Moon Village Architecture Working Group

2020-2021 MV Reference Architecture Studies

Overview

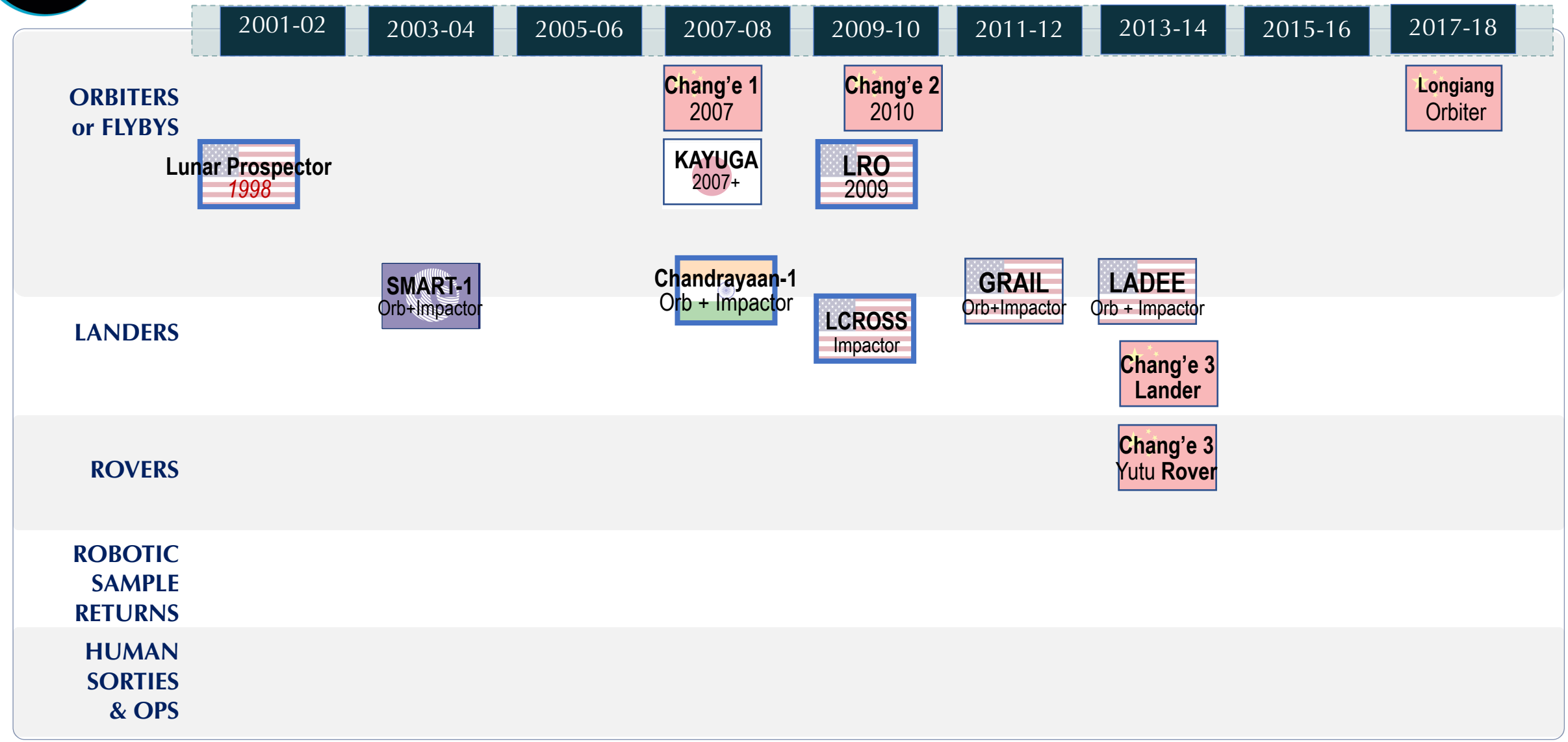
for AIAA Meeting

22 AUGUST 2020

John C. Mankins
Vice President, Moon Village Association
co-Chair, MVA Moon Village Architecture Working Group

Global Mission History / Timeline (10 January 2020)

Not all Missions / Cubesats / Payloads Shown



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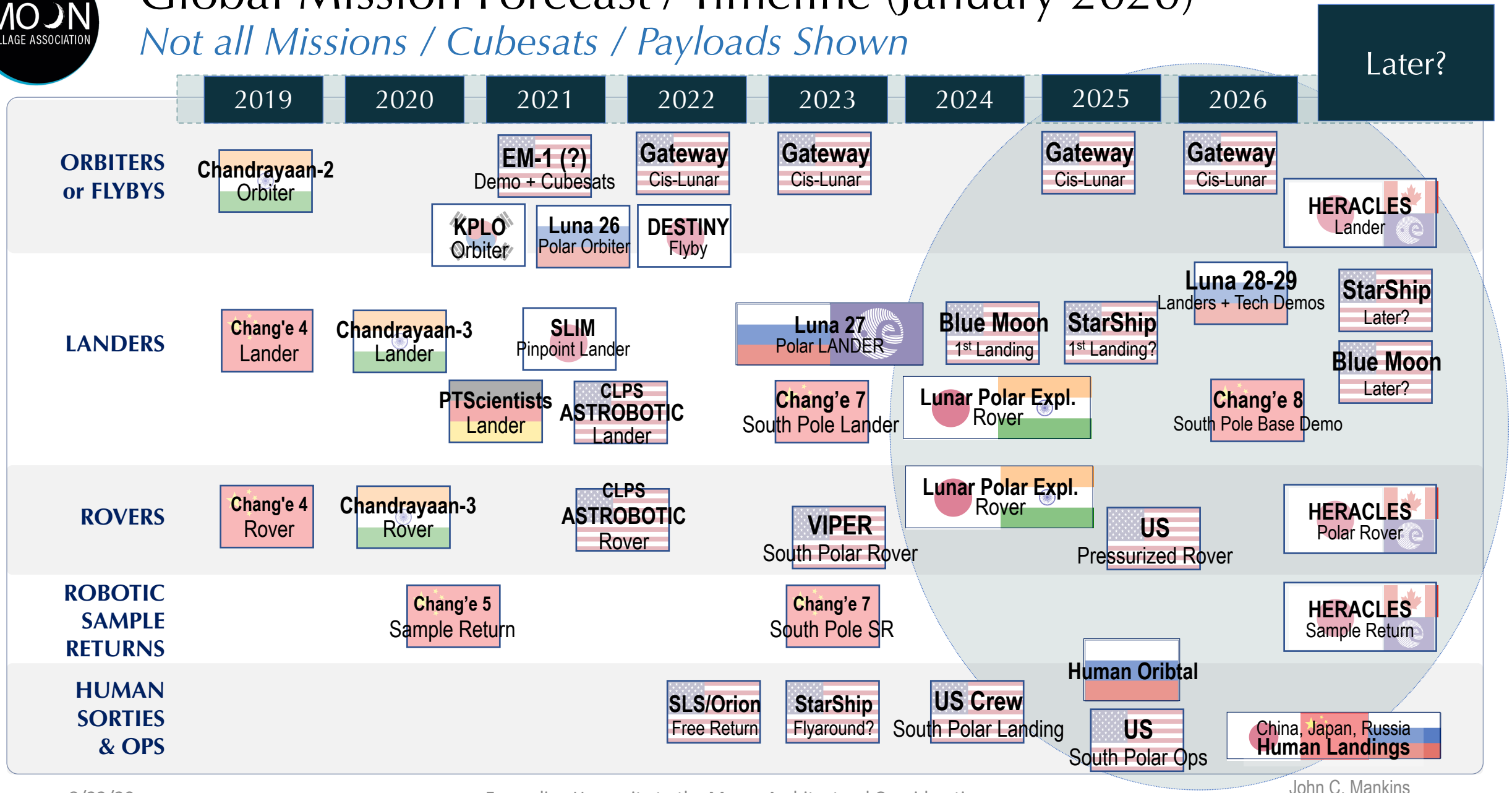
Vice President, Moon Village Association

Global Mission Forecast / Timeline (January 2020)

Not all Missions / Cubesats / Payloads Shown



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Vice President, Moon Village Association

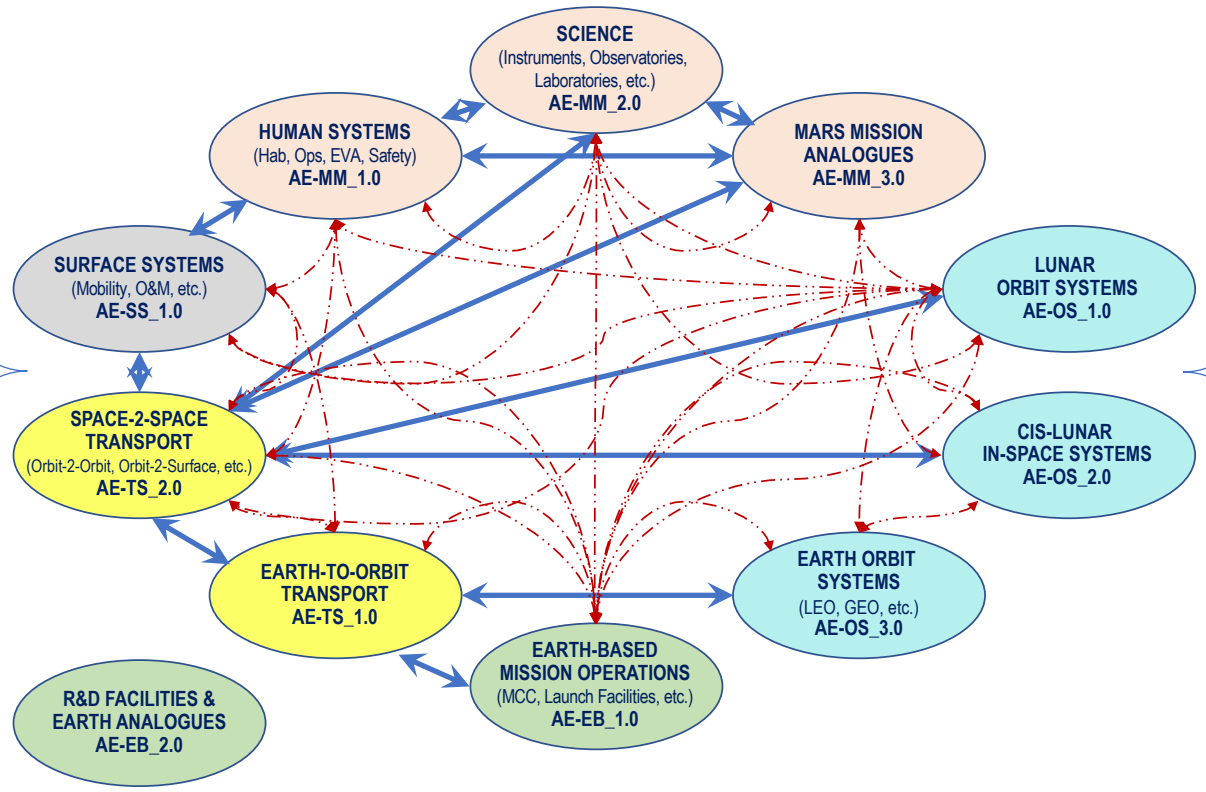

This is NOT a settlement

Moon Village Reference Architecture Case Study Conceptual Framework

Scenarios

- Scenario ALPHA
- Scenario BETA
- Scenario GAMMA

Architectural Elements



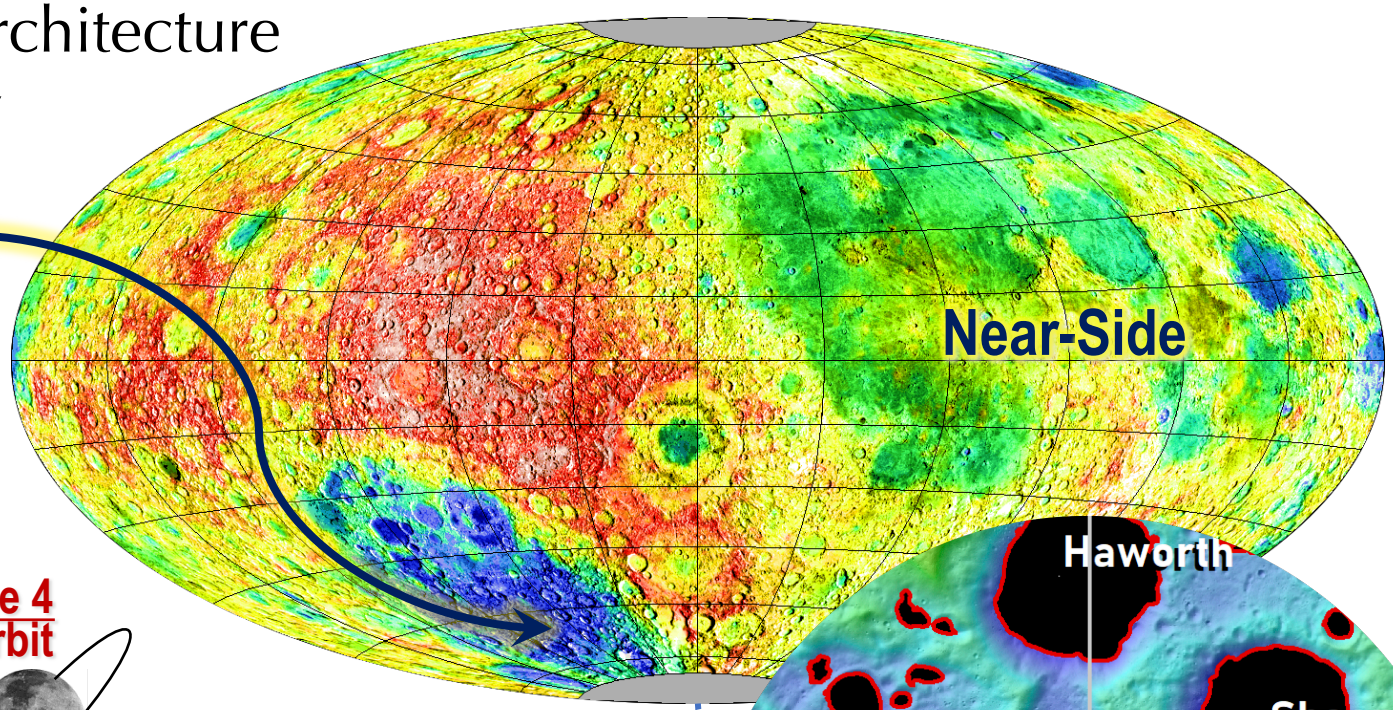
MV Architecture
Building Blocks

Moon Village Reference Architecture → Lunar Settlement Case Study
Key Assumptions

- Low-cost commercial access to low Earth orbit will transform cis-Lunar space operations during the next decade; the only question: precisely when?
  - Before 2025?
  - Before 2030 → **This is the Assumption for this Case Study**
- Massive government mission opportunities and commercial market ventures will be the result; examples include
  - Space-based global connectivity
  - Affordable megawatt power systems (solar, wireless and potentially nuclear)
  - Development of physical space resources – beginning with the Moon (and initially focused on volatiles)
  - Sustainable permanent human presence in cis-Lunar space

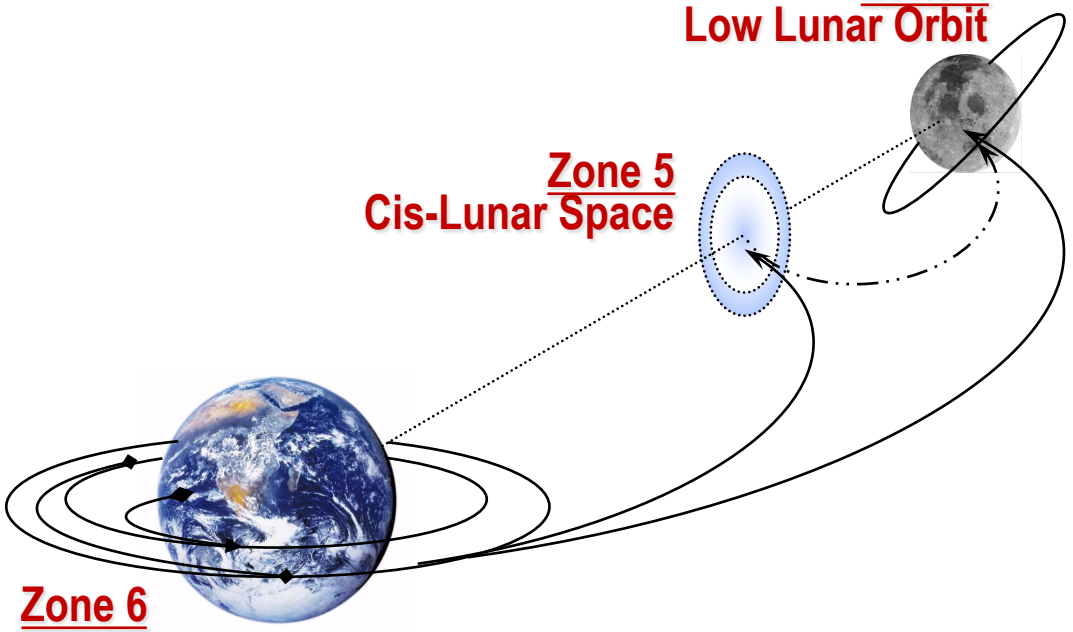
Moon Village Reference Architecture
2020-2021 Case Study

Zone 3
Lunar Surface Science / Observatory



Zone 4
Low Lunar Orbit

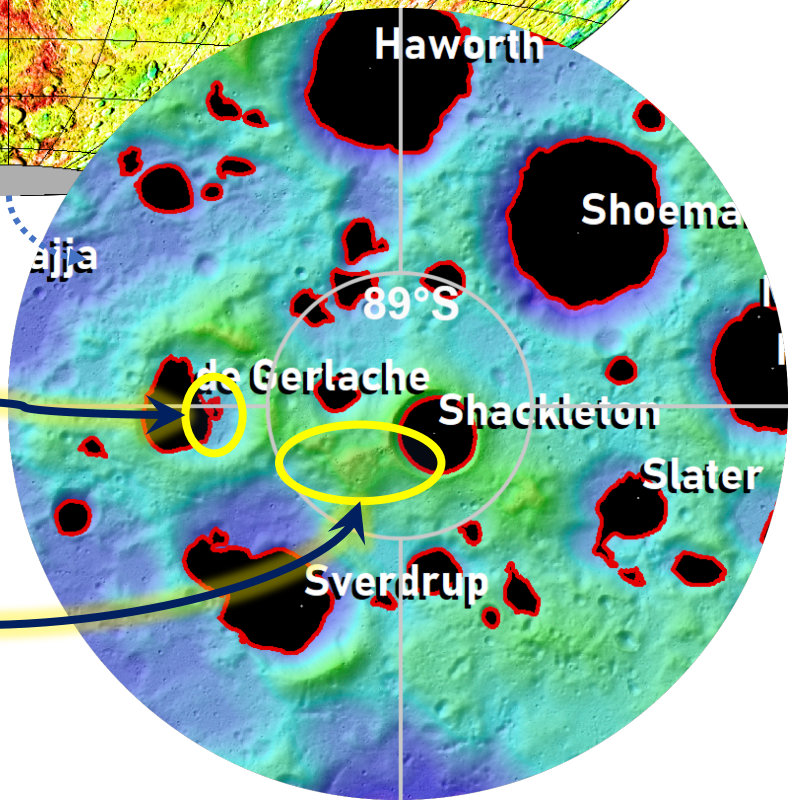
Zone 5
Cis-Lunar Space



Zone 6
Earth Orbit

Zone 2
PSR / Ice & Volatile Deposits

Zone 1
'Often' Illuminated Location: South Polar Ridge



2020-2021: Lunar Settlement Case Study
A Moon Village Reference Architecture – 2045

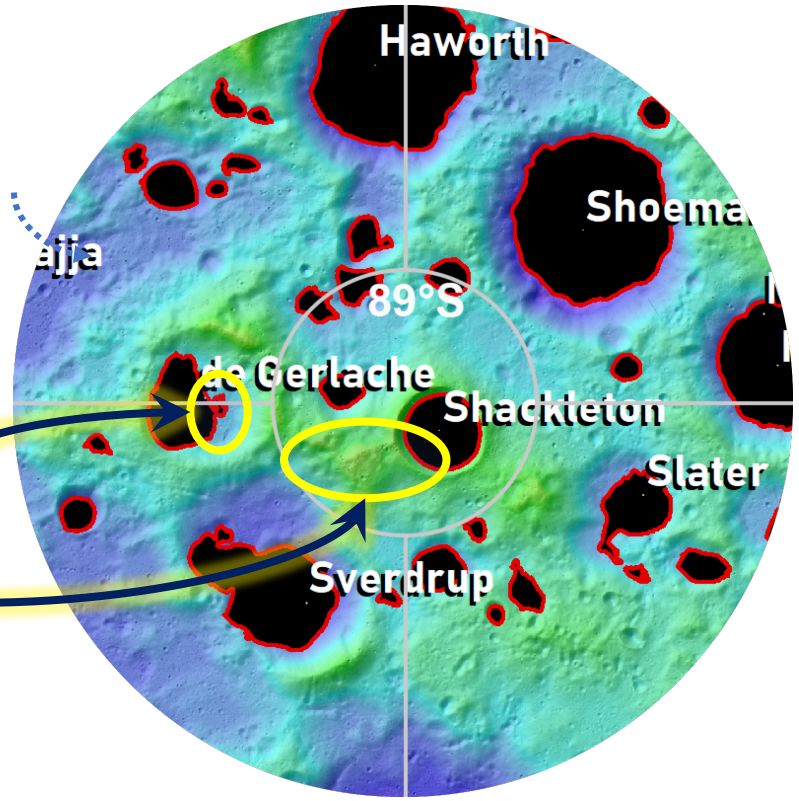
ZONE 1
South Polar Illuminated "Peaks"

- Crew Systems
  - Government Habs (Missions)
  - Commercial Habitats
- Products Storage (e.g., Propellants)
- Operations Services
  - Energy (SPG, Storage & WPT Transmitter) – For example c. 3 Locations
  - Communications & Nav Services
  - Transport (To/From PSR to PEL)
  - Others (e.g., Robots, Rovers, Repair, Dust Mgt, etc.)
- Technology R&D

- **The First Lunar Settlement**

ZONE 2
South Polar Permanently Shadowed Region (PSR)

- Regolith Mining Robotics (Mobile)
- Volatiles Extraction – Mobile or Fixed
- Processing & Product Storage – Fixed
- Mining Operations Services
  - Energy (WPT Receiver & Storage)
  - Communications & Nav Services
  - Others (e.g., Repair, Dust Mgt, etc.) Crew Systems (Tended)
- Transport (To/From PEL to PSR)
- Crew Systems (Tended)



MV Architecture Case Study Building Blocks

Utilities

- Communications & Networks
- Power Generation & Energy Systems
- Position Location and Navigation
- Imaging & Operational Sensing
- Computing and Data Management

Transport & Logistics

- Space Transport Systems (incl. Surface-2-Surface)
  - ✓ Space Transport Vehicles (Expendable, Reusable, etc.)
  - ✓ Landing Systems & Vehicle Support Systems
  - ✓ Advanced Launch Concepts
- Surface Transport (Crew, Cargo, Materials)

Operations

- Dust Mitigation
- Construction
- Physical Waste Processing & Recycling
- Manufacturing

Resources

- Resources Exploration & Characterization
- Mining Systems & Resources Extraction
- Resources Processing & Handling

Habitation / Self-sustaining 'Biospheres'

- Habitable Volume (Pressure Vessel, Air, Water, Lighting, Thermal Management, etc.)
- Radiation Protection
- Agricultural Systems
- Biological Waste Processing & Recycling

Human Operations & Health

- EVA Systems
  - ✓ Airlocks
  - ✓ EVA Suits
  - ✓ Personal Mobility Systems
  - ✓ EVA Maintenance Systems
- Medical Care Systems (Urgent Care, Immunology, Surgical Care, etc.)
- Lunar-Gravity Mitigation

Robotic Systems (Surrogates / Augmentation)

- Robotic Systems - Interior
- Robotic Systems – Interior / Exterior
- Robotic Systems – Exterior / Remote

Science Missions / Payloads

- Science of the Moon (geophysics)
- Science from the Moon (Astrophysics)
- Science on the Moon (Laboratories Sciences)

MVA 2020-2021 MV Reference Architecture Study Plan Forward…

- 2020 – Preliminary studies and modeling
  - ✓ Selected results will be presented at the online International Astronautical Congress (IAC) in October 2020.
- 2020 September – Initial 'Webinar' on MV Architecture Studies
- 2020 November – Preliminary inputs presented at the MVA 2020 Online Symposium
- 2020 December – An online MVA Workshop focusing on the MV Reference Architecture will be jointly organized; this will be an online event.
  - ✓ Interim reports will be developed and posted to the MVA website by January 2021.
- 2021 – Further joint studies will be organized
  - ✓ 2nd workshop focusing on the MV evolution in terms of international cooperation, business society and legal considerations will be jointly organized during late Spring 2021.
  - ✓ Possible ESTEC / Concept Development Facility Exercise – To Be Arranged
- 2021 Fall – Working results will be presented at the 2021 Moon Village Association Workshop and Symposium
- 2022 January – Final reports will be developed and posted to the MVA website