

# U.S. SPACE WEAPONS

## Big Intentions, Little Focus

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*Under the administration of President George W. Bush, Pentagon rhetoric has increasingly articulated a more robust vision of space as a future battlefield. This analysis details some of the ongoing spending for research and development programs identified in current U.S. Air Force, Missile Defense Agency (MDA), and Defense Advanced Research and Planning Agency (DARPA) planning and budget documents related to "space control" and "space force projection." This analysis finds that current support for "space superiority" and "space control" systems remains largely rhetorical—with little actual budgetary support. Unclassified technology development programs included in the six-year Future Years Defense Plan are a decade or more away from deployment. Programs related to offensive counterspace, space-based missile defense interceptors, and space-based strike total slightly less than \$300 million in FY 2006 funding. We conclude significantly higher expenditures in research and development would be required to develop and deploy killer microsattellites, space-based missile defense interceptors, and military space planes.*

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Under the administration of President George W. Bush, Pentagon rhetoric has increasingly conveyed a more robust vision of space as a future battlefield. In August 2002, the Joint Chiefs of Staff issued a doctrine document for space activities that articulated the concept of "space superiority."<sup>1</sup> Space superiority melds the U.S. military's primary use of space for support functions with two offensive missions: "space control" and "space force application." Subsequent Air Force documents elaborated the intention for the service to take on "new military missions in the areas of space protection and projecting force in and from space."<sup>2</sup> These documents define space control as providing "freedom to attack as well as freedom from attack" in space; whereas space force application as defined by the Pentagon refers to missions undertaken by space-based assets against terrestrial and on-orbit targets, as well as missile defense.<sup>3</sup> This analysis details some of the ongoing spending for research and development programs identified in current U.S. Air Force, Missile Defense Agency (MDA), and Defense Advanced Research and Planning Agency (DARPA) planning and budget documents related to space control and "space force projection."

The funding tracked in the Department of Defense (DoD) budget request is arranged in what U.S. physicist Richard Garwin calls "a technological sandbox"—small amounts of funding for a jumble of basic research efforts on such systems/subsystems as

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micro-satellites; miniature propulsion units for such satellites; directed-energy power sources, including laser technology and high-powered microwaves for use on land, sea, air and space; advanced optical systems for laser weapons applications; miniature kinetic kill vehicles for use against ballistic missiles and possibly against satellites; reusable spacecraft and space planes; and other similar programs.<sup>4</sup>

This analysis is restricted to the unclassified budget. Much of DoD spending on space is classified, inaccessible even to most members of Congress who are not cleared for access. Nonetheless, an unclassified analysis can reveal a considerable amount about Defense Department activities in space. First, few programs are completely classified. For example, although funding and details regarding the Microsatellite Propulsion Experiment (MPX) are classified, the existence of an "industry day" for the program is common knowledge.<sup>5</sup> Such a gray area allows many details of such programs to appear in the press, particularly trade publications. Second, the classified budget is better at hiding programs under development than those that have been launched into space. Once in orbit, even "stealth" satellites are visible to visual observers, who can draw conclusions about size and purpose of satellites based on orbital data. Therefore, it can be said with confidence that the United States does not currently deploy space control or force projection platforms in space. Third, unclassified space programs provide general information about the state of technological development. For example, unclassified efforts by the National Aeronautics and Space Administration (NASA), DARPA, and the Air Force to develop autonomous microsatellites suggest this technology remains in its infancy. Still, the possibility cannot be excluded that additional, classified research for space weapons technology development exists.

## Background

While both space control and space force application first appeared in the Reagan administration's 1988 National Space Policy (NSP) and were reiterated in the most recent NSP signed by President Bill Clinton in 1996, neither mission area has enjoyed the political and budgetary support to become a central tenet of de facto U.S. military space policy.<sup>6</sup> Indeed, the Air Force understood the Clinton-era NSP to prohibit an overt space war-fighting strategy. "There was a while in the 1990s when we couldn't say 'space control'—we couldn't talk about it," as General Ralph E. Eberhart, then-commander of the U.S. Space Command and U.S. Air Force Space Command, was quoted in May 2002 by *Jane's International Defence Review*.<sup>7</sup> The (now defunct) U.S. Space Command's 1998 *Long Range Plan* articulated a "need to develop national policies supporting space warfare, weapons development and employment, and rules of engagement" and "advocate national policy and legislation to support negation."<sup>8</sup> Space-based weapons for hitting terrestrial targets were out of the question: "At present, the notion of weapons in space is not consistent with national policy."<sup>9</sup>

That may be about to change, with the Bush administration's long-expected rewrite of the NSP. Proponents hope the National Security Council and White House will use the NSP, either explicitly in the document's language or implicitly via increased budgetary support, as support for these ideas. At the moment, however, a detailed review of the

current Pentagon budget (for fiscal years 2006–2009) shows little evidence of a coherent spending plan to implement the articulated space war–fighting strategy.

Perhaps not wanting to get out too far in advance of national policy, or perhaps because the subject of space weapons remains politically controversial, the Air Force has been coy about the requirements of a “space dominance” strategy and downright mum about how much it will cost to fight “in, from and through space.”<sup>10</sup> This reticence regarding requirements and budgets is opposed to the vigor with which senior Air Force officials have been proselytizing the need to pursue space superiority and space control aggressively. Separating the rhetoric from today’s reality takes a bit of detective work: combing through both Air Force weapons systems planning documents and the Pentagon’s recent budget documentation.

The latter, in particular, is no small task. First, the DoD does not have a formal space budget. Although the Air Force is the lead agency for space, actual spending is sprinkled throughout Pentagon agencies (including MDA and DARPA), the military services, and the classified National Reconnaissance Office. (Some small amounts of funding for dual-use military-civilian technologies can also be found in the NASA budget.) The Pentagon created a “virtual” Major Force Program (vMFP) to help itself track space spending, but this accounting device does not include basic research or funds appropriated for MDA or DARPA. Second, research for a single, space-related technology may be funded from multiple budget accounts. While major programs in near-term development (such as the troubled Transformational Satellite or TSAT) have their own budget lines, most research and development money is found in obscurely titled “grab bags,” such as “Multi-Disciplinary Advanced Development Space Technology.” There is no Air Force budget line item with an obvious title like “The Death Star.” Third, many technologies that enable the development of space weapon systems could also be used for benign purposes, such as inspecting damaged satellites or conducting space surveillance.

It is, however, possible to sketch programmatic activity at the DoD related to space warfare capabilities. DoD spending on the “space” vMFP has grown by about a billion dollars a year for the past six years. The DoD requested a total of \$22.5 billion in fiscal year 2006 (FY 06) for classified and unclassified space spending, up from \$19.8 billion in FY 05 and \$14.3 in FY 01.<sup>11</sup> In addition, Pentagon budget documents reveal interest in technologies to enable a space warfare strategy, as this analysis will detail below.

Air Force long-range planning documents do identify near-, mid- and long-term capabilities that could help fight “in, from and through space.” Matching such wish lists with actual spending reveals a number of proof-of-technology efforts that may become full-fledged space weapon programs. Two recent Air Force documents, called “Transformation Flight Plans,” outline the service’s planned transformation to meet modern warfare needs, including capabilities for warfighting in space between now and 2030. The November 2003 version included an annex that named desired weapons programs.<sup>12</sup>

Air Force officials downplayed the 2003 Transformation Flight Plan as a “wish list,” but the 2004 version describes the series as a “reporting” document that does “not represent new policy guidance or propose what the Air Force should do, but is instead intended to reflect decisions, information, and initiatives *already made and/or approved*

[emphasis added] by the Air Force capability-based planning, programming and budgeting process.”<sup>13</sup>

## Space Control

As noted above, space control is defined by the Joint Chiefs as operations to provide “freedom of action in space for friendly forces while, when directed, denying it to an adversary,” including “the broad aspect of protection of U.S. and allied space systems and negation of enemy adversary space systems” through “offensive and defensive operations.”<sup>14</sup> Air Force officials have expressed a preference for temporary, reversible measures to interfere with satellites.<sup>15</sup> One example of such temporary and reversible means is the Counter Satellite Communications System (Countercom). The 2003 Transformation Flight Plan slated the Countercom as a near-term requirement.<sup>16</sup> Countercom is a mobile, ground-based satellite-jamming system designed to disrupt radio-frequency links between satellites and their ground systems, although technical details are classified. The first Countercom unit was delivered to the 76th Space Control Squadron at Colorado Springs in the fall of 2004, and two more units were slated to be delivered in 2005 (although as of the end of the year, no additional announcements had been made).<sup>17</sup>

Despite this stated preference for nondestructive measures, budget documents reveal that the Pentagon also is working on a trio of technologies that would support destructive anti-satellite (ASAT) weapons: (1) microsattellites, (2) directed-energy weapons, and (3) kinetic kill weapons.

The following sections will review planned spending in each of these areas.

### *Microsatellites Capable of Performing Autonomous Proximity Operations*

Microsatellites have a mass of less than 100 kilograms (kg)—an order of magnitude smaller than most current satellites, which may weigh more than a ton. The *Defense Technology Area Plan* (2000) called for “the development of micro-satellite vehicles with significant capability,” including the ability to “conduct missions such as diagnostic inspection of malfunctioning satellites through autonomous guidance, rendezvous, and even docking techniques”—commonly called Autonomous Proximity Operations (APOs).<sup>18</sup>

NASA, DARPA and the Air Force all have APO programs, with NASA and the Air Force looking toward microsattellites to perform these missions. Table 1 shows spending on three programs to explore APOs.

- *Demonstration of Autonomous Rendezvous Technology (DART)*: A NASA satellite launched in 2005. DART attempted to rendezvous with a DoD communications satellite but collided with the satellite.<sup>19</sup> Orbital’s contract for DART was valued at \$47 million.
- *Experimental Spacecraft System (XSS)*: A series of Air Force Research Laboratory satellites designed to demonstrate imaging applications of proximity operations. The first satellite, the XSS-10, was launched in 2003. That satellite maneuvered to

**TABLE 1**  
 Microsatellite Research and Development (Millions of dollars)

R1	PE	Program	2004	2005	2006	2007	2008	2009	2010	2011
26	0603401F	Advanced Spacecraft Technology	105.6	89.8	60.9	67.2	78.7	84.1	92.4	94.1
	2181	Spacecraft Payloads	32.5	26.8	19.0	18.9	25.6	28.3	30.1	30.7
	3834	Integrated Space Technology Demonstrations [XSS]	30.2	23.4	22.0	26.3	29.1	32.3	35.5	36.1
33	0603287E	Space Programs and Technology		222.9	223.8	264.3	309.3	327.4	348.7	350.7
		Orbital Express	44.4	46.6	38.8	15.6				
		Spacecraft for the Unmanned Modification of Orbits			12.6					
NASA PROGRAM		Earth Orbit Capability (Spiral 1)	911.4	526.0	1120.1	1579.5	1523.7	1990.9	2452.2	

For an explanation of how to read this table, see Appendix 2.

within 35 meters of an expended Delta II rocket body, transmitting digital images to Earth, and conducted other on-orbit maneuvers for 24 hours before completing its mission.<sup>20</sup> The second satellite in the series, the XSS-11, was launched in 2005. The XSS-11 will remain in orbit for a year and conduct close-proximity operations to multiple targets of opportunity. Total spending on XSS-11 over FY 01–06 was set at approximately \$73 million (about twice the original estimate). The Air Force, according to a source with access to service plans, hopes the XSS program will lead to a low-cost design that can be mass-produced.

- *Orbital Express*: A DARPA program to demonstrate the feasibility of using automated spacecraft to refuel, upgrade, and extend the life of on-orbit spacecraft.<sup>21</sup> Boeing is building two satellites—the 700-kg Autonomous Space Transport Robotic Operations satellite (ASTRO) and a surrogate next-generation serviceable satellite (NEXTSat)—for an on-orbit demonstration of autonomous satellite servicing set for launch in March 2006.<sup>22</sup> DARPA is spending \$56.6 million in FY 05 on its Orbital Express program. Boeing’s contract for ASTRO is valued at \$113 million.

Although none of these satellites is a dedicated anti-satellite, each contributes to such a future capability. As the head of the Air Force XSS program told the newsletter *Inside the Pentagon*, “You can’t closely inspect a vehicle—say, one with an on-orbit malfunction—without getting ‘close’ and approaching from the right angle. To refuel, obviously you’d have to get more than close, and ‘dock’ with the vehicle.”<sup>23</sup>

The XSS program demonstrates the wide variety of defense applications for microsatellite technology. XSS is the successor of the Clementine 2 Asteroid Intercept Demonstrator developed by NASA and the then Ballistic Missile Defense Organization (BMDO). Clinton used his line-item veto to eliminate a congressional appropriation for Clementine 2 because he determined that the research “more logically . . . fit within the

space-based missile defense mission area” and was unnecessary because the U.S. missile defense deployment option at the time did “not include space-based weapons in its architecture.”<sup>24</sup> In 2000, the Air Force recast the program as a satellite inspector, and it was subsequently funded. The principal use of the XSS technology may be as an anti-satellite weapon. The “XSS-11 can be used as an ASAT weapon,” one Air Force official told *Inside the Pentagon*.<sup>25</sup> Moreover, the “single strongest recommendation” of an informal 1999 *Micro-satellite Technology and Requirements Study* prepared for Air Force Space Command was “the deployment, as rapidly as possible, of XSS-10-based satellites to intercept, image and, if needed, take action against a target satellite” based on technology from the Army’s kinetic energy (KE) ASAT program (see below).<sup>26</sup>

The three programs highlighted above were also considered for an innocuous “anti-satellite” mission of sorts: There was talk at NASA in 2005 about launching an autonomous “space tug” in 2006, using technology from DART, XSS, and ASTRO, to de-orbit the Hubble Space Telescope (although the agency recently shifted course for the near term to focus on repair). “We actually think that having three programs that are funded right now to look at aspects of this issue are really going to be a great help,” noted one NASA official.<sup>27</sup>

DARPA is also pursuing another program worth noting: Satellite for the Unmanned Modification of Orbits (SUMO). SUMO will integrate cameras and new robotic arms to “grapple space objects without custom interfaces” for “spacecraft salvage, repair, rescue, reposition, and debris removal, to extend service life or provide a safe and calculated de-orbit.”<sup>28</sup>

### *Directed-Energy Anti-Satellite Research*

The Air Force is putting increased emphasis on research into directed energy for both offensive and defensive purposes. Colonel Gail Wojtowicz, chief of the Air Force future concepts and transformation directorate, told an October 11, 2005, conference sponsored by the American Enterprise Institute: “Directed energy is the next weapons race,” stressing the service’s “big push” to pursue such technologies.<sup>29</sup> Furthermore, the 2003 *Transformation Flight Plan* notes a “recently completed Directed Energy Master Plan” that “articulates a strategy to develop and transition directed energy applications such as . . . space superiority and ballistic missile defense.”<sup>30</sup> The *Transformation Flight Plan* outlines directed-energy technologies to attack satellites, including ground- and space-based lasers, relay mirrors, and radio-frequency weapons. Table 2 details identifiable spending in the current budget plan by the Air Force and the Army.

Two facilities are used to work on ground-based lasers: the Air Force Research Laboratory’s (AFRL) Directed Energy Directorate, which operates the Starfire Optical Range at Kirtland Air Force Base, and DoD High Energy Laser Test Facility, which houses the Mid-Infrared Advanced Chemical Laser (MIRACL).

- The Air Force Research Laboratory’s Directed Energy Directorate appears to conduct antisatellite-related research using a facility at Kirtland Air Force Base in

**TABLE 2**  
Directed-Energy Research and Development (Millions of dollars)

R1	PE	Program	2004	2005	2006	2007	2008	2009	2010	2011
12	0602605F	Directed-Energy Technology	40.8	43.6	37.7	42.6	41.3	40.8	41.6	41.9
15	0602890F	High-Energy Laser Research	40.5	50.2	45.7	49.6	50.0	54.2	55.4	56.4
35	0603924F	High-Energy Laser Advanced Technology Program	10.5	9.8	5.8	3.7	3.7	4.0	4.1	4.2
139	0605605A	DoD High-Energy Laser Test Facility	18.2	15.1	17.7	18.4	19.1	19.2	19.7	20.2
9	0602500F	Multidisciplinary Space Technology	99.2	95.4	81.3	102.4	120.4	120.2	119.0	120.7
	5023	Laser and Imaging Space Technology	5.6	8.5	8.2	10.3	11.5	11.9	12.1	12.2
28	0603500F	Multidisciplinary Advanced Development Space Technology	58.2	56.9	53.4	68.6	69.5	72.5	77.9	82.8
	5031	Advanced Optics and Laser Space Technology	18.1	19.0	20.9	21.2	22.2	22.0	28.2	28.7
3	0601108F	High-Energy Laser Research Initiatives	11.6	12.2	11.9	12.3	12.3	13.4	13.7	13.9
30	0603605F	Advanced Weapons Technology	59.5	56.9	27.0	29.5	28.2	30.5	31.1	31.6

For an explanation of how to read this table, see Appendix 2.

Albuquerque, New Mexico. The Starfire Optical Range (SOR) comprises two large telescopes that use adaptive optics to compensate for atmospheric effects when tracking satellites and debris, as well as a beam director that is used “primarily for projecting laser beams at space objects.”<sup>31</sup> Currently, the AFRL Directed Energy Directorate plans to use the SOR to “perform atmospheric compensation/beam control experiments for applications including anti-satellite weapons,” including tests in 2007 to “demonstrate fully compensated laser propagation to LEO [low-Earth-orbit] satellites.”<sup>32</sup> The Air Force also plans to collect “empirical data” to update current lethality assessments and other programs to improve beam control, which may be carried out at Kirtland.<sup>33</sup> Table 3 details Air Force spending plans for the SOR on technology development and testing that could enable directed-energy ASATs.

- The Mid-Infrared Advanced Chemical Laser is a high-energy megawatt-class laser managed by the Army and based at the DoD’s High Energy Laser Test Facility on the White Sands Missile Range in New Mexico.<sup>34</sup> In 1996, the Army tested the MIRACL against a U.S. satellite to test the effect of the laser on satellite optics.<sup>35</sup> Its current status is unclear.

#### EAGLE

To extend the range of ground-based lasers, the 2003 *Transformation Flight Plan* proposes an Evolutionary Air and Space (or Aerospace) Global Laser Engagement (EAGLE) concept using “airborne, terrestrial or space-based lasers in conjunction with space-based relay mirrors . . . to achieve a broad range of effects from illumination to destruction.”<sup>36</sup> AFRL is

**TABLE 3**  
Starfire Optical Range Experiments Related to ASATs

Major Thrust	Perform atmospheric compensation/beam control experiments for applications, including anti-satellite weapons, relay mirror systems, satellite tests and diagnostics, and high-resolution satellite imaging.	US\$M
FY 2004	Completed integration and began testing of sodium-beacon laser on Starfire Optical Range (SOR) 3.5-meter telescope; this enabled full aperture point-ahead atmospheric compensation for low-power laser projection to satellites on weapons-class beam director.	3.9
FY 2005	Completed integration and began testing of sodium-beacon adaptive optics system, including compensated infrared imaging of low-Earth-orbit (LEO) satellites.	4.6
FY 2006	Begin testing of advanced laser-beacon adaptive optics system on SOR 3.5-meter telescope to increase imaging resolution/laser beam control; perform high-resolution satellite imaging at short wavelengths; demonstrate and characterize performance of point-ahead compensated laser propagation to LEO satellites using sodium-beacon adaptive optics.	4.9
FY 2007	Demonstrate fully compensated laser propagation to LEO satellites; measure beam profile and intensity on target; begin development of precision aimpoint stabilization through turbulence.	5.1

conducting research in support of the EAGLE concept.<sup>37</sup> For FY 04, Congress appropriated additional funds to support laboratory tests that would lead to a high-altitude relay mirror test.<sup>38</sup> In response, as FY 06 budget documents indicate, the Air Force has placed “greater emphasis on relay mirrors,” including making plans for “a high-power demonstration to kill a missile through a relay mirror.”<sup>39</sup>

#### SPACE-BASED DIRECTED ENERGY

In contrast to ground-based lasers and relay mirrors, the Pentagon has placed less emphasis on space-based directed-energy programs. The Missile Defense Agency has dropped plans to develop a Space-Based Laser (SBL), closing the SBL program office and canceling an FY 12 integrated flight experiment (IFX). Budget documents indicate that the DoD continues basic research on high-energy lasers that can operate in a gravity-free environment.<sup>40</sup> The 2003 *Transformation Flight Plan* indicates Air Force interest in a “constellation of satellites containing high-power radio-frequency transmitters” called the Space-Based Radio Frequency Energy Weapon that “would typically be used as a non-kinetic anti-satellite weapon.”<sup>41</sup> However, we were unable to determine from the unclassified budget whether this program is being supported by basic research.

#### *Kinetic Energy Anti-Satellite /Army Counterspace Technology Testbed*

The status of the KE ASAT program is unclear. The Pentagon has not requested funds for this program since the early 1990s, but congressional patrons periodically include money for the KE ASAT—now called the Army Counterspace Technology Testbed—in annual appropriations bills.



The KE ASAT comprises a kill vehicle and a booster—similar to a missile-defense interceptor—that would destroy a satellite either by colliding with the satellite or striking it with a large, Mylar membrane (often called a “fly swatter”) that contains an array of “high density pellets” to “provide penetration, crushing of the target structure, and removal of critical appendages.”<sup>42</sup> Despite claims that KE ASAT is designed to mitigate debris, a 1992 study by scientists at Lawrence Livermore National Laboratory concluded KE ASAT would generate debris.<sup>43</sup> The prospect of a giant “fly swatter” creating a large amount of orbital debris has undermined support for the program. The Clinton administration canceled the program in 1993. The Pentagon has not requested funding for the program, citing debris issues. In 2001, then-Commander of U.S. Space Command General Ralph Eberhart testified that the KE ASAT would create too much debris to be used against satellites.<sup>44</sup>

Despite official disinterest, Congress has sporadically funded the program in recent years. The Government Accountability Office (GAO), in a December 2000 report, found that the program remains “in a state of disarray” due, in part, to the program’s uncertain funding.<sup>45</sup> Table 4 shows congressional appropriations for the program since 1996.

In FY 2004 and FY 2005, Congress added \$7.5 million under MDA Ballistic Missile Defense Technology in FY 2004 and \$14 million in FY 2005 under MDA Ballistic Missile Defense Products for the program. Two Alabama-based companies, Davidson Technologies and Miltec, received contracts to support KE ASAT development using these funds. Davidson Technologies received contracts in 2001 and 2003.<sup>46</sup> In May 2004, Army Space and Missile Defense Command (SMDC) awarded Miltec a \$4 million increment to a \$12.4 million contract for the Army counterspace technology testbed.<sup>47</sup>

The Army renamed the program the Army Counter Space Technology Testbed (or Applied Counterspace Technology), shifting some of the money from work on KE ASAT appropriated by Congress to research on command-and-control systems for the Rapid Attack Identification Detection and Reporting System (RAIDRS). Yet, the Army also continues development of the KE ASAT kill vehicle, identified in the Army *Space Master Plan* as one of many “future operational capabilities for space control.”<sup>48</sup> SMDC has issued

**TABLE 4**  
Congressional Appropriations for KE ASAT (Millions of dollars)

R1	PE	Program	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
84	0603892D	Tactical Anti-Satellite Program Development	28.5	49.0								
82	0603872C	Joint Theater Missile Defense-Demonstration/Validation			37.5							
30	0603175C	MDA Ballistic Missile Defense Technology									7.5	
73	0603889C	MDA Ballistic Missile Defense Products										14.0

For an explanation of how to read this table, see Appendix 2.

a statement-of-work contract that requires the contractor to support flight tests “as needed.”<sup>49</sup> Program officers believe they could conduct an on-orbit demonstration for about \$60 million (an amount that would cover two flight-test vehicles and one spare).<sup>50</sup>

#### AIR LAUNCHED ANTI-SATELLITE MISSILE

The 2003 *Transformation Flight Plan* also describes Air Force interest in “a small air-launched missile capable of intercepting satellites in Low Earth Orbit,” dubbed the Air Launched Anti-Satellite Missile. The concept seems similar to the miniature homing vehicle that the United States test-fired from an F-15 fighter in the mid-1980s, destroying a U.S. satellite in low Earth orbit.<sup>51</sup> Whether there is direct funding for such a program is unclear, although the ongoing work by MDA on miniature kill vehicles could have applicability to an air-launched ASAT capability.

### Space Force Application

“Space force application operations (also sometimes termed Global Strike operations) consist of attacks against terrestrial-based targets carried out by military weapons systems operating in or through space.”<sup>52</sup> These capabilities are largely driven by the *Nuclear Posture Review*, which anticipated modernizing U.S. strategic forces through the addition of missile defenses and conventional strike capabilities. Space-based missile defenses, previously categorized as space control programs, are now considered “space force application” systems in planning documents.

#### *Space-Based Missile Defenses*

The United States is committed to improving the initial capabilities of the Ballistic Missile Defense System (BMDS) through additional measures that may include the “development and testing of space-based defenses, specifically space-based kinetic energy (hit-to-kill) interceptors and advanced target tracking satellites.”<sup>53</sup> Air Force Lieutenant General Trey Obering, director of MDA, told the American Institute of Aeronautics and Astronautics 3rd Annual U.S. Missile Defense Conference, “Emerging threats and uncertainty would really have us take a hard look at developing a space-based layer that we could add to the system.”<sup>54</sup> Proponents for Space-Based Test Bed point to the “Brilliant Pebbles” concept developed by the Lawrence Livermore Laboratory and Ball Aerospace during the 1980s as the source of technology for a new program.<sup>55</sup> Table 5 details identifiable MDA funding for planned technology development and testing related to space-based missile defenses.

In FY 2003, MDA consolidated funding for space-, land- and sea-based boost efforts into a single program: Ballistic Missile Defense System Interceptors (BMDS Interceptors). In FY 2005, MDA reduced the emphasis of this program on boost-phase interception in favor of providing additional opportunities to intercept ballistic missiles during the midcourse of their flight. Also known as “kinetic energy interceptors,” the budget for BMDS Interceptors contains two projects related to space-based missile defense interceptors.

- Near Field Infra Red Experiment (NFIRE) is a LEO satellite that will collect visible and infrared imagery of missiles during their boost phase as a “risk reduction effort” for

**TABLE 5**

Space-Based Missile Defense Research &amp; Development (Millions of dollars)

R1	PE	Program	2004	2005	2006	2007	2008	2009	2010	2011
74	0603886C	BMDs Interceptor	114.7	279.8	229.7	444.9	677.2	1137.3	1468.8	1717.5
		Near Field Infrared Experiment	44.5	68.0	13.7	10.8				
	R216	Space-Based Interceptors Test Bed		10.5	0.0	0.0	45.0	150.0	248.0	230.0
70	0603882C	BMD (Ballistic Missile Defense)	3711.7	4501.5	3266.2	198.4	3946.0	3650.8	3315.5	3183.6
		Midcourse Defense Segment								
		Multiple Kill Vehicles			82.0		219.6	272.9	306.5	308.2

For an explanation of how to read this table, see Appendix 2.

“future space-based boost phase interceptors.”<sup>56</sup> MDA plans to launch NFIRE in June 2006. Once in orbit, MDA will launch two ballistic missiles toward the NFIRE satellite as part of “fly-by” tests to allow the satellite to view ballistic missiles in flight. MDA voluntarily shelved plans to include what it termed a “kill vehicle” that NFIRE would fire at one of the target missiles. In August 2005, it was revealed that MDA planned to replace the kill vehicle with a German laser communications terminal.<sup>57</sup> However, in September 2005, the Senate Appropriations Committee included language in its report accompanying the FY 2006 defense bill that called on MDA to include the kill vehicle in the NFIRE satellite. The final fate of the kill vehicle is still unknown,<sup>58</sup> although MDA officials recently stated that a planned 2006 test would not include it.

- MDA will begin a one-year concept design phase for the Space Test Bed in FY 2008. After a contractor is selected, MDA plans to conduct “multiple space-based intercept tests”<sup>59</sup> with five space-based interceptors against medium- to intercontinental-range ballistic missiles through FY 2015. In FY 2016, MDA plans to enter production for a “limited constellation of space-based interceptors (50–100 satellites)” that “offers thin boost/ascent defense against intercontinental ballistic missiles.”<sup>60</sup>

MDA also conducts risk-reduction work for space-based interceptors under the Multiple Kill Vehicle (MKV) project. The MKV concept envisions using several small kill vehicles within a single interceptor missile to destroy multiple targets such as decoys. Previously funded as an advanced technology effort, MKV is now broken out in a separate project in the FY 2006 budget.<sup>61</sup> As noted above, MDA cancelled its dedicated program to develop a Space-Based Laser because of technology hurdles and cost concerns—although MDA continues to express interest in directed-energy systems.

**TABLE 6**

Funding for Common Aero Vehicle (Millions of dollars)

R1	PE	Program	2004	2005	2006	2007	2008	2009	2010	2011
60	0604855F	Operationally Responsive Launch	21.5	33.1	23.5	35.5	41.3	74.9	76.3	77.4
61	0604856F	Common Aero Vehicle	17.0	16.5	27.4	32.5	31.7	39.8	92.7	94.1
33	0603287E	Space Programs and Technology		222.9	223.8	264.3	309.3	327.4	348.7	350.7
		FALCON	17.5	12.5	25.0					

For an explanation of how to read this table, see Appendix 2.

**TABLE 7**  
Common Aero Vehicle Program of Work

Accomplishments/Planned Program	FY 2005 PBR (President's Budget Request)			From FY 04 to FY 05	FY 2006 PBR (President's Budget Request)		
	FY 03	FY 04	FY 05		FY 05	FY 06	FY 07
Initiation of CAV system definition, systems engineering, and flight-test planning for Phase I		4.293					
CAV system design and development, systems engineering, and flight-test planning/support for Phase II		3.000	10.910	+ 0.554	11.464	23.147	13.250
New in 2006 PBR: Initiation of HTV (Hypersonic Technology Vehicle) systems engineering and flight-test planning/support for Phase III		–	–				13.553
Support of early CAV/penetrator demonstration flights		3.000	7.700	– 7.7	0.000		
Analysis and assessment of alternative CAV concepts/requirements and program management support		4.232	3.000	+ 2.000	5.000		
New in 2006 PBR: Perform prompt global strike analysis of alternatives		–	–			4.247	5.726
Prepare hypersonics test corridor		0.500					
Develop critical CAV technology		2.000					
<b>Total cost</b>	<b>0.000</b>	<b>17.025</b>	<b>21.610</b>		<b>16.464</b>	<b>27.394</b>	<b>32.529</b>

*Space-Based Strike*

Consistent with the Pentagon's *Nuclear Posture Review's* emphasis on developing conventional strike options, the Air Force Space Command promulgated a *Prompt Global Strike (PGS) Mission Needs Statement (MNS)* that established a requirement for "rapid conventional strike worldwide to counter the proliferation of weapons of mass destruction."<sup>62</sup> The 2003 *Air Force Transformation Flight Plan* lists a series of capabilities required to attack targets rapidly and precisely anywhere on the globe in 90 minutes or less. Three of these capabilities—the Common Aero Vehicle, Space Maneuver Vehicle, and

Space Operations Vehicle—reflect long-standing Air Force interest in a military “space plane.”<sup>63</sup> Brigadier General Simon “Pete” Worden explains:

The basic space-access system would consist of a reusable suborbital space operations vehicle (SOV) that would operate solely within the United States. It could carry a reusable orbital “mini-space plane” or space maneuver vehicle (SMV) capable of carrying a payload into low Earth orbit. It could also carry an expendable upper stage or “modular insertion stage” (MIS), for access to higher orbits. Finally, it could carry weapons capable of being delivered over intercontinental ranges. The weapon’s carrier is called a “common aero vehicle” (CAV).<sup>64</sup>

Work on such a “space plane” is currently carried out by DARPA and the Air Force on a joint program called Project FALCON—Force Application Launch from CONUS.<sup>65</sup> A fourth capability—bundles of tungsten rods that would use kinetic energy to destroy targets on Earth—appears to exist largely as a concept that guides more general research.<sup>66</sup>

The CAV—a “hypersonic glide vehicle” that will “dispense conventional weapons, sensors or other payloads worldwide from and through space within one hour of tasking”—is the centerpiece of conventional strike efforts.<sup>67</sup> In December 2002, then-Deputy Secretary of Defense Paul Wolfowitz directed the Air Force and DARPA to establish a joint program office to accelerate the CAV to meet the PGS requirement.<sup>68</sup> The result was a joint Air Force-DARPA program called FALCON that comprises three systems: CAV, SLV, and a hypersonic cruise vehicle (HCV) to deliver “conventional payloads worldwide from and through space.”<sup>69</sup> Options reviewed for carrying the CAV included a reusable “space plane,” an on-orbit platform (currently considered too expensive and technologically challenging), and, in the near term, a ballistic missile. The program soon ran afoul of congressional appropriators, who expressed concern that Russia and China might misinterpret the launch of a CAV-carrying ballistic missile as a nuclear attack. The FY 05 appropriations bill restricted use of the funds to “non-weapons related research, such as microsatellite or other satellite launch requirements and other purposes as listed under the conferees recommendations.”<sup>70</sup> As a result, DARPA and the Air Force renamed CAV the Hypersonic Technology Vehicle and stopped “all weaponization activities.”<sup>71</sup> This restructuring, however, resulted in only modest changes to the unclassified work program—principally the cancellation of plans for a CAV/penetrator demonstration flight. Moreover, Pentagon officials have continued to express support for using CAV to create a squadron of conventionally armed ballistic missiles.<sup>72</sup> Press reports suggest the Pentagon’s 2005 *Quadrennial Defense Review* will recommend moving 50 Minuteman III ICBMs to Vandenberg Air Force Base for this mission.<sup>73</sup>

Concepts for hypervelocity rod bundles—nicknamed “Rods from God”—have existed since at least the 1980s under different names, such as “Long Rod Penetrators.” Generally, the concept involves a constellation of satellites, each housing several tungsten rods. Up to 20 feet long and about a foot in diameter, these rods would launch from space at extremely high speeds, striking underground targets with the force of a small nuclear weapon.<sup>74</sup> However, studies of this concept have shown that although Rods from God are theoretically possible, there are both physics and engineering challenges that may simply be impossible to overcome.<sup>75</sup> Despite the inclusion of hypervelocity rod bundles in the

*2003 Transformation Flight Plan*, we do not see any evidence in Air Force budget documents to suggest research on such a program is being funded.

## Conclusion

From analyzing current Pentagon budget documentation, we conclude that, for the moment, support for “space superiority” and “space control” systems remains largely rhetorical—with little actual budgetary support. The Bush administration has expressed interest in these new military missions in outer space. That interest has been reflected in statements by Pentagon officials about space dominance, as well as official military documents, especially those emanating from the Air Force. However, this interest has not yet been reflected in budget requests. Unclassified technology development programs included in the six-year Future Years Defense Plan are a decade or more away from deployment. Programs related to offensive counterspace, space-based missile defense interceptors, and space-based strike total slightly less than \$300 million in FY 2006 funding. Based on current levels of technological development and anticipated levels of budgetary support, we conclude significantly higher expenditures in research and development would be required to develop and deploy killer microsattellites, space-based missile defense interceptors, and military space planes. The Pentagon is not—at least in the unclassified budget—actively developing capabilities, such as new ground- or air-launched ASATs, that might be seen in a relatively short time.

In our view, this situation is unlikely to change in the near term. A space war-fighting strategy faces a serious budgetary constraint—compounded by the overall pressures on the DoD budget that have emerged over the last year—that we believe will leave new military missions perennially vulnerable in the annual appropriations process to a variety of political and technical objections. Furthermore, ASATs, space-based missile defenses, and space-based strike weapons cannot be deployed without the completion of a very capable supporting infrastructure to provide command, control, and intelligence (C2I) functions. Yet, current programs to “recapitalize” current U.S. space and C2I capabilities are experiencing dramatic delays and cost overruns that threaten to consume the entire military space budget, leaving little money for new military missions in space.

“Virtually every major space acquisition program,” the House Armed Services Committee (HASC) has observed, “has experienced or sits dangerously close to a Nunn-McCurdy breach” —a dramatic cost-growth requiring extraordinary intervention to save the program from cancellation.<sup>76</sup>

The Congressional Budget Office estimates that current space acquisition efforts will cost between \$10 billion and \$14 billion a year by 2010.<sup>77</sup> Congressional appropriators have stated clearly that the Pentagon must reduce its request for space systems. In the 2006 Defense Appropriations bill, Congress slashed funding for two of the Air Force’s ‘transformational’ space acquisition efforts—Space Radar and the Transformational Satellite System—to emphasize this point. Congressional concerns have also led to the restructuring of a pair of classified spy satellite programs.<sup>78</sup> Senator Wayne Allard, Republican-Colorado, a long-time supporter of military space programs, expressed the frustration of many members of Congress: “I strongly believe the continued mismanage-

ment of our space acquisition programs is a far greater threat to our space dominance than any external danger.”<sup>79</sup>

## NOTES

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2. *Final Report of the Commission to Assess United States National Security Space Management and Organization* (hereinafter Rumsfeld Commission report), Jan. 11, 2001, p. 87, <[www.defenselink.mil/pubs/space20010111.pdf](http://www.defenselink.mil/pubs/space20010111.pdf)>.
3. U.S. Air Force, *Counterspace Operations: Air Force Doctrine Document 2–2.1*, Aug. 2, 2004, p. 1.
4. See interview of Dr. Richard L. Garwin in Azimuth Media, *Arming the Heavens: The Push for Space Weapons* (documentary film) (Washington DC: Azimuth Media, 2004).
5. Air Force Material Command, “Microsatellite Propulsion Experiment Industry Day,” SpaceRef.com website, <[www.spaceref.com/news/viewsr.html?pid=13807](http://www.spaceref.com/news/viewsr.html?pid=13807)>.
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9. *Ibid.*, Chapter 6, p. 2.
10. Air Force Space Command, *Strategic Master Plan: FY 04 and Beyond*, November 5, 2002, p. 3.
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12. *The U.S. Air Force Transformation Flight Plan 2003*, Annex D.
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15. *Counterspace Operations: AFDD 2–2.1*. While the Air Force doctrine on counterspace fails to discuss a preference for less than lethal means, the *Joint Doctrine for Space Operations*, which in theory “outranks” the Air Force document, does note such a preference.
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17. Ann Imse, “U.S. deploys weapon to attack satellites,” *Rocky Mountain News*, Oct. 2, 2004; Jeffrey Lewis, “Counter Satellite Communications System Deployed,” Arms Control Wonk.com website, <[www.armscontrolwonk.com](http://www.armscontrolwonk.com)>. According to our definition, this would not be considered a space weapon, notwithstanding Air Force pronouncements, since it is a ground-based jammer. Nonetheless, it is significant that the Air Force considers it a counterspace weapon.
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24. White House Office of the Press Secretary, Press Release, Oct. 14, 1997, "Press Briefing: OMB Director Frank Raines, NSC Senior Director for Defense Policy and Arms Control Bob Bell and Deputy Defense Secretary John Hamre on the Line-Item Veto," <[www.clintonfoundation.org/legacy/101497-press-briefing-by-raines-bell-hamre-on-the-line-item-veto.htm](http://www.clintonfoundation.org/legacy/101497-press-briefing-by-raines-bell-hamre-on-the-line-item-veto.htm)>.
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26. Matt Bille, Robyn Kane, and Mel Nowlin, *Military Microsatellites: Matching Requirements and Technology*, American Institute of Aeronautics and Astronautics (AIAA) document AIAA-2000-5186, Sept. 19–21, 2000, p. 9.
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29. Col. Gail Wastowicz, comments delivered at the American Enterprise Institute conference, "The Future of the U.S. Air Force," Washington DC, October 11, 2005.
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34. The DoD High Energy Laser Test Facility is funded out of the Army Budget as Program Element 0605605A. See Dept. of the Army, Office of the Secretary of the Army (Financial Management and Comptroller), *Supporting Data FY 2006/2007 President's Budget*,



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  44. Kerry Gildea, "Space Command Chief Questions Value of KE-ASAT," *Defense Daily* 209 (March 29, 2001); Charles Aldinger, "General Warns: High-Tech Warfare Could Litter Space with Debris," Reuters, March 28, 2001, <[www.space.com/news/spaceagencies/space\\_war\\_debris\\_010328\\_wg.html](http://www.space.com/news/spaceagencies/space_war_debris_010328_wg.html)>.
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62. CAV Budget Submission. See also, *MNS AFSPC 002-01, Prompt Global Strike* (Air Force Space Command, 2003).
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65. Continental United States.
66. *U.S. Air Force Transformation Flight Plan 2003*, p. 65 and Annex D.
67. *U.S. Air Force Transformation Flight Plan 2003*, p. 66 and Annex D. While the *Transformation Flight Plan* and initial budget descriptions of CAV cited an option for on-orbit basing, Pentagon officials in recent months have insisted that internal Air Force studies have proven that on-orbit basing makes little cost-benefit sense.
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APPENDIX 1

Selected Space Research in the President’s FY2006 Budget Request (All amounts in millions of dollars)

R1	PE	Project	Program	Service	2004	2005	2006	+/-	2007	2008	2009	2010	2011
35	0603006A		Command, Control, Communications Advanced Technology	USA	9.3	9.5	12.1	-2.3	11.0	11.1	6.4	6.4	6.5
		592	Space Application Technology		5.4	6.8	9.1	-5.3	11.0	11.1	6.4	6.4	6.5
57	0603308A		Army Missile Defense Systems Integration (DEM/VAL)	USA	34.7	32.1	9.3	1.0	14.8	13.4	16.3	23.0	23.7
		978	Space Control		0.9	0.9	1.0	0.0	2.7	6.2	6.9	12.8	12.6
139	0605605A	E97	DOD HELSTF		18.2	15.1	17.7	1.1	18.4	19.1	19.2	19.7	2.0
26	0603401F		Advanced Spacecraft Technology	USAF	105.6	89.8	60.9	-5.0	67.2	78.7	84.1	92.4	94.1
		2181	Spacecraft Payloads		32.5	26.8	19.0	0.7	18.9	25.6	28.3	30.1	30.7
		3834	Integrated Space Technology Demonstrations [XSS]		30.2	23.4	22.0	-3.1	26.3	29.1	32.3	35.5	36.1
27	0603444F		Maui Space Surveillance System		50.2	58.2	5.8	-0.5	6.0	6.1	6.6	6.7	6.9
28	0603500F		Multi-disciplinary Adv Dev Space Technology	USAF	58.2	56.9	27.0	-32.6	68.6	69.5	72.5	77.9	82.8
		5031	Advanced Optics & Laser Space Technology		18.1	19.0	20.9	-1.9	21.2	22.2	22.0	28.2	28.7
		5034	Advanced Space Sensors		6.1	9.4	7.2	-1.5	12.0	12.8	12.8	7.9	8.1
45	0603438F		Space Control Technologies	USAF	13.0	14.9	14.2	0.1	23.3	31.0	41.1	42.1	42.8
		2611	Technology Insertion Planning and Analysis		8.8	8.6	9.5	0.0	12.7	16.0	21.1	21.6	22.0
		A007	Space Range		4.2	6.3	4.7	0.0	10.6	15.0	20.0	20.4	20.8
49	0603845F		Transformational SATCOM	USAF	325.1	467.2	835.8	-356.6	1068.2	1928.8	2390.0	2462.8	1917.4
53	0603858F		Space-Based Radar DEM/VAL	USAF	165.1	73.8	225.8	-240.4	356.2	568.5	1068.4	1315.8	1410.7
60	0604855F		Operationally Responsive Launch	USAF	21.5	33.1	23.5	0.1	35.5	41.3	74.9	76.3	77.4
61	0604856F		Common Aero Vehicle	USAF	17.0	16.5	27.4	0.2	32.5	31.7	39.8	92.7	94.1
75	0604421F		Counterspace Systems	USAF	70.7	26.1	24.7	-3.1	30.5	30.7	75.0	76.7	78.0
		A001	Counter Satellite Communications System		13.1	6.1	6.4	0.0	6.6	6.8	7.0	7.2	7.3
		A002	Counter Surveillance Reconnaissance System		49.5	0.2	0.0	-5.0	0.0	0.0	0.0	0.0	0.0
		A003	Rapid Identification Detection and Reporting System (RAIDRS)		8.2	16.2	18.3	-1.8	23.9	23.9	68.0	69.5	70.7
		A005	Offensive Counterspace (OCS) C2		0.0	3.5	0.0		0.0	0.0	0.0	0.0	0.0
77	0604441F		Space-Based Infrared Systems (SBIRS) High EMD	USAF	621.8	594.2	756.6	383.2	653.7	532.6	382.1	336.7	269.0
206	0305910F		SPACETRACK	USAF	90.8	139.0	151.1	0.3	210.6	354.6	431.6	598.6	593.3
		4930	Space-Based Space Surveillance		57.4	81.5	84.2	-0.2	109.9	192.9	201.4	292.1	206.1

APPENDIX (Continued)

R1	PE	Project	Program	Service	2004	2005	2006	+/-	2007	2008	2009	2010	2011
		5011	Space Situational Awareness Initiatives		11.9	12.0	16.3	0.1	11.1	9.5	8.1	8.5	8.6
		A008	Sensor Service Life Extension Programs (Sensor SLEPs)		17.8	36.8	25.5	0.3	31.1	10.7	0.5	0.3	0.2
		A009	Orbital Deep Space Imager (ODSI)		3.7	8.8	25.1	0.1	58.4	141.6	221.6	297.7	378.4
29	0603175C		<b>Ballistic Missile Defense Technology</b>	MDA	226.8	231.1	136.2	-63.2	184.9	197.2	205.2	212.4	218.8
33	0603287E		<b>Space Programs and Technology</b>	DARPA		222.9	223.8	-10.7	264.3	309.3	327.4	348.7	350.7
			Orbital Express		44.4	46.6	38.8		15.6				
			Space Surveillance Telescope		10.6	18.7	18.6		12.8				
			FALCON		17.5	12.5	25.0		50.0				
			Innovative Space-Based Radar Antenna Technology (ISAT)		41.2	46.0	45.0		43.0				
			Deep View		9.5	14.3	10.3		10.3				
			Spacecraft for the Unmanned Modification of Orbits				12.6		22.4				
50	0603765E		<b>Classified DARPA Programs</b>	DARPA	211.2	180.8	162.5						
70	0603882C		<b>Ballistic Missile Defense Midcourse Defense Segment</b>	MDA	3711.7	4501.5	3266.2	198.4	3946.0	3650.8	3315.5	3183.6	2545.9
			Multiple Kill Vehicles				82.0		219.6	272.9	306.5	308.2	113.5
73	0603884C		<b>Ballistic Missile Defense Sensors</b>	MDA	417.8	577.3	529.8	-260.4	995.7	1214.0	1186.1	1069.2	1018.6
			Space Tracking and Surveillance System		274.9	303.6	231.7	-281.7	420.4	533.8	614.2	758.8	98.1
	0812		Space Tracking and Surveillance System (STSS) Block 2006		262.8	255.8	231.2		208.2	64.5	11.1	7.7	7.1
	0912		Space Tracking and Surveillance System (STSS) Block 2008		0.0	0.0	0.0		45.2	29.3	24.1	14.1	13.8
	0012		Space Tracking and Surveillance System (STSS) Block 2010		12.1	47.8	0.0		0.0	0.0	0.0	0.0	0.0
	R112		Space Tracking and Surveillance System (STSS) Block 2012		0.0	0.0	0.5		167.0	440.0	579.0	737.0	77.3
74	0603886C		<b>Ballistic Missile Defense System (BMDs) Interceptor</b>	MDA	114.7	279.8	229.7	-888.9	444.9	677.2	1137.3	1468.8	1717.5
	R216		Space-Based Interceptors Test Bed			10.5	0.0		0.0	45.0	150.0	248.0	230.0
			Near Field Infrared Experiment (NFIRE)		44.5	68.0	13.7		10.8				
78	0603891C		<b>Special Programs (formerly ACES)</b>	MDA		231.2	349.5		482.9	826.2	1097.3	1015.2	1244.1
			<b>All Program Elements</b>		6265.2	7613.1	6848.1		8632.5	10263.5	11630.1	12157.4	11441.4
			<b>Space Control, Force Projection and related programs</b>		1787.8	2114.3	2695.3		3423.8	4793.2	6016.4	6792.9	5404.5
			<b>Weapons</b>		247.8	218.5	247.8		435.0	494.3	653.2	819.1	610.3
			<b>Weapons as a percentage</b>		14%	10%	9%		13%	10%	11%	12%	11%

## APPENDIX 2

### How to Read the Tables in this Article

The information in these tables is largely drawn from the “descriptive summaries” (R2s) that the Department of Defense submits to Congress as part of the President’s Annual Budget Request (PBR), also known as the Future Years Defense Program (FYDP).

R1	PE	Program	2004	2005	2006	2007	2008	2009	2010	2011
26	0603401F	Advanced Spacecraft Technology	105.6	89.8	60.9	67.2	78.7	84.1	92.4	94.1

**R1:** The Summary Budget Justification Material submitted by the Defense Department contains a list of Research and Development Programs called the “R1.” These programs are numbered sequentially by DOD Component (Army, Navy, Air Force and Defense Wide).

**Program Element (PE):** The Program Element Number is the “building block” of Defense budgeting.

The first pair of numbers—06—indicates that the program element falls under research and development. The second pair of numbers—03—indicates the “budget activity” or level of development (at right).

Budget Activity
01: Basic Research
02: Applied Research
03: Advanced Technology Development
04: Advanced Component Development and Prototypes
05: System Development and Demonstration
06: RDT&E Management Support
07: Operational Systems Development

The final three numbers distinguish one program element from another.

The final letter indicates the “component”—Armed Service or Defense Agency—that is responsible for the work. In the unclassified budget, most space accounts are assigned to the Army (A), Air Force (F), Defense Advanced Research Projects Agency (E), and Missile Defense Agency (C).

Therefore, PE 06 03 401 F is an Air Force (F) Research and Development Program (06) in the Advanced Technology Development Stage (03). To know whether Congress appropriated the full amount requested by the president, look at the 26th entry under *Research and Development—Air Force* in the appropriations legislation.

The FYDP also contains recent appropriations (2004 and 2005), the current request (2006), and anticipated future requests (2007–2011).