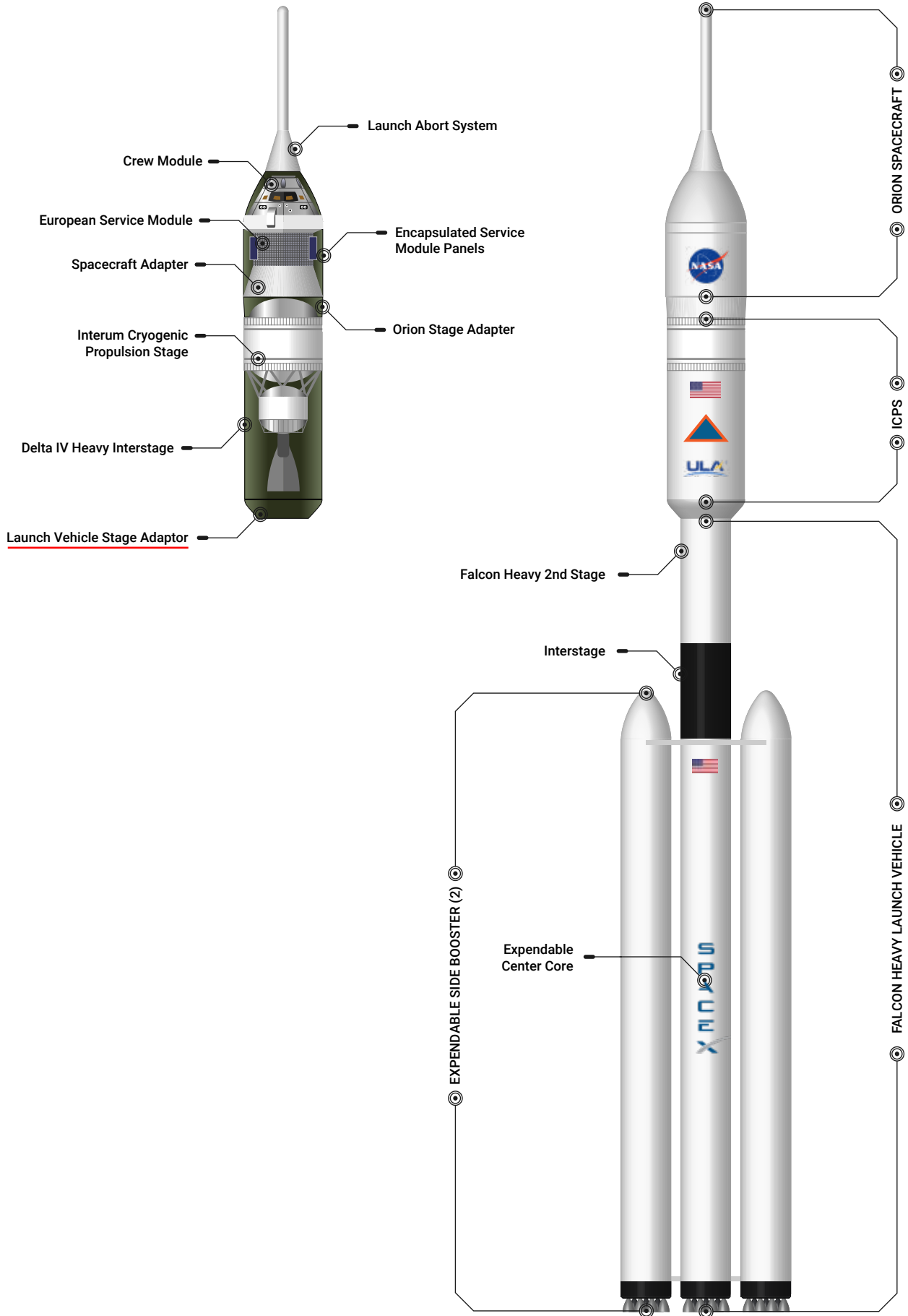
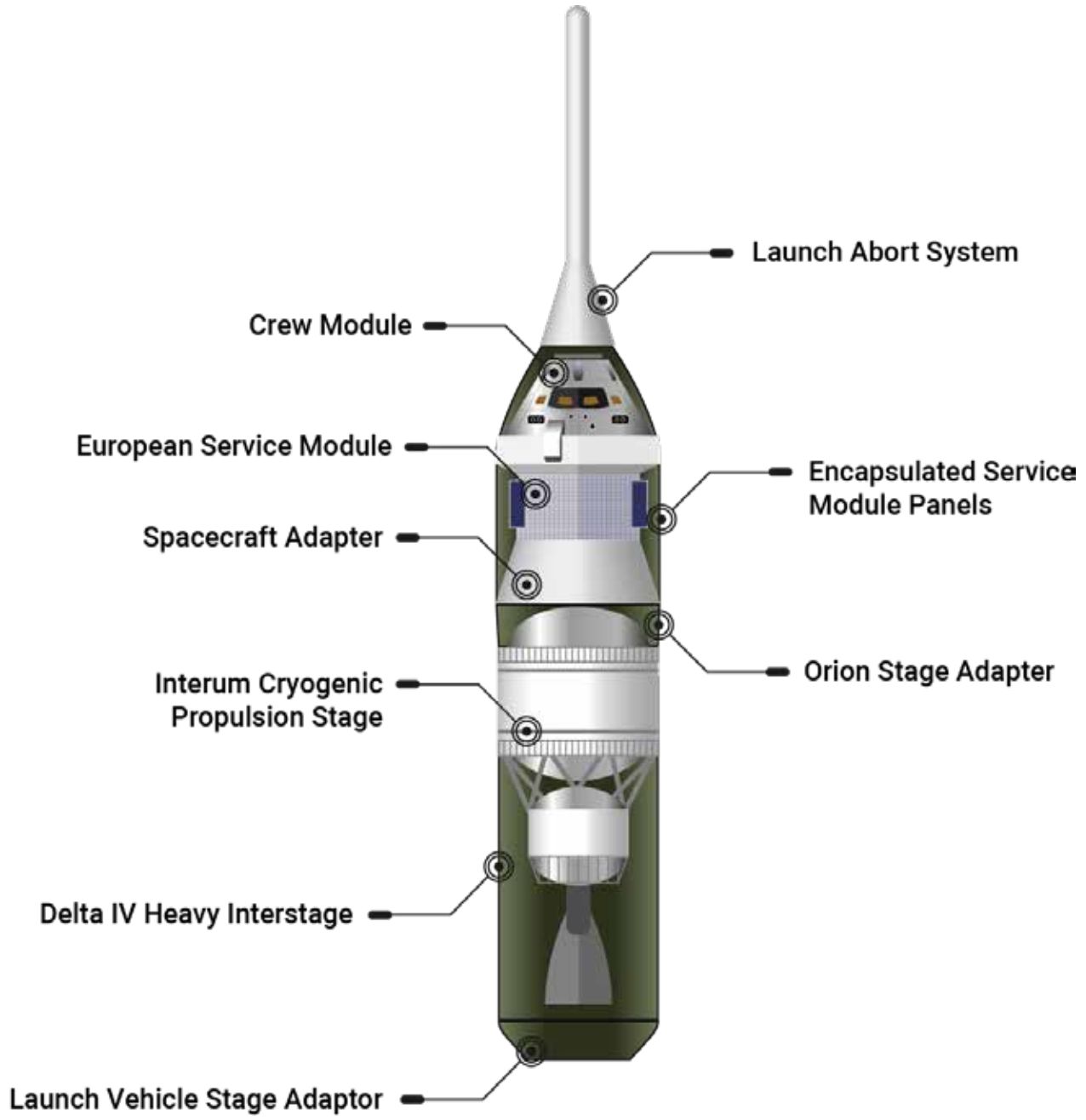


PRIVATE EM-1 PROPOSAL: FALCON HEAVY ORION ICPS



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Private Exploration Mission 1 Proposal

Falcon Heavy Orion ICPS

Proposal Overview

NASA is currently surveying options to fly the EM-1 on privately procured rockets. My unofficial proposal requires only one new component by leveraging flight proven hardware available in the commercial sector today. The rocket proposed consists of a Falcon Heavy Core Section & Second Stage and Delta IV Heavy Interstage, to launch the Interim Cryogenic Propulsion Stage (ICPS) and Orion Crew Module with European Service Module into a highly elliptical Earth orbit (~1800 km Apogee). See attached diagram for details.

Advantages

This proposed vehicle leverages the existing Encapsulated Service Module Panels, Orion Spacecraft Adapter, Orion Stage Adapter and Delta IV Heavy Interstage to mitigate the fairing size constraint which currently prohibits Falcon Heavy from carrying either the ICPS or the Orion Spacecraft while maintaining a similar aerodynamic profile in terms of diameter (5.2 m). All of the above components have been designed for exterior facing flight, replacing the need for a fairing all together. The Delta IV Heavy Interstage is designed protect the ICPS and support heavy payloads, no changes are needed. The Encapsulated Service Module Panels protect the service module during ascent, no change needed. The Orion Stage and Spacecraft adaptor are used in their current configuration to connect the Spacecraft and ICPS as they would during an SLS launch, again, no change needed. The only new element required for this vehicle is the “Launch Vehicle Stage Adapter” (LVSA). More information available in the Launch Vehicle Stage Adapter section.

This vehicle avoids the need to fly the ICPS and Orion Spacecraft on two separate private launches saving money by eliminating several distributed launch mission requirements:

1. Docking Attachment: Mission critical element which has not begun development.
2. Orbital Rendezvous Maneuver

3. ICPS Extended Mission Kit: Needed to enable the independent flight of the ICPS stage before rendezvous with Orion Spacecraft.
4. Two Separate Specialty Adapters: The launch of the Orion Spacecraft and ICPS on two separate rockets not outfitted to carry them would result in the need to develop two independent specialty adapters. One rocket only requires one specialty adaptor be designed, tested, and approved
5. Purchase of Two Vehicles and Missions

This reduction in requirements not only reduces overall cost of the mission but makes the June 2020 launch window more achievable.

Launch Cost Equation Comparison

1. Falcon Heavy Orion ICPS Proposal:
 - a. *Vehicle (FH = \$150M) + LVSA Development & Manufacture + Ground Support Adjustments + Vehicle Configuration Approval + Launch Operations*
2. Hypothetical Distributed Launch:
 - a. *Vehicle 1 + Vehicle 2 + Orion Adapter Development & Manufacture + ICPS Adapter Development & Manufacture + ICPS Docking Attachment Development & Manufacture + ICPS Extended Mission Kit Development & Manufacture + Ground Support Adjustments 1 + Ground Support Adjustments 2 + Vehicle 1 Configuration Approval + Vehicle 1 Configuration Approval + Launch Operations 1 + Launch Operations 2*

Mission Requirements:

1. Complete Mission Analysis: Ensure vehicle is possible to construct and fly.
 - a. Is the vehicle aerodynamically stable.
 - b. Is the weight distribution stable during flight.
2. Design New “Launch Vehicle Stage Adaptor”: This is the single new piece of hardware needed for the proposed vehicle. It connects the Delta IV Heavy Second Stage Interstage to the Falcon Heavy Second Stage.

3. Ground Support Alterations: Changes may be necessary to the SpaceX Strongback at pad LC-39-A to support the Hydrogen fueled ICPS Payload

Launch Vehicle Stage Adapter

The LVSA is the single new component which connects the Delta IV Heavy Second Stage Interstage to the Falcon Heavy Second Stage.

Requirements:

1. Able to support the mass of the ICPS and Orion Spacecraft (56,000kg).
2. Interface with the Falcon Heavy Second Stage.
3. Interface with the Delta IV Heavy Interstage.

Additional Value

NASA would improve U.S. launch and defense capabilities through facilitating the development and a private rocket in the near term with unprecedented capabilities by simply developing one new component (LVSA). The new rocket system would be ideal for deep space science missions such as Europa Clipper, Lunar Landers from the CATALYST program, and LOP-G modules.

Notes

The Falcon Heavy in fully expendable configuration can lift 63,000 kg to LEO. The Orion Spacecraft has a mass of 26,000 kg and ICPS a mass of 30,000 kg giving a combined mass of 56,000 kg. The Falcon Heavy can deliver this payload (in terms of mass) to LEO with margin. However, it would have to be calculated if the Falcon Heavy can lift the 56,000 kg to the elliptical orbit of 1800 km with the desired inclination. Creative mission design (such as having the ICPS adjust inclination) may be necessary to achieve an acceptably similar result so that the EM-1 mission can be successful.