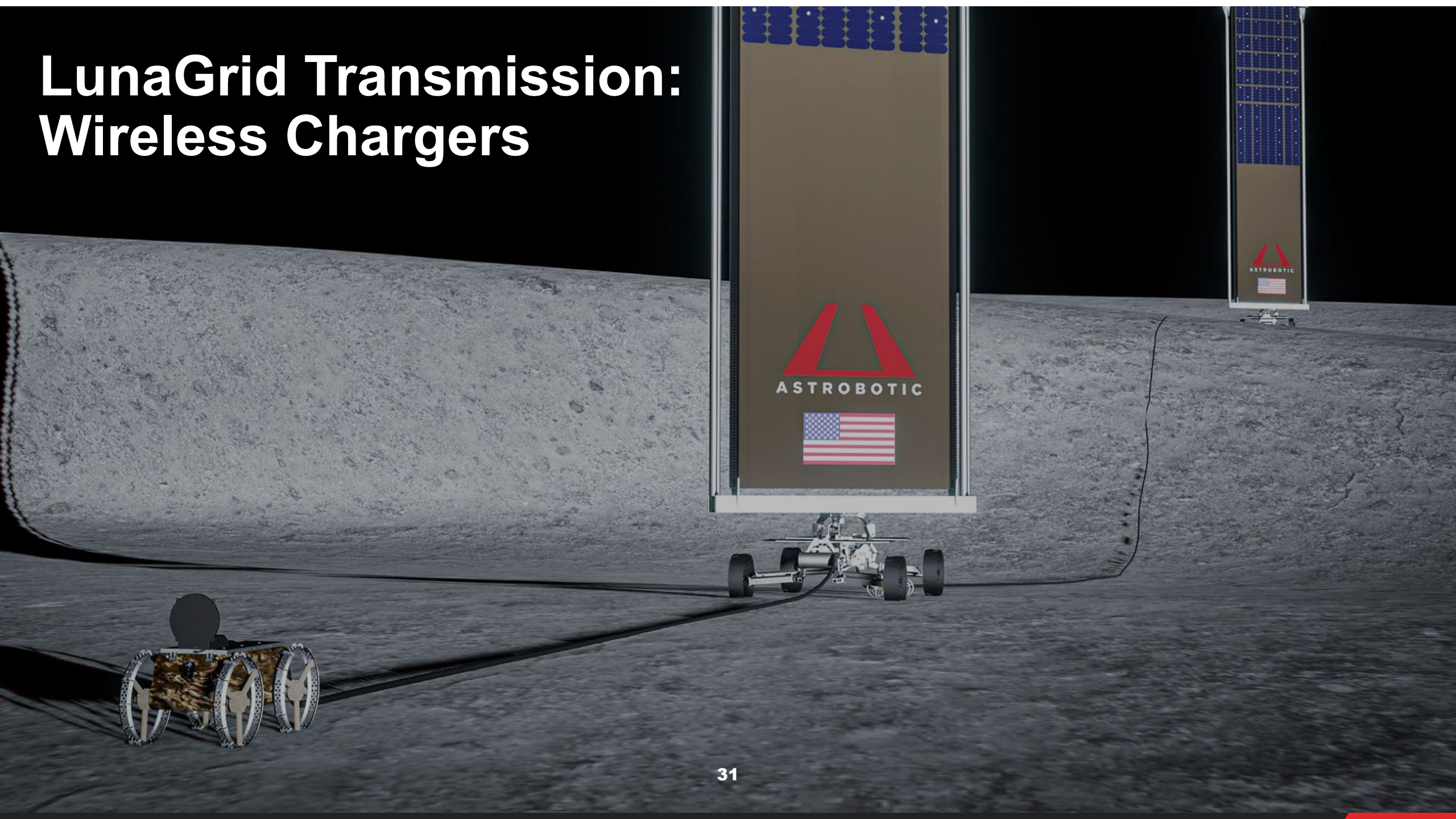
12.3KW BOL
10.3KW EOL

LIT mobility platform

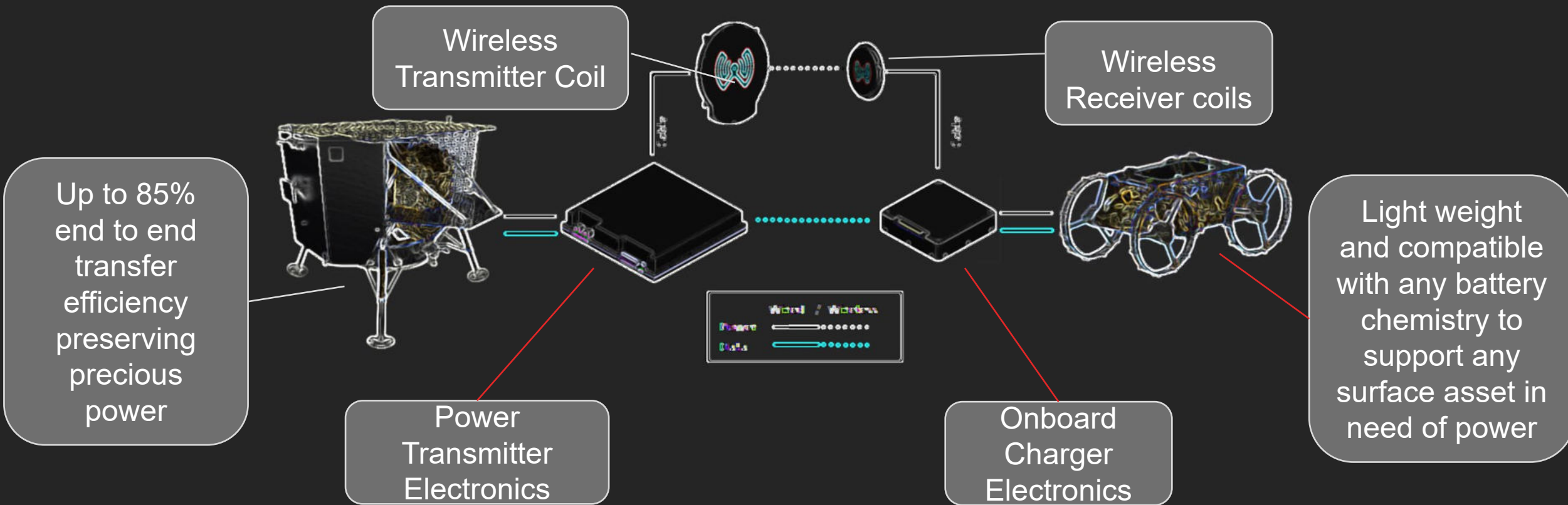


Redwire's ROSA has flight heritage and exceeds the VSAT mission requirements
Astrobot's LIT provides remote mobility without the reliance on other assets.

LunaGrid Transmission: Wireless Chargers



CUBEROVER + WIRELESS CHARGER



Astrobotic has developed wireless charging products under NASA's Tipping Point program

SYSTEM ADVANTAGES



Simple

Tether-free charging ConOps. Compact form factor for ease of integration



Durable

Rugged design and materials that stand up to the harsh dust, and extreme temperature swings of the lunar environment.



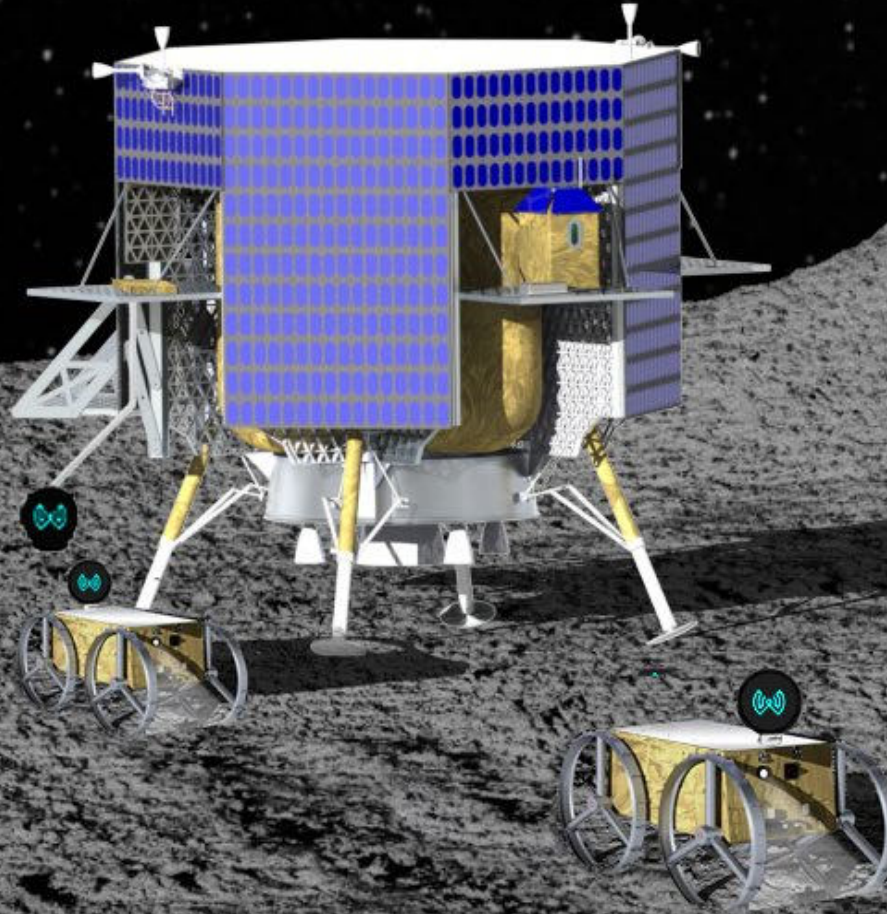
Flexible

Supports up to 70° of angular misalignment
≤4cm air gap between transmit & receive
125W, 400W power options



Efficient

Rapid charging provides up to **85% power transfer efficiency**, putting precious time and power back into your budget



Applications

Tool Recharging
Crew Suit Charging
Lander Assisted Charging
ISRU
Swarming
Scouting
Prospecting
Mining
Marsupial Missions
Tech Demos
Mars
Orbital Environments

CURRENT WORK AND MANIFEST

Astrobotic is currently working under a **NASA Phase II SBIR and NASA Tipping Point contract** to design and mature 125 W and 400 W charging system configurations.

Promising performance indications have resulted in significant commercial interest and lunar manifested opportunities

The wireless charger leverages **over \$7 Million** in NASA investments and commercial sales to date



A 125 W system has been selected to support NASA's Pilot Excavator mission to the Moon.

WIRELESS CHARGING TESTING



