National Aeronautics and Space Administration

Exploration Update

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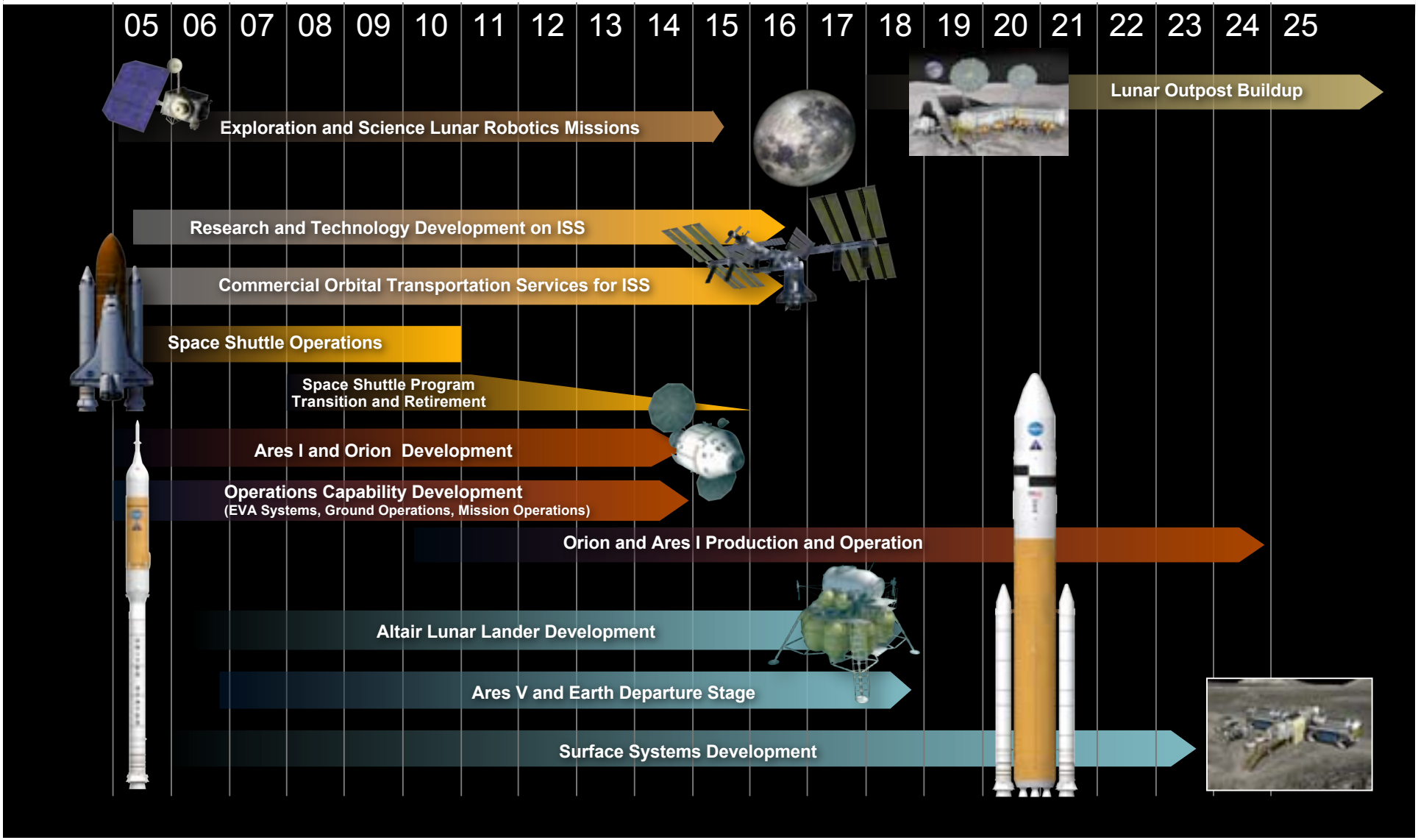
The U.S. Space Exploration Policy: Foundation for Exploration

- Complete the International Space Station
- Safely fly the Space Shuttle until 2010
- Develop & fly the Crew Exploration Vehicle no later than 2014
- Return to the Moon no later than 2020
- Extend human presence across the solar system & beyond
- Implement a sustained & affordable human & robotic program
- Promote international & commercial participation in Exploration

Exploration Roadmap



ESMD FY08 Objectives

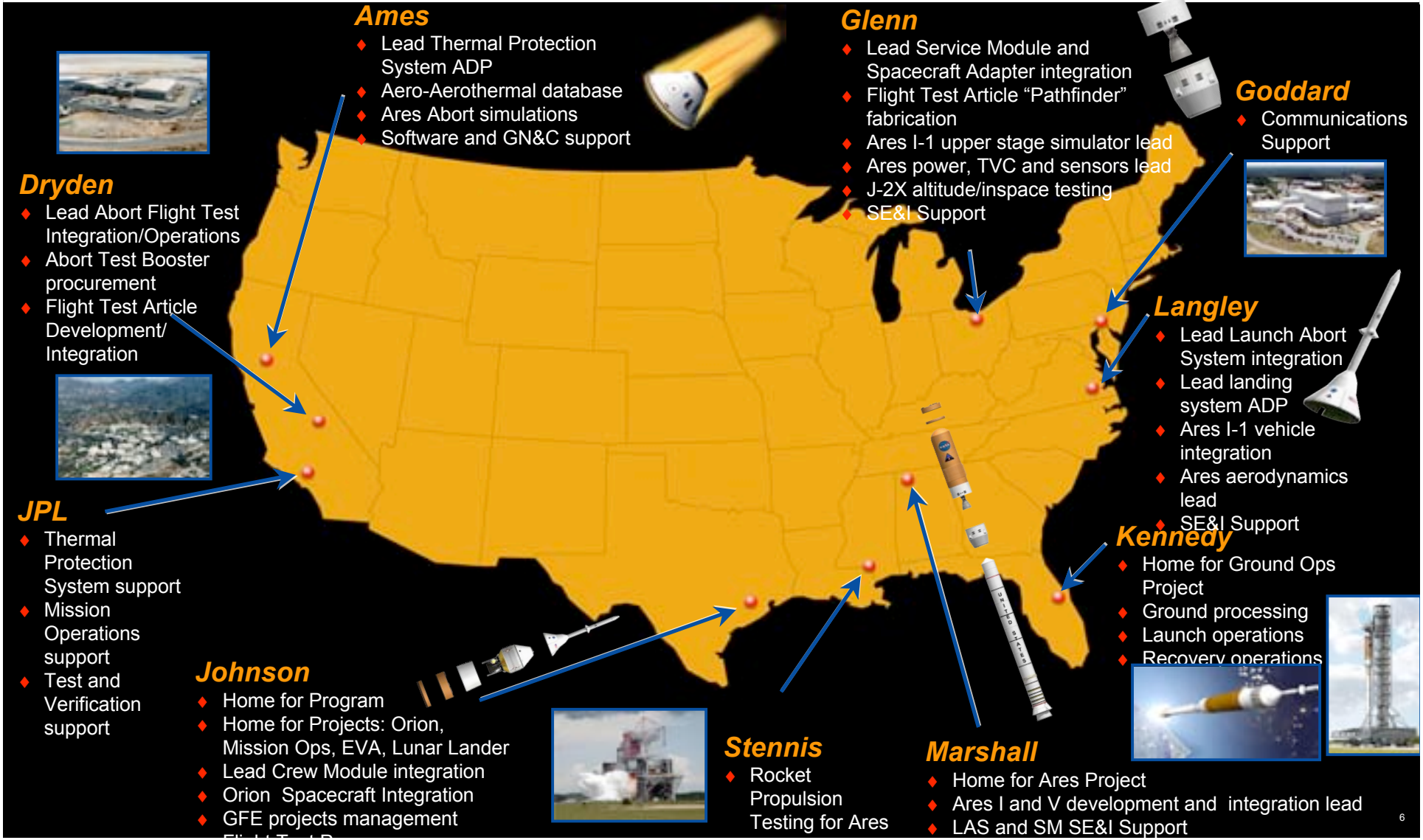
- **Constellation Program (CxP) – Complete milestones including:**
  - – Orion and Ares I Preliminary Design Reviews (PDR); Orion System Baseline Review Oct 08, PDR To Be Determined)
  - √ Extravehicular Activity System Definition Review
  - √ Lunar Capability Concept Review (Altair and Ares V Mission Concept Review Completed, Broad Area Announcements/Request for Information (RFI) out)
- **Procurements/Space Act Agreements (SAA) - Complete milestones:**
  - √ Award Ares Instrument Unit Avionics by Dec 07
  - Award the prime contract for CxP Space Suit System (protest under review)
  - √ Complete Commercial Orbital Transportation Services (COTS) Phase I, Round 2 SAA selection
- **Advanced Capabilities Division (ACD) - complete milestones including:**
  - √ Delivery of the next generation E-nose to International Space Station for integration
  - √ Human Research Program (HRP) Integrated Research Plan
  - √ Release one HRP NASA Research Announcement
  - √ Lunar Reconnaissance Orbiter (LRO) Pre-environmental review

ESMD FY08 Objectives (cont.)

- **Transition and Retirement (T&R) – Create a jointly-developed T&R budget line to include preliminary implementation strategy and mitigation plans**

- **Implement integrated program management across ESMD elements**
  - √ Support NASA's goals and objectives by ensuring that external stakeholders are informed of Exploration activities in a timely, coordinated and effective manner (OMB, Congress, Industry, International Partners & Public)
  - √ Enable and lead efforts to grow working relationships and partnerships across mission directorates, other federal agencies, industry and international partners

Constellation Leverages Unique Skills and Capabilities Throughout NASA and the Aerospace Industry



Driven by a Strategy

U.S. Space Exploration Policy

ESAS (2005)
Methodical approach to architecture mission mode using relevant FOMS

Global Exploration Strategy (2006)
Lunar Objectives Identified

LAT1 (2006)
Early Outpost at Polar Site

LAT2 (2007)
- **Cargo Lander**
- **Surface Mobility**
- **Cargo Unloading, Transport, Emplacement**

May '07 The Global Exploration Strategy – The Framework for Coordination

Nov '07 established the International Space Exploration Coordination Group (ISECG)

CxAT Lunar (May 2008)
Preparation for the LCCR Transportation System POD

Jan '08 Start of Chamber of Commerce Interface Standards activity via the SEC

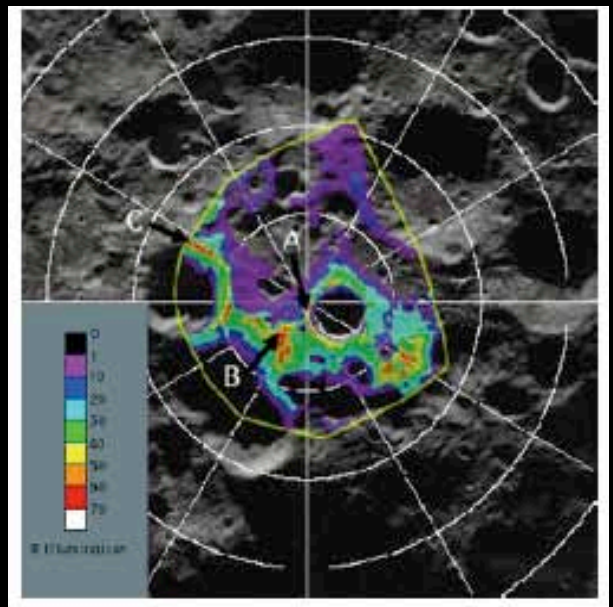
NASA/ESA comparative architecture assessment

LCCR (June 2008)
Transportation System POD

Additional review cycles
Lunar Surface Concept 2010 Etc.

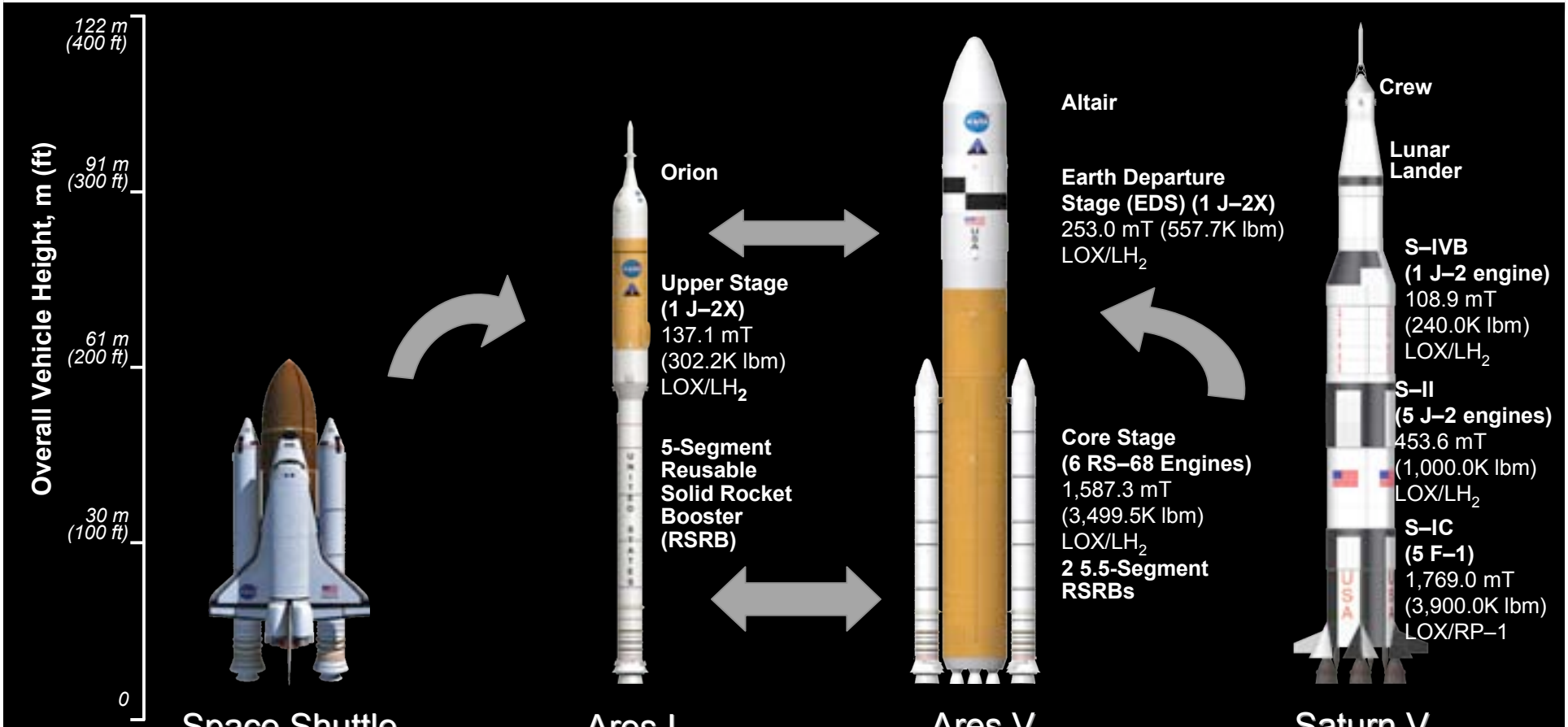
Possible South Pole Outpost

- **The lunar South Pole is a likely candidate for outpost site**
- **Elevated quatities of hydrogen, possibly water ice (e.g., Shackelton Crater)**
- **Several areas with greater than 80% sunlight and less extreme temperatures**
- **Incremental Deployment of Systems – one mission at a time**
  - Power system
  - Communications/navigation
  - Habitat
  - Rovers
  - Etc.



Lunar Landing

Building on a Foundation of Proven Technologies
– Launch Vehicle Comparisons –



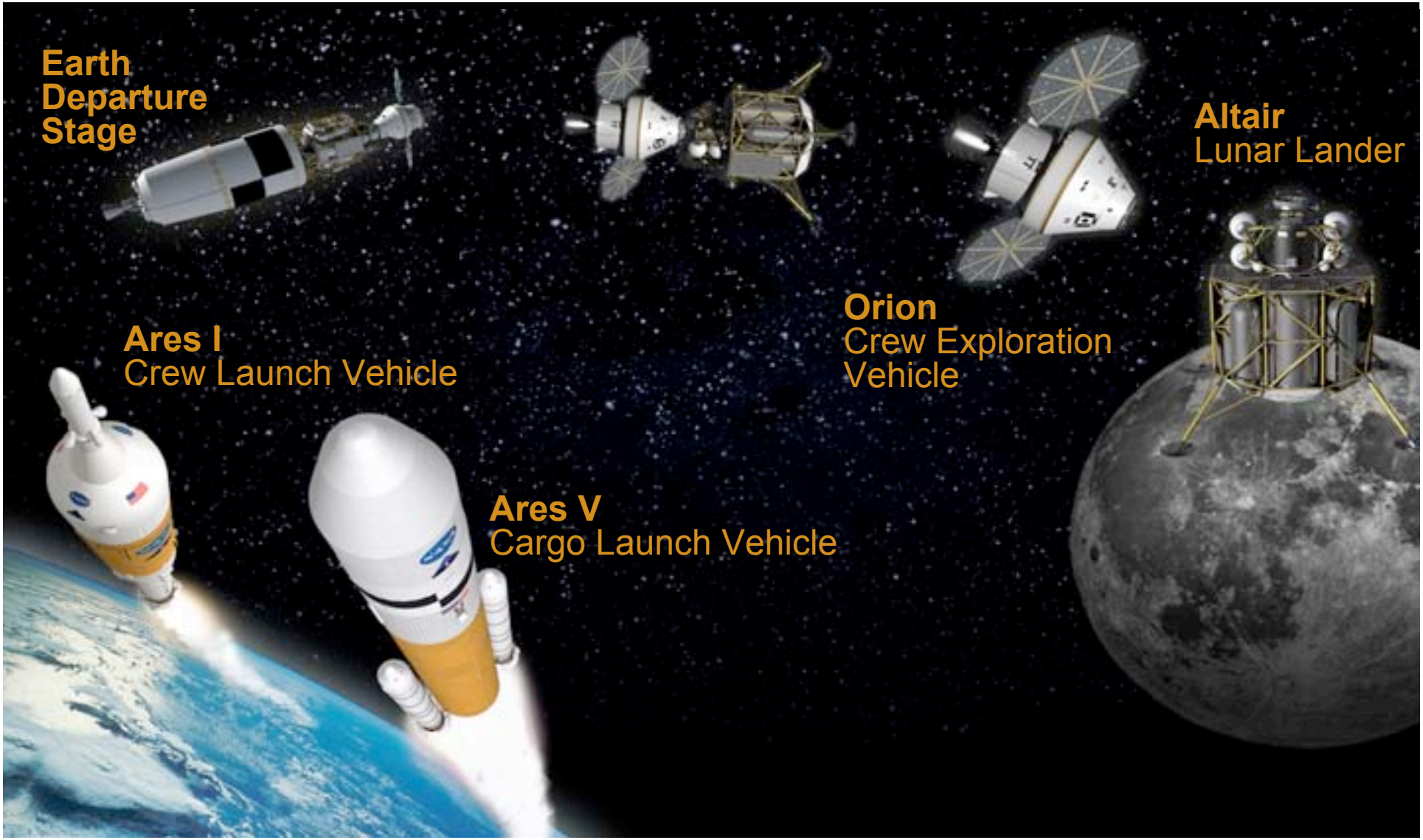
Space Shuttle
Height: 56.1 m (184.2 ft)
Gross Liftoff Mass:
2,041.1 mT (4,500.0K lbm)
Payload Capability:
25.0 mT (55.1K lbm)
to Low Earth Orbit (LEO)

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 TLI
~187.7 mT (413.8K lbm) to LEO

Saturn V
Height: 110.9 m (364.0 ft)
Gross Liftoff Mass :
2,948.4 mT (6,500K lbm)
Payload Capability:
44.9 mT (99.0K lbm) to TLI
118.8 mT (262.0K lbm) to LEO

Constellation Program Fleet of Vehicles



Constellation Architecture

Ares I-X Project Recent Progress Highlights

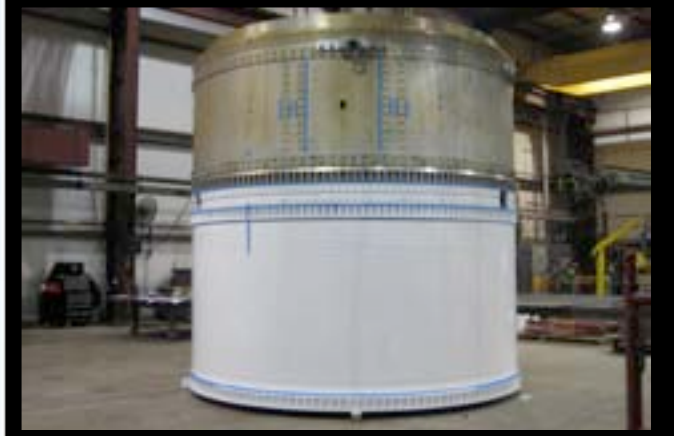
Crew Module

Aft Skirt

Upper Stage Segments in Shipment

Aft Segment Thermal Protection System

Drogue Drop Test No. 1



Fwd Skirt to Top of 5th Seg Simulator

2008: Technical Progress
Hardware Fabrication and Testing – Ares I

J2-X Power Pack Testing

J2-X Turbopump Development

Friction Stir Weld Process Development

First Stage Drogue Parachute Drop Test

DM-1 First Stage Exit Cone

A3 Test Stand Subscale Diffuser Test

2008: Technical Progress
Hardware Fabrication and Testing – Orion

Second Successful Jettison Motor Test

Crew Module for Pad Abort 1

Parachute Testing

PA-1 Launch Abort Systems Composite Structural Elements

Adapter Cone

Nose Cone

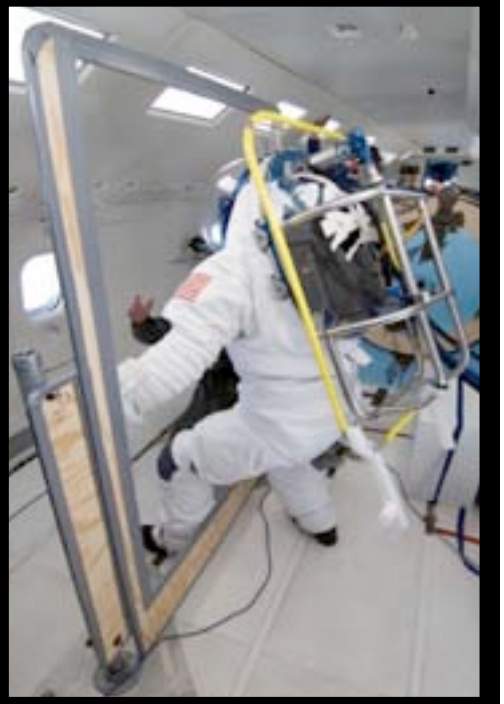
Abort Motor Static Test – 1

2008: Technical Progress
Hardware Fabrication and Testing – EVA Systems

Suit Don/Doff Volume Assessment

Handrail Translation Demonstration

Orion Hatch Ingress/Egress (1” short config)



Altair Hatches Ingress/Egress Test

2008: Technical Progress
Construction of Facilities

J2X A3 Altitude Test Stand Construction

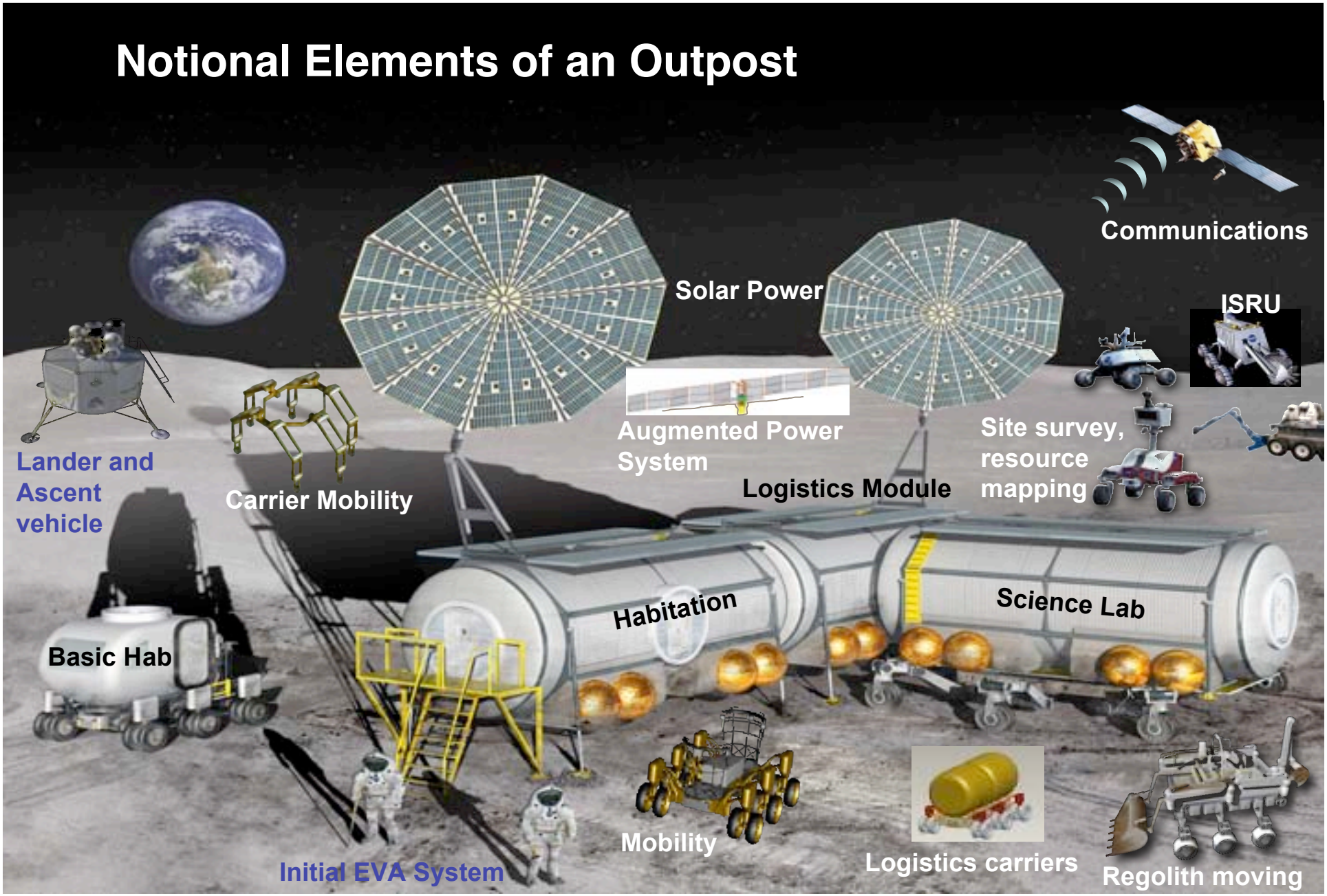
Dynamic Test Stand Modifications

Launch Complex 39B Lightning Protection System Construction

Orion Manufacturing Facilities at KSC

Launch Control Center Firing Room 1

Notional Elements of an Outpost



Small Pressurized Rover Analog

Summary

- **ESMD continues to deliver as promised**
  - Major work is underway
  - Contracts are in place
  - Our plan is executable
- **NASA has planned and paced the multi-decade Constellation program to live within its means, while carefully identifying and mitigating the threats to mission success**
- **This program will drive us toward new technologies;**
  - will enable a new area of economic activity
  - will strengthen our national security
  - will engage our technical and engineering workforce
  - will provide an opportunity to collaborate on important missions with our international partners
  - and will inspire a new generation of scientists and engineers

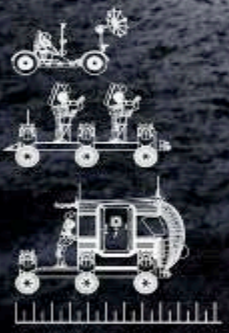
Backup

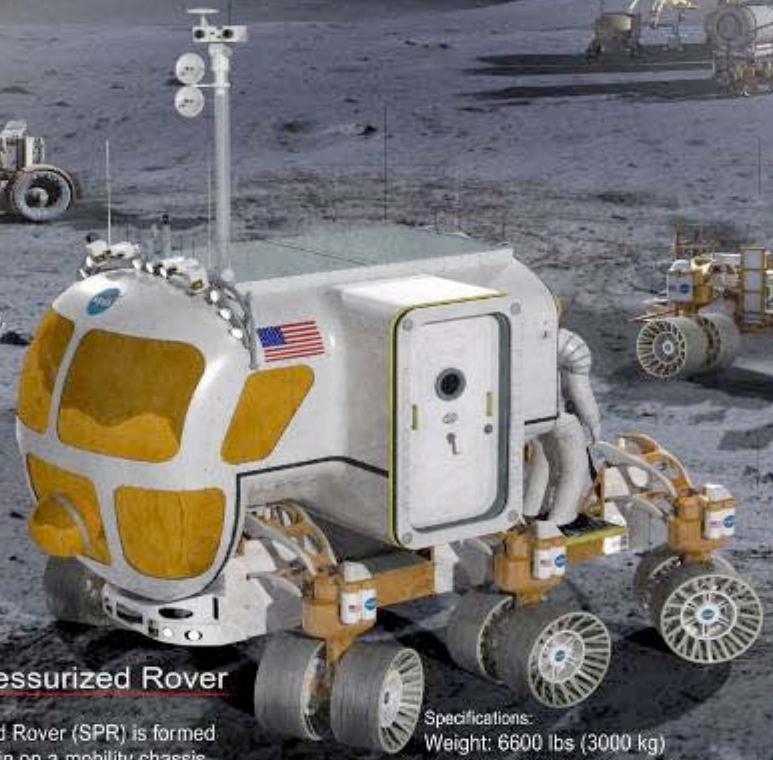
Lunar Surface Mobility Capability Comparison

The Original Rover

The Apollo Lunar Roving Vehicle (LRV) was an electric vehicle designed to operate in the low-gravity vacuum of the Moon and to be capable of traversing the lunar surface, allowing the Apollo astronauts to extend the range of their surface extravehicular activities.

Specifications:
Weight: 462 lbs (210 kg)
Payload: 490 kg (1080 lbs)
Length: 3.1 m (10 ft 2 in)
Wheel Base: 2.3 m (7 ft 6 in)
Height: 3.75 ft (1.1 m)
Wheels: 4 x 32 in diameter, 9 in wide





The Small Pressurized Rover

The Small Pressurized Rover (SPR) is formed by placing a crew cabin on a mobility chassis. The SPR cabin is designed to expedite EVA and provide a comfortable environment for longer range traverses. The SPR can mate with habitats and other SPRs.

Specifications:
Weight: 6600 lbs (3000 kg)
Payload: 2200 lbs (1000 kg)
Length: 15 ft (4.5 m)
Wheelbase: 13 ft (4 m)
Height: 10 ft (3 m)
Wheels: 12 x 39 in diameter, 12 in wide

The Chariot

The crew mobility chassis can carry up to four suited astronauts, various payloads, or be driven robotically. The modular system accepts "turrets" for suited crew, bulldozer blades, winches, survey instruments, manipulators, and other construction implements.

Specifications:
Weight: 2200 lbs (1000 kg)
Payload: 6600 lbs (3000 kg)
Length: 15 ft (4.5 m)
Wheelbase: 13 ft (4 m)
Height: 4 ft (3.3 m)
Wheels: 12 x 39 in diameter, 12 in wide

Importance of Mobility in the Lunar Architecture