FACT SHEET
Global Strike and the Falcon Program

Updated June 9, 2009 **www.SecureWorldFoundation.com**

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Background

General Curtis LeMay. **Photo: USAF.**

Once it became clear that aeronautical engineers could produce aircraft capable of striking targets a great distance from home base, the United States Air Force (USAF) developed a keen interest in establishing an efficient and effective method of reaching targets anywhere on Earth within a relatively short period of time. United States Army Air Forces General Curtis LeMay, commander of all strategic bombing in the Pacific during the latter part of World War II, was the first to develop a doctrine for strategic bombing, using his war-time experiences with the B-29 bomber as a basis. Upon establishment of the USAF in September 1947, LeMay was given command of the new Strategic Air Command (1946-1992), where he put his ideas to practice.[1] During his command, the Cold War was born. One arena in which the Cold War would be fought was what the USAF would later call the "aerospace" domain.[2] The USAF has since explored a variety of methods to extend its reach in a responsive and precise way through air and space.

In terms of using space as a medium to support its terrestrial operations, the USAF has employed expendable launch vehicles like the Atlas, Delta and Titan to send satellites into orbit, mostly for reconnaissance and intelligence gathering. It has also pursued several programs focusing on single-stage to orbit (SSTO) and two-stage to orbit (TSTO) vehicle systems in which all or part of system operated in space and included a reusable component capable of being piloted through the atmosphere during ascent, descent, or both. Several programs started in the late 1950s to focus on these technologies. Perhaps the best known was the X-20 Dyna-Soar, a TSTO spaceplane piloted by a single occupant for reconnaissance missions that would have been launched by a Titan 3 vehicle. With the concurrent and highly successful fielding of less-expensive spy satellites, however, it became clear Dyna-Soar was obsolete. The TSTO spaceplane concept has continued to be explored, however. Building on research from programs like the air-dropped hypersonic X-15 during the 1960s, the United States initiated the Space Transportation System (STS) in 1972, a partially reusable launch system commonly called the Space Shuttle. The program is expected to end in 2010 after a total of 131 successful flights.

An mock-up of the X-20 Dyna-Soar, date unknown. **Photo: USAF.**

An artist's concept of what NASP might have looked like during routine commercial operations. **Photo: Boeing.**

Reusable SSTOs are considered by many to be the "Holy Grail" of space access, and remains a major technological challenge. The first significant program dealing with this approach was the USAF's SCIENCE DAWN, a horizontal take-off/horizontal landing (HTHL) system researched in 1982. Following its cancellation was SCIENCE REALM in 1986, then HAVE REGION, which built upon light-weight material technologies from the 1970s. During this time, a program called COPPER CANYON was also being pursued by the Defense Advanced Research Program Agency (DARPA). In 1986, President Ronald Reagan announced: "...a new *Orient Express* that could, by the end of the next decade, take off from Dulles Airport, accelerate up to 25 times the speed of sound, attaining low earth orbit or flying to Tokyo within two hours." In 1986, the National Aero-Space Plane (NASP) was born, effectively replacing COPPER CANYON program but including DARPA, USAF, Boeing, the National Aeronautics and Space Administration (NASA), the Navy and the Strategic Defense Initiative Office (SDIO). NASP was redesignated the X-30 in 1990 with the program falling under the management of Rockwell International, but was cancelled in 1993 due to budget concerns.

While NASA started to explore follow-on options for the aging Space Shuttle (such as Lockheed Martin's X-33 *VentureStar* and McDonnell Douglas' DC-X, among others), the USAF remained interested in SSTO and TSTO concepts but did not pursue them in earnest until it teamed up with DARPA on the FALCON (Force Application and Launch from Continental United States) program in 2003. By that time, the concept of global reach and global strike as articulated generally by the Department of Defense (DoD) but specifically by the USAF had become quite sophisticated following advances in control, communications, computers, intelligence, surveillance and reconnaissance (C^4ISR).

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Falcon

Falcon, formerly FALCON, or Force Application and Launch from Continental United States, is a joint program between DARPA and the Air Force. The offensive element of FALCON was removed in 2004 due to Congressional concerns about fielding space weapons. Falcon represents the latest iteration in the DoD's efforts to maximize its global reach and prompt global strike capability, and effectively combined the USAF's common aero vehicle (CAV) work and DARPA's *Hypersoar* project.[3] The program is focused on two complimentary missions related to responsive space operations (RSO). One mission focuses on small launch vehicles (SLVs) utilizing proven technologies and processes. The second mission, focused on hypersonic capabilities, is intended to demonstrate high lift-to-drag aerodynamics, high-temperature materials, thermal protection systems, and advanced guidance, navigation, and control technologies . Combined, these missions should serve as a foundation from which to produce an operationally responsive reusable Hypersonic Cruise Vehicle (HCV) capable of delivering 5,443 kilograms (12,000 pounds) of payload to a distance of 14,484 kilometers (9,000 miles) from the continental United States in less than two hours.[4,5] In 2008, the USAF plans to spend $33 million on the Falcon program, and DARPA $50 million during the same year on hypersonic research.[6] The Falcon Program is composed of three phases.

Phase One—System Definition (TASK 1—Small Launch Vehicles and TASK 2—Hypersonic Weapon Systems)

During Task 1, contractors developed conceptual designs, performance predictions, cost objectives, and development and demonstration plans for a responsive SLV. The anticipated SLV will provide a low-cost, responsive launch capability capable of placing a small payload weighing about 454 kilograms (1,000 pounds) into low Earth orbit at a total launch cost of less than $5 million (excluding payload and payload integration costs).[5] The small, rapid nature of the planned SLV will provide operational experience necessary for RSO, as well as provide a "stop-gap" measure for launching DoD payloads into space promptly. The USAF spent about $35.4 million on RSO in 2007, and plans to spend $87 million in 2008.[6] During Task 2, contractors developed conceptual designs, concepts of operations and identified critical technologies for the HWS portion of the program, which ultimately led to three hypersonic technology vehicle (HTV) demonstrators.

Phase Two—Design and Development (TASK 1—SLV flights and TASK 2—HTV-1 and HTV-2 flights)

For Task 1, the objective was to demonstrate and flight-test an SLV. Space Exploration Technologies (SpaceX), selected to perform responsive launch demonstrations, continues to work on its Falcon 1 SLV following two failures in 2006 and 2007. The launch price for Falcon is $6 million. AirLaunch LLC was also selected to develop an SLV and is currently building on its successful air drop and propulsion tests.[8] Lockheed Martin, meanwhile, tested its hybrid engine concept. These engine tests ultimately led to the FaCET Program (Falcon Combined-cycle Engine Technology), which began receiving funding in 2006. FaCET involves a high-Mach turbine engine and supersonic-combustion ramjet (scramjet) for a combined-cycle powerplant enabling the HCV to take off from a runway and accelerate to a hypersonic cruise.[7]

Task 2 focuses on a flight-test of HCV demonstration systems. Lockheed Martin has been prime contractor for the development of HCV technologies since 2004. Two expendable, unpowered HTV-2 vehicles are being developed under this task (the HTV-1 has since been cancelled). The HTV-2 will use a multi-piece aeroshell with sharper, thinner leading edges that will be easier to fabricate and assemble. Two flight tests are planned, and involve launching both HTV-2s aboard separate Minotaur launch vehicles from Vandenberg Air Force Base beginning in 2009.[5] Reports that a third HTV-2 flight test will include a weapon are false.[8] The first HTV-2 vehicle will glide at Mach 20 over the 7,725-kilometer (4,800-mile) distance between California and Kwajalein Atoll in the Marshall Islands, home to the Ronald Reagan Ballistic Missile Defense Test Site. The second flight, in June 2009-2010, will be a more circuitous course, with the craft attempting a sharper angle of attack while performing pitch and yaw maneuvers.[7]

An artist's impression of what might follow the Blackswift Test Bed by 2025. **Photo: Paul DiMare.**

Phase Three—HTV-3 and Blackswift Test Bed

Progress on FaCET has since made original plans for an HTV-3 unnecessary, and plans were to move directly to the HTV-3X, called Blackswift. In this final phase, Blackswift, which was closer in design to the HCV objective, would have begun flight tests in 2012. The uncrewed vehicle would have taken off and landed like an airplane, using the hybrid engine developed as part of FaCET;[5] the turbine engine will accelerate the vehicle to around Mach 3 before the ramjet takes over and boosts the vehicle up to Mach 6.[9] However, Blackswift was cancelled in October 2008 following a significant budget cut in the FY2009 Budget from $120 million to just $10 million. DARPA and the USAF plan to proceed with the development of HTV-2s.[10]

1. Rife, Shawn P. "Five Myths About the Term 'Aerospace'," Air Force Doctrine Center essay, 2001. The word "aerospace" is not new to the US Air Force. As early as 1959, the Air Force defined aerospace as "an operationally indivisible medium consisting of the total expanse beyond the Earth's surface."
2. Narvez, Alfonso A. "Gen. Curtis LeMay, an Architect of Strategic Air Power, Dies at 83," *The New York Times*, October 2, 1990.
3. *FACT FILE: A Compendium of DARPA Programs*, August 2003, http://www.darpa.mil/body/news/2003/final2003factfilerev1.pdf (accessed June 30, 2008) and *USAF/DARPA FALCON Program*, Air-Attack fact sheet, http://www.air-attack.com/page/32/USAF--DARPA-FALCON-Program.html (accessed June 30).
4. DARPA website, http://www.darpa.mil/tto/programs/Falcon.htm (accessed June 30, 2008).
5. *Falcon Technology Demonstration Program: HTV-3X Blackswift Test Bed*, DARPA fact sheet, February 2008 (rev 3).
6. Hitchens, Theresa, V. Samson and S. Black. "Space Weapons Spending in the FY 2008 Defense Budget," CDI paper, February 21, 2007.
7. Little, Geoffrey. "Mach 20 or Bust: Weapons research may yet produce a true spaceplane," *Air & Space Magazine*, September 01, 2007. For an earlier take on the program, see Malik, Tariq. "Going Hypersonic: Flying FALCON for Defense," *Space News*, July 23, 2003.
8. Harrington, Caitlin. "USAF plans first-ever hypersonic weapon test in 2010," *Jane's Defence Weekly*, June 25, 2008. This article inaccurately stated that a third HTV-2 flight will carry a weapon. No part of the Falcon program will involve weapons, though it is possible that in the future Falcon-derived technologies may be used for this purpose by the USAF.
9. Lorenz, Phillip. "DARPA official: AEDC 'critical' to hypersonics advancement," *AEDC/PA*, May 17, 2007.
10. Harrington, Caitlin. "DARPA cancels Blackswift project," *Jane's Defence Weekly*, October 22, 2008.

Secure World Foundation • 314 West Charles St. • Superior, CO 80027
tel 303.554.1560 • *fax* 303.554.1562 • info@swfound.org