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Evolving Army Needs for Space-Based Support

Jeffrey L. Caton

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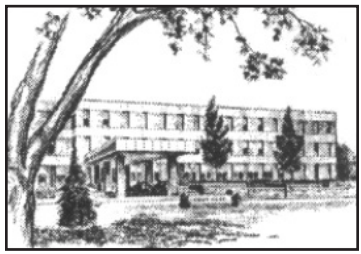

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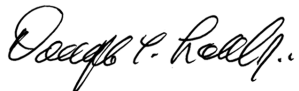
FOREWORD

To support warfighters in the 21st century, Army and joint space operations must adapt to a congested, contested, and competitive international space environment. This monograph examines how the Army is postured to meet current and future space-based support needs to conduct unified land operations. It also provides recommendations regarding how to facilitate the best evolutionary path for future Army space activities to meet the changing environment for unified land operations as well as the diverse challenges of ongoing global operations, technological advances by potential adversaries, increased international competition, and domestic resource constraints.

The monograph posits that the Army should retain its current focus on space operations as cross-domain support for terrestrial warfighter operations. It also suggests that the development of such support should include stakeholder and proponency issues with regard to cyberspace operations. Continuing to advance policies and strategies that embrace the joint, interagency, and international aspects of space operations will help ensure reliable and resilient support to operational and tactical commanders in any theater of operation.



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JEFFREY L. CATON is President of Kepler Strategies LLC, Carlisle, PA, a veteran-owned small business specializing in national security, cyberspace theory, and aerospace technology. He is also an Intermittent Professor of Program Management with Defense Acquisition University. From 2007 to 2012, Mr. Caton served on the U.S. Army War College (USAWC) faculty, including as Associate Professor of Cyberspace Operations and Defense Transformation Chair. Over the past 5 years, he has presented lectures on cyberspace and space issues related to international security in the United States, Sweden, the United Kingdom, Estonia, Kazakhstan, and the Czech Republic supporting programs such as the Partnership for Peace Consortium and the North Atlantic Treaty Organization Cooperative Cyber Defence Center of Excellence. His current work includes research on cyberspace and space issues as part of the External Research Associates Program of the Strategic Studies Institute, USAWC, as well as serving as a facilitator for Combined/Joint Land Force Component Commander courses at the Center for Strategic Leadership and Development, USAWC. Mr. Caton served 28 years in the U.S. Air Force, working in engineering, space operations, joint operations, and foreign military sales, including command at the squadron and group level. Mr. Caton holds a bachelor's degree in chemical engineering from the University of Virginia, a master's degree in aeronautical engineering from the Air Force Institute of Technology, and a master's degree in strategic studies from the Air War College.

SUMMARY

Is the Army properly postured to meet current and future space-based support needs to conduct unified land operations? This monograph addresses this fundamental question in two main sections:

- Current Army Space Operations. Considering the mandate by the National Command Authority in January 2012 to operate effectively in space, this section examines space capabilities as they are currently organized for the soldier and other joint warfighters. First, it identifies the five joint space mission areas as they compare to the Army's six warfighting functions. Next, the section presents an overview of current Army space forces, then builds the context of joint space forces and offers examples of international partnerships.
- Envisioned Future Army Space Operations. This section assesses current Army activities oriented to meet the evolving needs of the future space environment. This includes not only the continued integration and exploitation of existing space capabilities, but also the development and deployment of Army space support operations that provide responsive support to operational and tactical commanders in theater. Rather than delve into all joint space mission areas, it focuses on the three areas of current Army emphasis: future space force enhancement, future space force application, and the connection between space and cyberspace operations. The section then compares the direction of Army space endeavors against national policy and guidance to identify any critical deficiencies or incongruities.

This monograph is limited to unrestricted and unclassified open source information, thus any classified discussion must occur at other appropriate venues. The evolution of Army space operations is well documented in many sources. Therefore, this monograph serves not as a comprehensive history or detailed critique of the Army's myriad accomplishments. Rather, it serves as a primer for current and future space-based operations to provide senior policymakers, decisionmakers, military leaders, and their respective staffs with an overall appreciation for existing Army space capabilities and the challenges, opportunities, and risks associated with their use in joint operations.

EVOLVING ARMY NEEDS FOR SPACE-BASED SUPPORT

The U.S. Army has been involved with space-based military operations for well over a half-century. During this time, space operations have changed from a realm exclusive to scientists and engineers; to highly classified activities largely unknown to the general population; to the unveiling of space-based communication, imagery, surveillance, and environment capabilities that have become a foundation for all modern warfare. Today, such support is so ingrained in daily operations that most soldiers, sailors, airmen, and marines assume it has been, and always will be, available for their use. But with such reliance comes a vulnerability that potential adversaries may try to exploit.

Is the Army properly postured to meet current and future space-based support needs to conduct unified land operations? This monograph addresses this fundamental question first by examining current Army space operations within the broader context of joint operations. Next, it surveys key aspects of Army space activities envisioned for future operations. Finally, it compares the direction of Army space endeavors against national policy and guidance to identify any critical deficiencies or incongruities.

This monograph is limited to unrestricted and unclassified open source information, thus any classified discussion must occur in other appropriate venues. The evolution of Army space operations is well-documented in many sources. Therefore, this monograph serves not as a comprehensive history or detailed critique of the Army's myriad accomplishments in space operations, but rather as a primer for current and future space-based operations to provide senior policymakers, decisionmakers, military leaders, and

their respective staffs with an overall appreciation for existing Army space capabilities and the challenges, opportunities, and risks associated with their use in joint operations.

CURRENT ARMY SPACE OPERATIONS

The necessity of the U.S. military to operate effectively in space was emphasized by the National Command Authority in January 2012 when President Barack Obama and Secretary of Defense Leon Panetta provided strategic guidance for sustaining U.S. global leadership in the 21st century. Specifically, they directed that:

> DoD will continue to work with domestic and international allies and partners and invest in advanced capabilities to defend its networks, operational capability, and resiliency in cyberspace and space.[1]

Space capabilities comprise many diverse systems-of-systems, which include ground-based infrastructure, satellites and space launch vehicles, and the electromagnetic links that connect them.[2] But rather than discuss individual space systems, we will instead examine space capabilities as they are currently organized for the soldier and other joint warfighters. This includes an overview of current Army space forces within the context of joint space forces and of international partnerships.

Space Capability Requirements.

While a comprehensive knowledge of the space domain is not necessary for all warfighters, planners and senior officers should have a basic understanding of how space operations integrate and enhance their

domain military operations. To facilitate this understanding, we will briefly examine the major mission areas of space operations and compare them to Army warfighting functions. *Joint Publication (JP) 3-14, Space Operations*, has evolved and expanded significantly over the past decade to reflect the increasing integration of activities in the space domain with those in the traditional domains of land, sea, and air. The latest version (May 2013) addresses the fundamentals of military space operations, the command and control of space forces, the roles and responsibilities of Service components, and the methods of planning for space operations.[3] First, let us review the five major mission areas: space situational awareness; space force enhancement; space support; space control; and space force application.

Space situational awareness (SSA) provides the foundation for all space operations by characterizing the ongoing activities in the space domain. It has only recently been identified as a separate mission area; previous joint space doctrine listed SSA as a functional capability under the Space Control mission.[4] SSA constantly assesses the status of U.S. and cooperative space systems as well as those of multinational activity, to include that of potential adversaries. This assessment requires four functional capabilities. First is the ability to detect, track, and identify objects in space in order to establish and maintain an accurate catalog to utilize as part of a common operating picture. Second is the ability to conduct the threat warning and assessment necessary to attribute and differentiate causes of space effects among environment conditions, system anomalies, and potential hostile actions. Third is the ability to characterize not only observed space activity but also the possible strategy and intent of such activity, as well as the nature of any possible threat to the

ground, electromagnetic link, or space element of the system. The fourth functional capability is that of data integration and exploitation to help tie together the multisource data from the other three SSA functional capabilities in iterative processes that also enhance the functions.[5]

Space force enhancement capabilities increase the combat potential of the joint force by providing space-based support that improves effectiveness and reduces confusion. This is especially valuable for the joint force commanders who require access to denied areas that cannot be provided by traditional domain-based capabilities. The space force enhancement mission area comprises seven functional capabilities. The first is the ability to provide the necessary intelligence, surveillance, and reconnaissance (ISR) through space operations in a similar manner that ISR is provided through the traditional domain operations, except from a much higher vantage point. The next two capabilities, launch detection and missile tracking, use some common infrastructure and assessment methods; they each provide timely notification for the protection of joint forces as well as space assets. Environmental monitoring provides joint forces with data regarding meteorological and oceanographic conditions as well as factors in the space environment that may affect joint operations, such as solar flares, which may temporarily affect certain radio frequency transmission. The fifth functional capability, satellite communications (SATCOM), has become so ingrained in military operations that some may consider it a necessary vice, a force enhancement. Likewise, space-based capabilities for positioning, navigation, and timing (PNT), such as those provided by the Global Positioning System (GPS) satellite constellation, are not only critical to the vast majority of military operations, also

extremely important to commercial users and ordinary citizens worldwide. Navigation warfare (NAVWAR) is the seventh functional capability intended to assure friendly use of PNT information and to prevent adversary use of the same by leveraging space, cyberspace, and electronic warfare assets.[6]

Space support, like SSA, provides three functional capabilities that serve as the foundation to operate and sustain space forces. First is spacelift, which is the ability to deliver satellites and material into the required orbit around Earth. This requires space launch vehicles and launch infrastructure, as well as range operations, to ensure the safe and reliable launch and initial orbit attainment. Second, once a satellite is in orbit, space support is the basis of the functional capability for satellite operations that establishes the proper telemetry, tracking, and commanding (TT&C) links necessary to not only maneuver and operate the satellite and its payloads, but also to monitor and sustain its health status. Third, the ability for reconstitution of space forces is required to maintain operational satellite constellations by reconfiguring or replacing damaged satellites, repositioning satellites to cover for temporary gaps in coverage, or replenishing obsolete or expired satellites.[7]

Space control involves the ability to ensure the freedom of action for U.S. and friendly forces in space and, when necessary, to negate adversary space capabilities. It is divided into two functional capabilities: offensive space control (OSC) and defensive space control (DSC). OSC uses prevention measures to preclude "an adversary's hostile use of U.S. or third-party space systems/services to support their operations."[8] Prevention activities may utilize all forms of national power—diplomatic, informational, military, and economic—to protect the joint forces' advantages in space. OSC also may involve space negation, which

consists of "active defensive and offensive measures to deceive, disrupt, degrade, deny, or destroy an adversary's space capabilities."[9] DSC operations deal with preserving "the ability to exploit space capabilities via active and passive actions, while protecting friendly space capabilities from attack, interference, or unintentional hazards."[10] While they focus on responses to deliberate threats, such as GPS or SATCOM jammers, DSC operations also focus on incidental hazards, such as space debris, radio frequency interference, and solar effects.[11]

Space force application focuses on "combat operations in, through, and from space to influence the course and outcome of conflict by holding terrestrial targets at risk."[12] It includes activities such as ballistic missile defense and land- or sea-based intercontinental ballistic missiles.[13]

Clearly, military space operations are a joint venture. But how do Army forces leverage such capabilities to support its mission? In his March 2014 testimony to Senate Armed Service Committee, Lieutenant General David L. Mann, Commanding General of the U.S. Army Space and Missile Defense Command and Army Forces Strategic Command (USASMDC/ARSTRAT) noted that:

> space-based capabilities leveraged and employed across the National space enterprise enable each of these [six Army] warfighting functions. Virtually every Army operation relies on space capabilities to enhance the effectiveness of the force.[14]

This dependence is evident in Table 1, which depicts how specific joint space operations mission areas support the six Army warfighting functions of mission command, movement and maneuver, intelligence, fires, sustainment, and protection.

	Army Warfighting Functions					
Joint Space Operations Mission Areas	**Mission Command**	**Movement and Maneuver**	**Intelligence**	**Fires**	**Sustainment**	**Protection**
Space Situational Awareness						
Detect/Track/Identify			x			x
Threat Warning & Assessment			x			
Characterization	x	x	x	x		
Data Integration & Exploitation	x	x	x	x	x	x
Space Force Enhancement						
Intelligence, Surveillance, & Reece	x	x	x	x		x
Launch Detection	x	x	x	x		x
Missile Tracking	x	x	x	x		x
Environmental Monitoring	x	x	x	x	x	x
Satellite Communications	x	x	x	x	x	x
Positioning, Navigation, & Timing	x	x	x	x	x	x
Navigation Warfare (NAVWAR)	x	x	x	x	x	x
Space Supports						
Spacelift					x	
Satelite Operations	x	x	x	x	x	x
Reconstitution of Space Forces					x	
Space Control						
Offensive Space Control	x	x	x	x		x
Defensive Space Control	x	x	x	x	x	x
Space Force Application						
Ballistic Missile Defence	x	x	x	x	x	x
Intercontinental Ballistic Missiles						x

Table 1. Joint Space Operations Support of Army Operations.

Mann summarized the importance and scope of space operations to the Army with the statement that:

> integrating space capabilities enables commanders, down to the lowest echelon, to conduct Unified Land Operations through decisive action and operational adaptability.[15]

Let us now examine the specific elements of the Army total force that are dedicated to providing such critical space-based resources to all warfighters.

Army Space Forces.

The current structure of USASMDC/ARSTRAT had both evolutionary and revolutionary growth from its rather humble origins back in October 1957 as the Redstone Anti-Missile Missile Systems Office located at Redstone Arsenal, AL. During the 1960s through the 1980s, Army space-related efforts emphasized this anti-ballistic missile mission with programs such as Sentinel (the Lyndon Johnson administration), Safeguard (the Richard Nixon administration), and "Star Wars"—the Strategic Defense Initiative (the Ronald Reagan administration). These efforts reflected the ebb and flow of strategic arms buildups and limitation treaties that typified the Cold War between the United States and the Soviet Union.[16] President Reagan had a broader view of space operations and took actions toward the creation of a unified command dedicated to the space domain, and on September 23, 1985, U.S. Space Command (USSPACECOM) was established in Colorado Springs, CO.[17] The Army formed a planning group to design the Army component to this new joint command that became the Army Space Agency and eventually grew to become the U.S. Army Space Command, a field operating agency, on April 7, 1988.[18]

In 1991, Operation DESERT STORM ushered in a new era of modern warfare that successfully exploited space-based force enhancement in combat operations across all traditional domains. The lessons learned from this campaign expanded the Army's view of space support to expeditionary operations and led to the creation of deployed teams to provide space sup-

port and tactical missile warning as part of a greater emphasis on theater missile defense. The national missile defense was reduced in scope by President George H. W. Bush to the Global Protection against Limited Strikes (GPALS), with the Army taking lead on much of the system-of-systems development. The rest of the decade saw many organizational changes as the Army consolidated its space and missile development efforts and operations.[19]

On October 1, 1997, the field operating agency of the U.S. Space and Strategic Defense Command was redesignated a major Army command—the U.S. Army Space and Missile Defense Command (USASMDC). The new command's mission included a role as the Army proponent for space and ballistic missile defense and command of the 1st Satellite Control Battalion as well as joint responsibilities as the Army component to the U.S. Space Command (ARSPACE).[20] The operational structure of USASMDC continued to evolve, and the final major development came with the 2002 change to the Unified Command Plan that disestablished USSPACECOM and transferred its mission functions to a "new" U.S. Strategic Command (USSTRATCOM).[21] Consequently, USASMDC/ARSTRAT became the Army service component command to the new USSTRATCOM.[22]

In its current mission, USASMDC/ARSTRAT:

> conducts space and missile defense operations and provides planning, integration, control and coordination of Army forces and capabilities in support of U.S. Strategic Command missions (strategic deterrence, integrated missile defense, and space operations)

as well as continues to serve as the Army proponent for space and missile defense technology development.[23]

The Commanding General, USASMCD/ARSTRAT also serves as the commander of the USSTRATCOM Joint Functional Component Commander for Integrated Missile Defense (JFCC IMD), the "third hat" of command for that position.[24] The vision for the command views all of these responsibilities not only in terms of immediate warfighting needs, but also in medium- and long-range planning for future force requirements:

> As the Army's force modernization proponent for space, global missile defense, and high altitude; and as the Army's operational integrator for global missile defense, USASMDC/ARSTRAT will focus on three core tasks:
>
> 1. Provide trained and ready space and missile defense forces and capabilities to the warfighter and the nation (today).
> 2. Build future space and missile defense forces (tomorrow).
> 3. Research, test, and integrate space, missile defense, cyber, directed energy, and related technologies (day-after-tomorrow).[25]

To implement this vision within the current organization, the "today" part of the mission is led by the Deputy Commanding General-Operations; the "tomorrow" portion is headed by the Director, Future Warfare Center; and the "day-after-tomorrow" is managed by the Director, Technical Center.[26] The detailed doctrinal aspects of these operations are presented in *Field Manual (FM) 3-14, Army Space Operations*.[27] The remainder of this section focuses on current Army space operations in general terms, and the next section discusses various future aspects. Table 2 provides a summary of the current major Army space units that will be discussed.

Unit	Mission	Joint Space Operations Mission Areas
1st Space Brigade	Conducts continuous space force enhancement, space support, and space control operations in support of combatant commanders, enabling shaping and decisive operations.	Space Force Enhancement Space Support
53rd Signal Battalion	Manages satellite payload control of the DoD Wideband Constellation by operating and maintaining global Wideband Satellite Communications Operations Centers and a Defense Satellite Communications System Certification Facility.	Space Force Enhancement Space Support
1st Space Battalion	Provides theater support to warfighters: - Ballistic Missile Early Warning (JTAGS) - Army Space Support Teams - Commercial Imagery Team	Space Force Enhancement
117th Space Battalion	Colorado Army National Guard unit providing space support: - Army Space Support Teams - Commercial Imagery Team	Space Force Enhancement
100th Missile Defense Brigade (GMD)	Operates the GMD fire control network, provides positive operational control of ground-based interceptors at Fort Greely, AK, and Vandenberg AFB, CA, and ensures the protective security of the systems deployed there.	Space Force Enhancement Space Force Application
49th Missile Defense Battalion	Headquarters and Fire Direction Center at Fort Greely, Alaska.	Space Force Enhancement Space Force Application
Missile Defense Detachments	Detachment 1 at Vandenberg AFB for GBI operations support. AN/TPY-2 radar detachments that provide missile defense support to geographic commands: - Detachment 10 (U.S. Pacific Command) - Detachment 11 (U.S. European Command) - Detachment 12 (U.S Central Command) - Detachment 13 (U.S. European Command)	Space Force Enhancement Space Force Application

Table 2. Major Army Space Operations Units.[28]

1st Space Brigade.

The 1st Space Brigade is a multicomponent brigade established as a provisional unit in April 2003 and formally activated on May 25, 2005. The history of its three battalions goes back even further, the initial unit being the 1st Satellite Control (SATCON) Battalion created in May 1995 due to the expanded Army responsibilities for military satellite communications following Operation DESERT STORM. The battalion grew to five companies located worldwide, and on October 15, 2005, the unit became the 53rd Signal Battalion (SATCON).[29] Regarding its value to the warfighter, communications ranks among the most important of space-based enablers.[30]

Although space operations were making great strides in operationalization with the formation of USSPACECOM and its service components, the tactical Army was still largely unaware of the potential benefits. To help bridge this gap, the 1st Space Battalion was established on December 15, 1999, to provide theater support for missile warning and space force enhancement. The initial structure comprised four Army Space Support Teams (ARSSTs) to provide space products and five Joint Tactical Ground Stations (JTAGS) to provide ballistic missile early warning. As the need for deployed space support grew, additional ARSSTs and JTAGS were added as well as Commercial Imagery Teams to leverage space products for a broader range of sources.[31]

Serving as the Army National Guard counterpart of the 1st Space Battalion is the 117th Space Battalion, tasked to:

> enable operations by maximizing military utilization of space-based assets to include satellite imagery, missile warning systems, satellite communications, space-based weather and global positioning system capabilities.[32]

Originally formed as the 193rd Space Support Battalion in September 2001, it was redesignated to its current number in October 2007. The 117th Space Battalion includes 11 ARSSTs and one Center for Innovative Technology (CIT), which may also perform defense support to civil authorities (DSCA) missions. With the exception of support for Hurricane Katrina recovery, most of the DSCA operations have been limited to Colorado, such as imagery and mapping support for incident commanders during wildfires near Fort Collins, CO, in 2012.[33]

100th Missile Defense Brigade (Ground-based Missile Defense).

The 100th Missile Defense Brigade (Ground-based Missile Defense [GMD]) was activated on October 16, 2003, in Colorado Springs, CO, as a multicomponent unit of Army active and National Guard soldiers tasked to defend the homeland from ballistic missile attacks. In January 2004, the 49th Missile Defense Battalion was activated at Fort Greely, AK, as an Alaska National Guard unit tasked to operate the ground-based interceptors (GBI) stationed there.[34] These units brought to fruition the vision of the President George W. Bush administration to field a national missile defense rapidly following the U.S. withdrawal from the 1972 Antiballistic Missile Treaty in June 2002. The deployment of GBI systems and support equipment was

designed to be an evolutionary process that would allow for technology insertion as well as adaptability to the changing threat environment.[35]

Part of the brigade's evolution was the establishment of detachments for GBI and warning radar operations. In May 2011, Detachment 1 was established at Vandenberg Air Force Base, CA, as a unit of the California National Guard, formally culminating a 7-year effort to establish a force to secure and monitor the GBI systems located there.[36] Detachments were also established to operate the Army Navy/Transportable Radar Surveillance and Control Model 2 (AN/TPY-2), a high-resolution, phased-array radar designed specifically for ballistic missile defense.[37] These detachments are located within geographic combatant command areas of responsibility: Detachment 10 in the U.S. Pacific Command; Detachments 11 and 13 in the U.S. European Command; and Detachment 12 in the U.S. Central Command.

*Ongoing Army Space Operations Support***.**

The global nature of Army space operations is reflected in the slogan, "The sun never sets on USASMDC/ARSTRAT."[38] This is not an idle claim. Indeed, ARSSTs and CITs have been deployed to the U.S. Central Command on 86 occasions since 2001.[39] Space Support Elements (SSEs) provide support to deployed headquarters and brigade combat teams as the staff's focal point for maximizing space-related capabilities for intelligence (G-2), operations (G-3), and information (G-6).[40] Also, expertise for SSEs and ARSSTs can support the joint planning process through the development of Annex N, Space Operations, to operational orders for supported joint commanders.[41] JTAGS

operate from strategic positions in the U.S. Pacific Command and U.S. Central Command to provide accurate and timely missile warning data—launch location, flight tracking, and predicted impact area—to operational communities writ large.[42]

For space force enhancement, the Army has critical roles in the tracking and communications for friendly forces. USASMDC/ARSTRAT has operated the Mission Management Center for friendly force tracking (FFT; formerly blue force tracking) since its beginning in October 2001 with support to combat operations in Afghanistan. These support operations have become thoroughly integrated into joint forces to provide the PNT data necessary to enable confident and decisive maneuver using over 50 types of tracking devices. The system currently processes over one million location tracks each day to provide a common operating picture to forces worldwide.[43] USASMDC/ARSTRAT also operates Wideband SATCOM Operations Centers (WSOCs) and Regional SATCOM Support Centers (RSSC) in six locations worldwide—three in the continental United States and one each in Hawaii, Germany, and Japan.[44] With SATCOM as the Army's top space priority, these centers are undergoing the modernization and equipment replacement necessary to assure continued compatibility with new communication satellite systems.[45]

Joint Space Forces.

In addition to the efforts of ARSTRAT, other military service components also participate in both providing and utilizing space-based support to the warfighter. The U.S. Air Force component oversees space launch and satellite on-orbit checkout; operates

a ground-based satellite control network; operates several satellite constellations to accomplish all forms of space force enhancement; and operates ground-based radars that support space situational awareness and ballistic missile warning. The U.S. Navy component is implemented through the commander, U.S. Fleet Cyber Command, and focuses on network operations, associated space-control activities, satellite communication, and space situational awareness. The U.S. Marine Corps component does not operate any satellite systems but does focus on supporting space operations planning as well as integrating space force enhancement decentralized, combined arms operations.[46]

To accomplish the command and control of joint space forces, USSTRATCOM uses the Joint Force Component Command for Space (JFCC Space) designated as the commander, 14th Air Force, and headquartered at Vandenberg Air Force Base, CA. JFCC Space is comprised of three operations centers—the Joint Space Operations Center (JSpOC), the Joint Navigation Warfare Center, and the Missile Warning Center—that together serve to provide operational employment of worldwide joint space forces.[47] JFCC Space also serves as the Global Space Coordinating Authority, which works with any Space Coordinating Authorities (SCAs) designated by joint force commanders in geographic combatant commands.[48]

In addition to the military service components' space missions, there are many Department of Defense (DoD) agencies and other government groups that also contribute significantly to the success of joint space operations. These organizations and their relevant areas of support are summarized in Table 3. As indicated, some of the services that they provide may include products and services from commercial space users.

Support Agency	Areas of Support
Defense Information Systems Agency (DISA)	Military and commercial satellite and network
National Geospatial-Intelligence Agency	Military and commercial geospatial-intelligence products (e.g., maps, charts, navigation data, etc.)
National Security Agency/Central Security Service (NSA/CSS)	Signals intelligence, information assurance, and cryptological support
Defense Intelligence Agency (DIA)	Military intelligence and analysis from: - Missile & Space Intelligence Center - Defense Special Missile & Aerospace Center
Defense Threat Reduction Agency (DTRA)	Support for counter-weapons of mass destruction (WMD) efforts
National Reconnaissance Office (NRO)	Research, development, acquisition, and operation of national overhead reconnaissance systems
National Air & Space Intelligence Center (NASIC)	Assessment of foreign air & space threats
National Ground Intelligence Center (NGIC)	Assessment of potential adversary satellite jammers or other electronic warfare against space systems
National Oceanic & Atmospheric Administration (NOAA)	Military and commercial atmospheric data collection and dissemination
Missile Defense Agency (MDA)	Develop, test, and field an integrated and layered ballistic missile defense system

Table 3. Agencies and Organizations Supporting Joint Space Operations.[49]

International Partnerships.

Joint space doctrine promulgates that:

> international cooperation in military space-based ISR systems with allies and other partners may contribute to US national security objectives by enhancing

> interoperability, supporting coalition operations, and building partnership capacity.[50]

But these advantages are not limited to the ISR applications of space operations; DoD policy dictates that:

> DoD will cooperate with interagency, international, and commercial partners to define and promote safe and responsible space operations. This includes sharing space situational awareness and flight-safety information, as well as supporting the development of transparency and confidence-building measures and behavioral norms promoting responsible space operations.[51]

Army space forces have embraced these mandates and are working with military forces of many nations in diverse mission areas of space operations. For example, members of the Australian Defense Force work in concert with 53rd Signal Battalion soldiers at the WSOC in Hawaii, even earning the right to wear the U.S. space badge.[52] Also, partnerships are being fostered by JFCC-IMD via a long-term campaign called "Nimble Titan" to bring representatives from foreign militaries together to collaborate on global missile defense.[53] Participation in annual exercises has grown from eight countries in 2008 to 22 countries contributing in 2014.[54]

ENVISIONED FUTURE ARMY SPACE OPERATIONS

This section assesses current Army activities oriented to meet the evolving needs of the future space environment. This includes not only the continued integration and exploitation of existing space capa-

bilities, but also the development and deployment of "Army space support operations over time to provide dedicated, responsive theater focused support to operational and tactical commanders."[55] Rather than delve into all joint space mission areas, this focuses on the three areas of current Army emphasis: future space force enhancement, future space force application, and the connection between space and cyberspace operations. It then compares the direction of such Army space endeavors against national policy and guidance to identify any critical deficiencies or incongruities.

Ready Space Capabilities for the Future Enhancement.

Despite the extreme velocities at which space objects travel, the laws of physics dictate that satellites are fixed in their relative orbital framework. Recognizing this, USASMDC/ARSTRAT is conducting three Joint Capability Technology Demonstrations (JCTDs) to provide timely and tailored space-based communications and imagery support as well as prompt and responsive space launch capabilities.

Traditionally, military satellites have been large space vehicles with energy storage devices and redundant payload systems designed for years of service. While very capable, their operations could hardly be defined as agile or tactical. The USASMDC Technical Center has been exploring the use of microsatellites (10-100 kilograms) and nanosatellites (1-10 kilograms) with the aim of exploiting their benefits for the tactical warfighter:

> Appropriate constellations of nanosatellites and microsatellites in low earth orbit can provide a high de-

> gree of persistence for the warfighter which he or she can depend upon, much like the GPS is today. The presence of a proliferated constellation of relatively short life nano- or microsatellites allow for technology refresh opportunities and are problematic to adversaries who might want to eliminate space-based support to the warfighter. Technology demonstrations such as SMDCONE, Kestrel Eye, NanoEye, and SATS, together with the dedicated launch capability provided by the Multipurpose NanoMissile System, can help establish the case for inexpensive space force enhancement for the tactical warfighter through low cost, rapidly developed nanosatellite constellations.[56]

Such satellites could be used in anti-access/area denial (A2/AD) situations for such uses as exfiltrating data from unattended ground sensors, providing force enhancement coverage to remote operating locations, or augmenting existing space assets to support temporary upsurges in activities.

The first Army nanosatellite was successfully launched on December 8, 2010, marking the end of a drought of Army launches that had lasted over 50 years. The satellite, SMDC-ONE, rode to space as a secondary payload on a commercial Falcon 9 rocket; its primary mission of about 30 days was to demonstrate data receipt and transmission with ground stations.[57] Additional nanosatellites have been launched, most notably one in December 2013 in support of a U.S. Southern Command initiative to expand communication coverage for missions to include humanitarian assistance and disaster relief operations evaluated in partnership with Brazil and Peru. Two additional nanosatellite launches are scheduled for launch in December 2014.[58]

Kestrel Eye is an Army lead JCTD to develop a nanosatellite that can deliver 1.5-meter-resolution visible imagery directly to warfighters in theater without any interim data relay or filtering. It is designed to be tactically responsive, low-cost, and relatively durable with an operational life greater than 1 year. In essence, Kestrel Eye attempts to extend the operational concept of the unmanned aerial vehicle into space. With the appropriate constellation size, Kestrel Eye could provide persistent coverage accessible by handheld devices by warfighters in any theater of operation. [59]

Having a fleet of highly capable nanosatellites is of little use if they cannot be placed into the space domain in a prompt and effective manner. Current space launch schedule lead times are typically measured in years. To break this paradigm, the Army is leading another JCTD, the Soldier-Warfighter Operationally Responsive Deployer for Space (SWORDS). The goal is to leverage off-the-shelf technology and equipment to develop a low-cost vehicle ($1 million procurement cost per vehicle) that can achieve a launch cycle of 24 hours from storage call up to launch ready. The program includes ground engine testing and suborbital flights before a full orbital test flight.[60]

The three key JCTDs being pursued by USASMDC/ARSTRAT to prepare more agile and effective tactical space force enhancement programs are summarized in Table 4. Again, these are not the complete portfolio of the Army space technical center; other efforts include some diverse missions as high-altitude and persistent airship systems, such as the Long Duration Multi-Intelligence Vehicle (LEMV). For now, let us change focus to future space force application in contested A2/AD environments.

System	Description & Mission Highlights	Cost Goals
SMDC Nanosatellite Program (SNaP)	• Functionally effective data/ communication capability • Low-burden Beyond Line of Sight (BLOS) capability • Multi-functional relay capability • Tailored constellation mission matching	Less than $1 million per satellite production
Kestrel Eye	• Graphical User Interface (GUI) on Personal Digital Assistant (PDA) • Same-pass tactical user tasking and image delivery • Store / forward imagery passing • Tasking, Processing, Exploitation and Dissemination (TPED) integration	$1 million per satellite production
Soldier-Warfighter Operationally Responsive Deployer for Space (SWORDS)	• Launch on demand • Optimized orbit placement • Combatant Command launch operation flexibility • Rapid augmentation in event of hostilities via low-cost deployable launcher	$1 million per launch vehicle

Table 4. Army Space Joint Capability Technology Demonstrations (JCTDs).[61]

Future Force Application.

While the GMD units in Alaska and California provide significant ballistic missile defense capabilities, USASMDC/ARSTRAT continues not only to refine and enhance these existing systems, but also to look

at new technologies for anti-ballistic missile uses. One example is the use of directed energy to counter rocket, artillery, or mortar attacks. The High Energy Laser Mobile Demonstrator (HEL MD) is such a system; it has completed low power testing for target tracking and commenced high power (10 kilowatt) field tests.[62] The HEL MD is on track to demonstrate "a ruggedized and supportable high energy laser [50 kilowatt] with subsystems installed on a tactical military vehicle to enhance the safety of deployed forces" by 2017.[63]

Army space experts are also examining potential offensive force applications that traverse space, such as the Advanced Hypersonic Weapon (AHW) designed to "cooperatively develop an alternative vehicle to broaden research and development and reduce risk to the Prompt Global Strike program."[64] The payload delivery vehicle of the AHW was the Hypersonic Glide Body (HGB), which itself tested advanced concepts in thermal protection, navigation, guidance, and control. The AHW completed a successful test flight on November 17, 2011, from the Pacific Missile Range Facility in Hawaii to the Reagan Test Site (RTS) at Kwajalein Atoll. The RTS witnessed another noteworthy accomplishment in 2011 when its millimeter wave radar was upgraded to make it the highest resolution imaging radar in the world, a significant capability for its role as a contributing sensor in the Space Surveillance Network.[65]

Cyberspace Connections.

Arguably the most rapidly evolving arena of military activity is that of cyberspace operations. In addition to the connections between space and cyberspace in the nascent cyberspace doctrine, Army space has

enduring formal ties to the emerging commons. During the initial formation of U.S. Cyber Command as a subunified command to USSTRATCOM, USASMDC/ARSTRAT was designated as the interim Army Forces Cyber Command in 2009, pending the eventual establishment of 2nd Army in that role. With the emphasis of Army space forces on the prompt and secure exchange of operational information crucial to the deployed soldier, it is prudent for USACSMDC/ARSTRAT to continue to collaboration with U.S. Army Cyber Command to ensure unity of effort in all areas of the doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) development and refinement.[66]

This overlap between the space and cyberspace domains is also evident in the other space service components. On December 7, 2010, the 24th Air Force achieved its full operational capability and was formally designated Air Forces Cyber. Less than 3 years later it took on the role of Joint Force Headquarters-Cyber to serve as a command and control authority for joint cyberspace forces.[67] But the 24th Air Force remains an organization within Air Force Space Command, thus sharing a formal connection with JFCC-Space (the 14th Air Force). The opposite is true for the Navy, in which its cyberspace organization also has responsibilities for space operations. In the Navy's structure, the commander, 10th Fleet, is the commander, U.S. Fleet Cyber Command; in this role, the commander also serves as "the Navy's central operational authority for space in support of maritime forces afloat and ashore.[68]

Space Policies and Strategies.

The foundation for U.S. military space systems operations was updated and clarified as part of the legislatively mandated *2010 Space Posture Review*. The interim report from the study was submitted to Congress in March 2010, and its results helped to form the contents of the new *National Space Policy* released by the White House on June 28, 2010.[69] Upon the release of this new national policy, Secretary of Defense Robert Gates emphasized the continued vital nature of space systems to military operations as well as the changes in the international space environment that prompted the review:

> Our continued presence in space is vital to our national security. Space-based capabilities are critical to our military's ability to navigate accurately, strike precisely, and gather battle space awareness efficiently. However, changes in the space environment over the last decade challenge our operations. Today, space is increasingly contested as our systems face threats of disruption and attack, increasingly competitive as more states, private firms, and others develop space-based capabilities, and increasingly congested with orbital debris.[70]

Specifically, the *Space Posture Review* formed the National Security Space Guidelines section of the *National Space Policy*; these guidelines distinguished joint and individual responsibilities for the Secretary of Defense and the Director of National Intelligence (DNI).[71] The objectives of their collective work is to:

> invest in space situational awareness capabilities and launch vehicle technologies; develop the means to as-

> sure mission essential functions enabled by space; enhance our ability to identify and characterize threats; and deter, defend, and if necessary, defeat efforts to interfere with or attack U.S. or allied space systems.[72]

Guidelines were also provided for commercial and civil sectors of space activities.[73]

The DoD and DNI activities in space were further refined and codified in the *National Security Space Strategy*, a classified document which was released with an unclassified summary in January 2011. It echoed Gates' earlier comments, stating concisely that "the current and future strategic environment is driven by three trends – space is becoming increasingly **congested, contested,** and **competitive**."[74] To operate in this environment, three overarching national security space objectives were established:

> Strengthen safety, stability, and security in space; maintain and enhance the strategic national security advantages afforded to the United States by space; and energize the space industrial base that supports U.S. national security.[75]

In turn, to accomplish these objectives, five interrelated strategic approaches were provided that addressed the spectrum from peaceful and responsible use of space through the need of operations in a space environment degraded by effects from adversary attacks.[76] These themes have remained consistent and as previously noted, the goal to "operate effectively in cyberspace and space" was elevated to be among the President's top 10 priorities for DoD efforts promulgated in January 2012.[77]

How is the Army implementing these priorities for space operations? Army Space Policy is outlined

in *Army Regulation (AR)* 900-1, which declares that dependency on space-based capabilities:

> requires the Army to actively participate in defining space related capability needs that ensure necessary force structure and systems are developed and acquired to enable the land force to conduct the full range of military operations now and in the future.[78]

This policy identifies the five dominant stakeholder communities for space activities within the Army and briefly outlines their responsibilities regarding combat development (CBTDEV) and materiel development (MATDEV).[79] Together, these five groups contribute to the Army Space Council, which provides recommendations through the Vice Chief of Staff of the Army regarding activities to support four broad objectives:

1. To maximize the effectiveness of current space capabilities in support of operational and tactical land warfighting needs;
2. To influence the design, development, acquisition, and concepts of operation of future space systems that enable and enhance current and future land forces;
3. To advance the development and effective use of responsive, timely, and assured Joint interoperable space capabilities; and,
4. To seamlessly integrate relevant space capabilities into the operating force.

Details and priorities of efforts toward objectives were outlined in an earlier document, the *United States Army Space Master Plan*, issued in 2006 in two versions (one classified and one unclassified summary).[80] It also identified seven "Army Issues for Resolution" in areas

such as military SATCOM, use of commercial imagery, and utility of directed energy, which are being addressed in current Army space efforts.[81] Also initiated in 2006 was a Space Operations Concept Capability Plan to guide a comprehensive capabilities-based assessment (CBA) across not only Army stakeholders, but joint and interagency players as well.[82]

While in general terms the *Army Space Policy* is consistent with current national guidance, it was last released in 2009 and thus has not been updated to cite explicitly the evolving nature of the space environment articulated in the 2011 *National Security Space Strategy*. However, the guidance was carried forth in the *Army Space Operations White Paper* written in part to serve as a foundation to conduct an updated space operation CBA; it includes the key concepts that "space is a contested domain; [and operations therein] need cross-domain solutions."[83] These efforts are part of the 2011 Army Space Strategic Plan, which was informed by the national-level space guidance and focused on efforts "to assure access to resilient and relevant space capabilities that aid Army forces in unified land operations."[84] Most recently, these tenets were emphasized in the *2014 Army Strategic Planning Guidance* under the Strategic Priority of maintaining a ready and modern Army:

> • **Integrate Resilient Space Capabilities.**
>
> Enable all personnel, not just space specialties, to leverage space capabilities for improved combat effectiveness in contested operational environments, even in the face of adversary attempts to degrade, disrupt, or deny access to space capabilities.[85]

Essentially, the evolution of space-related themes in current Army policy and strategy documents appear to follow consistent trends that are in concert with national security space guidelines. Implementation of such guidance will help to ensure the continued integration of space-based capabilities into unified land operations.

Budget Trends.

Of course, one of the sure ways to judge the priority of efforts in the Pentagon is to examine the amount of resources that are dedicated to them. Figure 1 depicts the budgets for the space-based systems and missile defense programs within the context of the overall DoD equipment modernization portfolio for Fiscal Year 2015. Together, they comprise $15.4 billion—almost exactly 10 percent of the overall $153.9 billion modernization base.

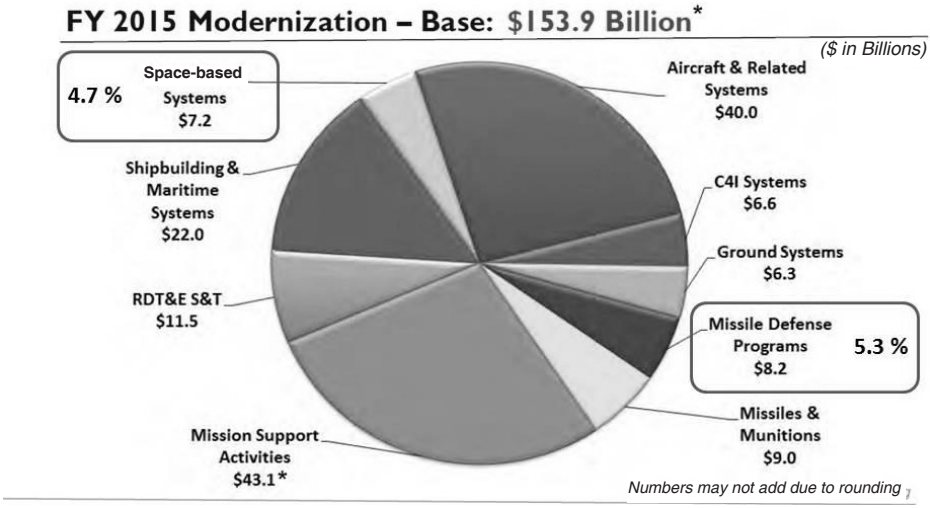

Figure 1. Space and Missile Defense Budget Context (Fiscal Year 2015).[86]

Missile defense funding dollars include ballistic missile defense systems ($6.8 billion), tactical ballistic missile defense ($1.0 billion), and tactical missile defense ($0.4 billion). Priorities are focused on five systems, two of which are in the Army's purview; the others are joint. First, the GMD element of the Ballistic Missile Defense System (BMDS) has continued funding to purchase GBIs toward the goal of having 40 GBIs at Fort Greely and four GBIs at Vandenberg AFB by Fiscal Year 2017, as well as technology investments to refine and improve fire control and target discrimination capabilities. Terminal High Altitude Area Defense (THAAD) systems are also funded to continue building an eventual force of 31 interceptor and associated components as well as support of four existing THAAD batteries and plans for a fifth battery in Fiscal Year 2015. The sea-based Aegis Ballistic Missile Defense continues to build with funding for 30 SM-3 Block 1B missiles as well as ship equipment upgrades. The Patriot Advanced Capability (PAC-3) system upgrades continue with funding for improved communications, interoperability, and electronic warfare capabilities. Related to the PAC-3 is its Missile Segment Enhancement (MSE) program funding, which procures 70 MSE interceptor missiles with increased lethality and improved survivability.[87]

Space-based system funding dollars are broken down into satellites ($4.2 billion), support ($1.6 billion), and launch ($1.4 billion). The modernization priorities center on six programs (one Navy and five Air Force), three of which are SATCOM constellations; the other three are for PNT satellites, infrared surveillance systems, and space launch vehicles. The Mobile User Objective System (MUOS) is DoD's next generation ultra-high frequency (UHF) SATCOM constellation,

and its funding covers various aspects of procurement, testing, and launch support for three satellites. The Advanced Extremely High Frequency (AEHF) system is a four satellite constellation to replenish the aging Cold War Military Strategic Tactical Relay (MILSTAR) system. AEHF funding continues procurement funding for two satellites as well as insertion of new technologies. The Wideband Global SATCOM (WGS) system is designed to augment and eventually replace the Defense SATCOM System (DSCS). The WGS funding addresses the checkout, launch, and support costs for two satellites. The remaining top priorities funds include GPS system support for the procurement of two Block III satellites and the continued development of the next generation operational control system as well as technology development for user equipment. The Space Based Infrared System (SBIRS) has continued funding for procurement of two satellites and technology insertion efforts. Finally, the purchase of the Evolved Expendable Launch Vehicle (EELV) block buys of three launch vehicles continues, as does funding for launch preparation and site operation.[88]

Since space-based capabilities are becoming increasingly integrated into Army operations, it is difficult to extract the exact amount of money spent for all space activities in a given budget. Table 5 provides some highlights of the Army space-related funding in the Fiscal Year 2015 DoD budget request. It includes almost 975 million dollars of funding for development, procurement, and support efforts.

Budget Activity	Space-Related Activity	Budget Amount (Millions of Dollars)
Aircraft procurement	GPS, SATCOM equipment	148.3
Other procurement	GPS, SATCOM, JTAGS	467.7
Applied research	Sensors, antenna, command & control	34.4
Advanced technology development	Command & control, electronic warfare	36.7
Advanced components & prototypes	Missile defense, space integration	26.8
System development & demonstration	SATCOM, tactical networks	62.04
Kwajalein Atoll support	Space & missile testing	176.0
Operational systems development	SATCOM, JTAGS	21.2
Miscellaneous space activities support	Security, communications	1.4
TOTAL		**974.5**

Table 5. Key Army Space-Related Funding in Fiscal Year 2015 DoD Budget.[89]

The Way Ahead For Army Space Operations.

This monograph examines the past and present of Army and joint operations as well as how these operations may fit into the congested, contested, and competitive international space environment. To facilitate the best evolutionary path for future activities, the monograph recommends the following actions be considered.

- The Army should retain its current focus on space operations as cross-domain support for terrestrial warfighter operations as it seems appropriate and prudent; it is unlikely that widespread physical warfare will occur in space in the near future.

- The Army should update its Army Space Policy (*AR* 900-1) to reflect the tenets of the 2011 *National Security Space Strategy* and to include cross-domain stakeholder and proponency issues with regard to cyberspace operations.
- The Army needs to ensure its approach to any nanosatellite program or similar system-of-systems comes from an architectural perspective that considers the impacts of these mini-constellations on ongoing military, national, commercial, and international activities in same orbit. Also, the Army must consider how the operational space environment may change if other countries try to establish similar constellations.
- The Army should keep its space organizations involved with the development of joint cyberspace doctrine and should push for deliberate and dedicated development of cyberspace theory writ large to better coordinate actions related to space, cyberspace, and the electromagnetic spectrum.
- The Army should retain its emphasis on force enhancement appropriate for the force with "the most boots on the ground." This includes support from, and exploitation of, space-based capabilities to "shoot, move, and communicate" better through:
  - timely and accurate position, navigation, and timing data;
  - continued refinement and expansion of friendly force tracking; and,
  - continued refinement and expansion of satellite communications.

- The Army should continue to integrate international cooperation into its operations to enhance interoperability as well as build crucial relationships that may provide access to locations critical to the ground-based segments of space systems.
- The Army should continue to provide support to combatant commanders and theater commanders via embedded and deployed teams—Space Support Elements, Army Space Support Teams, and Commercial Imagery Teams. The Army should continue to actively seek feedback and implement aggressive after-action reports and lessons learned processes to help ensure not only the proper number of teams sent, but also the bringing together of the proper subject matter mix.

The Army's development of its space capabilities and forces continues to evolve to meet the changing environment for unified land operations as well as the diverse challenges of ongoing global operations, technological advances by potential adversaries, increased international competition, and domestic resource constraints. Continuing to advance policies and strategies that embrace the joint, interagency, and international aspects of space operations will help to ensure reliable and resilient support to operational and tactical commanders in any theater of operation.

ENDNOTES

1. Barack Obama and Leon Panetta, *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense*, Washington, DC: Department of Defense (DoD), January 2012, p. 4. The context of the quote is:

> Operate Effectively in Cyberspace and Space. Modern armed forces cannot conduct high-tempo, effective operations without reliable information and communication networks and assured access to cyberspace and space. Today space systems and their supporting infrastructure face a range of threats that may degrade, disrupt, or destroy assets. *Accordingly, DoD will continue to work with domestic and international allies and partners and invest in advanced capabilities to defend its networks, operational capability, and resiliency in cyberspace and space*.

2. Brian Garino and Jane Gibson, "Space System Threats," Chap. 21, *AU-18 Space Prime*, Maxwell Air Force Base, AL: Air University Press, September 2009, pp. 273-282, available from *aupress.maxwell.af.mil/digital/pdf/book/AU-18.pdf*, accessed on October 4, 2014. This publication has evolved over many years to become one of the best one-stop references on most aspects of military space operations.

3. *Joint Publication (JP) 3-14, Space Operations*, Washington, DC: Joint Chiefs of Staff, May 29, 2013.

4 . *JP 3-14*, January 6, 2009, p. II-7. In this obsolete version of doctrine, space situational awareness (SSA) is a functional capability under space control:

> SSA is fundamental to conducting space operations. It is a key component for space control because it is the enabler, or foundation, for accomplishing all other space control tasks.

5. *JP 3-14,* May 29, 2013, pp. II-2 – II-4.

6. *Ibid.*, pp. II-4 – II-6. For those with the proper document access clearance and need to know, additional details can be found in the classified document *DoD Instruction (DoDI) S-3100.14, Space Force Enhancement* (U), January 12, 2001.

7. *Ibid.*, pp. II-6 – II-8. For further details on the policy, responsibilities, and procedures for space support, see *DoDI 3100.12, Space Support,* September 14, 2000, available from *www.dtic.mil/whs/directives/corres/pdf/310012p.pdf*.

8. *Ibid.*, p. II-8.

9. *Ibid.*, pp. II-8 – II-9. The definitions of the five elements of space negation are listed as:

> (a) Deception. Those measures designed to mislead an adversary by manipulation, distortion, or falsification of evidence to induce the adversary to react in a manner prejudicial to their interests.
>
> (b) Disruption. Those measures designed to temporarily impair specific targeted nodes of an adversary system, usually without physical damage to the space system.
>
> (c) Degradation. Those measures designed to permanently impair (either partially or totally) the utility of targeted adversary systems, usually with physical damage.
>
> (d) Denial. Those measures designed to temporarily eliminate the utility of targeted adversary systems, usually without physical damage.
>
> (e) Destruction. Those measures designed to permanently eliminate the utility of targeted adversary systems.

10. *Ibid.*, p. II-9.

11. *Ibid.* For those with the proper document access clearance and need to know, additional details can be found in the classified document *DoDI S-3100.15, Space Control* (U), January 19, 2001.

12. *Ibid.*, p. II-9.

13. *Ibid.*, (3-14), pp. II-9 – II-10. For those with the proper document access clearance and need to know, additional details can be found in the classified document *DoDI S-3100.13, Space Force Application* (U), September 14, 2000.

14. David L. Mann, Commanding General, U.S. Army Space and Missile Defense Command and Army Force Strategic Command, Statement for the Record before the Committee on Armed Services, Strategic Forces Subcommittee, Senate, 113th Cong., 2d Sess., March 12, 2014, p. 3, available from *www.armed-services.senate.gov/imo/media/doc/Mann_03-12-14.pdf*, accessed on September 19, 2014. For additional details on space capabilities in Army functional concepts, see Institute of Land Warfare, *U.S. Army*

Space Capabilities: Enabling the Force of Decisive Action, An AUSA Torchbearer National Security Report, Arlington, VA: Association of the United States Army, May 2012.

15. *Ibid*.

16. Sharon Watkins Lang, "Who Do You Think You Are? The Genealogy of an Organization: USASMDC/ARSTRAT," *Army Space Journal*, Vol. 11, Special Ed., Senior Enlisted Leaders Training Conference (SELTC), 2012, pp. 40-43. This article provides an excellent and concise history from 1957 to 2012 of the evolution of Army space operations.

17. Edward J. Drea *et al*., *History of the Unified Command Plan, 1946-2012*, Washington, DC: Joint History Office, 2013. The Army also had a role in the concept of forming U.S. Space Command (p. 49):

> Command arrangements for strategic nuclear forces, joint special operations, and space also interested the Army Operations Deputy. Uncertain whether the present unified and specified command system provided the best vehicle for planning and execution of the Single Integrated Operational Plan (SIOP) by US strategic nuclear forces, he recommended scrutiny of the present system. The growing worldwide threat of insurgency and instability convinced him that the Joint Chiefs of Staff also needed to assess the Joint Special Operations Command's ability to coordinate the conduct of conventional and unconventional warfare and special operations. In light of the new space programs, the USAF Space Command, and the possibility of a new unified command for space, the Army Operations Deputy proposed discussion of the impact of such developments upon national strategy, global planning, joint command arrangements, and global conflict.

18. Headquarters, Department of the Army, UNITED STATES ARMY SPACE COMMAND (UIC: W4XQAA), General Order No. 20, Washington, DC: Headquarters, Department of the Army, April 4, 1988. USARSPACE was activated as a Field Operating Agency of the Office of the Deputy Chief of Staff for Operations and Plans with the following mission:

2. Mission. The United States Army Space Command (USARSPACE) will serve as the Army component to United States Space Command (USSPACECOM). USARSPACE will provide USSPACECOM an Army perspective in planning for DoD space system support to land forces and strategic defense operations. USARSPACE will ensure integration of Army requirements into USSPACECOM planning for space support, respond to USCINCSPACE directed taskings, command assigned Army forces and conduct planning for DoD space operations in support of Army strategic, operational and tactical missions.

19. Lang, "Who Do You Think You Are?" p. 42.

20. Headquarters, Department of the Army, U.S. ARMY SPACE AND STRATEGIC DEFENSE COMMAND—REDESIGNATION, General Order No. 5, Washington, DC: Headquarters, Department of the Army, March 1, 1998. The new command's mission was diverse and challenging (p. 2):

3. The missions of the U.S. Army Space and Missile Defense Command are—

a. The CG, USASMDC, serves as the Army specified proponent for space and NMD [National Missile Defense] and as the Army operational integrator for TMD [Theater Missile Defense]. In accordance with Department of Defense and Army guidance, he coordinates, integrates, and/or executes combat development, materiel development, technology base, and advanced research and development activities for assigned space, NMD and other programs; is the Army integrating command for TMD; is directly responsible to the Army Acquisition Executive for acquisition matters; executes the Army Tactical Exploitation of National Capabilities Program (TENCAP) in accordance with the approved TENCAP Charter; manages and operates National Test and Range Facilities at U.S. Army Kwajalein Missile Range (USAKA/KMR), the High Energy Laser Systems Test Facility (HELSTF) and Wake Island; serves as Executive Director of the United States Army Space and Missile Defense Battle Lab and serves as the Army's Implementing Agent for the Strategic Arms Reduction Treaty (START).

b. The CG, U.S. Army Space Command (USARSPACE), commands all assigned forces, operates assigned facilities; is the Army Component to United States Space Command (USSPACECOM); responds to USCINCSPACE operational taskings; coordinates and integrates Army resources and requirements into USSPACECOM plans and operations for operational exploitation of space and missile defense capabilities; provides USCINCSPACE an Army perspective in planning for Department of Defense space systems; commands the 1st Satellite Control Battalion (1st SATCON); and manages the joint tactical use of assigned satellite communications systems; commands the Joint Tactical Ground Stations (JTAGS) and the Army Space Support teams (ARSST); provides operational support to the Space and Missile Defense Battle Lab; as directed, acts as the Army spokesman for space in joint forums.

c. The CG, USASMDC, articulates Army requirements for Joint programs for space and missile defense, technology base development, testing, and operational warfighting.

21. Drea *et al.*, *History of the Unified Command Plan, 1946-2012,* p. 86. The difference between the "new" and "old" USSTRATCOM was:

> On 22 July [2002] the Secretary forwarded Change-1 to the 2002 UCP to the President, who on 30 July signed the document that created a "new" USSTRATCOM that had the responsibilities for the nuclear missions of the "old" STRATCOM and space operations, including warning and assessment of space attack, previously assigned to USSPACECOM, the latter being disestablished. The accelerated pace enabled the President to nominate Admiral Ellis as STRATCOM commander on 2 August before Congress adjourned for its August recess.

22. Lang, "Who Do You Think You Are?," p. 43. For a detailed history of USASMDC/ARSTRAT from its origins through 2003, see James Walker, Lewis Bernstein, and Sharon Lang, *Seize the High Ground: The Army in Space and Missile Defense*, Redstone Arsenal, AL: History Office, USAMDC, 2003.

23. "U.S. Army Space and Missile Defense Command/Army Forces Strategic Command," factsheet, March 2014, available from *www.smdc.army.mil/FactSheets/SMDC_trifold_0314.pdf*, accessed on October 5, 2014.

24. Richard P. Formica, "2011 Achievements/2012 Priorities," *Army Space Journal*, Vol. 10, No. 3, Winter 2012, pp. 4-5, 16.

25. "USASMDC/ARSTRAT Organizational Vision Statement," USASMDC/ARSTRAT public website, available from *www.smdc.army.mil/2008/Vision.asp#CORE*, accessed on October 6, 2014.

26. Timothy R. Coffin, USASMDC/ARSTRAT Command Overview, Von Braun Memorial Symposium, Springfield, VA: American Astronautic Society, October 17, 2012, available from *www.astronautical.org/sites/default/files/attachment/Coffin%20 2012%20VB.pdf*, accessed on October 2, 2014.

27. Headquarters, Department of the Army, *Field Manual (FM) 3-14, Army Space Operations*, Washington, DC: Department of the Army, August 2014. Although this document is unclassified, its distribution is limited to DoD and DoD contractors in order to protect certain technical data. Thus, details of its contents are not included in this monograph.

28. U.S. Army Space and Missile Defense Command/Army Force Strategic Command, "Supporting the Warfighter through Space and Missile Defense," Redstone Arsenal, AL: USASMDC/ARSTRAT Public Affairs Office, June 2014.

29. Sharon Watkins Lang, "First in Space: The 1st Space Brigade," *Army Space Journal*, Vol. 11, Special Edition: Senior Enlisted Leaders Training Conference (SELTC), 2012, pp. 34-36. The 1st Satellite Control (SATCON) Battalion/53rd Signal Battalion (SATCON) key roles are (p. 34):

> With a mission of providing payload and transmission control of the DSCS constellation, the battalion's companies were organized according to location and situated around the globe at Forts Detrick and Meade in Maryland; Landstuhl, Germany; Camp Roberts, Calif.; and Fort Buckner, Okinawa, Japan. As technology has evolved, so too has the

mission. With the addition of the Wideband Global System configuration and its support requirements, D Company left Camp Roberts in 2011 and now is located at Wahiawa, Oahu, Hawaii.

30. David L. Mann, "Army Space and Missile Defense Plays a Critical Role in Protecting the Nation," *Army Magazine*, Vol. 64, No. 4, April 2014, pp. 41-44.

31. Lang, "First in Space," p. 35. For a detailed history of the early years of ARSST operation through 2002, see James Walker and James T. Hooper, *Space Warriors: The Army Space Support Team*, CMH Pub 70-91-1, Fort McNair, DC: U.S. Army Center of Military History, March 1999, July 2003 (Rev.).

32. "117th Space Battalion," available from *co.ng.mil/arng/units/space/default.aspx*, accessed October 5, 2014.

33. Robert W. Enzenauer, Donald P. Laucirica, and Jesse M. Morehouse, "A Space Blueprint for the National Guard," *Army Space Journal*, Vol. 11, Space Cadre Ed., 2012, pp. 34-36.

34. Institute of Land Warfare, *The Ballistic Missile Defense System: The Army Role in Limited Defensive Operations*, AUSA Background Brief No. 102, Arlington, VA: Association of the United States Army, October 2004.

35. Sharon Watkins Lang, "Guard . . . Engage . . . Destroy, For None Shall Pass: The 100th Space Brigade," *Army Space Journal*, Vol. 11, Special Ed.: Senior Enlisted Leaders Training Conference (SELTC), 2012, pp. 31-33. This article provides a concise history of the unit starting with the National Missile Defense Act of 1999 signed by President William J. Clinton.

36. *Ibid*., p. 33. Also see "100th Missile Defense Brigade (MDB)," available from *co.ng.mil/arng/units/gmd/default.aspx*, accessed on October 5, 2014.

37. Missile Defense Agency, *Army Navy / Transportable Radar Surveillance (AN/TPY-2)*, Fact Sheet, Fort Belvoir, VA: Missile Defense Agency, July 23, 2014, available from *www.mda.mil/global/documents/pdf/an_tpy2.pdf*, accessed on October 7, 2014.

38. Most official USASMDC/ARSTRAT PowerPoint briefings with Distribution A have the slogans "Secure the High Ground" and "The Sun Never Sets on USASMDC/ARSTRAT" along the bottom banner of each slide.

39. Mann, U.S. Army Space and Missile Defense Command and Army Force Strategic Command, Statement for the Record, p. 6.

40. Institute of Land Warfare, *Space Support Elements: Embedded Space Expertise in Army Modular Forces*, AUSA Background Brief No. 105, Arlington, VA: Association of the United States Army, November 2005.

41. *JP 3-14, Space Operations*, May 29, 2013, pp. III-4 and V-2. The format for Annex N is found in *Chairman of the Joint Chiefs of Staff Manual 3130.03, Adaptive Planning and Execution (APEX) Planning Formats and Guidance*, October 18, 2012. The document is unclassified, but limited to official distribution.

42. Mann, U.S. Army Space and Missile Defense Command and Army Force Strategic Command, Statement for the Record, p. 8. For insight into JTAGS operations, see Ed White, "The History of JTAGS," *Army Space Journal*, Vol. 5, No. 1, Winter, 2006, pp. 1F-3F; and Dave Price, "Organize As We Fight Army Theater Missile Warning—JTAGS," *Army Space Journal*, Vol. 5, No. 1, Winter, 2006, pp. 4F-5F.

43. *Ibid.*, p. 8. Also see "Friendly Force Tracking," *Army Space Journal*, Vol. 11, Special Ed.: Senior Enlisted Leaders Training Conference (SELTC), 2012, p. 39.

44. "Wideband Global SATCOM," *Army Space Journal*, Vol. 11, Special Ed.: Senior Enlisted Leaders Training Conference (SELTC), 2012, p. 37. A brief description of the WGS system:

> The Wideband Global SATCOM constellation is a high-capacity satellite communications system designed to support the Warfighter with newer and far greater capabilities than those provided by current systems, yet it is compatible with existing networks and terminals. WGS provides two-way X-band and Ka-band communications as well as Ka-band

broadcast services to U.S. Armed Forces and other agencies worldwide. The procuring agency is the U.S. Air Force Space Command's Space and Missile Systems Center at Los Angeles Air Force Base, California.

WGS will augment and eventually replace DOD communications services currently provided by the Defense Satellite Communications System, which provides Super High Frequency wideband communications, and by the Ka-band Global Broadcast Service, which uses direct broadcast satellite technology to provide critical information to U.S. and allied forces.

45. Mann, U.S. Army Space and Missile Defense Command and Army Force Strategic Command, Statement for the Record, p. 7.

46. *JP 3-14, Space Operations*, May 29, 2013, pp. III-4, IV-7 - IV-9.

47. "Joint Force Component Command for Space (JFCC Space)," factsheet, Offutt Air Force Base, NE: U.S. Strategic Command, December 2011, available from *www.stratcom.mil/factsheets/7/JFCC_Space/*, accessed October 8, 2014.

CDR JFCC Space serves as the single point of contact for military space operational matters to plan, task, direct, assess, and execute space operations. JFCC Space conducts space operational level planning, integration, and coordination with other USSTRATCOM joint functional components, other combatant commanders through their space coordinating authority (SCA), and other Department of Defense (DoD) partners, and when directed, non-DoD partners to ensure unity of effort in support of military operations, national security operations, and support to civil authorities.

48. *JP 3-14, Space Operations*, May 29, 2013, p. III-2. Details of the Space Coordinating Authority (SCA) include:

In selecting the appropriate option, the JFC considers the mission, nature, and duration of the operation; preponderance of space force capabilities made available; and resident

C2 capabilities (including reachback). The SCA has primary responsibility for joint space operations planning, to include ascertaining space requirements within the joint force.

Summarizing, the SCA's roles and responsibilities include:

(1) Integrating space capabilities.

(2) Planning, coordinating, and synchronizing space operations in the operational area and ensuring inputs from the joint force staff and components are incorporated.

(3) Maintaining situational awareness of theater space operations, and coordinating with the CCMD SCA or Commander, JFCC SPACE, to integrate theater space operations into DOD space operations.

(4) Providing consolidated space requirements through the JFC for coordination as required.

49. *Ibid.*, pp. IV-9 – IV-13.

50. *Ibid.*, p. A-2.

51. Undersecretary of Defense for Policy, *DoD Directive 3100.10, Space Policy*, Washington, DC: Department of Defense, October 18, 2012, p. 2. Regarding international cooperation in space, the policy goes on to state:

DoD will seek to expand space-related cooperation with international partners, building and sharing space capabilities with these partners to the extent practicable and leading combined space operations, including space-support operations. DoD space-related international cooperation activities will be based on mutual interest and will be conducted to enhance collective security capabilities, forge closer security ties with allies and friends, and advance U.S. policy objectives. In its efforts to expand space-related cooperation, DoD will:

(1) Proactively seek opportunities to cooperate with allies and selected international partners in developing space architectures and in designing, acquiring, and operating military space systems. DoD will pursue interoperable systems in which trusted participants share costs, benefits, and risks.

(2) Extend the battlefield advantages that space systems can provide to allies and coalition partners, to the maximum practicable extent.

(3) Work with international partners to protect mutual security interests related to dual-use technologies and services.

52. Mike Howard, "Moving Forward: U.S./Australian Partnership," *Army Space Journal*, Vol. 11, Space Cadre Ed., 2012, pp. 12-14.

53. Jason Gabrick, "Foreign Liaison Officer Program to Bed Down," *Army Space Journal*, Vol. 11, Space Cadre Ed., 2012, p. 15.

54. Dottie White, "Nimble Titan Examines Future Multinational Cooperation Opportunities for Missile Defense," Redstone Arsenal, AL: USASMDC/ARSTRAT Public Affairs, available from *www.army.mil/article/125169/Nimble_Titan_examines_future_multinational_cooperation_opportunities_for_missile_defense/*, accessed on October 6, 2014.

55. Department of the Army, *Training and Doctrine Command (TRADOC) Pamphlet 525-7-4, The United States Army's Concept Capability Plan (CCP): Space Operations 2015-2024*, Version 1.0, Fort Monroe, VA: Headquarters, U.S. Army TRADOC, November 15, 2006. The scope of this effort was defined as:

> The CCP is designed to achieve four imperatives:
> - Facilitate the integration of space capabilities across the full spectrum of Army and joint operations.
> - Improve the Army's ability to exploit existing space capabilities.
> - Deliver space capabilities that address Army needs (capability requirements) and priorities by influencing the design of space-based systems and payloads.
> - Systematically and deliberately evolve Army space support operations over time to provide dedicated, responsive theater focused support to operational and tactical commanders.
>
> Central to achieving these imperatives, the concept describes the need for a layered infrastructure involving specific space enablers at the strategic, operational and tactical levels. This infrastructure consists of facilities, personnel, organizations and equipment that extend space-based enablers to the "last tactical mile." Using an operational level vignette,

and the Army capstone concept's seven key operational ideas (shape and entry operations, operational maneuver from strategic distances, intratheater operational maneuver, decisive maneuver, concurrently and subsequent stability operations, distributed support, and network-enabled battle command) the CCP illustrates the integration and contribution of space-enabled capabilities in a future Modular Force operational setting.

56. John R. London III, A. Brent Marley, and David J. Weeks, *Army Nanosatellite Technology Demonstrations for the Tactical Land Warfighter*, paper presented at the 27th Army Science Conference, Orlando, FL, Redstone Arsenal, AL: USASMDC/ARSTRAT Technical Center, September 2010, p. 8.

57. John Cummings, "Army Nanosatellite on First Flight," Army News Release, Redstone Arsenal, AL: USASMDC/ARSTRAT Public Affairs, available from *www.army.mil/article/49115/army-nanosatellite-on-first-flight/*, accessed on October 10, 2014.

58. Jose Ruiz, "Nanosatellite Launch Marks SOUTHCOM's Entry to Space," U.S. Southern Command New Release, Miami, FL: USSOUTHCOM Public Affairs, available from *www.southcom.mil/newsroom/Pages/MEDIA-RELEASE-Nanosatellite-launch-marks-SOUTHCOM%E2%80%99s-entry-to-space.aspx*, accessed on October 10, 2014.

59. "Kestrel Eye Visible Imagery Nanosatellite Technology Demonstration," factsheet, Redstone Arsenal, AL: USASMDC/ARSTRAT Technical Center, no date, available from *www.smdc.army.mil/FactSheets/KestrelEyeTC0112.pdf*, accessed October 5, 2014.

60. "SWORDS: Soldier-Warfighter Operationally Responsive Deployer for Space," factsheet, Redstone Arsenal, AL: USASMDC/ARSTRAT Technical Center, no date, available from *www.smdc.army.mil/FactSheets/SWORDS.pdf*, accessed October 5, 2014.

61. Tom Webber, "USASMDC/ARSTRAT Update: Maximizing Capabilities and Targets of Opportunities in Austere Times," presentation at the 2012 AUSA Missile Systems Conference, Red-

stone Arsenal, AL: Association of the United States Army, April 12, 2012, available from *www.smdc.army.mil/2008/TechnicalCenter.asp*, accessed October 2, 2014, slide 11.

62. *Ibid.*, slide 10.

63. David L. Mann, Commanding General, U.S. Army Space and Missile Defense Command and Army Force Strategic Command and Joint Functional Component Command for Integrated Missile Defense, Statement for the Record before the Committee on Armed Services, Strategic Forces Subcommittee, Senate, 113th Cong., 2d Sess., March 25, 2014, pp. 6-7.

64. Webber, "USASMDC/ARSTRAT Update: Maximizing Capabilities and Targets of Opportunities in Austere Times," slide 8.

65. Debra G. Wymer, "Technical Expertise and Dedication," *Army Space Journal*, Vol. 10, No. 3, Winter 2012, pp. 14-15. The upgrade on the RTS millimeter wave radar changed its operating frequency from 2 gigahertz to 4 gigahertz, thus improving its imaging resolution from 12 centimeters down to 6 centimeters.

66. Jac W. Shipp, "Space & Cyberspace: The Overlap and Intersection of Two Frontiers," *Army Space Journal*, Vol. 10, No. 1, Spring/Summer 2011, pp. 40-43.

67. "24th Air Force Fact Sheet," JBSA-Lackland, TX: 24th Air Force Public Affairs, June 2014, available from *www.24af.af.mil/library/factsheets/factsheet_print.asp?fsID=15663&page=1*, accessed on October 10, 2014.

68. *JP 3-14, Space Operations*, May 29, 2013, p. IV-7.

69. "Strategic Defense Reviews: Space Posture Review," U.S. Department of Defense website, available from *www.defense.gov/spr/*, accessed on October 25, 2014.

70. Robert Gates, "Defense Secretary Robert Gates Statement on the National Space Policy," News Release No. 703-697-5131/5132, Washington, DC: Department of Defense, June 28, 2010, available from *www.defense.gov/spr/docs/National_Space_*

Policy_SecDef_June_28_2010.pdf, accessed on October 25, 2014. Secretary Gates went on to note the interagency and international nature of space operations:

> Together with other departments and agencies, the Department of Defense will take a number of steps to support the new National Space Policy, and will work with the Office of the Director of National Intelligence to develop a strategy document to address specific national security requirements for outer space. We will look to leverage growing international and commercial expertise to enhance U.S. capabilities and reduce vulnerabilities.
>
> Finally, we will pursue activities consistent with the inherent right of self-defense, deepen cooperation with allies and friends, and work with all nations toward the responsible and peaceful shared presence in space.

71. Barack Obama, *National Space Policy of the United States of America*, Washington, DC: The White House, June 28, 2010, pp. 13-14.

72. "Fact Sheet: The National Space Policy," White House website, available from *www.whitehouse.gov/the-press-office/fact-sheet-national-space-policy*, accessed October 25, 2014, p. 2.

73. Obama, *National Space Policy of the United States of America,* pp. 10-13.

74. Robert M. Gates and James R. Clapper, *National Security Space Strategy: Unclassified Summary*, Washington, DC: Secretary of Defense and Director of National Intelligence, January 2011, p. 1.

75. *Ibid.*, p. 4.

76. *Ibid.*, p. 5. The five strategic approaches are: (1) Promote responsible, peaceful, and safe use of space; (2) Provide improved U.S. space capabilities; (3) Partner with responsible nations, international organizations, and commercial firms; (4) Prevent and deter aggression against space infrastructure that supports U.S. national security; and, (5) Prepare to defeat attacks and to operate in a degraded environment.

77. Obama and Panetta, *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense*, p. 3. Consistent with the *National Security Space Strategy,* the space environment for DoD operations was described as:

> Growth in the number of space-faring nations is also leading to an increasingly congested and contested space environment, threatening safety and security. The United States will continue to lead global efforts with capable allies and partners to assure access to and use of the global commons, both by strengthening international norms of responsible behavior and by maintaining relevant and interoperable military capabilities.

78. Headquarters, Department of the Army, *Army Regulation 900-1, Army Space Activities: Department of the Army Space Policy*, Washington, DC: Department of the Army, January 23, 2009, p. 6.

79. *Ibid.*, p. 1. The five dominant Army stakeholder communities in space are: (1) The Chief Information Officer/G–6 (CIO/G–6) represents the Network and Communications community; (2) The Deputy Chief of Staff, G–2 (DCS, G–2) represents the Army's Intelligence community; (3) The Deputy Chief of Staff, G–3/5/7 (DCS, G–3/5/7) represents the electronic warfare community; (4) The Commanding General (CG), U.S. Army Space and Missile Defense Command/U.S. Army Forces Strategic Command (USASMDC/ARSTRAT) represents the Army Space community; and, (5) the CG, U.S. Army Training and Doctrine Command (TRADOC) represents the land force CBTDEV community. The Army will overcome the space-related development process challenges through collaborative cross-proponent efforts centered on the operational and tactical needs of land forces.

80. Ron Dickerman, "Army Space Master Plan," *Army Space Journal*, Vol. 6, No. 1, Winter 2007, pp. 18-19, 46-47.

81. "2006 United States Army Space Master Plan," Public Affairs factsheet, Redstone Arsenal, AL: US Army Space and Missile Defense Command, available from *www.smdc.army.mil/FactSheets/ASMP.pdf*, accessed on October 5, 2014. The seven Army Issues for Resolution regarding space operations were:

1. ISSUE - MILSATCOM: The Army must seek innovative solutions, to include partnering with commercial providers, to overcome MILSATCOM shortfalls in capacity, user access and delays in capability improvements.

2. ISSUE – Where should the Army invest in near-space and high-altitude, long-endurance platforms as a lower cost, more responsive alternative to space platforms if they prove technologically feasible?

3. ISSUE: Establish DOTMLPF development proponents (where they do not currently exist), and assign responsibilities for potential Army involvement in tactical satellite and near-space and high-altitude, long-endurance capabilities and operations.

4. ISSUE: Assess the utility in pursuing a more efficient commercial imagery policy and process in order to better support time-sensitive tactical use.

5. ISSUE: Plan for the prioritized migration from using commercial SATCOM to using MILSATCOM as the primary means of transmitting mission-critical data.

6. ISSUE: Army-operated elements of the Ballistic Missile Defense System (BMDS) must be supported in accordance with the BMDS Transition and Transfer Plan to defeat space-transiting ballistic missiles launched against the US homeland, allies, deployed forces and other national interests, and the BMDS plan to provide enhanced missile detection and assured warning for the US homeland and regional combatant commanders.

7. ISSUE: Assess the utility of using directed energy as a weapons system within the Future Force. Consider mission areas, applications and constraints as part of the assessment.

82. *TRADOC Pamphlet 525-7-4, The United States Army's Concept Capability Plan (CCP): Space Operations 2015-2024*, pp. i-ii.

83. Richard P. Formica, "U.S. Army Space Capabilities: Enabling the Force of Decisive Action," PowerPoint briefing, Redstone Arsenal, AL: U.S. Army Space and Missile Defense Command, June 1, 2012, slide 6, available from *www.smdc.army.mil/CG/2012/LTGFormicaPresentation.pdf*, accessed on September 1, 2014.

84. Institute of Land Warfare, *U.S. Army Space Capabilities: Enabling the Force of Decisive Action*, An AUSA Torchbearer National Security Report, Arlington, VA: Association of the United States Army, May 2012, p. 6. For additional background on recent Army space strategy documents, see also Richard P. Formica, "Synchronizing Efforts: Providing Capabilities 24/7/365," *Army Space Journal*, Vol. 11, Space Cadre Ed., 2012, pp. 4-5; and Timothy R. Coffin, "Joint the Conversation: Partnering through Interdependency," *Army Space Journal*, Vol. 11, Space Cadre Ed., 2012, pp. 8-9.

85. Raymond T. Ordierno and John M. McHugh, Army Strategic Planning Guidance 2014, Washington, DC: Department of the U.S. Army, available from *defenseinnovationmarketplace.mil/resources/ASPG2014.pdf*, accessed October 25, 2014, p. 23. Additional key mentions of space-based activities related to Army priorities include:

- **Adapt the Army Force Generation Model.**
  Sustain the Total Army's ability to provide a manned, trained and equipped force to meet the full range of current and emerging CCDR requirements, to include areas such as space, cyberspace, missile defense, and countering weapons of mass destruction. (p. 22)

- **Build Resilient Mission Command at the Tactical and Operational Level.**
  Enable Army forces to operate through enemy attacks on its mission command systems, to include denial of capabilities in specific domains, to include space and cyberspace. (p. 23)

86. Office of the Undersecretary of Defense (Comptroller)/ Chief Financial Officer, *United States Department of Defense Fiscal Year 2015 Budget Request: Program Acquisition Cost by Weapon System*, Washington, DC: Department of Defense, March 2014, available from *comptroller.defense.gov/Portals/45/documents/defbudget/fy2015/fy2015_Weapons.pdf*, accessed on July 11, 2014, p. i.

87. Office of the Undersecretary of Defense (Comptroller)/ Chief Financial Officer, *United States Department of Defense Fiscal Year 2015 Budget Request: Program Acquisition Cost by Weapon System,* pp. 4-1 – 4-6.

88. *Ibid.,* pp. 7-1 – 7-7.

89. Values in Table 5 were derived from the Appendix of the report "U.S. Defense Space-Based and Related Systems Fiscal Year 2015 Budget Comparison, Update 6," Colorado Springs, CO: Space Foundation, July 20, 2014, pp. 34-40, available from *www.spacefoundation.org/sites/default/files/downloads/Update%206%20FY%202015%20DoD%20Space%20Budget%20Comparison.pdf*, accessed on October 2, 2014. These values were also checked against FY2015 budget documents from the Under Secretary of Defense (Comptroller), specifically the Procurement Programs (P-1) Amendment and Research Development, Test & Evaluation Programs (R-1) Amendment, available from *comptroller.defense.gov/budgetmaterials.aspx*, accessed October 11, 2014.

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