National Aeronautics and Space Administration

space launch system

For Orbiter 2016 Space Flight Simulator

Development Team

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www.nasa.gov

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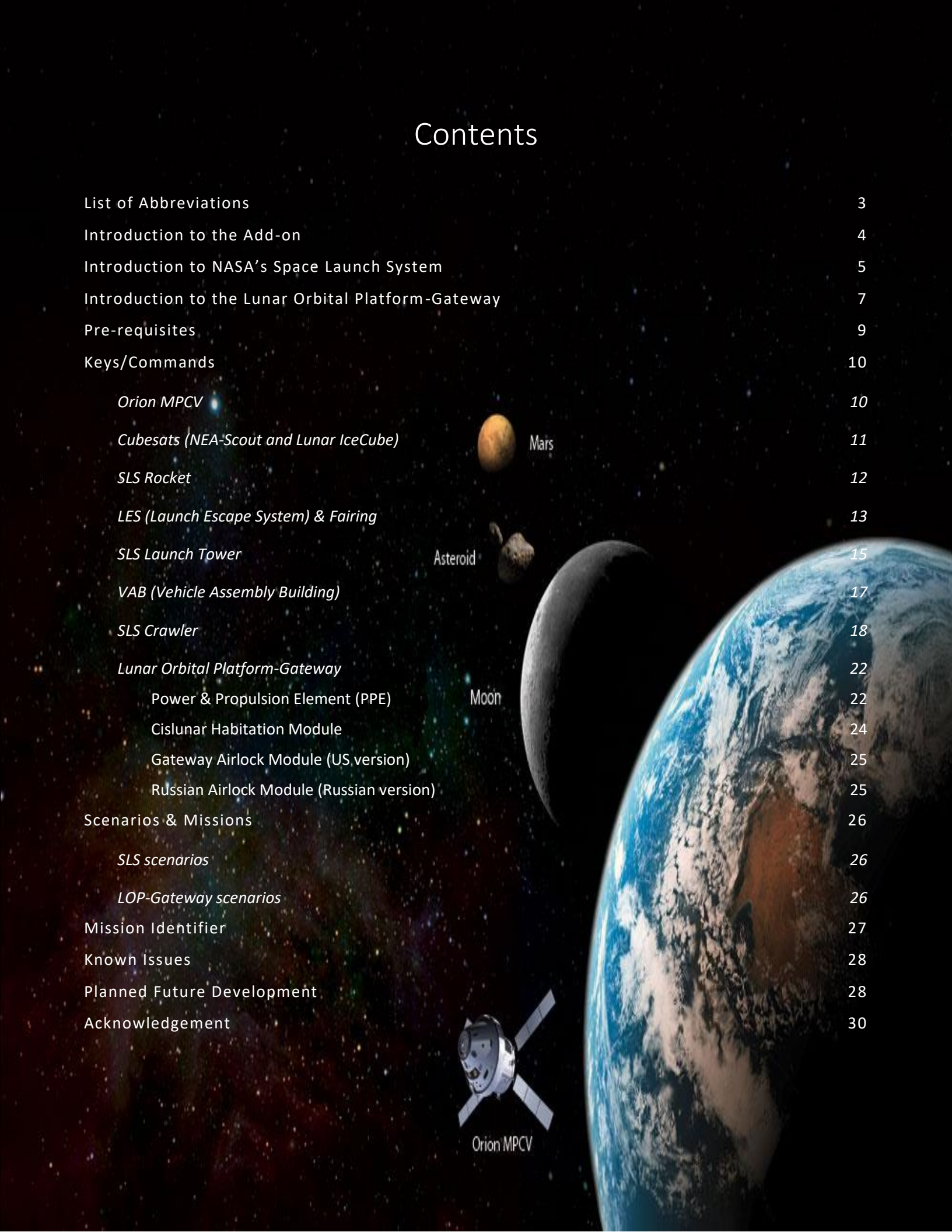


List of Abbreviations

CAA: Crew Access Arm

DRO: Distant Retrograde Orbit

DSG: Deep Space Gateway

EM: Exploration Mission

EML-2: Earth-Moon Lagrangian Point 2 (L2)

ESA: European Space Agency

EUS: Evolved Upper Stage

ICPS: Intercryogenic Propulsion Stage

LES: Launch Escape System

LOP-Gateway: Lunar Orbital Platform-Gateway

N_2H_4: Hydrazine

NASA: National Aeronautics and Space Administration

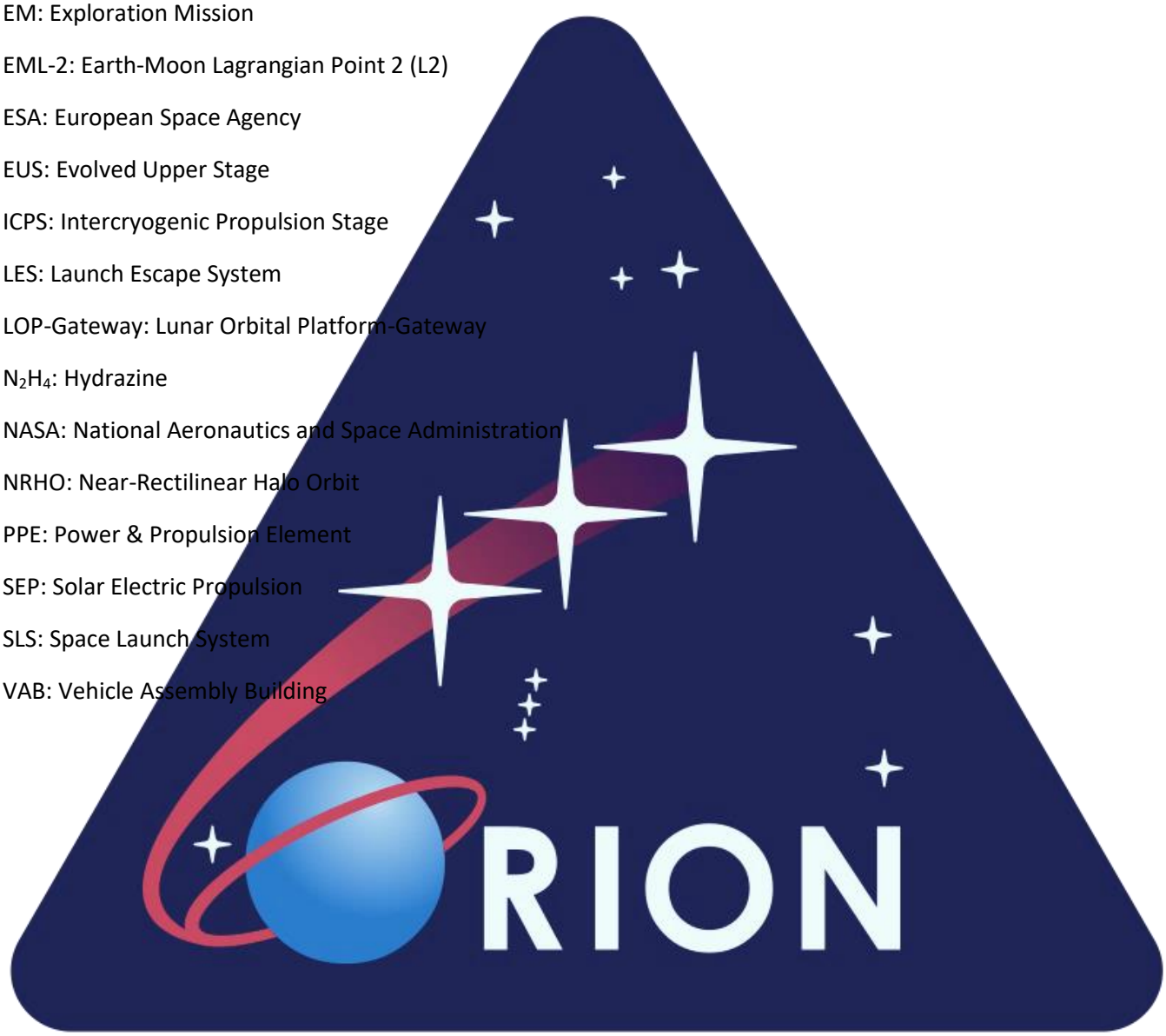
NRHO: Near-Rectilinear Halo Orbit

PPE: Power & Propulsion Element

SEP: Solar Electric Propulsion

SLS: Space Launch System

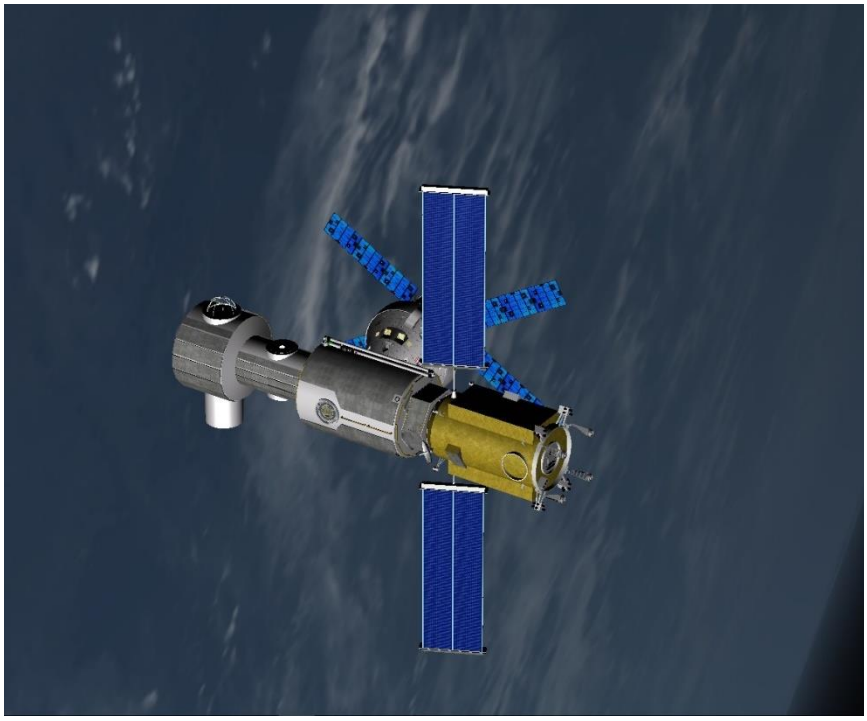
VAB: Vehicle Assembly Building



Introduction to the Add-on

Thanks for downloading the SLS & LOP-Gateway add-on! This add-on aims to create as accurate as possible the real SLS that will be launched from 2020 onwards. Included in the add-on are the SLS rockets (Block 1, Block 1B Crew, Block 1B Cargo and Block 2) and the LOP-Gateway modules proposed by NASA.

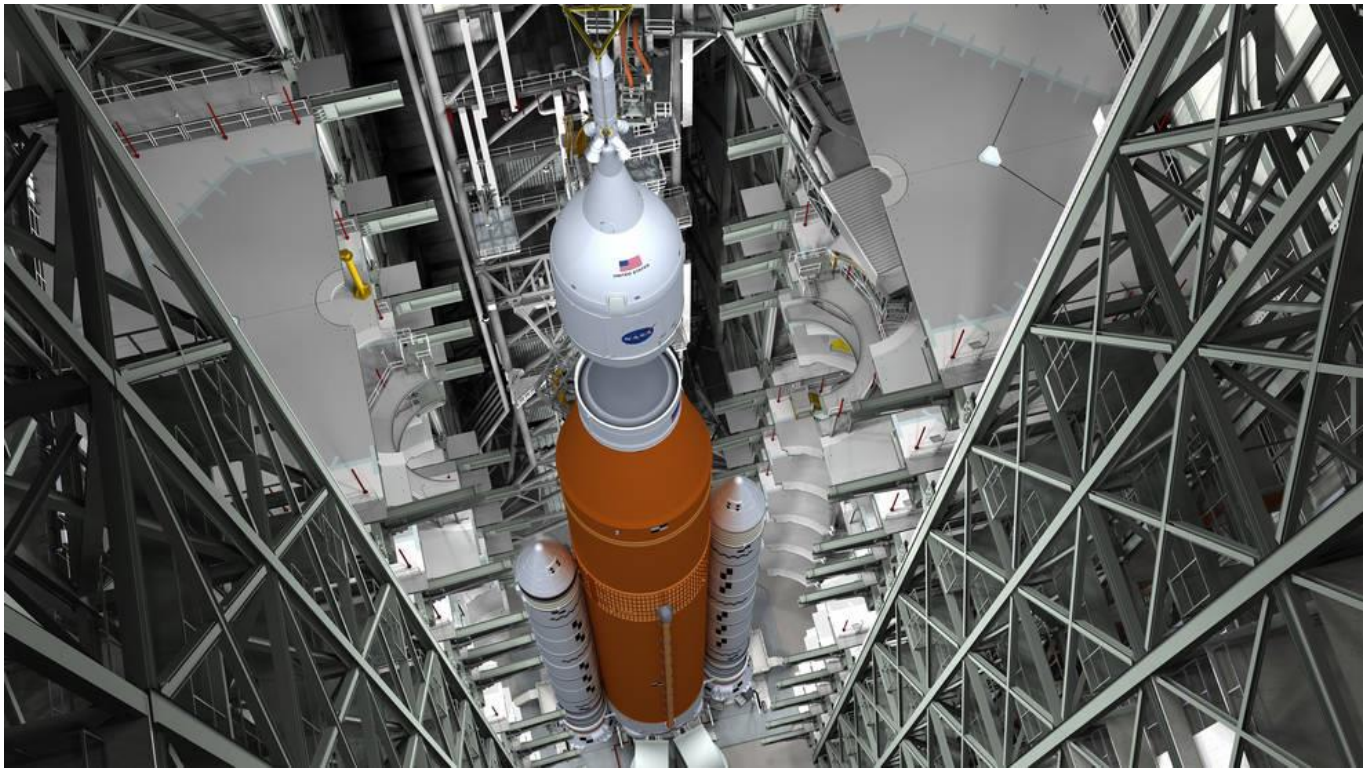
The real SLS Block 1 construction is well underway but the LOP-Gateway vessels are still under development and by and large, exist on papers only, though some high-performance SEP thrusters have been tested at various NASA centers.



Included in this add-on are the SLS fleets, the LOP-Gateway complex, ground systems, cubesats and francisdrake's Orion MPCV.

The team will update the SLS & LOP-Gateway add-on as new information about them surfaces. Stay tuned for more eye candies!

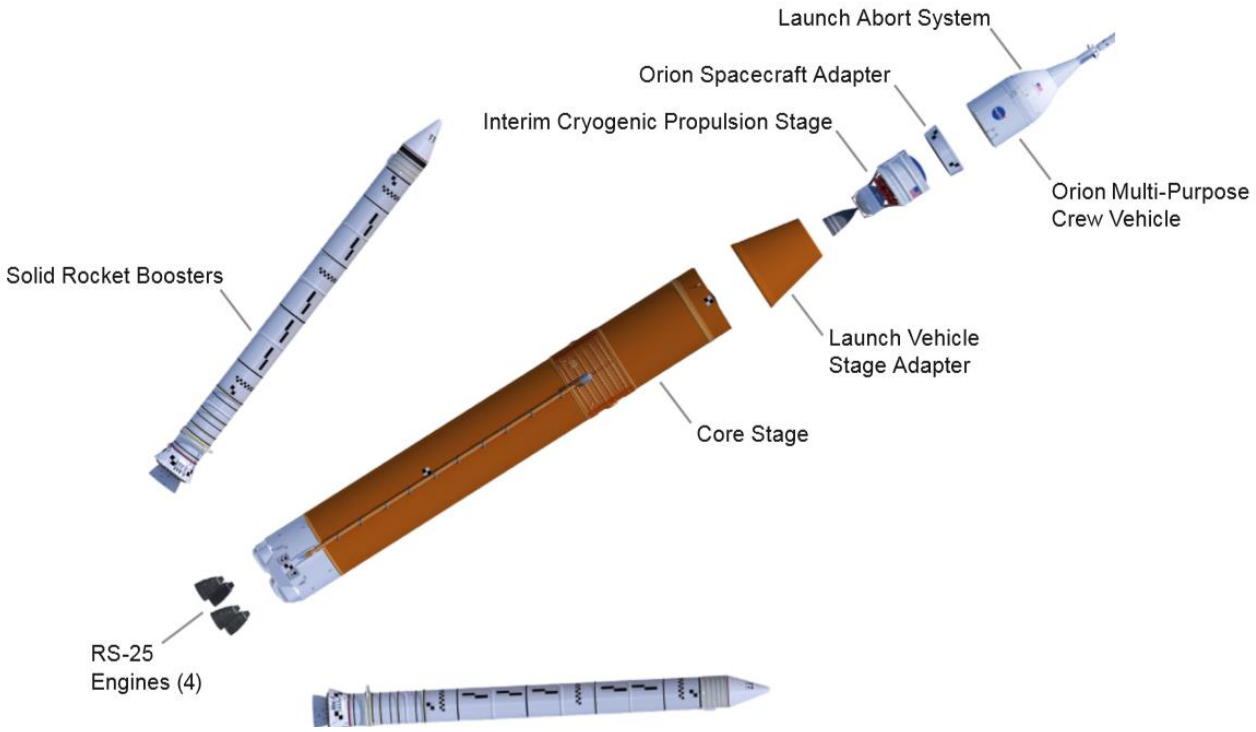
Introduction to NASA's Space Launch System



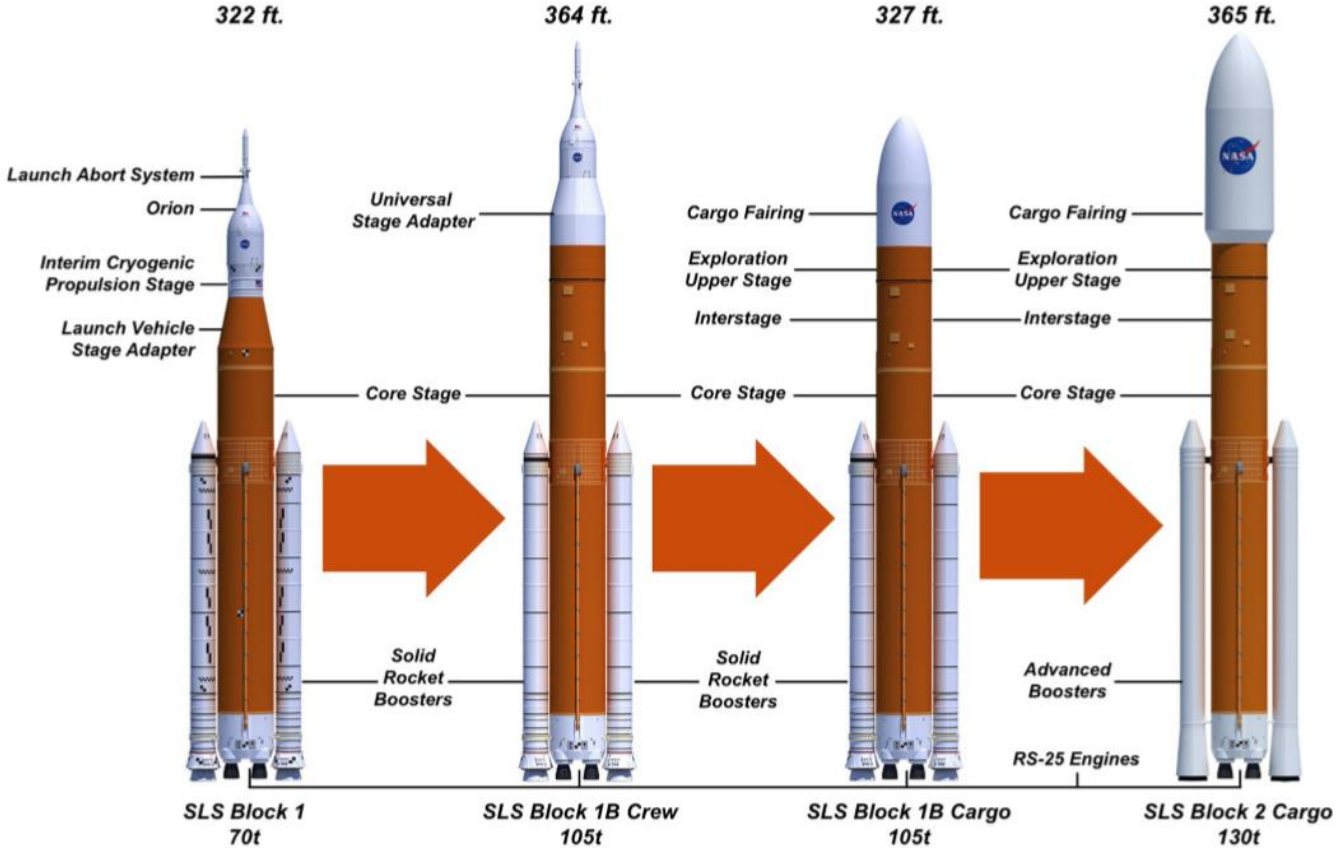
NASA's Space Launch System, or SLS, is a powerful, advanced launch vehicle for a new era of human exploration beyond Earth's orbit. With its unprecedented power and capabilities, SLS will launch crews of up to four astronauts in the agency's Orion spacecraft on missions to explore multiple, deep-space destinations.

To fit NASA's future needs for deep-space missions, SLS is designed to evolve into increasingly more powerful configurations. The first SLS vehicle, called Block 1, has a minimum 70-metric-ton (77- ton) lift capability. It will be powered by twin five-segment solid rocket boosters and four RS-25 liquid propellant engines, as well as a modified version of an existing upper stage. The next planned evolution of the SLS, Block 1B, will use a new, more powerful Exploration Upper Stage (EUS) to enable more ambitious missions and deliver a 105-metric-ton (115-ton) lift capacity. A later evolution, Block 2, would replace the current five-segment boosters with a pair of advanced solid or liquid propellant boosters to provide a 130-metric-ton (143-ton) lift capacity. In each configuration, SLS will continue to use the same core stage design with four RS-25 engines.

SLS Block 1 Initial Configuration

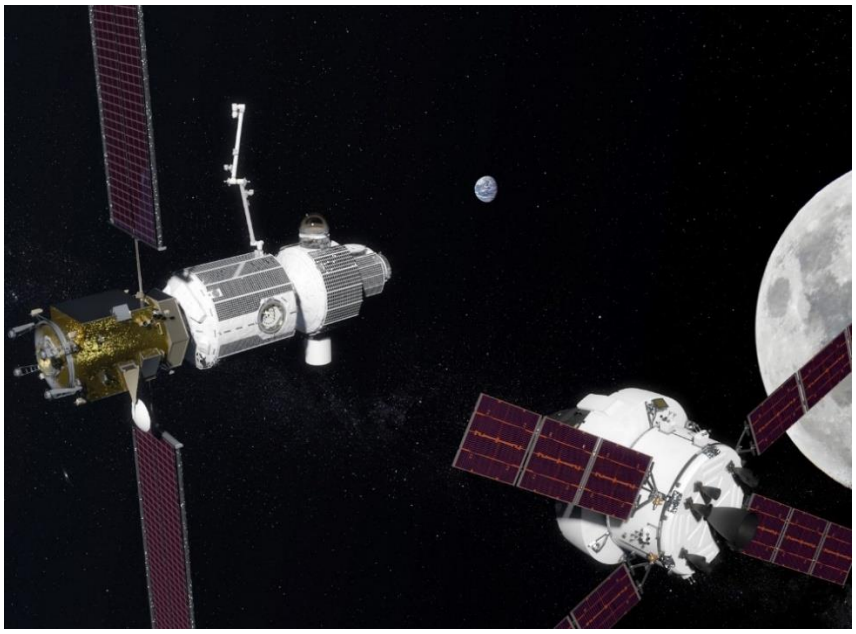


SLS Evolved Configurations



Introduction to the Lunar Orbital Platform-Gateway

Contrary to the SLS, The LOP-Gateway (previously named Deep Space Gateway) initiative is being led by the International Space Station partners: ESA, NASA, Roscosmos, JAXA, and CSA. Plans are currently at an early stage of definition and envision a power and propulsion system, a small habitat for the crew, a docking capability, an airlock, and logistics modules.

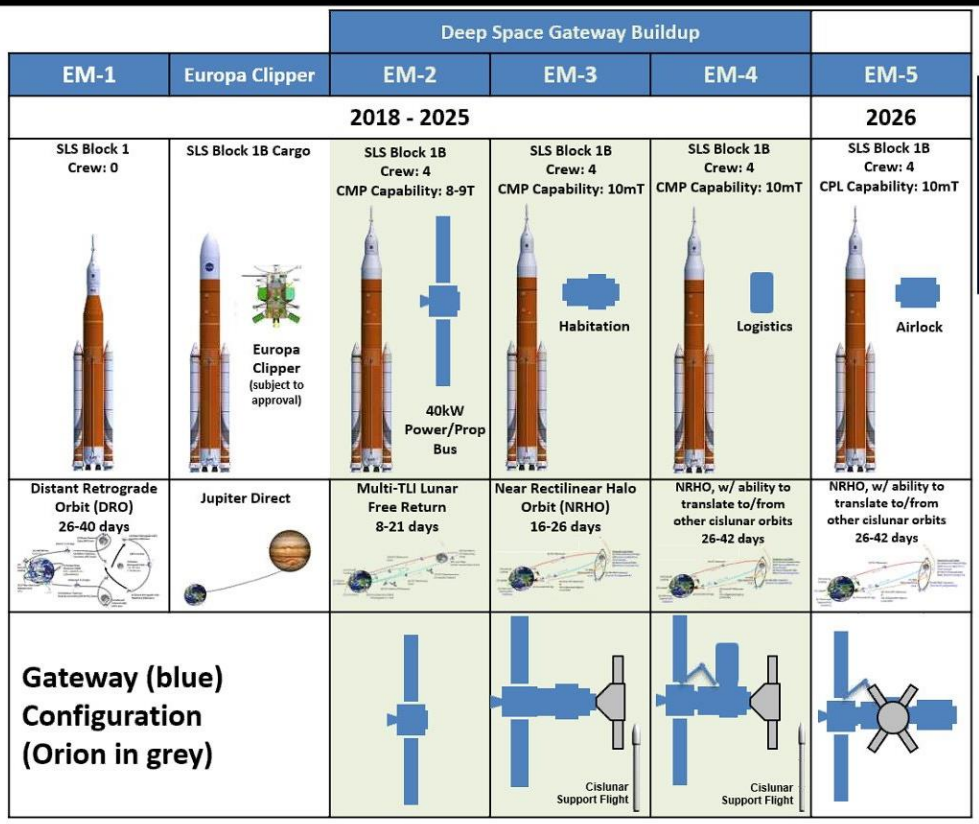


The LOP-Gateway will be humanity's first spaceship, a crewed platform in deep space from which human exploration of the Solar System can set forth. During the 2020s, the LOP-Gateway will be assembled and operated in the vicinity of the Moon, where it will move between different orbits and enable the most distant human space missions ever attempted. The LOP-Gateway will be a testing ground for the challenges of long-duration human missions in the environment of deep space.

NASA has selected five U.S. companies to conduct four-month studies for a power and propulsion element that could be used as part of the deep space gateway concept. Each company has proposed their own model of LOP-Gateway. In this add-on, however, we have chosen to follow the original NASA artist's illustration when designing the LOP-Gateway modules.

Phase 1 Plan

Establishing deep-space leadership and preparing for Deep Space Transport development



These essential Gateway elements can support multiple U.S. and international partner objectives in Phase 1 and beyond

Known Parameters:

- Gateway to architecture supports Phase 2 and beyond activities
- International and U.S. commercial development of elements and systems
- Gateway will translate uncrewed between cislunar orbits
- Ability to support science objectives in cislunar space

Open Opportunities:

- Order of logistics flights and logistics providers
- Use of logistics modules for available volume
- Ability to support lunar surface missions

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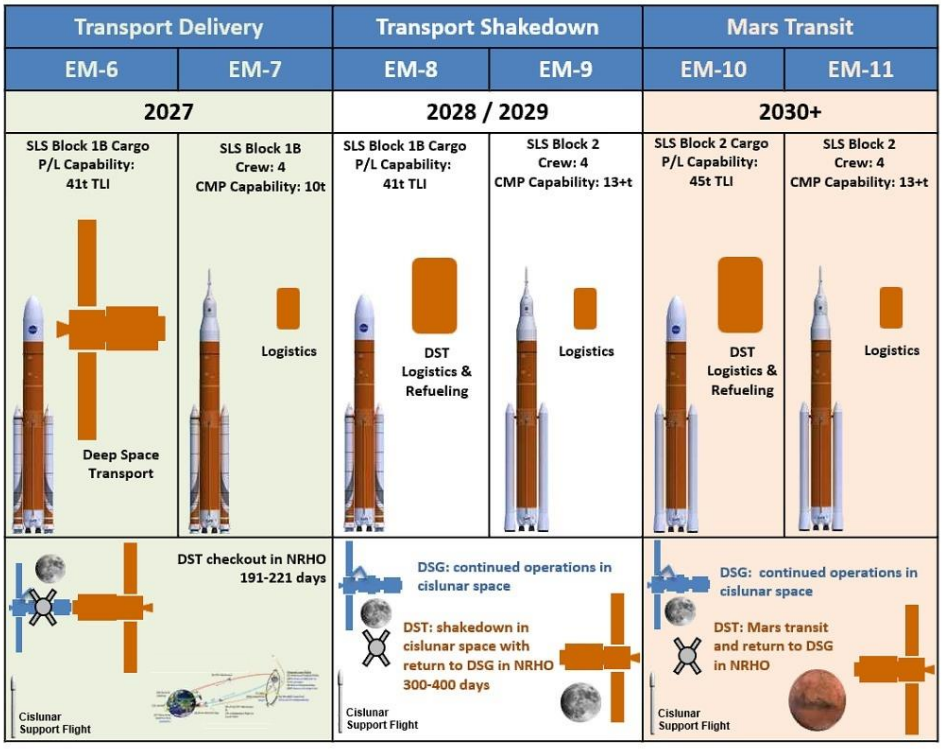
(PLANNING REFERENCE) Phase 2 and Phase 3

Looking ahead to the shakedown cruise and the first crewed missions to Mars



Reusable Deep Space Transport supports repeated crewed missions to the Mars vicinity

Known Parameters:

- DST launch on one SLS cargo flight
- DST shakedown cruise by 2029
- DST supported by a mix of logistics flights for both shakedown and transit
- Ability to support science objectives in cislunar space

Open Opportunities:

- Order of logistics flights and logistics providers
- Shakedown cruise vehicle configuration and destination/s
- Ability to support lunar surface missions

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Pre-requisites

These are the mandatory installs for the SLS & LOP-Gateway add-on:

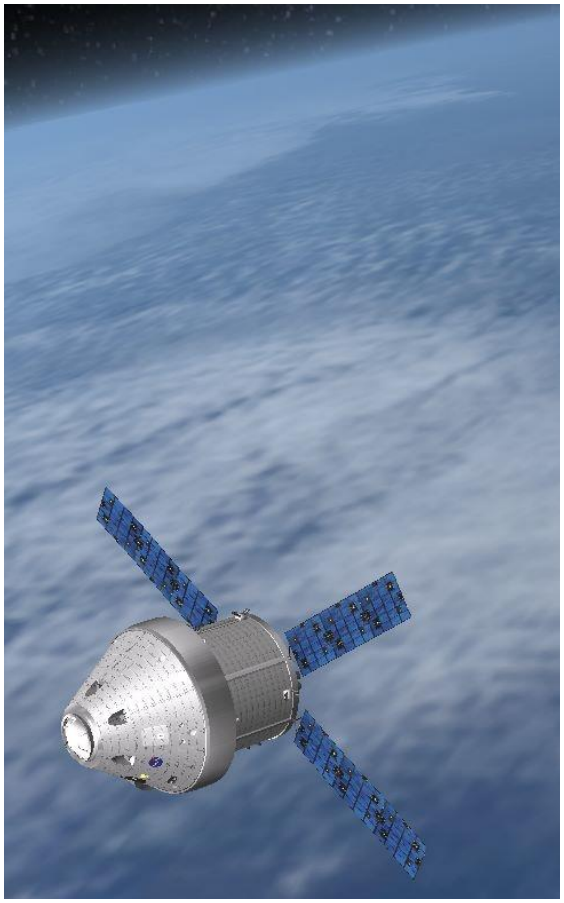
1. Orbiter 2016 Space Flight Simulator
2. Multistage 2015 for Orbiter 2016
3. Spotlight 2 for Orbiter 2016
4. Vinka's Spacecraft4.dll
5. Vinka's Multistage2.dll
6. Stage.dll for Orbiter 2010

These are optional add-ons to be installed for trajectory planning and guidance. Having a good grasp of these MFDs will ease your trip to cislunar space.

1. IMFD 5.7
2. LTMFD 1.5
3. IEAT MFD
4. BurnTimeCalculator
5. TransX
6. Lagrange MFD

Keys/Commands

Orion MPCV



[A] Auxillary thrusters on/off

[C] Deploy drogue, deploy chute;

drogue will deploy automatically at 3000 m,

main chute will deploy at 800 m altitude

[K] Open / close the hatch door

[S] Deploy solar panels, swivel forward / straight

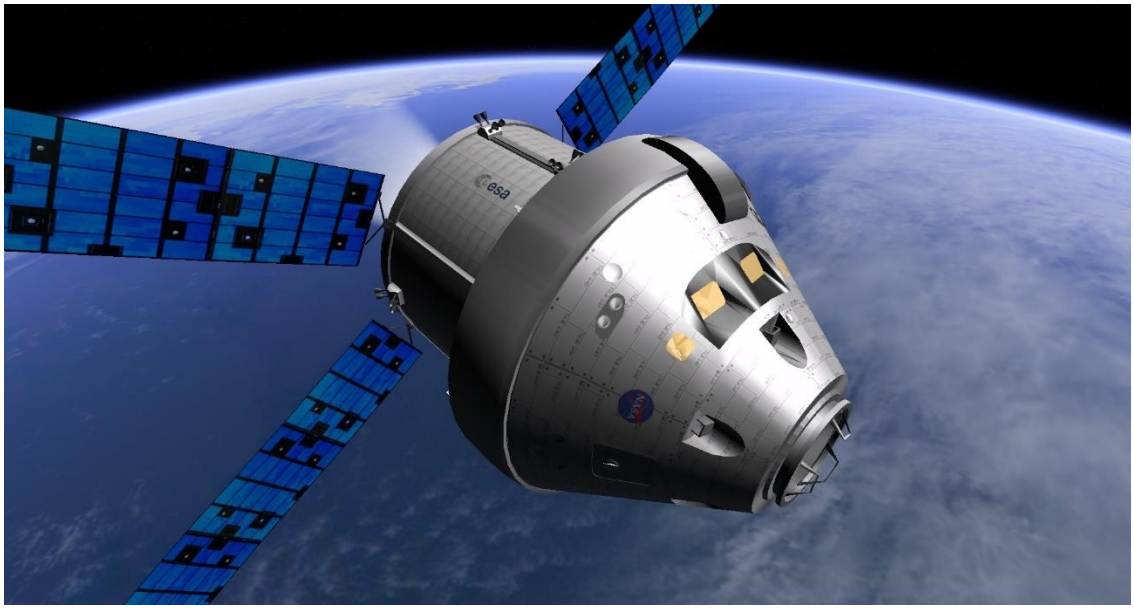
[D] Solar panels swivel back / straight

[Ctrl + J] Jettison the resource module

This add-on includes the Orion MPCV capsule from francisdrake (Franz Barner).

The team has, by and large, retained the original add-on structure.

The only modification made to the MPCV is the new LES texture which features a reposition of the US flag to the correct orientation on the LES based on the latest SLS animation videos available online. (See below.)



Cubesats (NEA-Scout and Lunar IceCube)

[Shift + 1] Turns on lights at the back

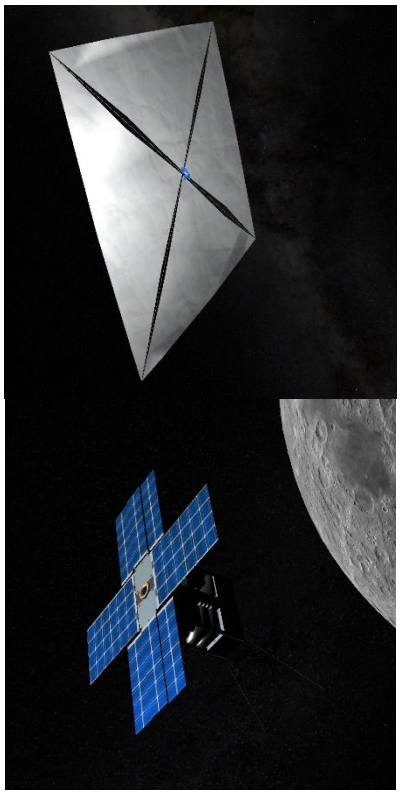
[Shift + 2] First stage of solar panel deployment

[Shift+ 3] Second stage of solar panel deployment

[Shift + 4] Antenna deployment

[Shift + 5] Turn on a flickering light to simulate data transfer

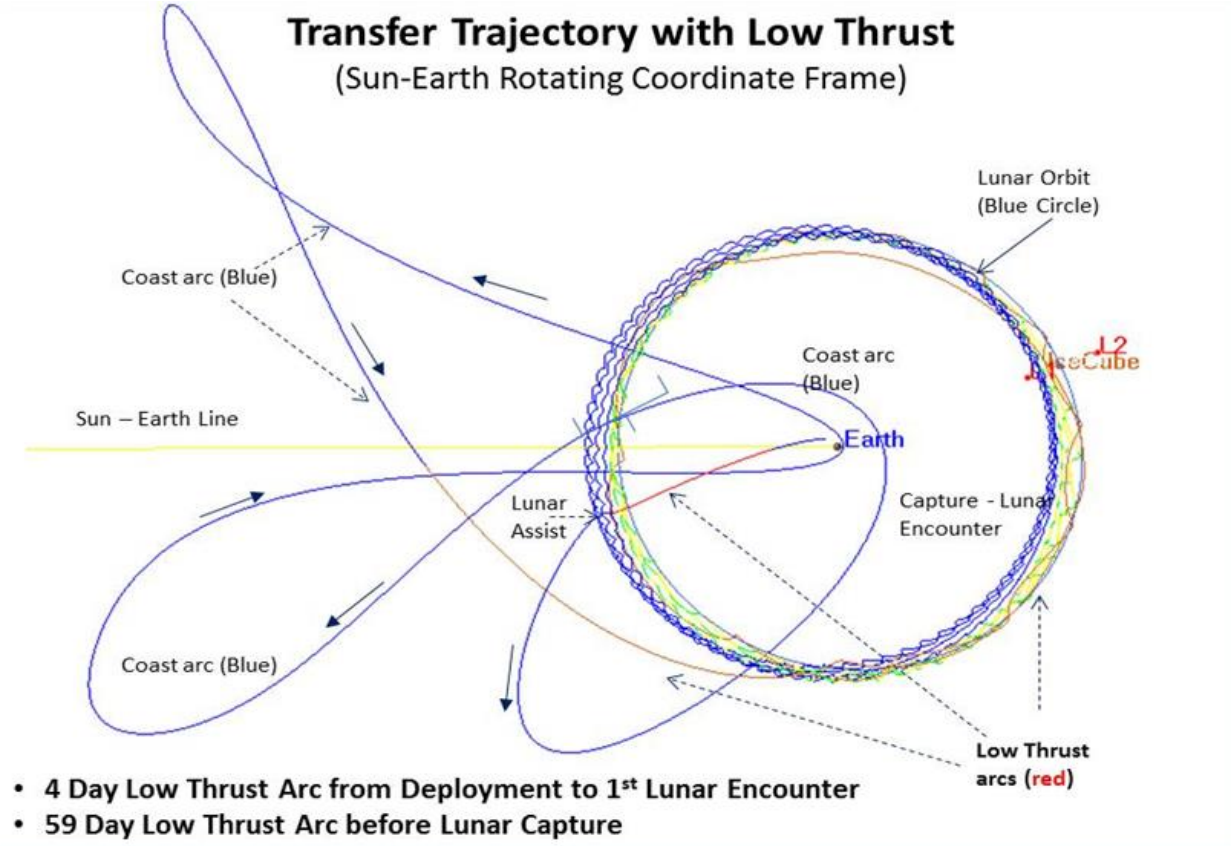
[Shift + 6] Deploy solar sails (Only for NEA scout)



This add-on includes 2 cubesats made by *longjap* for the EM-1 mission. NEA-Scout is planned to rendezvous with NEOs like asteroid 1991 VG. However, the asteroid is not included in this mission.

Lunar IceCube is a planned NASA nanosatellite mission to prospect, locate, and estimate size and composition of water ice deposits on the Moon. Target orbit: 100-km polar selenocentric orbit. The flight plan devised is shown below:

Note on cubesats in EM-1



SLS Rocket

(*Multistage 2015 control keys apply here)

[P] Engage/disengage launch autopilot

[J] Manually jettison boosters/stages

A total of 5 variants of SLS rockets are available in this add-on, namely:

Block 1 (Crew)

Block 1B (Crew)

Block 1B (Cargo)

Block 2 (Cargo, Liquid boosters)

Block 2 (Cargo, Solid boosters)

Since this is a Multistage 2015-based add-on, users are expected to have some experience in operating MS2015 add-ons. Basic config and guidance file editing skills are needed if users wish to customize the scenarios provided in this add-on or to create their own scenarios.

Kindly refer to the MS2015 user guide for more information about how to control MS2015 vessels. Don't hesitate to ask in the forum or contact us should you have any inquiries.

**Note: The fairing and LES used in this add-on are controlled by the Orion-MPCV vessel and NOT MS2015. Thus, one should not attempt to press the "F" key (default control key for LES/fairing jettison in MS2015) in the scenario to jettison the fairing or LES tower.*

LES (Launch Escape System) & Fairing

[J] Activate the LES system (Also jettisons the fairing panels/shrouds)

[C] Jettison the LES tower and activate the automatic chute sequence

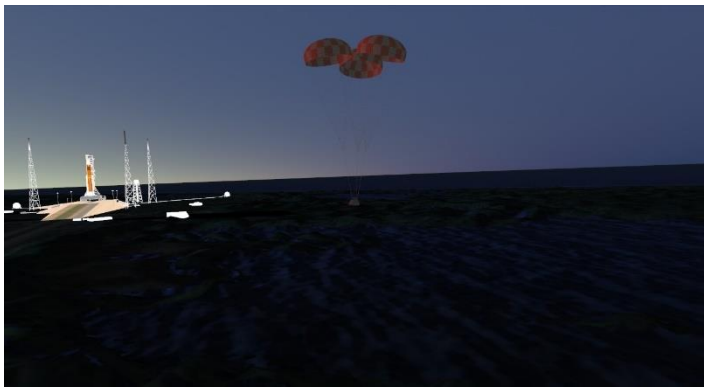
The LES and fairings are treated in a separate section from the rest as they are not controlled by MS2015 but by the Orion MPCV vessel instead, thus they follow the default control keys for the LES that come with Franz's Orion but not the MS2015.

The only difference between the LES and fairing in this add-on, as compared to Franz's, is the new textures used, as noted earlier.

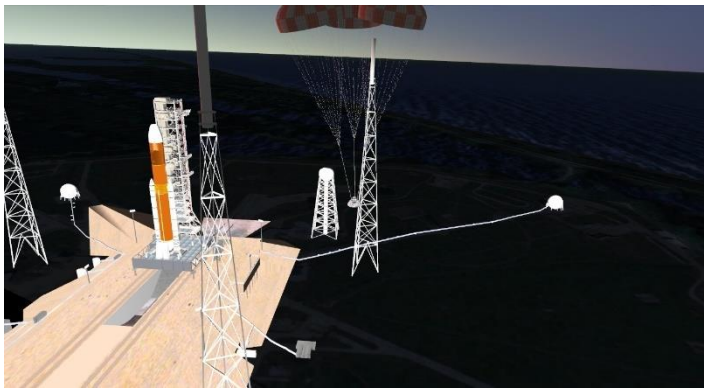
The LES is found to be quite sensitive to wind, as they contribute to differences in airflow around the rather slim tower and the variations of air pressure that follows causes it to spin easily when "atmospheric wind effects" are enabled. Beta-testing results have shown that the LES might sometimes behave erratically when ejected from the SLS. (It might spin out of control or just rises a few meters before being hit by the charging SLS beneath it.)

One should also enable "atmospheric wind effects" in the "Parameters" tab of the Orbiter Launchpad when planning to test the LES for a pre-launch abort, i.e. activating the LES when the rocket is grounded. This is to ensure the wind will blow the Orion capsule away from the launch pad in the event of a pre-launch abort. Beta-testing results have shown that with "atmospheric wind effects" enabled, a pre-launch abort can project the Orion capsule as far as 1.4 km away from the launch pad, as compared to just several meters away from the launch pad without the wind.

Pre-launch Abort



"Atmospheric wind effects" enabled



"Atmospheric wind effects" disabled

Note: For compatibility purpose, we have named the mesh files to be exactly the same as that of the original LES and fairing used in Franz's Orion MPCV. One should therefore backup the following mesh files if they intend to use the original textures for the fairings and LES used in Franz's Orion MPCV add-on instead:

[Orbiter root folder]/Meshes/Orion-MPCV/orion-fair1.msh

[Orbiter root folder]/Meshes/Orion-MPCV/orion-fair2.msh

[Orbiter root folder]/Meshes/Orion-MPCV/orion-fair3.msh

[Orbiter root folder]/Meshes/Orion-MPCV/orion-las.msh

SLS Launch Tower

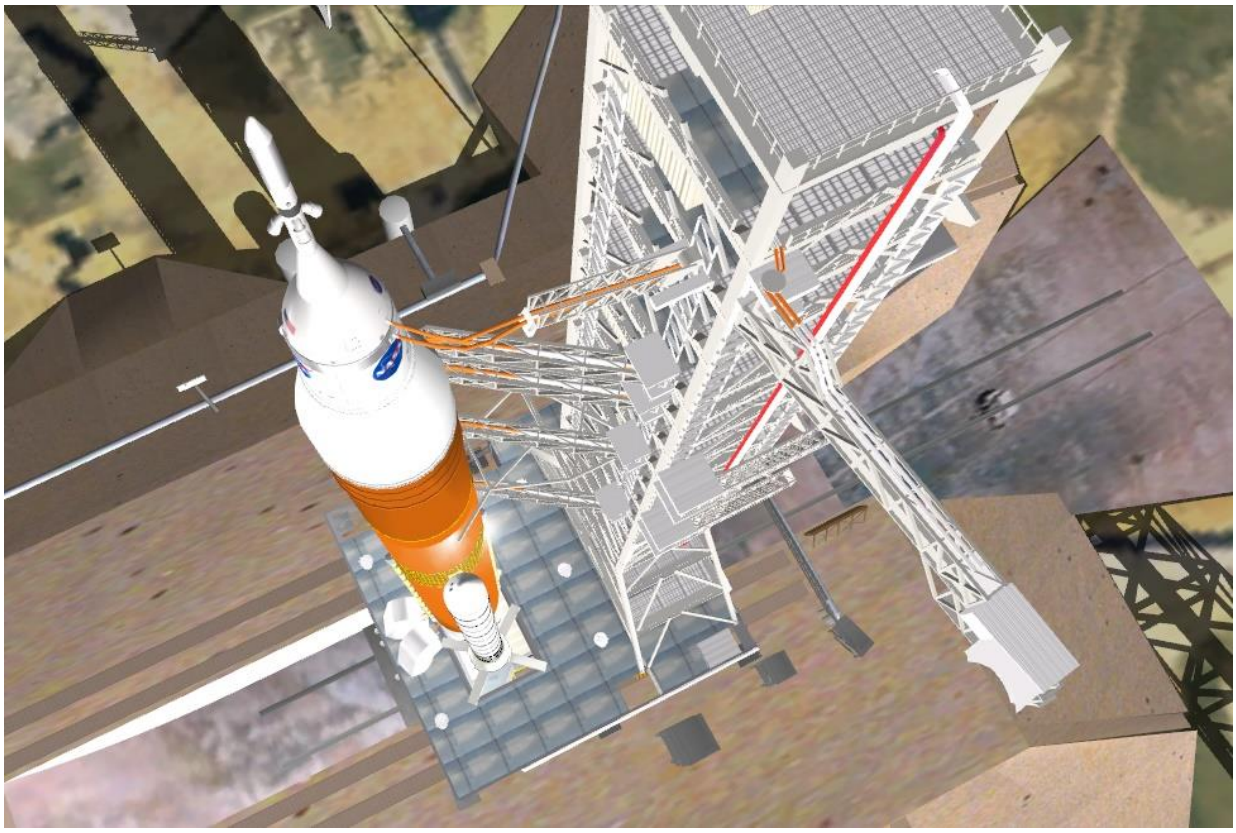
[1] Rotate / retract the Crew Access Arm (CAA)

[7] Rotate / retract all other arms / umbilical cables manually (Never press this key in the actual scenario for automation!)

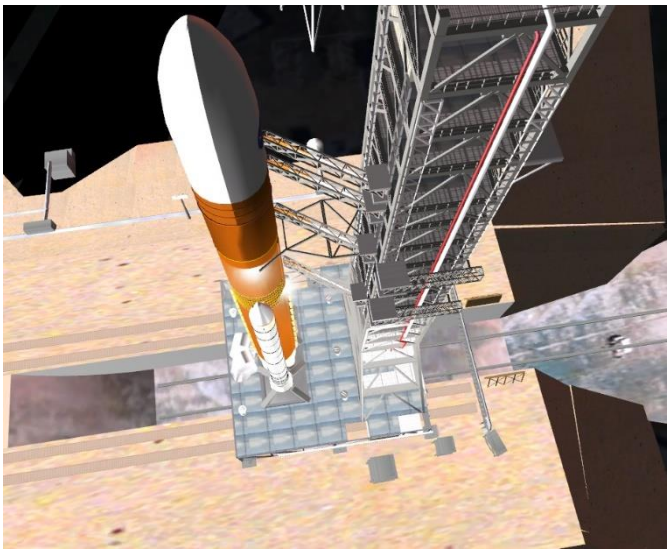
(Only CAA needs to be retracted manually before launch. Other arms will automatically retract upon launch)

The launch tower included in this add-on are made based on SLS animation videos and NASA PDF documents available online. Only the external part of the towers is given considerable thought throughout the making whereas the internal structure of the towers is not well-portrayed in this add-on. 4 variants of launch towers are available in this add-on, i.e. Block 1, Block 1B Crew, Block 1B Cargo and Block 2 Cargo.

The launch tower itself is moveable and can be transported on the crawler together with the launcher. However, the 6 Spotlights (lighting system) surrounding the launch pad is attached to the launch pad and not the launch tower. Hence, the tower will turn dark at night when they are transported on the crawler and one needs to turn on the crawler light to illuminate the launcher stack.



Take note that all launch tower arms (except the Crew Access Arm, CAA) will retract automatically upon liftoff and one should not intervene the process beforehand if automation is desired. Once the arms are retracted manually before liftoff (press “7”), though can be extended to their original position by pressing “7” again, they will NOT retract for the second time (automatically) during liftoff. You need to exit the simulation and rerun it to reset the arms’ parameters.



Also, the CAA is not present for launch towers made specifically for cargo version launchers, although it is remains unclear as to whether NASA will construct different variants of launch towers for different versions of launchers.

VAB (Vehicle Assembly Building)

[1] Turn on/off lights

[9] Open / close all platforms at once

[Shift + 0] Open / close all platforms except the topmost 2

[Shift + 1] Open / close topmost platform

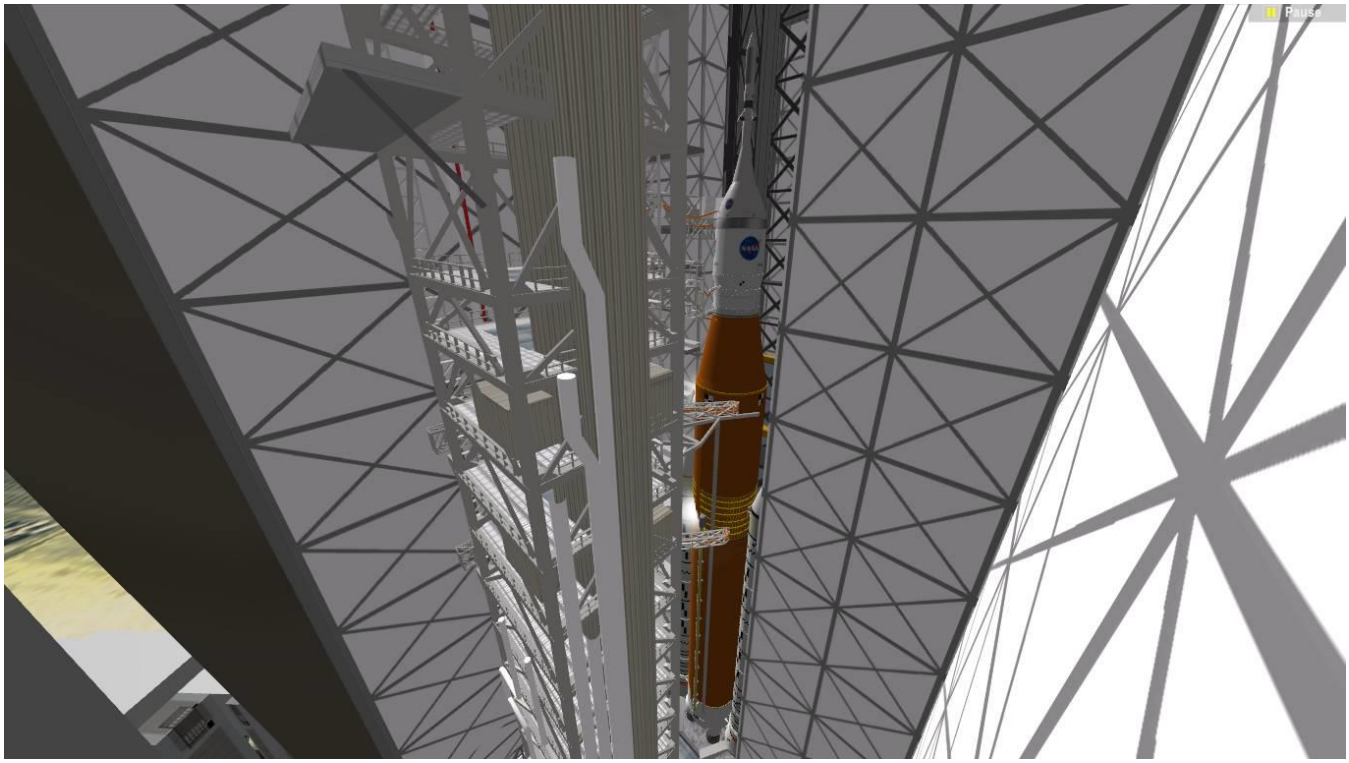
[Shift + 2] Open / close 2nd to highest platform

[Shift + 3] Open / close 3rd to highest platform

... (and so on until the last platform at the base of the SLS)

The VAB is modified in this add-on to accommodate the giant SLS launcher as well. 2 variants of VAB (one for Block 1 and another for Block 1B) are modelled but they are similar to one another with addition or removal of several VAB platforms.

There is no plan for creating a VAB for Block 2 version for now as NASA has not shed light on the future of Block 2 iteration of the SLS.



SLS Crawler

[8] Accelerate the crawler (Forward Gear)

[2] Decelerate the crawler (Reverse Gear)

[4] Neutral Gear (Crawler will slow down on its own due to friction from surface)

[Numpad +/-] Increase/Decrease target speed (Gear must be in forward/reverse state while setting target speed)

[K] Raise the launch pad

[J] Lower the launch pad

[5] Detach the launch pad from the crawler

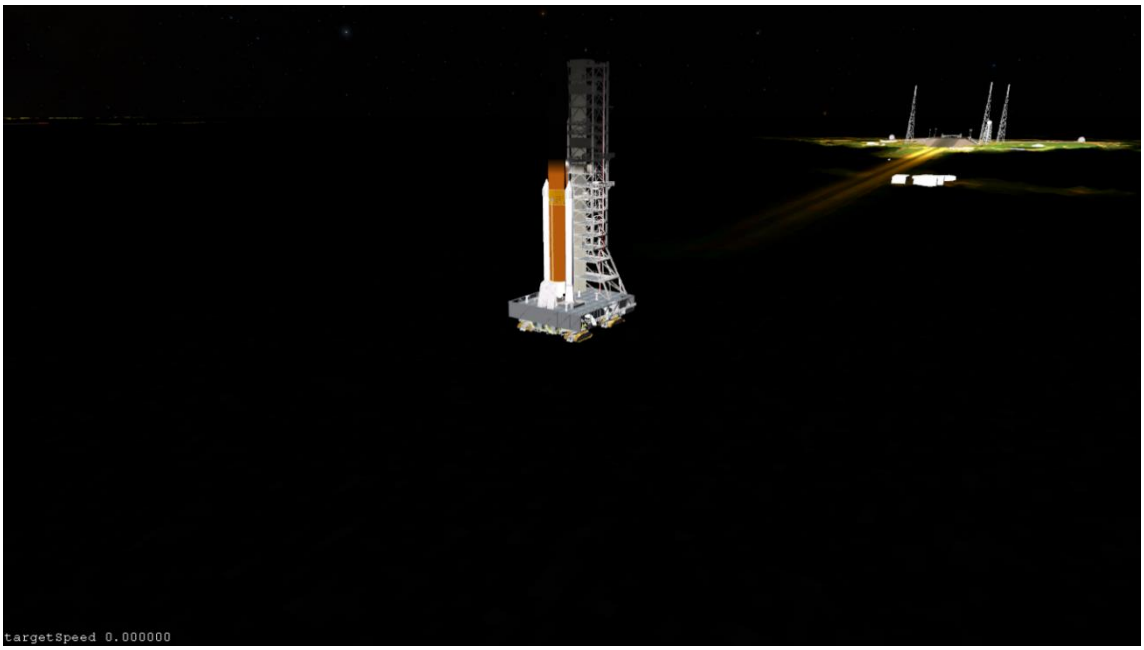
[4] Attach the launch pad to the crawler

[B] Turn on/off the lights

[V] Cycle between front, back and side camera views

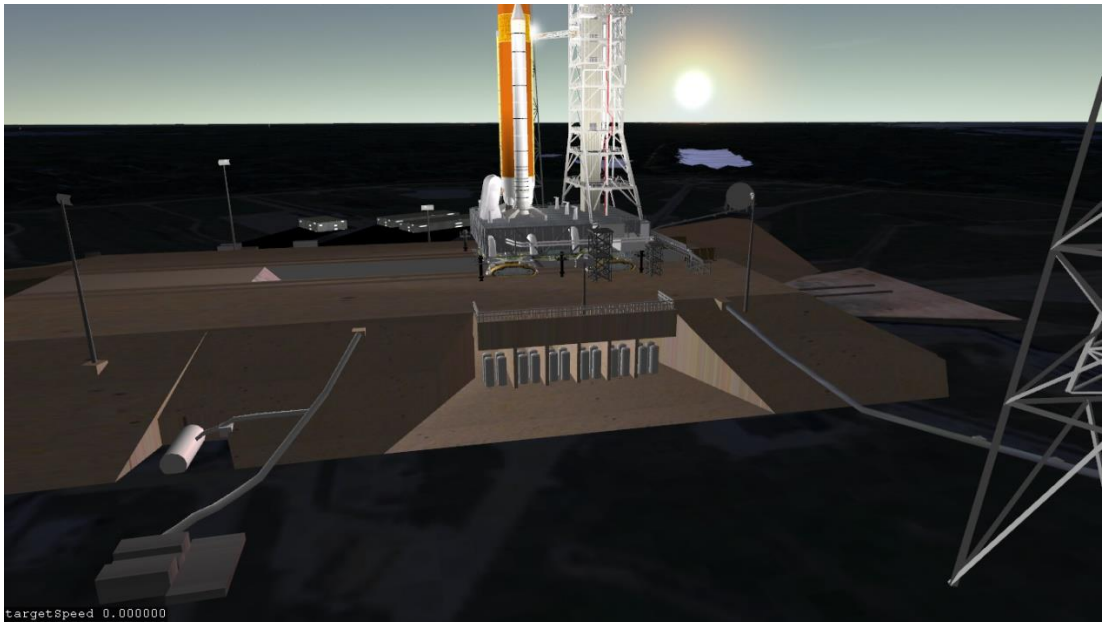
A crawler for transporting the SLS launcher is included in this add-on. The crawler has the ability to be controlled in both the front and back cabin and it can reach a top speed of 2.78 m/s. However, the crawler does not feature animations on caterpillar threads like the one included in the original Multistage 2015 add-on. Also, the crawler lights are not able to illuminate the crawlerway ahead in the dark, which makes it impossible to operate the crawler at night.

The cabin's interior view is much simplified compared to the actual crawler and are not modelled based on the actual crawler's interior.

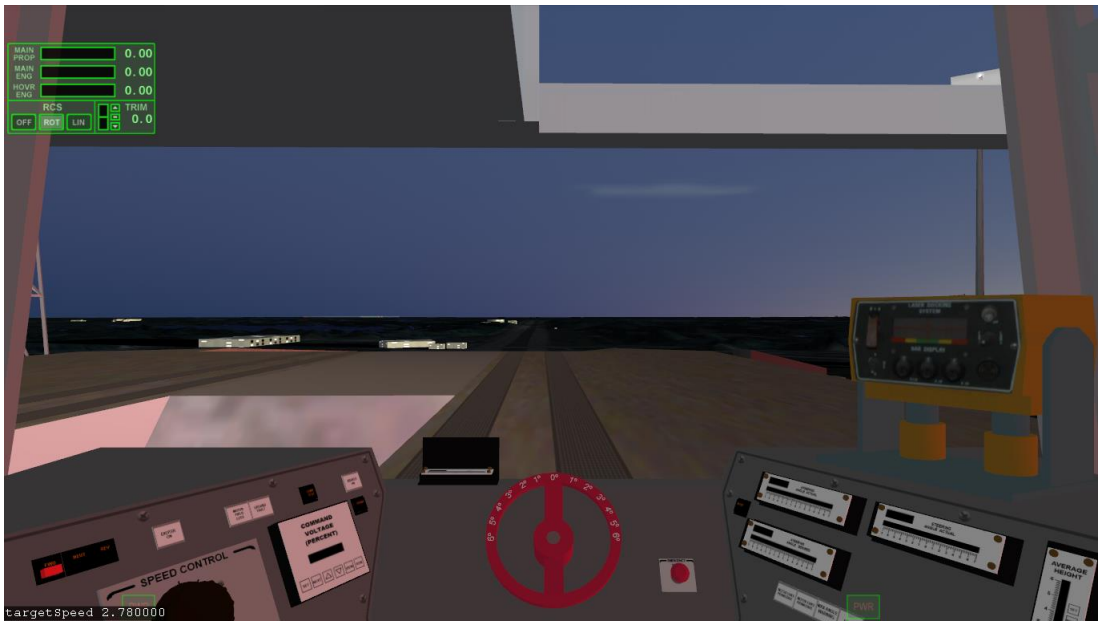


Follow the instructions below on how to control the crawler.

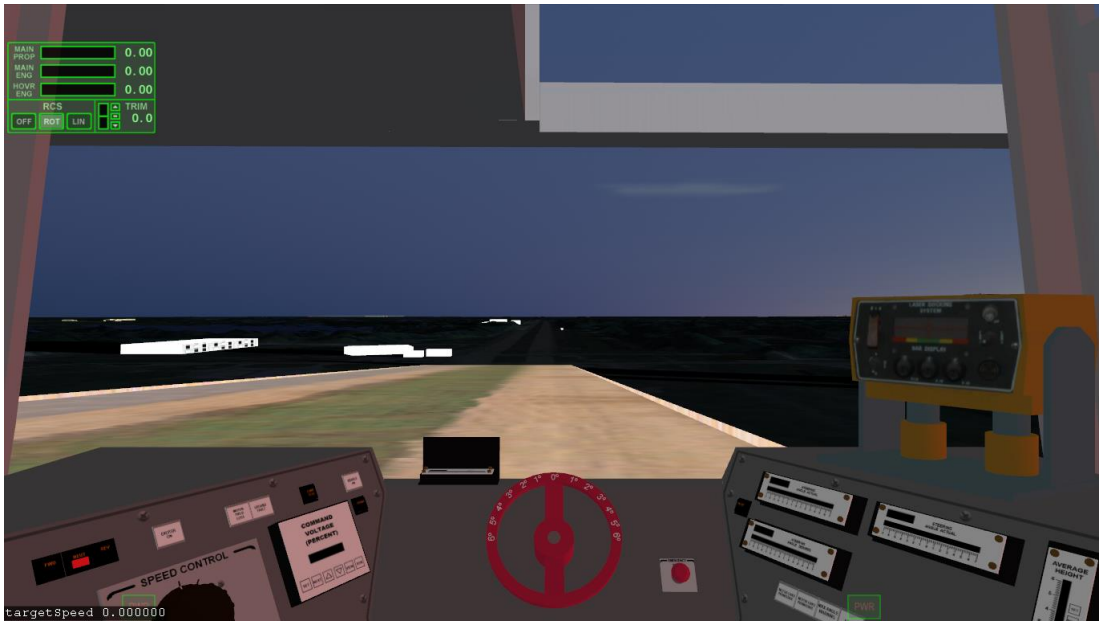
1. To begin with, load the “SLS Block 1B Crew (EM-2) on Crawler” scenario and you should see the crawler with the launch tower stack attached to it. Press “4” to attach the launch pad to the crawler.



2. Press “F1” and jump into the cockpit view of the crawler. Your cockpit view should show you a view facing the crawlerway ahead. Otherwise, press “v” a few times and cycle through the different camera views until you are at the right cockpit view. You are now in neutral gear. To get the crawler move, engage “forward” gear by pressing “8” on your numpad. Then, press “+” on your numpad to increase the target speed as shown on the lower left corner of your screen. The crawler should start rolling forward.



3. Just before reaching the slope that leads you down to the crawlerway, engage “neutral” gear to slow down your crawler i.e. press “4” on numpad. You will see a reduction in target speed as frictional force sets in to oppose your forward motion. Eventually your crawler comes to a stop (target speed reads 0).



4. Now engage reverse gear (press “2” on numpad) and press “+” on numpad to increase target speed. Once again, your crawler is moving but in the opposite direction, i.e. the crawler is reversing.

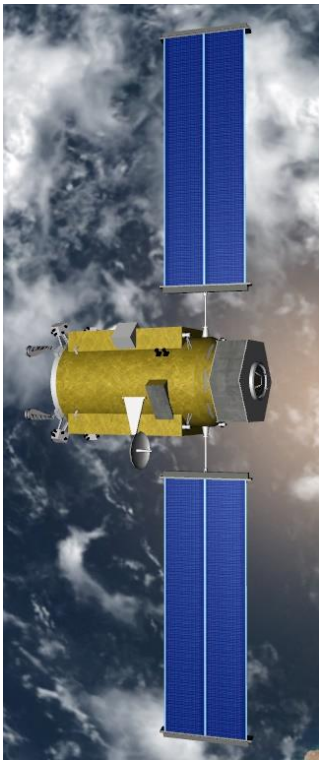
5. Engage neutral gear to stop your crawler's motion. Try experimenting with left and right turn with "1" and "3" on the numpad while the crawler is stationary or in motion. The crawler is able to make a left/right turn with a maximum turn angle of 6 degrees.

6. Try driving the crawler a little further down the crawlerway, at a distance from the launch pad. Now, press "v" to cycle to the next camera view, which puts you in the opposite cabin facing the launch pad. It's time to drive the crawler from this opposite cabin. Engage forward gear, set your desired target speed and off you go, heading back towards the launch pad. While the crawler is in motion, try cycling through the different camera views available (press "v") and explore the Cape from different perspectives.

Lunar Orbital Platform-Gateway

This add-on includes the following modules for the LOP-Gateway:

Power & Propulsion Element (PPE)



[K] Stow / latch solar panel support bar

[1] Deploy / retract solar panels

[3] Open/close the Science airlock

[4] Stow / latch thrusters into position

[5] Select between 1, 2, 3 and 4 engines

The Power and Propulsion Element is slated to enter an NRHO after being launched atop an SLS Block 1B Crew in the early to mid-2020s as part of the EM-2 mission. The PPE will be the first element of the DSG complex. PPE utilizes a ~40 kW Solar Electric Propulsion (SEP) ion engine with the ability to switch between 1, 2 and 4 engines. The PPE's external visualization is based on several NASA artists' concept and images available online while the vessel is configured based on a research paper by a team of astrodynamicists working on trajectory analysis for NASA and other resources online.

The PPE will also feature a science airlock on the hexagonal forward docking port, and 2 communication antennas (one for lunar communication and one for Earth communication).

The latest PPE info (17th August 2017) comes from the draft version of the Level 3 & 4 requirements for the Power and Propulsion Element (PPE) as part of the NextSTEP2 Appendix C (PPE Studies).

Summary for DSG PPE:

Mass (Based on August draft)

Dry Mass	6300 kg	(Including hydrazine, N_2H_4) N_2H_4's mass is TBD as of the August draft, hence, we preclude it from the wet mass calculation and assume that it is part of the dry mass of the PPE.
Wet Mass	1200 kg	We take the minimum value as suggested by the August draft. Tank capacity of PPE is 2000 kg and the remaining 800 kg will be refueled in the future.
Total Launch Mass	7500 kg	Exclude 500 kg limit imposed by NASA management (Actual maximum tonnage is 8 tons.)

Thrust (Calculation by Brian Jones, based on AAS paper)

Based on the research paper above which predicted a 385 m/s dV for insertion into NRHO over the course of 22 days, the acceleration required is

$$a = \frac{385\ m/s}{(22\ x\ 86400)\ s}$$

$$a = 0.0002025\ m/s^2$$

For a 7500 kg vessel, the engine thrust required is

$$T = 7500\ kg \times 0.0002025\ m/s^2$$

$$T = 1.52\ N$$

This is the thrust required by 3 engines (per AAS paper above). Hence, for one engine,

$$T = 1.52\ N \div 3$$

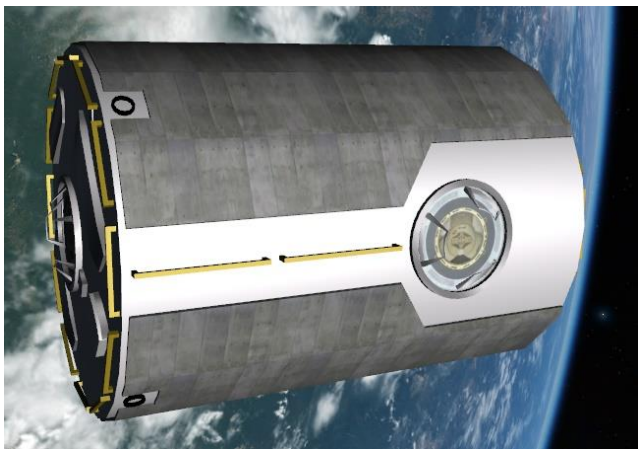
$$T \cong 0.5\ N$$

For maximum thrust, however, we consider the maximum theoretical SEP system available per the AAS paper, which for one thruster string, has the following settings:

Thrust (mN)	589
Inpur power (kW)	13.3
Mass flow rate (mg/s)	22.9
System efficiency (%)	57

The PPE will feature 2 docking ports, a forward one for docking with other LOP-Gateway modules, such as the habitation module and an aft refueling docking port.

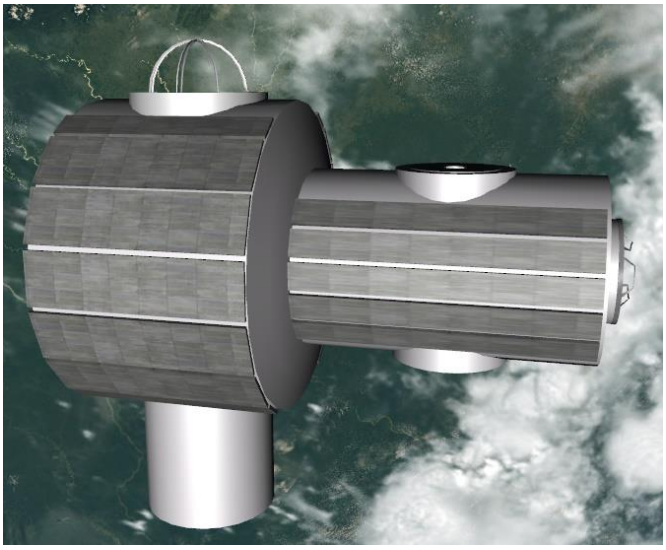
Cislunar Habitation Module



This will be used for long duration habitation on board the space station. It will be sent during EM-3 and will have 4 docking ports. 2 docking ports on the longitudinal axis will joint the habitation module with other modules of the LOP-Gateway while the other 2 docking ports on the 2 sides of the module will be used for docking with either a NASA's Orion spacecraft or a Roscosmos' PTK Federatsiya spacecraft. There will be handrails on the exteriors of the habitation module to facilitate any potential EVAs conducted by orbinauts.

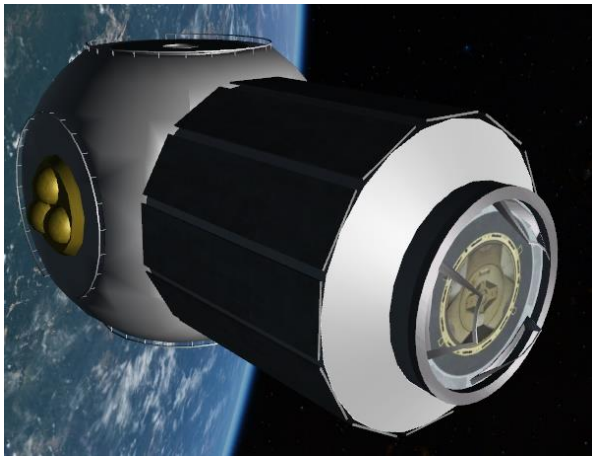
The habitation module does not have any propulsion capability or power source in this add-on. To maneuver this module, one must dock with the PPE or any other spacecraft with orbital maneuvering capabilities.

Gateway Airlock Module (US version)



In this add-on, 2 versions of airlock modules are shown. The US version features 2 docking ports at the longitudinal axis and an airlock. There are also protruding “pillars” on the modules as shown in several NASA artists’ illustrations which we suspect are used for observation purposes.

Russian Airlock Module (Russian version)



The Russian airlock module was proposed back in 2016 by Russian engineers. It would have a docking port for attachment with the other LOP-Gateway modules (in this add-on, we created an additional docking port at the opposite end to the first one), 2 EVA hatches at the spherical end of the module and a *Rodnik* Water Supply System Tank (the 3 yellow spheres surrounded by a yellow ring). Like all other LOP-Gateway modules (except the PPE), there will be no propulsion system in this module.

(Note: The last module, the logistics module, which will feature a robotic arm on it, is currently planned for development, see “Planned Future Development” section below.)

Scenarios & Missions

2 separate scenario folders are available: SLS and LOP-Gateway scenarios. (Mars missions to be added later.)

SLS scenarios

Block 1 (Crew)

This folder includes scenarios for the EM-1 mission. There are 3 scenarios in this folder, one starts with the SLS at the launch pad just 8 hours and 38 minutes from its planned launch time. The other begins with SLS in the VAB, waiting to be transported to the launch pad, 2 days before launch. A third scenario starts with Orion in DRO. For mission sequence and timeline, kindly refer to the EM-1 Mission Flight Notes made by Brian (included in the Doc/SLS & LOP-Gateway folder). Thanks for helping Brian!

Note: EM-1 is supposed to have 13 cubesats launching. However, only 2 cubesats are included in the scenario. Other cubesats will be included in future versions of this add-on.

Block 1B (Crew)

This folder includes a scenario of SLS on the launch pad, SLS in the VAB and a SLS on the launch pad with the crawler. Take not that no EM-2 mission flight plan is included. (It's too hard to find one.)

Block 1B (Cargo)

This folder includes a scenario of SLS on the launch pad and SLS in the VAB. The Cargo version has a large fairing and is uncrewed. No payloads are included in the rockets. One can attach payloads atop the rocket by editing the config file in the Multistage2015 folder.

Block 2 (Cargo)

There are 2 variants of Block 2 Cargo version proposed, one uses advanced liquid boosters and the other uses solid boosters. We include both variants here for simulation purposes. Included scenarios are the Block 2 rockets on the launch pads. No payloads are included in the rockets. One can attach payloads atop the rocket by editing the config file in the Multistage2015 folder.

(Don't be surprised by the black solid boosters! They are first proposed here.)

LOP-Gateway scenarios

LOP-Gateway complex in LEO

This is a fictional scenario with the LOP-Gateway complex in LEO. In reality, the LOP-Gateway would be in orbit around HEO and cislunar space. Possible future orbits for LOP-Gateway include Halo orbits around EML-2, NRHO or even Earth-Moon Cycler Orbits!

LOP-Gateway complex in DRO

Scenario with LOP-Gateway in DRO. DRO is a highly stable orbit and requires minimum dV for station-keeping.

Mission Identifier

EM-1

The Exploration Mission-1 artwork showcases the Space Launch System (SLS) rocket carrying the Orion spacecraft and lifting off from Launch Pad 39B at NASA's Kennedy Space Center in Cape Canaveral, Florida. The triangular shape represents the three main programs that comprise NASA's Deep Space Exploration Systems: Orion, SLS, and Exploration Ground Systems, and is a classic shape for NASA mission emblems dating back to the shuttle era.

Several elements within the design carry symbolic meaning for this historic flight. The silver highlight surrounding this patch gives nod to the silver Orion spacecraft, including the European service module that will be voyaging 40,000 miles past the Moon in deep space. The orange rocket and flames represent the firepower of SLS. The setting is historic Launch Pad 39B, represented by the three lightning towers. The red and blue mission trajectories encompassing the white full Moon proudly emphasizes the hard work, tradition, and dedication of this American led-mission while also embracing NASA's international partnership with ESA (European Space Agency) as both agencies forge a new future in space.

The Exploration Mission-1 emblem was designed in collaboration by the creative team working for the Deep Space Exploration Systems programs, which includes Orion, SLS, and Exploration Ground Systems, located at NASA Headquarters in Washington, Glenn Research Center in Cleveland, Johnson Space Center in Houston, Marshall Space Flight Center in Huntsville, Alabama, and Kennedy. Because the maiden mission of SLS and Orion is uncrewed, the program teams had the rare opportunity to conceive the mission identifier. Exploration Mission-2, which will fly with crew, will have an insignia designed by NASA's Astronaut Office with the help of the crew that will fly aboard the most capable deep space system to take flight.

Known Issues

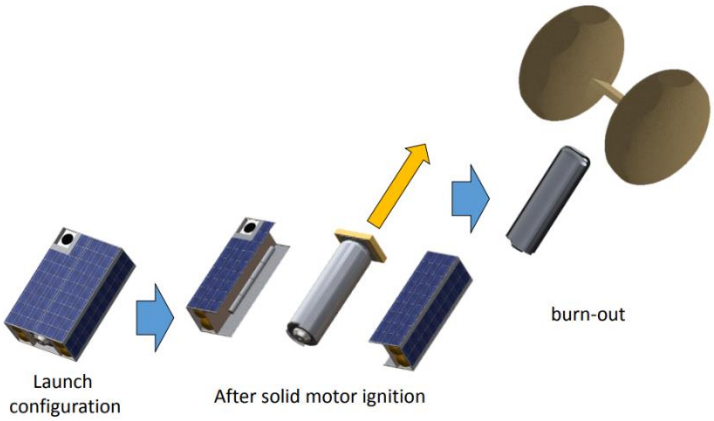
Listed below are several issues that are known to exist and their corresponding solutions.

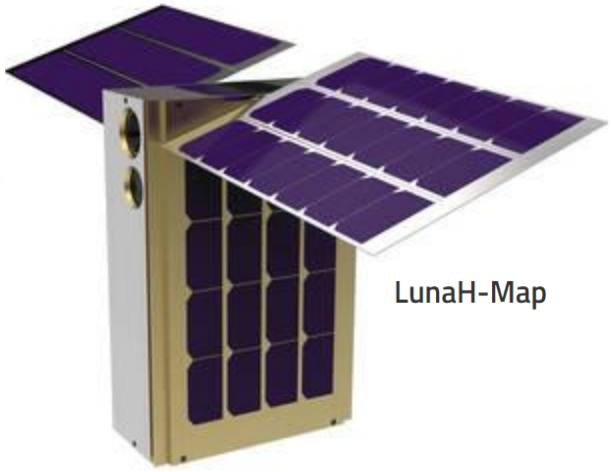
	Issues	Solution(s)
1	The Crawler fails to climb the slope towards the launch pad (LC-39).	This happens in particular when the crawler is positioned directly on the inclined slope when the scenario is started. Relaunch the scenario and if the problem still persists, modify the scenario file to position the crawler on a flat area (not on the slope).
2	The LES is fired straight ahead and remain very close to the SLS beneath it as it charges skywards.	Try jettisoning the LES at other times or disable the “atmospheric wind effects” at the Orbiter Launchpad.
3	Low frame rate	This occurs due to the presence of too many spotlights. One can try turning off Spotlight 1,3,4 and 5, leaving Spotlight 2 and 6 on and enable crawler lights when crawler is near the launch pad. This will illuminate the whole launch pad with just 2 default spotlights. Alternatively, remove Spotlight 1,3,4 and 5 from the scenario file manually before starting the simulation.

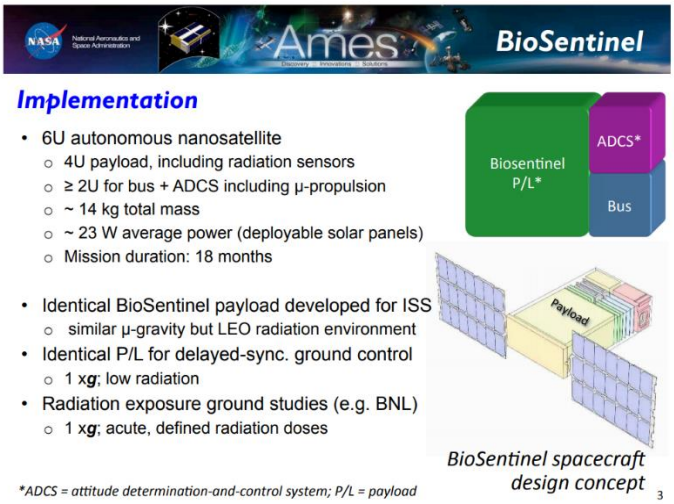
Feel free to contact the team at Orbiter Forum and report your problem there should you encounter any bugs/issues. Thanks for the feedback!

Planned Future Development

OMOTENASHI configuration

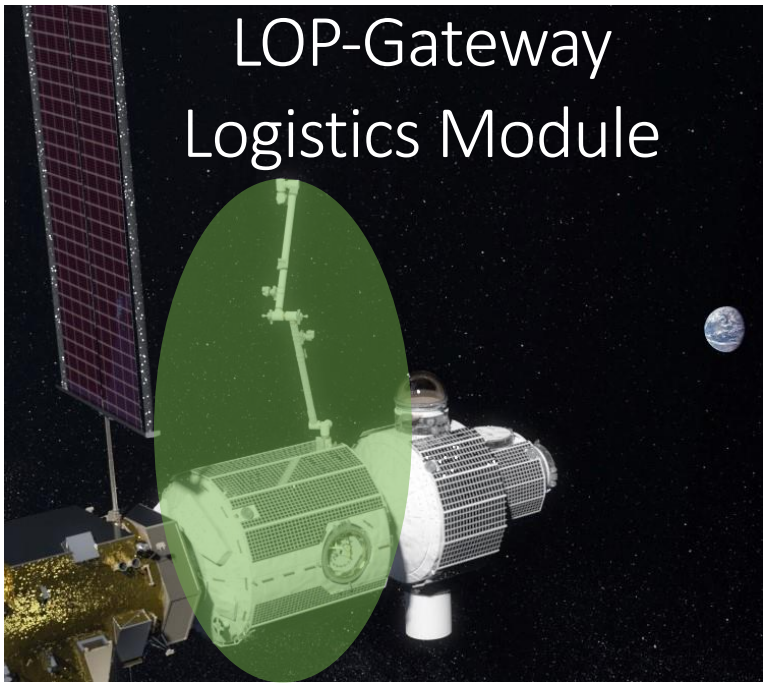






More EM-1 Cubesats!

JAXA's moon lander sounds promising…



Acknowledgement

This complex add-on project would not have been completed without the assistance and involvement of the following individuals and parties:

John Gattis (gattispilot)	Developing all the necessary textures, meshes, configuration files and modules for the LOP-Gateway and the SLS
Brian Jones (BrianJ)	Beta-testing the add-on and designing trajectories for the EMs
Zheng Tien (Nicholas Kang)	Beta-testing the add-on and creating this manual
Franz Barner (francisdrake)	Providing the Orion MPCV spacecraft and support for the LES texture modifications
Dr. David Sundström (DaveS)	Providing support for the Crawler lighting and structural designs
(fred18)	Creating Multistage2015 for which this project heavily relies on
Derk and Friedrich (IronRain and Face)	Providing advice on copyright issues
Dr. Martin Schweiger (martins)	Creating this wonderful spaceflight simulator called Orbiter!

…and add-on developers who created great add-ons like IMFD, LTMFD, Lagrange MFD, users who support our project and OH admins who provide a platform for spaceflight enthusiasts to upload their add-ons.

Thanks for all of your patience and kindness! Happy orbiting!

Nicholas Kang

April 2018

*All errors or omissions remain my sole responsibility