Space Exploration Initiative

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The Vision

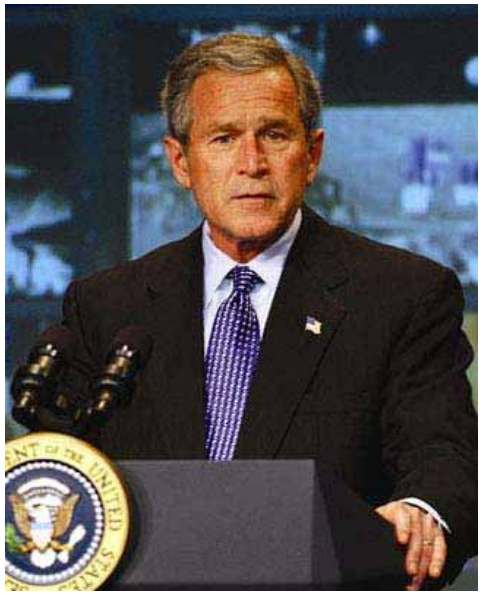
Constellation Program

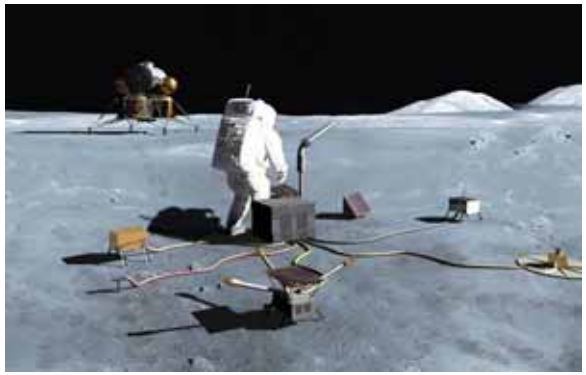
Launch Vehicles

Michoud Assembly Facility –the Coastal Connection

A Bold Vision for Space Exploration, Authorized by Congress

- **Complete the International Space Station**
- **Safely fly the Space Shuttle until 2010**
- **Develop and fly the Crew Exploration Vehicle no later than 2014 (goal of 2012)**
- **Return to the Moon no later than 2020**
- **Extend human presence across the solar system and beyond**
- **Implement a sustained and affordable human and robotic program**
- **Develop supporting innovative technologies, knowledge, and infrastructures**
- **Promote international and commercial participation in exploration**





NASA Authorization Act of 2005

The Administrator shall establish a program to develop a sustained human presence on the Moon, including a robust precursor program to promote exploration, science, commerce and U.S. preeminence in space, and as a stepping stone to future exploration of Mars and other destinations.

Constellation Program

NASA's Exploration Roadmap

05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

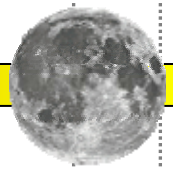
Initial CEV Capability

1st Human CEV Flight

Lunar Outpost Buildup

7th Human Lunar Landing

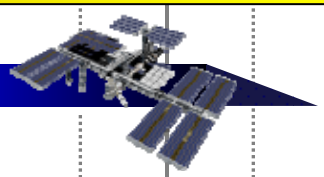
Lunar Robotic Missions



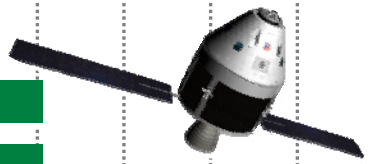
Science Robotic Missions

Mars Expedition Design

Commercial Crew/Cargo for ISS

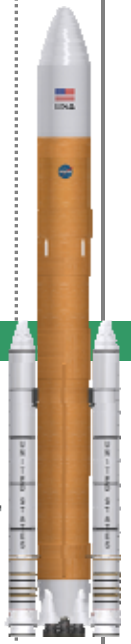


Space Shuttle Ops

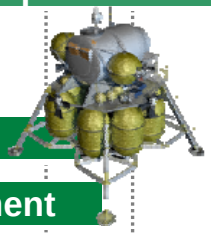


CEV Development

Crew Launch Development



CEV Production and Operations



Early Design Activity

Lunar Lander Development

Lunar Heavy Launch Development

Earth Departure Stage Development

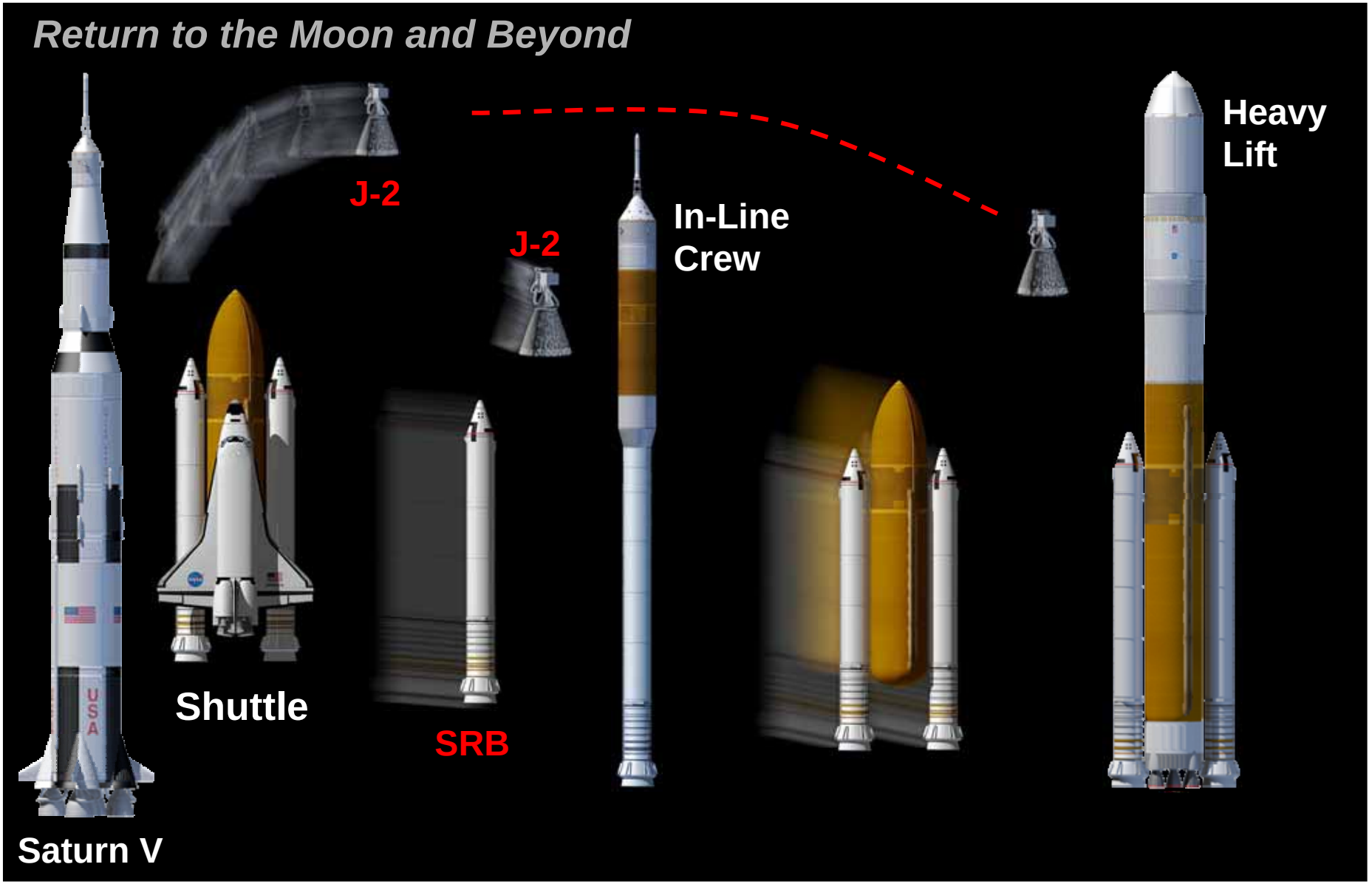
Surface Systems Development

The Moon - the 1st Step to Mars and Beyond…

- Regaining and extending operational experience in a hostile planetary environment
- Developing capabilities needed for opening the space frontier
- Preparing for human exploration of Mars
- Science operations and discovery

Next Step in Fulfilling Our Destiny As Explorers

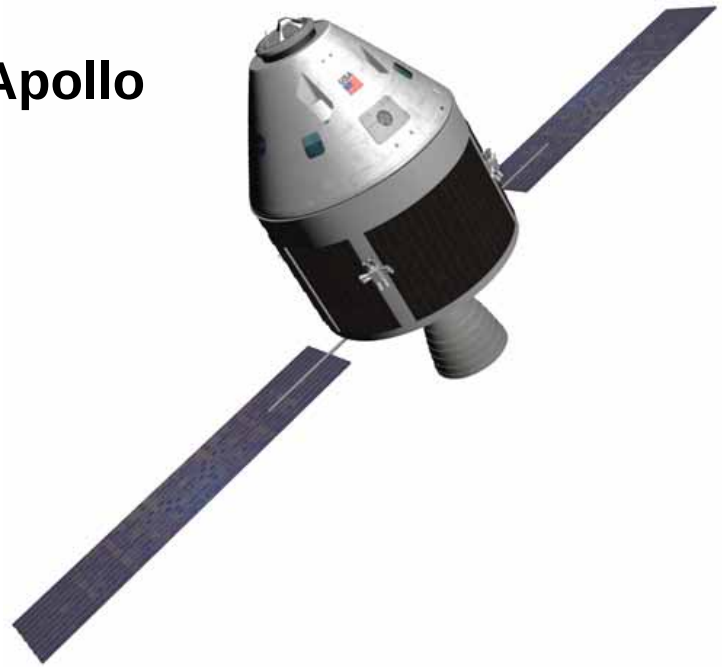
Heritage Derived Launch Vehicles



How We Plan to Return to the Moon
Crew Exploration Vehicle:

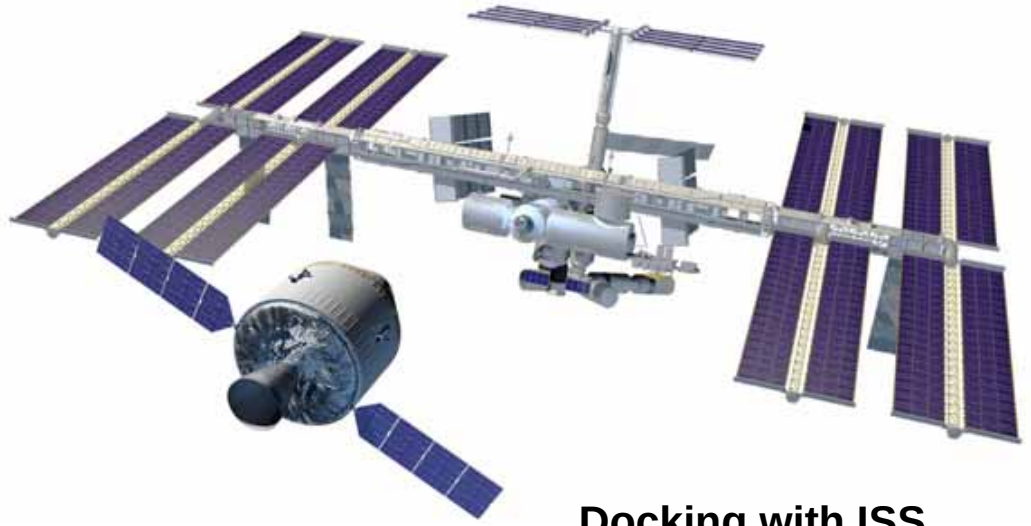
- **A blunt body capsule is the safest, most affordable and fastest approach**
  - Separate Crew Module and Service Module configuration
  - Vehicle designed for lunar missions with 4 crew Can accommodate up to 6 crew for Mars and Space Station missions
  - System also has the potential to deliver pressurized and unpressurized
    - cargo to the Space Station if needed

- **5 meter diameter capsule scaled from Apollo**
  - Significant increase in volume
  - Reduced development time and risk
  - Reduced reentry loads, increased landing stability and better crew visibility



CEV Mission to International Space Station

Crew Exploration Vehicle



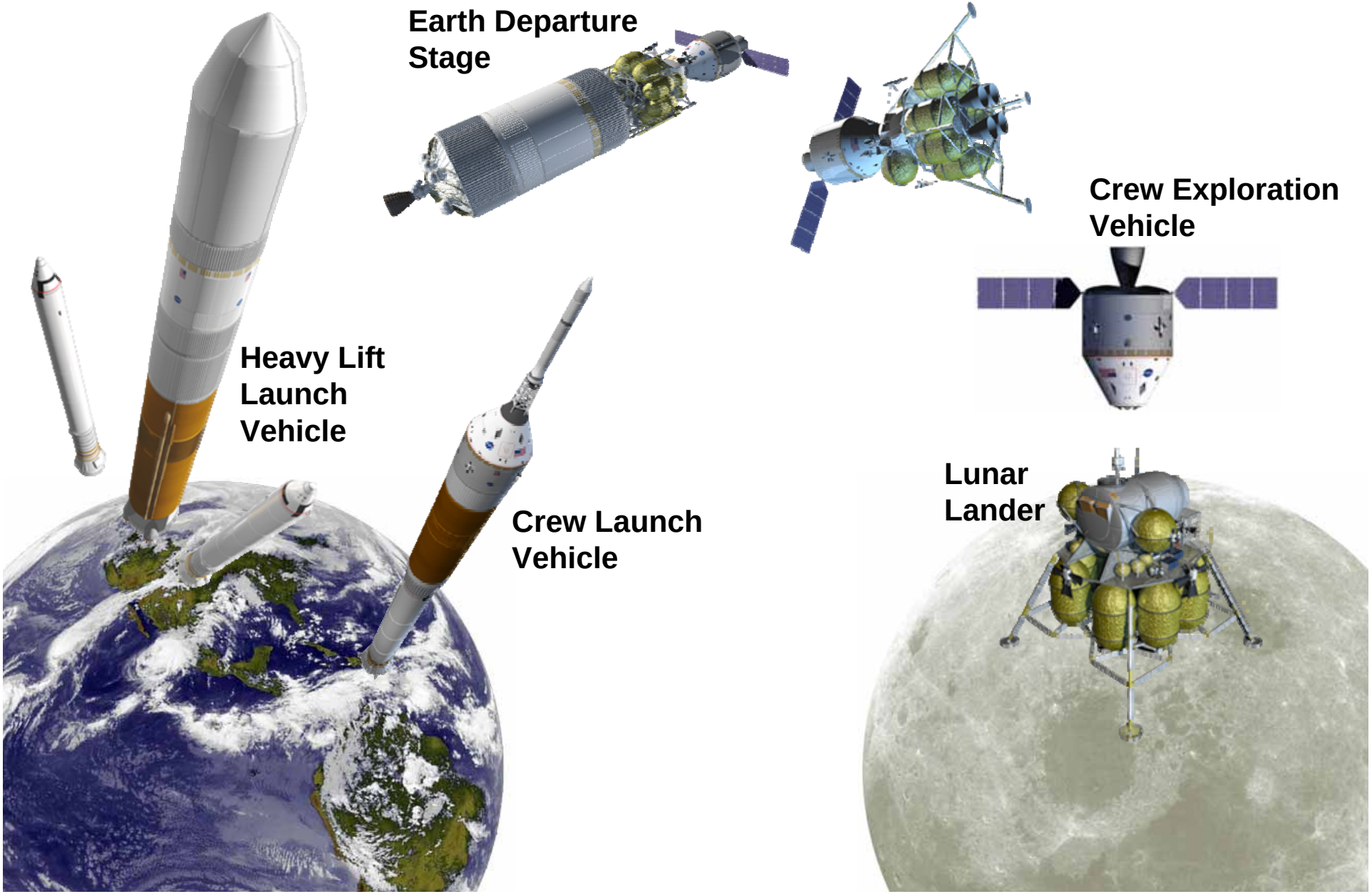
Docking with ISS

Crew Launch Vehicle

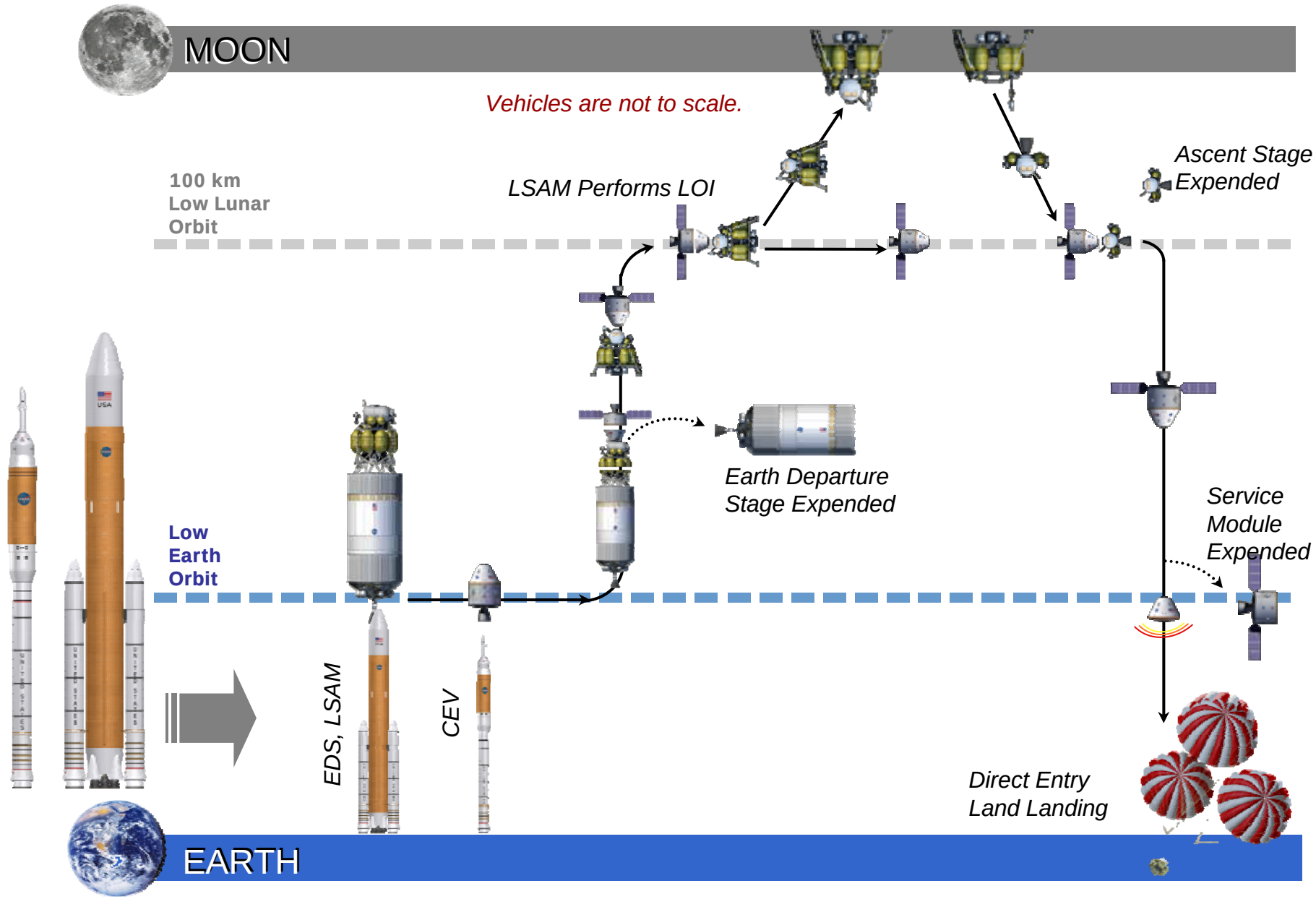
Servicing the International Space Station

- **NASA will invite industry to offer commercial crew and cargo delivery service to and from the Station**
- **The CEV will be designed for lunar missions but, if needed, can service the International Space Station. Annually, the CEV has the potential for:**
  - 2 crew flights
  - 3 pressurized cargo flights
- **The CEV will be able to transport crew to and from the station and stay for 6 months**

Components of Program Constellation



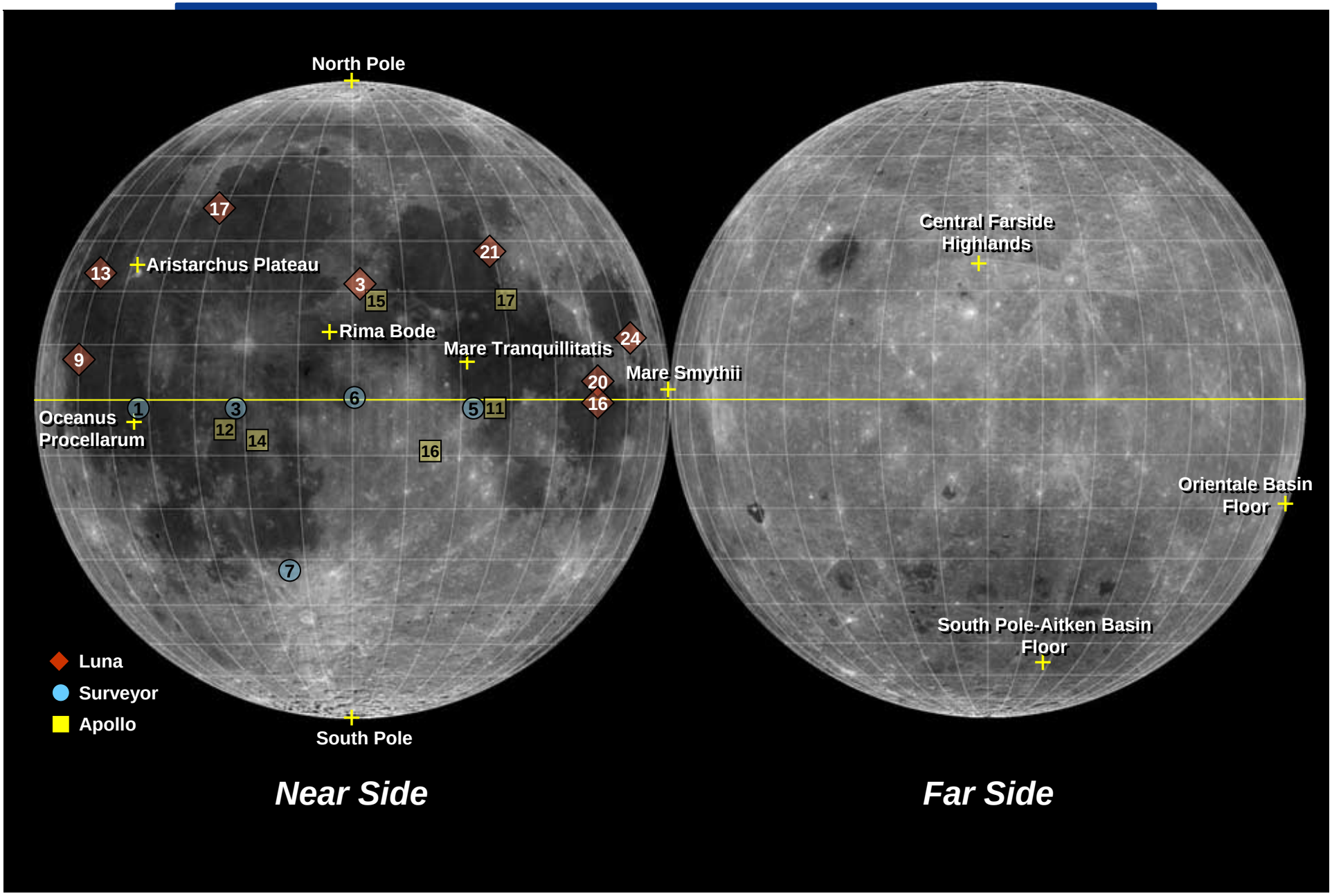
Typical Lunar Reference Mission



Lunar Lander and Ascent Stage

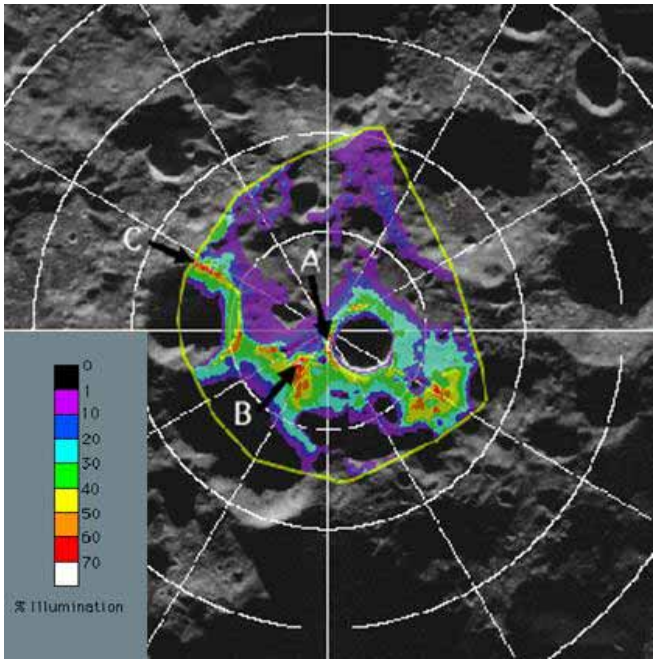
- **4 crew to and from the surface**
  - Seven days on the surface
  - Lunar outpost crew rotation
- **Global access capability**
- **Anytime return to Earth**
- **Capability to land 21 metric tons of dedicated cargo**
- **Airlock for surface activities**
- **Descent stage:**
  - Liquid oxygen / liquid hydrogen propulsion
- **Ascent stage:**
  - Storable Propellants

High Priority Lunar Exploration Sites



Possible South Pole Outpost

- **The lunar South Pole is a likely candidate for outpost site**
- **Elevated quantities 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.



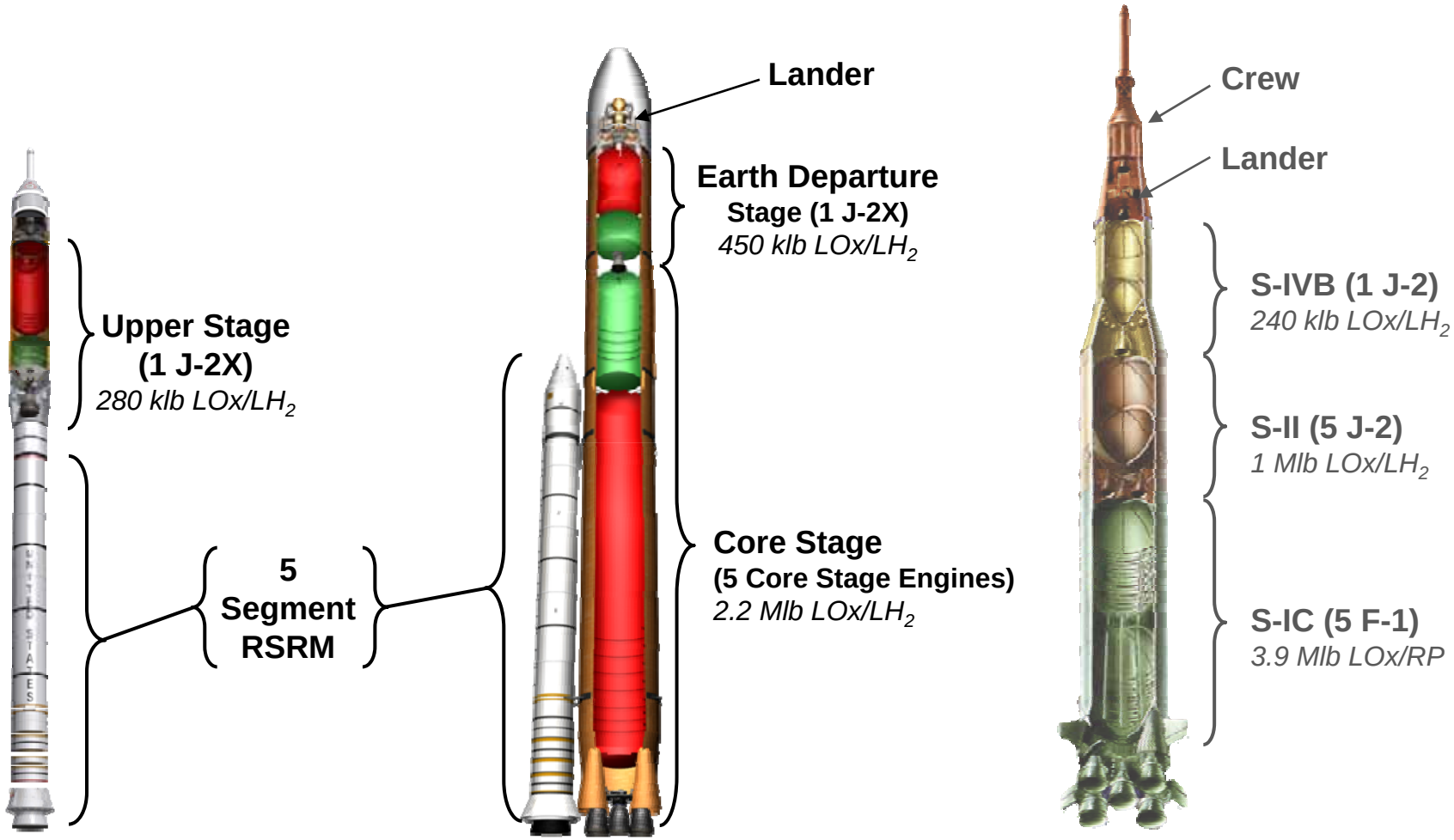
Constellation Launch Vehicles

Exploration Launch Vehicles

- **Crew Launch Vehicle**
  - Single 5 segment RSRB/M First Stage
  - Upper Stage powered by a single engine derived from the Saturn J-2
- **Cargo Launch Vehicle**
  - Twin 5 segment RSRB/M First Stage (from CLV)
  - Core stage derived from the heritage systems
  - Powered by 5 LOx/LH2 core stage engines
  - CLV-derived avionics
- **Earth Departure Stage**
  - Upper Stage derived from heritage systems
  - Powered by a single CLV upper stage engine - 2 burn capability
  - CLV-derived main propulsion systems and avionics

Future development

Launch Vehicle Comparison



Height: *309 ft*
Gross Liftoff Mass: *2.0Mlb*

55 klbm to LEO

Crew Launch Vehicle

Height: *358 ft*
Gross Liftoff Mass: *6.4Mlb*

121 klbm to Trans-Lunar Injection
147 klbm to TLI in Dual Launch Mode with CLV

Cargo Launch Vehicle

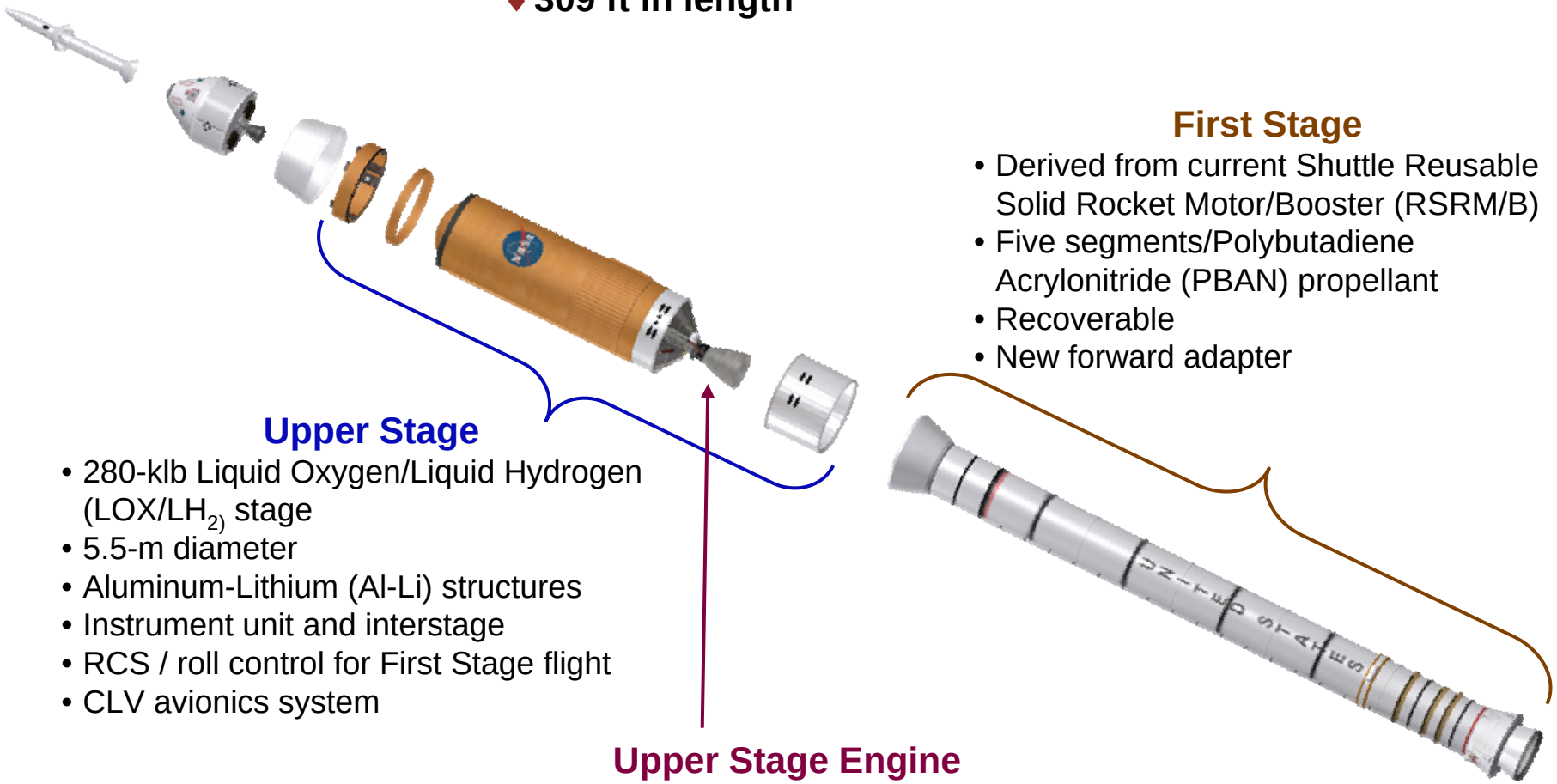
Height: *364 ft*
Gross Liftoff Mass: *6.5Mlb*

112 kblm to Trans-Lunar Injection

Saturn V

Overall CLV System Element Description

- **~25-mT payload capacity**
- **2-Mlb gross liftoff weight**
- **309 ft in length**



First Stage

- Derived from current Shuttle Reusable Solid Rocket Motor/Booster (RSRM/B)
- Five segments/Polybutadiene Acrylonitride (PBAN) propellant
- Recoverable
- New forward adapter

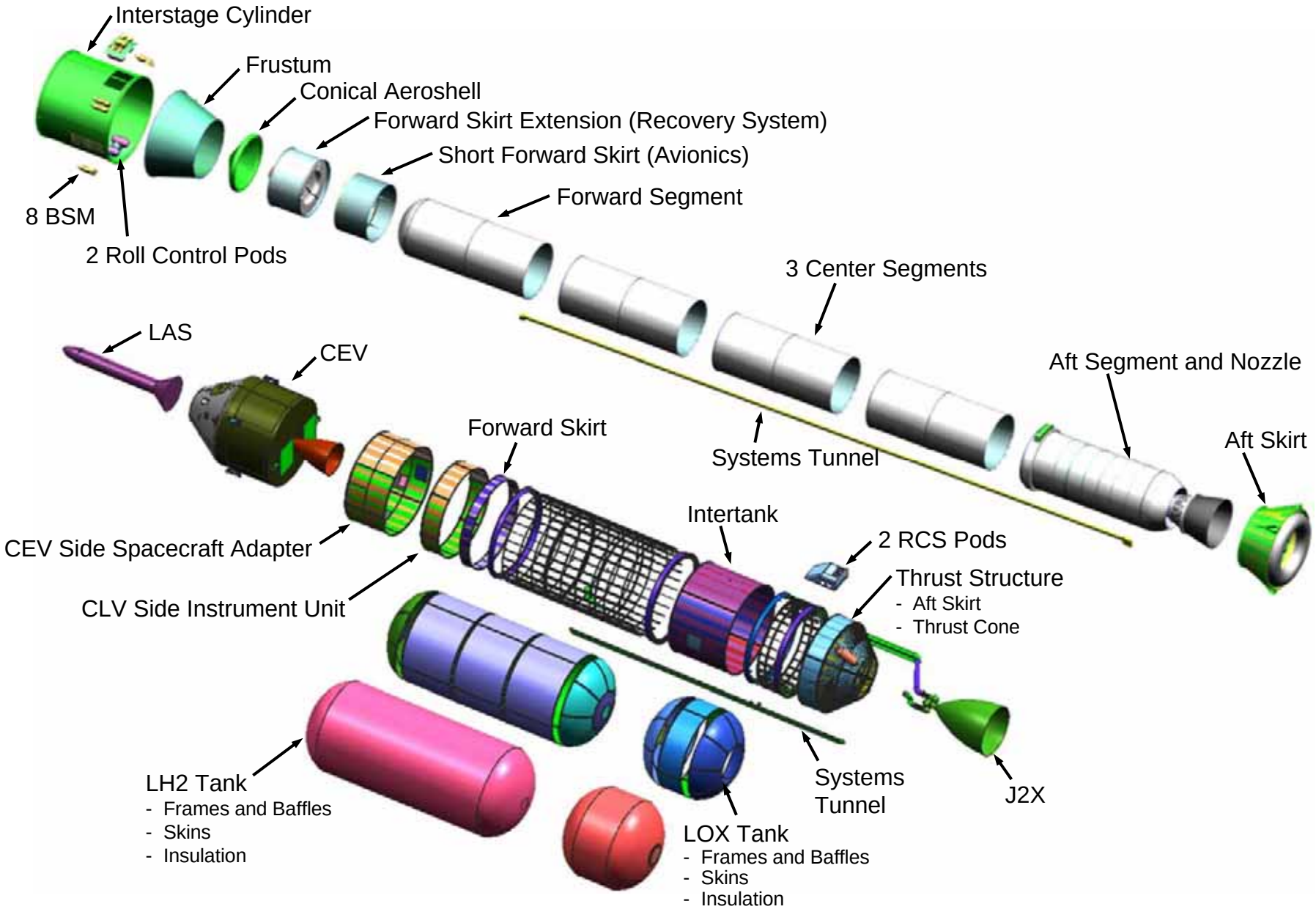
Upper Stage

- 280-klb Liquid Oxygen/Liquid Hydrogen ($LOX/LH_{2)}$ stage
- 5.5-m diameter
- Aluminum-Lithium (Al-Li) structures
- Instrument unit and interstage
- RCS / roll control for First Stage flight
- CLV avionics system

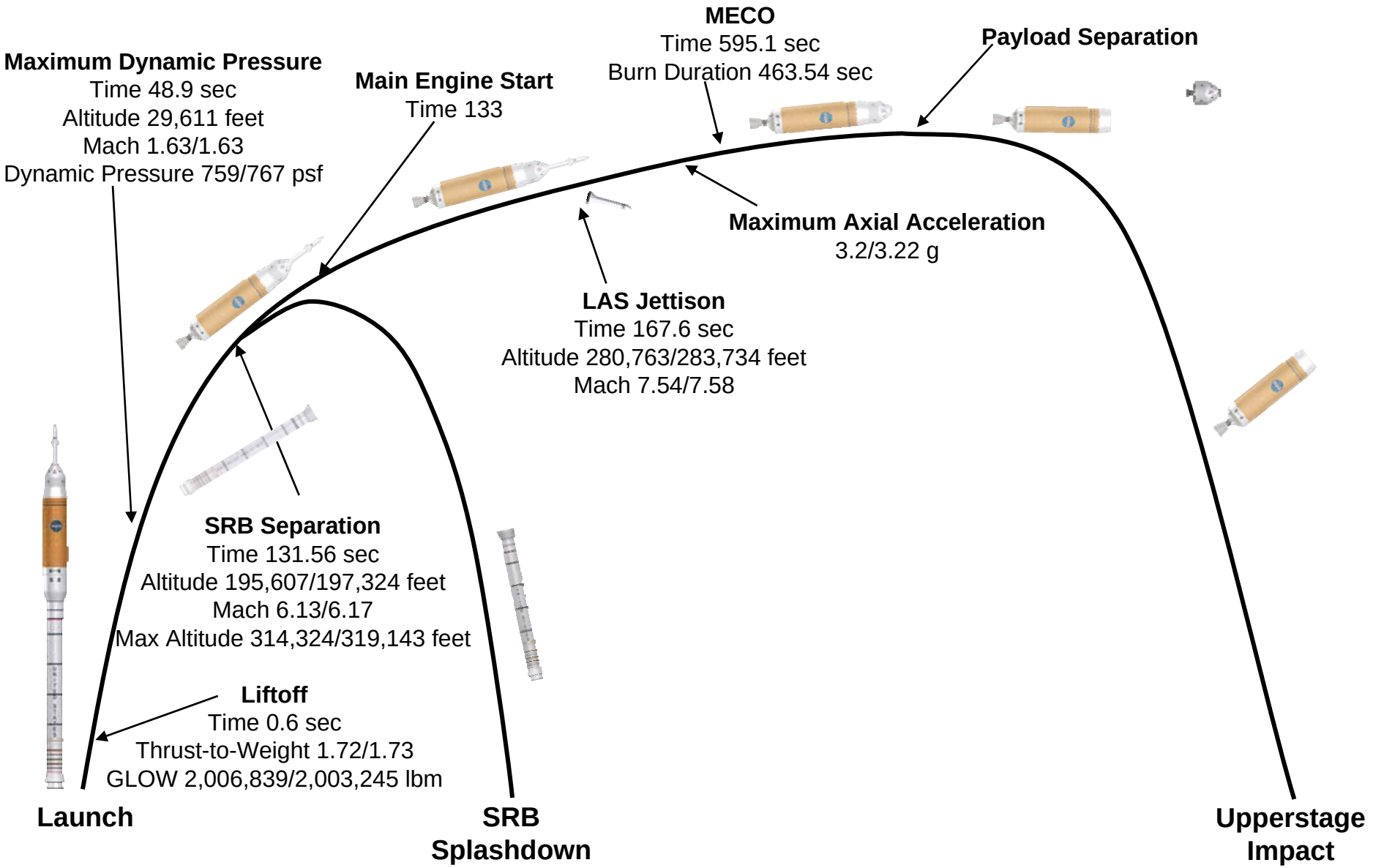
Upper Stage Engine

- Saturn J-2 derived engine (J-2X)
- Expendable

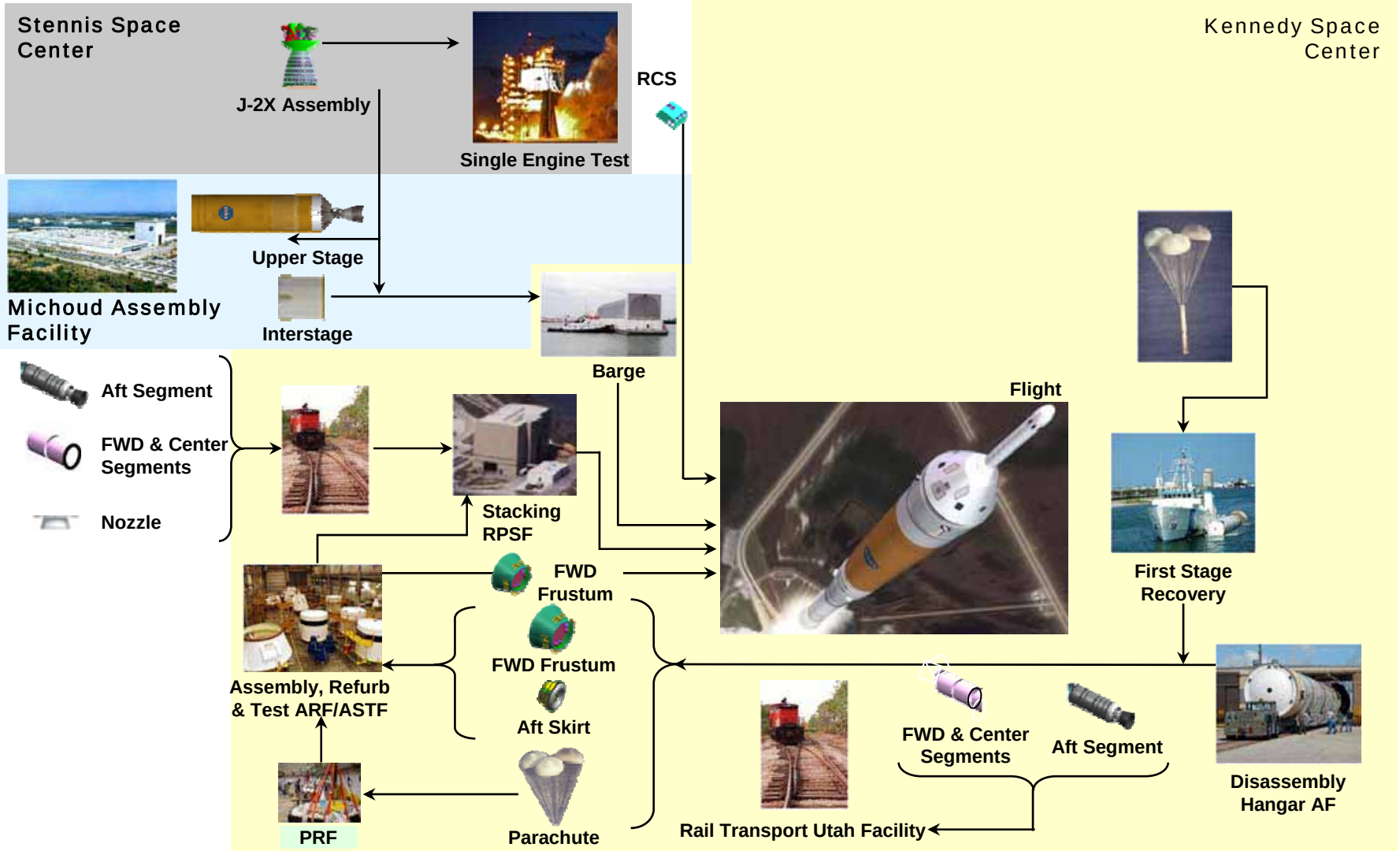
CLV Configuration – Expanded View



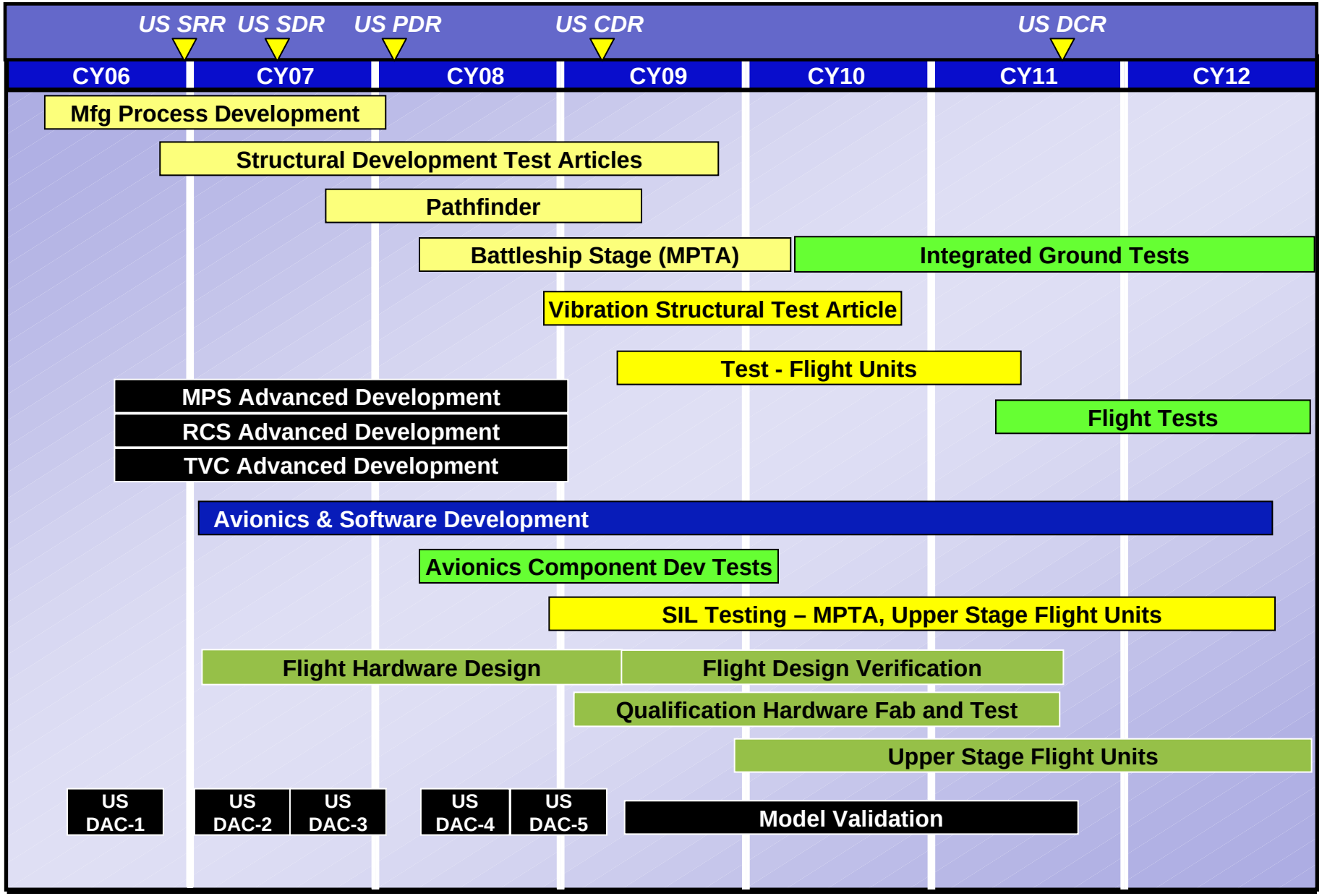
Reference Missions (28.5°/ 51.6°)



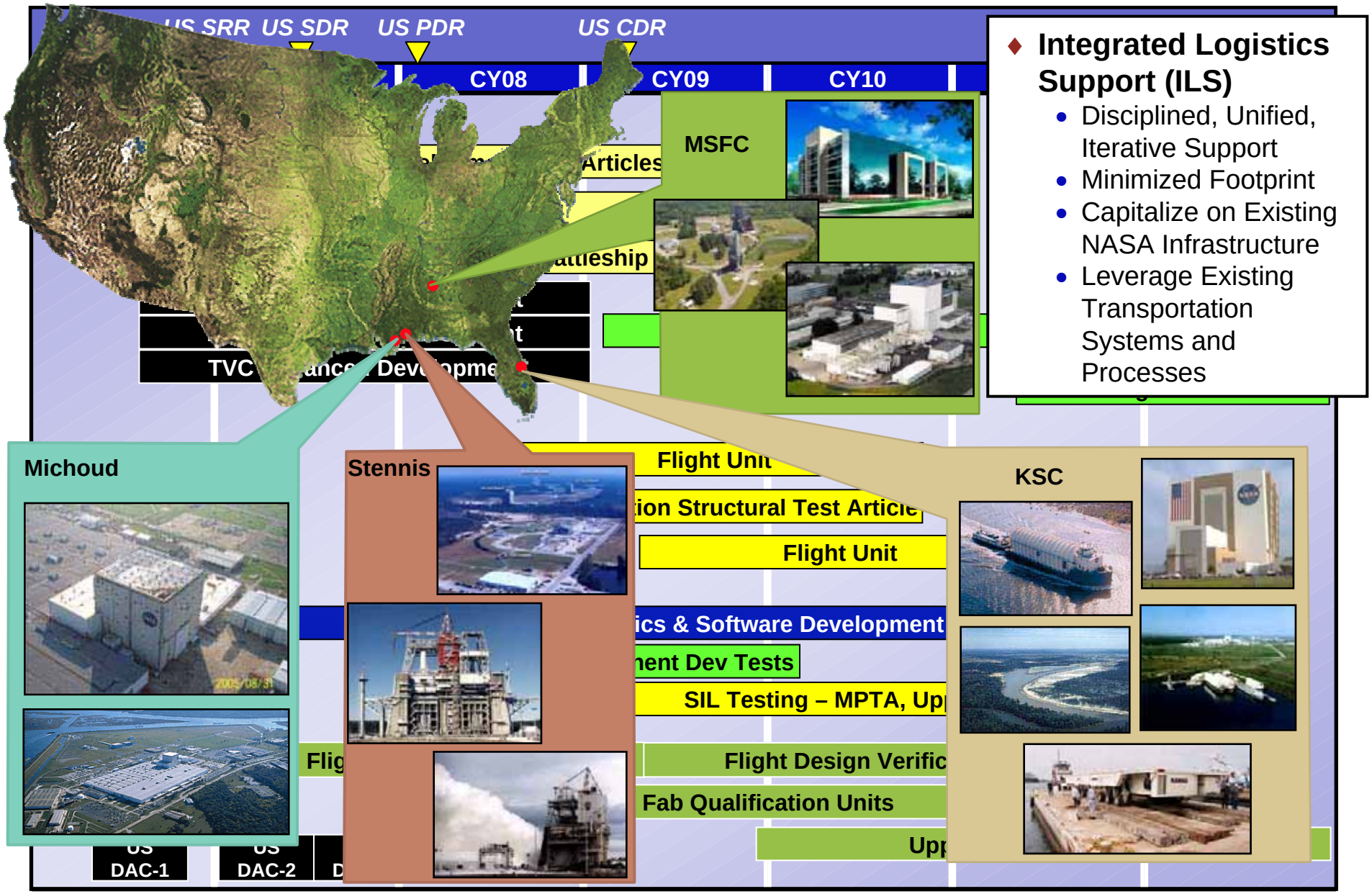
Preliminary CLV Manufacturing / Refurbishment Flow



Upper Stage Integrated Roadmap



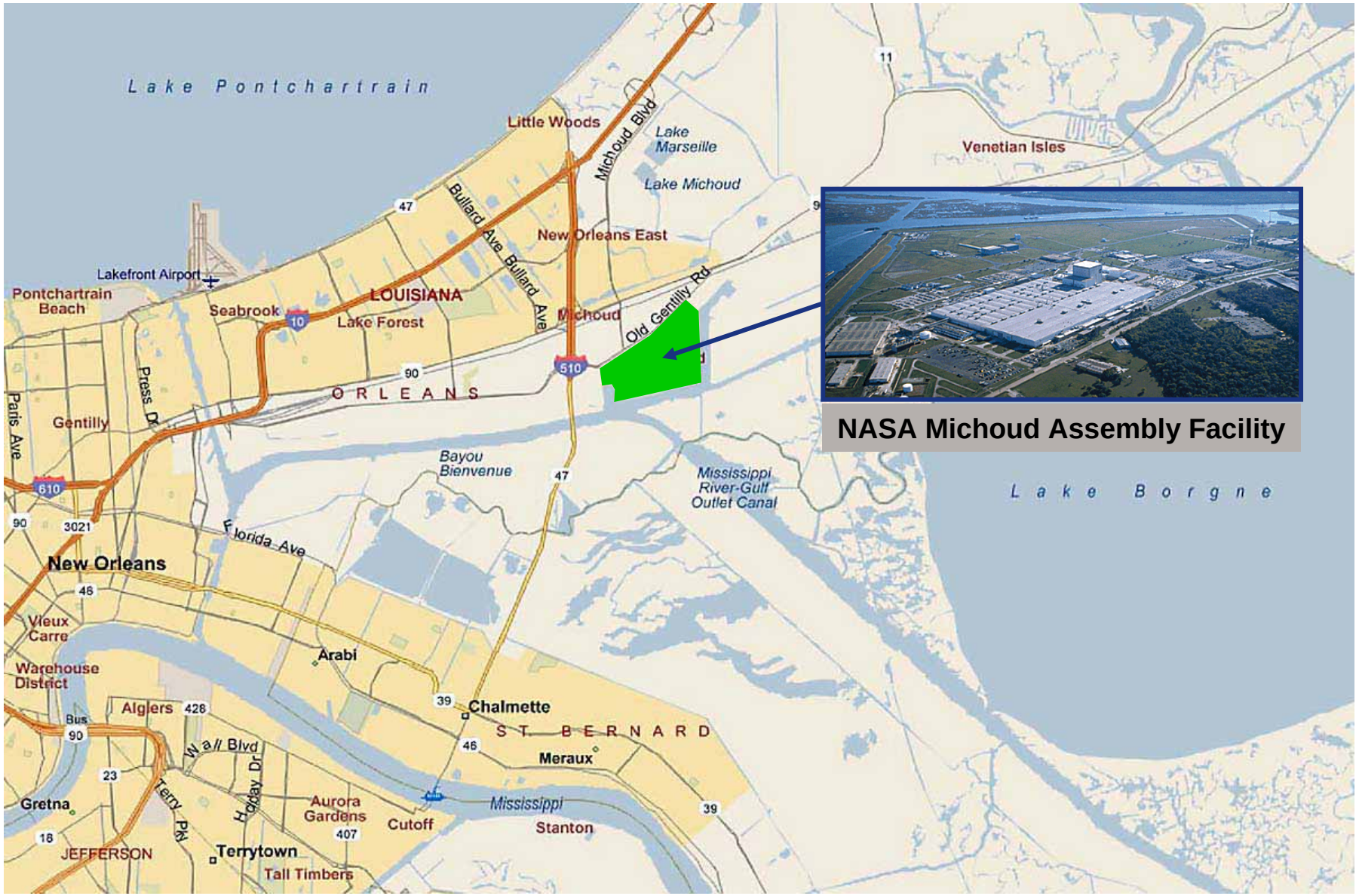
Upper Stage Integrated Logistics



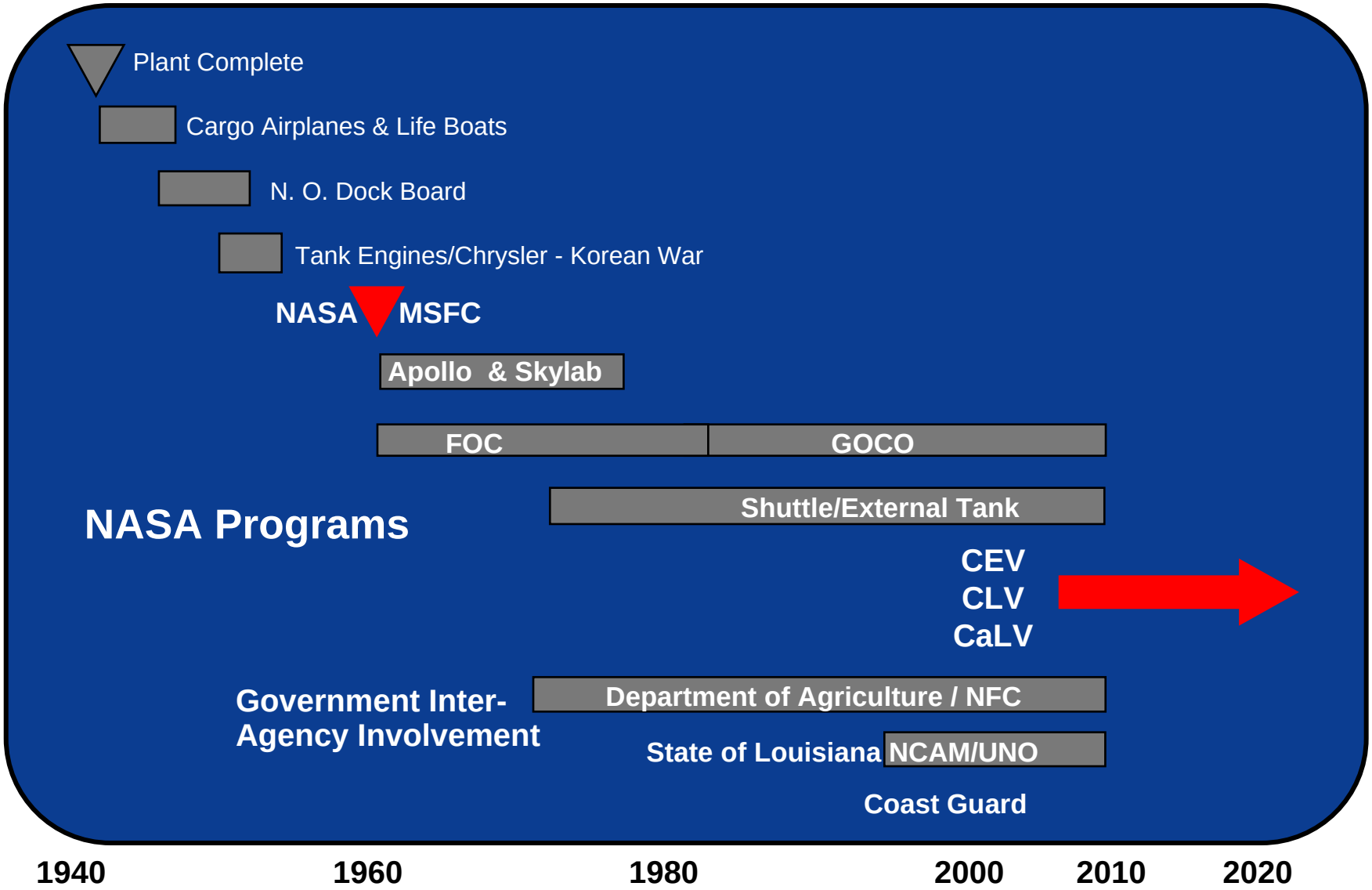
- **Integrated Logistics Support (ILS)**
  - Disciplined, Unified, Iterative Support
  - Minimized Footprint
  - Capitalize on Existing NASA Infrastructure
  - Leverage Existing Transportation Systems and Processes

Michoud Assembly Facility

Regional Map



Michoud Assembly Facility (MAF) History



Capabilities

Infrastructure in place for manufacturing of large aerospace structures

- **Site Capabilities**
  - 832 acre site
  - 3.8 M ft^2 total infrastructure (deep water access)
  - 900,000 ft^2 Office Facilities
  - 400,000 ft^2 Warehouse Facilities
  - 200,000 ft^2 Site Operations
  - 27 Major Utility Systems
  - – Port/Harbor Facilities
  - – Interstate access
  - – Nearby railway accessible
  - – On site parking (5,300 vehicles)
- **Manufacturing Capabilities**
  - 2.2 Million ft^2 Manufacturing Space (open high-bay areas)
  - Full complement of plant equipment, tooling, and skills
- **Testing Capabilities (component and full scale)**
  - – Pneumatic testing
  - – Hydrostatic testing
  - – Structural load testing
- **Advanced Manufacturing Capabilities**
  - National Center for Advanced Manufacturing (NCAM)

MAF Capabilities

Infrastructure in place for manufacturing of large aerospace structures

- **Laboratory Capabilities**
  - Production Support
  - Materials and Processing
  - Analytical Chemistry / Metallurgy
  - Large Structures Test

- **Environmental Program**
  - All operating permits and infrastructure in place (8)
  - Industrial Wastewater Treatment Facility (IWTF)
  - Pollution prevention / recycling / Site Remediation
  - Energy Cost Reduction Program
- **Available Green Space**
  - 225 acres for new office, manufacturing, and test

Michoud is a National Asset with $2.2B of capabilities

Michoud's Full Complement of Services

Production Support Systems

Production / Test

Industrial Wastewater Treatment Facility

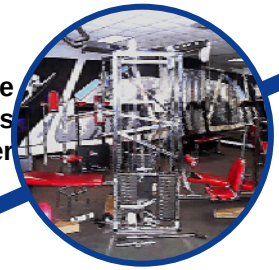
Major Utility Systems

Port / Harbor Operations

Childcare Facility
La Petite Academy

Information Systems - Telecommunications

Employee Wellness Center



Cafeterias

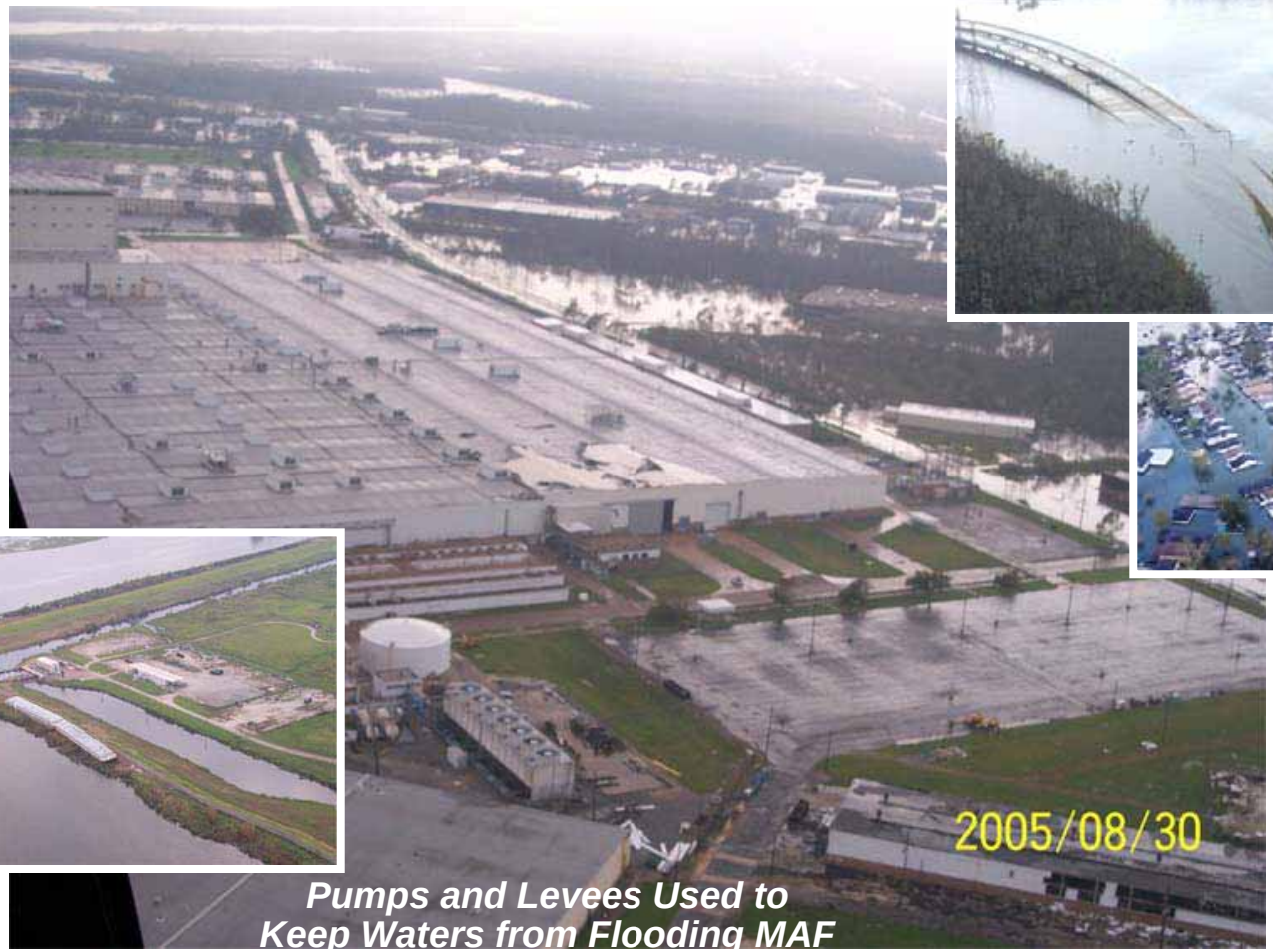
Security

Medical

Fire Protection

Maintenance

Katrina – MAF Impacts



Pumps and Levees Used to Keep Waters from Flooding MAF

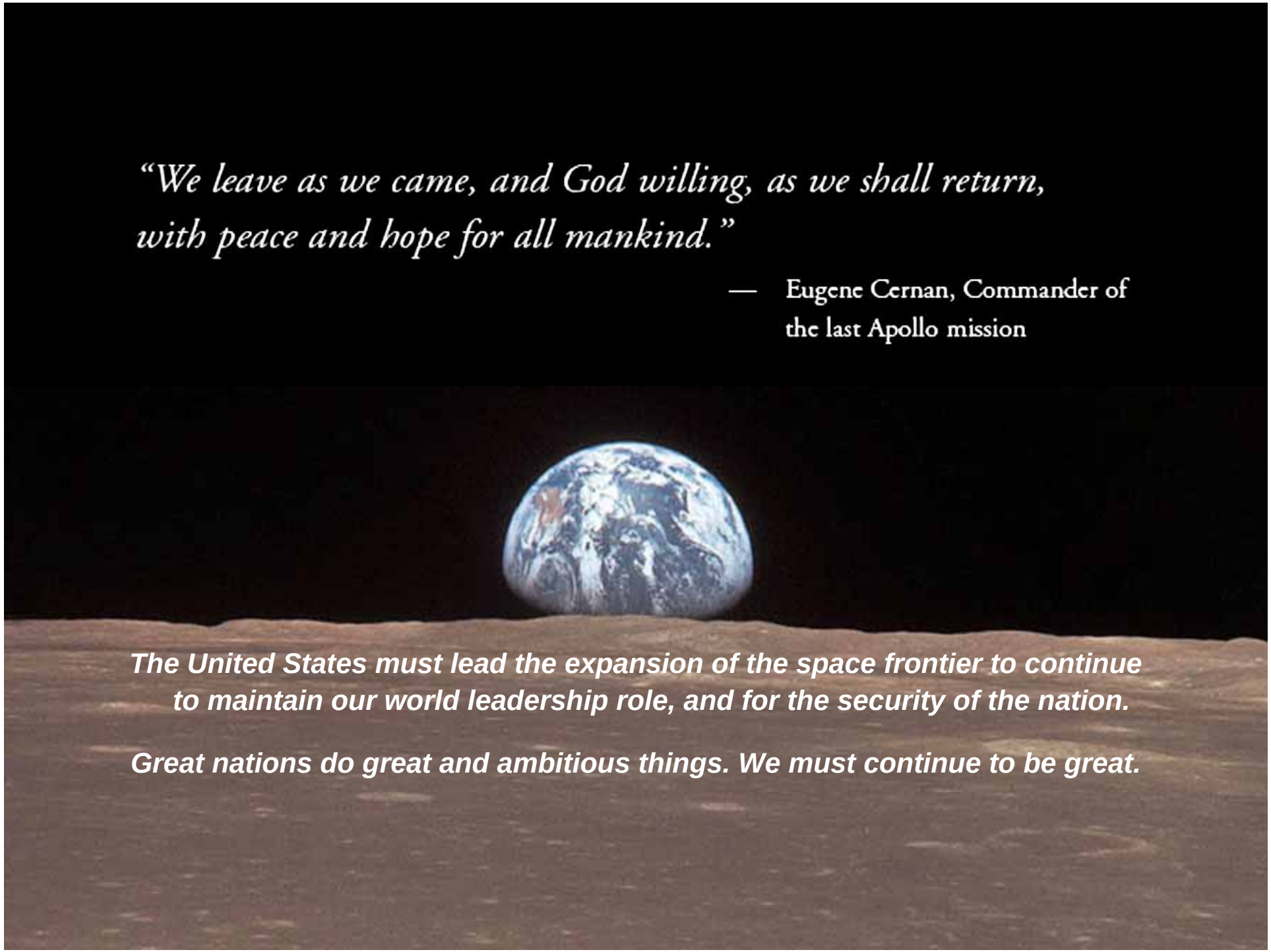
Surrounding Areas and Local Neighborhoods

Michoud Assembly Facility Was an Island - - - Pumps Kept Flood Waters at Bay

Katrina – Damage/Recovery to date

- **Hardware processing facilities**
  - Roof damage on VAB, proof test facility, tank storage and Orbiter hardware facility, shipping warehouse
- **Office facilities**
  - Roof damage on Bldg 102, windows damaged in nearly all office buildings
    - Bldg 350 and 320 habitable
    - Bldg 101 suffered minor damage
    - Bldg 102 roof repairs required
- **Damage was realized but it was not catastrophic**

Full workforce returned to operations on 10/31



The United States must lead the expansion of the space frontier to continue to maintain our world leadership role, and for the security of the nation.

Great nations do great and ambitious things. We must continue to be great.