### Abstract

Peer competitors with the United States will achieve space parity and degrade U.S. and allied satellite capabilities during a conventional conflict, requiring the MAGTF to adjust tactics, techniques, and procedures to operate successfully. Based on this increased threat, it is a requirement to prepare the MAGTF to operate in an environment in which the U.S. does not have space superiority. The loss of space superiority can have negative impacts on all warfighting functions. The author reviews the threat, discusses the increasing U.S. military reliance on satellites and provides twelve specific recommendations to improve the ability of the MAGTF to operate successfully in an environment without space superiority.

### Subject Terms

Marine Air-Ground Task Force, MAGTF, loss of space superiority, threats to satellites, defense in depth, GPS, cognitive radio, pseudo-satellites, pseudolites.
FUTURE WAR PAPER

The Implications of the Loss of Space Superiority on the

Marine Air-Ground Task Force

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The United States Marine Corps may be unable to rely on critical space-based assets fifteen to twenty years from today. Although the U.S. currently maintains space superiority, diminishing U.S. economic supremacy will contribute to the rise of peer and near-peer competitors such as China and Russia. These nations will continue to build space and counter-space technologies that could enable them to achieve space parity or superiority during a conventional conflict. Although space-based assets were until recently considered strategic assets that only contributed indirectly to success on the battlefield, they are now indispensable to tactical and operational commanders. This trend will continue during the next twenty years and the loss of space superiority could place the tactical commander in an unrecoverable position if alternate capabilities are not readily available. For the Marine Corps, a future attack on U.S. space-based communications and intelligence assets would cause significant degradation of Marine Corps Air-Ground Task Force (MAGTF) capabilities across all warfighting functions. This paper examines how the MAGTF can prepare to operate successfully in a future conventional conflict when adversaries degrade U.S. and allied satellite capabilities.

During the next fifteen to twenty years, the international system will increasingly become more multi-polar with gaps in national power narrowing between developed and developing countries. In particular, the Chinese and Indian economies are expected to grow at a rate that would place them 2nd and 3rd behind the U.S. by 2022. China, exceeding expectations, surpassed Japan in August 2010 to become the second largest economy and economic forecasts indicate China could pass the U.S. as early as 2030. Although China and India lag behind the U.S. in per capita income, their growing economies and increasingly educated workforce will enable them to continue to advance and compete with the U.S. in space and counter-space technology. The critical need for American engineers and scientists was identified by the Hart-
Rudman commission in 2001 and since then the U.S. has continued to decline relative to China and India with respect to producing scientists and engineers capable of filling the significant requirements of the aerospace industry. The substantial decrease in U.S. economic influence coupled with the decline of American skilled aerospace engineers will likely narrow the technological gap, enabling potential adversaries to degrade or destroy U.S. space-based assets during a future conventional conflict.

Potential adversaries of the U.S. are developing several methods that could enable them to disable or destroy critical U.S. spaced-based assets in the future. As noted in the 2001 Rumsfeld Space Commission Report, "...we know from history that every medium – air, land and sea – has seen conflict. Reality indicates that space will be no different." Future threats range from the degradation of satellite capabilities using various hacking or jamming techniques to the physical destruction of satellites using kinetic weapons, microsatellites, or directed energy weapons. Additionally, with China, India, Russia, and other countries developing, testing and deploying counter-space weapons, the potential increases for unintentional damage to U.S. military and commercial satellites. Since the intent of this paper is to focus on how the MAGTF might mitigate the impact of the loss of space-based assets on operations, only a brief overview of possible future threats to U.S. satellites is presented to demonstrate the wide-range of counter-space options available to an adversary.

The threat to any particular U.S. spaced-based asset depends primarily upon altitude, hardening of the satellite, and employment of countermeasures. Satellites in low earth orbit (LEO) are most vulnerable to attack due to their relatively close distance to the earth. Most U.S. satellites are in LEO, but military satellites are generally hardened to shield against radiation. Many of these satellites are actually low enough for SCUD class missiles to target them with the
appropriate guidance system and warhead. The immediate and eventual threat from a nuclear blast to these satellites is also substantial even at a distance of several hundred to thousands of kilometers. In addition to nuclear detonations in space, high-powered microwave weapons can have a similar impact especially against non-hardened commercial satellites. These types of weapons can also affect satellites much further away in geosynchronous orbit. Along with nuclear and microwave proximity weapons, satellites are also vulnerable to kinetic strikes from direct ascent weapons, such as rockets or missiles, launched from earth or high-altitude aircraft. In addition to the aforementioned threats, satellites also face potential danger from recently developed weapons such as high-energy lasers and microsatellites.

China, Russia, and India all have the capability to develop ground-based high-energy laser weapons by 2025. Although the use of ground-based lasers as ASATs has yet to be proven, the technology is currently available and will likely spread to potential adversaries. China has been developing this capability for several years and according to a 2006 Department of Defense report to Congress, "...at least one of the [Chinese] satellite attack systems appears to be a ground-based laser designed to damage or blind imaging satellites." China also fired a laser at a U.S. surveillance satellite in September 2006 in a possible attempt to disable it. In addition to lasers, microsatellites present another potential threat to U.S. spaced-based assets. China, Russia, and Brazil are developing microsatellites or co-orbital satellites potentially capable of use as ASATs. These satellites can maintain a prolonged dormant orbit until maneuvered to attack an adversary's satellite either kinetically or through electronic means and could be used singularly or in swarms to target key U.S. space-based assets in various orbits during a conflict while potentially maintaining anonymity. Despite the fact that this technology
is under development, potential U.S. adversaries already have the means to degrade U.S. spaced-based assets, demonstrating the immediate need for mitigation.

Although it is impossible to predict which nations could threaten the U.S. twenty years hence, it is important to note that Russia, China, and India all have active ASAT programs. The U.S. and Russia have conducted ASAT tests for decades to include the American detonation of multiple nuclear weapons in space from 1958 to 1962 that negatively affected satellites for years. More recently, in January 2007 China conducted a successful ASAT missile test against an aging weather satellite which created over 300,000 pieces of dangerous debris. The Chinese ASAT missile struck its target at an altitude of 530 miles, which is approximately the altitude of U.S. imagery satellites. Although ASAT initiatives are not new, the decline in U.S. space superiority coupled with the fact that satellites have increasingly become the backbone for U.S. military tactical communications, targeting and intelligence, surveillance, and reconnaissance (ISR) make the ASAT threat potentially devastating for an unprepared U.S. military force.

Over the past two decades the U.S. military has become increasingly reliant upon satellites for communications, targeting, and ISR down to the tactical level. This reliance on satellites is illustrated by the rapidly increasing amount of data flowing over these systems to directly support tactical units. During Desert Storm, a total of sixteen military and five commercial satellites supported troops with a maximum transmission rate of 200 million bits per second (Mbps) – this rate is about equivalent to 40,000 simultaneous telephone calls. Only ten years later, over fifty satellites supported troops in Operation Iraqi Freedom (OIF) in 2003 with 2.4 gigabits per second (Gbps). This trend in increasing bandwidth is likely to continue and is even predicted to be as high as 137 Gbps by 2020. Of additional concern is the fact that commercial satellites, including France’s leading satellite services company, supplied the
majority of communications capacity as well as some imagery during OIF.\textsuperscript{30} In addition to communications, Global Positioning System (GPS) satellites assisted in guiding 5,000 Joint Direct Attack Munitions (JDAM) during 2001-02 Afghanistan operations and 6,000 JDAMs during 2003 combat operations in Iraq.\textsuperscript{31} In order to meet the predicted requirement for data flow and maintain and improve the accuracy of precision strike weapons, the U.S. military intends to rely more heavily on satellite systems in the future.\textsuperscript{32}

This trend is clearly illustrated in the Marine Corps' plan for a future communications architecture that includes the development of the Marine Corps Enterprise Network (MCEN). The MCEN is the communications architecture to enable Marines to tie in to the Global Information Grid (GIG) in accordance with Congressional and Department of Defense guidance.\textsuperscript{33} The GIG is the cornerstone to the theory of Network-Centric Warfare (NCW) and Network-Centric Operations (NCO). The objective of the future GIG is to enable all DoD users and external mission partners from the tactical to strategic levels to rapidly obtain, share and use information to their advantage.\textsuperscript{34} This networking is designed to assist friendly forces in rapidly identifying, targeting and maneuvering against enemy forces. The Marine Corps is planning to take advantage of the GIG and NCO through MCEN and the Marine Corps Expeditionary Network (eXNET). The eXNET incorporates future joint capabilities through evolving satellite constellations such as the Transformational Communication System and the Mobile User Objective System. These systems will replace the current satellite systems and along with the Joint Tactical Radio System will provide the backbone of the Marine eXNET.\textsuperscript{35} Although these systems will be less susceptible to jamming and hardened to withstand certain energy attacks, they remain vulnerable to many of the previously mentioned kinetic strikes and even without attack may not be able to support expected demands.\textsuperscript{36} The vulnerability of these and other key
satellites such as GPS and our national intelligence satellites could present a significant challenge for the MAGTF in future conventional conflicts.

The MAGTF will face critical challenges in the areas of command and control, communications, targeting, intelligence, and maneuver if an adversary successfully attacks our space-based assets during a future conflict. It is important to identify how these challenges relate to the overall likely missions and critical tasks of the MAGTF during a future war scenario. Based on *Marine Corps Vision and Strategy 2025*, the Marine Corps has six future core competencies: (1) conducts persistent forward naval engagement and is always prepared to respond as the nation’s force in readiness, (2) employs integrated combined arms across the range of military operations, and can operate as part of a joint or multinational forces, (3) provides forces and specialized detachments for service aboard naval ships, on stations, and for operations ashore, (4) conducts joint forcible entry operations from the sea and develops amphibious landing force capabilities and doctrine, (5) conducts complex expeditionary operations in the urban littorals and other challenging environments, and (6) leads joint and multinational operations and enables interagency activities.

The key aspects of these core competencies are the ability to operate with joint, coalition and interagency partners, to employ integrated combined arms, conduct forcible entry operations, and to conduct a wide range of expeditionary missions in the urban littorals and other environments. Each of these elements requires the MAGTF to communicate with other members of the operating forces and implies coordination with higher headquarters and reach-back support. Additionally, the ability to conduct combined arms and forcible entry operations implies robust command and control, communications, intelligence, targeting, and maneuver capabilities. Although potential missions for the MAGTF encompass the entire range of
operations from humanitarian assistance to full-scale conventional war, the latter is of most concern since it is in this scenario that U.S. space-based assets are more likely to be targeted by a peer or near-peer adversary. This scenario also presents the most significant threat to U.S. national interests and requires a close examination of how the current U.S. edge in modern warfare could be degraded in the future.

The U.S. military currently maintains a significant advantage in conventional warfare primarily because of its ability to rapidly penetrate and exploit a modern defense in depth. The key elements of this advantage consist of the U.S. capability to obtain and maintain local air and maritime superiority, the ability to significantly degrade an enemy defense prior to conducting a ground assault, and the ability to target and maneuver faster than the enemy during the ground assault. This advantage is generally achieved in phases. Initially advantage is achieved by developing an intelligence picture through unobtrusive overhead intelligence collection and human intelligence (HUMINT) to identify enemy positions, strengths, and intentions throughout the area of operations. During establishment of air and maritime superiority the U.S. rapidly identifies and targets key elements of an enemy’s command and control, integrated air defense systems, aircraft, ballistic missiles, naval vessels, coastal missiles, mines and other potentially significant weapons systems. In order to identify these elements the U.S. conducts ISR using space-based assets, HUMINT assets, air reconnaissance, and special operations forces (SOF) and then conducts attacks using various munitions increasingly including GPS-guided weapons. Prior to the ground assault, the U.S. military identifies key elements of the defense such as enemy defensive positions, obstacles, vehicles, equipment, and personnel through the use of space-based ISR, HUMINT assets, SOF and following establishment of air superiority, an increasing amount of airborne ISR. During the ground assault, a significantly degraded enemy is
defeated through the superior employment of combined arms and maneuver warfare.\textsuperscript{38} In order to defeat the enemy through maneuver warfare it is imperative for the U.S. to rapidly identify, target and maneuver against an enemy who is attempting to prevent the penetration and exploitation of the defense through the use of direct and indirect fire and counter-attack. The U.S. advantage in maneuver warfare is generally achieved through superior command and control, communications, intelligence and precision targeting. These capabilities will all be increasingly influenced by satellites in the future and the loss of space-based systems will significantly decrease the U.S. advantage in conventional conflicts.

The loss or degradation of key military and commercial satellites will have a profound impact on the MAGTF in a future conventional conflict. The MAGTF will most likely operate as a part of a larger coalition and joint force and may be required to conduct forcible entry operations during a future conventional war. During a forcible entry operation, the MAGTF will need to penetrate and exploit an enemy defense in depth and in the most challenging cases this will require an amphibious assault. During an amphibious assault the MAGTF will avoid attacking enemy prepared positions and attempt to penetrate the defense and exploit the defense through deception and envelopment.\textsuperscript{39} In order for the MAGTF to be most successful, the coalition force will need to achieve local air and maritime superiority and the MAGTF will need to dominate the enemy through overwhelming accurate fire and rapid maneuver that prevents the enemy from effectively halting the offensive or conducting a counter-attack. This domination will require the MAGTF to conduct intelligence, navigation and maneuver, targeting, command and control, and communications better than the enemy. In a future conflict, these capabilities will be increasingly tied to space-based assets. In order to prepare for such a conflict, it is critical for the Marine Corps to examine how each of these areas could be impacted by the loss
of key military and civilian satellites and how the MAGTF could mitigate the negative effects of such a scenario.

The ability of the MAGTF to successfully penetrate and exploit a future defense in depth will require naval and air superiority and the ability to conduct intelligence, navigation and maneuver, targeting, command and control, and communications better than the enemy and potentially without space-based assets. Intelligence support will of course be essential and during the early phases of recent conflicts, this intelligence has been provided in large measure by national and theater assets relying heavily on space-based systems producing imagery intelligence (IMINT) and signals intelligence (SIGINT). The ability to collect information through space-based assets without violating an adversary's airspace enables intelligence personnel to develop a baseline regarding normal air, ground and naval activity to include composition, disposition and strength. Although the enemy picture developed through the use of space-based assets is never perfect, obtaining a basic view of an enemy defense prior to an attack contributes significantly to the ability to achieve air and naval superiority and to target, penetrate and exploit the enemy defense in depth. Additionally, the loss of space-based assets will extensively degrade the ability to operate Unmanned Aerial Vehicles (UAVs) since many of these systems use SATCOM for guidance and dissemination. The loss of space-based assets will also impact MAGTF intelligence by disrupting reach-back to critical service and theater intelligence centers. Additionally, the interruption in SATCOM will require ground reconnaissance elements to transmit data over long distances via other means. In order to mitigate the negative effects on MAGTF intelligence due to the loss of space-based assets the Marine Corps must undertake doctrinal, technological, and training initiatives.
In order to maintain an advantage in intelligence following the loss of key satellites, the Marine Corps must make operating without space-based assets a priority for the development of doctrine, technology, and training. Only through an in-depth analysis and realistic simulations of conditions replicating operations without space-based assets can the MAGTF fully understand and mitigate the impact of attacks on key satellites. This applies to intelligence as well as all other battlefield functions. The Marine Corps should encourage the initiation of theater-level exercises conducted without the use of space-based assets to determine potential methods to mitigate for the loss of such systems.

In particular, the MAGTF will need to rely on increased coalition, joint and organic air assets to include UAVs capable of non-satellite line of sight (LOS) operations to mitigate for the loss of space-based IMINT and SIGINT. This will require future aircraft to operate without SATCOM, conduct ISR and potentially target without GPS guided munitions. The UAVs will need to operate using non-satellite LOS which may require the development of UAVs capable of relaying data to other aircraft and conducting automated analysis of the data onboard the platform to identify potential targets. One possible solution is the creation of an airborne UAV control and analysis center. This aircraft or dirigible would operate at an altitude enabling direct LOS with multiple UAVs. If manned, aircraft personnel could directly control UAVs and conduct analysis to develop targets and assist in directing fires. If unmanned, this aircraft could be connected to a ground control and analysis station via a fiber-optic cable similar to the Joint Land Attack Elevated Netted Sensor. Another potential solution is development of fiber optic controlled UAVs resembling Raytheon’s enhanced fiber-optic guided missile. Additionally, development of UAVs capable of air dropping recorded IMINT and SIGINT data would enable analysts to conduct routine targeting and intelligence development. Such fiber-optic connections
and air drops would be well-protected from enemy jamming and would significantly decrease the amount of wireless communications.

It is important to note that although current counter-insurgency and man-hunting operations require significant UAV reconnaissance and surveillance efforts relaying tremendous amounts of data, the ISR requirements needed to determine key elements of an enemy defense in depth will be aided by the fact that enemy weapons, vehicles, and equipment have more readily detectable signatures. In a conventional conflict, the use of high-altitude aircraft with sensors to determine the general locations of enemy tanks, artillery, aircraft, and vehicles on the ground can serve to cross-queue UAVs and other aircraft to more accurately determine a location and conduct targeting. Although some of these capabilities will necessarily need to exist outside of the Marine Corps’ inventory, there are several initiatives the Marine Corps should independently undertake to mitigate the loss of satellites.

The loss of key intelligence satellites will require the MAGTF to place increased emphasis on deep ground reconnaissance and initial terminal guidance (ITG). MAGTF ground reconnaissance units will need to conduct operations without GPS and SATCOM thus placing more emphasis on night training with the lensatic compass and using HF and potentially UHF or VHF radio to send voice and data transmissions. Additionally, degradation of GPS will require reconnaissance units to rely more on lasers to designate targets or adjust fire using traditional call for fire procedures. The MAGTF could also compensate for lack of ISR coverage on the battlefield through the use of ground sensors. Although these sensors are often employed in a defensive environment, they could also be airdropped along likely enemy counter attack routes in order to provide early warning and cross-queuing of other ISR or targeting assets. As previously mentioned, if the MAGTF or another force operated an airborne control and analysis center, this
aircraft could also receive data from ground sensors to assist in developing the intelligence picture and conducting targeting. In order to more efficiently transmit the large amounts of data efficiently from UAVs, reconnaissance teams, sensors, and other ISR assets the MAGTF should examine methods and technological advances to improve voice and data transmission.

To compensate for the loss of key satellites, the Marine Corps should encourage the development of radio technology that efficiently transmits voice and data over long distances. This technology generally involves the ability to compress and more efficiently transmit data and the development of relay systems to extend the range of transmissions. Although it is difficult to predict how radio technology will progress, current advancements provide an indication that HF radio technology could compensate somewhat for the loss of key satellites. Current HF radios have the capability to transmit data using modems at a much slower rate than SATCOM, but with a significant decrease in the requirement for live video feed from UAVs in the scenario mentioned, HF and other portions of the electromagnetic spectrum could partially compensate for the loss of SATCOM in certain areas. Advances in data compression technology may also provide the ability to transmit more information using the same amounts of bandwidth. Along with data compression, the improved real-time assignment of frequencies and transmission parameters based on operating conditions will assist with overall data flow efficiency. This technology is termed cognitive radio and the concept is based on sensing and analyzing the operating environment to determine the particular frequencies and parameters to transmit in order to most efficiently use the radio hardware and the electromagnetic spectrum. This technology would enable radios capable of transmitting in multiple bandwidths to determine the most efficient means of transmitting the data and as a result make more efficient use of electromagnetic spectrum. In addition to operating more efficiently, extending the range of radio
transmissions is possible through the development of relay technology. In particular, the use of pseudo-satellites or pseudolites can significantly extend the range of radios and can partially compensate for the loss of SATCOM. The pseudolite concept is based on a high-altitude long endurance unmanned aircraft or dirigible carrying digital communications relays similar to those in satellites. This technology was recently employed successfully by the U.S. Army using a dirigible in Afghanistan and also used by MAGTF units in communications exercises. This relatively inexpensive dirigible extends UHF communications from less than a mile to over 400 miles and with developing technology could be applied to other frequency ranges. In addition to these developments, the Marine Corps should also examine the possibility of using preexisting fiber optic cables to augment communications. The increasing urbanization along the littorals is increasing the proliferation of fiber optic infrastructure and providing a prospective communications capability for the MAGTF during future conflict. Although these technologies may compensate to a degree for the loss of key communications satellites, the MAGTF will face additional challenges in the areas of maneuver and targeting with the loss of GPS satellites.

As mentioned, navigational aids will likely be disrupted by the loss of key satellites during a future conflict. This potential disruption requires the Marine Corps to examine impacts to MAGTF fires and maneuver and potential methods to mitigate these impacts. In particular, the Marine Corps should explore the development of ground and sea based GPS transmitters able to operate from fixed positions within the MAGTF battle space. Such GPS transmitters could be placed on pre-surveyed locations ashore or on buoys to provide a local GPS capability for the MAGTF and potentially replace satellite-based GPS. Concurrently, the identification of potential requirements due to the complete loss of GPS will also be critical. For example,
maneuver units will require more extensive training on vehicular and foot navigation using the lensatic compass and map reading. This will also place a premium on the development and distribution of updated and accurate digital and paper maps. In addition to the challenges presented in navigation without GPS, the MAGTF will need to compensate for the lack of GPS-guided munitions in providing fire support. The potential degradation or loss of GPS would have significant effects on the accuracy of JDAMs, Small Diameter Bombs, and GPS-guided artillery rounds such as the M982 Excalibur and will require targeting using laser, infrared, radar, or potentially cruise missile technology such as terrain contour matching. In order to compensate for the loss of GPS, the Marine Corps should ensure GPS-guided bombs are also laser capable and that apportionment rates of all munitions are increased appropriately based on reduced accuracy and the need for multiple strikes. The challenges associated with communications, navigation and targeting after the loss of key satellites will also require increased emphasis on effective command and control.

In order to defeat a future defense in depth following the loss of key satellites, the MAGTF will need to conduct command and control using remaining communications systems effectively and efficiently. Due to the future MAGTF’s reliance on SATCOM, the loss of key communications satellites will degrade the MAGTF’s ability to communicate with higher, adjacent and subordinate units. Since no single activity in war is more important than command and control it is critical for the MAGTF to make the most of remaining communication systems by preparing personnel to operate effectively with limited information. Marine Corps communications personnel should conduct exercises to determine the impact of the loss of SATCOM and develop alternative communications plans that take advantage of the previously mentioned technologies. Additionally, commanders should place increased emphasis
on the use of mission command and control and mission tactics during training and planning in order to decrease the amount of command and control required during operations. The potential loss of command and control technology such as the Blue Force Tracker will also require the MAGTF to develop procedures and conduct training that enables effective coordination and prevents fratricide. Only through planning for the loss of SATCOM and conducting realistic exercises to identify shortfalls and develop alternative methods of command and control can the MAGTF be fully prepared for a future conventional conflict.

In summary, a future conventional conflict with peer or near-peer competitors may involve the loss of key military and commercial satellites and significantly degrade the MAGTF's ability to conduct amphibious operations. The future MAGTF is on the path to relying heavily on satellites although there is an increasing recognition that these space-based systems may not be available during future conflict. In order to prepare and compensate for the loss of space-based assets the Marine Corps should consider the following recommendations:

1. Conduct exercises to determine impacts of the loss of key military and commercial satellites.
2. Encourage the development of airborne control and analysis platforms.
3. Encourage development of UAVs that use fiber-optic links and/or air dropped dissemination.
4. Train MAGTF deep reconnaissance forces without SATCOM and emphasize ITG.
5. Develop and train with improved air dropped ground sensors and relays.
6. Encourage the development of pseudolites, cognitive radio, and data compression.
7. Examine the potential of connecting to preexisting fiber-optic infrastructure in the littorals.
8. Encourage the development of ground-based GPS transmitters.
9. Emphasize navigation without GPS and encourage other Services to do the same.
10. Encourage development of targeting and guidance systems that operate with and without GPS.
11. Ensure the MAGTF receives additional munitions to compensate for the loss of precision.
12. Place additional emphasis on mission command and control and mission tactics.

These recommended efforts are intended as a departure point for future study and debate. By implementing these recommendations, the Marine Corps can take the lead in preparing for future conflicts and remaining the force most ready when the nation is least ready.
Notes


2 Space Parity, Space Superiority and Space Supremacy are defined in Air Force Doctrine Document 2-2, Space Operations: “The Air Force categorizes relative advantage in the space domain by space parity, space superiority, and space supremacy. Space parity describes a roughly equal degree of power between friendly and adversary use of space capabilities. Next, space superiority is that degree of space advantage of one force over another that permits the conduct of operations at a given time and place without prohibitive interference by the opposing force. Space superiority does not mean the enemy is prevented from interfering with friendly operations, but rather that friendly losses or disruption will not prevent friendly forces from achieving objectives. Finally, space supremacy is that degree of space advantage of one force over another that permits the conduct of operations at a given time and place without effective interference by the opposing force. See U.S. Department of the Air Force, Space Operations, AFDD 2-2 (Washington, DC: U.S. Department of the Air Force, November 27, 2006), 6, http://www.dtic.mil/doctrine/el/service_pubs/afdd2_2.pdf (accessed November 25, 2010).


11 O’Hanlon, “Neither Star Wars Nor Sanctuary,” 68.


14 O’Hanlon, “Neither Star Wars Nor Sanctuary,” 67-68.


16 O’Hanlon, “Neither Star Wars Nor Sanctuary,” 76-77.


20 O’Hanlon, “Neither Star Wars Nor Sanctuary,” 87.


23 Chun, 3-4.


For additional information on centers of gravity, critical vulnerabilities, and surfaces and gaps see: U.S. Marine Corps MCDP 1, 45-49, and 92-95.

This conclusion is based on the author’s experiences as an intelligence officer at Navy Central Command/5th Fleet during the initial planning phases of Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF).


The dirigible used in Afghanistan cost approximately $20,000 and Space Data Corporation is developing dirigibles to be employed with VHF radio relays. This information is based on the author’s conversations with Jerry Quenneville, Vice President, Business Development Space Data Corporation in October 2010.


56 For more information regarding mission command and control and mission tactics see: Headquarters U.S. Marine Corps, Command and Control, 77-81 and 109-110.


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