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DARK ENERGY DILEMMA

Why NASA's planet-hunting astrophysics telescope is an easy budget target, and what defeat would mean PAGE 24

APRIL 2018 | A publication of the American Institute of Aeronautics and Astronautics | aerospaceamerica.aiaa.org

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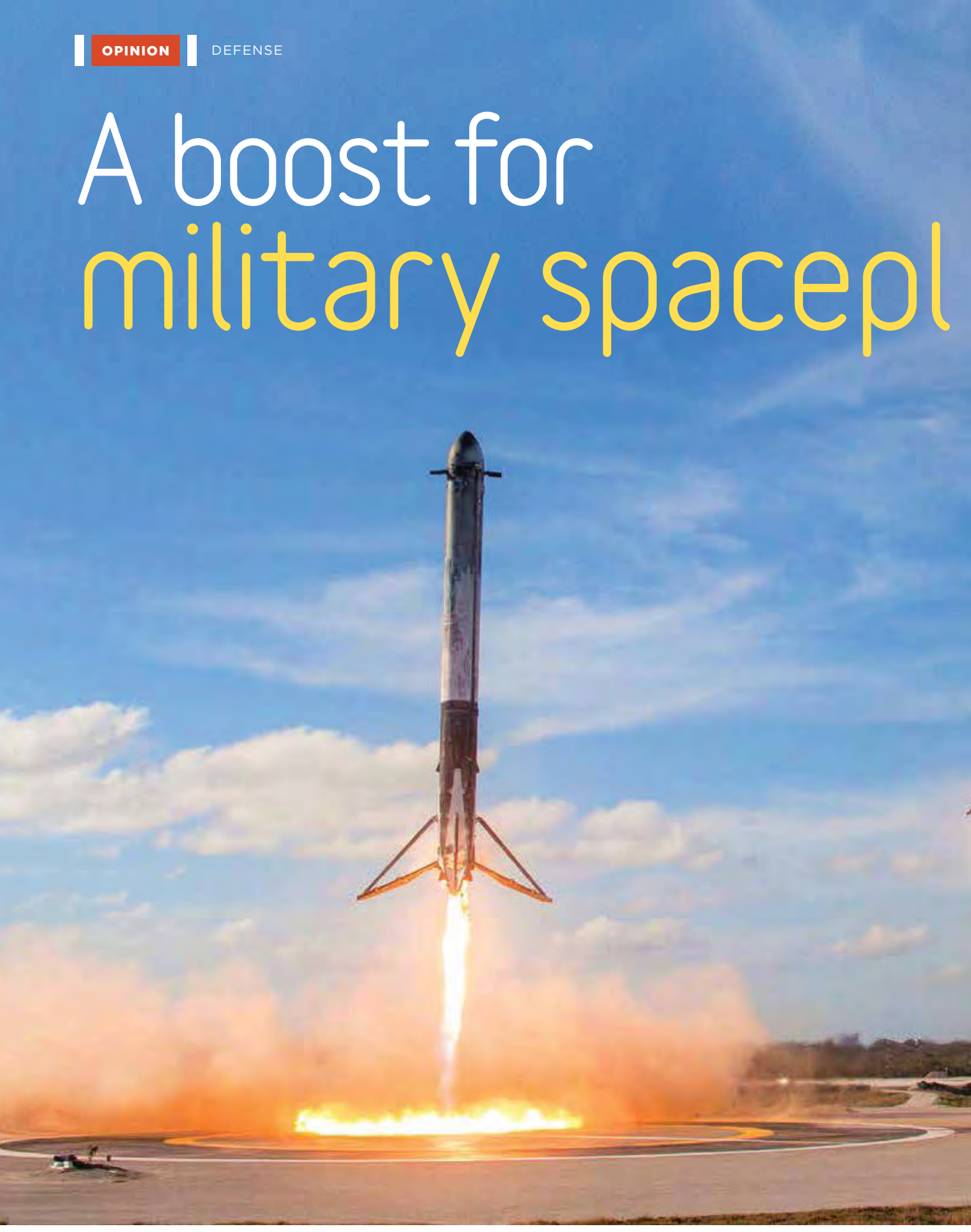
A boost for military spacepl



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SpaceX

The U.S. Air Force has long wanted the ability to project conventional weapons and surveillance equipment anywhere in the world in minutes. Despite spending billions on various concepts, the capability has remained elusive. Military space expert Jess Sponable says its time for the service to take a fresh look at the feasibility of spaceplanes for this role.

BY JESS SPONABLE

◀ Two of a Falcon Heavy's three core boosters land at Cape Canaveral Air Force Station in Florida.

The launch of the SpaceX Falcon Heavy in February and the recovery of two of the massive vehicle's three boost stages should cause a tectonic shift in the U.S. Air Force's thinking about the feasibility of building a small fleet of spaceplanes to project eyes, ears and presence globally.

Here's why.

Based on publicly reported information, the recovered stages had an attractively high propellant mass fraction, a calculation of propellant mass over takeoff gross mass. A higher mass fraction enables larger payloads, and when reusability is introduced, this adds up to the potential for enhanced reliability and much lower launch costs per kilogram.

In short, the SpaceX feat suggests that it is now economically viable to construct and operate a new class of vehicle: Global reach military spaceplanes able reach anywhere in the world in under an hour.

Extrapolating into the future is always risky, but the impressive mass properties and public plans of SpaceX, including the planned Big Falcon Rocket or BFR, provide a highly credible roadmap that the Air Force could follow for its own endeavors with contractors.

Military spaceplanes will likely not need the massive payloads of the Falcon Heavy and BFR, instead far smaller vehicles with one or two stages can operate from distributed bases inside the United States. In lieu of SpaceX's launch on schedule, the military spaceplanes would be launched on demand, be fully reusable, turn around in hours and routinely fly to space or overfly any location on Earth. Depending on the mission, they could be designed to glide high within the Earth's atmosphere or fly on top of it at the edge of space. Short single pass missions would enhance survivability in any threat environment.

In terms of physical size and dry weight, both of which drive cost, military spaceplanes scaled down from SpaceX vehicles would be no larger than commercial aircraft. Indeed, the payload/dry weight ratio, a measure of productivity in the

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▲ The Defense Department and then NASA flew the vertical takeoff and landing Delta Clipper Experimental, or DC-X, in the 1990s.

commercial sector, would be similar to conventional aircraft, suggesting that ultimately costs will be similar as well. Gross weights would be heavier compared to commercial aircraft, but the difference would be largely due to the oxidizer, which only costs about 10 to 15 cents per kilogram and is far cheaper than jet fuel. They would be "spaceplanes" not because they have wings or look like aircraft but rather because they fly with aircraft-like operability, sortie rates, and recurring flight costs.

SpaceX, of course, still flies a small expendable upper stage, and the Falcon 9 and Falcon Heavy are limited by their expendable vehicle origins, but SpaceX's next step, the BFR, aims to be fully reusable. SpaceX is leveraging their design and operational experience to create a future of routine, fully reusable, aircraft-like access to space or any location on Earth. By leveraging the technology and cost efficiency demonstrated by SpaceX and other emerging entrepreneurs, experimental spaceplanes or even operational systems can potentially be developed at a fraction the cost of many current military aircraft.

Spaceplanes are hardly a new concept. Ever since the Army Air Forces became the U.S. Air Force in 1947, the service has envisioned and invested many billions toward creating global reach spaceplanes. For decades Strategic Air Command (SAC) provided the impetus behind high speed aircraft including the X-15, X-24, XB-70, and the development of spaceplane concepts, including the X-20 DynaSoar and the X-30 National Aero-Space Plane, neither of which flew. The NASP program alone spent over $5 billion in today's dollars, no small investment. In addition, weapons experiments like the Boost Glide and Advanced Maneuvering Reentry Vehicles were flown. Then, with the end of the Cold War, SAC was retired, and its assets were reassigned to other major commands. Also retired, unintentionally, was much of the Air Force's strategic thinking about future weapon systems, and any significant investments to continue the service's heritage of advancing high speed technologies.

SAC had thought about how to fight in a world of nuclear superpowers, growing terrorism, religious and political extremism, the proliferation of weapons of mass destruction, multi-polar powers and technology run rampant. Without SAC, leaders of the reorganized Air Force shifted toward investing in the service's traditional technologies: Superior short-range aircraft and bigger, more exquisite satellites. Equally significant, most investment in the Air Force's high-speed future tailed off, with spending instead focused on improving proven technologies and refining existing approaches.

Thankfully, some work on advanced launch and landing technologies persisted. In the early 1990s, the Strategic Defense Initiative Organization flew the vertical takeoff and landing Delta Clipper Experimental, or DC-X, and then transitioned the technology to NASA, which continued the flights. Ultimately, the vertical takeoff and landing vision was picked up by the commercial sector – Blue Origin and SpaceX – rather than by the military. In the late 1990s, researchers from the Air Force and NASA air dropped a very different experimental vehicle, the Boeing-built X-40, which evolved into the X-37 orbit test vehi-

cle, essentially a recoverable satellite. In parallel, NASA continued maturing reusable technologies.

Ultimately America's true geniuses, our entrepreneurs, stepped up to the plate. Elon Musk achieved the first big success by flying back a Falcon 9 stage in December 2015, but Jeff Bezos' Blue Origin is not far behind. Even Boeing is investing with DARPA, under the Experimental Spaceplane XSP program, in their Phantom Express spaceplane. .

With DARPA's aggressive goals of very long-life and a high ops tempo of ten flights in ten days, Boeing is arguably the closest to achieving the aircraft-like operability needed for military spaceplanes. Yet other entrepreneurs are maturing expendable launch vehicles with plans to migrate toward reusable systems in the future, like SpaceX. While entrepreneurs innovated, the Air Force began to rekindle its heritage of advancing technologies: in 2014 the service published its 30 year "call to the future" urging airmen to develop global vigilance, global reach, global power capabilities. This vision supports modernizing conventional crewed and unmanned air systems, but every mission and core competency identified, whether intentional or not, also advocated for the capabilities global reach spaceplanes can provide.

Militarizing space

Speaking to the Air Force Association in February, the Air Force chief of staff, Gen. David Goldfein, reportedly warned, "It is not a question of if but when airmen will be fighting in space." He had it partially right. The real issue is not fighting in space but rather flying through or near space to accomplish a myriad of Air Force missions. Launch on demand for augmenting and reconstituting lost capability will be essential, especially in the coming era of proliferating satellite constellations. Launch on demand also enables single pass reconnaissance anywhere on Earth even if our large, exquisite satellites are lost. Such concepts require only a small squadron of global reach sortie vehicles flying with impunity from the United States. Surge flight rates could be implemented when required. The spaceplane fleet could be akin to the 1990s SR-71 fleet of twelve aircraft, only without the vulnerabilities. Spaceplanes could fly and fight through any attack against our space systems. If the future warrants the development of boost glide vehicles to counter those espoused in Vladimir Putin's state-of-his-nation address in March, the U.S. Air Force's military spaceplanes could be optimized for testing and executing such combat missions. Next generation spaceplanes with their global reach, hypersonic speeds, and relative invulnerability to today's air and space defenses will make them invaluable to the Air Force, from Air Mobility Command to every combatant command.

Our ground, sea, air and space assets project our eyes, ears and presence overseas at a combined cost of over $200 billion annually, all before the first shot is fired. Spaceplanes will not replace these assets but over time they can lead the way to a force mix that also emphasizes rapid temporal response and globe shrinking speeds. These are critical attributes for deterring, and when necessary, waging future conflicts.

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In a world of proliferating terrorism and nuclear weapons the ability to respond near instantaneously may well be the only credible defense. Whether rapidly replacing lost assets in orbit or flying a single pass reconnaissance mission from the central United States, the response time, relative invulnerability and speed of spaceplanes can be key to deterring the escalation of future conflicts.

If history is a guide, it's far from certain that the U.S. military will decide to develop military spaceplanes. Indeed, the U.S. Army failed to keep up with worldwide developments in aviation for over 30 years after the Wright brothers flew. Instead, the technology was matured overseas where the finest military aircraft were made. It took another world war, massive loss of life, and the greatest generation to shake the U.S. out of our complacency. There is synergy between the entrepreneurial and military needs, but the military cannot change without investment.

If the Air Force is serious about its technological heritage, it needs to step up and invest in a series of X-planes and projects that leverage entrepreneurial investments and pave the way to launch on demand global reach capabilities. The investments should not just be about modernizing Air Force Space Command, they should be about dragging the Combat Air Forces into the space age. Like the U.S. Army, the Air Force has chosen not to invest for over a quarter century. A narrow mission oriented "stovepipe" organizational structure, politics and bureaucratic inertia all drove those decisions, but the SpaceX success with reusable boosters suggests it may be time to rethink that decision. One thing for sure, no bucks, no Buck Rogers. ★

Jess Sponable
left DARPA in November where he was program manager for development of the XSP Experimental Spaceplane. He has supported satellite, launch and spaceplane initiatives and technology development since 1987 as a civil servant, in the private sector and as an Air Force officer before retiring as a lieutenant colonel. Sponable was program manager for the DC-X vertical takeoff and landing rocket in the early 1990s.