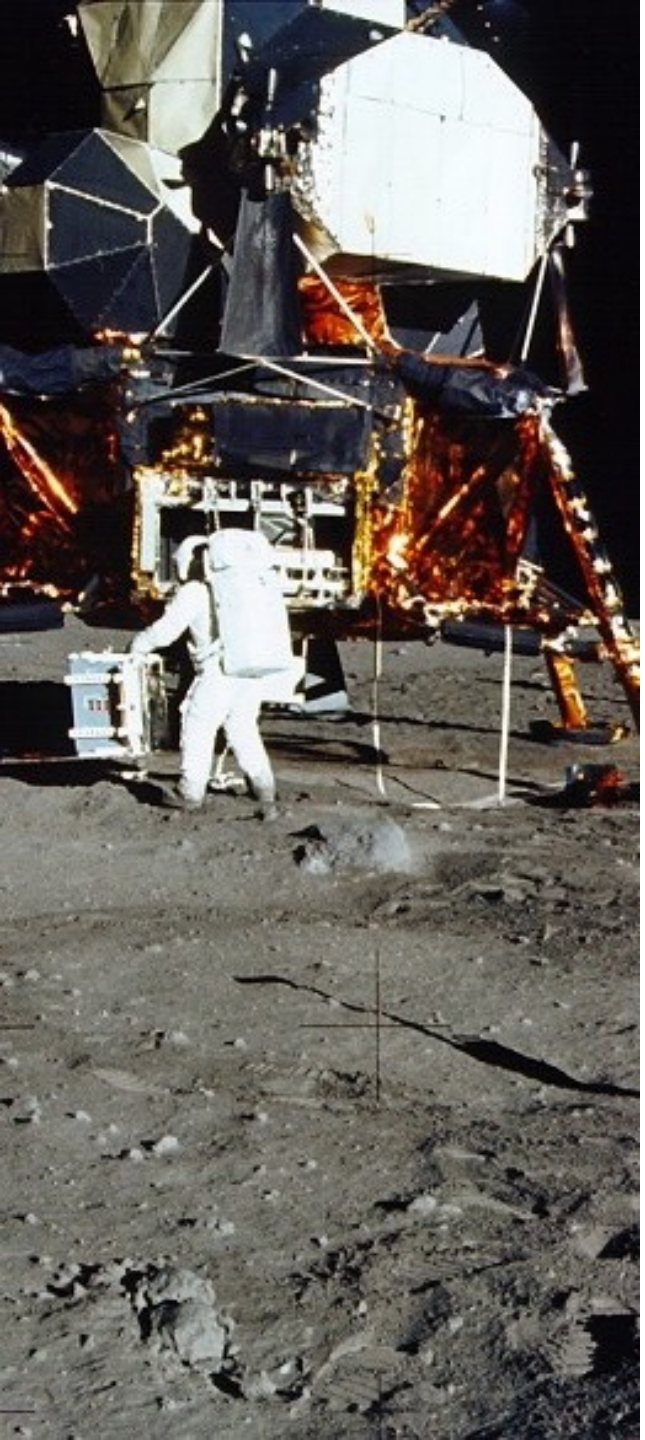


HUMAN LANDING SYSTEM

Tara Polsgrove

Lead Systems Engineer



Human Landing System

HLS

The first human landing systems in history to be developed by U.S. industry will take astronauts from lunar orbit to the surface and back again.

- Carries crew to the lunar surface and returns them to lunar orbit
- Serves as a habitat on the lunar surface for early Artemis missions
- Houses equipment for surface activities including moonwalks, sample collection, and scientific experiments

Initial Human Landing System

HLS

Uncrewed demo and first Artemis crew landing

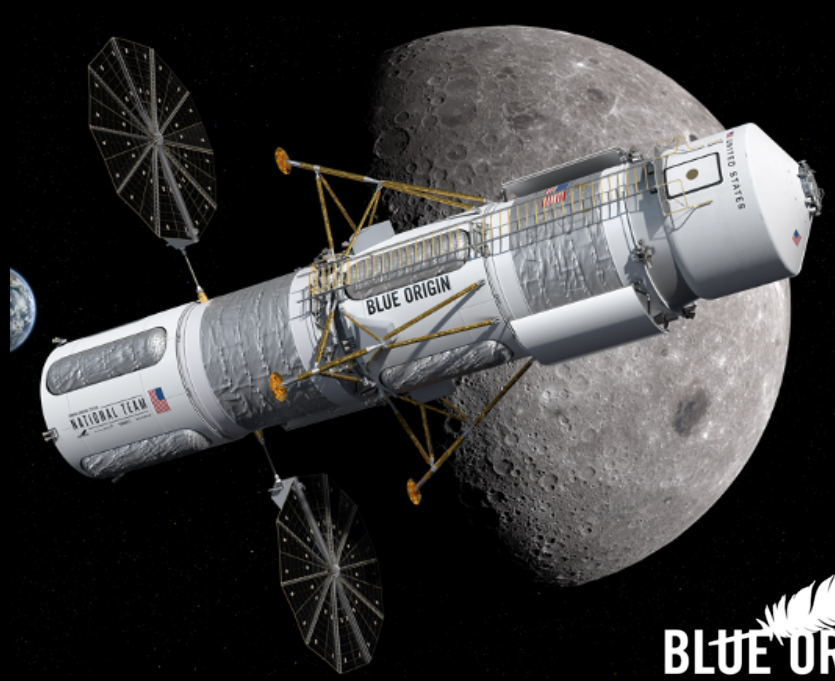
APR 2020	Base Period Selections Announced
MAY 2020	Base Period Contracts Awarded
AUG 2020	Contractor Certification Baseline Reviews
OCT 2020	Option A Solicitation Issued
DEC 2020	Contractor Continuation Reviews
APR 2021	SpaceX selected for Option A Design Development Test and Evaluation (DDT&E) and a Crewed Demo Mission*
JULY 2021	Option A Contract Award**
NOV 2021	US Court of Federal Claims Upholds SpaceX Selection, Progress Resumes



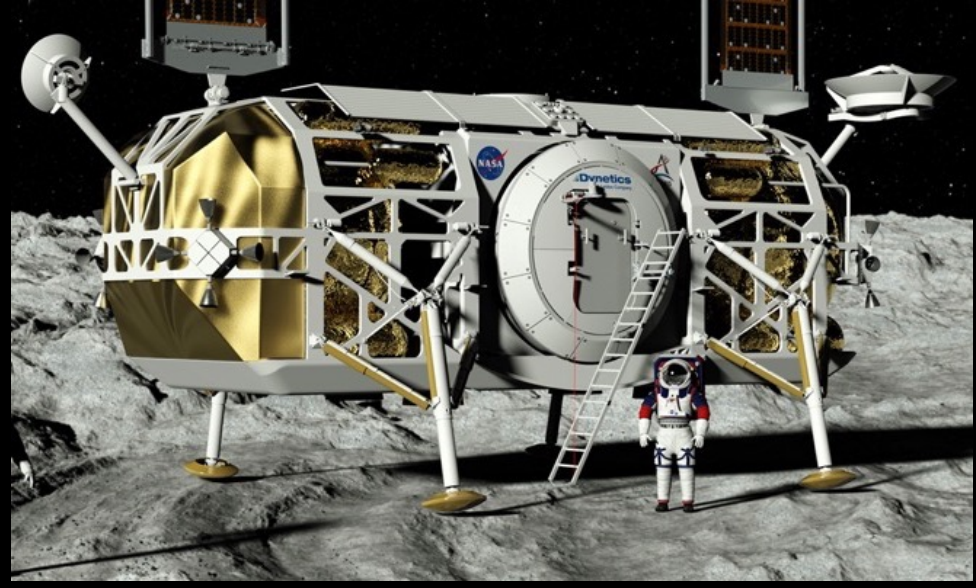
Image Credit: SpaceX

NextSTEP Appendix N

In preparation for Sustaining Lunar Development, NASA selected five providers in September 2021 to develop lander design concepts, evaluate mission requirements, and mitigate risks by conducting critical component tests and advancing the maturity of key technologies.

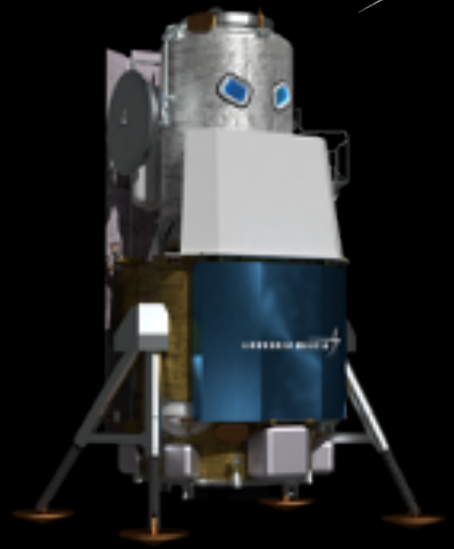


BLUE ORIGIN

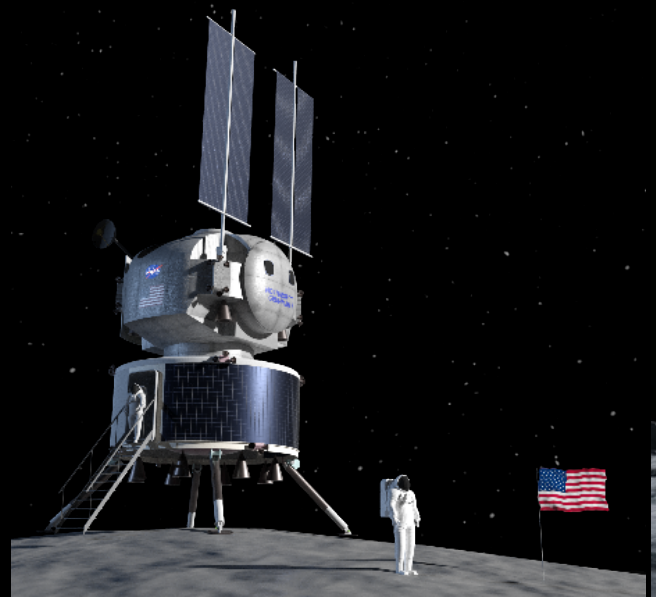


Dynetics
A Leidos Company

LOCKHEED MARTIN



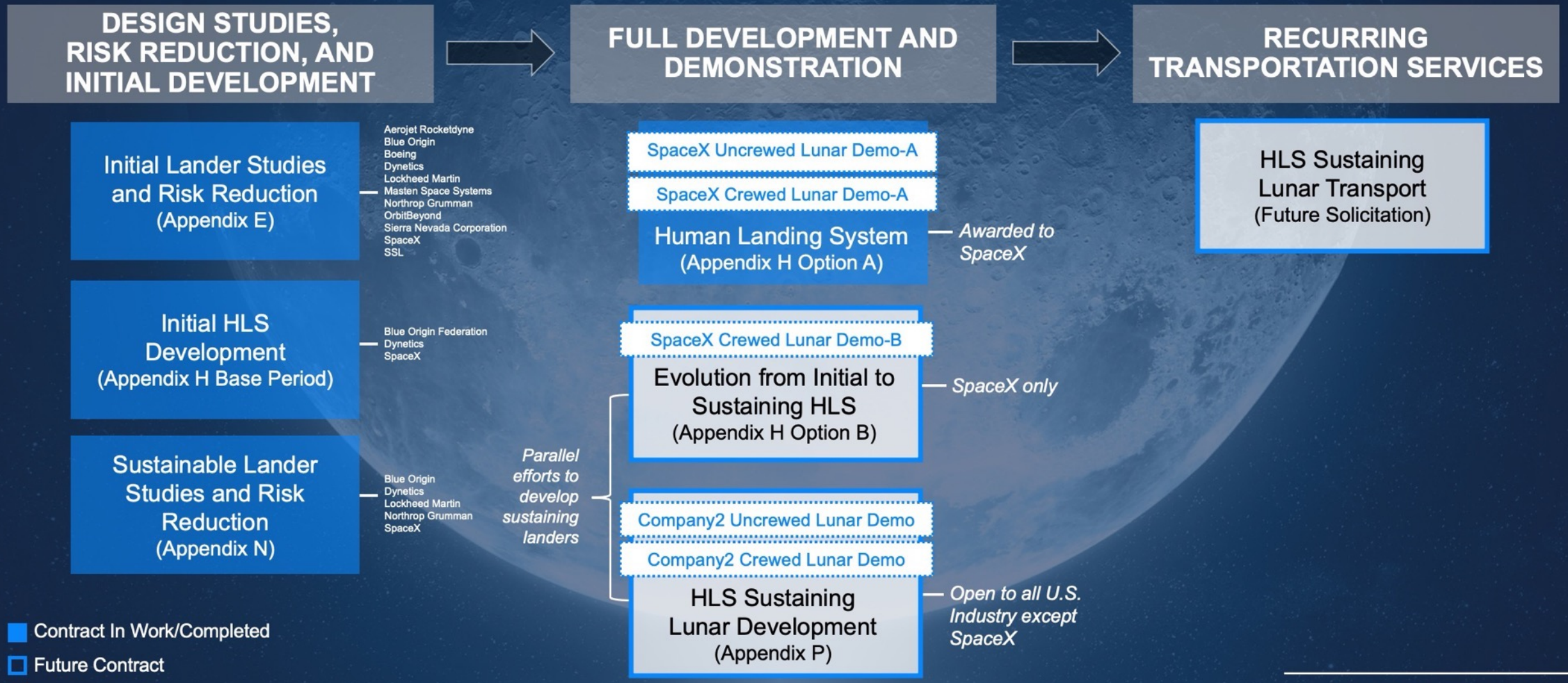
NORTHROP GRUMMAN



SPACEX



Human Landing System (HLS) Procurement Path



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ARTEMIS III

Landing on the Moon

1 LAUNCH
SLS and Orion lift off from Kennedy Space Center.

2 JETTISON ROCKET BOOSTERS, FAIRINGS, AND LAUNCH ABORT SYSTEM

3 CORE STAGE MAIN ENGINE CUT OFF
With separation.

4 ENTER EARTH ORBIT
Perform the perigee raise maneuver. Systems check and solar panel adjustments.

5 TRANS LUNAR INJECTION BURN
Astronauts committed to lunar trajectory, followed by ICPS separation and disposal.

6 ORION OUTBOUND TRANSIT TO MOON
Requires several outbound trajectory burns.

7 ORION OUTBOUND POWERED FLYBY
60 nmi from the Moon.

8 NHRO INSERTION BURN
Orion performs burn to establish rendezvous point and executes rendezvous and docking.

9 LUNAR LANDING PREPARATION
Crew activates lander and prepares for departure.

10 LANDER UNDOCKING AND SEPARATION

11 LANDER ENTERS LOW LUNAR ORBIT
Descends to lunar touchdown.

12 LUNAR SURFACE EXPLORATION
Astronauts conduct week long surface mission and extra-vehicular activities.

13 ORION REMAINS IN NHRO ORBIT
During lunar surface mission.

14 LANDER ASCENDS TO LOW LUNAR ORBIT

15 LANDER PERFORMS RENDEZVOUS AND DOCKING

16 CREW RETURNS IN ORION
Orion undocks, performs orbit departure burn.

17 ORION PERFORMS RETURN POWERED FLYBY
60 nmi from the Moon.

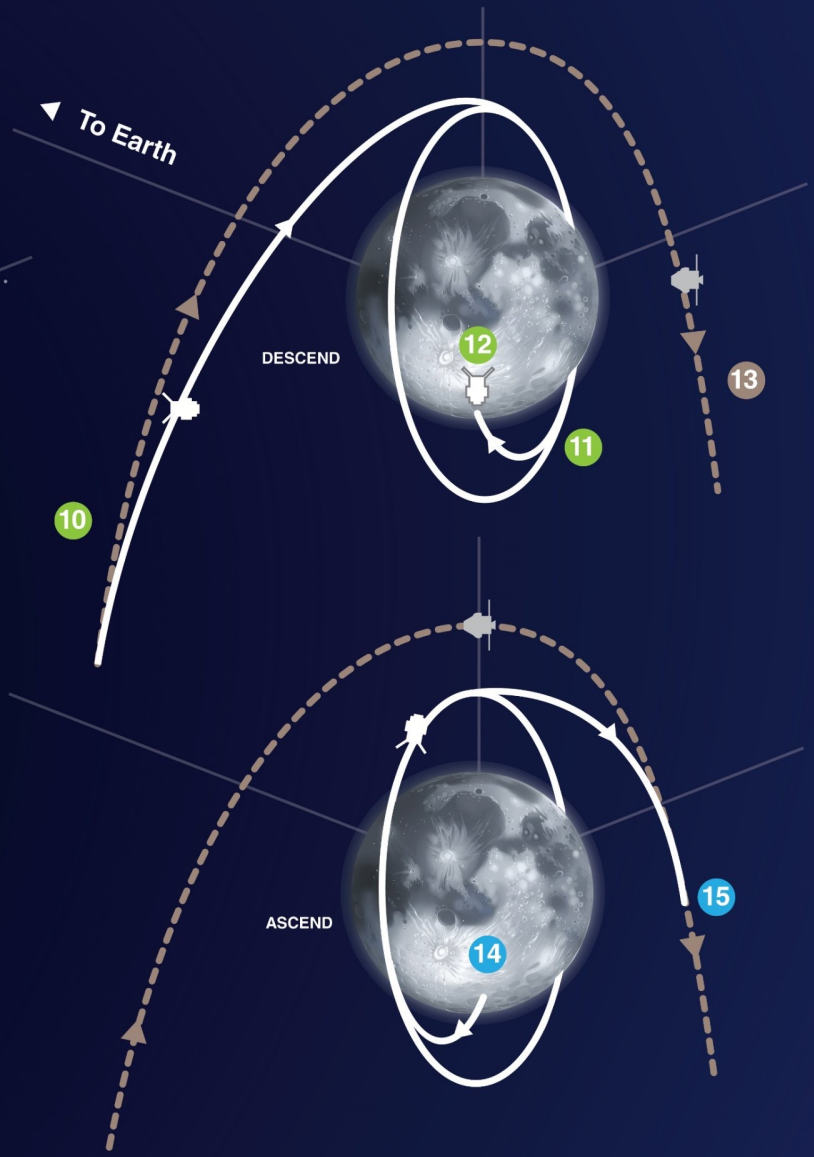
18 FINAL RETURN TRAJECTORY CORRECTION (RTC) BURN
Precision targeting for Earth entry.

19 CREW MODULE SEPARATION FROM SERVICE MODULE

20 ENTRY INTERFACE (EI)
Enter Earth's atmosphere.

21 SPLASHDOWN
Ship recovers astronauts and capsule





PREPARING FOR MARS AT THE MOON

IN ORBIT



DEEP SPACE AGGREGATION
Assembling a complex ship in deep space using international interoperability standards



MARS TRANSIT HABITAT
Round the clock, years-long operations of the Mars transport habitat and life support system



ORBIT TO SURFACE OPERATIONS
Gaining confidence in the operations involved with an orbiting outpost that deploys a lander and its crew to a planetary surface



COMMERCIAL RESUPPLY AND REFUELING
Leveraging the space logistics supply chain for industry provided cargo deliveries

Initial round-trips to Mars will be about two years with ~30 sols on the surface

ON THE SURFACE



SPACESUIT ADVANCEMENTS
Improving spacesuit design across Artemis missions with astronaut input and private sector innovation



MOBILE OPERATIONS
Living and working ‘on the go’ inside a mobile habitat for weeks at a time



PLANETARY PROTECTION
Mitigating dust transfer and establishing pristine sample curation protocols



HUMAN ROBOTIC EXPLORATION
Robots pre-positioning surface assets and conducting reconnaissance for astronaut expeditions

MOON AND MARS EXPLORATION

Operations on and around the Moon will help prepare for the first human mission to Mars

