

Neil deGrasse Tyson

A realistic moon plan

SLS versus commercial

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SPECIAL REPORT  
SPACE

## DARK ENERGY DILEMMA

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target, and what defeat would mean **PAGE 24**



# Wanted: a realistic moon plan

The Trump administration wants to return Americans to the moon, first in orbit, followed by expeditions to the surface. Questions abound about the plan's feasibility. Astronaut and planetary scientist **Tom Jones** offers advice for avoiding a third failed attempt to get Americans back to our celestial neighbor.

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► **Commercially built lunar landers, like Blue Origin's Blue Moon, may take NASA scientific and resource payloads to the moon in the early 2020s. Proven lander designs should help NASA produce a human-rated ship for lunar landings in the late 2020s.**

◄ **The footprints of astronauts Neil Armstrong and Buzz Aldrin are visible in the dust around the United States flag they planted on the moon's surface on July 20, 1969. It remains to be seen whether NASA will have the financial and political support to return Americans to the moon.**

NASA

**I**n announcing the Trump administration's strategy for returning to the moon, Acting NASA Administrator Robert Lightfoot told an audience in Huntsville, Alabama, that the agency would work with contractors to construct a minimalist outpost near the moon to support astronauts on annual visits of increasing duration, while serving as a tech lab and transportation hub for eventual sorties to the surface. My sense is that this outpost may eventually evolve into a 2030s "dockyard" for building a piloted ship headed for Mars.

NASA says it knows how to build this Lunar Orbital Platform-Gateway or LOP-G (Memo to NASA: Find a better name). Assembly in space would begin in 2023 when a Space Launch System rocket lifts off carrying the first Orion spacecraft with a crew aboard. NASA also says it knows what astronauts will do during successive visits: conduct lunar observations, control surface rovers and test exploration equipment. What isn't so clear is how this return-to-the-moon venture will succeed where two previous NASA efforts have failed to launch. I'm not at all certain that the Trump administration has committed to delivering the required funds and political support NASA will need for our return to the moon.

### **Achilles' heel: Funding**

The lunar gateway's purpose will be to enable human explorers to test life support and critical deep



Blue Origin

space systems in the harsher environment beyond low Earth orbit. When Vice President Mike Pence promised in October 2017 “a renewed American presence on the moon,” NASA refocused its planning for this outpost from an orbital way station to a gateway both to the nearby lunar surface and deep space — namely, Mars.

NASA hopes subsequent Trump administration budgets will enable steady expansion of the gateway and periodic crew visits of a month or more. Crews would ride on NASA’s Space Launch System rocket, and supplies would be rocketed to lunar orbit by international partners or, more likely, by firms including SpaceX, Boeing and Blue Origin.

Meanwhile, robots will establish routine access to the moon’s surface, renewing scientific studies, prospecting for resources, and scouting habitat locations. As the moon campaign hits full stride, astronauts would venture to the surface in the late 2020s.

The lunar campaign’s Achilles’ heel will always be miserly funding. NASA predicts it will cost about \$2.7 billion over five years to mount a Lunar Exploration Campaign and see the initial launch of the gateway. Yet the administration’s proposed 2019 NASA budget contains just a slight increase — to \$19.9 billion — followed by another four years of flat spending. To find money for the moon, NASA has been told to shuffle funds away from space and Earth science, and the International Space Station, redirecting them toward the lunar campaign.

That’s a tall order. Congress will likely reject these priority shifts, leaving the lunar program underfunded. NASA may be able to pay for a few test flights of Orion and the Space Launch System, but it won’t be able to afford robotic landers and a human-tended lunar outpost, let alone build a piloted lunar module. NASA’s top line budget must increase, or we will still be looking at the moon from afar as the ISS plunges into the Pacific after 2028, the projected engineering “drop dead” date for the station. Time to write your congressman.

### **Sunsetting ISS**

No feature of the administration’s NASA budget has drawn more controversy than its proposal to terminate government ISS funding by 2025. Shifting station operations to the commercial sector by then could free up \$3 billion annually in subsequent years for lunar exploration.

Setting a firm date for this transition is a gambit to force NASA to start easing ISS toward a private operator, while NASA would remain a research customer for tests of key deep-space technologies, such as a new spacesuit, life support systems, and biomedical countermeasures against radiation and free-fall deconditioning. But the process will be neither simple nor quick.

Congress will not allow a flat-out giveaway of a multibillion-dollar government asset to the private sector. Nor can NASA hand over ISS modules owned by our international partners.

This creates a conundrum. NASA needs ISS to be available beyond 2024 to prove the technologies for inhabiting deep space. But it also needs additional funds for building up lunar operations. The president and Congress must fund critical ISS research even as they direct a growing presence around the moon. The reality is that NASA’s top line budget must increase. A 5 percent boost to about \$21 billion is the minimum investment needed. That’s less than half a percent of the overall federal budget. Want the moon? Pay for it.

### **Don’t lose the moon**

Funding alone won’t guarantee a return to the moon. Here are some additional steps NASA should take:

Don’t low-ball the resources needed. The misfires of the Space Exploration Initiative in the 1990s and the Constellation Program in the 2000s were partially due to unrealistic budgeting — too high in the case of the Space Launch Initiative and too low in the case of Constellation. NASA should tell Congress and the public what it will cost to return to the moon, and if voted those resources, perform within that budget.

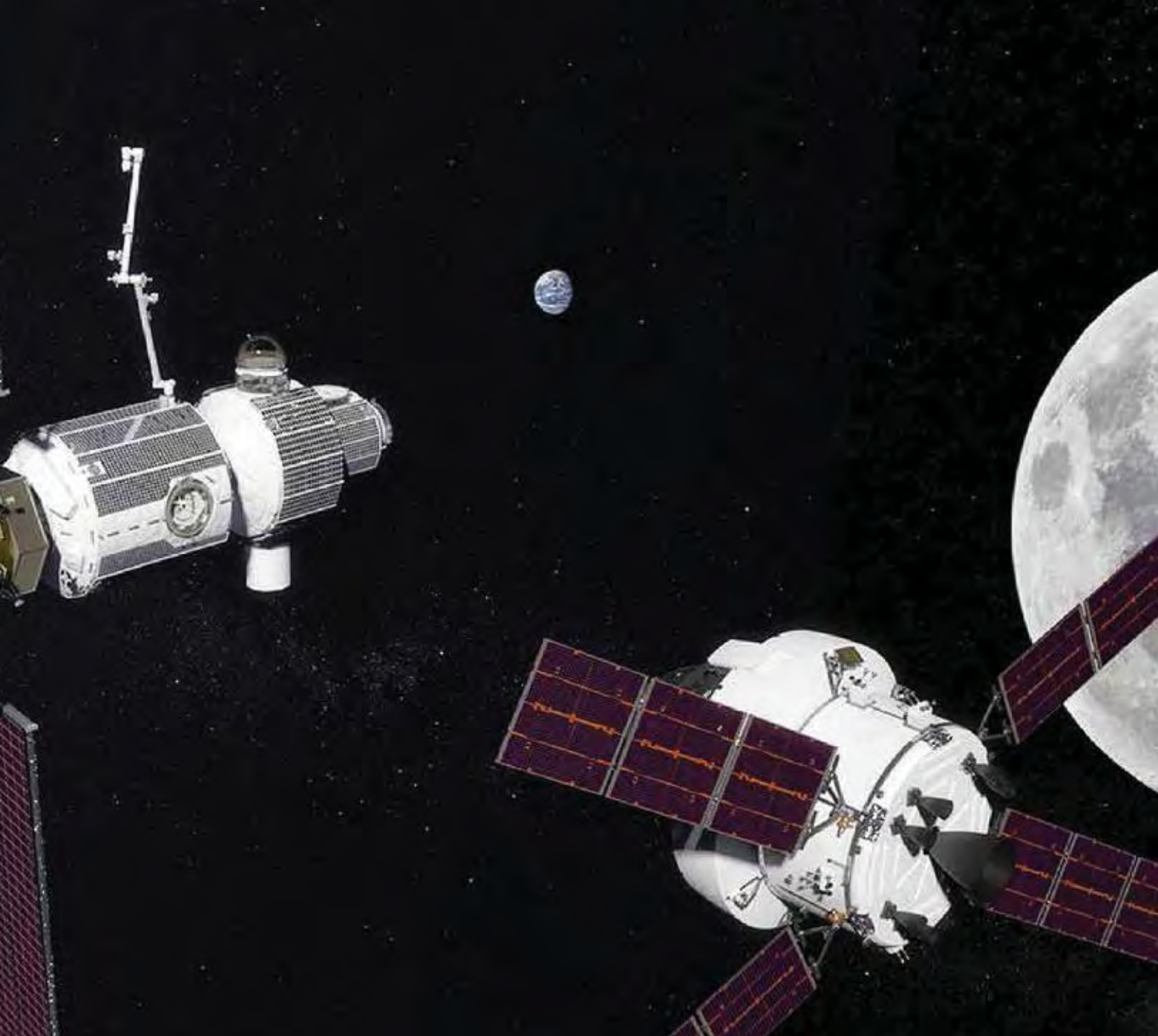
Negotiate with our ISS international partners to collaborate around the moon, but be leery of putting any one partner in the critical path to establishing the lunar gateway. We learned in the ISS program the costs of assigning critical hardware elements to cash-strapped (and an increasingly adversarial) Russia.

Don’t buy a lunar lander the way NASA has always done such things — by hiring contractors to meet detailed and unprecedented specifications. Ask industry to evolve commercial designs, like Blue Origin’s robotic Blue Moon lander, toward a piloted vehicle. Human access to the moon’s surface should be a competition-driven service, rather than an expensive, government-run transport monopoly.

Finally, put human explorers at the center of the moon story. Use the unique skills of astronauts to tackle the deepest scientific mysteries of the moon. Put them to work building and maintaining optical and radio telescopes on the moon’s far side. Follow up robotic discoveries to have astronauts tap the richest water ice deposits on the moon. Assign them to establish pilot plants that turn that ice into rocket propellant, paving the way for a profit-driven resource economy on the moon. Show how astronaut habitats, power supplies, rovers and spacesuits will provide the experience needed to deploy those same systems to Mars.



NASA



▲ This artist's rendering shows NASA's proposed Lunar Orbital Platform-Gateway, which would test hardware for future trips to the moon and Mars.

### A meaningful step toward Mars

For the last 10 years NASA has had the luxury of talking about humans on Mars without doing much to make it a reality. Now, the agency has been told to prove it can reach the moon. To do so, NASA must overcome bureaucratic ossification, congressional indifference, defenders of the status quo, and an ever-shortening national attention span.

But there are reasons for optimism. New commercial space firms can develop innovative spacecraft designs and affordable launch and logistics services. SpaceX's launch of the Falcon Heavy in February is a good example of impressive industry capabilities unavailable to the NASA of the 1990s-2000s. Enlisting the commercial sector to tap

lunar and asteroid resources might be the key to make deep space a realm where humans can stay.

The move toward the moon can happen quickly — politicians and the public might stay interested long enough to let humans again explore a world we've scarcely touched. A decade of experience on and around the moon can give NASA and its partners the technological maturity to reduce the risk of Mars expeditions and lower their costs to acceptable levels.

The moon offers America a chance to show it is still a rising technological power, willing to put its explorers at the cutting edge of scientific, engineering and economic frontiers. Given the national will and adequate resources, NASA and its partners can do the job. The moon is still there — let's go. ★