

Outpost

Optimizing Science & Exploration Working Group (OSEWG) - Lunar Surface Science Scenarios

**Planetary Science Subcommittee
October 2, 2008**

**Gordon Johnston, OSEWG Co-Chair, SMD
Laurie Leshin, OSEWG Surface Science Scenarios Working Group Co-Chair**

Outline



- **OSEWG Scope, Strategy, and Momentum**
- **Exploration Architecture Overview**
 - Ares V and Altair - - concept development, point of departure
 - Lunar Surface Systems – concept development
 - LRO/LCROSS - Lunar Mapping, Modeling, and Data Integration
- **Lunar Surface Science Scenarios**



Optimizing Science & Exploration Working Group - Chartered to Achieve...



OSEWG chartered by ESMD and SMD in FY2007; updated in FY2008.

OSEWG leadership reports to ESMD and SMD Deputy AAs

Scope:

- Coordinate and guide science and exploration planning
- Identify and provide science objectives (in requirements terms) for consideration of inclusion into the development of the Constellation architecture.
 - Includes *all* science
 - Scope includes not only the outpost, but also sortie, orbiters...
 - Science objectives input provided by NAC, NRC SCEM, LEAG...
- Engage the science and exploration communities (includes LEAG, CAPTEM, MEPAG, and other fora)
- Serve as liaison to LEAG for SMD and ESMD (through PSS, if/as needed)
- Remain cognizant of related activities (e.g., NASA Partnership Integration Committee, SMD Lunar Program, LEAG, ILEWG)





OSEWG Strategy & Momentum...

OSEWG Strategy:

1. Focus on optimizing science and exploration objectives through collaboration on surface science scenarios (SSS).
 - OSEWG SSS Working Group (SSSWG)
2. Focus ESMD-SMD coordination and communications in 3 areas:
 1. Analogue Missions
 2. Science Objectives
 3. Lunar Data Integration
3. Engage industry & academia for input, peer review and participation in planning, prioritizing and development of products.

Momentum:

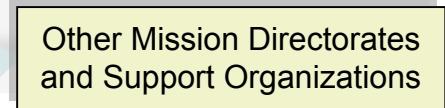
- August 20, 2008: EARD modified to include an return mass objective of 250kg; the threshold requirement remains 100kg
- Oct 1, 2008: Funding 6 FTE to help implement OSEWG leadership strategy
- Organizing and aligning science objectives, studies, etc., with action plans
- OSEWG website being developed for access by external communities (via LPI)
- ESMD and OSEWG initiated more direct engagement of the lunar science community through the LEAG, LPI and NLSI



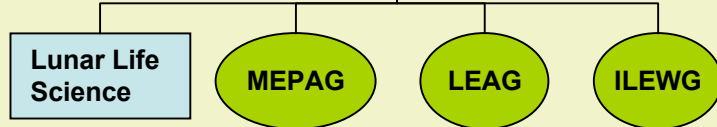
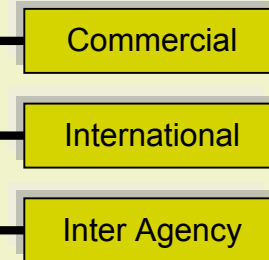
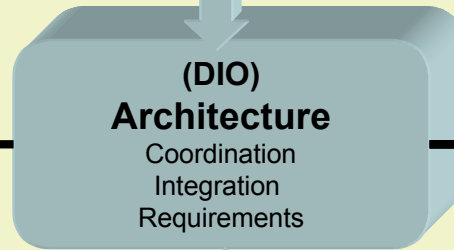
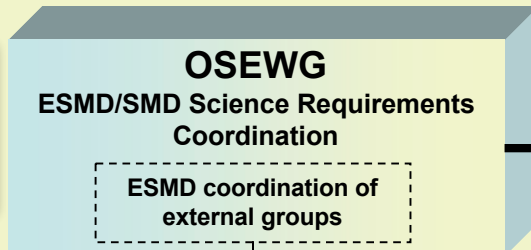
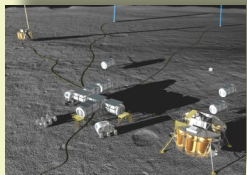
OSEWG Coordinates Science Requirements for Inclusion into Constellation Architecture



Crafts the Policy & Agreements

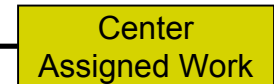
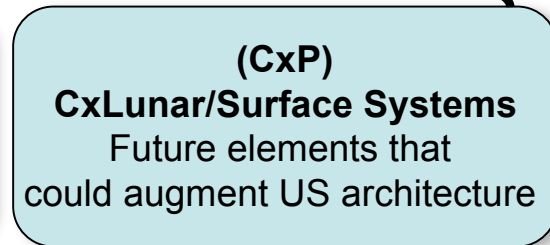
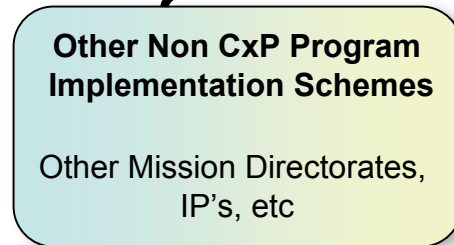


Crafts the Architecture and Partnerships



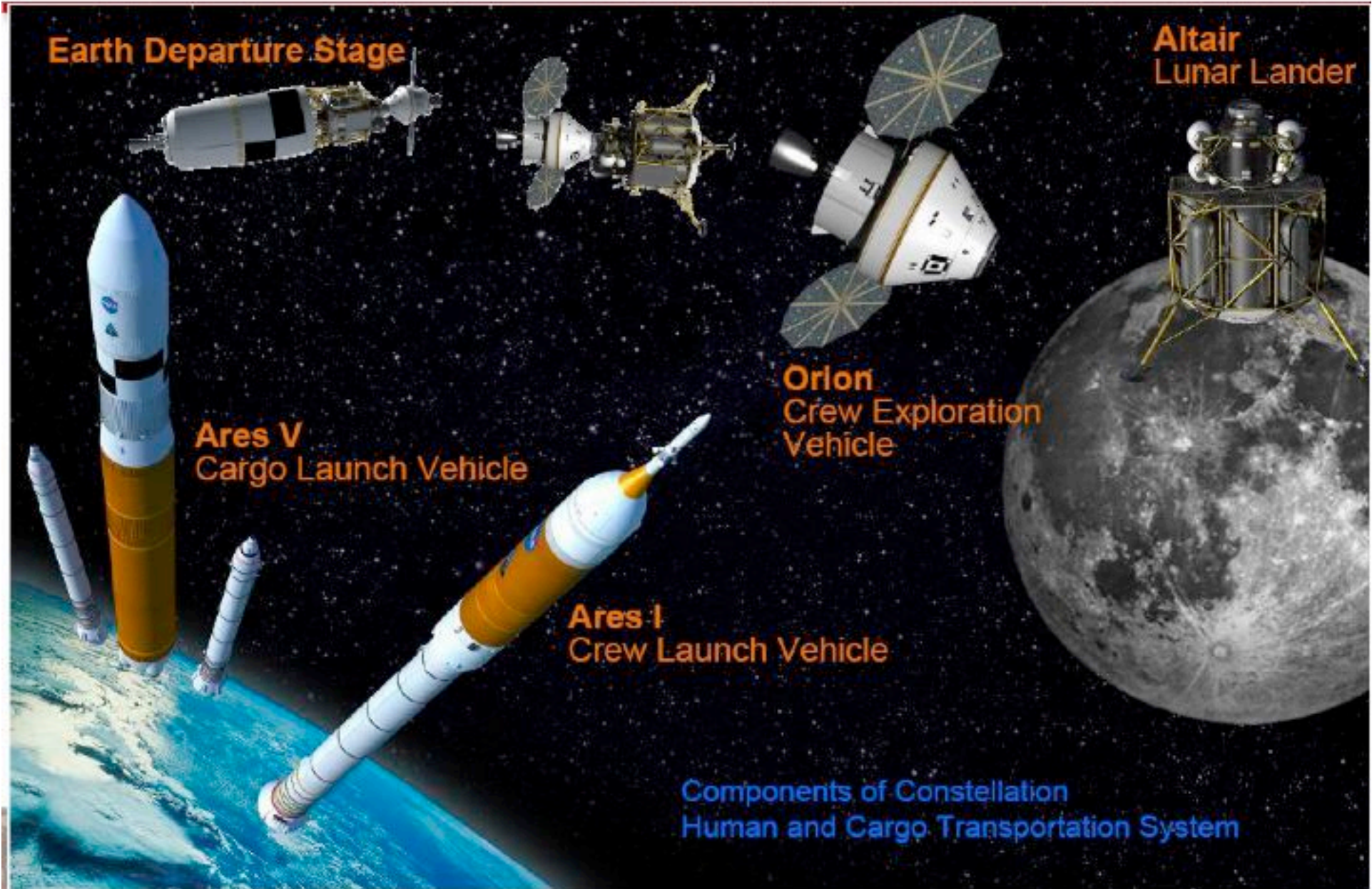
With assistance from CxP etc.

Crafts the Design



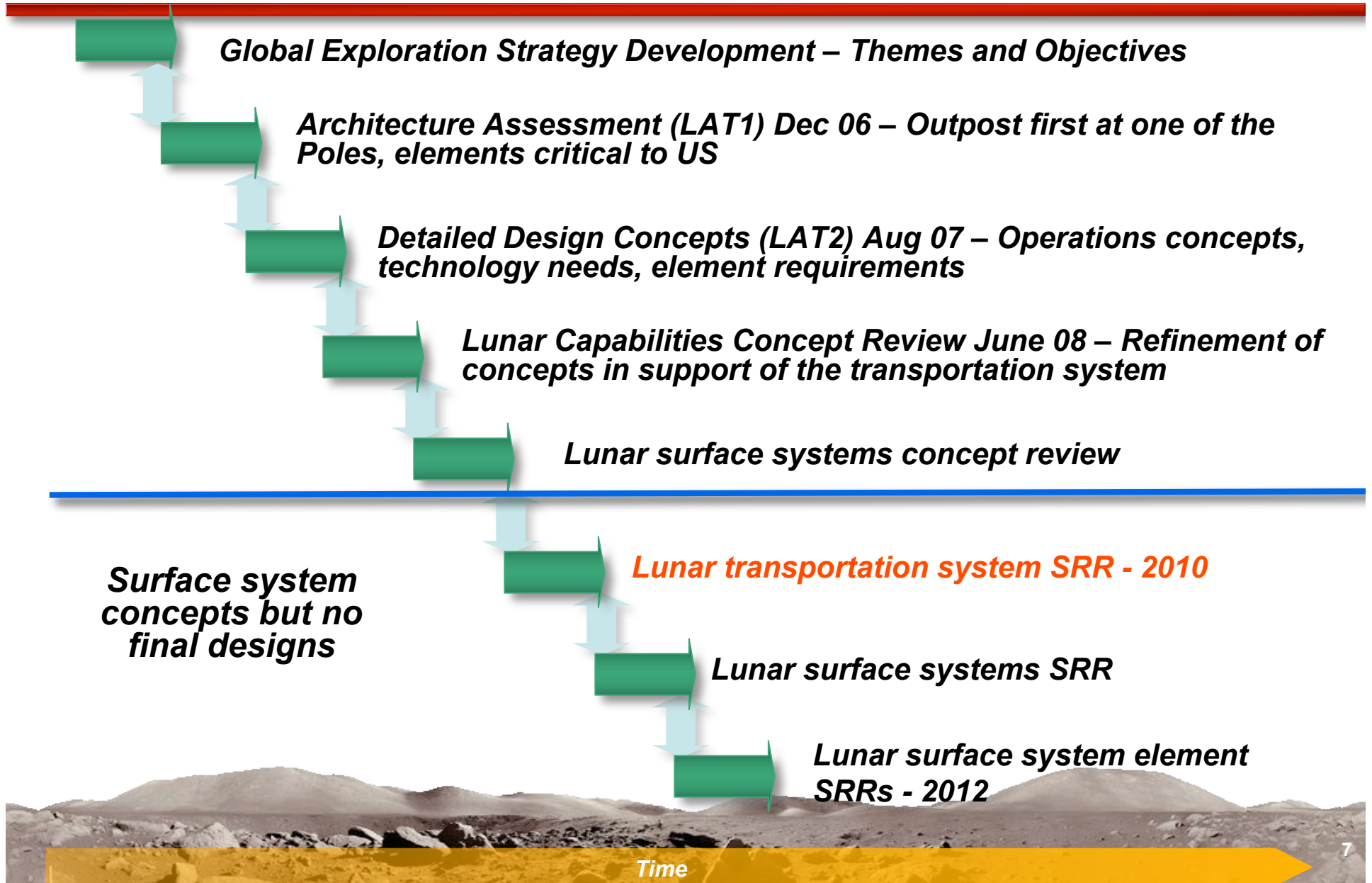
DIO – Directorate Integration Office, ISECG – International Space Exploration Coordinating Group, IP – International Partners, LEAG – Lunar Exploration Advisory Group, ILEWG – International Lunar Exploration Working Group, MEPAG – Mars Exploration Program Advisory Group, OER – Office of External Relations, OSEWG – Outpost Science Exploration Working Group, PIC – Partnership Integration Committee

Exploration Transportation Architecture

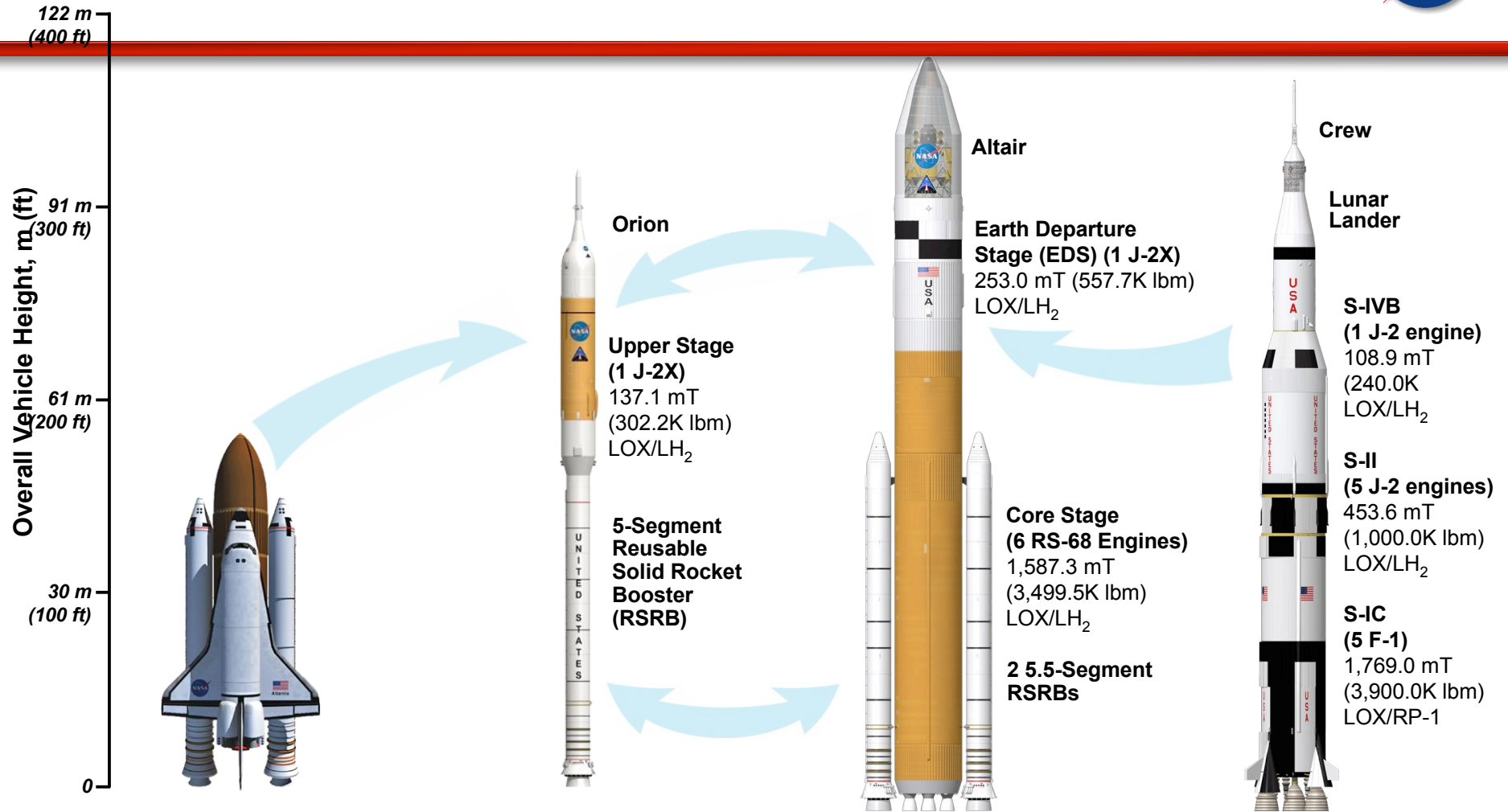


Architecture Driven By A Strategy

Where We Have Been and Next Steps



Ares V Conceptual Design



Space Shuttle

Height: 56.1 m (184.2 ft)
Gross Liftoff Mass: 2,041.1 mT (4,500.0K lbm)
Payload Capability: 25.0 mT (55.1K lbm) to Low Earth Orbit (LEO)

Ares I

Height: 99.1 m (325.0 ft)
Gross Liftoff Mass: 927.1 mT (2,044.0K lbm)
Payload Capability: 25.5 mT (56.2K lbm) to LEO

Ares V

Height: 116.2 m (381.1 ft)
Gross Liftoff Mass: 3,704.5 mT (8,167.1K lbm)
Payload Capability: 71.1 mT (156.7K lbm) to TLI (with Ares I)
 62.8 mT (138.5K lbm) to Direct TLI
 ~187.7 mT (413.8K lbm) to LEO

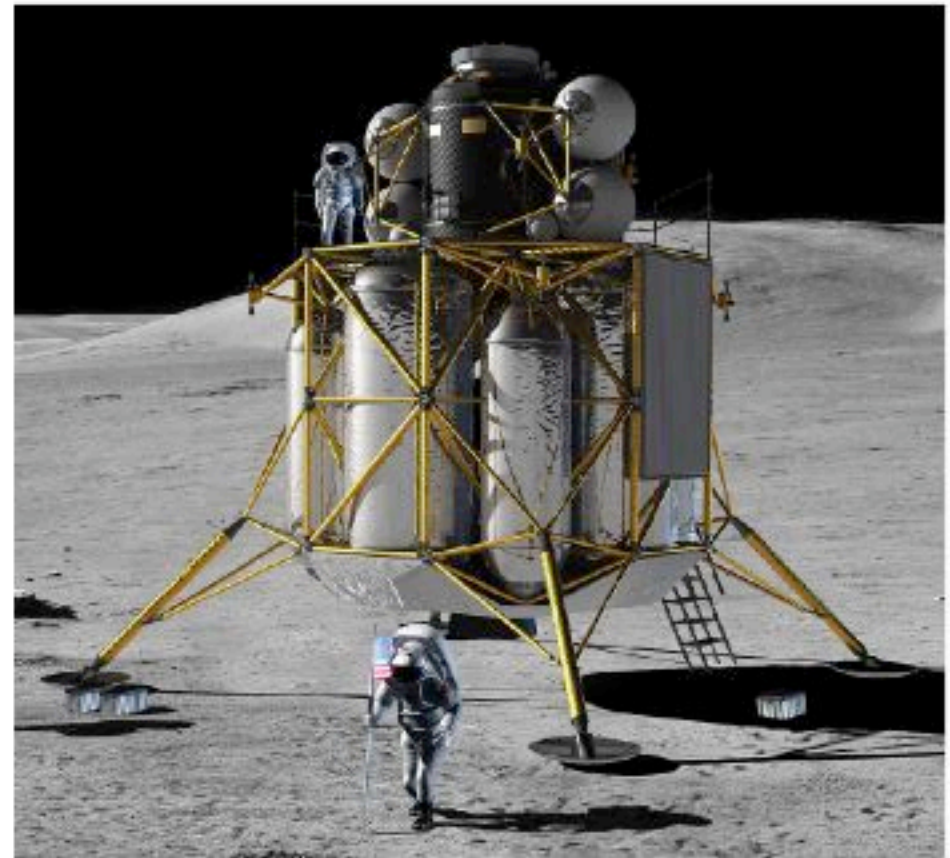
Saturn V

Height: 110.9 m (364 ft)
Gross Liftoff Mass: 2,948.4 mT (6,500K lbm)
Payload Capability: 44.9 mT (99K kbm) to TLI
 118.8 mT (262K lbm) to LEO

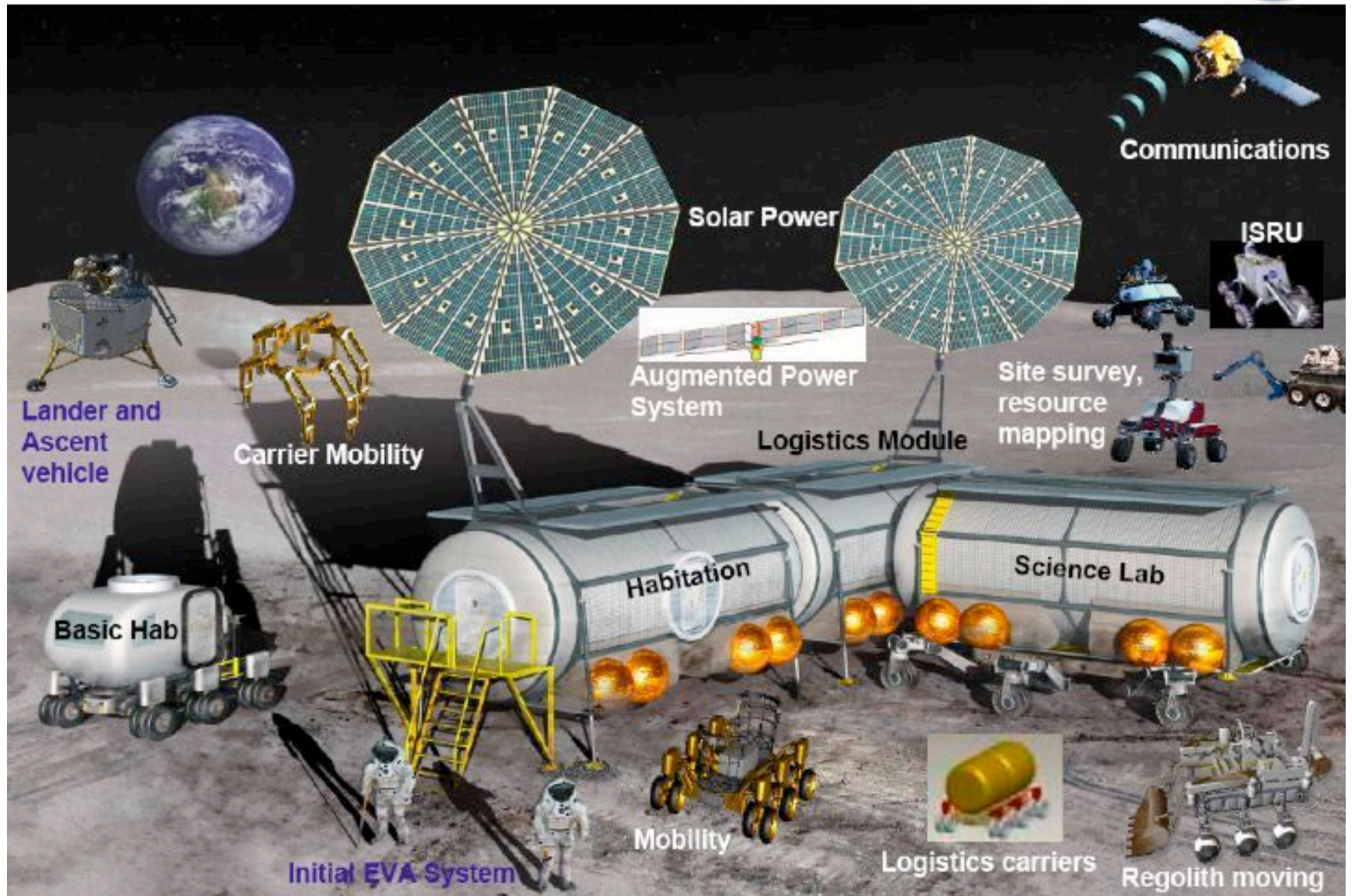
Altair Conceptual Design



- Four (4) crew to and from the surface
 - Seven days on the surface
 - Lunar outpost crew rotation
- Global access capability
- Anytime return to Earth
- Capability to land 14 to 17 metric tons of dedicated cargo
- Airlock for surface activities
- Descent stage:
 - Liquid oxygen / liquid hydrogen propulsion
- Ascent stage:
 - Hypergolic propellants or liquid oxygen/methane



Lunar Surface System Concepts



Lunar Mapping, Modeling and Data Integration

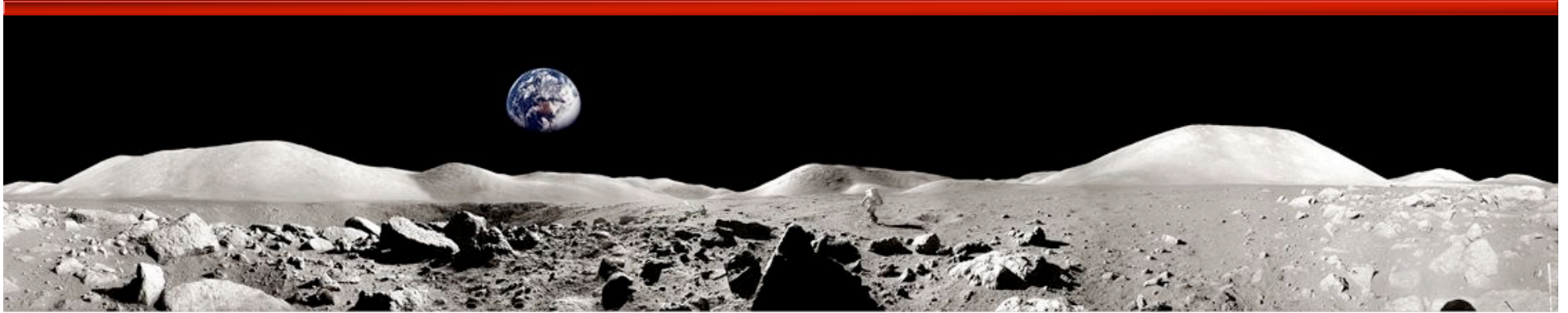


- **The Lunar Reconnaissance Orbiter Camera (LROC) project of LRO has developed a target planning system to solicit, prioritize, and plan on-orbit operations to acquire exploration and science targets.**
- **Science targets are being solicited from the science community by the LROC project coordinated through the LRO project science office.**
- **The LPRP Lunar Mapping and Modeling Project (LMMP) is working with Constellation to identify required characteristics of exploration targets, i.e. geometry, landing hazard assessment, slopes, lighting, etc.**
- **The LMMP is tasked to ensure that LRO data sets will be geodetically controlled and co-registered based on a control network derived from the LRO/LOLA data.**
 - Exploration-relevant data will be geodetically controlled and co-registered.
 - SMD will geodetically control and co-register science data.
 - All LRO data will be available in the Planetary Data System
- **LPRP has chartered the Lunar Geodesy and Cartography Working Group**
 - Will report results and findings to the IAU/IAG Working Group on Cartographic Coordinates and Rotational Elements





Shackleton Rim Landing Movie



Surface Science Scenarios

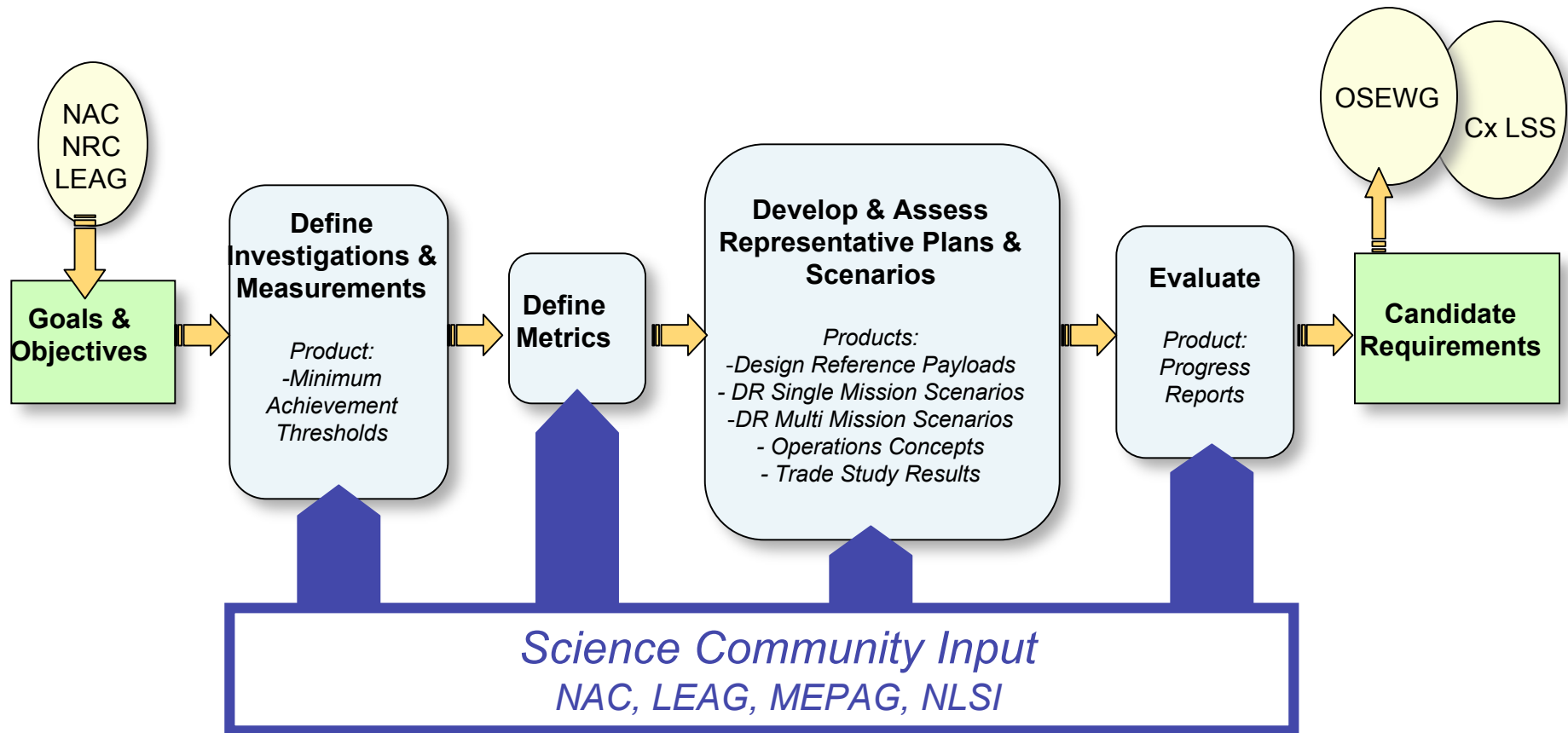


OSEWG Surface Science Scenario Working Group Objectives

- Construct
 - Campaign-level (multi-mission) Science Scenarios
 - Lunar Surface Science Scenarios for single missions
 - Design Reference Science Investigations that highlight scientific goals and objectives for examination by the appropriate teams for planning surface and orbiting lunar surface missions, campaigns, and architectures
- Use analysis of selected surface scenarios to drive concepts of operations and requirements for
 - the Constellation program and appropriate projects (e.g., Altair, EVA, and Surface Systems Projects)
 - SMD Programs (e.g., LASER, LSSO, MMAMA, ASTEP)
 - missions (e.g., LADEE, ILN)
 - and present requirements for incorporation into the appropriate requirements documents
- Use analysis of selected surface scenarios to drive planning for analog studies
- Engage the science and exploration communities (through LEAG, CAPTEM, and other forums) and the NAC in the discussion of surface scenarios, including responding to NAC actions with respect to surface scenarios



OSEWG Surface Science Scenario Working Group Activity Flow



Science Surface Scenario Working Group

Key Activities



- **Work with LEAG to understand new set of Goals and Objectives**
- **Develop science scenarios for different mission types and sites**
 - ✓ “Sortie” missions with “Apollo-like” mobility at two sites (so far)
 - Longer traverse missions at multiple sites including pole
 - A multi mission scenario of polar outpost + 3 sorties
- **Develop overarching approach for metrics for evaluating likely scientific return from lunar missions and campaigns as measured against NAC lunar science objectives from Tempe Workshop, NRC SCEM Report Objectives and LEAG**
- **Translate key scenario findings into candidate science-driven requirements to consideration by OSEWG for inclusion on the CARD or EARD**



Example Science Activities per Science Community Objectives

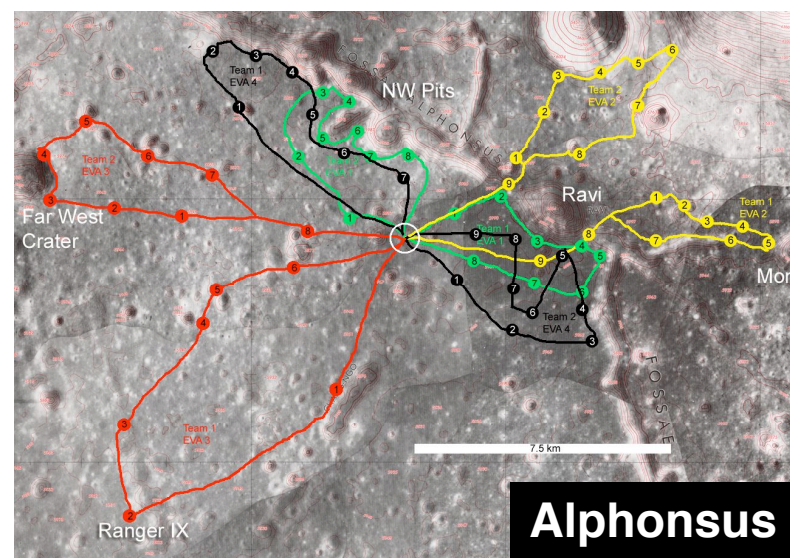
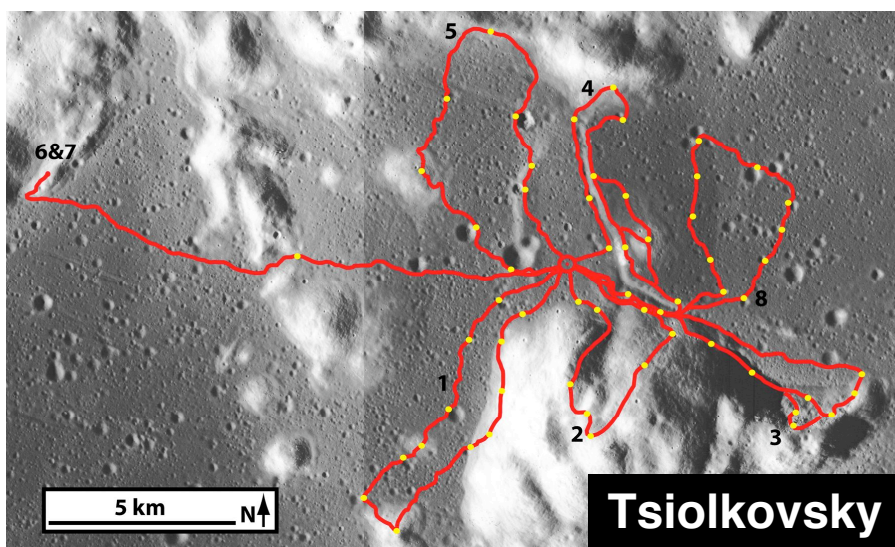


- Geophysical Network (-PSS-2)
 - Build on ILN work
 - Include field testing in Analogs plan
- Solar Wind measurement and flux instrumentation (-HPS-4)
- In-situ Electro-Magnetic and Charged-Dust Environment at a potential Outpost or other lunar site (-C-14)
- Astrophysics Observatories (-APS-2):
 - Deployment and servicing capabilities
 - Maintenance, refurbishment, and upgrade
 - Potential to integrate with other Exploration operations
- Planetary Protection
 - instrumentation such as robotic sample collection & sensitive, rapid assay methods using field-portable equipment (-PPS-2, -PPS-4)
- Earth observation, constant Earth-view locations (-ESS-1, -ESS-2)
- Instrumentation concepts and activities identified through LSSO, ILN, NRC studies, etc.



Workshop: Planning Sorties at Tsiolkovsky and Alphonsus

- Two groups of four scientists were tasked with Tsiolkovsky or Alphonsus craters and asked to design an exploration plan driven by scientific rationale. The exercise assumed a total of eight, two-man EVAs of eight hours, including the use of two unpressurized rovers
- Results reported at NLSI Lunar Science Conference in July, and final report is being written





Workshop: Preliminary Recommendations

- **Robotic mission designed as precursor *and* follow up is fundamental to maximize success of human mission.**
 - Hazard assessment & scientific analyses
- **Flexible EVA plans**
- **Mass of returned samples estimated at ~300 kg for 7-day sortie mission (based on Apollo 17 sampling); requires requirement update**
- **Enable scientific investigations with field instruments:**
 - Digital handlens
 - Spectral cameras
 - Handheld geochemical analysis tools
 - Ground penetrating radar
- **Deploy network or instrument station sites**
 - e.g. Geophones, seismic sources, surface magnetometers
- **Continued support for ongoing efforts to geo-reference uncontrolled data sets**



OSEWG Surface Science Scenario Working Group

