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Super Heavy Lift Launch Vehicles: Global Status and European Perspectives

1. Overview

A Super Heavy Lift Launch Vehicle (SHLLV) can be defined as a rocket with a capacity to Low Earth Orbit (LEO) substantially larger than the existing generation of heavy lift vehicles – above 50t – and whose main purpose is to fulfil human spaceflight missions Beyond Earth Orbit (HSF-BEO).

As of today, three space powers are engaged in the development of a SHLLV.

In the U.S., NASA's Space Launch System (SLS) is at an advanced stage of development, following a block-upgrade approach allowing for cargo and crewed missions. The first version, which is expected to carry out a first launch in 2019, will have a capacity of 70t to LEO, to be further upgraded in several variants ultimately reaching more than 130t to LEO in 2030. In addition to NASA, two U.S. private companies are also developing SHLLVs: SpaceX and Blue Origin. The former is pursuing the development of Falcon Heavy and Big Falcon Rocket (BFR), with respective capacities of 65t and 250t in their expendable versions, while the latter is developing New Glenn, which will be positioned in the lower-end of the super heavy segment with a capacity around 50t. Interestingly, all these private vehicles include partial reusability in their design.

In Russia, plans to develop a SHLLV have been hampered by the country's difficult economic conditions, with priority given to modernising and consolidating the family of launchers in the medium-heavy segment. Yet, latest announcements indicate that the development of a super heavy lift vehicle has been accelerated, with the aim of achieving a first launch in 2028 and first manned lunar landing in 2030.

As for the Chinese SHLLV, the Long March 9 (LM-9 or CZ-9) is currently under study, with a planned capacity of 140t to LEO, a first flight in 2025 and – similarly to the U.S. and Russia – a lunar landing in the 2030s.

2. Objectives

As noted, all institutional SHLLVs have HSF-BEO missions as their primary goal. The SLS in particular has, so far, a consolidated mission schedule of 11 launches between 2019 and 2033 primarily intended to deploy the Deep Space Gateway (DSG) in lunar orbit with modules and crew, and ultimately to achieve a manned interplanetary flight to Martian orbit in 2033. Similar, though less detailed, objectives are contained in Russian and Chinese long-term exploration strategies, with SHLLVs seen in these three space powers as cornerstones of their space policies.

It appears therefore evident that the development of a SHLLV is still inherently interlinked with long-term strategies to re-affirm or establish a country's technological primacy, prestige, and capacity to be autonomously at the forefront of future large-scale space endeavours. In this respect, it is not surprising that, while most current and future space exploration endeavours entail a certain degree of international cooperation, this does not seem to apply to access to space.

Additionally, it is worth noting that the emergence of privately-developed super heavy launchers is leading to a diversification of purposes in this segment, inasmuch they try to offer their very large orbital capacity not only for human spaceflight but also for satellite operators. Remarkably, New Glenn has already signed launch contracts with OneWeb and Eutelsat, while Falcon Heavy with ViaSat as well as the USAF, thereby paving the way for a role of private super heavy launchers in the market of national security and defense missions.

3. Considerations

Europe has taken a policy decision not to develop a SHLLV in the foreseeable future. Given a forecasted launch cadence of less than one per year for the SLS (at a reported cost of over 500 M$ per launch at 2012 estimates), and amid a worldwide multiplication of SHLLVs efforts, concerns around these vehicles abound, ranging from potential global overcapacity to a risk of replicating the experience of Saturn V and the Space Shuttle, which were ultimately shut down due to unsustainable fixed costs.

Whether this will be the case or not also for the new generation of SHLLVs remains to be seen. In any case, without a strong set of long-term objectives with respect to human spaceflight and exploration, as well as lacking robust political and programmatic rationales for such a development, European stakeholders seem to be comfortable in relying on such foreign launch capacity, even for the highly ambitious human spaceflight missions of the post-ISS era.

In long-term scenarios of space exploration, Europe is thus poised not to compete, but rather to cooperate with international partners, most likely the U.S, contributing with its own capacities (such as the Orion European Service Module) albeit not positioning itself – so far – on the highly critical space transportation segment for future global exploration endeavours.

However, the rise of commercial SHLLVs could affect the strict boundary between so-far clearly distinct purposes for this class of vehicles. Indeed, since in the space transportation's market the offer tends to shape the demand, the emergence of two launch service providers on the verge of offering commercial launches at the threshold of 50t to LEO could influence satellite operators to envision larger satellites, or establish different launch strategies to somehow exploit such an outsized capacity. This notwithstanding, it must be noted that since such plentiful capacity to orbit is being established before a strong demand is created, all possible uses are, as of now, highly speculative.

Today, Europe is strongly and successfully positioned in the small-to-heavy segment of space transportation. With most, if not all, applications linked to manned space exploration, no strong case to develop a European SHLLV can be reasonably made with regard to achieving autonomous institutional human spaceflight capabilities. This is likely to perdure, unless unforeseen adverse circumstances in the international cooperation mechanisms arise in the future, or concrete space exploration objectives backed by political support are made in this regard. On the other hand, a future scenario in which manned space exploration services are purchased for European missions from private companies could also be envisioned; one advantage being represented by possible reduced investments and broader cooperation possibilities.

Moreover, on the purely commercial side, the already projected increase in competitive pressure from international launch service providers addressing the small-to-heavy market segment could be reinforced by a perhaps less anticipated competition from commercial SHLLVs on the upper side, as they enter into service.

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