



NASA's Human Landing System

Dr. Greg Chavers

Deputy Program Manager

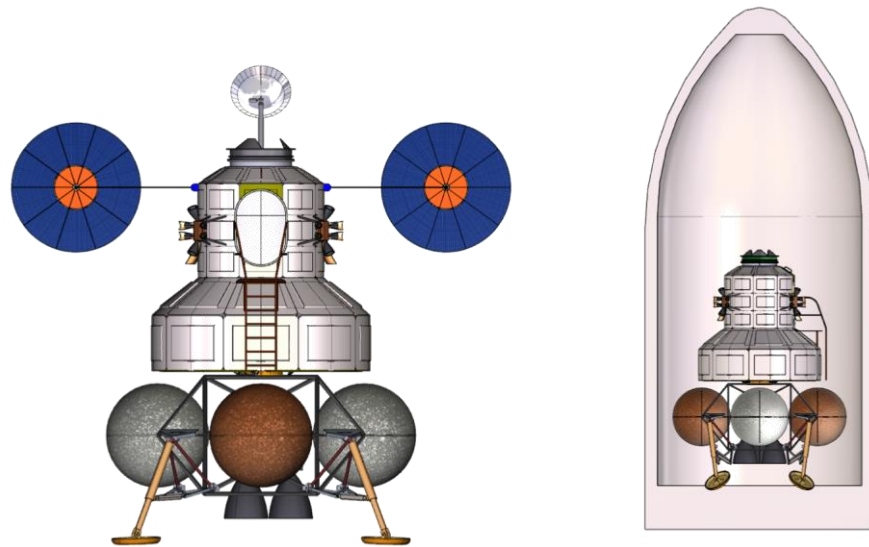
Human Landing System Program



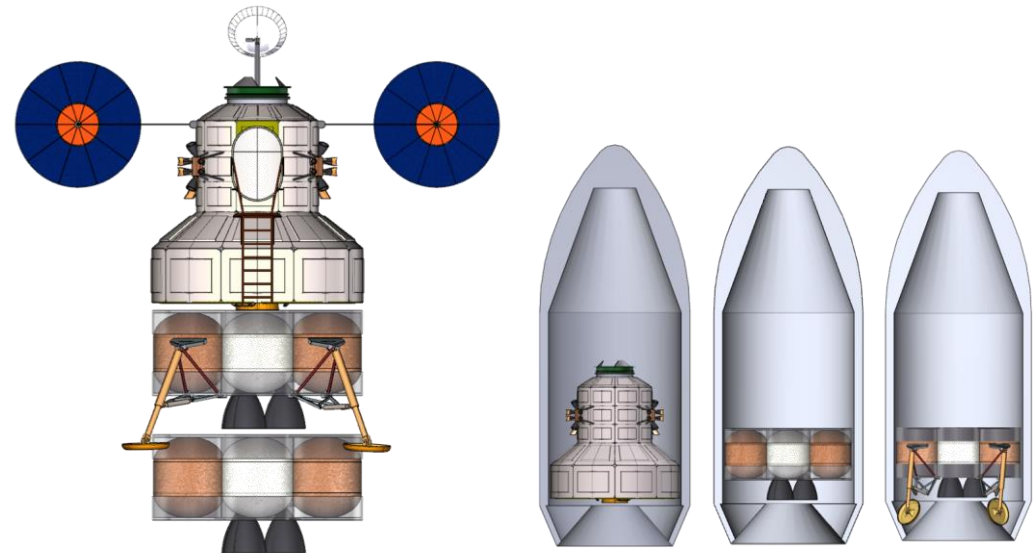
Fast Delivery to the Moon



Two-Element Architecture



Three-Element Architecture



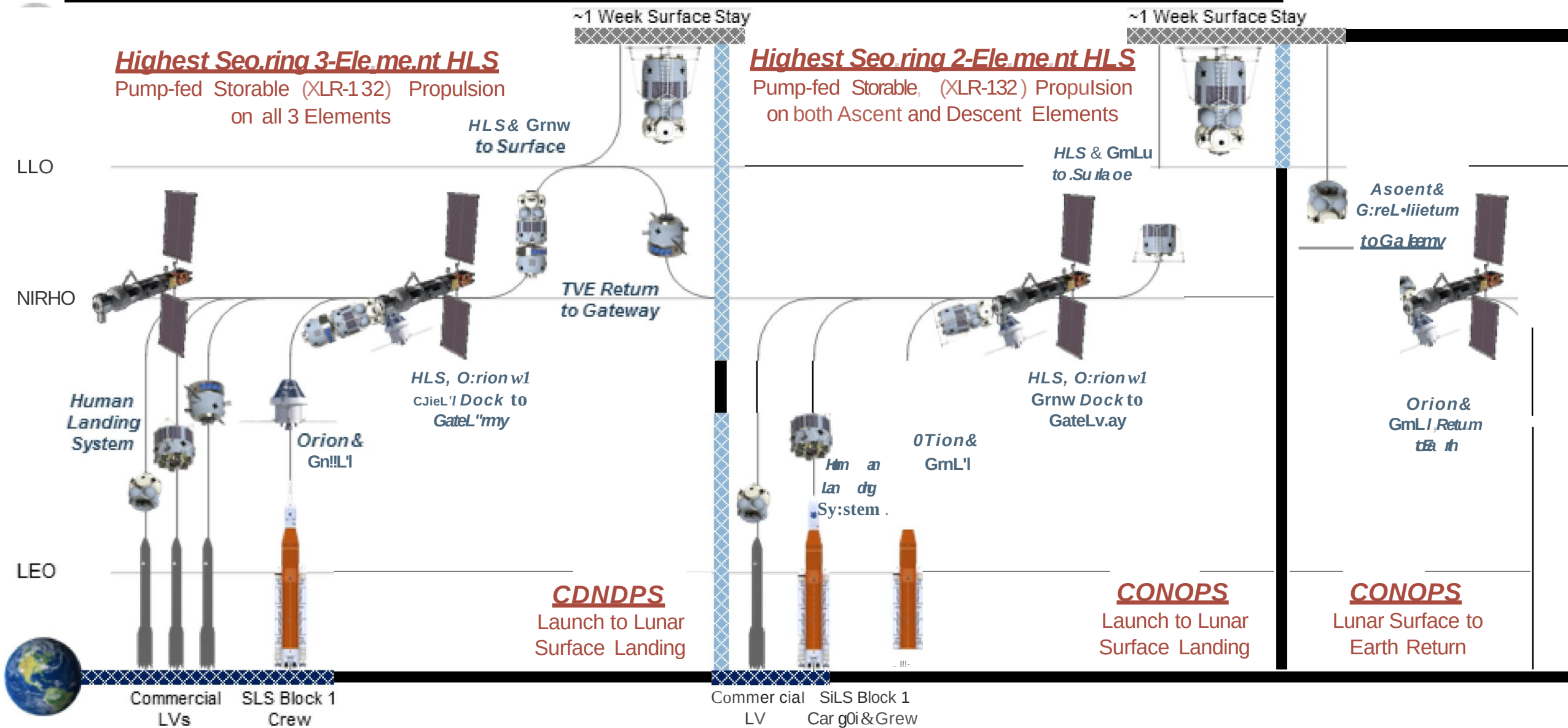


Appendix E Studies: HLS Concepts of Operation

- 11 U.S. Companies to advance human lunar landers, started summer 2019
 - App E companies were allowed to update their concepts based on Appendix H requirements
-
- | | |
|---|---|
| • Aerojet Rocketdyne – Canoga Park, CA | • OrbitBeyond – Edison, NJ |
| • Blue Origin – Kent, WA | • Sierra Nevada Corporation – Louisville, CO and Madison, WI |
| • Boeing – Houston, TX | • SpaceX – Hawthorne, CA |
| • Dynetics – Huntsville, AL | • SSL – Palo Alto, CA |
| • Lockheed Martin – Littleton, CO | |
| • Masten Space Systems – Mojave, CA | |
| • Northrop Grumman Innovation Systems – Dulles, VA | |

NextStep-2 App. E HLS Architecture CONOPS

-AEROIET.../C...ETDYN E

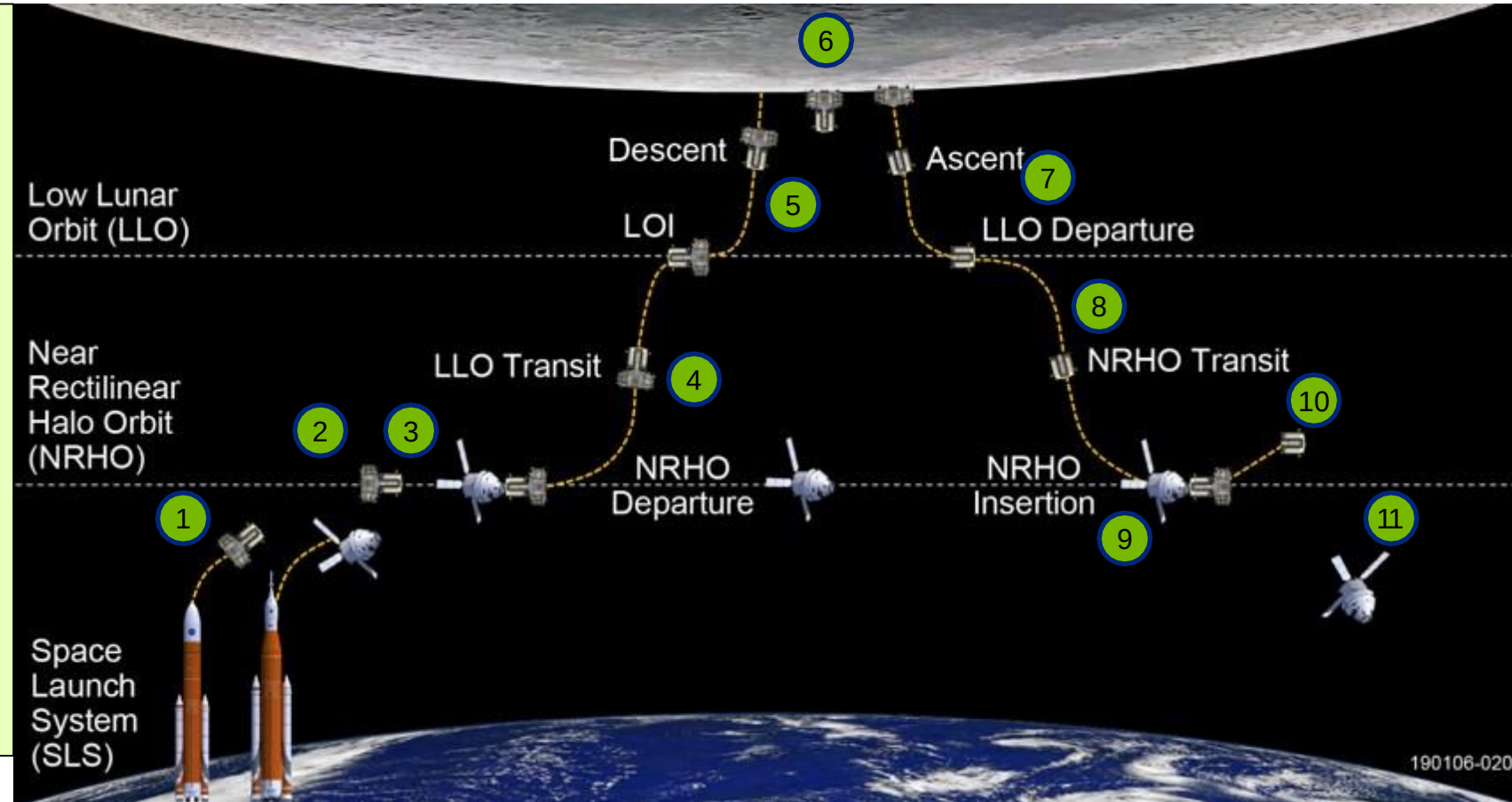


Utility and Uncertainty Analysis Used to Determine Highest Scoring HLS Architectures



Boeing HLS ConOps Summary - 2024

1. Integrated AE-DE launched on an SLS derived commercial HLS launch vehicle
2. AE-DE enter NRHO; provides a “Go” for Orion crew launch
3. Orion docks with the AE-DE
4. AE-DE separates from Orion; departure burn to transfer to LLO
5. AE-DE de-orbit initiation burn, powered descent, and Lunar landing
6. Surface Stay (~7.3 Days)
7. AE ascent burn to LLO
8. AE transits to NRHO
9. Orion docks with the AE
10. AE separates from Orion to disposal orbit
11. Orion returns to Earth



LLO

NRHO

TLI

Orion

SLS Block 1

Earth Surface



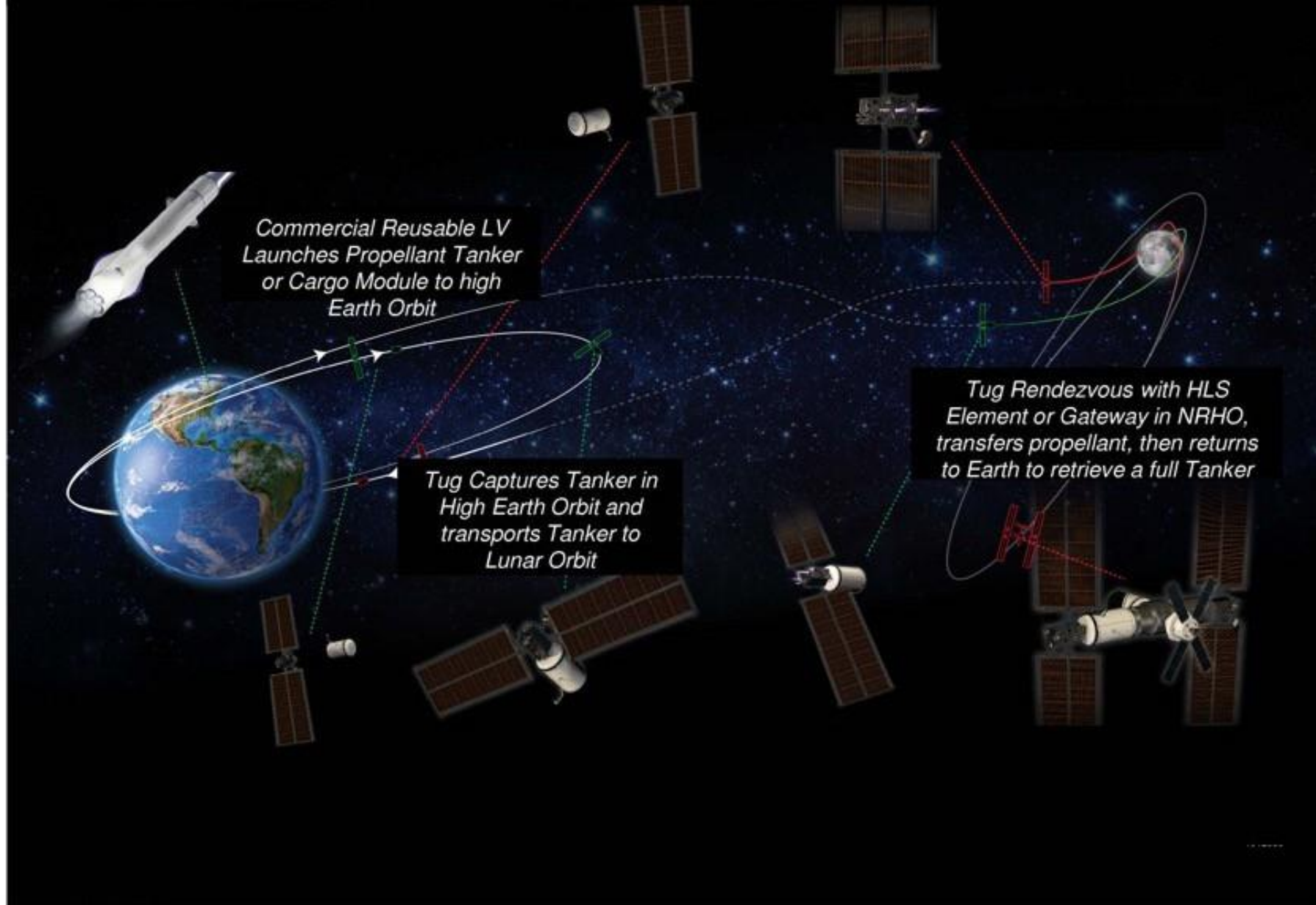
transje
Flomay

©2020 Lockheed Martin Corporation. All Rights Reserved.

Reusable Refueling Element Recurring Mission Sequence

6 month round trip cycle time

Tug self-refueled after four round trips





Moon

Descent & Landing

Ascent

Transit to LLO

Split descent & disposable TE distribute delta-V and reduce DE mass

Aggregation at Gateway

Lunar Transit

LLO

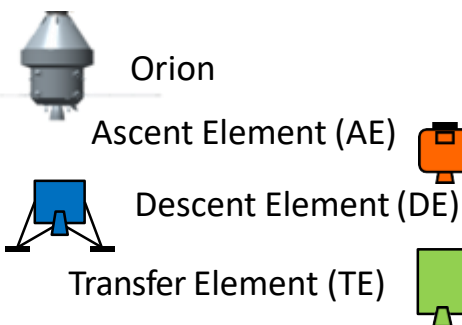
NRHO

TLI

GTO



Earth



Rapid prototypes reduce risk for 2024

- ▶ Long Duration Cryogenic TankSet
- ▶ Cryogenic Fluid Management System
- ▶ Descent and Landing Software
- ▶ Cislunar System Integration Lab
- ▶ Gateway Refueling Connector Mechanism

Human Landing System – NextSTEP-2 Appendix H



- Firm Fixed-Price, milestone-based proposals for design, delivery, and demonstration
- Final solicitation issued September 30
 - Drafts issued July 19 and August 30; +1,150 comments from industry
- Proposals submitted November 5, 2019
- Selections announcement Spring 2020



Let's go.
The time is now.
We have the capability
We have the purpose
We have the charge
We have the responsibility

ARTEMIS

