ISECG GER Mission Scenario Details: Moon Next

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Agenda & Contents

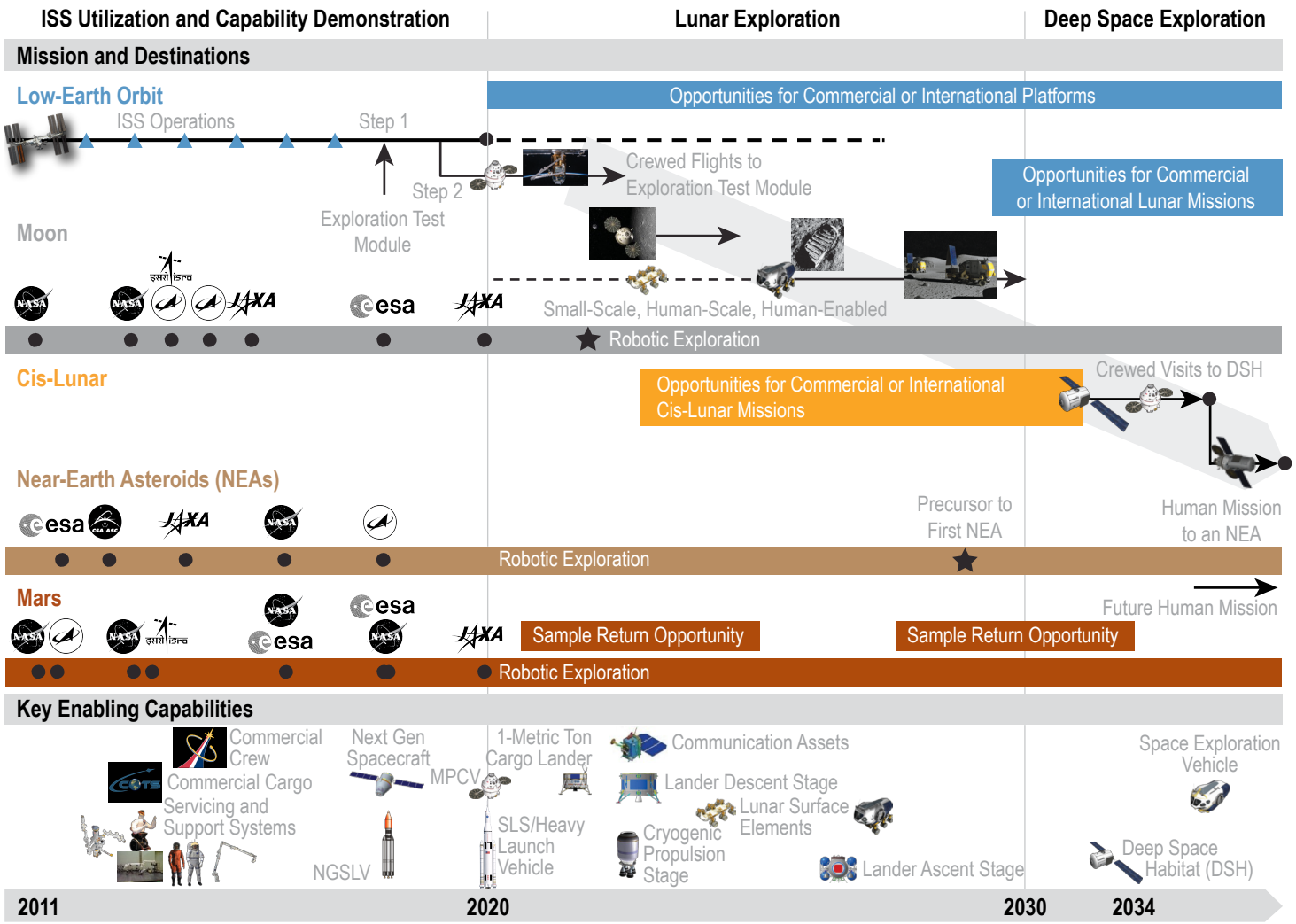
Outline:

- **Moon Next - Key Features**
- **Mission Scenario: Moon Next**
- **Moon Next Capabilities and Missions**

Moon Next - Key Features

- Targeted utilization of the ISS to advance capabilities needed for human exploration
- Continued availability of access to LEO through commercial or government provided capabilities
- Targeted science and ISRU efforts which build on knowledge from recent and planned robotic precursors
- Early deployment of both medium and large cargo landers, to deliver human-scale robotic systems
- Five “extended-stay” missions at the polar region, each with a crew of 4
- Demonstration of long-distance surface mobility needed for Mars exploration
- Technology pull for technologies such as dust management and mitigation techniques, precision landing, and advanced life support
- Lunar campaign followed by one mission to a Near Earth Asteroid
- Lunar campaign can be extended if discoveries warrant

Mission Scenario: Moon Next
Evolutionary Strategy Demonstrating Technologies Needed for Mars



Mission Scenario: Moon Next
Phase: ISS Utilization and Capability Demonstration

Crewed Missions
Robotic Precursor Mission
Initial Capability Mission
Robotic Mission
Technology Demonstration

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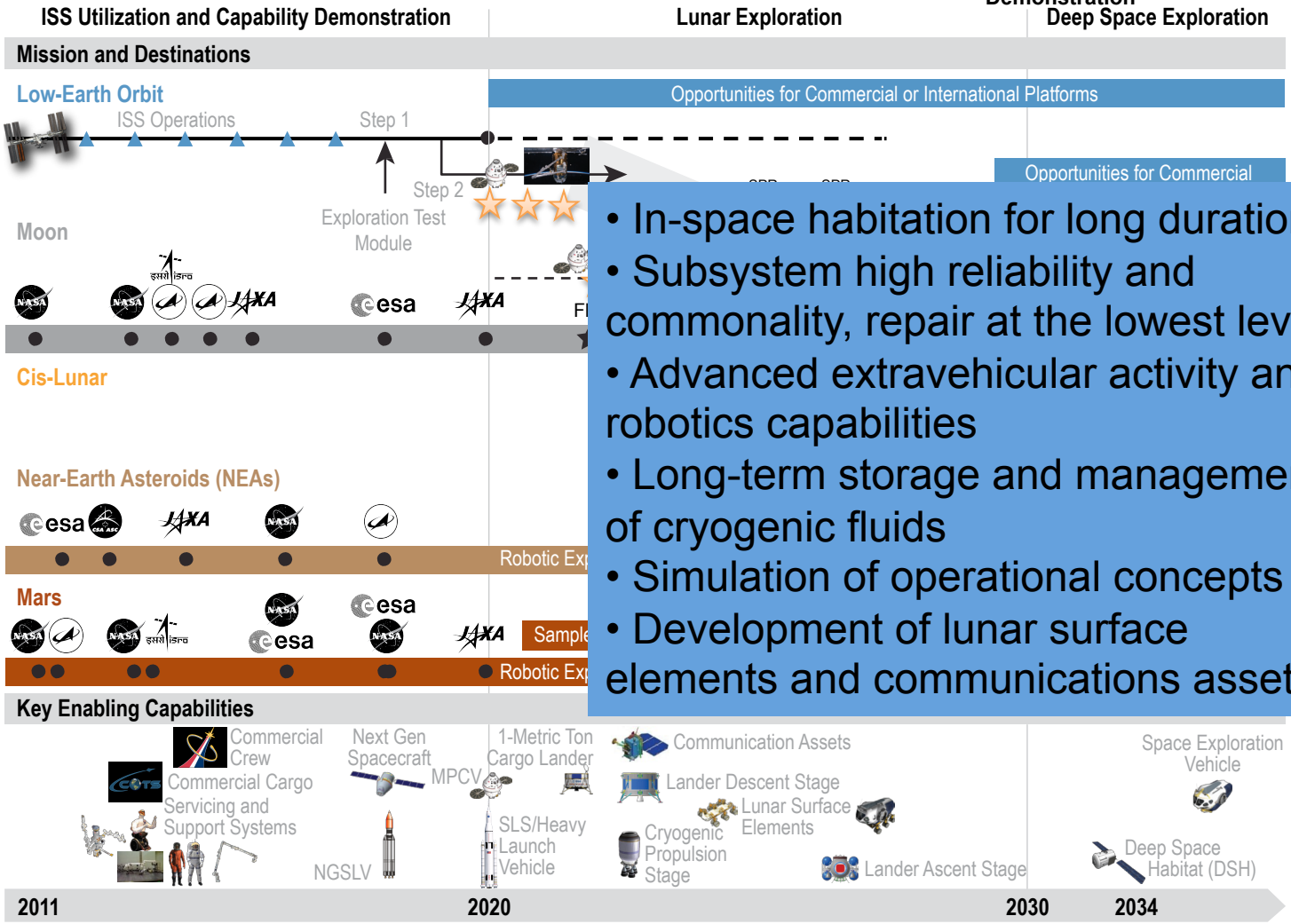
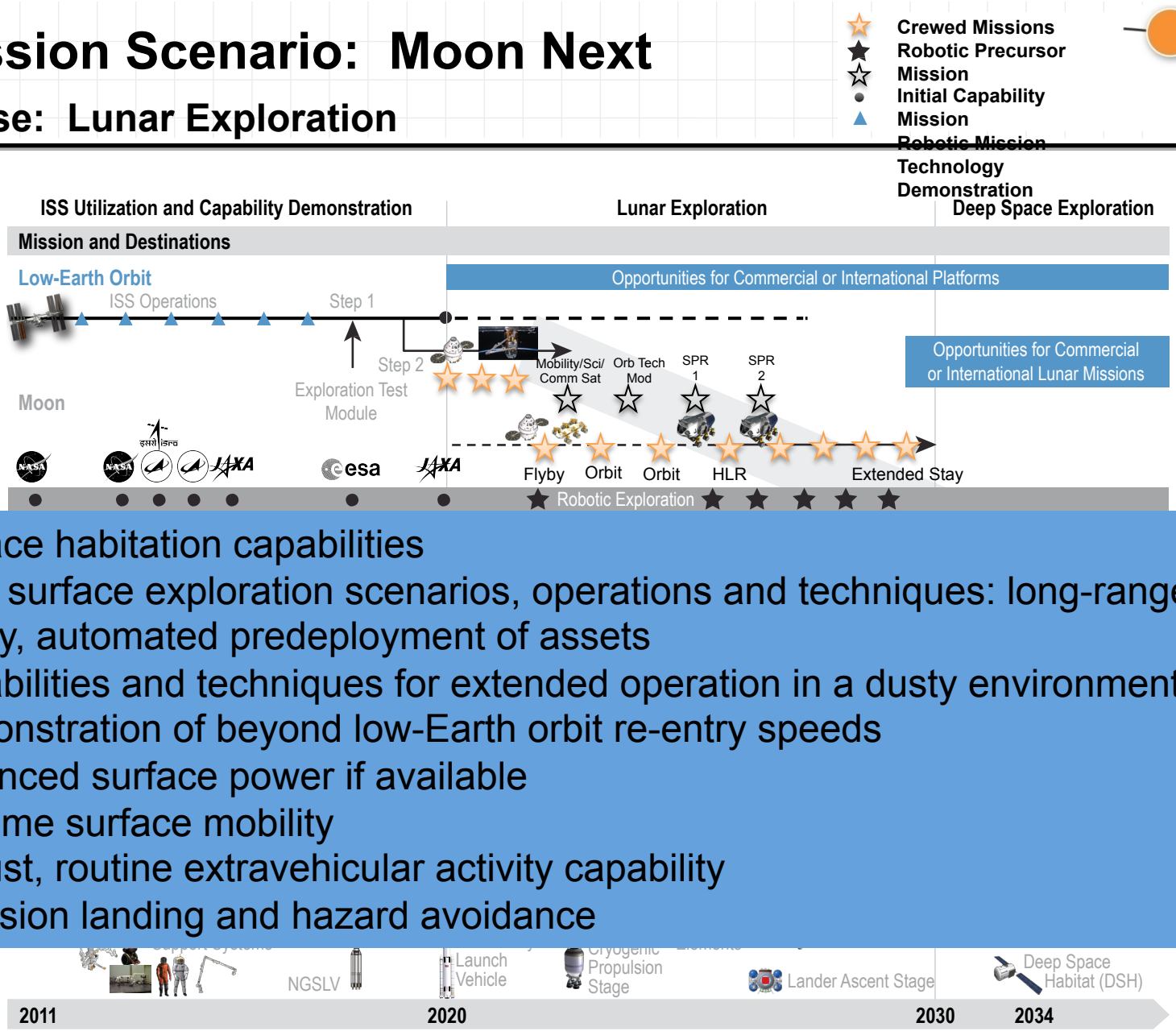


- In-space habitation for long durations
- Subsystem high reliability and commonality, repair at the lowest level
- Advanced extravehicular activity and robotics capabilities
- Long-term storage and management of cryogenic fluids
- Simulation of operational concepts
- Development of lunar surface elements and communications assets

Mission Scenario: Moon Next

Phase: Lunar Exploration



- Surface habitation capabilities
- Mars surface exploration scenarios, operations and techniques: long-range mobility, automated predeployment of assets
- Capabilities and techniques for extended operation in a dusty environment
- Demonstration of beyond low-Earth orbit re-entry speeds
- Advanced surface power if available
- Extreme surface mobility
- Robust, routine extravehicular activity capability
- Precision landing and hazard avoidance

Mission Scenario: Moon Next

Phase: Deep Space Exploration

- Crewed Missions
- Robotic Precursor Mission
- Initial Capability Mission
- Robotic Mission
- Technology Demonstration

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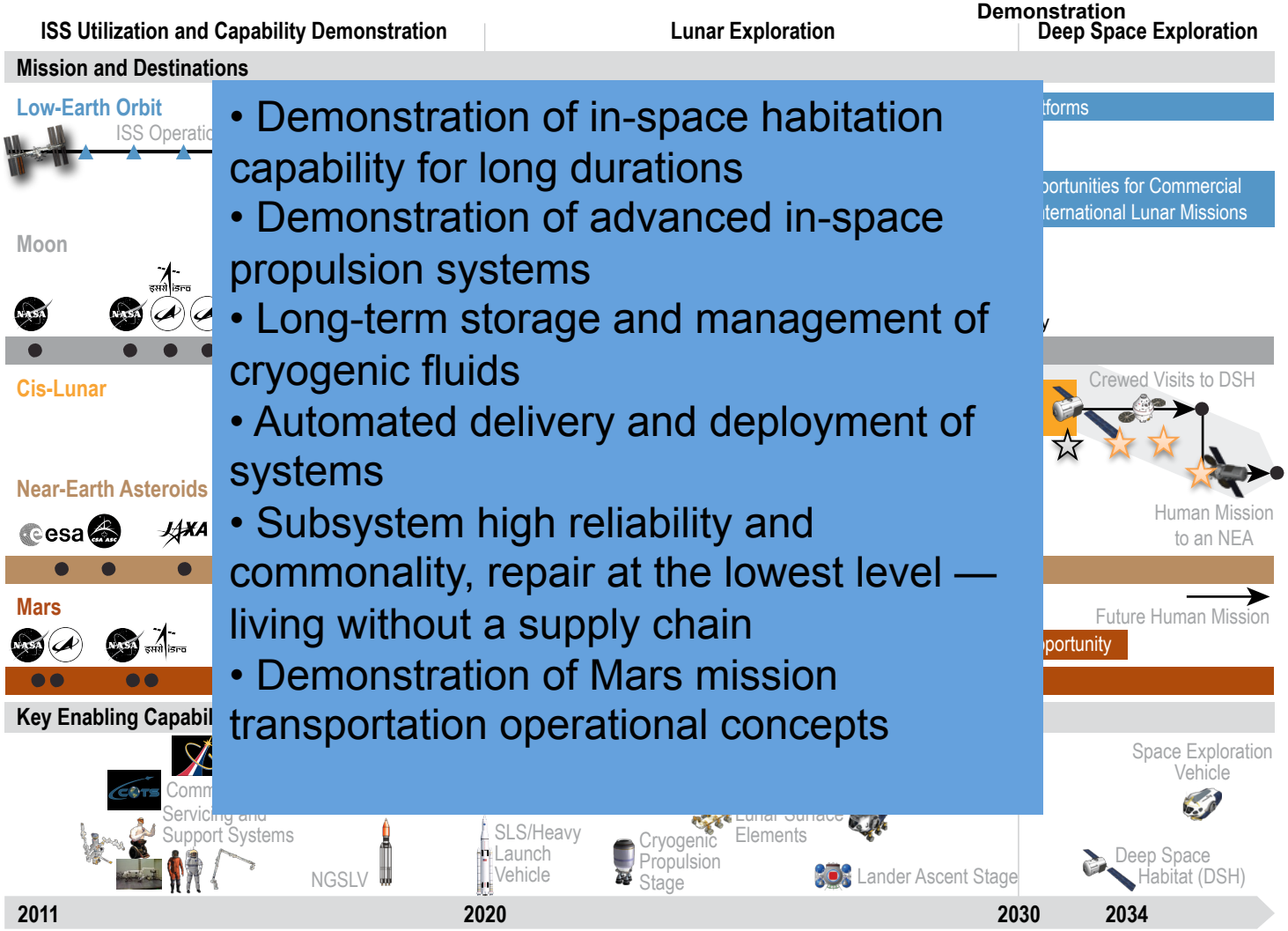


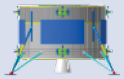
- Demonstration of in-space habitation capability for long durations
- Demonstration of advanced in-space propulsion systems
- Long-term storage and management of cryogenic fluids
- Automated delivery and deployment of systems
- Subsystem high reliability and commonality, repair at the lowest level — living without a supply chain
- Demonstration of Mars mission transportation operational concepts

Moon Next DRMs & Capabilities

Common Capabilities

	NASA Space Launch System (SLS)	Launch vehicle that has the capability to deliver cargo or crew from Earth to orbit.
	NASA Multi-purpose Crew Vehicle (MPCV)	Crew vehicle capable of delivering a crew to exploration destination and back to Earth.
	Roscosmos Next Generation Space Launch Vehicle (NGSLV)	Launch vehicle that has the capability to deliver cargo or crew from Earth to orbit.
	Roscosmos Next Generation Spacecraft	Crew vehicle capable of delivering a crew to exploration destination and back to Earth.
	Cryogenic Propulsion Stage (CPS)	In-space stage that provides delta V to architecture elements using traditional chemical rocket engines, cryogens, and storables and may include the capability for propellant transfer.
	Servicing Support Systems	Systems and tools to enable crew and robots to service in-space systems and assemble larger capabilities, including extravehicular activity suits.
	Commercial Crew	Commercial system capable of taking crew to low-Earth orbit.
	Commercial Cargo	Commercial system capable of taking cargo to low-Earth orbit.

Unique Capabilities

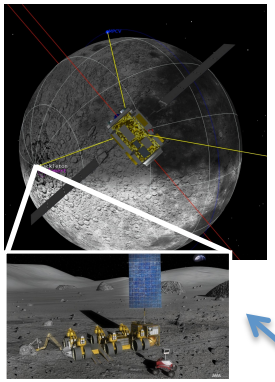
	Lunar Cargo Descent Stage	System designed to land payload of up to 8-metric tons on the lunar surface.
	Lunar Ascent Stage	Works in combination with the largest descent stage as a system for transporting crew to and from the surface of the Moon.
	Surface Elements	These systems have the capabilities that enable humans to effectively complete surface destination objectives
	1-Metric Ton Cargo Lander	System designed to land up to 1-metric ton on the lunar surface.

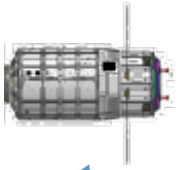
"Moon Next" Design Reference Missions
Robotic Precursor Mission
Crew-to-Low Lunar Orbit
Crew-to-Lunar Surface – 7-day Sortie Mission
Crew-to-Lunar Surface – 28-day Extended Mission
Cargo-to-Lunar Surface (small)
Cargo-to-Lunar Surface (large)

Missions Prior to Human Lunar Return

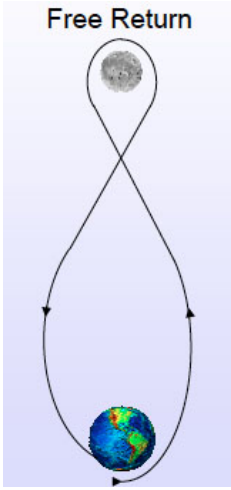
- **Prior to sending humans to the surface of the Moon, several options were discuss for conducting increasingly challenging missions in cis-lunar space:**

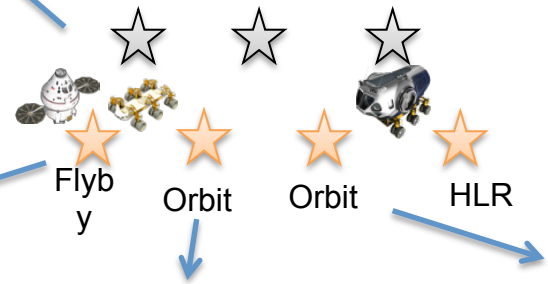
-Communications link
-used for robotic teleoperations on the surface





-If asset is deployed in Lunar Vicinity: Added habitable volume to support longer follow on missions
-Potential Temporary Safe Haven if surface must be abandoned





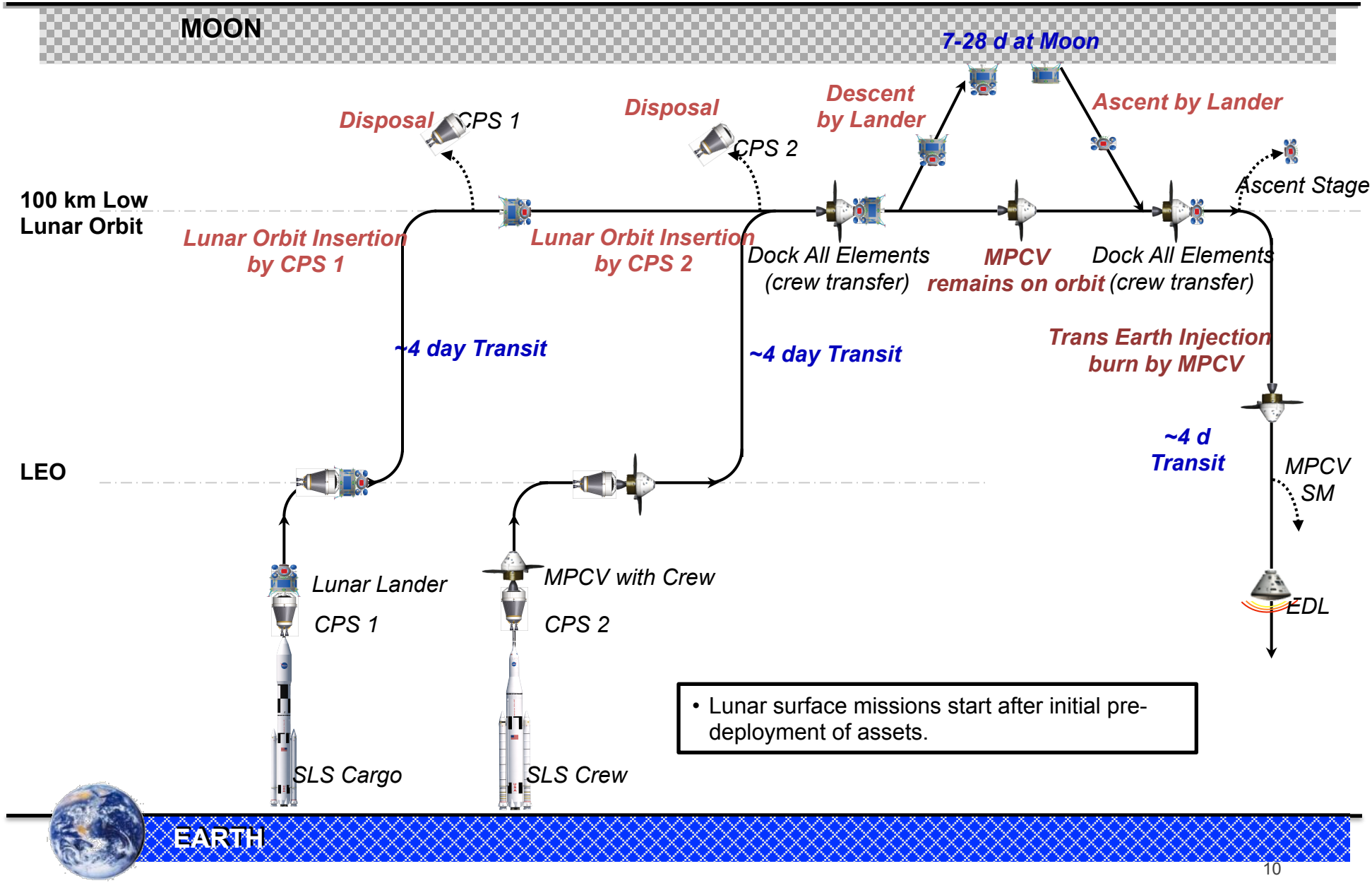
-Lunar Flyby Mission (Free Return)
1st Flight of International Crew of 4

-Lunar Orbit Mission (Equatorial)
-Total Mission Duration up to 21 days for 4 crew
-1st telepresence operation of robots on lunar within cognitive timescale surface

-Lunar Orbit Rendezvous in Polar Orbit With Orbiting Tech Module or Dissimilar Crew System
-Conduct mission 4 Crew for 14 days in LLO for teleoperated robotics preparing for Human Lunar Return

DRM: Crew to Lunar Surface

Lunar Orbit Rendezvous



- Lunar surface missions start after initial pre-deployment of assets.

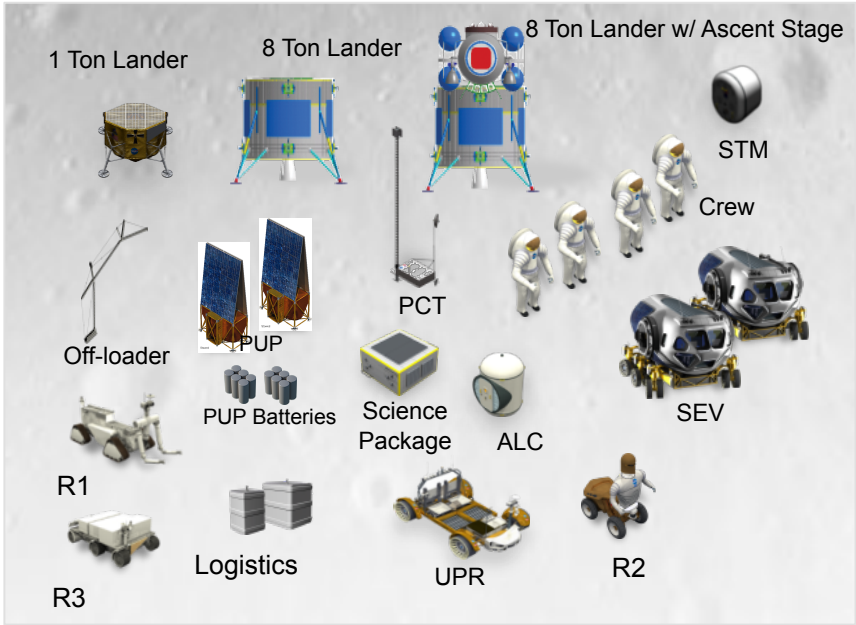
Robotic Precursors

- 1 t class lander delivering several small robots to one of the lunar poles. These robots work together to identify a suitable landing site for an upcoming 8 t human class lander
- In addition to local reconnaissance, the small rovers gather science data, validate technologies and refine concurrent operations. This will be the first time ever that multiple robots will be working together in close proximity on another celestial body.
- The robots will practice servicing operations, scout the region for future crew/ cargo landing areas, and deploy landing aides.
- All robots will send back to Earth a steady stream of engaging and informative data and video, including the descent and touchdown of future crewed/cargo landers.
- Next, the human scale 8 t lander touches down at the site identified by the small robots. It is carrying a version of the mobility chassis which operates in autonomous and ground supervised modes at speeds and ranges far exceeding any previous planetary surface rover, and is outfitted with enough energy storage to survive the 14 day eclipse period. It will also be outfitted with hundreds of kilograms of science instruments and manipulators. It will also be capable of transporting one or more of the previously delivered small robots as it explores which could be used for servicing and remote observation.

Lunar Destination Elements

- **The GER lunar campaign accumulates surface elements prior to the crew's arrival via a combination of small (~1 mt) and large (~8 mt) cargo landers**

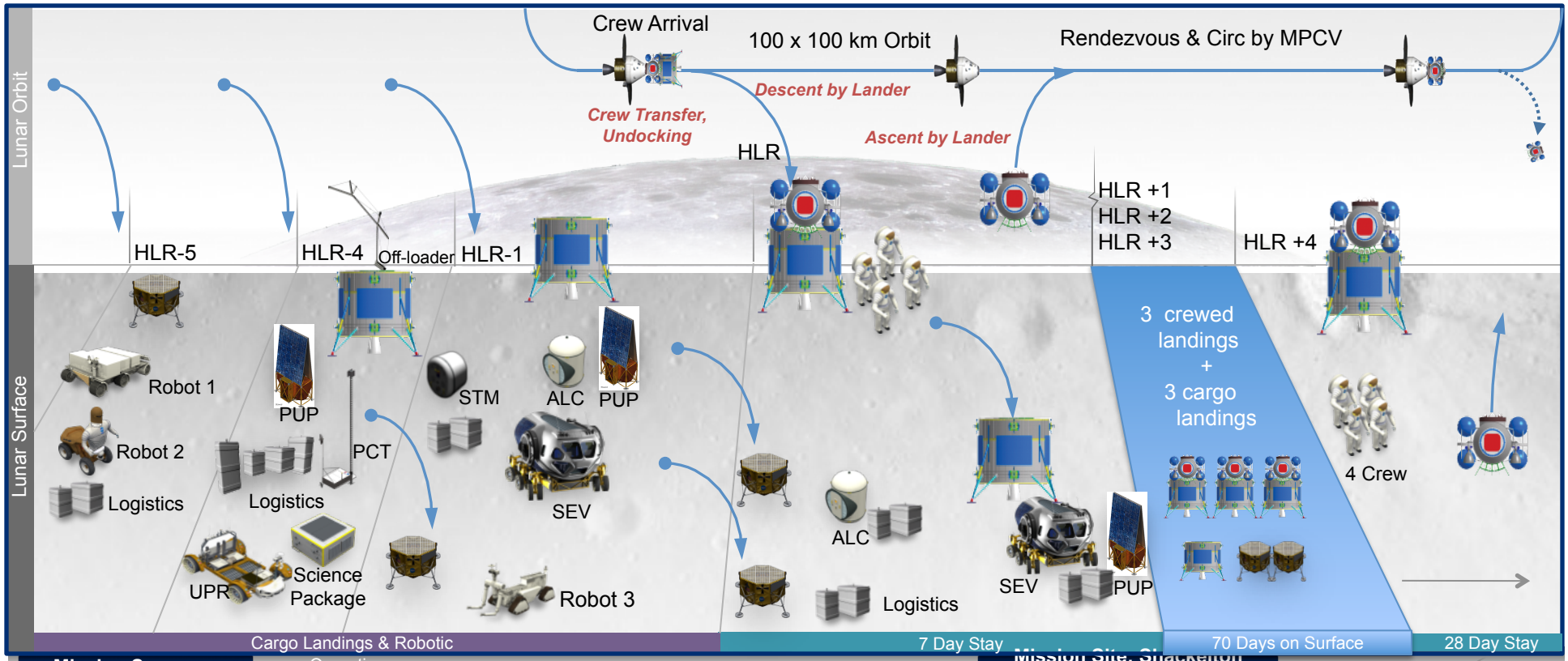
Element	QTY	Notes
Crew	4	International Astronaut Crew
PUP (Portable Utility Pallet)	3	• 100 kW-hr battery storage each • 2 kW solar array each • Transported by SEVs
PCT (Portable Communications Terminal)	1	Provides high bandwidth communications Transported by PUP It is assumed that at lease 1 LRS is on orbit
Robotic Precursor 1 (R1)	1	Small International Science Rover
Robotic Precursor 3 (R3)	1	Small International Science Rover
UPR (Unpressurized Rover)	1	Provides Excursion Capability before second SEV arrives
Off-loader (LSMS or Cradle)	1	Can tele-robotically offload cargo landers or be used off the back of an SEV.
Science Package	1	Pre-deployed in second mission
Logistics	9	Multiple logistics payloads required for 28 day capability
STM (Suitport Transfer Module)	1	Allows transfer of material through a Suit-port
SEV (Space Exploration Vehicle)	2	200 kW-hr battery storage each Average speed toward destination = 5 km/hr



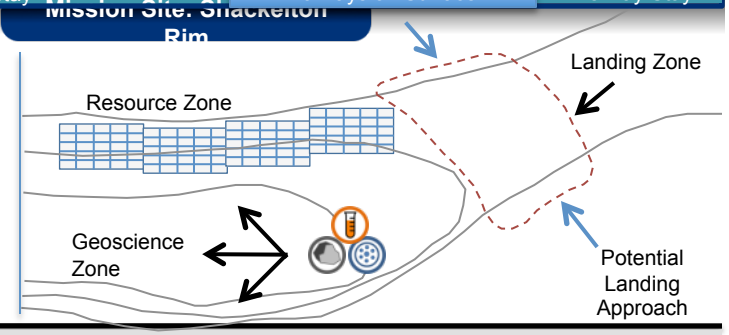
Element	QT(Y	Notes
Robotic Precursor 2 (R2)	1	Small NASA Robotic Assistant & Science Rover
ALC (Airlock Logistics Carrier)	7	Pressurized Logistics

GER Extended Stay & Surface Mobility Emphasis

4 Large cargo landers, 6 small cargo landers, 5 crewed mission



Mission Summary

Five years prior to Human Lunar Return, cargo missions begin to deliver robotics and science equipment. The crew arrives with two large cargo landers and two small logistics landers, and spends 7 days on the surface. Over the next five years, a total of five crewed missions with surface stays of up to 28 days are completed.

Mission Site: Shackelton Rim