

International Dimension of Human and Robotic Exploration Activities

**United Nations/Jordan
Workshop on Global Partnership
in Exploration & Innovation
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**Thomas Weissenberg
ESA External Relations**

- Resolution on European Space Exploration Strategy adopted by Ministers at CM14 informed definition of European Exploration Envelope Programme approved at CM16
- Resolution Strategy recognises “**global cooperation**” among the 4 overarching objectives with a dedicated Chapter III focusing on **Global cooperation through flexible partnerships**
- E3P Period 1 addresses goals and objectives of ESA Exploration Strategy, including 3 destinations: LEO, Moon and Mars and to support realisation of strategic guidelines, among which the search for **new opportunities for cooperation** with both other space agencies and the private sector, while maintaining **NASA as a core partner**

E3P Period 1

On-going activities include:

- ✓ ExoMars TGO operations and completion of ExoMars rover for 2020 launch
- ✓ continuation of European participation in ISS until 2024, including utilisation activities, delivery of ESM-1 and provision of ESM- 2 to NASA Orion crew vehicle; complementary barter activities and preparation of beyond LEO activities
- ✓ development of European contributions to Russian Moon missions
- ✓ preparation of next robotic and human exploration missions beyond LEO (i.e. MSR) and development of selected enabling technology
- ✓ the implementation of commercial partnership initiatives in exploration

Majority of activities implemented in international cooperation with existing or new partners



Global Exploration Roadmap V3

ON TO MARS

MARS SURFACE

MARS ORBIT

Robotic Mars Sample Return



Goal of Humans on the Martian Surface



Mars Transportation Capabilities

Mars Orbital Mission

TO THE MOON

LUNAR SURFACE

LUNAR ORBIT

Robotic Resource Prospecting Missions



IN LEO

EARTH ORBIT



Human Lunar Surface Exploration

Deep Space Gateway

Gateway Moon and Mars Mission Support Operations



Orion and SLS



Commercial Transportation Systems



Russian Crew Transportation System

International Space Station

China Space Station

Future Platforms



CORNERSTONES

1. LEO **exploitation >2024** (ISS and transitioning to post-ISS commercial partnerships)
2. Early Human mission beyond LEO (**ESM + Gateway**)
3. Long term lunar surface exploration, initiated with **robotic precursor mission**
4. **Mars Sample return** (back-up Phobos)

TECHNOLOGY DEMONSTRATORS

1. rendezvous/docking demonstrator
2. ISRU demonstrator

MISSIONS OF OPPORTUNITY

1. Cooperation with CMSA on Chinese Space Station (CSS)
2. Commercialised lunar missions (communication, logistic services)
3. Cooperation with international partners on robotic lunar exploration

E3P Cornerstone #1 – ISS



The International Space Station legal framework is built on **three levels of international co-operation agreements**:

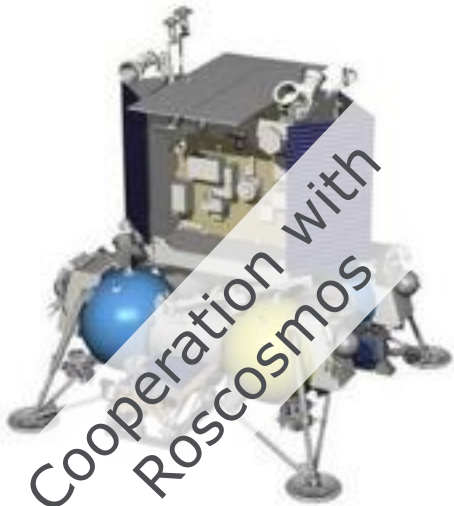
- The **International Space Station Intergovernmental Agreement**, often referred to as 'the IGA'
- Four **Memoranda of Understandings** (MoUs) between the National Aeronautics and Space Administration (NASA) and each co-operating Space Agency: European Space Agency (ESA), Canadian Space Agency (CSA), Russian Federal Space Agency (Roscosmos), and Japan Aerospace Exploration Agency (JAXA)
- Various bilateral **Implementing Arrangements** between the space agencies have been established to implement the Memoranda of Understandings

E3P Cornerstone #3 – Robotic Lunar Exploration Campaign: Mission Concepts



Implementing the ESA Science and Research Plan through missions with gradually increasing complexity

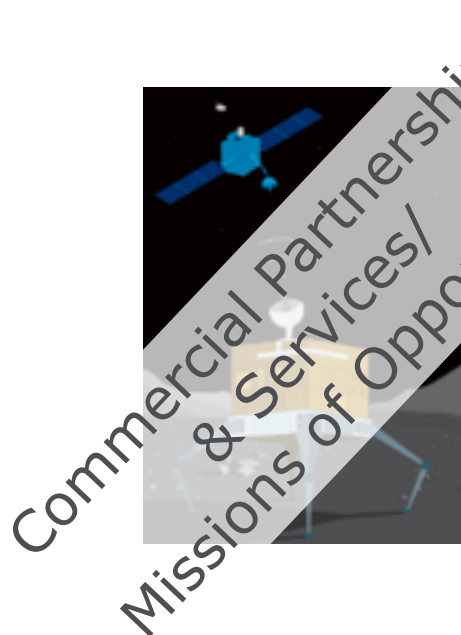
Luna Resource



Lunar Pathfinder



Robotic Surface Missions



HERACLES



Resource Prospecting
Precision Landing

Lunar CubeSats
Com/ Nav Service

Surface Payloads
Delivery Service

Sample Return
Ascent/ Extended Mobility



- Based on ISECG work and IECST study, ESA, CSA and JAXA working since 2013 on definition human lunar surface demonstrator mission concept
- Multilateral Mission Definition Study (Phase A) Plan initiated in September 2017, with support of NASA as observer and expected to be concluded by mid-2019
- Letter of Intent (LoI) signed end 2017/early 2018 between CSA, ESA and JAXA on joint study on future lunar exploration activities, with NASA and Roscosmos regularly informed

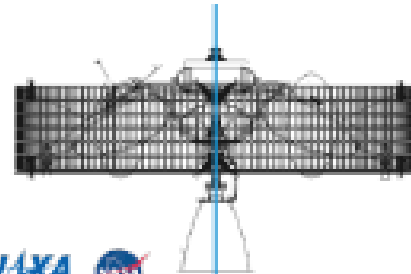
HERACLES Architecture Elements and Potential Roles



Launch

Mission
Capabilities

Delivery of space segment
Certification for exploration missions

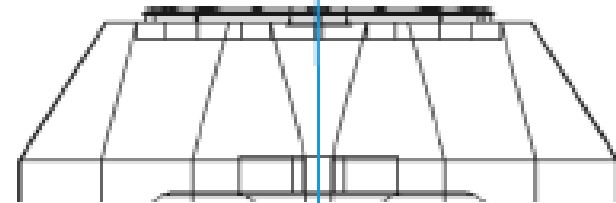


Lunar Ascent Element (LAE)

Mission Moon launch demonstration, sample delivery
Payload 22kg sample container
Mass (wet) 1100 kg
Technologies Propulsion, Visual navigation for rendezvous, GNC, night survival

Ground Segment

Mission Operation and sample curation
Capabilities Flight and surface operations, sample reception, analysis, curation

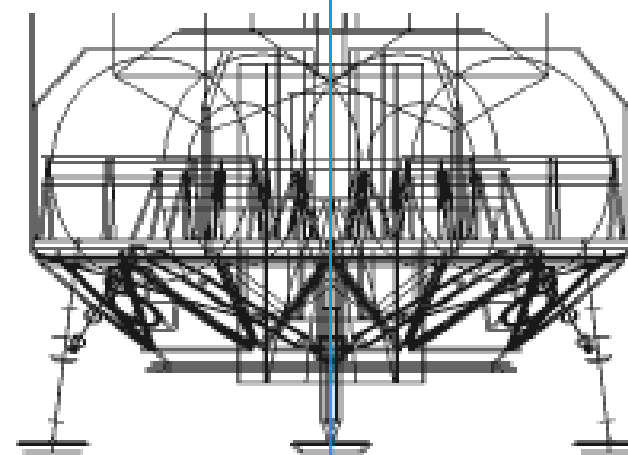
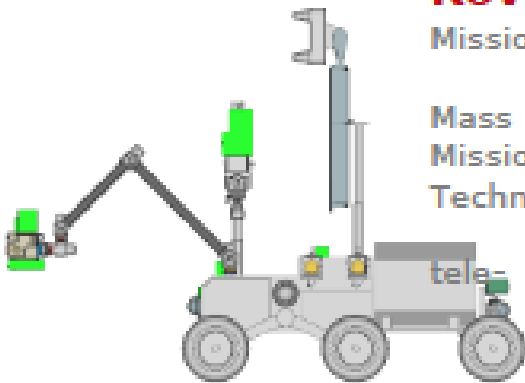


Rover Garage Element

Mission Host rover, rover deployment
Mass 140kg
Technologies Light-weight structures, mechanisms

Rover

Mission Long duration surface operation
Mass 330 kg
Mission Sample collection
Technologies Long-range mobility, autonomous and operations, night survival



Lunar Descent Element (LDE)

Mission Lunar landing demonstration
Payload 1570 kg to the lunar surface
Technologies Propulsion, Hazard detection and avoidance, GNC





- ExoMars, consisting of 2 missions (2016 and 2020), as one of pillars of ESA's Exploration strategy
- ExoMars has evolved into ESA-Roscosmos cooperation, with NASA contributions
- ESA-Roscosmos cooperation Agreement on ExoMars signed in 2013 (ESA/C(2013)32), while MoU with NASA signed by ESA DG and NASA Administrator in April 2014 (ESA/C(2014)79) and amended in February 2017

Cooperation with China - CMSA



- ESA/CMSA Cooperation Agreement on Human Spaceflight Activities signed in December 2014
- 3 dedicated working groups set up in 2015 the areas of
 - ✓ Space Experiments and Utilisation
 - ✓ Astronauts Selection, Training and Flight
 - ✓ Space Infrastructure
- **Overall objective : possible European contribution to CSS in exchange for European astronaut flights and joint scientific activities**

