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## **Military Role in Space Control: A Primer**

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# Military Role in Space Control: A Primer

## Summary

This report reviews Department of Defense (DOD) military space control efforts and related policy and resources. Since the 1991 Gulf War, U.S. military forces have become increasingly reliant on space resources for communications, intelligence imagery, weather, warning, navigation, and timing. Asserting that U.S. space assets have become an integral part of today's warfare, the Department of Defense (DOD) has begun to emphasize the importance of protecting these resources. Although U.S. military space systems have been relatively unchallenged, military leaders anticipate increasing threats to these systems, because they provide a significant military advantage.

DOD defines space control as “the combat, combat support, and combat service support operations to ensure freedom of action in space for the United States and its allies and, when directed, deny an adversary freedom of action in space.” DOD space control initiatives are embryonic and mostly represent legacy resources used for space surveillance. The DOD budget, however, identifies early stages of developing counterspace measures.

Military space control efforts, like many other facets of military space, are in a significant phase of transition. The ability of the United States to harness “space power” may be critical to victory on the battlefield, especially as information dominance becomes more pervasive in the ensuing evolution of network centric warfare. Congress might be faced with decisions involving the projection of military operations into space, survivability of space systems, and DOD programs to promote a continual awareness of activities in space. This report will not be updated.

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# Military Role in Space Control: A Primer<sup>1</sup>

## Introduction

The Secretary of Defense asserts that “Space is the ‘ultimate high ground.’”<sup>2</sup> Since the 1991 Gulf War, U.S. military forces have become increasingly reliant on space resources for communications, intelligence imagery, weather forecasting, warning, navigation, and timing. Space-based services facilitate rapid collection, transmission, and dissemination of information to U.S. forces and decision makers. Consequently, some say, space is becoming an area the United States may have to protect.

Space control is one of four national security space mission areas defined in the current National Space Policy (1996).<sup>3</sup> DOD defines space control as the “combat, combat support, and combat service support operations to ensure freedom of action in space for the United States and its allies and, when directed, deny an adversary freedom of action in space.”<sup>4</sup> Space control describes the means to ensure U.S. forces have unhampered access to space and space-based services and to deny an enemy the advantages of space capabilities. Counterspace operations support the space control mission and consist of “those operations conducted to attain and maintain a desired degree of space superiority by allowing friendly forces to exploit space capabilities while negating an adversary’s ability to do the same.”<sup>5</sup>

Congress might be faced with decisions involving the increased projection of military operations into space, the survivability of space systems, and oversight of

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<sup>1</sup> Prepared under the supervision of Edward F. Bruner, Specialist in National Defense, Foreign Affairs, Defense, and Trade Division.

<sup>2</sup> “Testimony of U.S. Secretary of Defense Donald H. Rumsfeld prepared for the House Armed Services Committee hearing on 2003 Defense Budget Request,” February 6, 2002, p. 11. A copy of the testimony can be found at the website of the House Armed Services Committee at [<http://www.house.gov/hasc>].

<sup>3</sup> The White House, “Fact Sheet on National Space Policy” (as defined by Presidential Decision Directive 8/National Science and Technology Council), September 19, 1996, p. 3-4. A copy of the document can be found at the website of the Office of Science and Technology Policy, Executive Office of the President, at [<http://www.ostp.gov/NSTC/html/pdd8.html>].

<sup>4</sup> U.S. Department of Defense, *Joint Chiefs of Staff, Joint Doctrine for Space Operations*, Joint Publication 3-14, August 9, 2002, p. GL-6. A copy of the document can be found at the Joint Electronic Library at [<http://www.dtic.mil/doctrine/jpoperationsseriespubs.htm>].

<sup>5</sup> U.S. Air Force, *Space Operations*, Air Force Doctrine Document 2-2, November 27, 2001, p. 12. A copy of the document (AFDD 2-2) can be found at the official site for Air Force administrative publications at [<http://www.e-publishing.af.mil>].

DOD programs to promote a continual “situational awareness” of activities in space. This report reviews DOD military space control efforts and related policy and resources.<sup>6</sup>

## Military Reliance on Space Systems

Military space control seeks to preserve the military advantage the U.S. military gains from space. Whether in the form of global communications, Intelligence Surveillance and Reconnaissance (ISR), navigation signals, meteorological information, or missile warnings, the most important commodity offered from space may be information. On March 25, 2004, during his testimony to the Senate Subcommittee on Strategic Forces, Retired Vice Admiral Arthur K. Cebrowski, Director of Force Transformation, Office of the Secretary of Defense, stated,

Transformation across the force is happening much faster than we expected when we announced the journey just 28 months ago. Not just a concept and not just action in the future, transformation is happening today. It's happening due in large part to information and power derived from our vital space capabilities.<sup>7</sup>

Beginning with the Persian Gulf War in 1991, there has been a steady infusion of space capabilities into virtually all aspects of U.S. military operations — navigation, communications, meteorology, missile warning, and targeting information management.<sup>8</sup> The most prominent example includes the use of Global Positioning System (GPS)-guided precision munitions. In 1999, GPS-guided weapons demonstrated all-weather precision strike capability during Operation Allied Force in Serbia and in Kosovo. During the Afghanistan conflict in 2001, precision munitions comprised two-thirds of all the bombs dropped during the first two months of the war. Of those precision munitions, 64 percent were GPS-guided Joint Direct Attack Munitions.<sup>9</sup>

Military reliance on space also extends to commercial and civil space resources. According to Army General Joseph Cosumano, Commander of U.S. Army Space and Missile Defense Command and Army Space Command, during Operation Iraqi Freedom, over 70 percent of military communications were provided by commercial

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<sup>6</sup> For more information, see CRS Issue Brief IB92011, *U.S. Space Programs: Civilian, Military, and Commercial*, by Marcia S. Smith.

<sup>7</sup> “Statement of Arthur K. Cebrowski, Director of Force Transformation, Office of the Secretary of Defense, before the Subcommittee on Strategic Forces Armed Services Committee, United States Senate,” March 25, 2004, p. 2. A copy of the testimony can be found at the website of the House Armed Services Committee at [<http://www.house.gov/hasc>].

<sup>8</sup> Preston, Bob, and Baker, John, “Space Challenges” in *Strategic Appraisal: United States Air and Space Power in the 21<sup>st</sup> Century*, Khalilzad, Zalmay and Shapiro, Jeremy, editors, Project Air Force, 2002, p. 154-156. Published 2002 by RAND. This document may be obtained at [<http://www.rand.org>].

<sup>9</sup> *Ibid*, p. 155, footnote 13.

satellites.<sup>10</sup> According to a threat analysis from the U.S. Naval Postgraduate School, U.S. military dependence on space systems may continue to outpace DOD budget and production capability. The analysis concludes that DOD may have to continue looking to the commercial and civil sectors to satisfy a portion of its space service requirements.<sup>11</sup>

## Vulnerability of U.S. Military Space Resources

Space systems consist of three segments: the space segment containing satellites, the ground segment that controls the system operations, and the electromagnetic links that connect the space segment to the ground segment. The most significant threats to space systems may be the physical, electronic, and information warfare threats faced by the personnel, facilities, and equipment comprising the ground segment and the links to and from the space segment. However, the possibility also exists for the emergence of threats to U.S. space-based satellite systems.<sup>12</sup> In January 2001, the report of the *Commission to Assess United States National Security Space Management and Organization* (the commission is also called the “Space Commission”), made a statement about the susceptibility of U.S. space systems. The report states,

The relative dependence of the U.S. on space makes its space systems potentially attractive targets. Many foreign nations and non-state entities are pursuing space-related activities. Those hostile to the U.S. possess, or can acquire on the global market, the means to deny, disrupt, or destroy U.S. space systems by attacking satellites in space, communications links to and from the ground, or ground stations that command the satellites and process their data...An attack on elements of U.S. space systems during a crisis or conflict should not be considered an improbable act. If the U.S. is to avoid a “Space Pearl Harbor” it needs to take seriously the possibility of an attack on U.S. space systems.<sup>13</sup>

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<sup>10</sup> Roosevelt, Ann, “Space Control Vital for Future Operations, General Says,” *Defense Daily*, November 3, 2003, p. 11-12.

<sup>11</sup> Douglas, Michael L., and Gray, Arlene J., *The Warfighters’ Counterspace Threat Analysis (WCTA): A Framework for Evaluating Counterspace Threats*, September 2000, Naval Postgraduate School, Monterey, California, p. 16.

<sup>12</sup> Baines, Phillip J., “Prospects for Non-Offensive Defenses in Space” in *New Challenges in Missile Proliferation, Missile Defense, and Space Security*, James Clay Moltz, editor, Center for Nonproliferation Studies, Occasional Paper No. 12, July 2003, p. 31-33. This paper may be found at the website of the Monterey Institute of International Studies (MIIS), Center for Nonproliferation Studies (CNS), [<http://www.cns.miis.edu>].

<sup>13</sup> *Report of the Commission to Assess United States National Security Space Management and Organization*. Pursuant to Public Law 106-65, Washington, D.C., January 11, 2001, p. viii-ix. This report is available at [<http://www.defenselink.mil/pubs/spaceintro.pdf>]. A synopsis of the report is provided in CRS Report RS20824, *Military Space Activities: Highlights of the Rumsfeld Commission Report and Key Organization and Management Issues*, by Marcia S. Smith, February 21, 2001.

A wide range of military space control options may help mitigate possible threats. Broad-based space control concepts include offensive and non-offensive means. Offensive methods may include directed energy weapons (DEW) which include radio frequency weapons, lasers, and particle beam weapons.<sup>14</sup> Offensive weapons may also include kinetic energy weapons (KEW) which would use the kinetic energy of a direct impact, or pass close enough to a target for shrapnel from an exploding device to destroy it.<sup>15</sup> Non-offensive techniques include passive defense methods that protect a satellite from attack or minimize the effects of an attack, such as hardening, shielding, or redundancy (e.g., fielding many satellites, so that the loss of one is minimized). Other non-offensive methods may include active defensive means which avoid or minimize the impact of attack by maneuvering a space vehicle to avoid damage or rapidly reconstituting a system if it has been damaged during an attack.<sup>16</sup> Refer to Appendix-1 for descriptions of other space control techniques that may be explored.

## Impacts of Possible Attacks

Attacks on U.S. space assets — military, commercial, or civil — may reduce or eliminate the military effectiveness gained by terrestrial warfighters from space systems. Tom Wilson, former Space Commission staff member, states, “As harmful as the loss or degradation of commercial or civil assets would be, an attack on intelligence and military satellites would be even more serious for the nation in time of crisis or conflict.”<sup>17</sup> In a threat assessment prepared for the Space Commission, Wilson outlines several scenarios of how an attack on U.S. space assets would affect military forces. They include:<sup>18</sup>

- Impairing or eliminating reconnaissance satellites would reduce situational awareness and could lead to military surprise, an underestimation of enemy strength and capabilities, less effective planning, and less accurate targeting and battle damage assessments;

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<sup>14</sup> Spacy, William, “Assessing the Military Utility of Space-Based Weapons,” in *Space Weapons: Are They Needed?* Logsdon, John M. and Adams, Gordon, editors, Space Policy Institute, Security Policy Studies Program, Elliott School of International Affairs, The George Washington University, Washington, D.C., October 2003, p. 123. A copy of this report may be found at the George Washington University, Space Policy Institute website at [<http://www.gwu.edu>].

<sup>15</sup> *Ibid*, p. 132.

<sup>16</sup> Baines, p. 39-43.

<sup>17</sup> Wilson, Tom, *Threats to United States Space Capabilities*, Prepared for the Commission to Assess United States National Security Space Management and Organization, January 2001, p. 40. This report may be found at the Federation of American Scientists website, [<http://www.fas.org>]. The information presented in this paper is based on research done by the author. Although it was prepared for the Commission in conjunction with its deliberations, the opinions expressed in this paper are those of the author and do not represent those of the Commission or any of the Commissioners.

<sup>18</sup> *Ibid*.

- Impairing or eliminating satellite communications systems would disrupt troop command and control at all force levels;
- Impairing or eliminating weather satellites and earth observation systems would make it more difficult to plan effective military operations;
- Impairing or eliminating navigation satellites would make troop movements more difficult, aircraft and ship piloting problematic, and could render many precision-guided weapon systems ineffective or useless; and
- Impairing or eliminating satellites that detect missile launches would degrade U.S. ability to perform missile launch warning, missile defense, and could increase the psychological impact of an adversary's missile attacks.

## Possible Threats and Key Players

In future conflicts, potential U.S. opponents may possess technologies that will challenge U.S. space-based capabilities. Adversaries might attempt to jam satellite uplinks or downlinks. This would make commercial systems, wideband services, and small mobile users most vulnerable.<sup>19</sup> In the summer of 2003, a group of Iranians operating in Cuba disrupted a U.S.-built commercial satellite communications transponder carrying a broadcast (Voice of America) to the Middle East.<sup>20</sup> This example and the attempted jamming of GPS signals by Iraqi forces in Operation Iraqi Freedom may suggest that future adversaries are willing and able to attack America's military and commercial space capabilities by this method.<sup>21</sup>

Because of trends in technology proliferation, globalization of space industries, and commercialization of space systems, many countries may have the capability to deploy technologies that can impede U.S. space systems and the ground facilities that command them. An opponent may exploit electronic countermeasures to disrupt satellite navigation signals or may choose to develop laser-like means to "dazzle" imagery and sensing systems. More technically sophisticated opponents may choose

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<sup>19</sup> Preston and Baker, p. 167-170.

<sup>20</sup> Department of the Air Force, U.S. Air Force Space Command, "Strategic Master Plan FY2006 and Beyond," October 1, 2003, p. 21. This document may be found at the website of Air Force Space Command at [<http://www.peterson.af.mil/hqafspc>]. Butler, Amy, "Heavy DOD Reliance on Commercial SATCOM Prompts Questions of Protection," *Defense Daily*, April 13, 2004, p. 1.

<sup>21</sup> Air Force Space Command, "Strategic Master Plan FY2006 and Beyond," October 1, 2003, p. 21.



to develop direct ascent anti-satellite interceptors or ground-based high-energy lasers to use against low altitude satellites.<sup>22</sup>

## National Space Policy

Presidential Decision Directive/National Science and Technology Council (PDD/NSTC)-8 defines U.S. national space policy. Directed by President Clinton on September 19, 1996, the policy identifies key space activities to be conducted in the interest of U.S. national security. It designates the Secretary of Defense and the Director of Central Intelligence as the responsible officials for overseeing these actions. The policy directs the following national security space activities:<sup>23</sup>

- Providing support for the United States' inherent right of self-defense and for the defense of allies and friends;
- Assuring mission capability and access to space;
- Deterring, warning, and, if necessary, defending against enemy attack;
- Ensuring that hostile forces cannot prevent the United States from using space;
- Ensuring that the United States has the ability to conduct military and intelligence activities in space;
- Enhancing the operational effectiveness of U.S. and allied forces;
- Countering, if necessary, space systems, and services used for hostile purposes;
- Satisfying military and intelligence requirements during peace, crisis, and all levels of conflict; and
- Supporting the activities of national policy-makers, the Intelligence Community, the National Command Authorities (NCA), Military Services, and other Federal officials.

Addressing military space control, PDD/NSTC-8 directs that “consistent with treaty obligations, the United States will develop, operate, and maintain space control capabilities to ensure freedom of action in space and, if directed, deny such freedom of action to adversaries.” The policy directs that space control capabilities may also be “enhanced by diplomatic, legal, or other military measures to preclude an

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<sup>22</sup> Preston and Baker, p. 169. The Soviet Union fielded a co-orbital antisatellite system. It is not currently thought to be operational. See CRS Issue Brief IB85176, *ASATs: Antisatellite Weapon Systems*, by Marcia S. Smith. This archived issue brief is available on request from its author.

<sup>23</sup> Fact Sheet on National Space Policy (PDD-NSTC-8), p. 3.

adversary's hostile use of space systems and services.”<sup>24</sup> On June 28, 2002, President George W. Bush directed the National Security Council (NSC) to chair a review of national space policies to focus on possible “revision, consolidation, or elimination of the existing national space policy statements related to space activities, and report to the NSC Deputies Committee by February 28, 2003.”<sup>25</sup> To date, the NSC has not made any public recommendations to revise the current policy.

## DOD Space Policy

Following directly from the 1996 National Space Policy, Secretary of Defense William S. Cohen issued Department of Defense Directive (DODD) 3100.10, “Space Policy,” on July 9, 1999. Before this directive, the last major revision of DOD space policy was in 1987. A memo from Secretary Cohen, which accompanies the DOD directive, states:

Space is a medium like the land, sea, and air within which military activities shall be conducted to achieve U.S. national security objectives. The ability to access and utilize space is a vital national interest because many of the activities conducted in the medium are critical to U.S. national security and economic well-being.<sup>26</sup>

Specifically addressing space control and the defense of the United States, Secretary Cohen stated:

The capability to control space, if directed, will contribute to achieving the full dimensional protections, battlespace dominance, and information superiority necessary for success in military operations.<sup>27</sup>

DODD 3100.10 establishes DOD policy and assigns responsibility for space activities within DOD. The following are some of the policies that DODD 3100.10 identifies relating to military space control.<sup>28</sup>

- Ensuring the freedom of space and protecting U.S. national security interests in the medium are priorities for space and space-related activities. U.S. space systems are national property afforded the right of passage through space and the right to operation in space without interference; and

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<sup>24</sup> Ibid, p. 4.

<sup>25</sup> The White House, *Fact Sheet On National Space Policy Review*, National Security Presidential Directive/NSPD-15, June 28, 2002, p. 1.

<sup>26</sup> U.S. Department of Defense, Department of Defense Directive 3100.10, *Space Policy*, July 9, 1999, p. 2. This document may be found at the Washington Headquarters Services website at [<http://www.dtic.mil/whs/directives>].

<sup>27</sup> Ibid, p. 3.

<sup>28</sup> Ibid, p. 6-7.

- Purposeful interference with U.S. space systems will be viewed as an infringement on U.S. sovereign rights. The U.S. may take all appropriate self-defense measures, including, if directed by the National Command Authorities (NCA), the use of force, to respond to such an infringement on U.S. rights.

## **Space Control Mission and Counterspace Operations**

Counterspace operations implement the space control mission. Air Force Doctrine Document 2-2 (AFDD 2-2), Space Operations, states the purpose of counterspace operations is to “attain and maintain a desired degree of space superiority by allowing friendly forces to exploit space capabilities while negating an adversary’s ability to do the same.”<sup>29</sup> AFDD 2-2 further defines counterspace operations as consisting of three sub-missions: Space Situational Awareness (SSA), Defensive Counterspace (DCS), and Offensive Counterspace (OCS). The SSA mission includes “traditional space surveillance, reconnaissance of space assets, collecting and processing of space intelligence data, and the analysis of the space environment.” Defensive Counterspace operations serve to safeguard the ability to “exploit space by protecting space capabilities from enemy attack or interference.” Offensive Counterspace operations “preclude an adversary from exploiting space to his advantage.”<sup>30</sup>

## **DOD Space Control Initiatives and Priorities**

DOD space control initiatives explore a mix of key technological capabilities and emphasize the protection of national security interests against known vulnerabilities and credible threats. On February 25, 2004, in his statement before the House Armed Services Committee’s Subcommittee on Strategic Forces, Peter B. Teets, Under Secretary of the Air Force, described the near and mid-term DOD space control initiatives and priorities to ensure freedom of action in space. DOD near-term initiatives investigate new space surveillance capabilities and ways to integrate them into space systems that enhance space situational awareness. DOD is investing to improve the ability to detect, track, and characterize objects in space. By upgrading to new hardware on selected radar and optical sensors, DOD endeavors to modernize the Space Surveillance Network and establish it as the mainstay for space situation awareness. DOD seeks to integrate improved SSN sensor data with space intelligence and environment data to produce a common “space picture” for military decision-makers.<sup>31</sup>

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<sup>29</sup> Air Force Doctrine Document 2-2, p. 12.

<sup>30</sup> Ibid, p.12-14.

<sup>31</sup>“Statement by the Under Secretary of the Air Force, The Honorable Peter B. Teets, before the Committee on Armed Services, United States House of Representatives Subcommittee (continued...)”

Space control may also involve the use of “antisatellite” (ASAT) weapons to prevent a satellite from performing its mission through destroying it or damaging its sensors. The Army is currently developing a Kinetic Energy Antisatellite (KEAsat) system, using ground-launched interceptors that would destroy a satellite through impact, although the program does not have widespread DOD support. In recent years, for example, Air Force officials have expressed concerns about these types of weapons because of collateral damage that could be caused to U.S. and allied satellites from resulting debris. DOD has not requested funding for KEAsat in many years, but Congress added money for it in FY1996, FY1997, FY1998, FY2000, FY2001, and FY2004. The KEAsat program was initiated in 1989 after the Air Force discontinued an earlier ASAT development program in which the interceptor was launched from an F-15 aircraft. Several tests of that ASAT device were conducted, but congressional restrictions on tests against objects in space led the Air Force to cancel the program in 1988.<sup>32</sup> Congressional interest in restricting tests against objects in space has been renewed by the Missile Defense Agency’s (MDA’s) Near Field Infrared Experiment (NFIRE) to study exhaust plumes from rockets to assist in the design of sensors for other MDA systems. NFIRE is designed to carry one sensor on the main NFIRE spacecraft, and a second sensor on a “Kinetic Kill Vehicle” (KKV) that would be ejected from the main spacecraft to make very close observations of a rocket’s plume. MDA’s FY2005 budget documentation noted that the KKV might impact the rocket, stimulating debate over whether it was a type of ASAT or space-based weapons test. DOD reportedly is close to deciding to delete that part of the mission to assuage congressional concerns.<sup>33</sup>

Under Secretary Teets described DOD near- to mid-term plans to deploy two new space-based surveillance and characterization sensors: Space Based Space Surveillance (SBSS) and Orbital Deep Space Imager (ODSI). SBSS would be a constellation of optical sensing satellites in low-earth orbit designed to provide timely and accurate information on satellite locations. The first SBSS satellite is planned to launch in FY2007. Once operational, the system is to improve U.S. ability to detect deep-space objects by 80 percent over the current system. The second new system, ODSI, would be a constellation of geo-synchronous orbit

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(...continued)

on Strategic Forces regarding the Fiscal Year 2005 National Defense Authorization Budget Request: Status of the Space Programs,” February 25, 2004, p. 7-8. A transcript of this testimony may be found at the website of the House Armed Services Committee at [<http://www.armedservices.house.gov>].

<sup>32</sup> The F-15 ASAT program itself was a follow-on to an earlier Air Force ASAT system that used ground-launched nuclear interceptors based at Johnston Island. That system was deactivated in 1975. The U.S. also has performed research on other types of ASAT weapons, such as ground-based lasers. For more information on the history of the U.S. ASAT program, see CRS Issue Brief IB85176, *ASATs: Antisatellite Weapons Systems*, by Marcia S. Smith. This archived issue brief is available directly from its author.

<sup>33</sup> For information on the KEAsat program, NFIRE, and other space control activities, see CRS Issue Brief IB92011, *U.S. Space Programs: Civilian, Military and Commercial*, by Marcia S. Smith.

satellites that is to provide a significant improvement in the ability to track and characterize objects in space.<sup>34</sup>

Another defensive counterspace initiative still in development is the Rapid Attack Identification Detection and Reporting System (RAIDRS). Under Secretary Teets described RAIDRS to have the ability to detect radio frequency interference on communication satellites and the capacity to locate the attacking source on Earth. The system will also detect laser attacks attempting to disrupt missile-warning satellites, such as the Defense Satellite Program (DSP). In addition, offensive counterspace programs are developing and testing the first counter-communications systems. The first of these systems has been delivered to the 76<sup>th</sup> Space Control Squadron at Peterson AFB, Colorado. The delivery of two more of these first-generation units is expected in FY2005.<sup>35</sup>

In the FY2005 DOD appropriations act (P.L. 108-287), Congress fully funded space control, but made a net cut of \$50 million from counterspace systems, leaving \$26 million. The reduction comprised a cut of all \$53 million from the Counter Surveillance Reconnaissance System (the Senate report stated that the Air Force decided to terminate the program).<sup>36</sup>

Each military branch has “line items” identified as space control programs in their budgets. These budgets fund Operations & Maintenance (O&M) costs and Research, Development, Testing & Evaluation (RDT&E) efforts. The Air Force budget contains most of the DOD space control funds. Appendix-2 and Appendix-3 describe major space control budget activities in the President’s Budget.

## Possible DOD Long-Term Programs

In the long-term, DOD envisions a wide range of space superiority programs and systems. Appendices C and D of the 2003 Air Force Transformation Flight Plan describe space control initiatives which would explore a wide range of space situational awareness, offensive counterspace, and defensive counterspace programs.<sup>37</sup> Key unclassified SSA efforts are to include developing on-board space environment sensors to provide warning of space weather activities, such as solar flares or winds, to help rule out hostile attack as the cause of a satellite malfunction.<sup>38</sup> Key unclassified OCS initiatives are to study developing other counter-communication, counter-surveillance, and counter-reconnaissance systems. In

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<sup>34</sup> Peter B. Teets, op.cit., p. 8.

<sup>35</sup> Ibid, p. 8-9.

<sup>36</sup> S.Rept. 108-284, p. 169.

<sup>37</sup> Department of the Air Force. HQUSAF/XPXC. *U.S. Air Force Transformation Flight Plan*, November 2003, Appendices C & D, p. C-11-p. D-11. This document was produced by HQ USAF/XPXC, Future Concepts and Transformation Division. A copy of this document may be found at the Air Force Link website at [<http://www.af.mil/library>].

<sup>38</sup> Ibid, p. C-12 and p. D-4. See description of the Compact Environmental Anomaly Sensor II ACTD which is described as a SSA initiative on p. C-12.

addition, OCS efforts are to explore technology for a short pulse laser, an air-launched anti-satellite missile, a ground-based laser, a space-based radio-frequency energy weapons, and other information operations systems.<sup>39</sup> DCS efforts are intended to enhance both active and passive defensive capabilities and explore various launch concepts to create a more responsive, reliable, and affordable lift family capability which could be used to launch the next generation of responsive satellites.<sup>40</sup> Appendix-4 provides a summary of key space control programs DOD described in its transformation plan.

## Appendix 1. Space Control Methods

- **Hardening.** Hardening components on a satellite protects its receivers, amplifiers, and sensors from directed-energy weapons. Using filters and optical shutters prevents laser or microwave weapons from causing harm. Hardening a satellite makes it increasingly difficult to harm it.<sup>41</sup>
- **Shielding.** This technique keeps electromagnetic pulses (EMP) generated by nuclear detonations or weapons systems from penetrating satellite cavities and severely damaging a satellite. Metal shielding and resistant paint coats on the internal surfaces enhance survivability.<sup>42</sup>
- **Circuit Protection.** Another important protection strategy is the use of “circumvention circuits” in satellite design. During an EMP event, protective circuits switch off non-essential components to prevent possible damage by secondary nuclear or EMP attacks.<sup>43</sup>
- **Denial and Deception.** Denial prevents an adversary from gaining information about space systems by reducing the electro-optical and electro-magnetic signature of satellites. Using thermal blankets and energy-absorbing materials on satellites makes optical and heat emissions harder to detect by enemy sensors or radars. Deception is another technique. This method misleads an adversary into believing false information about a space system. The use of decoy satellites is an example of how deception could force an enemy to waste resources on false targets or withhold fire for fear that it is “shooting” at a decoy.<sup>44</sup>

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<sup>39</sup> Ibid, p. C-12

<sup>40</sup> Ibid.

<sup>41</sup> Baines, p. 40-41.

<sup>42</sup> Ibid.

<sup>43</sup> Ibid.

<sup>44</sup> Ibid, p. 39-40.

- **Maneuvering.** Satellites can maneuver to evade enemy surveillance or targeting. However, most satellites do not carry fuel for this purpose. A satellite can no longer perform its mission once its limited supply of propellant is gone. Using maneuvers to avoid threats would significantly reduce the useful life of a satellite. Developing an on-orbit refueling capability in the future could present new opportunities to consider satellite maneuvers as a cost-effective space control method.<sup>45</sup>
- **Redundancy and Reconstitution.** To increase survivability, most satellites have redundant subsystem packages to prevent single-point failures, and most system constellations have multiple satellites to provide system-level redundancy. A Launch-On-Demand (LOD) capability is another option that could quickly regenerate a constellation after an attack.<sup>46</sup>
- **Dispersion of Space Systems.** Because most satellite orbits are predictable, scattering them into various orbital altitudes and positions offers added protection. Dispersion also includes the building of networks of many smaller satellites, or micro-satellites. The “micro-sats” would operate collectively to perform the services of larger and more vulnerable satellites and result in a more survivable system.<sup>47</sup>
- **Ground Segment Security.** Ground control stations provide critical links used to operate space systems. Since terrestrial targets are much easier to destroy than targets in space, the ground control segment is probably the most vulnerable. Protecting the ground segment not only includes the hardening of facilities to survive kinetic weapons or EMP attack, but also physical, personnel, and information security measures. To protect against cyber intrusions or electronic attacks, firewalls and encryption techniques may be critical as well. In addition, mobile ground stations could be used to evade detection and attack, or assume control if a primary facility were destroyed.<sup>48</sup>
- **Stealth and Cloaking.** By minimizing energy reflection and maximizing the absorption of energy, stealth and cloaking technologies make satellites difficult to detect through use of radar, infrared, visual, or acoustic sensors. An option, in the future, may

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<sup>45</sup> Ibid, p. 41-42.

<sup>46</sup> Ibid, p. 43.

<sup>47</sup> Ibid, p. 43-44.

<sup>48</sup> Ibid, p 45.

be to camouflage a space vehicle in an “adaptive skin” that changes molecular characteristics and deflects or absorbs incoming energy.<sup>49</sup>

- **Satellite Bodyguards.** A large fleet of “satellite bodyguards” in orbit could protect vital U.S. space assets. Space-based bodyguards would function as a network of integrated micro-satellites designed to protect other satellites. These escorts would detect enemy presence and take actions to negate the threat. A bodyguard system would likely be costly and require key network components including sensor detection arrays, high-speed cross-linking communications, and a robust re-supplying launch capability.<sup>50</sup>
- **Directed Energy Weapons (DEW).** This weapon concept involves projecting intense energy to disable or destroy a satellite. DEWs would damage a satellite by using lasers, focused radio frequencies, or particle beams. The notion presents several engineering and technological challenges. One is trying to solve how to prevent the loss of energy as the beam travels through the atmosphere. Another challenge is the need to develop a highly complex targeting solution to focus a beam on a target for sufficient time to cause damage.<sup>51</sup>
- **Kinetic Energy Weapons (KEW).** KEWs generate high-velocity projectiles to destroy a target. A kinetic energy anti-satellite (ASAT) weapon may be launched from the ground, air, or space. An ASAT would approach a satellite and impact, explode, or propel shrapnel at the intended target to destroy it. “Space mines” employ a variation of the KEW concept. Pre-positioned near their intended target well before hostilities break out, a space mine waits in reserve for a signal to detonate. A significant problem with KEWs is that they could create debris and possibly present a danger to other space assets.<sup>52</sup>

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<sup>49</sup> Zielinski, Robert H., Worley II, Robert M., Black, Douglas, S., Henderson, Scott A., Johnson, David C., “Star Tek-Exploiting the Final Frontier: Counterspace Operations in 2025,” presented as part of *Air Force 2025*, a study to examine concepts, capabilities, and technologies, August 1996, p. 28-29. Department of the Air Force. Air Command and Staff College. Maxwell, AFB. AL. A copy of this report may be found at the website of the Air University, Air Force 2025 program at [<http://www.au.af.mil/au/2025>].

<sup>50</sup> Ibid.

<sup>51</sup> Chun, Clayton K. S., “Striking Out to Space: Technical Challenges to the Deployment of ASAT Weapons,” p. 28-29. in *New Challenges in Missile Proliferation, Missile Defense, and Space Security*, James Clay Moltz, editor, Center for Nonproliferation Studies Occasional Paper No. 12, July 2003. This paper may be found at the website of the Monterey Institute of International Studies (MIIS), Center for Nonproliferation Studies (CNS), [<http://www.cns.miis.edu>].

<sup>52</sup> Spacy, p. 133.



## Appendix 2. O&M Budget Activities

	FY2003	FY2004	FY2005
Air Force: Space Operations — SPACETRACK (space) <sup>a</sup>	\$65.33M	\$79.486M	\$96.198M
Air Force: Global C3I and Early Warning <sup>b</sup>	\$17.668M	\$18.275M	\$18.985M

<sup>a</sup> Department of the Air Force, *Fiscal Year (FY) 2005 Budget Estimates, Operation and Maintenance, Active Forces*, Volume 1, February 2004, p.319. This report may be found at the Defense Link website at [<http://www.defenselink.mil/comptroller/defbudget>].

<sup>b</sup> Ibid, p. 178. This budget activity group includes other space programs that are not part of the space control mission area, so they have been excluded from the budget numbers represented. “Space Control” within this budget activity makes up only a small fraction of this budget, which has a baseline of \$.97B in FY2004 and \$1.13B in FY2005.

**Air Force Space Operations.** This funding activity supports the DOD SPACETRACK program, which is a worldwide network of space surveillance sensors. The network’s electro-optical and radar sensors provide data for the following functions: space object identification and cataloging; satellite attack warning; space treaty monitoring; and scientific and technical intelligence gathering. Funding in this activity group includes support for Ground-Based Electro-Optical Deep Space Surveillance (GEODSS), HAYSTACK, Millstone, Globus II, Moron Optical System, and the Maui Space Surveillance Site.<sup>53</sup> Also included is the Air Force Space Surveillance System (formerly the Naval Space Surveillance System (NSSS)), which includes both the Air Force Space Surveillance Fence and the Alternate Space Control Center (ASCC). The AFSSS transferred from the Navy to the Air Force in FY2004.<sup>54</sup> The FY2005 request for SPACETRACK was matched by appropriations conferees.<sup>55</sup>

**Air Force Global C3I and Early Warning.** Listed under “Combat Related Operations,” the Air Force funds counterspace operations in a budget activity identified as “space control.” The program includes the acquisition of advanced counterspace systems used for counter-communications, counter-surveillance, counter-reconnaissance, and attack identification/detection. The Air Force plans to

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<sup>53</sup> Ibid, p. 318.

<sup>54</sup> Department of the Air Force, *Procurement Program, Fiscal Year (FY) 2005, Budget Estimates Other Procurement*, (February 2004), p. 234. This document provides a description of the AFSSS. This document can be found at [<http://www.saffm.hq.af.mil/FMB/pb/2005/proc.html>]; select “Other Procurement.”

<sup>55</sup> P.L. 108-287 (H.Rept. 108-622, p. 113).

field three mobile counter-communication systems in FY2004.<sup>56</sup> Appropriations conferees cut \$20 million from the FY2005 request for Global C3I and Early Warning, but the space control segment will be unaffected and thus, fully funded.<sup>57</sup>

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<sup>56</sup> *Fiscal Year (FY) 2005 Budget Estimates, O&M, Active Forces*, Volume 1, p. 176.

<sup>57</sup> Public Law 108-287. H.Rept. 108-622, p. 116, and telephone conversation between CRS and USAF Office of Legislative Liaison.

### Appendix 3. RDT&E Budget Activity

Each military service pursues RDT&E activities in space control. The Army requested, and appropriations conferees matched, \$13M in FY2005 to explore space control surveillance, negation and battle management techniques.<sup>58</sup> The Navy is pursuing space control initiatives in Space and Electronic Warfare (SEW). Appropriations conferees matched the Navy's request of \$25.9M for FY2005.<sup>59</sup> The Air Force budget funds the majority of space control RDT&E efforts and received \$252.7M in FY2005. Air Force space control initiatives are funded in FY2005 under three programs: SPACETRACK (\$161.8M), Space Control Technology (\$15.0M), and Counterspace Systems (\$75.9M).<sup>60</sup>

**SPACETRACK Program.** This budget reflects a collection of linked developmental efforts aimed at accelerating the evolution of the Space Surveillance Network (SSN). One of the program's main efforts is to build an operational architecture capable of disseminating to warfighters a Space Common Operational Picture (Space COP). The Air Force FY2004/2005 Biennial RDT&E Budget Estimates identify the following initiatives:<sup>61</sup>

- **Acquiring the Space Based Space Surveillance (SBSS) system,** which is a constellation of satellites designed to provide timely space situational awareness. The project follows the successful testing of optical sensors on the Mid-Course Space Experiment (MSX). MSX demonstrated the ability to track objects in space from a space-based platform. The Air Force estimates a budget of \$78.9M in FY2004 and \$109.5M in FY2005. Appropriations conferees cut \$27 million from this program in FY2005, and added \$5.4 million for a radar

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<sup>58</sup> Department of the Army, *Supporting Data FY 2004/2005 President's Budget Submitted to OSD, Descriptive Summaries of the Research, Development, Test, and Evaluation, Army Appropriation, Budget Activities 1, 2, and 3, Office of the Secretary of the Army (Financial Management and Comptroller)*, February 2003, Army RDT&E Budget Item Justification (R-2 Exhibit), Budget Activity 3 - Advance technology development, PE 0603006A-Command, Control, Communications Advanced Technology, p. 394-398. This report may be found at the Defense Link website at [<http://www.defenselink.mil/comptroller/defbudget/fy2005>]. Public Law 108-287 (H.Rept. 108-622, p.242).

<sup>59</sup> Public Law 108-287 (H.Rpt.108-622, p.278).

<sup>60</sup> Department of Defense, Defense Budget Materials, Office of the Undersecretary of Defense (Comptroller) FY2005 Budget, RDT&E Budget (R-1), February 2004. p. F-4, F-5, and F-12. This report may be found at the Defense Link website at [<http://www.defenselink.mil/comptroller/defbudget/fy2005>].

<sup>61</sup> Department of the Air Force, Fiscal Year (FY) 2004/2005 Biennial Budget Estimates, Research, Development, Test and Evaluation (RDT&E), Descriptive Summaries, Volume III, Part II, Budget Activity 7, February 2003, p. 1737-1767. This report may be found at the SAF/FM website at [<http://www.saffm.hq.af.mil/FMB/pb/afpb.html>].

upgrade.<sup>62</sup> The effort continues past FY2009 and has an approximate total cost of \$801.6M through FY2009.<sup>63</sup>

- **Developing the Orbital Deep Space Imager (ODSI).** The system will provide near-real time, high-resolution imagery of geosynchronous satellites. This capability will support battle space awareness and defensive counterspace operations. The Air Force projects a cost of \$3.9M in FY2004 and \$8.8M in FY2005. Appropriations conferees matched the FY2005 request.<sup>64</sup> The development effort will continue past FY2009 and has an estimated total cost of \$499.7M through FY2009.<sup>65</sup>
- **Implementing Service Life Extension Programs (SLEP).** The programs aim to extend the life of SPACETRACK radar systems by upgrading the hardware and software of equipment located at Eglin Air Force Base, the Navy Space Surveillance Fence, and at the HAYSTACK site at Westford, Massachusetts. The estimated budget is \$19.8M in FY2004 and \$31.7M in FY2005. Appropriations conferees matched the FY2005 request.<sup>66</sup> The program will continue through FY2008 and has an estimated total cost of \$116.8M.<sup>67</sup>

**Space Control Technology Program.** This program supports a range of activities including planning, development, demonstrations, prototyping, modeling, simulations, exercises, and development of counterspace tactics. The Air Force FY2005 budget request supports two Advanced Component Development and Prototype (ACD&P) projects that investigate space control technologies. They are

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<sup>62</sup> Public Law 108-287 (H.Rept. 108-622, p.330).

<sup>63</sup> Department of the Air Force, Fiscal Year (FY) 2004/2005 Biennial Budget Estimates, Research, Development, Test and Evaluation (RDT&E), Descriptive Summaries, Volume III, Part II, Budget Activity 7, February 2003, p.1749.

<sup>64</sup> Public Law 108-287 (H.Rept. 108-622, p.330).

<sup>65</sup> Department of the Air Force, Fiscal Year (FY) 2004/2005 Biennial Budget Estimates, Research, Development, Test and Evaluation (RDT&E), Descriptive Summaries, Volume III, Part II, Budget Activity 7, February 2003, p. 1737.

<sup>66</sup> Public Law 108-287 (H.Rept. 108-622, p.330).

<sup>67</sup> Department of the Air Force, Fiscal Year (FY) 2004/2005 Biennial Budget Estimates, Research, Development, Test and Evaluation (RDT&E), Descriptive Summaries, Volume III, Part II, Budget Activity 7, February 2003, p. 1759.

Space Range and Technology Insertion Planning and Analysis (TIPA).<sup>68</sup> Appropriations conferees matched the FY2005 request for both of these programs.<sup>69</sup>

The FY2005 budget for the Space Range Initiative is \$6.4M. The program supports a “virtual” test range at Nellis Air Force Base in Nevada, which develops space tactics and conducts operational testing and training of new space systems. ACD&P efforts include the development of a “Scintillation Phenomonology” Support Sensor (SPOSS), “Red” UHF testing system, an Adversary Network Emulator, and a mobile communications analysis and test system.<sup>70</sup>

TIPA initiatives, appropriated \$8.7M in FY2005, include efforts from all counterspace areas. Space Situational Awareness efforts focus on developing key enabling technologies — monitoring, detecting, identifying, tracking, assessing, verifying, categorizing, and characterizing objects and events in space. Defensive Counterspace (DCS) efforts aim to evaluate the vulnerability of U.S. satellites, space links, and ground control facilities, by studying protective measures against numerous threats including optical jammers, radiation effects, kinetic energy impacts, data fusion, and data mining. The investigation also examines techniques to deny an adversary the use of U.S. assets, such as GPS. OCS efforts concentrate on the development of advanced techniques involving operations in counter-communications, counter-surveillance, and counter-reconnaissance. The current objective of OCS initiatives is to produce negation capabilities that have temporary, localized, and reversible effects.<sup>71</sup>

The Kinetic Energy Anti-Satellite (KEAsat) program has had Congressional support despite no funding requests by DOD in several years. Past ASAT initiatives include both Air Force and Army programs. See CRS Issue Brief IB92011, *U.S. Space Programs: Civilian, Military, and Commercial*, September 8, 2004, pp. CRS-12 and CRS-13, for a discussion of U.S. ASAT development.

**Counterspace Systems Program.** This program capitalizes on Space Control Technology initiatives. The FY2005 budget is \$75.9M with estimated total costs through FY2009 of \$361.1M.<sup>72</sup> The Air Force FY2005 RDT&E budget identifies the following three major initiatives:

- **Counter-Satellite Communications System (CSCS):** The program FY2005 budget is \$6.24M. This request was matched by

<sup>68</sup> Department of the Air Force, *Fiscal Year (FY) 2005 Budget Estimates, Research, Development, Test, and Evaluation (RDT&E), Descriptive Summaries*, Volume II, Budget Activities 4-6, February 2004, p. 517. This report may be found at the Defense Link website at [<http://www.defenselink.mil/comptroller/defbudget/fy2005>].

<sup>69</sup> Public Law 108-287 (H.Rept. 108-622, p.314).

<sup>70</sup> Department of the Air Force, *Fiscal Year (FY) 2005 Budget Estimates, Research, Development, Test, and Evaluation (RDT&E), Descriptive Summaries*, Volume II, Budget Activities 4-6, February 2004, p. 524-527.

<sup>71</sup> *Ibid*, 519-523.

<sup>72</sup> *Ibid*, 869.

appropriations conferees.<sup>73</sup> It explores the development of mobile and transportable systems with a capability to disrupt satellite communications signals. One system was delivered in FY2004 and two more are scheduled for delivery in early FY2005. Important acquisition milestones (System Requirements Review and Critical Design Review) are scheduled to begin in late FY2005 for a second-generation "Block 20" system.<sup>74</sup>

- **Counter-Surveillance Reconnaissance System (CSRS):** This program had supported concept exploration and follow-on system development of mobile and transportable systems to counter space-based surveillance and reconnaissance capabilities. In the FY2005 DOD appropriations act (P.L. 108-287), Congress fully funded space control, but made a net cut of \$50 million from counterspace systems, leaving \$26 million. The reduction comprised a cut of all \$53 million from the Counter Surveillance Reconnaissance System (the Senate report stated that the Air Force decided to terminate the program).<sup>75</sup>
- **Rapid Identification Detection and Reporting System (RAIDRS):** This system is intended to detect the source of attacks on space assets and provide decision-makers with near real-time attack warning, threat identification, and threat characterization. Current efforts focus on developing target "geo-location" and laser detection capabilities. Initial system delivery should occur in late FY2006. The second spiral capability should begin in FY2008 and will focus on developing "data fusion" capabilities. The FY2005 budget is \$16.4M and continues past FY2009.<sup>76</sup> Appropriations conferees matched the FY2005 request.<sup>77</sup>

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<sup>73</sup> Public Law 108-287 (H.Rept. 108-622, p.326).

<sup>74</sup> Department of the Air Force, *Fiscal Year (FY) 2005 Budget Estimates, Research, Development, Test, and Evaluation (RDT&E), Descriptive Summaries*, Volume II, Budget Activities 4-6, February 2004, p. 871-874.

<sup>75</sup> S.Rept. 108-284, p. 169.

<sup>76</sup> Department of the Air Force, *Fiscal Year (FY) 2005 Budget Estimates, Research, Development, Test, and Evaluation (RDT&E), Descriptive Summaries*, Volume II, Budget Activities 4-6, February 2004, p. 879-882.

<sup>77</sup> P.L. 108-287 (H.Rept. 108-622, p. 326).

## Appendix 4. Possible Long-term Space Control Initiatives<sup>78</sup>

- **Air-Launched Anti-Satellite Missile:** This program is to develop small air-launched missiles capable of intercepting satellites in low-earth orbit.
- **Communication/Navigation Outage Forecasting System:** The system is to combine data from ground-based and sea-based sensors to provide real-time predictions of disturbances in the ionosphere that might affect satellite communications and navigation systems. This would help space forces distinguish between an attack on space systems and natural phenomena.
- **Compact Environmental Anomaly Sensor II:** This system is to be an on-board space environment sensor that would help rule out hostile attack as the cause of a satellite malfunction and provide warnings of dangerous space environment conditions.
- **Global Launch and Test Range:** The program is to provide necessary Command and Control for the Space Maneuver Vehicle and the Space Operations Vehicle. The system would be a key enabler of responsive launch and operation of new space vehicles and refueling/repair of existing vehicles.
- **Ground-Based Laser:** The system would propagate laser beams through the atmosphere to Low-Earth Orbit satellites to provide robust defensive and offensive space control capability.
- **Orbital Transfer Vehicle:** This program could significantly increase the flexibility, warfighting utility, and protection of U.S. space assets by repositioning and enabling on-orbit servicing of those assets.
- **Space-Based Radio Frequency Energy Weapon:** This system would be a constellation of satellites containing high-power radio-frequency transmitters that possess the capability to disrupt, destroy, or disable a wide variety of electronics and national-level command and control systems. It would be a non-kinetic anti-satellite weapon.
- **Space Maneuver Vehicle:** This program is to provide a rapidly reusable orbital vehicle deployed from the Space Operations Vehicle or Evolved Expendable Launch Vehicle. It would be capable of executing a wide range of Space Control missions.

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<sup>78</sup>*Air Force Transformation Flight Plan, Appendices C & D, p. C-11-D-11.*

- **Space Operations Vehicle:** This vehicle would be intended to provide on-demand spacelift capability with rapid turn-around, multiple standardized payloads, space vehicle maintenance, ISR, offensive and defensive counterspace, and space surveillance capabilities