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X-37B mystery mission; Into space and back again; DARPA looks for aircraft-like operations in space; Beefing up RPAs ....

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BRING IT ON DOWN, NOW

Though the Air Force hasn't been very forthcoming about just what it's been doing with its two X-37B spaceplanes, some details emerged out of the fourth Orbital Test Vehicle mission. It landed at Cape Canaveral, Fla., on May 7, after setting a record of nearly 718 days on orbit. The two-ship fleet of the stub-winged, 29-foot-long robotic craft able to carry small payloads to space and back to Earth again has now accumulated 2,085 days in space.

Program Manager Lt. Col. Ron Fehlen said the mission was "another success." Not only did it "set an on-orbit endurance record," the landing marks the first time the spacecraft recovered at Kennedy Space Center in Florida, he noted. "We are incredibly pleased with the performance of the space vehicle and are excited about the data gathered to support the scientific and space communities," he said.

The landing in Florida signals the Air Force's desire to marry launch and landing activities for the X-37B at a single location. Disused NASA space shuttle facilities at Kennedy Space Center now host activities to prep the X-37B for flight and mount it on Atlas 5 boosters. Landing the spaceplane there saves the time, effort, and money needed to send a detachment of technicians to Vandenberg AFB, Calif.—where the first three missions landed—to safe the craft, remove its payload, and pack the whole thing up to be shipped back to Florida for processing and reuse.

"The ability to land, refurbish, and launch from the same location further enhances the OTV's ability to rapidly integrate and qualify new space technologies," Randy Walden, head of USAF's Rapid Capabilities Office, said in a press release. The RCO manages the X-37 program.

After receiving the order to return to Earth, the craft is capable of executing an autonomous re-entry and landing. A USAF official said capability for landing at Vandenberg will be retained for the time being.

Atypically, the Air Force in 2015 outlined some of what the X-37 would be up to on OTV-4. One of its tasks was to test "electric propulsion," and another was to expose a number of materials to the environment of space for a long period of time to see how they held up. The Air Force has said the thruster is of the Hall Effect type, which accelerates exhaust gas atoms in a magnetic field, and the testing would help refine propulsion on the Advanced Extremely High Frequency (AEHF) communications satellite. The engine was built by Aerojet Rocketdyne.

Such an ion drive would also be useful in sending robotic spacecraft out to and around geosynchronous orbit and would offer the advantage of getting a lot of mileage out of a limited supply of propellant on future satellites. Potentially, future spacecraft could refuel reconnaissance or surveillance satellites that have used up their propellant, saving the considerable cost of replacing them if their sensors and other equipment are still functional. The Hall Effect being tested on the X-37B used xenon gas as its fuel.

The US Air Force's X-37B Orbital Test Vehicle 4 at NASA's Kennedy Space Center Shuttle Landing Facility in Florida on May 7.

The materials experiment harkens back to NASA's Long Duration Exposure Facility, a school bus-sized satellite parked in orbit by the shuttle for six years, then brought back to see the effects of radiation, micrometeoroids, and alternative high heat and deep cold on an array of materials. It was a precursor to building the International Space Station. Presumably, the Air Force is evaluating a new generation of space materials that could be used on future long-duration satellites.

By comparison, OTV-4 was the longest X-37 mission to date. OTV-1, with X-37B No. 1, flew for 224 days in 2010. No. 2 flew OTV-2 for 468 days between 2011 and 2012, and OTV-3, again with spaceplane No. 1, lasted 675 days from 2012 to 2014. The Air Force said it is preparing to launch a fifth OTV mission "later" this year.

COOL STUFF

The X-37B was developed to be able to maneuver in space, but the Air Force tends not to talk about that or about how it might be taking advantage of that capability. According to satellite-tracking hobbyists, on OTV-4, the X-37 adjusted its altitude from a low of 190 miles up to as high as 225 miles, at a 38 degree inclination to the equator. That elevation of orbit would take it over China, Iran, Afghanistan, and Iraq, among other places. The payloads on previous X-37B missions are believed to have evaluated some new sensors for reconnaissance spacecraft, but the Air Force will not comment on those missions.

In 2015, shortly before the OTV-4 mission began, Air Force Gen. John E. Hyten—now head of US Strategic Command, but then head of Air Force Space Command—told the CBS TV magazine "60 Minutes" the X-37 is "for cool things."

The minishuttle "goes up to space, but unlike other satellites, it actually comes back. Anything that we put in the payload bay that we take up to space we can now bring back. And we can learn from that." Asked if the X-37 would someday become a space weapon system, Hyten replied, "I cannot answer that question."

Photo: United Launch Alliance via DOD

The Air Force has not said how many trips to space it expects to get out of each X-37, but Hyten's predecessor at AFSPC, Gen. William L. Shelton, told *Air Force Magazine* in 2011 that no more of the craft were planned, and at that time, the Air Force was struggling to afford operating the vehicles and was considering terminating the project.

Boeing, builder of the X-37Bs for the Air Force, declined to comment when asked if it was developing a larger version for the service, as it publicly proposed in 2011. The scaled-up, 48-foot craft it pitched, dubbed X-37C, could be man-rated and serve as a space taxi for taking astronauts to and from the International Space Station or simply carry larger military payloads to and from orbit.

"AIRCRAFT-LIKE" OPERATIONS

The Defense Advanced Research Projects Agency is working on an experimental spaceplane dubbed XS-1, with the goal of reducing both the time required to get to space and the cost of doing so, each by "orders of magnitude," versus traditional launch vehicles, DARPA documents show.

The program has three goals: to fly an XS-1 10 times in 10 days; to loft a 3,000-pound payload for under $5 million per flight; and fly a demonstration system one time, orbiting a 900-pound payload. Program objectives—the high-end, hoped-for performance—are to get the craft into a 100 nautical mile circular orbit with a 1,500-pound payload at 90 degrees inclination to the equator. Another objective, according to DARPA, is to "fly XS-1 to Mach 10+ at least once and stage at high Mach to minimize the size and cost of the upper stage." Overall, DARPA is looking to achieve an "aircraft-like" operations tempo and cost in space access.

Three industrial teams have been working on the project: Boeing, partnered with Blue Origin; Masten Space Systems with XCOR Aerospace; and Northrop Grumman with Virgin Galactic. Northrop's Scaled Composites subsidiary designed the SpaceShipOne, winner of the Ansari XPrize in 2004 as the first to launch a private manned spacecraft to space. Virgin Galactic's tourist/commercial SpaceShipTwo is based on that design. Blue Origin is a new-entrant rocket company founded by Amazon magnate Jeff Bezos. It won a NASA contract last year to experiment with suborbital research flights. Masten Space Systems won the Google Lunar XPrize competition in 2009 to design a commercial lunar lander.

Phase II of DARPA's XS-1 spaceplane program—in which it will select a single competitor to proceed to the flying stage—is open to all comers, however.

The XS-1 will require breakthroughs in metals, composites, and "hybrid" materials, although DARPA documents indicate most of the required technologies are at Technology Readiness Levels of five or higher, meaning the technologies have worked in a lab and are ready for functional prototyping. (See "Infographic: TRLs, Explained," August 2016, p. 22.)

In mid-May, DARPA said it expected to award a contract to one company or team for Phase II "soon." According to plans on its website, a critical design review is expected in early Fiscal 2018, and a flight test should come in late 2019.

CAF-UP THE REAL NUMBERS

The Air Force has in recent years talked about having 55 fighter squadrons—the fewest in its history—but that number doesn't count its sizable remotely piloted aircraft fleet. That will soon change, but exactly how hasn't been decided.

"One of the things on my to-do list" is to figure out how RPAs should be brought "into the discussion" of the Air Force's overall strike capability, newly minted chief of Air Combat Command (ACC), Gen. James M. Holmes, said in an April interview with *Air Force Magazine.*

The figure of 55 squadrons belies the fact that the Air Force has "60 lines" of RPAs in the Combat Air Forces, Holmes said. A line represents a combat air patrol, translating to about four aircraft each, for a total of about 240 to 250 MQ-9 Reapers. The Reaper's predecessor, the MQ-1 Predator, is being phased out and will exit the inventory by the end of next year.

"We renamed our MQ-9 squadrons 'attack squadrons' for a reason: They're attack squadrons," Holmes explained. An important part of thinking about the RPAs that way is that it forces ACC to consider "how you're going to replace them and what you're going to do with them."

Holmes said he can't "stop buying MQ-9s just because I've bought out what I need." To sustain a fleet of about 250 Reapers, he'll have to buy about 20 more per year to offset attrition losses. "I have to replenish them," Holmes said, until the time comes to switch to an "MQ-X" or "whatever comes next." The timing of such a program hasn't been decided yet.

It's a sure bet the Air Force will continue to upgrade the Reaper and experiment with using it in higher-end combat scenarios, Holmes predicted. The turboprop-powered aircraft has recently participated in a Red Flag exercise, but he cautioned that the event didn't signal the start of an "experimentation campaign" with the aircraft in a contested environment to "find out what it can do." Part of the problem in exploring the full capabilities of the Reaper, he said, is that every RPA and operating crew USAF has is needed for training or contingencies now underway.

The Air Force has begun upgrading the MQ-9 with longer wings and tail control surfaces, additional weapon stations, and external fuel tanks. The improvements extend the aircraft's time on station and have the effect of adding more aircraft to the fleet at a much smaller cost than buying additional airplanes.

Holmes acknowledged that ACC is looking at using the Reaper in ways it hasn't been used before and that a follow-on would probably have to be a more survivable platform. The time will come soon, Holmes said, when "we have to be looking at a replacement platform." But he is "not ready to do that, yet."

Just as he needs 20 RPAs a year to maintain the fleet, Holmes said he'll also have to buy 150 fighters a year to keep the fighter fleet at a reasonable average age—an ambitious goal that may not be in the cards. At only 100 fighters a year—still more than twice the Air Force's 2017 F-35 buy—"I'd be on a 20-year recapitalization schedule," Holmes said, adding, "I've been on more like a 50-year recapitalization schedule."