National Aeronautics and Space Administration

Progress on Enabling Unprecedented Payloads for Space in the 21st Century

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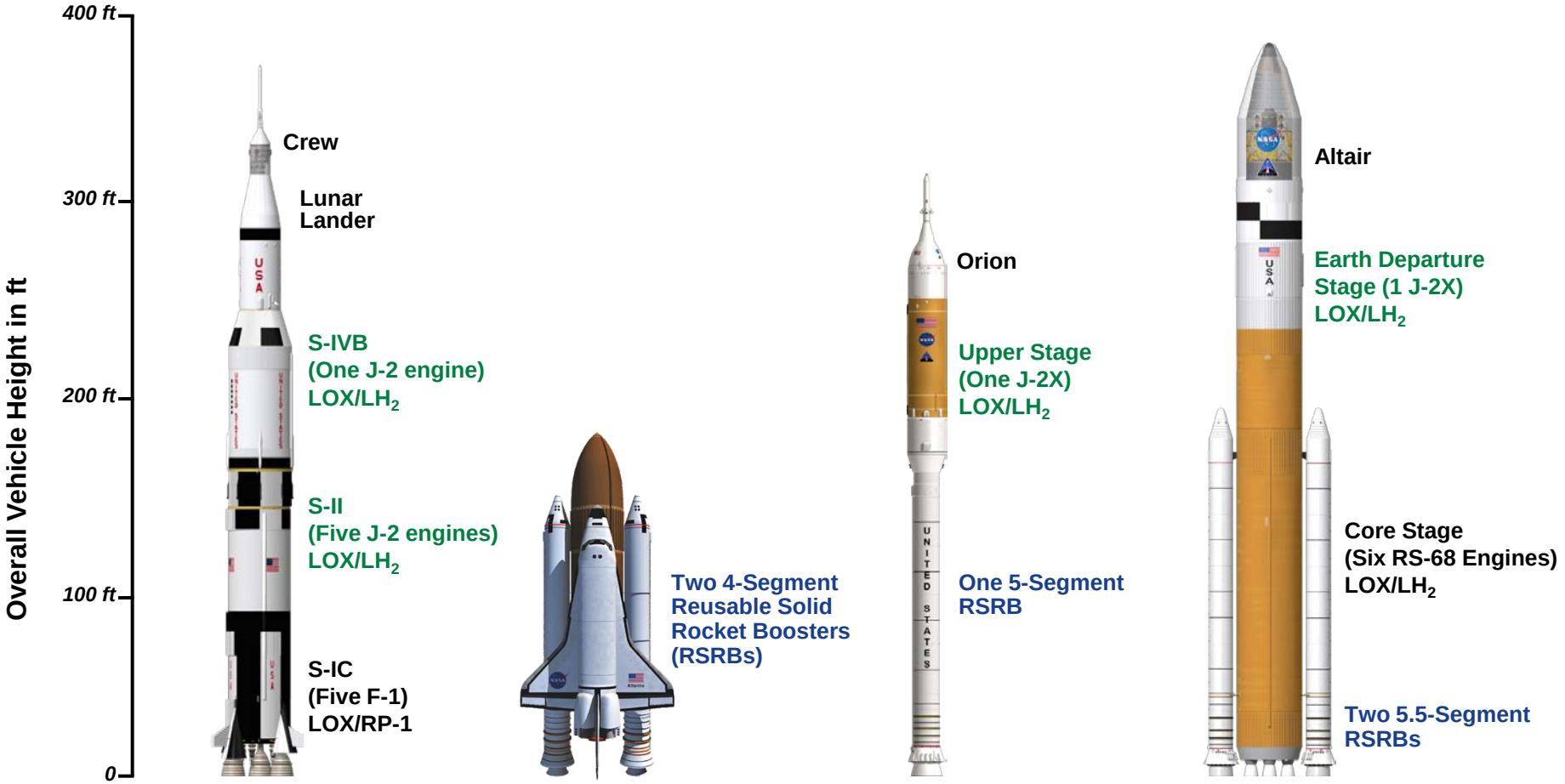
Reference Ares V on the Launch Pad

Introduction

- The NASA Ares Projects Office is developing the launch vehicles to move the United States and humanity beyond low earth orbit
- Ares V is a heavy lift vehicle being designed to launch cargo into LEO and transfer cargo and crews to the Moon
- Heavy Lift is a national asset with applications to science, business, and national defense
- This is a snapshot of development. Ares V is early in the requirements formulation stage of development pending White House and Congressional deliberations
- Work date will be useful to any future heavy lift development

Ares V in Context

– *Launch Vehicle Comparisons* –



	Saturn V: 1967–1972	**Space Shuttle:** 1981–Present	**Ares I:** First Flight 2015	**Ares V:** First Flight 2018
Height	360 ft	184.2 ft	325.0 ft	381.1 ft
Gross Liftoff Mass (GLOM)	2,948.4 mT (6,500K lbm)	2,041.1 mT (4,500.0K lbm)	933.2 mT (2,057.3K lbm)	3,704.5 mT (8,167.1K lbm)
Payload Capability	99.0K lbm to TLI 262.0K lbm to LEO	55.1K lbm to LEO	54.9K lbm to LEO	156.7K lbm to TLI with Ares I 413.8K lbm to LEO

Requirements for Lunar Crew, Cargo Missions

LUNAR SORTIE MISSION			
CARD Requirement	**Mass (t)**	**Mass (lb_m)**	**Derived Performance Rqt.**
Orion [CA4139]	20.2	44,500	
Crewed Lander [CA0836]	45.0	99,208	
Total TLI [CA0848]	66.9	147,575	Derived TLI > 66.9 t
	45.0	99,208	Derived ETO > 45.0 t

- ETO Mission Destination: 130 nmi, 29°
- Loiter Duration: 4 days (CARD TBD)
- TLI Maneuver Starting Conditions: 100 nmi, 29°
- TLI ΔV = 3175 m/s + Gravity Loss

LUNAR CARGO MISSION			
CARD Requirement	**Mass (t)**	**Mass (lb_m)**	**Derived Performance Rqt.**
Cargo Lander [CA5231]	53.6	118,168	
Total TLI [CA0847]	54.6	120,372	Derived TLI > 54.6 t
Total ETO Goal [CA0847]	54.6	120,372	Derived ETO > 54.6 t

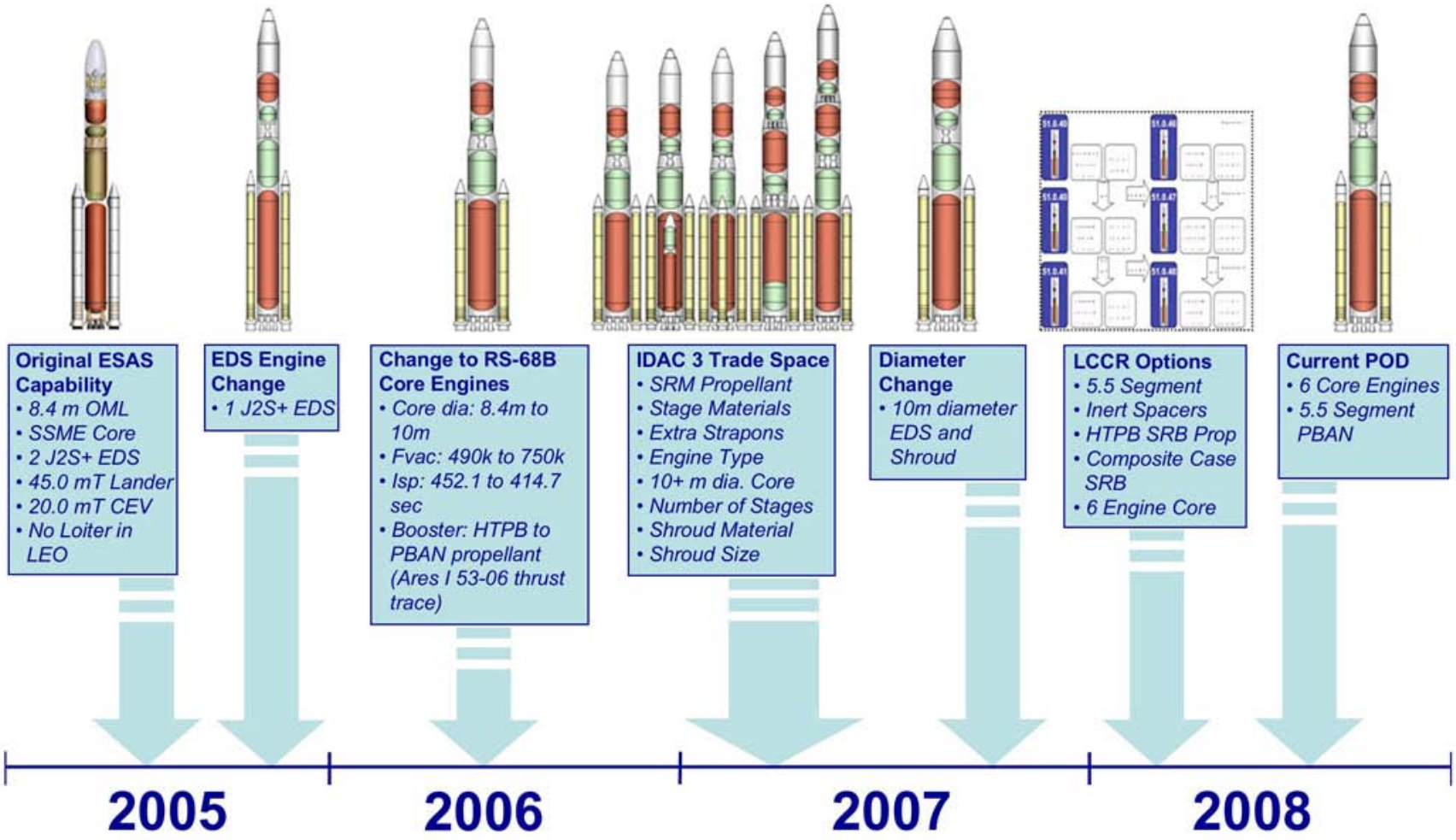
- ETO Mission Destination: Phasing Orbit
- Loiter Duration: None (no loiter capability on EDS)
- Note that Saturn V TLI payload capability was 48.6 t (Apollo 17 - CM/SM/ LM/SLA) and
- Ares V Earth-to-TLI requirement exceeds Saturn V Capability by 31%

Driving CARD Performance Requirements

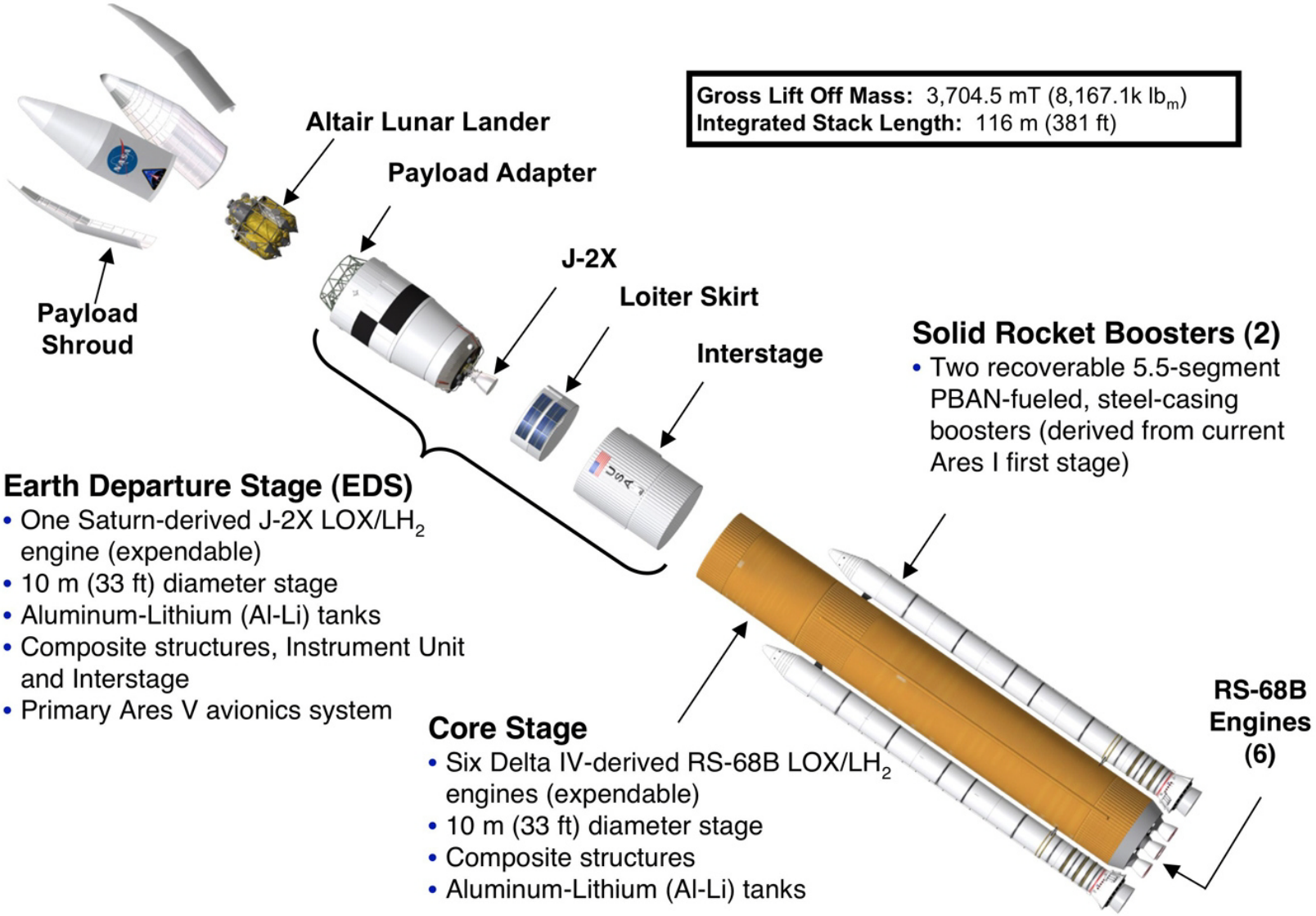
CARD Req't	Requirement	Rationale
CA0391-HQ	The CaLV shall utilize twin shuttle-derived 5-segment SRBs along with a core stage that employs 5 modified RS-68 engines for first stage propulsion.	♦ Draws Performance Constraints around Booster Selection and Core Stage Design ♦Boosters and Core Stage Provide ~70% of Delta V for LEO Insertion
CA0847-PO	The CaLV EDS shall deliver at least 66,939 (TBR-001-076) kg (147,266 lbm) from Earth Rendezvous Orbit (ERO) to the start of the Trans-Lunar Coast (TLC) for crewed lunar missions.	♦Defines TLI Payload most strenuous performance parameter ♦TLI Payload Sizes EDS
CA0836-PO	The LSAM shall have a Control Mass of 45,000 (TBR-001-075) kg (99,180 lbm) at the time of launch for Lunar Sortie and Lunar Outpost crew missions	♦Defines LEO Payload for Crew Mission ♦Contribute ~2/3 Mass for TLI Payload ♦TLI Payload Sizes EDS
CA4139-PO	The CEV shall have a Control Mass of 20,185 (TBR-001-159) kg (44,500 lbm) at the time of CaLV rendezvous.	♦Contribute ~1/3 Mass for TLI Payload ♦TLI Payload Sizes EDS
CA0051-PO	The CaLV EDS shall provide a minimum translational delta-V of 3,150 (TBR-001-258) m/s (10,335 f/s) for the TLI for crewed lunar missions.	♦Defines Delta V thus propellant Needed for Delta V ♦TLI Delta V Sizes EDS
CA0850-PO	The CaLV EDS shall meet its requirements after loitering in low Earth orbit (LEO) at least (TBD-001-975) days after orbit insertion for crewed lunar missions.	♦Defines Propellant Reserves for EDS Stage ♦Major Factor in subsystem Selection and Design for EDS
CA0282-PO	The CaLV shall deliver at least 125,000 (TBR-001-220) kg (275,578 lbm) to a (TBD-001-072) Earth orbit for Mars exploration missions.	♦Defines Mars Mission Max Payload per launch ♦Orbit and Payload size the Ares V
CA3215-PO	The CaLV shall launch cargo into a (TBD-001-565) Earth orbit for Mars missions.	♦Further defines performance capability of Ares V

Blue = All Missions **Grey = Lunar Requirements** **Red = Mars Requirements**

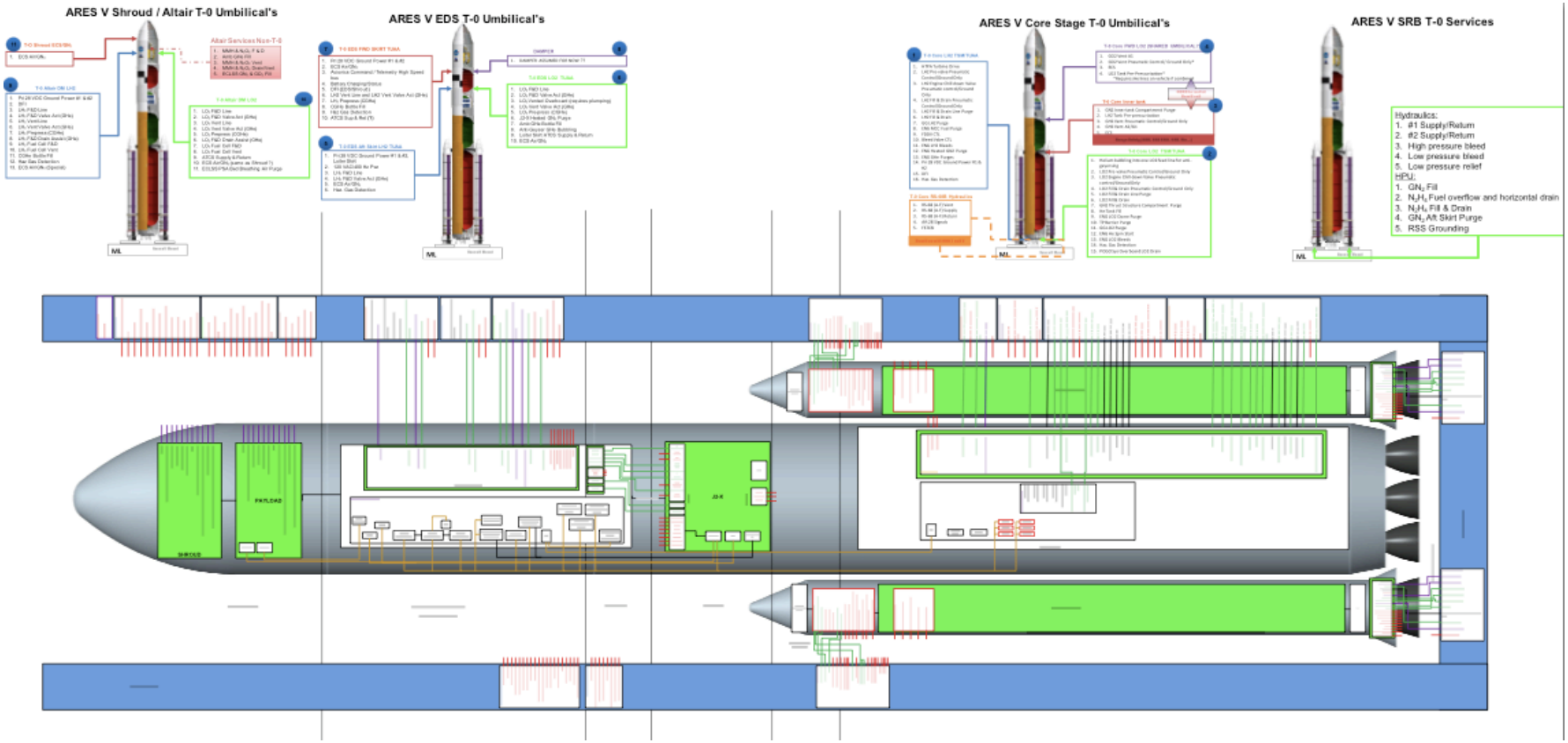
Ares V Evolution from ESAS to LCCR



Current Ares V Reference Configuration

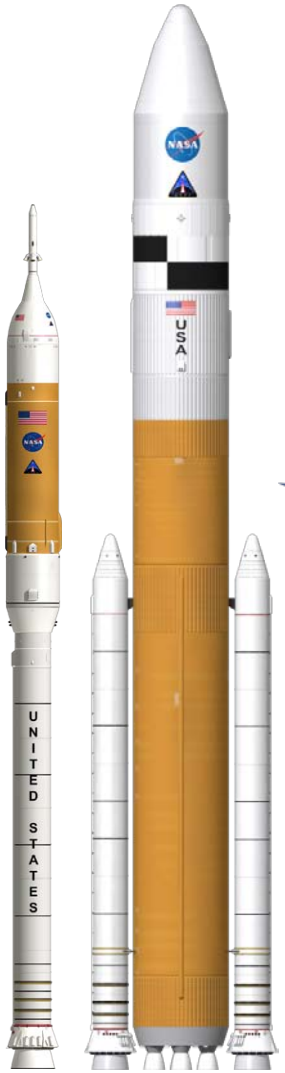


Ares V Integrated Functional Schematic



Range of Architecture Options Enabled

A Few Examples (Payload to TLI)



Baseline
(71 mT with Ares I)

Crew Capability using Ares I Upper Stage with Ares V Core
(35 mT

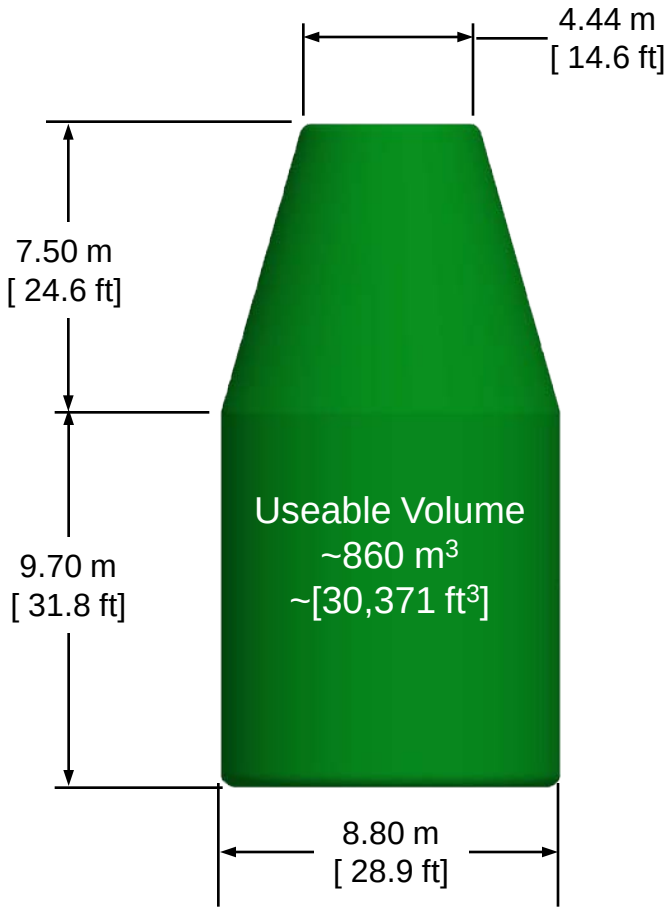
Common First Stage with Ares I
(68 mT with Ares I)

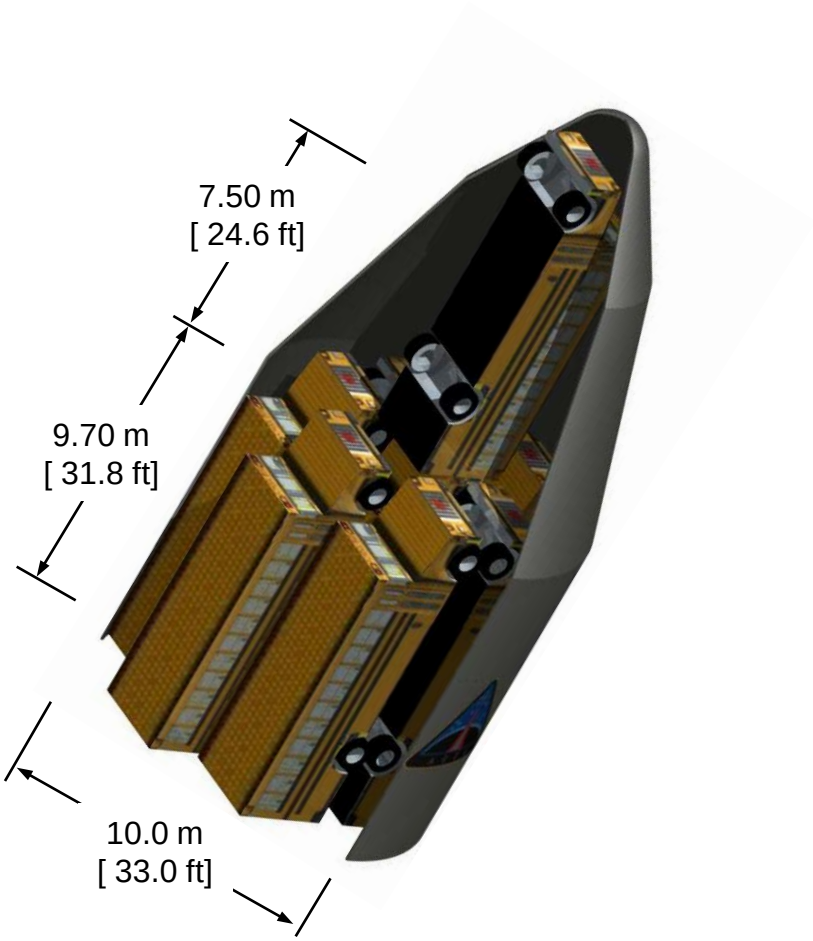
Crew Capability
(45–51 mT)

Advanced Solid First Stage
(75 mT with Ares I)

Single Launch Capability
(55–63 mT)

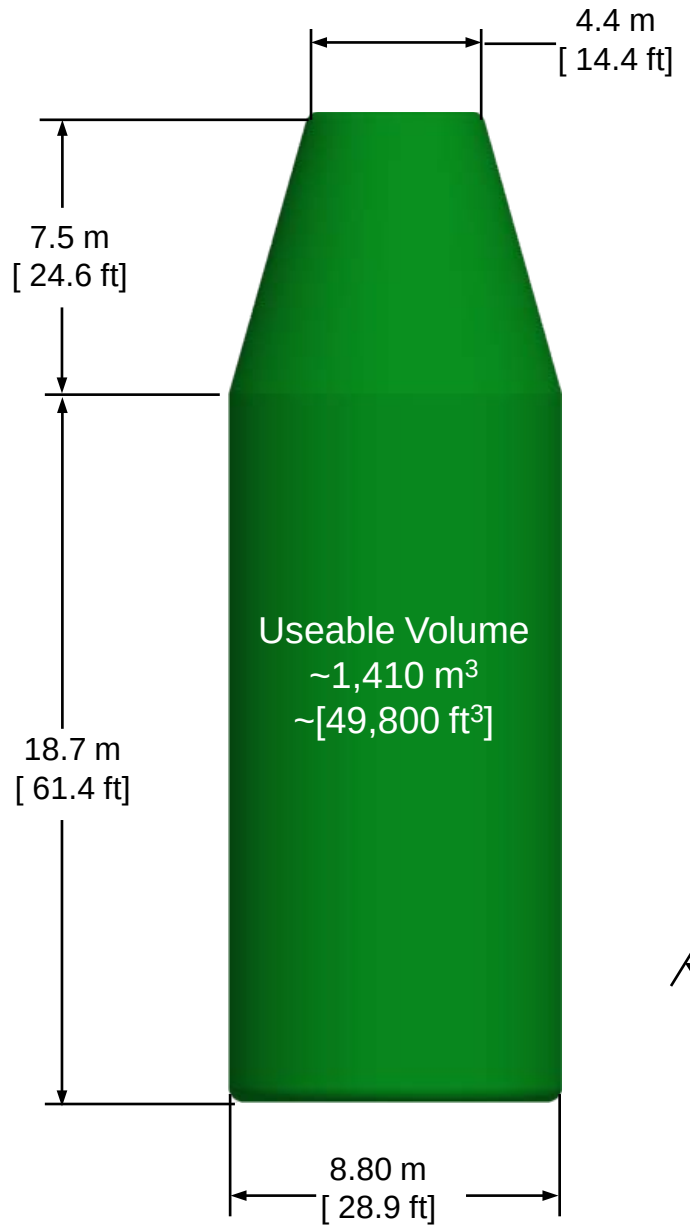
Current Ares V Shroud Concept

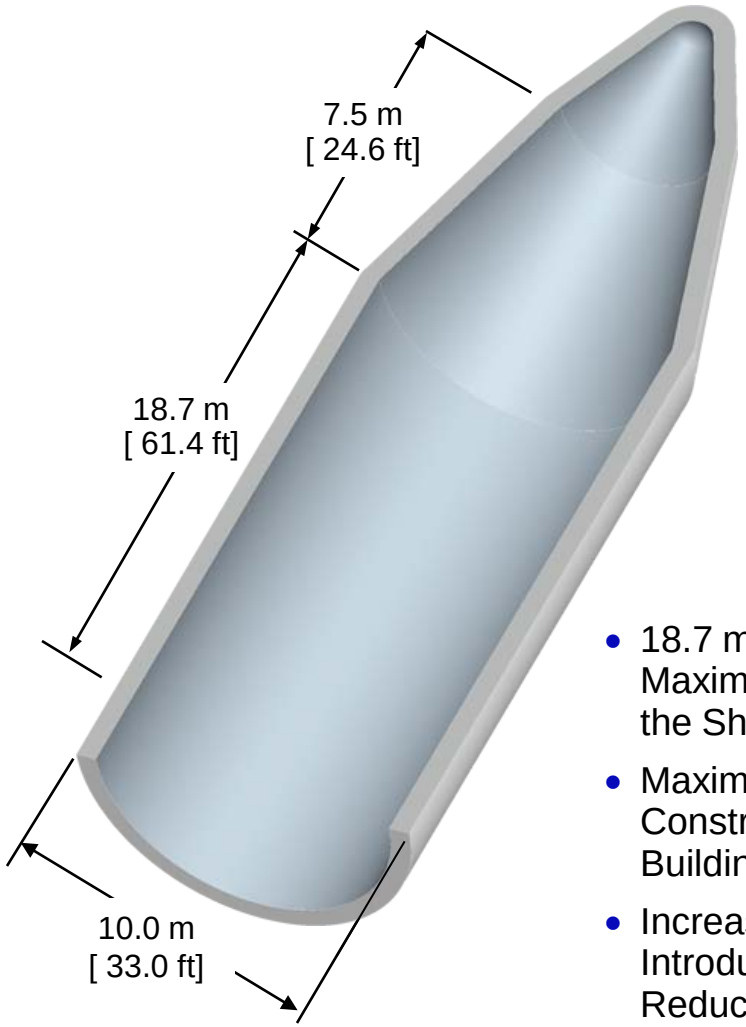




One 66-passenger school bus
= 33x8x10.3 ft / 20,100 lb empty

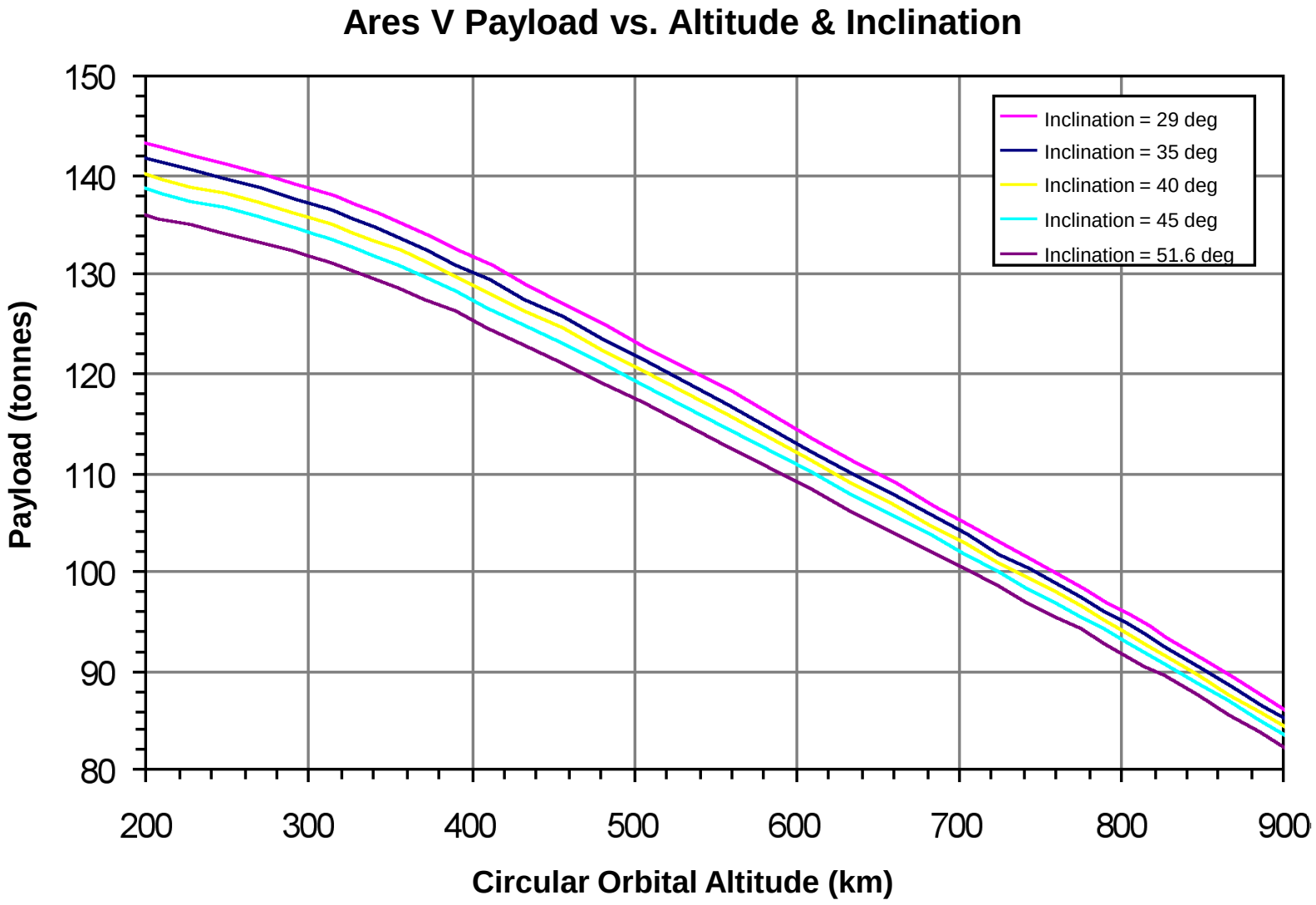
Notional Shroud for Other Missions



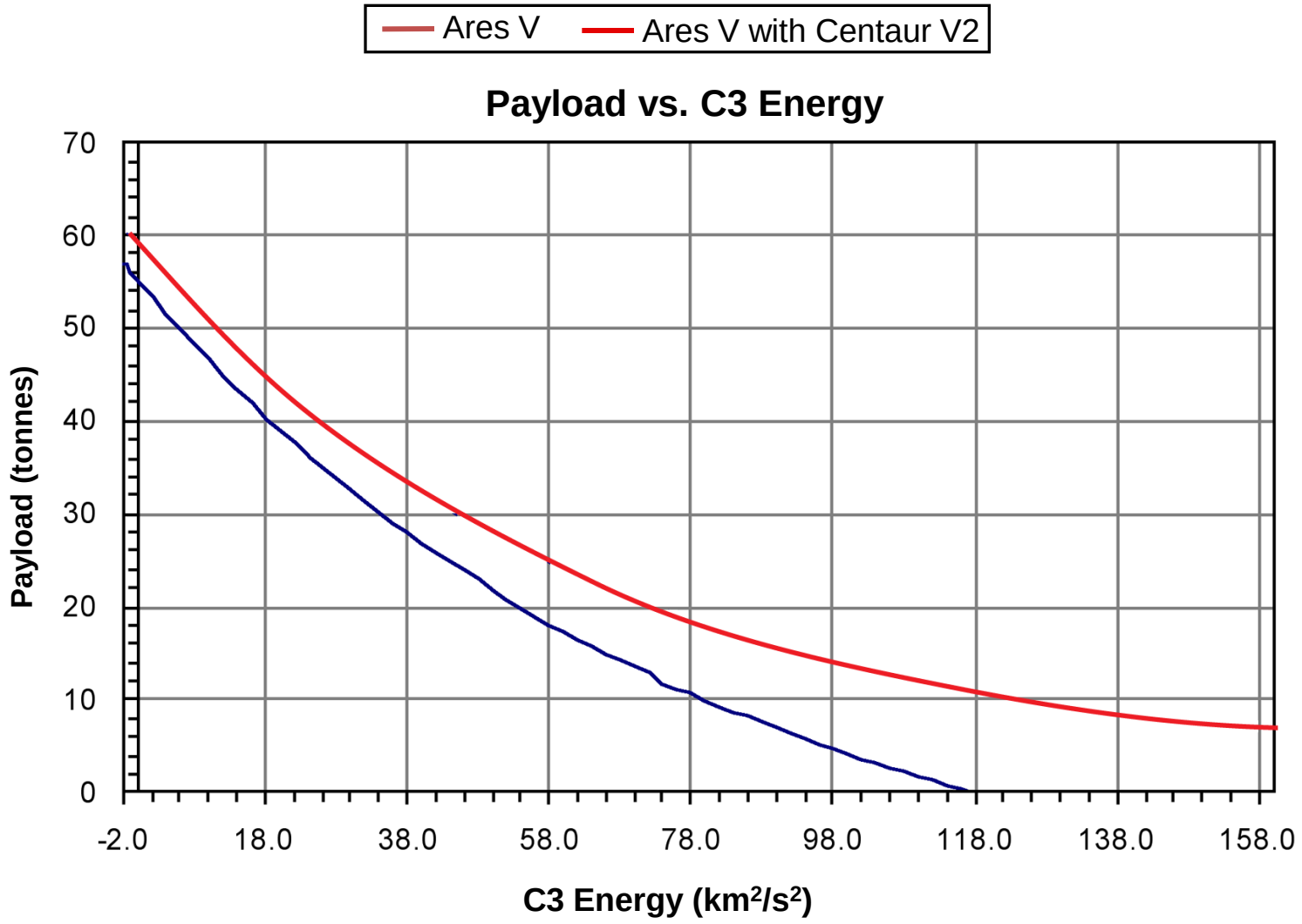


- 18.7 m Represents the Maximum Barrel Length for the Shroud
- Maximum Barrel Length Constrained Vehicle Assembly Building (VAB) Height
- Increased Barrel Length Introduces Theoretical Reduction of Payload Capability of 200 kg

Heavy Lift LEO Performance
(Based on Ares V 51.00.39 Configuration)



Heavy Lift Escape Performance
(Based on Ares V 51.00.39 Configuration)

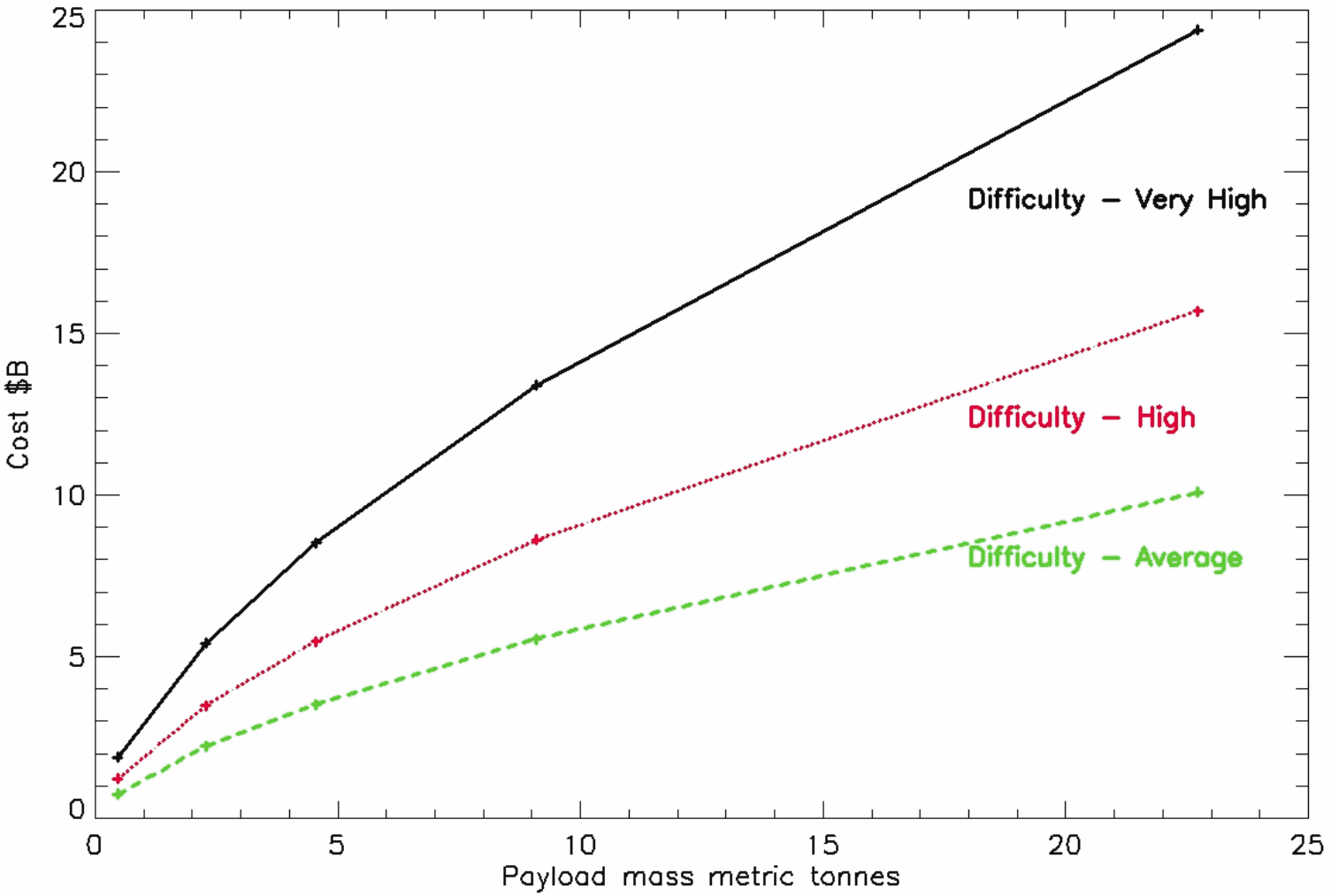


Heavy lift Trajectories for Selected Trajectories from KSC

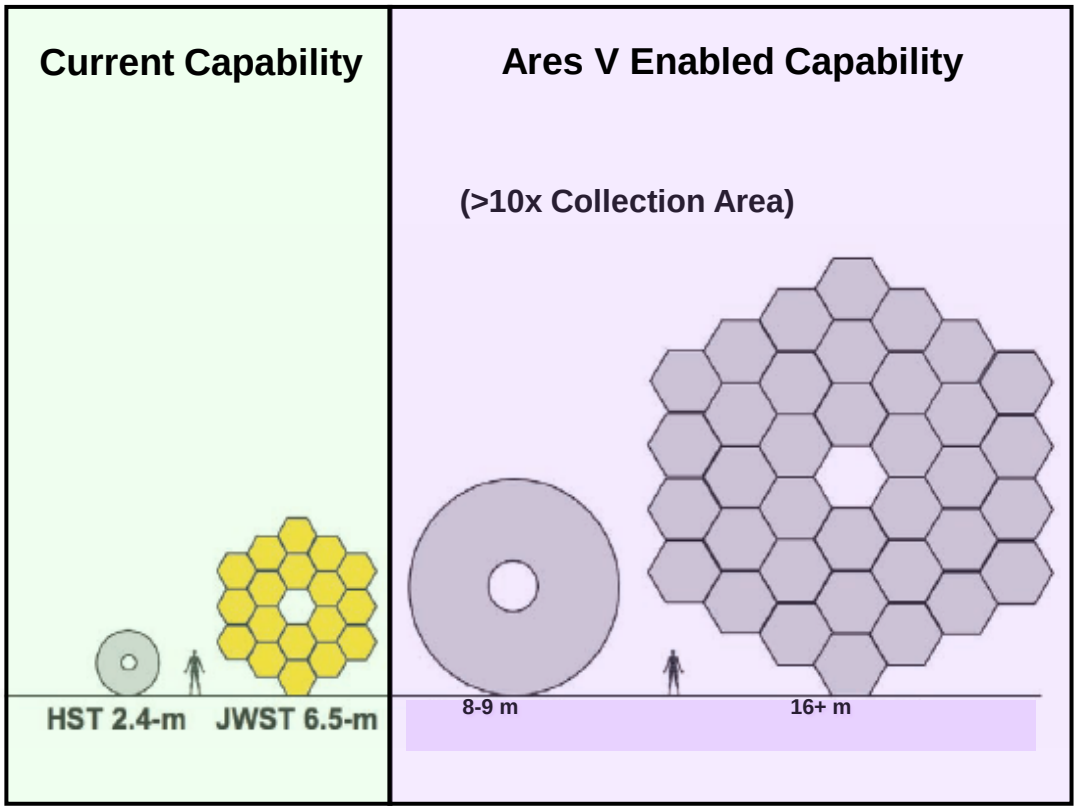
Mission Profile	Target	Constellation POD Shroud		Extended Shroud	
		Payload (lbm)	Payload (mt)	Payload (lbm)	Payload (mt)
4) Sun-Earth L2 Transfer Orbit Injection	C3 of -0.7 km^2/s^2	124.000	56.5	123,000	56
5) Earth-Moon L2 Transfer Orbit Injection	C3 of -1.7 km^2/s^2	126,000	57.0	125,000	57
3) GTO Injection	Transfer DV 8,200 ft/s	153,000	69.5	152,000	69
2) GEO	Transfer DV 14,100 ft/s	77,000	35	76,000	34.5
1) LEO (@29º inclination)	241 x 241 km	315,000	143	313,000	142
6) Cargo Lunar Outpost (TLI Direct), Reference	C3 of -1.8 km^2/s^2	126,000	57	125,000	57
7) Mars Cargo (TMI Direct)	C3 of 9 km^2/s^2	106,000	48	105,000	48

* based on Ares V LV 51.00.39

NASA Advanced Missions Cost Model



Mass/Volume vs. Simplicity/Cost



"It is very clear from the outset that the availability of the Ares V changes the paradigm of what can be done in planetary science."

– Workshop on Ares V Solar System Science

"Exciting new science may be enabled by the increased capability of Ares V. The larger launch mass, large volume, and increased C3 capability are only now being recognized by the science community."

– National Academy of Science's

"Science Opportunities by NASA's Constellation Program"

Ares V Summary

- NASA has completed a large body of concept work on heavy lift. More than 1,700 alternatives have been investigated since ESAS
- Future direction depends on direction from White House/Congress
- Heavy lift is a nation asset capable of playing a critical role in exploration, Earth and space science, national security, and commerce
- Ares Projects is interacting with the potential user community to determine needs
- Ares Projects provides a knowledge base for any future heavy lift decision

www.nasa.gov/ares