

"HERACLES

Preparing Human Exploration by Integrated Certification of Crew and Hardware for Lunar Surface Operations"

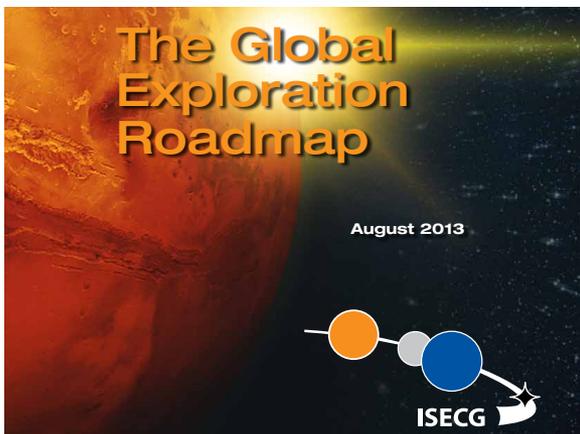
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ESA/ESTEC

Future In-Space Operations Telecon 06/04/2016



CONTEXT

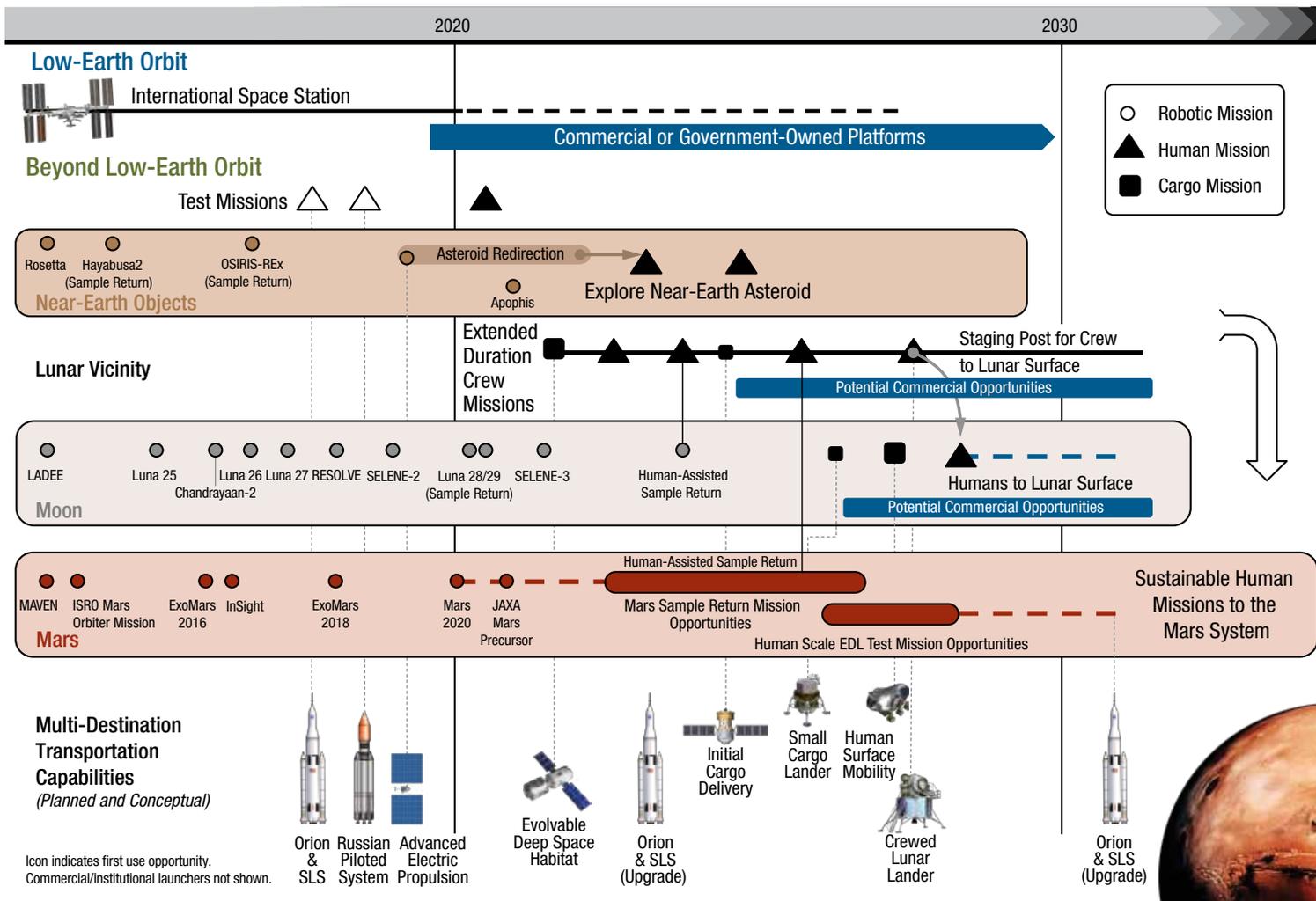




CONTEXT



ISECG Mission Scenario





MISSION STATEMENT



"The Human-Enhanced Robotic Architecture and Capability for Lunar Exploration and Science (HERACLES) is to establish the elements and capabilities for sustainable human exploration of the Moon and human-robotic exploration of Mars while maximising opportunities for unprecedented scientific knowledge gain"



MISSION OBJECTIVES



- Achieve human rating of critical subsystems of a lunar lander by flight test:
 - ascent and descent engine
 - autonomous GNC for descent, landing, ascent, and rendezvous
- Provide opportunities for crew certification
 - surface mobility operations
 - surface landing operations
- Advance understanding of ISRU by
 - sample return
 - deployment of a pilot plant
- Provide opportunities for scientific research
 - sample return
 - in situ investigation
- Prepare international partnership for roles in lunar surface exploration

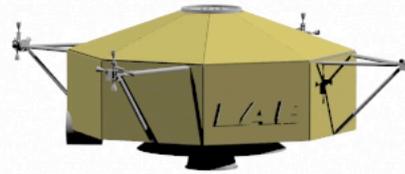


BASIC ARCHITECTURE ELEMENTS



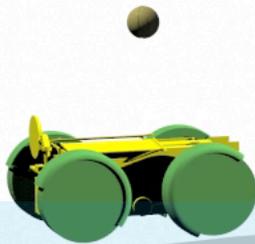
Sample Container

Mass: 25 kg
Samples: up to 15kg
Cryo-Samples: 1kg
Cryo temperature: -140 °C



Lunar Ascent Element

Dry mass: 600 kg
Wet mass: 1,300 kg
Thrust: 6kN



Rover

Mass: 500 kg
Speed: 5 km/h
Lifetime: 2y
Communication: 10-Mbps
Robotics: 2 arms
Night survival
Eclipse operations
Ground and orbit crew control

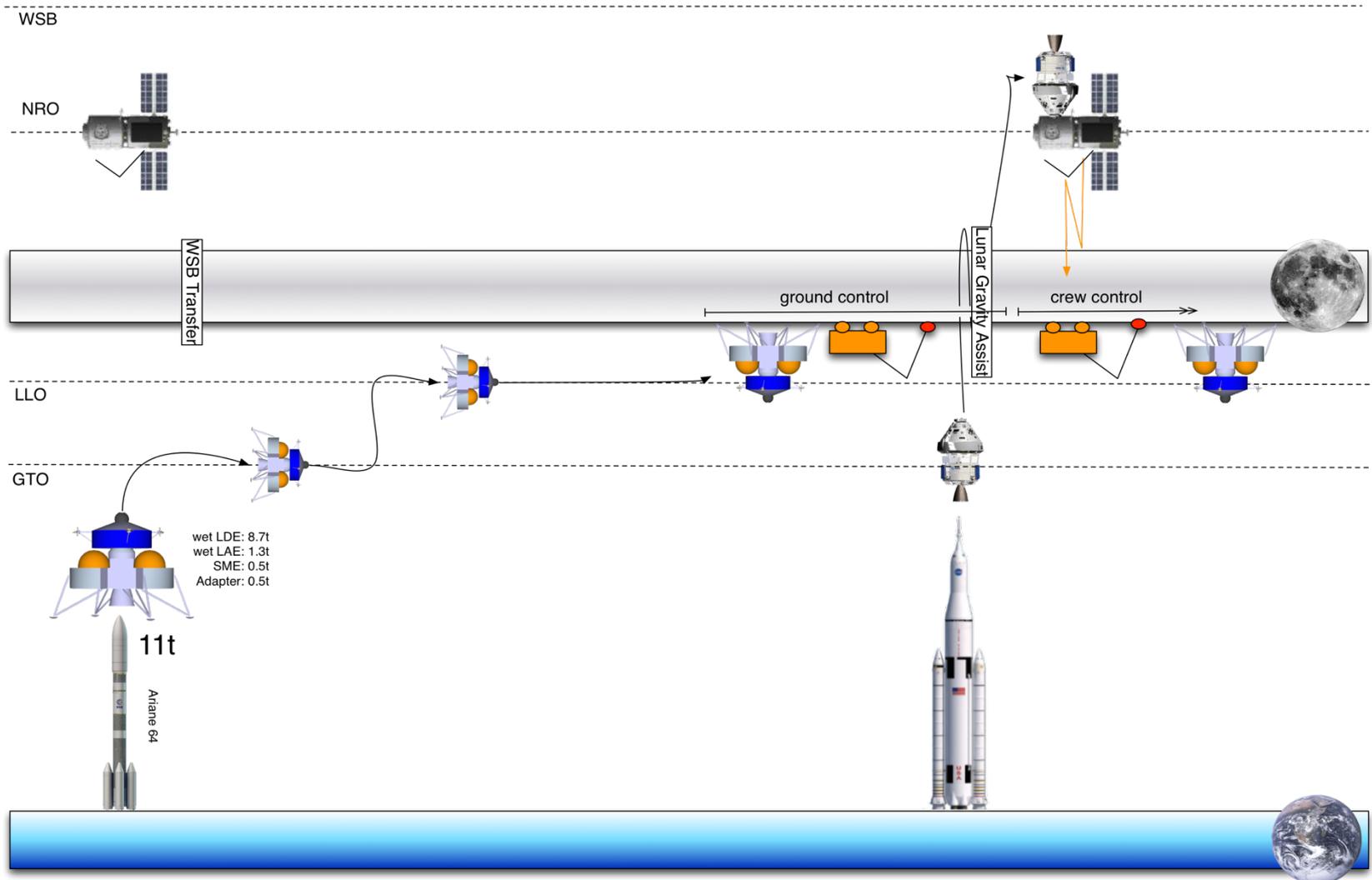


Lunar Descent Element

Dry mass: 1,800 kg
Wet mass: 8,700 kg
Thrust: 30 kN

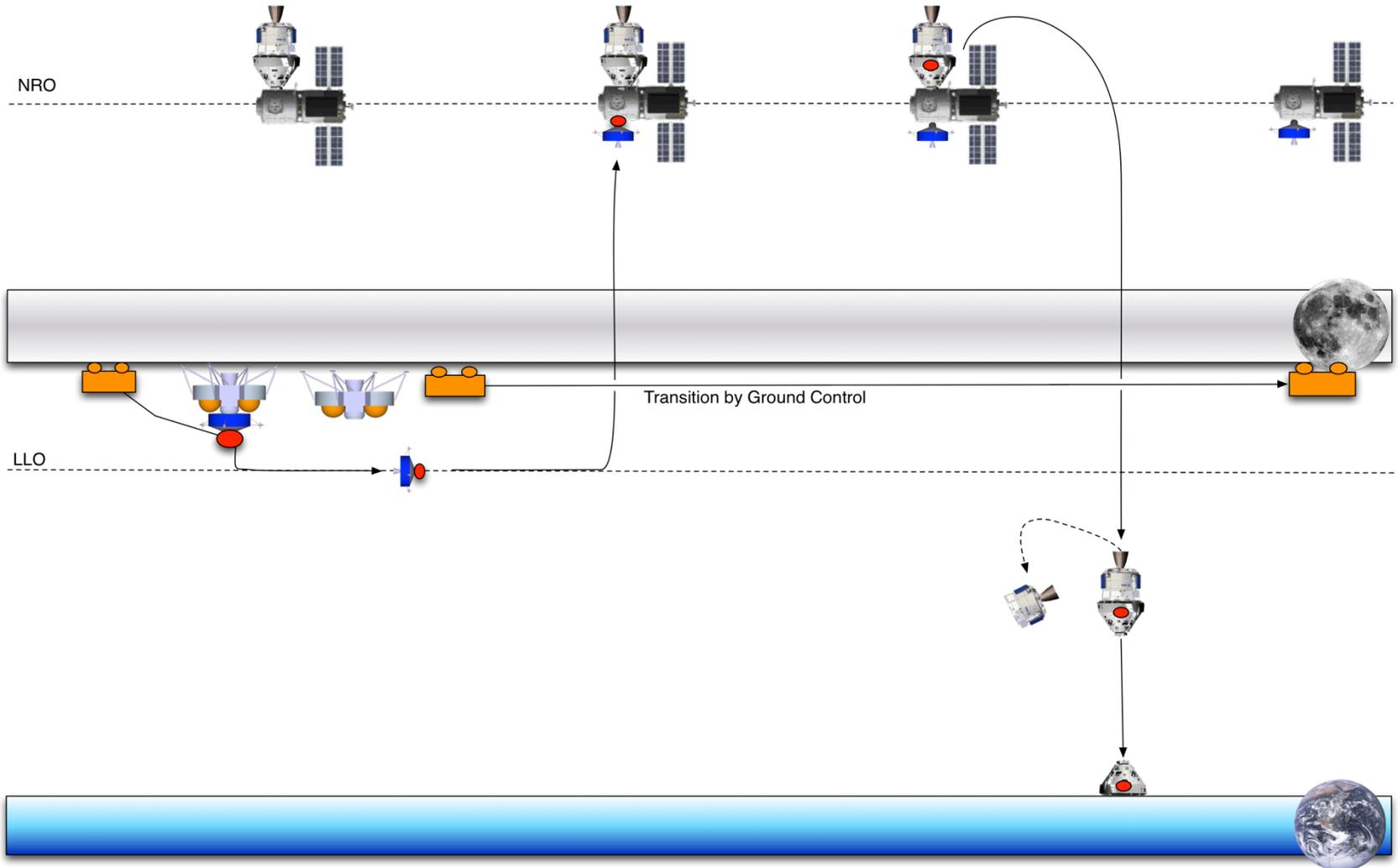


REFERENCE SCENARIO – HERACLES (1/3)



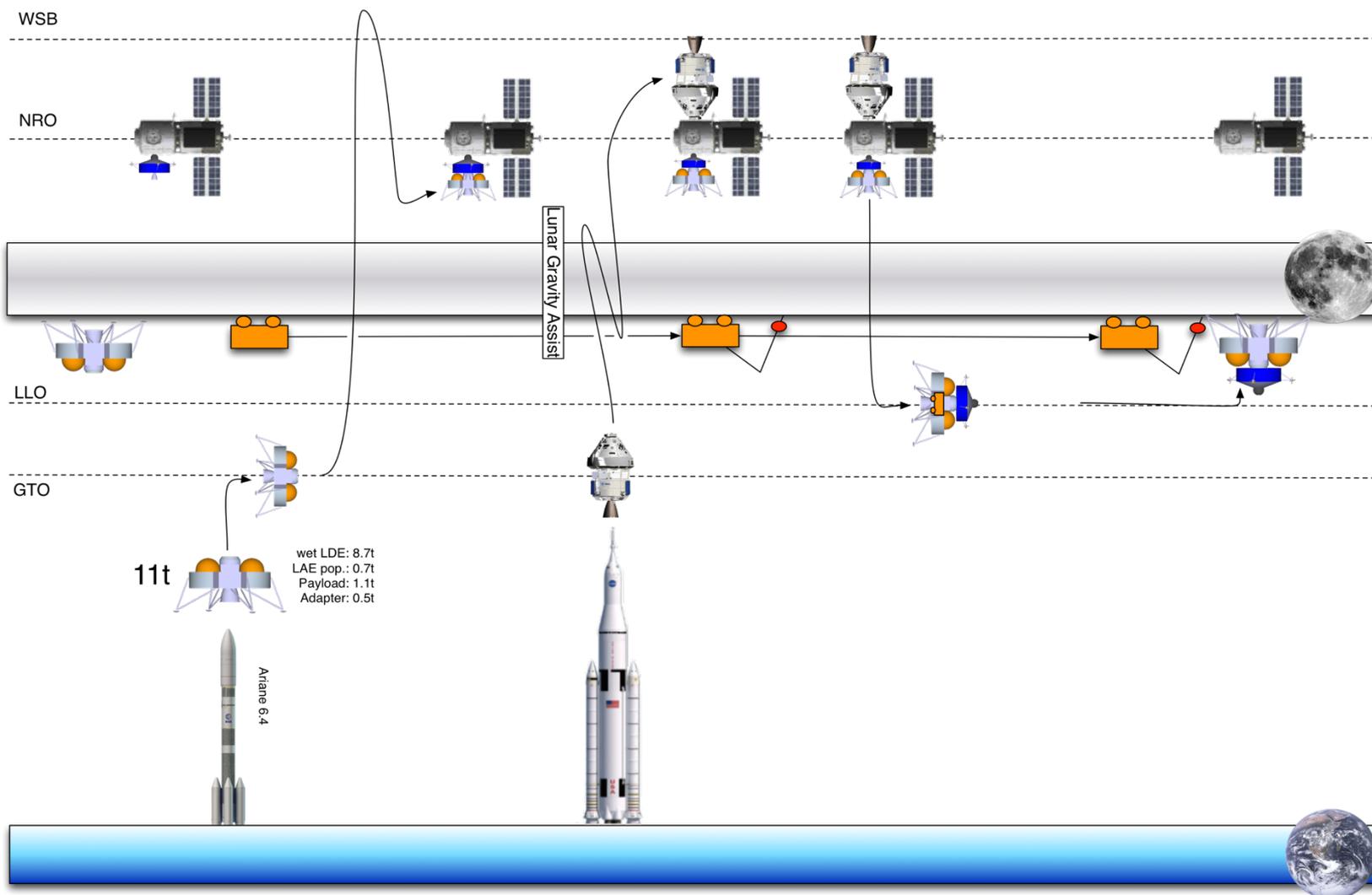


REFERENCE SCENARIO – HERACLES (2/3)



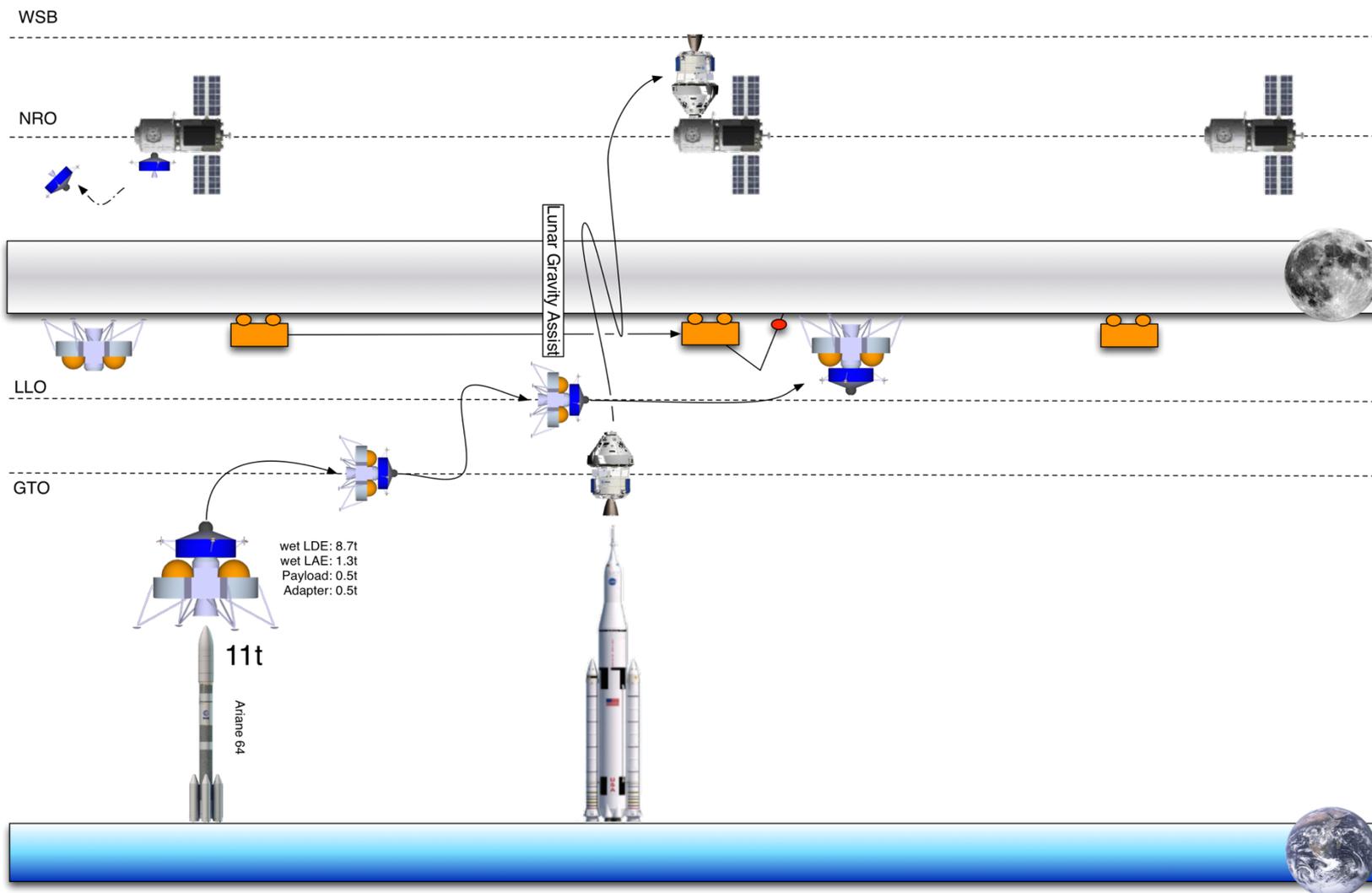


REFERENCE SCENARIO – HERACLES (3/3 REUSE)





REFERENCE SCENARIO – HERACLES (3/3 NON-REUSE)





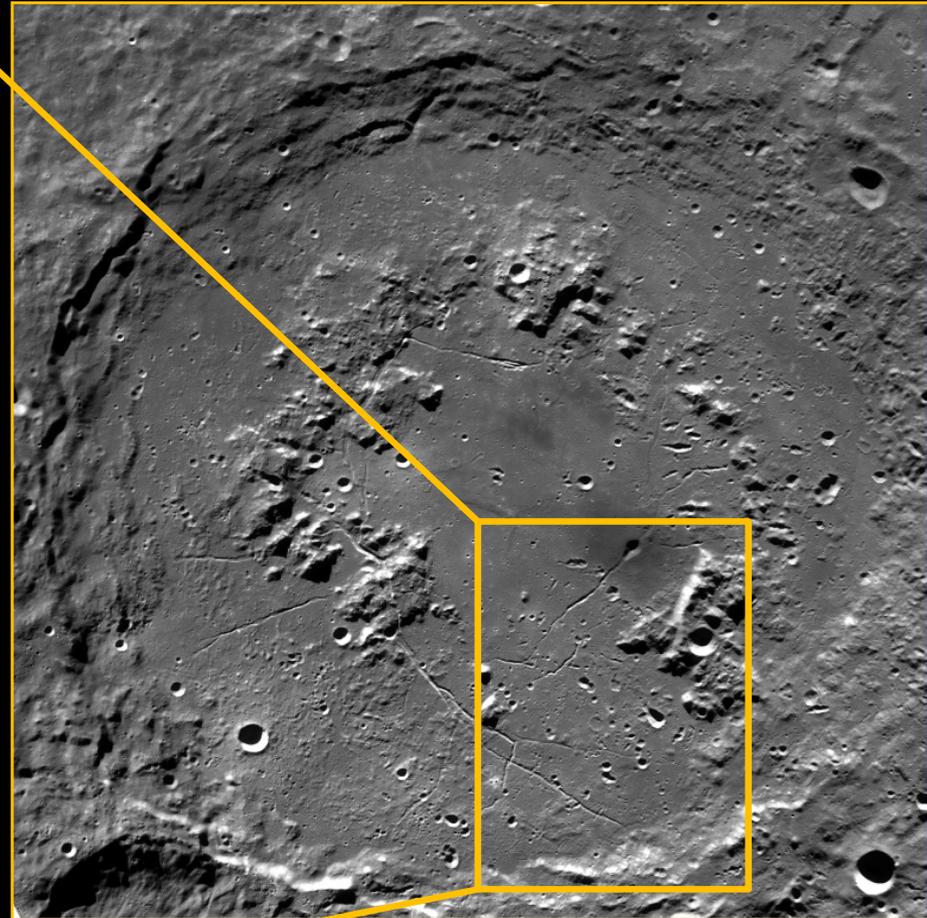
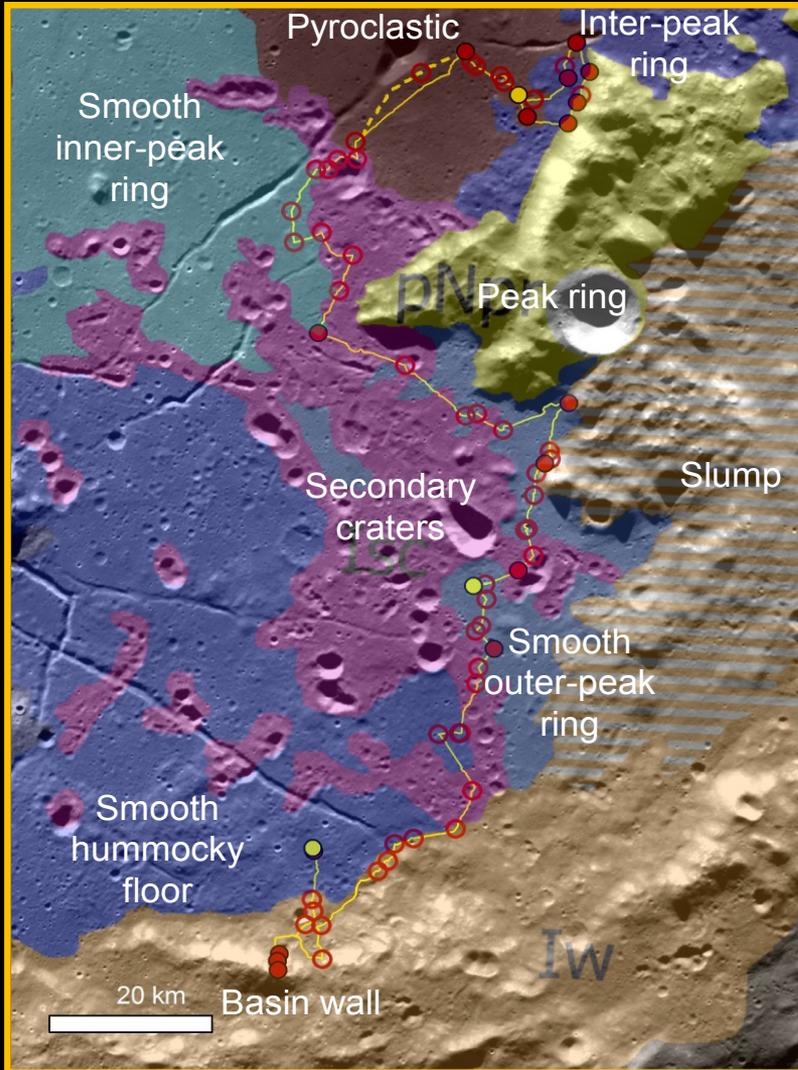
TOP-LEVEL HERACLES OPERATIONAL CONCEPT



- Detailed coordinated (ESA & international partners) ConOps available
- Coordinated Surface Campaign Description Document available (performance wrt. exploration and science objectives in agenda point 3)
- Based on exploitation of cis-lunar infrastructure: eDSH and Orion
- Crew role in sample return and vehicle control is essential element
- Flexibility in operational authority: autonomous systems, ground crew, orbital crew → optimum tele-ops approach as per METERON test plan (agenda point 2)
- Extended duration operations for reusable elements: ascent stage and rover
- Multiple surface missions mimicking human architecture
 - N x 70d for lunar module (= DNDND = 5x14)
 - 2 y for rover



EXAMPLE LANDING SITE: SCHRÖDINGER



Basin diameter ~320 km



INSPIRATIONAL "FIRSTS"



1. First soft landing south of 41°S
2. First soft landing Pole-ward of 45° latitude
3. First return of samples outside the KREEP region
4. First landing on the far side
5. First equipment surviving lunar night
6. First rover tele-operated by orbital crew
7. First sample delivery to orbital station
8. First assembly of lunar lander in orbit
9. First return of SPA samples
10. First return of PSR samples
11. First cryogenic sample return
12. First reuse of lunar ascent stage
13. First rover to visit more than one landing sites
14. First production of oxygen from lunar regolith
15. First climb of lunar mountain by rover
16. First lander tele-operated by orbital crew

THANK YOU !