DARPA's Potential Space Weapons Programs

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The Defense Advanced Research Projects Agency (DARPA) is undertaking research in its "Space Programs and Technology" section that could yield space weapons capabilities, as demonstrated in its fiscal year 2009 (FY 09) budget justification documents.[1]

According to DARPA, "A space force structure that is robust against attack represents a stabilizing deterrent against adversary attacks on space assets. The keys to a secure space environment are situational awareness to detect and characterize potential attacks, a proliferation of assets to provide robustness against attack, ready access to space, *the ability to neutralize man-made space environments*, and a flexible infrastructure for maintaining the capabilities for on-orbit assets."

While none of the programs listed below is explicitly aimed at the development of counterspace or space-based weaponry, each by its nature shows some applicability to either the counterspace or force application from space missions as described by the U.S. Air Force.

Space Programs and Technology

PE 0603287E, Project SPC-01

Figures are in $ millions

Program	FY 07	FY 08	FY 09	DARPA's notes	Potential?
Orbital Express Space Operations Structure	34.711	0.0	0.0	"The goal of the Orbital Express Space Operations Architecture program was to validate the technical feasibility of robotic, autonomous on-orbit refueling and reconfiguration of satellites to	This sort of maneuvering power could provide a latent offensive, anti-satellite capability.

				support a broad range of future U.S. national security and commercial space programs. Refueling satellites would enable frequent maneuver to improve coverage, change arrival times to counter denial and deception and improve survivability, as well as extend satellite lifetime….The Orbital Express advanced technology demonstration designed, developed, and tested on-orbit a prototype servicing satellite (ASTRO) and a surrogate next generation serviceable satellite (NextSat). The elements of Orbital Express demonstration, coordinated with the Air Force Space Command and Air Force Space and Missile Command, was tied together by non-proprietary satellite servicing interfaces (mechanical, electrical, etc.) facilitating the development of an industry wide on-orbit servicing infrastructure. Orbital Express successfully launched in March 2007 as part of the Air Force Space Test Program's STP-1 mission. The demonstration program met all mission success criteria and was completed in July 2007."	
Falcon	51.5	25.0	25.0	"The Falcon program objectives are to develop and demonstrate hypersonic technologies that will enable prompt global reach missions. This capability is envisioned to entail a reusable Hypersonic Cruise Vehicle (HCV) capable of delivering 12,000 pounds of payload at a distance of 9,000	This program could yield a space-based strike capability, and could allow misunderstandings to arise about the nature of the HCV's payload (i.e., another country might see the HCV

				nautical miles from CONUS in less than two hours. The technologies required by a HCV include high lift-to-drag technologies, high temperature materials, thermal protection systems, and guidance, navigation, and control. Leveraging technology developed under the hypersonic technology vehicles (HTVs) to incrementally demonstrate these required technologies in flight. The HTV-2 program will demonstrate enabling hypersonic technologies for future operational systems through rocket-boosted hypersonic flights with sufficient cross-range and downrange performance to evaluate thermal protection systems, aerodynamic shapes, maneuverability, and long-range communication for hypersonic cruise and re-entry vehicle applications. The HTV-3X program will demonstrate key Hypersonic Cruise Vehicle technologies in a realistic flight environment by developing a re-usable hypersonic aircraft test bed capable of takeoff from runway under turbojet power, acceleration to Mach 6 speed under combined turbojet and scramjet propulsion, controlled deceleration, and runway landings. In order to implement this flight test program in an affordable manner, Falcon will develop a low-cost, responsive Small Launch Vehicle (SLV). The SLV will be capable of launching small satellites into low earth and	being launched and mistake it for a nuclear-tipped ballistic missile).

				sun-synchronous orbits and will provide the nation a new, small payload access to space capability. Thus, the Falcon program addresses many high priority mission areas and applications such as global presence and space lift. DARPA established an MOA with the Air Force for the HTV-2 program in May 2003 and with NASA in October 2004. Falcon capabilities are planned for transition to the Air Force."	
Blackswift Test Bed (formerly HTV-3X)	0.0	35.0	70.0	"The Blackswift Test Bed program will develop an extended duration hypersonic test bed will allow for the study of tactics for a hypersonic airplane that includes a runway take-off, Mach 6 cruise, and a runway landing. This test bed is an evolution of the reusable Hypersonic Cruise Vehicle developed under the Falcon program. Key technologies that will be demonstrated include efficient aerodynamic shaping for high lift to drag, lightweight and durable (reusable) high-temperature materials and thermal management techniques including active cooling, autonomous flight control, and turbine-based combined cycle propulsion. To accomplish this objective, the Blackswift program will leverage propulsion component technologies developed by the Air Force and DARPA. It is envisioned that flying this hypersonic aircraft test bed in a relevant, flight environment will permit the future	It could provide ample opportunity to work on a space-based strike capability.

				development of enhanced-capability reusable high-speed vehicles for intelligence, surveillance, reconnaissance, strike or other national need missions. This program will transition to the Air Force following completion of flight-testing."	
Microsatellite Demonstration Science and Technology Experiment Program (MiDSTEP)	8.0	10.0	8.0	"The Microsatellite Demonstration Science and Technology Experiment Program (MiDSTEP) will develop the advanced technologies, capabilities, and space environment characterization required to demonstrate a suite of advanced lightweight microsatellite technologies integrated into high performance microsatellites across the continuum from low earth orbit (LEO) to deep space super geo-synchronous (GEO) environment. The program will integrate a variety of advanced technologies, which have not been previously flight-tested, and may include: lightweight optical space surveillance/situational awareness sensors, lightweight power, chemical and electric propulsion systems, advanced lightweight structures, advanced miniature radio frequency (RF) technology including micro crosslink and use of commercial off the shelf (COTS) approaches, active RF sensor technology, COTS processor and software environment, miniature navigation technologies, including the use of starfields for deep space navigation, and autonomous	This sort of maneuvering capability could be used to power anti-satellite weapons; microsatellite ASATs would also be more difficult to detect and track.

				operations. The developed capabilities will include high thrust, high efficiency solar thermal propulsion systems that can enable responsive orbit transfer as well as provide radiation high-density electrical power. The program will also explore ultra-stable payload isolation and pointing systems and components to enable advanced miniature communication systems. In addition, the program will also consider affordable, responsive fabrication and integration approaches and the possibility of networking microsatellites/modules to create a flexible architecture of assets responsive to multiple missions and threats. If successful, MiDSTEP will demonstrate these technologies in space. The anticipated transition partner is Air Force Space Command."	
System F6	12.224	21.095	37.270	"The goal of the System F6 program is to demonstrate a radically new space system composed of heterogeneous network of formation flying or loosely connected small satellites that will, working together, provide at least the same effective mission capability of a large monolithic satellite. Current large space systems used for national security purposes are constrained due to their monolithic architecture. They can be launched only a small number of large launch vehicles, cannot be readily upgraded and/or reconfigured with new hardware	This sort of microsatellite capability could yield a dual-use anti-satellite capability.

				on-orbit, and are risk-intensive, since the unforgiving launch and space environments can result in the total loss of investment with one mistake. The System F6 will partition the tasks performed by monolithic spacecraft (power, receivers, control modules, etc.) and assign each task to a dedicated small or micro satellite….This program will develop, design, and test new space system architectures and technologies required to successfully decompose a spacecraft into fundamental elements. Such architectures include, but are not limited to, ultra-secure intra-system wireless optical and RF arrays, distributed spacecraft computing systems, and reliable, robust, rapidly re-locatable ground systems. The anticipated transition partner is the Air Force."	
Front-end Robotics Enabling Near-term Demonstration (FREND)	13.196	11.4	10.7	"The goal of Front-end Robotics Enabling Near-term Demonstration (FREND) program is to develop, demonstrate, and fly robotic manipulator technologies designed to allow interaction with geosynchronous orbit (GEO)-based military and commercial spacecraft, extending their service lives and permitting satellite repositioning or retirement. Existing GEO spacecraft are outfitted with sufficient propellant to provide for needed station keeping, repositioning, and retirement maneuvers, which in many cases defines their useful mission durations….FREND	This sort of maneuvering capability coupled with the ability to grapple or dock with non-cooperative satellites could yield highly effective anti-satellite capabilities.

				technologies can enable significant service extension to these spacecraft through re-boosting near end-of-life. FREND combines detailed stereo photogrammetric imaging with robotic multi-degree-of-freedom manipulators to autonomously grapple space objects not outfitted with custom interfaces. A FREND-based servicing spacecraft offers the potential for spacecraft salvage, repair, rescue, reposition, de-orbit and retirement, and debris removal. The anticipated transition partner is the Air Force."	
Fast Access Spacecraft Testbed (FAST)	4.3	7.0	12.0	"The goal of the Fast Access Spacecraft Testbed (FAST) program is to demonstrate a suite of critical technologies required to perform rapid orbital repositioning in the geosynchronous belt. The ultimate goal of FAST is to demonstrate technology to enable a high-efficiency, high-power (50-80 kW), fast-transfer roaming satellite permitting on-demand access to any point on the geosynchronous ring or within the high-altitude, super synchronous "graveyard" (where derelict systems are regularly repositioned in order to free up orbital slots within the ring), greatly improving our space situational awareness capabilities. The FAST demonstrator satellite, while possessing high power (20 kW or more), would be revolutionary in its small size. At just 500 kilograms, a FAST spacecraft would carry a novel solar power collection and	This rapid orbital repositioning capability could provide for killer satellites based in geostationary orbit (GEO).

				distribution system, composed of large-aperture (5-10 m diameter) concentrating mirrors, high-efficiency solar photovoltaics, and ultra-lightweight, deployable radiators, achieving specific power (130 watts/kilogram at the power substation level) figures an order of magnitude better than today's state of the art. The anticipated transition partner is the Air Force."	
NanoPayload Delivery (NPD)	0.0	3.0	6.0	"The goal of a NanoPayload Delivery (NPD) program is to validate the technical feasibility of ultra-lightweight, rapid response spacecraft delivery from land, sea, or air-based platforms. Such nanopayloads (1-10 kilograms) could be boosted to low earth orbit (200 km altitude) in a matter of hours following call-up. Multitude sorties are envisioned, enabling a number of small spacecraft to be placed in an orbit "box" and aggregated together to perform a mission. The NPD program will develop and test a lightweight rocket platform similar in size to existing small missile systems such as the High-Speed Anti-Radiation Missile (HARM), AIM-7, or AIM-120. Current technology does not permit such small systems to reach orbit, owing to disproportionately high drag and low thrust-to-weight rocket engines. NPD will leverage ongoing technology development efforts, which permit the fabrication of microscale pumps, thrust chambers, and valves. Such rocket	These nanosatellites could be used in an anti-satellite capacity, and would be particularly difficult to detect and track due to their tiny size.

				engines, which are theoretically capable of thrust-to-weight ratios of 100: 1 or greater, would allow for significant reductions in overall engine mass and permit nanosatellites to be placed in low orbits for several weeks to months. The delivery system would rely on one of several methods for launch, including: (1) a stock aircraft, such as the F-15E or F-16, (2) a truck-mounted erector, or (3) the deck of a small naval vessel. The goal for per-sortie cost is $100,000. Fielding NPD will allow U.S. forces to rapidly emplace short-term capabilities in low-orbit, when they are needed, without resorting to legacy domestic launch systems that are sized and costed for much larger payloads. NPD will also allow many non-traditional users (e.g. laboratories, operational commanders, and small commercial firms) the capability to "use space" by lowering the significant barrier to entry into space. NPD will allow a streamlined, inexpensive approach to launch, descoping lengthy test and documentation requirements and demanding far fewer engineers, technicians, range personnel, and spacecraft operators per mission. Potential transition customers include the Air Force and Navy."	
High Delta-V Experiment (HiDVE)	0.0	4.0	7.0	"The goal of the High Delta V Experiment (HiDVE) program, an outgrowth of the MiDSTEP program, is to design, develop, and demonstrate a low-mass, low-	The ability to insert nanosatellites into one orbit and rapidly move them could be used to create nearly

				volume, high delta-V solar thermal propulsion (STP) engine suitable for integration with a ~15 kg nanosatellite host. The enabling technologies are very high-temperature materials and innovative receiver and concentrator designs. A HiDVE system will provide small satellites, historically constructed without propulsive capability, with substantial delta-V affording nanosatellites increased orbital range, in terms of both attitude and plane. In addition, this flexibility will be essential to future nanosatellite mission designers and operators, who will be able to take advantage of less-than-optimal insertion orbits and later move to an intended mission orbit. Specific objectives of the HiDVE program include: development and demonstration of a functioning STP system in a relevant environment; an operational test plan that outlines the steps needed to flight-qualify an integrated nanosatellite with an STP system."	impossible to detect anti-satellite weapons on orbit.
Micro Electric Space Propulsion (MEP)	4.689	0.0	0.0	"The Micro Electric Space Propulsion (MEP) would have demonstrated flexible, lightweight, high-efficiency, scalable micro-propulsion systems to enable a new generation of fast, long-lived, highly flexible, and highly maneuverable 1-100 kg-class satellites/spacecraft."	Highly maneuverable satellites based on such propulsion systems could be used in an anti-satellite capacity, either to directly target another satellite via collision or to move closer to a target satellite to disrupt it using

					directed energy payloads.

Advanced Aerospace Systems
PE 0603286E, Project AIR-01
Figures are in $ millions

Program	FY 07	FY 08	FY 09	DARPA's notes	Potential?
Rapid Eye	0	10.5	15.9	"The goal of the Rapid Eye program is to develop a high altitude, long endurance unmanned aerial aircraft that can be rocket-deployed from the continental United States world-wide within 1-2 hours to perform intelligence, surveillance, reconnaissance (ISR), and communication missions. The enabling technologies are inflatable/folding structures, stable and dense energy storage, and low-oxygen propulsion. Rapid Eye will provide decision makers rapid-reaction ISR and persistent communication capability for emerging situations. The anticipated transition partner is the Air Force."	This program could be converted to carry a weapons payload, similar to the Prompt Global Strike system.

[1] All of the information comes from DARPA's FY 09 "RDT&E Budget Item Justification Sheet (R-2 Exhibit)," DARPA, February 2008, http://www.defenselink.mil/comptroller/defbudget/fy2009/budget_justification/pdfs/03_RDT_and_E/Vol_1_DARPA/DARPA%20PB09%20RDTE%20Part%202.pdf/.