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Committee on Science, Space and Technology

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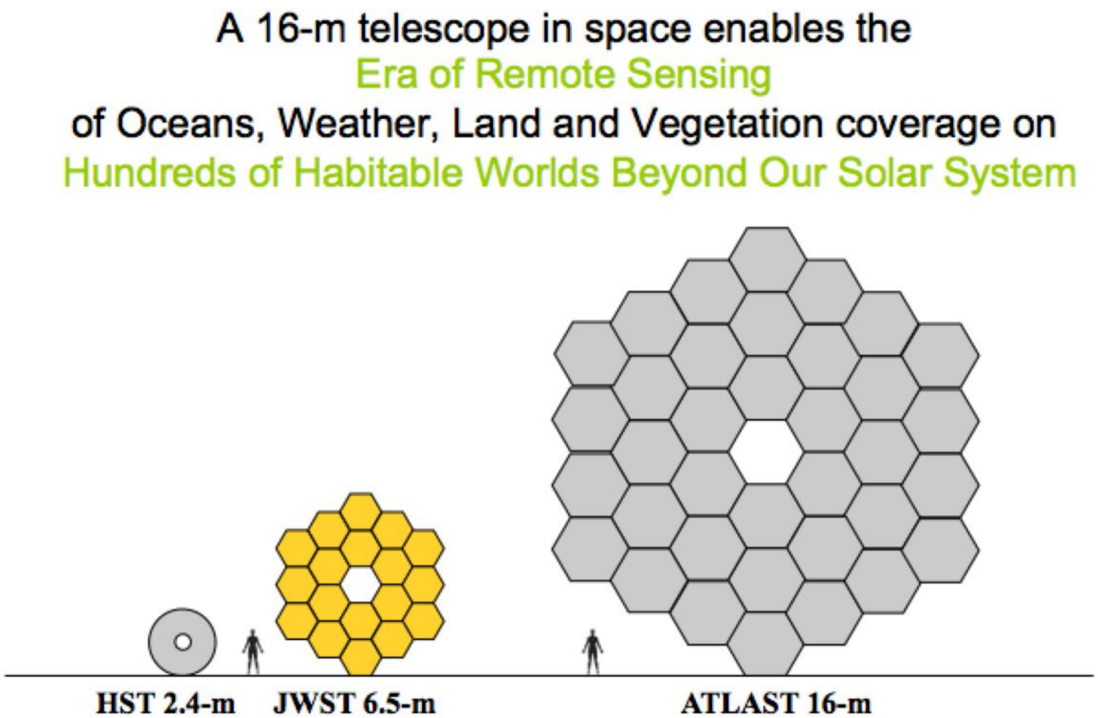
Mr. Chairman and Members of the Subcommittee, thank you for the opportunity to testify about the scientific uses of NASA's Space Launch System or SLS. Since the dawn of the space age, visionaries such as James Webb, the second NASA Administrator (who put the Agency on the path to land men on the Moon), realized space technologies could engage the scientific community and create new scientific capabilities. That partnership between science and NASA led to globally recognized icons of science such as the Hubble Space Telescope, and most recently the Curiosity Mars lander. The SLS has the potential to enable us to cost-effectively build the next generation of ambitious space telescopes and planetary probes. This will allow us to observe amazing phenomena that are well beyond the capabilities of the Hubble or James Webb Space Telescopes or our existing fleet of interplanetary spacecraft.

Imagine being able to answer the question that stirs endless wonder across the millennia: "Are we alone?" The answer is now within reach. Imagine being able to observe weather on a habitable Earth-like planet orbiting a nearby star other than our Sun. Imagine being able to take a detailed picture of a black hole and see the cataclysmic fate of matter as it disappears into oblivion at the event horizon. Imagine returning samples of Martian soil back to Earth in a single mission for detailed analyses, or landing new generation of probes on far more distant bodies such as the icy moons of Jupiter or Saturn. One such ambitious mission could drill through the ice of Europa and see if life may have existed or continues to exist there.

Our imagination can become reality if NASA and the science community can find cost-effective ways to use the Space Launch System. For example, the cost and complexity of some of these missions will be greatly reduced as compared to what it would take to develop missions to fly on smaller less capable launch vehicles. On the other hand, some missions would simply be infeasible without SLS.

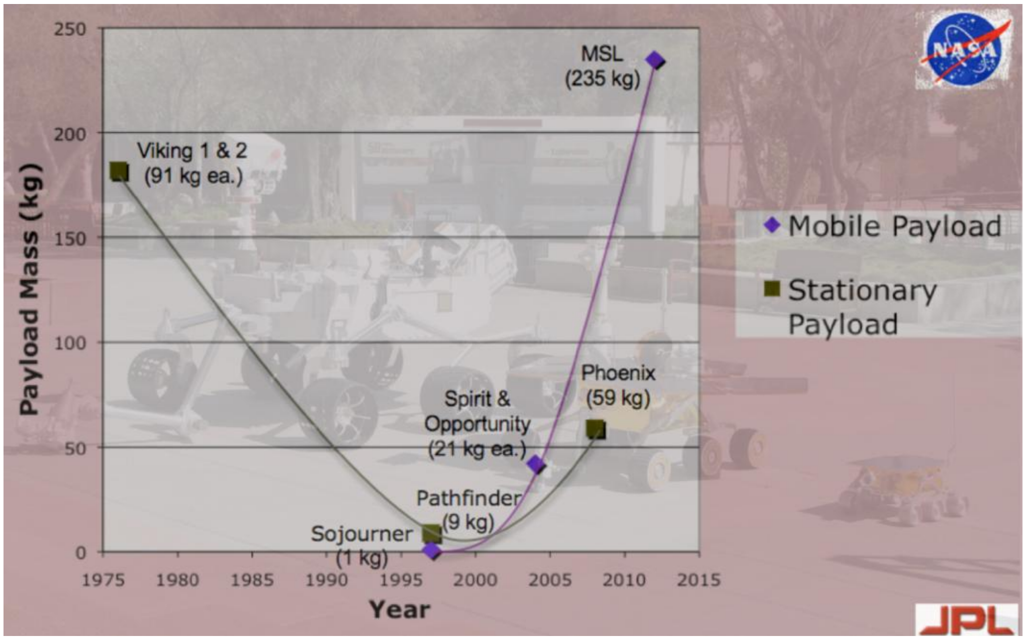
Today's ambitious space science missions have adapted to the limitations of current launch vehicles. For example, the James Webb Space Telescope is designed with many lightweight components so it could be launched with existing rockets – technologies had to be developed that reduced the mass of the JWST by over a factor of 100 compared to a comparable ground-based telescope. To fit within the confines of its launch vehicle's fairing JWST's mirrors and components had to be deployable. While these lightweight deployable components enable the JWST mission and have all been thoroughly tested, they also added complexity and cost to JWST's design.




The SLS has the potential to change the paradigm for ambitious space science missions. For example, the SLS provides the means for building a space telescope three to four times bigger than JWST allowing us to not only directly observe daily changes in weather on planets in other star systems but to search for evidence of biological activity – LIFE – on hundreds of potentially habitable worlds that exist beyond our solar system. Such observations require a telescope that has a primary mirror that is 15 to 25-meters across. The SLS will be able to loft as much as 130 metric ton of payload to low Earth orbit. This means that more conventional materials could be used in the spacecraft and observatory design. Ultra-lightweight components could be replaced with heavier and more rigid structures. This simplifies the design and cost. The SLS would allow us to efficiently bring greatly simplified building blocks of such a telescope to low Earth orbit where it could be assembled and then moved to a more distant orbit where it would conduct these amazing observations. **SLS is a key tool needed to answer the question "Are We Alone?"** by **both** being the transport capability for bringing telescope complements into space and by providing the human and/or robotic infrastructure to assemble such a system in space.

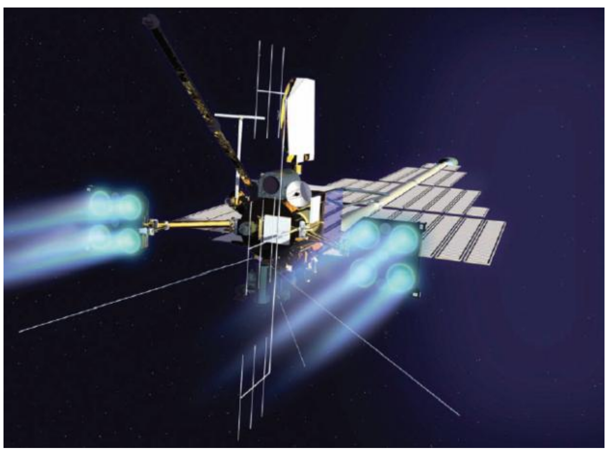
In the recent Planetary Decadal Survey, the top priority was a Mars sample return mission. But to make this complex mission feasible with existing launch technologies it had to be carried out over three separate launches, significantly stretching out this mission's duration and potential cost. The current SLS has the capability to combine all three into a single launch. It isn't just that all three missions can be combined into a single launch, but the individual components can again be simplified. Because of the greater launch mass capability of SLS, more traditional structural materials and approaches can be used, more conventional electronics can be taken into deep space since we can afford the significant additional mass of shielding these delicate electronic components from cosmic rays – all leading to reduced mission risk and potentially reduced cost.

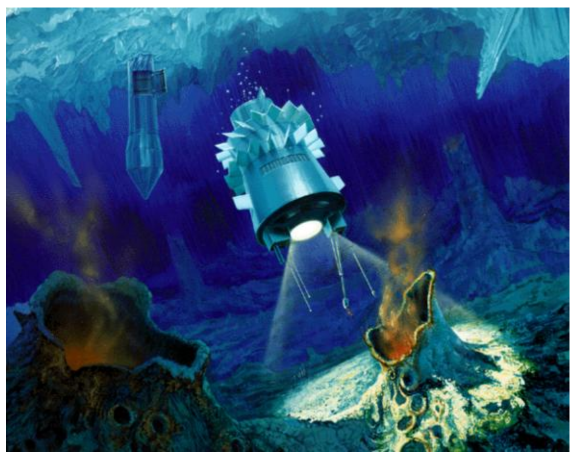
We now know there are many fascinating environments in our own solar system that beg for more detailed exploration. For example Europa, a moon of Jupiter, appears to have a large ocean below its thick outer layer of ice. The SLS once again enables these types of missions in two ways: the large mass launch capacity would allow the design of the sophisticated robotic laboratories required at these exotic locations, but equally important, the increased energy of an SLS may enable direct flights to the outer reaches of the solar system. If a Europa bound mission does not have




The increasing mass (and complexity) of NASA's Mars landers over time. To further increase the capabilities of future landers will either require multiple launches, or launch capability like the SLS.

to rely on gravity assist "sling shots" around other solar system bodies, the travel time to Europa could be reduced from seven years to only four years using SLS, significantly reducing mission risk and overall mission cost.





Two missions could that could be enabled by an affordable Space Launch System, [left] a long duration Jupiter Icy Moons Orbiter spacecraft (courtesy JPL), and [right] a probe to explore the oceans beneath Europa's ice mantle (courtesy APL).

On even grander scales, we can re-kindle the vision of the early space science pioneer Lyman Spitzer who first proposed the Hubble Space Telescope, and envision building a space observatory that has the resolution of a mirror that is a kilometer or just under a mile in diameter! Of course, we wouldn't build it as a single structure but by flying as many as 50 1-meter telescopes that fly in a precise formation that spans a 1-kilometer diameter. Such an array of telescopes would allow us to undertake remote sensing, at a resolution and cadence of today's Earth sensing systems, not of Earth but of other worlds around other stars. This kind of telescope array would normally require tens of launches with conventional launch vehicles and would never be undertaken unless we had the capabilities of the Space Launch System.

So what are the characteristics of an SLS that enable such an exciting scientific future for the US space program?

First, the 70 to 130 metric ton lift capacity to Low Earth Orbit (LEO) means that more conventional materials and components could be used in the spacecraft and observatory design – ultra-lightweight components could be replaced with heavier and more rigid structures, high-cost specialized electronics could be replaced with more commercial like systems. This simplifies the design and, as a consequence, reduces mission risk.

Second, the SLS must be able to launch not just more mass, but the payload fairing must be able to accommodate large volumes so we can simplify telescopes and large missions by reducing all or many of the on-orbit deployments that would be otherwise needed if one only had access to smaller launch vehicles. The next generation of UV-optical space telescopes will benefit from fairing diameters of at least 8-meters, and for some designs, up to 10-meters in diameter. Fairing height is important as well – some space science missions may need up to 25 meters of fairing height.

Third, the increased energy of the SLS launch vehicle also means planetary science payloads can be launched over a wider range of launch windows, in some cases being able to travel directly to solar system bodies, saving transit time, giving more flexibility in launch schedules or providing more regular access to otherwise hard to reach solar system objects.

Finally, to realize its enormous scientific potential, the cost of using the SLS has to be affordable to science.

Throughout history, whether it is Captain Cook's voyage to observe the transit of Venus, or Darwin's passage on the Beagle's voyage of discovery, exploration and science have been partners. Throughout NASA's history, science has thrived and been enabled by the US investments in space exploration, the most spectacular example being the partnership between the Human Space Program and Science that enabled 22 years of unparalleled discoveries with the Hubble Space Telescope. If we want NASA to be greater than the sum of its parts, science can only realistically use a Space Launch System if its availability for research missions is both reasonably frequent (probably at least one per year) and not excessively costly to the science mission providing the payload. There is precedent for the latter in that the cost of the Space Shuttle for missions like the Hubble was not fully borne by NASA's Science Mission Directorate but rather provided as part of NASA's space flight infrastructure for use by the entire Agency. Science, once again, should be viewed as an essential and exciting partner in the exploration endeavor, but science cannot drive the development of a human space flight system.

In closing, the SLS can definitely enable several very ambitious and imaginative scientific missions that only NASA and this nation can do. The results will be truly inspirational, and will irreversibly change our view of ourselves as a species and our place within this vast Universe.

Mr. Chairman, thank you for your support, and that of this Subcommittee. I would be pleased to respond to any questions you or the other Members of the Subcommittee may have.