



Initially Identified Areas of Interest for Europe

ESA

ESA-ESRIN, 16 January 2009

European Areas of Interest

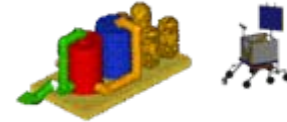


▶ **Lunar Cargo Lander**  + Payloads

▶ **Power Systems**



▶ **In-situ Resource Utilisation (ISRU)**



▶ **Communication / Navigation Systems**



▶ **Robotic Support Systems**



▶ **Fixed and Mobile Habitats**



▶ **Participation in int'l lunar transportation architecture**

+ ▶ **Enabling Capabilities**



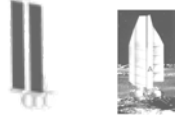
Introduction to Lunar Lander

European Areas of Interest



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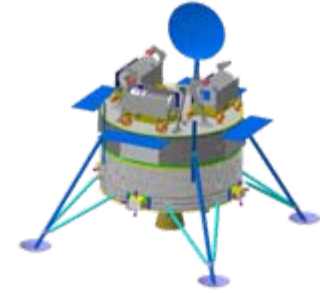
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Lunar Lander (1/4)



► Consolidated Mission Scenarios (with NASA, JAXA, ISECG)

- Preparation of human missions (before 2020)
 - Lunar environment characterisation
 - ISRU demonstration
- Support of Human sortie missions (after 2020)
 - Pre-deployment of logistics and cargo
(e.g. communication, navigation, mobility, power plant assets)
- Outpost build-up and sustained surface operations (after 2020)
 - Delivery of non-pressurised and pressurised logistics and infrastructure elements
 - Provision of consumables

NASA assessment:

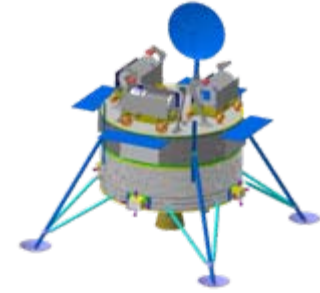
“Delivery of pressurized logistics significantly improves crewed surface stays over the first 3 years and could remove one ALTAIR launch from the manifest”.

Therefore:

Early availability at beginning of base construction (2020) is critical to achieve maximum benefit.



Lunar Lander (2/4)



▶ European Autonomy

- Automated lunar exploration, e.g.
 - Utilising (deep) driller (access to lunar sub-surface)
 - Search for territes (regolith top layer)
 - Utilising a hopper (access to permanently-shaded craters)
 - *Special case*: LOFAR deployment (LOW-Frequency ARray for radio astronomy)
- Capability demonstrations, e.g.
 - Soft/precision landing with hazard avoidance
 - ISRU (oxygen production)
 - Life support systems
 - Fuel cells
 - Habitation technologies





Lunar Lander (3/4)

▶ **ESA-NASA Cooperative Study**

- Phase 1: January to May, 2008
- A joint review of each agency's lunar architecture studies with the intent of identifying potential synergies between ESA and NASA concepts



“The ESA lunar logistics lander would significantly extend surface exploration opportunities by enabling enhanced mobility, extended habitation, and new science opportunities.”



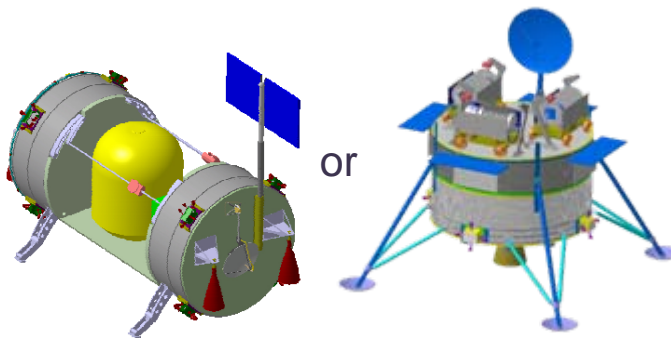
- **The Lunar Lander is a key asset for international cooperation on the basis of autonomous European capability.**

Lunar Lander (4/4)

► Concept Studies

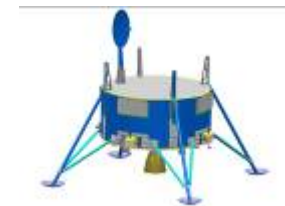
Full Ariane 5 Lunar Lander

- Launch mass 9.4 t
- Lander P/L mass 1.3 to 1.7 t
- Delivery of elements and logistics for surface infrastructure development and exploration



Shared Ariane 5 Lunar Lander

- Different concept studied
- Lander P/L > 200 kg
- Human mission preparation



Introduction to ISRU

European Areas of Interest



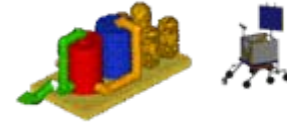
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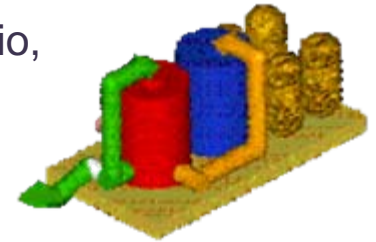




In-situ Resource Utilisation (ISRU)

▶ Supporting sustainable surface exploration

- Oxygen provision for various systems: life support, fuel cells, propulsion systems
- Reducing logistic re-supplies: Break-even time (produced vs. re-supplied O₂): from 18 months (depending on operations scenario, ECLSS loop closure)
- Providing dissimilar redundancy



▶ Moon-Mars Synergies

- Remotely controlled / automated operations
- Long-term hardware reliability
- Protection technologies against harsh environment (dust)

▶ Cooperation

- Basic element for international surface architecture
- On-going CAA study with NASA
- Joint international technology development possible



Introduction to Fixed and mobile Habitats

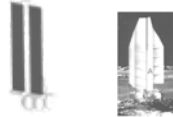
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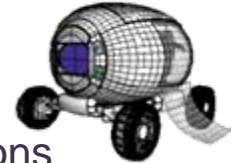
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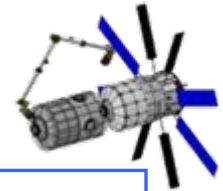


Fixed and Mobile Habitats



► Design concepts

- Mini-hab: supporting small crew for short missions
- Pressurised rover: providing long-range mobility for human surface exploration
- LEO / LLO stations: supporting assembly, servicing and habitation



► Coherence

- Building on strong European heritage:
 - Columbus module
 - ATV
 - ARES life support system

► European visibility

- Contributing key element to international surface architecture
- Foster European astronaut presence

► Cooperation

- On-going CAA studies with NASA and JAXA

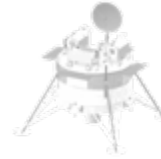


**a) Introduction to
Enabling
Capabilities**

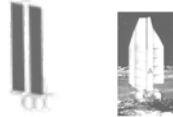
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Lunar Cargo Lander
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In-situ resource utilisation
Communication /
Navigation systems
Robotic support systems
Fixed and mobile habitats

Enabling capabilities

Autonomous Landing
Technology
Cryogenic Systems
Energy Provision Systems
Energy Storage
Thermal Control System
Electronics Systems
Structures and Mechanisms
Planetary Environment: Dust
ISRU
Human Robotic Systems
Environment Control & Life
Support System



b) Close-out

**Enabling
Capabilities**



Exemplary assessments of synergies between space/non-space roadmaps in three domains aiming at identifying synergies and potentials for collaboration between space and non-space domain.



Robotics

Trends in industrial robotic technologies and their connections to space exploration demands

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Fuel Cells

Report on technological prospects of industrial fuel cell technologies in consideration of space exploration needs

technological prospects of industrial fuel cell technologies in consideration of space exploration needs



Water and air management (Habitation)

Report on trends in water management and HVAC in consideration of space exploration needs

trends in water management and HVAC in consideration of space exploration needs





- ▶ **Define innovation goals** for enabling research and development for sustainable human space exploration aligned with international long-term programme planning and beyond currently approved projects
- ▶ **Assess the status of research and development in Europe** and world-wide in the defined innovation domains
- ▶ **Map European organisations** with relevant competences in the various innovation domains and existing project and activities against innovation goals
- ▶ **Identify gaps and overlaps**
- ▶ **Propose European focus areas**

