USASMDC/ARSTRAT Whitepaper

Assured Tactical Access to Space

2016 - 2028

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Contents

This paper addresses future Army warfighting operations as they pertain to space and proposes a new concept, *assured tactical access to space*, a concept the Army must strongly consider to ensure mission success of future land combat operations. This paper likewise highlights the critical junctures between space and Army operations not treated in the *Army Capstone Concept* and the *Army Operating Concept*. Questions may be directed to USASMDC's Concepts & Wargames Division at (256) 955-5797 or (719) 554-4218.

Introduction

As TRADOC Pam 525-3-0, *The Army Capstone Concept (ACC)*,[1] points out, the growing dimension of uncertainty in a multitude of operational environments presents military forces and leaders with numerous challenges. Persistent and long-enduring military conflicts exacerbate the warfighting problem. To get at the complex problems we find in today's conflicts, the *ACC* asks and attempts to answer the following fundamental questions:

1. What is the Army's vision of future armed conflict, and how should the Army conduct joint land operations that facilitate strategic objectives?
2. What capabilities should the Army provide to joint force commanders to meet a broad range of national security threats on short notice, for indeterminate duration, and in response to unanticipated events?[2]

Based on these important questions, this white paper has two major aims. The first—based on Army and joint wargames results[3] and follow-on research—is to answer these questions for the Army from the perspective of space operations, to provide answers about space operations at the *Army Capstone*-level, to help address key aspects of space operations not addressed in the *Army Operating Concept (AOC)*, and to articulate space concepts to inform more fully the required capabilities found in the *Army Functional Concept*.[4] The second aim of this paper is to provide observations and recommendations that will drive concept development and experimentation (CDE) for the US Army, joint stakeholders, and other key members of the space community of practice.

The important questions posed by the ACC beg two more questions that are critical to the Army's future vision for land combat operations and are crucial to understanding how the Army of the future will be able to respond on short notice to national security threats. These questions address the space-enabled effects required to meet the Army's future vision.

1. How does the Army further operationalize space to support full spectrum operations?
2. How does the Army balance the technological mismatches between available space capabilities and operational capacities?

These two questions will guide the discussion throughout to contextualize how future land forces will use space-enabled effects to gain and maintain *operational adaptability*[5] during all phases of ground combat operations.

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[1] *The Army Capstone Concept: Operational Adaptability – Operating Under Conditions of Uncertainty and Complexity in an Era of Persistent Conflict*. TRADOC Pam 525-3-0. 21 December 2009.
[2] *ACC,* pp. 5-6.
[3] Especially those games conducted by SMDC/ARSTRAT, namely, Space Power Seminar Wargame (Feb 09), SMDC Warfighter Forum (Dec 09), D3SOE Seminar Wargame/Unified Quest 2010 (Feb 10 and May 10, respectively).
[4] In short, the paper should help shape many elements of the total Army Concept Framework and likewise address Army and joint warfighting challenges.
[5] *ACC,* pp. i-ii.

The ACC fittingly recommends that Army forces and leaders "must strive to reduce uncertainty through understanding the situation in depth, developing the situation through action, fighting for information, and reassessing the situation to keep pace with the dynamic nature of conflict."[6] Simultaneously, it is important that Army warfighters[7] understand the conditions that have brought them to this point. This includes the context of Army space, relevant assumptions about Army space, future operating environments—conditions that will change the face of warfighting. To face challenges of the future it is also important to realize a central military problem: in gaining and maintaining the high levels of situational awareness necessary to reduce uncertainties and clear the fog of war, land component warfighters have learned to trust and depend on space capabilities that enable full spectrum operations. The way forward, however, for space-enabled support must be measured by how much warfighters are assured tactical access to space, the access to space capabilities that meets land warfighter mission requirements and timelines. Assured access to space capabilities at the tactical level is, and will continue to be, vital for land combat operations.

Framework

Army Space in Context

When considering the implications of the effects of space capabilities on the land warfighter, the Army does not have a long history to draw upon. Operation Desert Storm is often suggested as the first space-enabled war. For the Army, Desert Storm kicked off a full-scale integration of space into land combat operations. During Desert Storm, satellite communications enabled the Army to expand rapidly its tactical network to support the dramatic offensive that drove into Iraq and Kuwait. The attributes of persistence and wide-area coverage overcame the limitations of the Army's terrestrial-based network built for the Cold War battlefield. It was also during Desert Storm that the Army was introduced to Positioning, Navigation, and Timing (PNT) capabilities delivered by the Global Positioning System (GPS) "NavStar" constellation. Positioning and navigation capabilities greatly contributed to the speed of maneuver, and allowed more precise delivery of fires, during the offensive phase of operations. Following Desert Storm, the Army moved quickly to adapt and further develop space capabilities that could support the tactical fight. Even though the Cold War ended in the 1990s, the Army found itself continuously deploying and executing a full range of operations around the globe—from Somalia to the Balkans—and other far-reaching AORs of the combatant commands. At the same time, the Army embarked on a transformation campaign designed to adopt innovative information technologies that would enable the latest forms of warfare based on information dominance. This new kind of warfare promised to make war more precise and more lethal for the side that could dominate the information environment. During this time, space became a key enabler that could be extended to support the tactical fight. It was the homeland attacks of 9/11 and the subsequent campaigns in Afghanistan and Iraq, though, which signaled the transition to normalizing space on battlefields. As these campaigns have further progressed, satellite communications and GPS-delivered

[6] *ACC*, 1-4b. p. 8.

[7] For the purposes of this paper, the terms "warfighter" or "warfighters" denote those land combat forces at command echelons that are responsible for planning and executing critical combat missions and other operational tasks. Primarily the terms refer to Army and other land forces operating at the tactical levels of warfare.

PNT became significant capabilities that support every warfighting function—and important resources upon which warfighters very seriously depend.

The Army's use of satellite communication has surged exponentially since Operation Desert Storm. Battalion Commanders now have access to wideband SATCOM, access previously available only at division headquarters. While Operations Iraqi Freedom (OIF) and Enduring Freedom (OEF) were executed with approximately only half of the number of combat troops deployed to Desert Storm, nearly three times the amount of SATCOM is currently required for theater operations. The contrast between today's operating areas those of WWII, coming well before the advent of space communications, becomes even starker (see Figure 1).

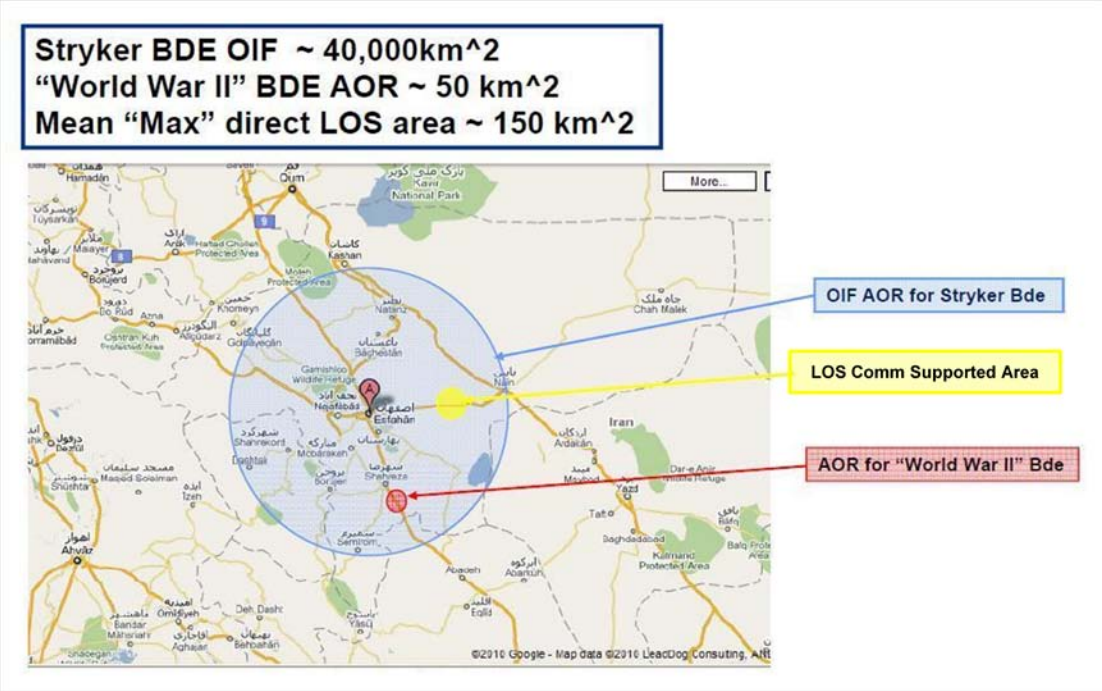

Figure 1: Comparison of Past and Present Brigade AORs and Communications Coverage

Without doubt, the increase of satellite communications serves as a force multiplier, providing greater coverage and enabling greater span of control over battlefields. For example, Brigade Combat Teams today control areas of operations about the total area of New Jersey. During World War II, an Army Division controlled that amount of coverage. Mostly this can be attributed to wider-area communications coverage (see Figure 2).

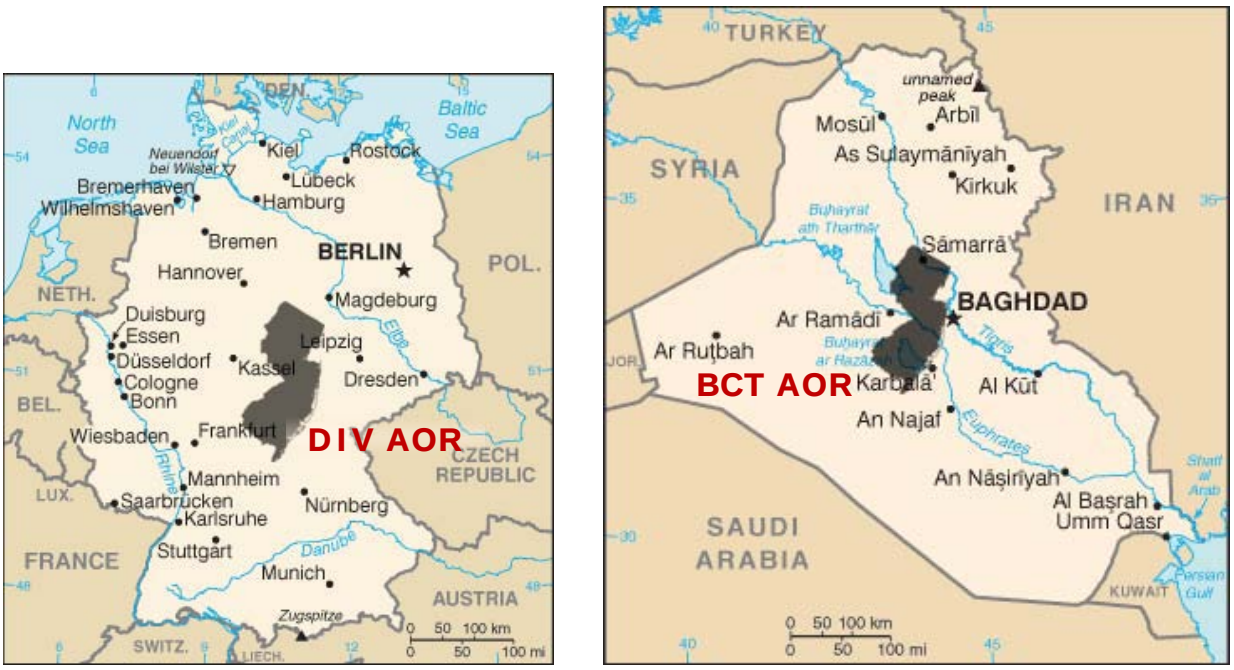

Figure 2: Wider area SATCOM coverage allows greater spans of control and, therefore, expanded AORs.

The Army's use of GPS has also greatly increased over the past 15 years. While initially thought of primarily as a navigation capability, GPS-based PNT has also become essential to timing and precision fires. Better accuracy and timing has increased lethality while reducing collateral damage. Another benefit of better precision is a reduced logistical burden and footprint within the AOR. Moreover, an often-overlooked GPS capability is the delivery of an exquisitely precise timing capability that communications networks actually depend upon to function across the globe. When considering the vast nature of the global information grid (GIG), a precise timing source is required to synchronize networks from strategic levels of command and control (C2) all the way down to the foxhole. This high level of precision and the greater demands for information, therefore, cannot be fulfilled without the system backbones of space—GPS and SATCOM—major systems without which Army forces would surely find critical operations seriously degraded.

Assumptions Relevant to Army Space

For the purposes of this paper—and while keeping a good eye on the *Army Operating Concept*—the following assumptions relevant to Army space apply.

- US Forces will operate in environments where space [capabilities are] increasingly contested.[8]
- Adversaries will use whatever means possible, either low or high-technology means, to disrupt, degrade, or deny enablers that use the space domain, all the while maximizing their own use of space capabilities.

[8] *Army Operating Concept, 2016-2028*. TRADOC Pam 525-3-1. 19 August 2010. 1-3b (2).

        - Degraded space operations may ultimately affect Army force capabilities related to all six Army functional areas: mission command, intelligence, movement and maneuver, fires, protection, and sustainment.
    - US Forces may unintentionally degrade their own operations with blue-on-blue electromagnetic interference (EMI).
    - Networks integrate systems found in all warfighting domains: land, air, space, maritime, and cyberspace.
        - The network cannot in and of itself deliver information superiority.[9]
        - Network systems include the human interfaces within those systems.
        - Networks may or may not have sound architectures and sustainable infrastructures.
        - Network defense is critical to applying and sustaining combat power.
    - DoD and US Forces will depend more heavily in the future on commercial satellites and other commercial augmentations for communications, PNT, and intelligence products and services.
    - US Forces will collaborate with coalition and host-nation forces on space and cyber-enabled capabilities.
    - Space and cyber systems operate in separate domains but when intersecting, they become force multipliers that enable and strengthen combat power; at the same time their intersections and interdependencies makes them both vulnerable to exploitation.

Future Operating Environments

Complexity, uncertainty, rapid change, and a wide variety of threats mark future operating environments for joint and Army forces, and in the midst of this challenging context, space capabilities can provide ways to reduce uncertainty and suppress threats. In fact, warfighters now count on space-enablers to reduce the fog of war created by dynamic environments like these. At the same time, however, the technical aspects of space operations could be perceived as highly complex, adding greater demands to the warfighting environment. This means that while space enablers can (and should) be employed as combat multipliers, they must be integrated in such a way so as not to add complexity to a rapidly changing operational environment. The *ACC* agrees with this principle, saying that while technological advantages are vital to warfighting effects, the Army "must take an evolutionary, rather than a revolutionary or 'leap ahead,' approach to force development."[10] By following this tenet, new developments in space-enabled systems will become more readily accepted and employed by soldiers on battlefields.

As the recently published *National Military Strategy* points out, the future space-threat environment itself will likewise be challenging.[11] Future allies and adversaries continue to close space and other technology gaps. Adversaries incessantly find new ways to deny, disrupt, and degrade SATCOM, PNT resources, satellite-based intelligence functions, missile warning, and the systems that depend on

[9] *ACC*, 1-3 a (1). p. 7.
[10] *ACC*, 2-4 e. p. 15.
[11] *The National Military Strategy of the United States of America, 2011*. 8 February 2011, p. 3.

these capabilities. Not only will near-peer adversaries try to deny space capabilities; terrorist, criminal, and other organizations will do the same—with low and high technology means. This means that warfighters depending on space-based capabilities such as PNT and Friendly-Force Tracking (FFT) must recognize that space-denial technologies can and will be used against them to disrupt critical, carefully planned missions. Warfighters must accept the risk of evolving space-enabled technologies for friendly and adversary forces alike; they should be prepared for the worst and adopt backup plans that ensure mission success.

As the 2010 *National Space Policy* directs, DoD and Army forces of the future must actively seek out and contract commercial-space access.[12] Over the past few years, the Army began anticipating this move because the reliance on commercial space-force enhancement has grown exponentially since the 1990s. The Army and joint communities, at the same time, began to accept the low likelihood the military would be able to maintain payloads strictly on national-military space platforms. Additionally we have learned DoD will be unable, as originally thought, to migrate military payloads currently residing on commercial satellites to dedicated US systems. High costs and lengthy delivery times have been the main factors—dedicated military platform and payload systems just cost too much and take too long to develop and employ. The Transformation Communications Satellite (TSAT) program that promised a robust communications payload that would provide communications-on-the-move (COTM) capabilities nearly anywhere on the globe was cancelled in 2009, leaving the Army and the other services to identify other ways to fill the gaps in communications requirements. With the cancellation of TSAT and with budgets shrinking across the services, commercial space platforms are beginning to be seen as necessary solutions to fill those gaps, and they have already demonstrated solid potential for the future.

As the services considered the cost and time required to fulfill space requirements, the commercial satellite industry has begun to provide potential solutions for different space mission sets. One of these solutions—dedicating military systems-payloads on commercial satellites—is otherwise known as "hosted payloads." An example of a hosted payload is the IP Router in Space (IRIS) project in which a payload was launched on an Intelsat IS-14 spacecraft in November 2009. The Army provided Operational Management of the demonstration. The IRIS payload, developed by Cisco Systems, investigated the utility of direct IP routing in space for U.S. military operations. IRIS will allow U.S. government systems to communicate directly with a single satellite, potentially improving the speed and efficiency of military communications in a significant way. IRIS was developed, built, and integrated in less than three years and was judged a tremendous success not only by the Army but also by the entire joint and DoD stakeholders' communities.[13] Land component operations stand to gain much from commercial "hosted payloads" in the near future.

The future operational environment includes the growing interdependencies between space and cyber. As was mentioned earlier as a basic assumption, "space and cyber domains are interdependent force multipliers that enable and strengthen combat power, but the widespread shifting and ephemeral intersections of space and cyber domains are not clearly understood, making both domains vulnerable

[12] *The National Space Policy of the United States of America.* 28 June 2010, p. 10.
[13] *Space News*, 19 July 2010, A1.

to systems exploitation and attack." The first Army Space Power Wargame (conducted in February 2009) describes the space and cyber domains as "global warfighting domains in which distinctive space and cyber military activities are conducted. Both [space and cyber] generate effects in and through their own domains, and across the other domains (e.g., air, land, and maritime) . . . . These domains share networked systems and associated physical infrastructures."[14] By extension, then, we can conclude that space and cyber architectures both enhance capabilities and increase vulnerabilities.

Kevin Coleman, Chief Cyber Correspondent for *Defense Tech* describes a salient example of the shared vulnerabilities between space and cyber domains in a 1 March 2010 article titled "Cyber War = Space War," explaining that

> Satellites in geostationary orbits provide broadband connectivity to businesses and customers. Those satellites and their computer control ground stations present a viable target for offensive cyber actions. A hacker could disrupt or interfere with satellite control communications and could disrupt the delivery of broadband services. In the absence of such command signals, a satellite would malfunction.[15]

This spells "double trouble" for both space and cyber, putting both domains at risk at certain critical juncture points. With that realization, shared space and cyber vulnerabilities will be seized upon as opportunities, meaning that future warfare "between modern militaries would be both a space war and a cyber war; in fact, they would be one and the same. Russia, China, and the U.S. have all stated they don't want a space war, but are all preparing for one if one occurs."[16] As the junctures between space and cyber become more recognizable, and exploitable, the Army and joint space-cyber communities will be better positioned if they are prepared to protect shared space-cyber nodes and have formulated plans to mitigate the effects of space-cyber attacks.[17]

Meeting Future Challenges

The Military Problem

When considering future paths for the development and deployment of space capabilities to support land combat operations, the required capabilities of the *Army Capstone* and *Operating Concepts* serve as baselines for Army Space requirements, requirements that can be articulated to the joint space communities responsible for the actual development and servicing of these assets. When considering the central ideas of these concepts we must ask the following questions. How do we assure access to the most important space force enhancement capabilities for our tactical forces? How do we diversify our capability portfolio or employment procedures to mitigate an increasingly contested environment? What technologies do we pursue? How do we better leverage joint, coalition, and commercial partner capabilities? How do we develop and train our leaders to exploit better the advantages of our space

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[14] Shipp, Jac. *Cyber Concept Paper*. USASMDC/ARSTRAT, Future Warfare Center, SMD Battle Lab, 2009.
[15] Coleman, Kevin. "Cyber War = Space War." *Defense Tech Online*. 1 March 2010.
[16] Coleman, Kevin. "Cyber War = Space War." *Defense Tech Online*. 1 March 2010.
[17] It is also worth mentioning that while space can provide a conduit for cyber, cyber is a physical domain separate from space, and that while their intersections are many cyber operations can be conducted without transversing the space domain. In this case, "double trouble" does not exist between cyber and space; cyber vulnerabilities, then, become restricted to more locally connected cyber networks.

capabilities? The Army must answer these questions to make certain it has dependable access to space-enabled capabilities.

Central Idea: *Assured Tactical Access to Space*

Meeting the challenges presented in the *ACC* and *AOC*—especially the characteristics of "operational adaptability" and "operating decentralized"—will place greater demands on our leaders and command-and-control mechanisms. It will be necessary to develop capabilities that deliver space down to the lowest tactical level, the "tactical edge." Operating decentralized will require competent and confident leaders supported by reliable capabilities that will enable communications, situational awareness, and superior decision-making. The Army modularity construct itself requires that units are dislocated geographically from higher headquarters; smaller Army units operate increasingly detached from, and independent of, more fixed and stable higher-level command-and-control (C2) headquarters. This increased responsibility has stressed not only the capabilities and skill sets of our younger leaders but has also outpaced the technical capabilities to keep these organizations connected. Thus, Army modularity, and the *AOC,* demand that tactical units have space capabilities[18]—those capabilities once seen only at Division-and-above will need to be accessed down to the lowest echelons. Space-based communications and GPS are "must haves" that allow communications at long distances on the move and deliver accurate positioning, navigation, and timing information. They provide the capabilities and capacities for the Army to increase the coverage of operating areas, to have precise knowledge of troop locations, and to deliver fires more accurately.

Alongside SATCOM and GPS, Army warfighters also depend on other space-force enhancement assets, namely those on-orbit intelligence-and-warning resources that provide missile warning and overall battlespace characterization. A number of space systems offer land warfighters valuable battlespace situational awareness and missile warning. In particular, the Overhead Persistent Infrared (OPIR) program offers both missile warning and intelligence, real-time critical dependencies for theater commanders' decision-making and the execution of tactical ground missions. If the Army of the future is to fight effectively when decentralized—and at the same time maintain operational adaptability—*assured tactical access to space*[19] becomes imperative. Simply put, this means space must be delivered when and where warfighters need it for mission accomplishment.

Supporting Ideas. Four supporting ideas contribute to the development and delivery of a*ssured tactical access to space* capabilities. Although space is often considered an esoteric and technical domain, the ideas that follow spread across the whole DOTMLPF-solutions construct and oblige the Army to take a more holistic approach toward them, an approach that goes beyond simply developing and procuring more user devices. These ideas are:

- Diversifying architectures using a multi-domain approach
- Influencing partners' capabilities and programs

[18] *AOC*, p. 18, 3-5d. ". . . organizations at the lowest tactical level must have required enablers to integrate joint capabilities in mission planning and execution."

[19] More fully, this paper defines "assured tactical access to space" as guaranteed access to space capabilities that meets land-warfighter mission requirements and timelines (during all phases of full-spectrum operations).

- Gaining and maintaining advantages to tactical space access
- Building versatile and adaptable Army space organizations

Diversifying Architectures Using a Multi-Domain Approach

It is no longer the case that the Army operates in an assured and non-contested space environment. In the early stages of OIF, for instance, the Iraqis attempted to jam GPS signals with jammers readily available for purchase online. Thus, the Army must be prepared to fight in denied, degraded, and disrupted space operational environments.[20] To prepare to fight space capabilities in a contested space environment, it is incumbent on the Army to follow a multi-domain approach by advocating for and leveraging capabilities in the terrestrial, aerial, high-altitude, and space layers. This approach would diversify networks; it would construct a NetOps environment that builds secure and reinforcing information architectures; and it would create a redundant, reliable system of ISR platforms and payloads. A multi-domain approach provides defense-in-depth, making it both difficult and resource-intensive to attack military comms and ISR delivery systems. A multi-domain approach not only provides resiliency it also grows bandwidth capacity, increasing the likelihood of timely tactical access. Finally, operating over widely dispersed operating areas, and in the most austere environments, will challenge Army warfighters to establish and maintain communications links—a multi-domain approach will be required for wide-area and austere operations in order to establish networks swiftly and securely.

Influencing Partners' Capabilities and Programs

When considering the Army's growing dependencies on space, it is important to realize that the Army is fully dependent on the joint community and commercial markets. The Army does not primarily build, launch, and operate any space systems. In past cases, the Army was unable to voice capability requirements or prioritize operational requirements. The Army's approach was to focus on building terminals that leveraged pre-existing on-orbit capabilities. The Army should avoid this approach in the future. In the future, the Army must use the Army Concept Framework as an opportunity to flex its institutional muscles, to articulate and justify its operational requirements to the joint space community—the goal being to ensure strategic on-orbit assets will deliver tactical effects for the Army when and where they are needed.[21]

The emerging joint Operational Responsive Space (ORS) program offers an opportunity for the Army to influence the development of rapid-response space solutions intended to solve operational problems or fill the gaps in under-serviced regions. If executed as currently conceived, COCOM commanders would be able to leverage ORS satellites for land-component operations under his AOR for ISR and satellite communications (SATCOM).

In the case of SATCOM, the joint space communities' capacity has already been outstripped by operational demands. To meet the growing appetite for bandwidth, the joint warfighting community

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[20] Memorandum, CDR USA TRADOC to Chief of Staff of the Army, Encl. 6, "Preparing to Fight through Degraded Space Operations," 27 July 2010.

[21] *Army Space Power 2035: A Look Forward*. "Space capabilities once thought of as strategic in nature will now be applied onto the battlefield for tactical effects." SMD Battle Lab, Frontiers Division, p. 1, (2007).

has turned to the commercial market to meet over 80% of its wideband SATCOM needs.[22] Programs such as the Transformational Communications Satellite were intended to reverse this trend. However, competing funding demands and schedule delays led to the cancellation of this program with no suitable replacement identified (Figure 3).

The growing dependency on the commercial sector is complicated by the fact that DoD does not procure COMSATCOM in a long-term manner and depends on the commercial spot market to meet unforeseen operational demands. Although this approach has worked in the past, long-term market surveys indicate that by 2017 there will be little or no useful available bandwidth available in the spot market. Moreover, several regions will see a decrease in overall available bandwidth by 2014-15 (Figure 4).[23]

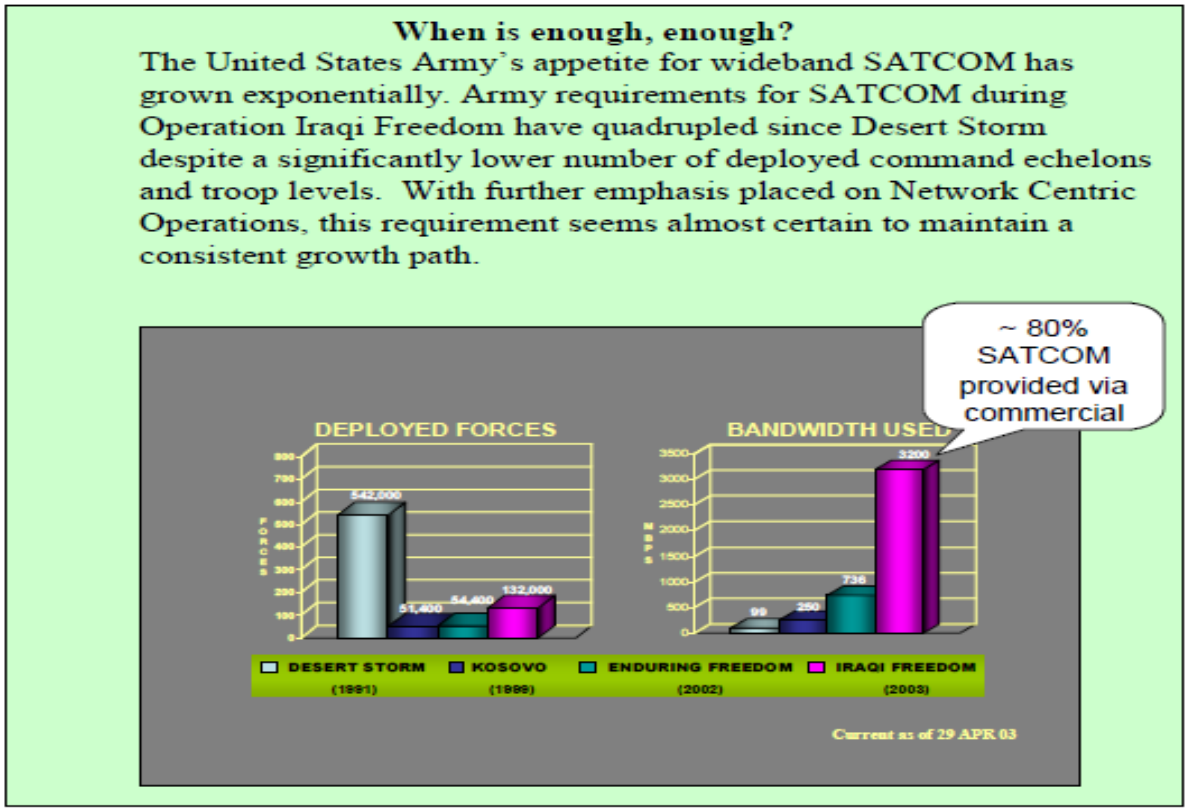

Figure 3: Increase in Bandwidth Requirements since Operation Desert Storm

[22] *2009 Satellite Architecture*. Space and Missile Defense Future Warfare Center. Huntsville, AL. 2009.

[23] Gonzales, Daniel, Isaac R. Porche III, Shara Williams, and Bradley Wilson. *Managing Growing Army Demands for Bandwidth: Predicting Growth Trends and Developing Solutions for Future Army Forces*. RAND Study, 59-64. March 2009.

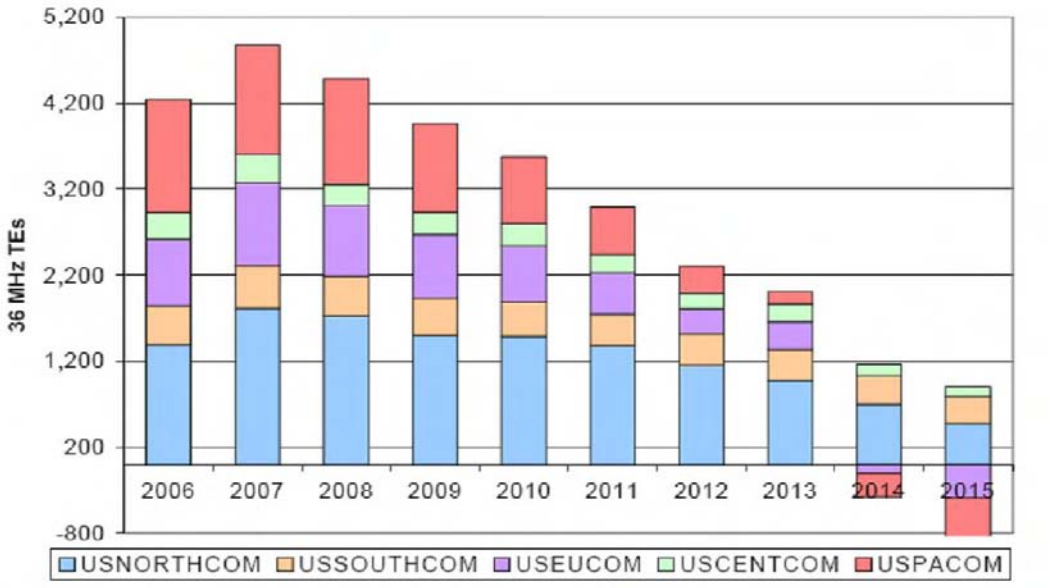

Figure 4: Commercial COMSAT Capacity May Not Meet Demand in Key Regions Because of Tightening Spot Lease Markets

The Army must work with its DoD partners to develop a strategy that recognizes the value of commercial space-based assets and that recommends procurement of contracts that offer vital long-term global access. As the Army deliberately brings new commercial capabilities to bear, they must set their sights on enduring programs and contract for long-term commercial space access. As part of that effort the Army would gain greater capability flexibility by influencing requirements that commit to acquiring customized hosted payloads that fill the gaps in critical communications and multi-intelligence services. At the same time, as the Army works with the joint community on defining and establishing system requirements, the Army must also overcome current policy hurdles relating to security and information assurance so that greater access can be offered to our allies and, as necessary, with other non-traditional coalition partners. Furthermore, as the Army builds partnership capacity, it must become adept at, and more willing to, leveraging coalition partner capabilities, going well beyond established data-sharing relationships. As a growing number of nations develop space-based technologies, the Army must consider how to integrate and leverage these capabilities so they can be brought into the fight.

Gaining and Maintaining Advantages to Tactical Space Access

As discussed earlier, assured access will require more than a different materiel acquisition process for space systems. *Assured tactical access to space* will require training in the proper employment of these capabilities. As was noted during the recent Unified Quest 2010 Campaign of Learning, our forces deploying into the Iraqi and Afghan theaters are not training with space capabilities in mind nor are they training for the eventuality that space access will be degraded during critical phases of the fight. We have already mentioned the growing number of countries that are pursuing, if not already possessing, capabilities to counter our advantages gained from space access. Although these adversaries may pose the greatest risk, they do not represent the most prevalent risk—the threats from

our own forces. Recent experience in OIF has shown that most space-system degradation is a result of self-inflicted electromagnetic interference (EMI), not hostile action. Much of the friendly interference can be attributed to a lack of proper training and non-existent TTPs to guide employment of space, aerial, and terrestrial radio frequency (RF) receivers and transmitters operating in-theater. In a word, inefficient frequency and spectrum management makes information access problematic.

Today's Army strives to train the way it plans to fight; the Army of the future must do the same. This means the future force needs to train in environments that allow leaders and units all levels to build confidence while fighting through adversaries' attempts to degrade space capabilities. This training must be grounded in validated TTPs that provide guidance in the proper employment of space systems in conjunction with other RF emitters on the battlefield but also provide a basis for rapid mitigation and restoral actions against hostile actions intended to disrupt friendly space capabilities. Based on lessons learned in recent operations we must assure these TTPs can be adapted to agile adversaries who have proven themselves readily adjustable to our protection methods or countermeasures.

Because we can expect a contested EM environment during future conflicts, Army forces will require an ability to have situational awareness over the entire space-supported network architecture. Continuous monitoring of communications architectures and an acute awareness of its risks and vulnerabilities will become key responsibilities of Army space operations officers and mission partners (signal and intelligence officers, for instance) during combat operations. Our space forces must be able to discern quickly hostile action from self-inflicted EMI so that proper remedial actions can be taken and, if necessary, apply countermeasures to isolate and eliminate threats.

Because we will be operating in a more contested and congested space environment, securing tactical access must include more than protecting Army systems. The Army's tactical advantage must also be sustained by achieving sufficient Space Situational Awareness (SSA); only by having an adequate level of SSA will the Army be able to deny those space control capabilities—capabilities such as jamming and spoofing—that future adversaries will likely employ. With ample SSA, Army forces of the future will also have the ability to integrate capabilities to disrupt future adversaries' command, control, communications, computer, and intelligence (C4I) capabilities.

Since commercial space assets and services are becoming so prevalent, it is very likely that future adversaries will be operating on the satellites the US uses or they will lease other satellites vital to our own or coalition interests. Therefore, the Army must have the capability to employ precise measures to deny access to adversary-based platforms. As multiple countries pursue space-based PNT capabilities, Army forces must likewise adopt the means to deny those space force enhancements to our enemies.

Building Versatile and Adaptable Army Space Organizations

Assured tactical access to space will depend in large measure on the abilities of trained Army space operators and units skilled in leveraging and integrating space capabilities in support of the tactical fight. Future operations will place great demand on the abilities of all Army organizations to accomplish full spectrum operations and to adapt to rapid transitions from one operational phase to another. Army's space forces, integral to planning and execution of full spectrum operations, must

likewise adapt to phased transitions, whether they are organic space personnel or space teams attached to various Army echelons.

Tactical space planning must begin early, early enough to identify the initial operational requirements and then integrate and synchronize the required capabilities into the fight. Because space capabilities cut across domains and warfighting functions, space officers must be adept at assessing operational architectures for vulnerabilities and identifying approaches to mitigate the associated risks. Space Officers at the tactical level will be in the vanguard by leading efforts to mitigate the effects of a D3SOE environment. Space officers must ensure commanders understand the risks to operations when C2, intelligence-gathering, and PNT functions have been degraded and assist them in developing training programs and TTPs to overcome degraded operations. Since tactical users will often first notice the effects of degradation, space teams must be trained and equipped at the tactical level to monitor and detect attacks within the spectrum, the networks, and relevant space architectures. Along with monitoring and responding to degraded capabilities, Army Space Officers, furthermore, must also become adept at planning and performing missions related to Special Technical Operations (STO), Alternative Compensatory Control Measures (ACCM), and the full complement of space control capabilities afforded to ground warfighters. In so doing, they will gain a fuller understanding of defensive and offensive space operations and will be better able to adapt.

Because space is an inherently technical domain and a key aspect of the information environment, the Army will require space forces that are trained in planning, operating, and delivering tactically focused space support. As we have seen demonstrated over the past two decades, the rapid pace of technology advancement and fielding presents challenges on how to best leverage the latest relevant technologies to ensure the Army maintains the tactical advantage. With new capabilities on the horizon such as Operational Responsive Space (ORS) assets and High Altitude (HA) platforms, needs will arise to control platforms, manage payloads, and perform post-mission analyses. The current structure of the Army's Space Brigade should evolve from a "space-planning augmentation" capability into Army Space Brigade teams bringing primary capabilities to future ORS and HA operating concepts and architectures. Furthermore, the Space Brigade of the future should continue to enhance current SSA planning efforts at Army tactical operations centers, especially those activities that help integrate space and cyber operations into headquarters' fires-and-effects cells. To conduct activities such as these, Army space forces will require having a robust operational suite that adds ground-based offensive technologies to deny the advantages of space to adversaries.

The generating force is the foundation of adaptable space forces. The Army must continue to advance its space training, incorporating the latest operational trends and capabilities into its education and training programs. Space training must be broadened beyond the current focus on designated space operations officers; it must include other space professionals and enablers found in the growing civilian space cadre. These civilian space professionals must become fully vested in the Army profession of arms by adopting a warrior ethos. This ethos will not only help ready Army space forces for combat but will complement the uniformed space force by being willing and able to perform any and all space measures short of down-range presence.

Using space-enabled devices and tools have become common tasks. Instructors and trainers must work to integrate those common tasks into soldier and leader training venues. Theater-tailored training must be developed and integrated into pre-deployment programs to support deploying forces.

To leverage fully what space can offer Army warfighters, the Army's technical community must take fundamentally different approaches to conducting R&D and finding materiel solutions. Primary efforts should no longer focus strictly on developing programs of record (POR) and formulating risk-reduction activities. The Army's space materiel developers must shift their attention toward making space capabilities more tactically responsive, focusing on capabilities that meet the most urgent mission needs. Instead of pursuing the most exquisite capabilities that require lengthy and costly development cycles, greater importance should be placed on integrating commercial space capabilities to ensure more rapid development of resources to meet the more pressing needs of the tactical fight. Finally, the Army must consider alternative acquisition strategies outside of the ponderous JCIDS process for space acquisition; a program such as the highly successful Army TENCAP program, for instance, could be expanded beyond its current emphasis on intelligence services.

Space in Support of Army and Joint Operations

As part of a force that includes joint, interagency, and multinational partners, Army forces exercise mission command (MC)[24] to conduct combined-arms maneuver (CAM)[25] and wide-area security (WAS)[26] to defeat enemies and stabilize environments. Space capabilities support all three battlefield functions—mission command, combined-arms maneuver, and wide-area security—and without access to space, Army forces performing these functions would not operate as effectively, efficiently, and safely. Without adequate space PNT support, combined arms maneuver (which includes fires) would become slow, cumbersome, unsynchronized, and much less accurate. Without sufficient coverage by on-orbit ISR collection assets, wide-area security would become less-intelligible guesswork, especially when operating across far-reaching AORs. Without access to SATCOM, mission command, the function that provides C2 and synchronization of forces, would become tremendously difficult and would bog down Army forces tasked with either CAM and WAS missions. As the *Army Operating Concept* frequently suggests, then, space-enabled effects are indispensible for supporting joint and Army missions.

For Army forces to prevail in a wide range of contingencies—including defeating adaptive enemies in major combat operations, responding with civil agencies to attacks or natural disasters, supporting and stabilizing fragile states facing internal or external threats, and preventing human suffering—

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[24] *AOC*, 3-4 a (1). Mission Command (MC) is defined as "the exercise of authority and direction by the commander . . . to integrate the warfighting functions using the operations process and mission orders to accomplish successful full-spectrum operations." p. 12.

[25] *AOC*, 3-4 c (1). Combined Arms Maneuver (CAM) is defined as "the application of the elements of combat power in a complementary and reinforcing manner to achieve physical, temporal, or psychological advantages over the enemy, preserve freedom of action, and exploit success." p. 13.

[26] *AOC*, 3-4 d (1). Wide-Area Security (WAS) is defined as "the application of the elements of combat power in coordination with other military and civilian capabilities to deny the enemy positions of advantage; protect forces, populations, infrastructures, and activities; and consolidate tactical and operational gains to set conditions for achieving strategic and policy goals." p. 14.

requires *assured tactical access to space* capabilities. Just as Army forces must be operationally adaptable and able to rapidly transition from one mission to another, space forces and capabilities must be able to adapt rapidly to a variety of operations including full-spectrum operations, humanitarian relief missions, and missions within the homeland. The *AOC* establishes eight Army operations that must be integrated throughout all of the Army's mission areas.[27] All eight operational areas require space capabilities for effective operations and mission success: Full-Spectrum Operations, Homeland Defense (HD) and Civil Support (CS), Sustained Engagement, Entry Operations, Preventing Proliferation and Countering WMD, Cyberspace Operations, and Foreign Humanitarian Assistance, and Space Operations. A brief discussion of each area and its space requirements follow. The section below on Army Space Operations highlights more fully how Army Space operations influence the joint fight.

Full-Spectrum Operations. Army forces down to the company level conduct offensive, defensive, stability, and civil support operations simultaneously to defeat enemies and secure populations. This range of contingencies requires integrated space capabilities that can rapidly transition from one operation to another without the loss of access or capability. This requirement for rapid transitions will require space architectures (space, link, and ground elements) responsive to dynamic environments. Each type of operation will require access to a full range but different mix of space force enhancement capabilities delivered by a combination of systems (a multi-layered approach). Army forces are likely to face an adaptable enemy with similar technical capabilities; therefore, a full range of space control capabilities must be integrated into land combat operations. A crucial part of that integration is an understanding that the Army must assure that space control activities—separate and distinct from cyber operations—are synchronized *effectively* within the cyber/electromagnetic contest. Coordination between space and cyber operations is discussed more fully below.

Homeland Defense (HLD) and Civil Support (CS). The Army supports the security of the homeland through homeland defense and civil support operations. HLD operations, much like full-spectrum operations, require ample access to space force enhancement capabilities. Because much of the military space architecture is dedicated to geographical areas overseas, Army operations in the homeland will require greater access to *commercial* space capabilities. Space capabilities may be employed to support response-and-recovery efforts by leveraging space sensors for surveillance and post-event assessments; space payloads may also be used for communications to restore civil authority and repair critical C2 infrastructures. Both operations will require space forces capable of interacting with civil authorities and providing space products that have few security-classification barriers.

Sustained Engagement. The Army conducts engagement activities to increase partner security and capacity. Space operations are conducted to support Army forces employed in these operations through a tailored mix of space force enhancements. Space operations can also be used in direct support of host nation partners in support of internal security needs and command and control mechanisms.

[27] *AOC*, 5-1—5-9. pp. 26-34.

Entry Operations. Always operating as part of the joint force, the Army frequently conducts opposed or unopposed entry operations to accomplish missions in support of the joint commander's campaign objectives. Prior to beginning entry operations space capabilities can provide geo-intelligence and electronic intelligence to support IPB activities. When entry operations begin, space-based communications are employed to support enroute mission planning and command and control networks. In most cases, joint and Army forces' primary communications backbones will be space-based until initial lodgment is secured. OPIR systems will provide timely intelligence, battlefield awareness, and missile warning during all phases of entry operations. Once initial entry is established, space capabilities will be reinforced by the rapid establishment of a multi-domain network to facilitate a timely buildup of the Army tactical network. To support forced entry operations, space operations must be considered for interdiction and disruption of adversary C2 systems.

Preventing Proliferation and Countering WMD. The proliferation of WMD continues to undermine global security, further complicating efforts to sustain peace and prevent arms races. Space operations support counter-WMD with multi-intelligence activities and by monitoring high-risk areas for potential WMD/CBRNE events. Space capabilities will provide event detection and early warning to counter the employment of WMD and, if necessary, help mitigate mass effects.

Cyberspace Operations. Cyberspace operations include computer network operations and activities to operate and defend the global information grid. Space operations is a key element serving as primary means of extending the global information grid to the tactical fight as well as providing the precise timing needed to synchronize digital networks. Defensive Space Control operations will ensure that Army forces prevail in the cyber/EM contest by providing an awareness of critical interdependent space and communication nodes. Offensive Space Control operations will also be conducted alongside other cyber/EM activities to deny technical advantages to established and potential adversaries.

Foreign Humanitarian Assistance. Foreign humanitarian assistance operations assist governments and security organizations in easing human suffering caused by natural and manmade disasters such as hurricanes, tsunamis, earthquakes, mass atrocities, or terrorist attacks. When Army forces are called upon to respond to crises outside the U.S. homeland, space capabilities will be employed to respond to disaster events as well as providing other space force enhancements to enable mission command of Army forces deployed to support these operations.

Army Space Operations in Support of the Joint Fight. Space operations by their nature are joint enterprises. All service components use strategic space assets to create desired tactical advantages, and the Army is no different, providing joint theater support in a number of ways. Army Forces support the Joint Force Commander by employing Army-unique space-related capabilities to meet his critical information requirements. Unquestionably, Army space uniforms already bring land-warfighter expertise to planning, allocation, and the employment of joint and national space capabilities. To ensure the land-combat vision contributes to the joint fight, the Army assigns Space Operation Officers to combatant joint staffs for key operational planning functions; the Army also provides Army space teams to augment joint and operational elements during combat operations. Army forces also execute

several space-support activities for the Joint warfighter by planning and managing communications satellite payloads for DoD. Army forces likewise conduct a full range of ground-based space superiority activities using both non-kinetic and kinetic means to support USSTRATCOM's and JFCC Space's critical operational demands. Leveraging on-orbit strategic assets—DSP and SBIRS[28] satellites—the Army's Joint Tactical Ground Station (JTAGS) system provides continuous ballistic missile warning to combatant commanders. Finally, the Army's generating force—through means of its technical base—provides rapid space technology solutions to respond quickly to theater-specific shortfalls. In the future, Army space teams may actually be responsible for payload control on HA and other aerial platforms to help prosecute the joint fight.

Conclusion

Future tactical land warfighters must have assured access to space. Land warfighters' dependencies on space will only increase as time goes on and requirements for space access will expand at rates even greater than before. As Army leadership begins to recognize the concept of *assured tactical access to space,* the Army will be compelled to take a more engaged approach to ensuring warfighters have the best capabilities delivered at the right place, at the right time.

The space domain arrays itself across all warfighting functions and all phases of operations. Operational adaptability requires access to space in all environments and access to space becomes even more critical when operating under austere conditions. Diversifying networks by employing all domains—terrestrial, aerial, high altitude, and space—as a unified architecture, makes good sense. The Army must also expand joint, coalition, and other partnerships to reassure ready access to space-enabled capabilities. By developing versatile, adaptable space organizations, the Army will remain ready to deploy all types of mission sets and across all warfighting functions. The Army must be prepared to fight using space, but must also be prepared to fight under degraded space conditions. To fight on the tactical edge, Army units must gain and maintain situational awareness of the electromagnetic spectrum, must understand when EM interference comes from friendly or enemy sources, and must train to respond and operate under both sets of conditions. SMDC/ARSTRAT and TRADOC have documented these recommendations and have staffed them through their leadership channels. SMDC/ARSTRAT and TRADOC will continue to promote these concepts in a number of ways.

Road Ahead

Ongoing efforts to help the Army exploit the space domain include, but are not limited to,

- Revising the Army Space Concept Capability Plan (CCP) to stimulate an Army Space Capabilities-Based Assessment (CBA) effort.
- Validating Army Space requirements by conducting a seminar wargame to explore offensive and defensive PNT implications for the Army.
- Conducting a Future Army Space Support Operations Table-Top wargame that examines and proposes Army space force structures for future Army and joint fights.

[28] "Defense Support Program" and "Space-Based Infra-Red System."

- Integrating space into the Army Concept Framework by leveraging the Unified Quest 2011-2012 Campaign of Learning and developing actionable recommendations.
- Supporting TRADOC's Centers of Excellence and other proponents on training venues recommended by the TRADOC CDR to the Army Chief of Staff in the Unified Quest 2010 Final Report.[29]
- Continuing experimentation efforts on high altitude and other tactically responsive capabilities (such as SMDC-1) as a way to establish a resilient tactical architecture for the Army.

The intent of this white paper was to outline a number of present and future concepts based on observations made during recent wargame events and to address future Army warfighting operations pertinent to space; also proposed is an enabling concept, *assured tactical access to space*, a concept the Army must embrace to ensure mission success of future land combat operations. The discussion also highlighted a number of those vital connections between Army operations and space that were not treated in the *Army Capstone Concept* and the *Army Operating Concept*. It is the intent that the concepts discussed here will be readily accepted by key Army stakeholders to assure the success of forces operating at all echelons, and especially those ground forces operating on the tactical edge.

[29] Memorandum, CDR USA TRADOC to Chief of Staff of the Army, Encl. 6, "Preparing to Fight through Degraded Space Operations," 27 July 2010.

Acronyms and Glossary

ACC: *Army Capstone Concept*

AOC: *Army Operating Concept*

ASAT: Anti-Satellite weapon system

ASCC: Army Service Component Command

Assured Tactical Access to Space: guaranteed access to space capabilities that meets land-warfighter mission requirements and timelines (during all phases of full-spectrum operations)

BLOS: "beyond line of sight," usually considered over 600 miles

C2: Command and Control

C4I: Command, control, communications, computers, and intelligence

CAM: Combined-Arms Maneuver

CBA: Capabilities-Based Assessment

CCP: Concept Capability Plan

CDE: Concept Development and Experimentation

COMSATCOM: Commercial Satellite Communications

COTM: "communications on the move"

COCOM: Combatant Command

CTA: Capstone Threat Assessment

D3SOE: Denied, Degraded, Disrupted Space Operational Environment. Acronym based on SMDC's wargame of the same name and adopted by TRADOC and other communities of interest

DSP: Defense Support Program (a dated satellite system still in use); used for theater missile warning

EM: Electromagnetic

EMI: Electromagnetic Interference

FFT: Friendly Force Tracking

GIG: Global Information Grid

GPS: Global Positioning System

HA: High Altitude

HALE: High-Altitude Long-Endurance; a term applied to high-altitude platforms that can provide persistent communications and ISR capabilities

Hosted Payloads: military and defense sensors/payloads placed on commercial industry satellites

IPB: Intelligence Preparation of the Battlefield

IRIS: "IP Router in Space," an SMDC/FWC JCTD and an example of a DoD payload hosted on a commercial satellite

JCTD: Joint Concept Technology Demonstration

JCIDS: Joint Capabilities Integration and Development System

JFACC: Joint Force Air Component Command, Joint Force Air Component Commander

JTAGS: Joint Tactical Ground System; Army system that provides missile threat warning to COCOMs

LOS: Line of Sight/Line of Sight propagation

MC: Mission Command (Army Functional Concept)

MILSATCOM: Military Satellite Communications

Miniaturized Satellites: satellites that are much smaller than conventional-sized on-orbit assets. They are frequently divided into four categories based on size and weight: Minisats, Microsats, Nanosats, and Picosats

OEF: Operation Enduring Freedom

OIF: Operation Iraqi Freedom

ORS: Operationally Responsive Space

OPIR: Overhead Persistent Infrared

PNT: Positioning, Navigation, and Timing

POR: Program of Record

RF: Radio Frequency

SATCOM: Satellite Communications

SBIRS: Space-Based Infra-Red System (current and future satellite system, programmed to replace DSP system); used for theater missile warning

SOCOM: Special Operations Command

SSE: Space Support Element

TACSAT/TACSAT III: Tactical Satellite/Tactical Satellite (3rd Generation)

TENCAP: Tactical Exploitation of National Capabilities

TSAT: Transformation Communications Satellite system

TTP: Tactics, Techniques, and Procedures

WAS: Wide-Area Security

WMD: Weapons of Mass Destruction