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ACHIEVING AIR SUPERIORITY WITHOUT SPACE SUPERIORITY: Not in a Timely Manner!

By

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CERTIFICATE

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Contents

Page

Abstract

This paper examines whether the United States Air Force (USAF) can achieve air superiority against a robust, determined adversary without concurrent space superiority. Since Operation Desert Storm, the USAF has become so dependent on space-based assets that it cannot gain and maintain air superiority in a timely manner without space superiority. The U.S. cannot assume it will be able to maintain space superiority against all adversaries, particularly when those adversaries understand the leverage space systems provide.

To limit the scope of this study, the paper focuses on just the offensive counterair mission of the air superiority function. The paper does not speculate as to how the U.S. lost space superiority. It simply assumes the USAF lacks space superiority at the beginning of hostilities and cannot rely on or use its space systems for the foreseeable future. The paper is divided into three main chapters—striking fixed targets, striking time-sensitive targets, and command, control and communications. Each chapter reviews operations from recent conflicts to demonstrate the USAF's dependence on space superiority to accomplish each mission area. The paper concludes with a chapter that summarizes the impacts of losing space superiority and makes some broad recommendations.

Potential adversaries are unlikely to challenge the United States without first trying to deny its military the clear advantage provided by space superiority. The United States must be prepared for the loss of space superiority and develop systems and procedures for continuing the fight with the loss of some or all of its space-based systems. Assuming space assets will always be there is a mistake. The USAF must be prepared to fight without space superiority.

Chapter 1

Introduction

> ***Air Superiority:*** *That degree of dominance in the air battle of one force over another which permits the conduct of operations by the former and its related land, sea, and air forces at a given time and place without prohibitive interference by the opposing force.*[1]
>
> --Air Force Doctrine Document (AFDD) 2-1.1

This paper examines whether the United States Air Force can achieve air superiority against a robust, determined adversary without concurrent space superiority. Since Operation Desert Storm, the USAF has become increasingly dependent on space assets to accomplish its mission. From command and control, communications, and weather forecasting to missile warning, navigation, and precision targeting, the USAF now relies heavily on space. In fact, the USAF has become so dependent on space-based assets that it cannot gain and maintain air superiority in a timely manner without space superiority. The U.S. simply cannot assume it will be able to maintain space superiority against all adversaries, particularly when those adversaries understand the leverage space systems provide.

To limit the scope of this study, the paper focuses on just the offensive counterair mission of the air superiority function. AFDD 2-1.1 defines offensive counterair as "operations to destroy, disrupt, or neutralize enemy aircraft, missiles, launch platforms, and their supporting structures and systems both before and after launch, but as close to their source as possible."2

The paper does not speculate as to how the U.S. lost space superiority because how it was lost is not germane to the argument. Suffice it to say, however, that losing space superiority is a real possibility. For example, one nuclear weapon exploded in the atmosphere over the battlefield would significantly impact most space-based systems. The paper simply assumes the USAF lacks space superiority at the beginning of hostilities and cannot rely on or use its space systems for the foreseeable future.

Space pervades all aspects of the offensive counterair mission, so dividing the paper into logical, non-overlapping mission areas is not possible. For instance, communications satellites play a significant role in such diverse mission areas as weather forecasting, targeting, and command and control. Because no approach is necessarily better than another, the paper is divided into three main chapters—striking fixed targets, striking time-sensitive targets, and command, control and communications. Each chapter reviews operations from recent conflicts to demonstrate the USAF's dependence on space superiority to accomplish the respective mission area. Although the U.S. did not face a robust adversary during Operations Enduring and Iraqi Freedoms, the space architecture required to achieve air superiority was in place. Using these conflicts as data points is still relevant. The paper concludes with a chapter that summarizes the impacts of losing space superiority and makes some broad recommendations.

Chapter 2

Fixed Targets

> *NATO forces rapidly achieved air supremacy in the theater by destroying Serb interceptor aircraft in the air and on the ground and by destroying or damaging their airbases…However, reducing the Serb defensive radar-guided surface-to-air missile systems that are effective against aircraft flying at higher altitudes proved more difficult than anticipated as a result of the tactics employed by the Serbs.*[3]
>
> --Report to Congress
> Kosovo/Operation Allied Force After-Action Report

Achieving air superiority begins by destroying and/or suppressing the adversary's Integrated Air Defense System (IADS). An IADS has many fixed target sets—some obvious, some not. The obvious, "primary" targets include long-range acquisition radars, strategic (non-mobile) surface-to-air missile (SAM) sites, command and control headquarters, and airfields—to list just a few. The not-so-obvious target set includes facilities that support the primary targets, such as a power generation plant supplying electricity to one of the long-range acquisition radars. Suppressing these fixed targets is a critical first step to achieving air superiority because active enemy air defenses, in particular radar-guided SAMs and antiaircraft artillery (AAA), put all aircraft at significant risk. For example, during the first week of Operation Desert Storm—the last time the U.S. faced a robust IADS threat—all 17 coalition aircraft lost to enemy action were downed by Iraqi SAMs and AAA.[4] Active air defenses also keep intelligence, surveillance and reconnaissance (ISR), command and control, air refueling, and other support aircraft farther from the battlespace.

Locating Fixed Targets

Satellites play an absolutely vital role in locating fixed targets, especially pre-war when aircraft overflight of enemy territory is nearly impossible. Intelligence analysts locate fixed targets primarily through signals intelligence (SIGINT) and near real-time imagery intelligence (IMINT). Although the U.S. keeps most of its SIGINT and IMINT capabilities highly classified, the intelligence community has acknowledged it operates satellites with these capabilities.[5] While it is true that ISR aircraft can also perform this mission, they do so at great peril against an effective enemy IADS. For instance, the U.S. lost two U-2 aircraft to enemy SAMs in the early 1960s, one over the Soviet Union and one over Cuba, while they were attempting to collect IMINT.[6] More recently, China forced down a U.S. Navy EP-3 while it was conducting a SIGINT mission in international airspace.[7]

Because they orbit "freely" in space, satellites are not restricted by enemy territorial boundaries or airspace and offer the ability to gather intelligence practically anytime and anywhere. ISR aircraft may be able to collect significant SIGINT data while flying in international airspace off the North Korean coast, but they are much less capable of collecting that data from deep inside China, mainly due to the line-of-sight requirement. In other words, SIGINT sensors must be able to "see" their target in order to collect the data necessary to determine an accurate location. Terrain features, such as mountains or hills, and the curvature of the Earth have a considerable impact on the sensor's ability to gather that data. Operating from high above the terrain, however, satellites have a nearly unrestricted line-of-sight capability to any location on the planet.

Once a SIGINT satellite or aircraft has located a suspected radar or communications site, IMINT satellites come into play. With their near-persistent surveillance capability, IMINT satellites allow intelligence analysts to determine the purpose and exact geographic coordinates of a fixed target. During peacetime, ISR aircraft cannot generally gather meaningful imagery without violating international law and potentially escalating a conflict. IMINT satellites also offer the ability to monitor change at a given location. For example, analysts can often determine the operational status of a new SAM site or airfield by monitoring activity at the construction site. Of course, IMINT satellites do not rely solely on SIGINT cues to locate fixed targets. Analysts can "find" new targets by studying wide-area photos. Once they have discovered a target of interest, they can re-task the satellite to take a close-up photo to study the area in greater detail. IMINT satellites can also be cued by human intelligence, such as an attaché or foreign contractor with knowledge about a new enemy air defense system.

Satellites play an equally important role in helping to determine the exact geographic coordinates of fixed targets. Before the advent of precision-guided munitions, aircrews only needed a target's general location in order to drop their "dumb" bombs. Since Operation Desert Storm, however, the U.S. has increasingly relied on "smart" weapons to increase accuracy and decrease collateral damage. During Operation Iraqi Freedom, for example, 68.3% of the 29,199 munitions released were precision-guided. In contrast, only 7.5% of the 227,000 munitions released during Operation Desert Storm were precision-guided.[8] More accurate weapons mean fewer weapons to destroy a given target, fewer non-combatant injuries, and fewer coalition sorties over the target area. This efficiency significantly reduces aircrew exposure to enemy air defenses.

Most precision-guided weapons, and certainly the GPS-aided variety such as the Joint Direct Attack Munition (JDAM), require highly-accurate coordinates in order to strike the intended target. There are essentially two methods to determine these coordinates, and both rely heavily on space superiority. The first method involves "lifting" mensurated coordinates from an imagery photo, the vast majority of which are collected by satellites. The second method requires an individual to stand at the intended target while holding a GPS receiver or to use a laser range finder (either airborne or ground based) to extrapolate the target's coordinates. Naturally, obtaining permission from North Korean officials to stand on one of their runways in order to determine its exact coordinates may be difficult. Intelligence analysts also use IMINT to select desired mean points of impact, or DMPIs, for a given target. So, for instance, an analyst might select four DMPIs along a 10,000-foot runway, or one weapon impact every 2,000 feet, to render the runway unusable. Analysts use the same concept to target a SAM site or a power generation facility.

Striking Fixed Targets

Satellites play an equally vital role during the execution phase of strike operations, from helping to forecast the weather to guiding precision weapons into their targets. The U.S. now depends on multiple, different satellite systems to strike the fixed targets of an enemy's air defenses. Satellites are also key components of the global command and control network that enables precision strike, but this subject will be discussed in more depth in Chapter 4.

Satellites have revolutionized weather forecasting, making it more of a science than an art. Although not a military example, nothing illustrates this fact more than Hurricane Katrina, which likely would have killed thousands of more people had weather satellites not alerted New Orleanians of its approach. The U.S. has also come to rely on weather satellites to accomplish its mission. From Operation Desert Storm to Iraqi Freedom, accurate and timely weather forecasts have allowed U.S. strike aircraft to render almost any fixed target vulnerable to attack, either during the day or at night. On 24 January 1991, for example, Defense Meteorological Satellite Program (DMSP) imagery depicted an overcast Basra and a clear Baghdad, but a second readout less than two hours later indicated the opposite. Given these conditions, DMSP—along with civilian weather satellites—enabled the most sophisticated air campaign in history.[9] Adverse weather also hampers target acquisition and identification, increases risk to aircrews, and complicates collateral damage concerns and bomb damage assessment. During Operation Allied Force, cloud cover was greater than 50 percent more than 70 percent of the time. In fact, weather conditions allowed for unimpeded air strikes on only 24 of 78 days.[10]

Accurate weather forecasting has taken on even more importance as the USAF has been forced to operate from widely dispersed bases, many far removed from the target area. During all three of the recent operations, air operations and strike execution were impacted by the requirement for favorable weather conditions in up to four geographically dispersed locations. These locations were the target area, the base from which the strike aircraft were operating, the base from which the supporting aircraft were operating, and the orbit location for the refueling and ISR aircraft.[11] Current weather data also proved especially useful for enhancement of night vision and infrared targeting. In this regard, DMSP weather data proved vital for the success of precision-guided laser and optical weapons, which rely on clear skies for accurate target designation.[12]

GPS-guided munitions, on the other hand, do not require clear skies to hit their targets, but they do require space superiority. Over the past 10 years, the U.S. has increasingly grown to rely on these types of weapons. In the opening days of Operation Allied Force, for instance, the coalition employed cruise missiles to limit the exposure of manned aircraft to enemy air defenses, as well as to minimize collateral damage.[13] The conflict's after action report to Congress summed it up best. "Sea-launched and air-launched cruise missiles…provided the capability to penetrate enemy air defenses and attack a wide spectrum of targets throughout the battlespace. Attacking day or night in any weather, GPS-guided weapons placed all target sets at risk, denying the enemy sanctuaries created by weather or the use of heavily concentrated defenses."[14] During Operation Iraqi Freedom, 33 percent of all precision-guided munitions employed were all-weather capable.[15]

GPS satellites add tremendous military capability beyond just helping to guide bombs and missiles to their targets. They also guide special operations forces (SOF) and aircrew to their destinations. In the opening hours of the 1991 Gulf War, SOF Pave Low helicopters equipped with GPS teamed with U.S. Army Apache attack helicopters to destroy two Iraqi radar sites, creating a major gap in the Iraqi air defense system.[16] During Operation Iraqi Freedom, GPS-equipped SOF and CIA paramilitary units were operating deep inside Iraq prior to the formal onset of hostilities. These units moved rapidly to secure key infrastructure, such as Iraqi airfields, once the shooting began.[17] Additionally, GPS provides the highly-accurate navigation signal required for the synchronization of complex airborne operations.[18] An attack that originates from widely dispersed bases, is extremely synchronized and concentrated over the target area, and is very dispersed on egress has the best chance of achieving the desired surprise and effect. GPS enables precise approaches to SAM sites, command and control nodes, and enemy airfields by exploiting the weaknesses at the "seams" of an IADS and provides the opportunity to conduct that operation in any weather. To orchestrate such an attack, aircrew and battle management centers need to know precise position, speed and time for routing and waypoint arrival times. GPS provides these parameters and enables high-reliability and efficient marshalling to enhance operational security.[19]

Lastly, the highly-accurate GPS time signal facilitates this airborne synchronization by allowing all players to communicate via the HAVE QUICK radio. HAVE QUICK radios use frequency hopping as a means of thwarting enemy jamming. Although not technically "secure" communications, HAVE QUICK radios change frequencies so often (many times per second) that enemy forces have great difficulty either intercepting or jamming the communications. In order to function properly, HAVE QUICK radios require a "time of day" (TOD) input so all users can hop among the frequencies at the same time and rate.[20] Over the past several years, GPS has become the common "place" all users go to get that current TOD.

Destroying and/or suppressing the fixed targets of an adversary's IADS is a necessary first step to achieving air superiority. Left unchecked, a robust IADS puts all coalition aircraft at significant risk and threatens all USAF missions. History shows the impact of a robust IADS, with enemy SAM and AAA systems responsible for downing numerous friendly aircraft. The U.S. has come to rely on its space-based assets to first locate and then strike the fixed targets on an adversary's IADS.

Chapter 3

Time-Sensitive/Emerging Targets

In Afghanistan…special operations forces communicate directly with B-52s as they call in close air support. Near-real-time video signals from unmanned air vehicles are used to identify and then engage targets. That soldier on the ground calling in CAS could care less whether his signal bounced off a satellite…and even less what specific satellite it was! Likewise, the pilot dropping the JDAM on a time-critical target didn't care that his targeting information originated from a UAV and was relayed via a satellite system. The only thing they're concerned with is that the capability is available when and where needed.[21]

--General Lance W. Lord
Commander, Air Force Space Command

Locating and striking time-sensitive targets—also commonly referred to as either mobile or emerging targets—is a much more complex task than locating and striking fixed targets. Whereas planners can develop a methodical air campaign to suppress and destroy the fixed targets of an enemy's IADS, they cannot do the same for mobile targets (primarily because they have yet to locate them). In particular, mobile SAMs pose a very credible threat to coalition aircraft during the opening days of hostilities, and they continue to do so as long as they remain operational. Table 3.1 illustrates just how effective mobile SAMs have been against USAF aircraft since Operation Desert Storm. Note that mobile SAMs (SA-6, 9, 13 and 16) shot down nine of the thirteen USAF aircraft during that time, and there is some speculation the Serbs used radars from mobile SAMs to cue the SA-3s during Operation Allied Force.[22] Mobile SAMs, of course, represent just one type of time-sensitive target. Since 1991, when the USAF demonstrated how effectively it could destroy the fixed targets of Iraq's IADS, adversaries have increasingly relied on mobility to "hide" from USAF aircraft. This has made locating and destroying these time-sensitive targets that much more important. The USAF cannot accomplish this mission without space superiority.

Date	Type	Enemy Weapon	Guidance	Time
19 Jan 1991	F-15E	SA-2E	Radar	Night
19 Jan 1991	F-16C	SA-6	Radar	Night
19 Jan 1991	F-16C	SA-3	Radar	Day
31 Jan 1991	AC-130H	SA-16	Infrared	Day
2 Feb 1991	A-10A	SA-16	Infrared	Day
15 Feb 1991	A-10A	SA-13	Infrared	Day
15 Feb 1991	A-10A	SA-13	Infrared	Day
19 Feb 1991	OA-10	SA-9	Infrared	Day
22 Feb 1991	A-10A	SA-16	Infrared	Day
27 Feb 1991	OA-10A	SA-16	Infrared	Day
2 Jun 1995	F-16C	SA-6	Radar	Day
27 Mar 1999	F-117	SA-3	Radar?	Night
2 May 1999	F-16CG	SA-3	Radar?	Night

Table 3.1: USAF Manned Aircraft Combat Losses Since 1991[23]

Locating Time-Sensitive Targets

Satellites are involved, either directly or indirectly, with practically every aspect of locating time-sensitive targets. Whether it is the Defense Support Program (DSP) or communications satellites that enable both control of unmanned air vehicles (UAV) and data relay for ISR aircraft, space systems now play a critical role in the hunt for mobile targets. So critical, in fact, that locating time-sensitive targets without satellites hardly seems imaginable.

DSP has been in operation since the early 1970s, originally designed to detect intercontinental ballistic missile launches from the former Soviet Union. DSP proved its worth to theater commanders, however, during Operation Desert Storm, when DSP satellites detected the launch of Iraqi Scud missiles and provided warning to coalition forces.[24] Using infrared sensors to detect heat from missile and booster plumes against the Earth's background, DSP has the capability to detect a missile launch within 30 seconds and can provide the geographic coordinates of the launcher as well as the missile's projected impact point.[25] In 1995, the USAF made technological improvements to the DSP's ground processing systems, giving it the capability to detect the launch of even smaller missiles.[26]

While DSP has revolutionized theater missile defense, it is the communications satellites that have revolutionized time-sensitive targeting—in more ways than one might imagine. Although the communications satellites certainly enable global command and control (more on that subject in Chapter 4), they are absolutely vital to UAV operations. They also play a critical role in disseminating airborne ISR data.

UAVs have come a long way since Operation Desert Storm, where they played a minor role and the only reconnaissance drone available was the Pioneer. First in the Balkans, then in Afghanistan, and most recently in Iraq, UAVs are the key enabler in the time-sensitive targeting process. They scout for enemy targets and relay that information to strike elements.[27] UAV operations, however, would be nearly impossible without the communications links back to their operators—links that are provided almost exclusively by communications satellites. While it is true that tactical UAVs, such as the MQ-1 Predator, can be controlled through line-of-sight communications with their launch and recovery elements, these links do not extend far enough to allow for operations over enemy territory. Controlling larger UAVs, such as the new Global Hawk, would be impossible without satellite communications as they launch and recover thousands of miles from the target area. Of course, gaining real-time intelligence from the UAV fleet would also be impossible without satellite communications links.

To say the U.S. has become dependent on UAVs for real-time intelligence and time-sensitive targeting would be an understatement. As of October 2005, Predators alone were logging 4,000 hours a month in support of the war on terrorism and other operations. Since the September 11, 2001 terrorist attacks, Predators have flown more than 103,000 combat hours in global operations, including a monthly record of 4,700 in July 2005.[28] While it is true that many of these hours supported more than just the offensive counterair mission, the sheer number demonstrates how reliant the U.S. has become on the Predator. It has endeared itself to the warfighter because it provides a persistent eye in the sky over dangerous areas, with sophisticated sensors and cameras feeding full-motion video to ground troops and aircraft.[29]

A closer tie to the offensive counterair mission can be seen from the Global Hawk's second-ever operational deployment in support of Operation Iraqi Freedom. During that deployment, the Global Hawk flew just fifteen missions, accounting for only three percent of the U.S. airborne imagery. However, those 4,800 images helped lead to the destruction of more than half of the time-sensitive targets (including 13 SAM batteries, 50 SAM launchers, 70 SAM transporters, and 300 SAM canisters).[30] Not only would controlling Predators and Global Hawks be impossible without communications satellites, but the vital images and videos they collect could not be downloaded in a timely fashion without that same space-based communications architecture.

Communications satellites are also vital to relaying information collected by airborne ISR platforms. The E-8C Joint STARS (Joint Surveillance Target Attack Radar System), for example, is an airborne battle management platform designed to provide theater ground and air commanders with ground surveillance to support attack operations and targeting. The plane's phased array radar can detect ground moving targets (i.e. a mobile SAM) and cue other sensors and/or strike aircraft.[31] In addition to the Joint STARS, communications satellites are used to control and relay data from U-2s, RC-135s and E-3 AWACS (Airborne Warning and Control System), among other aircraft. Without space superiority, the USAF would have great difficulty locating and identifying time-sensitive targets.

Striking Time-Sensitive Targets

Locating a time-sensitive target is, of course, only the first step in the "sensor-to-shooter" kill chain. As much as the USAF has come to rely on space-based systems to locate and identify mobile targets, it relies even more on them to complete the kill chain and strike the target. Since Operation Allied Force, the USAF's rapid and dynamic targeting capability involves reachback, distributed operations and real-time ISR collection to shorten the sensor-to-shooter timeline. Satellites play a key role in detecting and relaying real-time threat information to the combined air operations center (CAOC), enabling commanders to make strike decisions and pass orders to strike aircraft. With those orders, strike aircraft then use space-based systems to navigate to the target area and precisely deliver their weapons.[32]

Nowhere is the shortening of the sensor-to-shooter kill chain more apparent than in the UAV force, particularly the Predator. Able to penetrate heavily defended airspace without the concern for loss of life, the Predator is an ideal offensive counterair platform. As previously discussed, the Predator can locate a target using its own on-board sensors or be cued to one by another ISR platform or ground element, among others. Once located, the MQ-1 can strike the target with up to two AGM-114 Hellfire missiles. In the near future, the USAF will field the MQ-9 Predator B, able to carry a payload up to 3,000 pounds, including numerous missiles and precision-guided bombs (both laser- and GPS-guided). The MQ-9 will also have a synthetic aperture radar (SAR), featuring an all-weather and ground moving target indicator capability.[33]

Predator B will provide a hunter-killer capability and feature the ability to use SAR to hunt for targets, then cross-cue target data to the electro-optic/infrared sensor.[34] Lt Gen Walter E. Buchanan, Commander of U.S. Central Command Air Forces, appropriately described the UAVs' contribution to time-sensitive targeting. "I have seen our unmanned aircraft system force evolve from one that was principally an intelligence-collection platform in Bosnia to one that today has a very potent air-to-ground capability and represents a truly flexible, combat platform."[35] It would be impossible to use the UAV force in this manner without space-based systems.

Satellites are also revolutionizing the way conventional aircraft strike time-sensitive targets. During Operation Allied Force, space systems allowed for the incorporation of the Multi-Source Tactical System into the cockpit of U.S. bombers. "The system displayed space-derived information (intelligence), to include near real-time information of threats, position and status of friendly platforms, mission rehearsal data and updated target parameters and imagery."[36] The system proved so successful that on several occasions, commanders were able to retarget bombers en route to their targets, allowing the first-ever CAS push[37] for the B-1. Additionally, the USAF equipped the B-2 with digital satellite radios, which allowed pilots to receive target coordinates from command centers and feed them directly into the aircraft's computers. Pilots were then able to get mission updates on the fly digitally, versus trying to do it over voice radio and manually entering the target data into their computers.[38] Rapid information allowed the optimization of weapon systems and enabled a shorter observe-orient-decide-act (OODA) loop.[39] By the ground phase of Operation Iraqi Freedom, the CAOC was able to put bombs on target within 20 minutes of being alerted by intelligence. In all, coalition air forces struck 700 targets based on dynamic retargeting in support of ground forces, and carried out over

150 missions against time-sensitive targets.[40] Again, many of these targets were outside the offensive counterair mission (i.e. leadership, WMD, etc), but the employment concepts still apply.

U.S. Special Forces are leveraging satellites to bring airpower to bear on their emerging targets as well. During Operation Enduring Freedom, for example, specially trained combat controllers determined a target's geographic coordinates by using a laser range-finder connected to a hand-held GPS receiver. These coordinates were then passed by radio (sometimes UHF, sometimes SATCOM) to aircraft loitering overhead and entered into GPS-guided JDAMs. Operating in this manner, a relatively small number of SOF personnel, about 300 by the fall of Kandahar, were able to dramatically increase the effectiveness of U.S. precision strikes.[41]

Locating and striking an adversary's time-sensitive targets is just as vital to achieving air superiority as attacking its fixed targets. Since Operation Desert Storm, when the U.S. demonstrated how effectively it could destroy the fixed targets of Iraq's IADS, adversaries have increasingly relied on mobility to evade detection. This had made locating and destroying these time-sensitive targets that much more important. The USAF cannot accomplish this mission without space superiority.

Chapter 4

Command, Control and Communications

> *You cannot execute the American way of war without rapid communications, and the CAOC relied on gigabytes of data flowing in and out of the center. Bandwidth was increased by about 600 percent over pre-OIF operations to support daily operations. DSCS satellites were repositioned to provide two prime and three residual satellites coverage of the region. As a result, they were able to boost the capability to approximately 700 Megabytes/second (Mbps) in the region and carry 80 percent of theater traffic.*[42]
>
> --Brig Gen Larry D. New
> OIF Joint Director of Space Forces

Gaining and maintaining air superiority requires effective command and control, and effective command and control requires a robust and reliable communications capability. From the launch of the first communications satellite, the USAF has relied on both military and commercial satellites to carry an ever-increasing volume of its voice and data communications. Since Operation Desert Storm, the USAF has also grown to depend on communications satellites to improve situational awareness among its command and control centers and its aircraft. Lastly, with the transition to an expeditionary force, the USAF now deploys fewer personnel into the theater, relying on the "reachback" concept to distribute the CAOC's workload to centers of excellence around the world.

Communications

To this day, the USAF relies on communications satellites more than any other space-based system to accomplish its missions. Satellite communications allow the USAF to deploy to any hotspot in the world and still remain in contact with leadership, whether it is the local, in-theater headquarters or the President and Secretary of Defense.[43] They also allow units to deploy to bare-base locations with austere infrastructure and begin operations within just a few days of arrival. In addition, communications satellites support many common services, such as the Defense Switching Network (DSN) service and video-teleconferencing (VTC) capability, as well as access to e-mail services, the Non-Secure Internet Protocol Router Network (NIPRNET), and the Secure Internet Protocol Router Network (SIPRNET).[44]

The demand for satellite communications is constantly growing. General Mike Ryan, former Chief of Staff of the Air Force, stated that the amount of bandwidth required for Operation Allied Force was five times the amount required for Operation Desert Storm and that the network connected 40 different locations in 15 countries. While some of this network used landlines, much of it was made possible only through the use of satellites.[45] During Operation Iraqi Freedom, satellite bandwidth was approximately 42 times the capacity available during Operation Desert Storm and significantly enhanced command and control. For example, an upgraded Military Satellite Communications System (MILSTAR) could securely transmit an air tasking order (ATO) in six seconds rather than an hour, as was previously required. This provided tremendous capabilities that allowed the USAF to execute agile, responsive air operations as the threats and targets changed.[46] Additionally, the Global Broadcast Service (GBS) provided over 350 Megabytes/second of worldwide throughput and directly contributed to combat operations by supplying 1.25 terabytes per day of very large video streams and data files to the U.S. Central Command area of responsibility. Frequently, combat units established their GBS connection as soon as they encamped and were receiving current intelligence, imagery products and multiple video broadcasts within minutes.[47]

As if all this bandwidth was not enough, U.S. Strategic Command leaders predict the need for additional bandwidth will triple in the next few years, likely outstripping the Wideband Gapfiller Satellites now under development.[48] This increased need for bandwidth is primarily being driven by the proliferation of UAVs, which has the potential to cause bandwidth shortages and impact other operations. As an example, the U.S. European Command operated just two Predators simultaneously from Bosnia during Operation Allied Force. Each needed 6 Mbps to support video dissemination within the theater and the U.S., a requirement that severely stressed the Defense Information Systems Network architecture and required preemption of lower-priority channels while the UAVs were in flight. Even with only a handful of UAVs operating in Kosovo, military communications systems were stressed to the point where operational trade-offs were required and some activities had to be delayed or cancelled.[49] With communications satellites either degraded or completely out of service, commanders would be forced to make even more tradeoffs to at least maintain some UAV capability.

Situational Awareness

Space-based systems have enabled extraordinary levels of situational awareness among warfighters at all levels—the CAOC, other command and control centers, widely dispersed wings, and even aircraft in flight. From tracking aircraft, personnel and equipment as they deploy into the theater, to controlling aircraft in the fight, to gathering post-flight intelligence and maintenance information, satellites allow commanders to "stay in the know" and actively control the fight more than ever before. Without this "common operational picture" (COP), the USAF would have great difficulty gaining and maintaining air superiority.

An integral component of the COP is the Global Command and Control System (GCCS). Although not a space-based system, GCCS relies on satellites to lash together several hundred sites worldwide via the DoD's SIPRNET. It incorporates the force planning and readiness assessment applications required by battlefield commanders to effectively plan and execute operations. The COP function of GCCS correlates and fuses data from multiple intelligence sources and sensors to provide warfighters the situational awareness needed to be able to act and react decisively. The COP also provides the CAOC with near real-time "blue force tracking" data, much of it gathered and/or relayed by space-based systems, and it serves as the critical link among warfighters, national agencies, and a variety of dissemination architectures.[50] Finally, GCCS provides an extensive suite of integrated office automation, messaging, and collaborative applications that allow CAOC and wing mission planners to both develop the air campaign and control its execution phase.[51]

During the execution phase, space-based systems are key enablers that allow the CAOC to maintain a high level of situational awareness. Satellites provide the capability to receive, process, and exploit SIGINT data from selected national and theater sensors, and receive, process, exploit, and generate timely intelligence and information. During Operation Iraqi Freedom, this time to access theater and national imagery was reduced by as much as six to ten hours, and national and theater SIGINT support for targeting operations was reduced by as much as thirty minutes to two hours.[52] A variety of airborne ISR sources also down-linked their data via satellites into the CAOC, where operators analyzed the information, integrated the target lists, and provided strike approval. As a result, the Joint Forces Air Component Commander (JFACC) was able to gain enhanced situational awareness and improve his CAOC's ability to shape the battlespace.[53] In fact, this entire process reinforced the dictum that centralized control and decentralized execution of air and space forces are critical to force effectiveness.[54]

Finally, satellites have significantly enhanced situational awareness for combat search and rescue. During both Operations Allied Force and Iraqi Freedom, space systems ensured the CAOC not only had the exact location of the downed aircrew, but also gave the rescue aircraft situational awareness on the surface-to-air threats. Thanks to space, none of the downed aircrew in these operations became prisoners of war. In fact, the two aviators shot down over Iraq were rescued within 90 minutes of ejecting. As General John P. Jumper, former Chief of Staff of the Air Force, said, "space took the search out of search and rescue."[55] Most of this situational awareness would not be possible without space-based systems.

Reachback

Reachback is a concept of operation that absolutely could not work without the bandwidth and connectivity provided by communications satellites. First used extensively during Operation Allied Force,[56] reachback is the concept of distributing the CAOC's workload to other centers of excellence throughout the world. This not only reduces the demand on the already overworked CAOC, but it also allows the USAF to deploy fewer support personnel and less equipment into the theater, thereby reducing both the strain on the transportation system and the personnel tempo. In addition to reachback, AFDD 2-8, *Command and Control*, describes distributed operations as independent and interdependent nodes that participate in the operational planning and decision-making process to accomplish missions for engaged commanders.[57]

Reachback can be as simple as a VTC, an e-mail, or a website. During Operation Allied Force, for example, space-based systems made possible the exchange of large amounts of data, such as VTCs and high-resolution imagery. In addition, the extensive growth and availability in defense data and communications networks enabled remarkable coordination via secure e-mail by staffs in European commands and supporting commands outside Europe. The SIPRNET also permitted personnel engaged in the theater to access up-to-date information posted for their use on military websites around the world.[58] VTCs have become a way of life in Operations Enduring and Iraqi Freedom. With permanent headquarters at Shaw Air Force Base in South Carolina and expeditionary headquarters at Al Udeid Air Base in Qatar, the U.S. Central Command Air Forces maintains its battle rhythm through extensive use of VTCs. The CAOC also participates in almost daily VTCs with U.S. Central Command, Combined Forces Command-Afghanistan, and Multinational Force-Iraq to oversee and coordinate current and future operations.[59]

Reachback has revolutionized the targeting and bomb damage assessment (BDA) processes. In Kosovo and the Federal Republic of Yugoslavia, for instance, targets were developed through the combined efforts of numerous agencies in the U.S. cooperating closely with headquarters in Europe. Planning and integration of air-launched cruise missile attacks from B-52s operating from the continental U.S. and the United Kingdom were closely coordinated by commanders and planners who were widely separated geographically. BDA of strikes made against targets in Kosovo was conducted by agencies and commands located in the U.S. in close coordination with commands in Europe. This system of using geographically-dispersed activities to perform and integrate bomb damage assessment became known as federated BDA.[60] The concept was used extensively by the CAOC to support both Operations Enduring and Iraqi Freedom and is still in use today.[61]

The USAF used reachback during Operation Allied Force to support a number of ISR platforms. The aircraft deployed forward, but the data reduction and analysis components remained at the home base. Reconnaissance systems, such as the U-2 aircraft, collected data in the theater, then transmitted that data stateside so it could be processed and returned to the theater as information for the appropriate command and control and operational nodes.[62] As discussed earlier, the USAF used this reachback technique as part of the federated intelligence process to perform timely BDA, thus reducing the number of scarce imagery analysts required to deploy to the theater.[63] The Global Hawk also used reachback to reduce its in-theater footprint during Operation Iraqi Freedom. About one-third of the 100 people who supported the missions worked in the comfort of an air-conditioned building in the U.S. Logistics costs shrank because fewer tactical command shelters were needed in theater. Reachback cut the Global Hawk's price tag and operating costs. On the operational side, the USAF will be able to trim payroll costs by keeping stateside about 40 people, including imagery analysts, sensor operators, pilots, and contractor support teams.

The USAF must have effective, reliable command and control to achieve air superiority. From the launch of the first communications satellite, the USAF has come to depend on both military and civilian satellites to establish its command and control network. The USAF uses this critical network to maintain operational control of its aircraft, as well as to provide situational awareness among its command centers and its aircraft. The USAF also needs communications satellites to employ its reachback concept so it can distribute the CAOC's workload to centers of excellence around the world. These employment concepts would not be possible without space superiority.

Chapter 5

Impacts and Recommendations

Loss of space superiority would clearly impact every level of waging modern war. From deliberate planning, tracking friend and foe, to target development, engaging targets and assessing damage. Imagine for a second…reliving [recent operations] without precise navigation and timing…or eliminating the use of precision-guided munitions, which rely on space-borne assets.[64]

--General Lance W. Lord

The U.S. Air Force has become so dependent on space-based assets that it cannot gain and maintain air superiority in a timely manner without space superiority, especially against a well-equipped and determined adversary. As General Lord notes, the USAF now depends on space to support practically every mission area, from deploying to the fight to conducting bomb damage assessment to reordering spare parts. This luxury of uncontested space superiority, however, has allowed the USAF to become complacent. A determined adversary will take advantage of this complacency, attack the USAF's space-based assets, and extend the time it takes for the USAF to achieve air superiority. Unfortunately, the USAF will certainly lose additional aircraft and personnel while it attempts to reestablish space superiority.

To briefly illustrate just how much the USAF has come to rely on space superiority, compare a typical bombing mission from World War II to one from Operation Iraqi Freedom. During both conflicts, bombers launched from Great Britain to strike distant targets. In the early 1940s, B-17 mission planners relied on intelligence that was, at best, days old and not that detailed. If they were lucky, mission planners could give the crews an overhead photograph, but again it was probably days to weeks old and likely did not show BDA from recent missions. When the B-17 crews stepped to their aircraft, they got best guesses for target area threats and weather. After takeoff, they essentially lost communications with their command and control elements and had no way of receiving mid-mission updates. Navigation and bombing were primitive. It would not be uncommon for the B-17s to arrive over the target area and find it covered by clouds. If they could release their weapons, many fell well outside the target area and caused extensive collateral damage. On the way home, the crews had no way of providing BDA or strike effectiveness back to command and control headquarters. Time-sensitive targeting did not exist.

Things were much different for the B-52s in 2003. Their mission planners had access to intelligence (imagery, threat and target analysis, etc.) that was sometimes seconds old and had been processed at centers of excellence throughout the world. They had exact coordinates of many of the threats and could therefore optimize their ingress and egress routes to minimize exposure. They had exact target coordinates, allowing the crews to release one GPS-aided weapon on the target. If threats or the targets changed while the B-52s were en route, command and control elements could contact them anytime and provide updated information. The crews also had accurate, detailed weather forecasts for the entire flight and, again, could be contacted in flight if the weather changed. The B-52s participated in time-sensitive targeting because they were linked to numerous ISR platforms, command and control headquarters, and the tactical air control parties on the ground. After they released their weapons, the B-52 crews could provide immediate reports and BDA to all players, enabling the CAOC to order a re-strike, if necessary.

While losing space superiority would not set back the USAF to the days of World War II, it would significantly hamper the current generation of Airmen from achieving air superiority in a timely manner. To begin with, just locating the adversary's fixed targets would be much more difficult. Without satellites, the USAF would have no capability to collect current imagery of targets deep within the adversary's territory, unless it decided to risk low-density ISR aircraft. The USAF would also be unable to collect SIGINT data on many IADS components. Even if the USAF was able to collect SIGINT "hits" with its ISR aircraft (i.e. RC-135, EP-3), it would be unable to cross-cue to an IMINT satellite and determine target-quality geographic coordinates. The U.S. could insert SOF personnel, or possibly rely on HUMINT sources, to determine target coordinates, but they would need GPS data to determine target-quality coordinates.

Striking fixed targets without space superiority is an equally daunting task. The timeliness and accuracy of weather forecasts would dramatically decrease. Aircrews would frequently be "surprised" by en route and/or target area weather. Adverse weather can severely impact air refueling, marshalling, and weapons employment. Aircrews could also arrive over the target area with improper weapons (i.e. carrying laser-guided bombs) that cannot be employed through a cloud deck. With non-existent or degraded GPS data, GPS-aided munitions would lose critical accuracy, impacting both collateral damage considerations and effects. Additionally, unreliable GPS data would expose coalition aircraft to an increased threat from the adversary's IADS. Aircrews would no longer be able to precisely navigate through the weaknesses of the IADS "seams."

Locating and striking time-sensitive targets becomes a near impossibility without space superiority. From DSP to ISR aircraft to SOF personnel on the ground, nearly all information to locate a mobile target flows either from or through space. Likewise, nearly all the information and command and control required to analyze and prosecute mobile targets also travels through space. To put it bluntly, time-sensitive targeting without space superiority is simply not possible.

As for command, control, and communications, it too would be severely degraded by a lack of space superiority. It is difficult to imagine the USAF conducting an air campaign without today's communications satellites. Simply distributing the voluminous ATO would require the USAF to revert to the Operation Desert Storm days of flying it out to the aircraft carrier. Having to rely solely on land lines would also affect the USAF's widely distributed operations, making NIPRNET and SIPRNET connectivity much less universal. This would impact, as just one example, the entire transportation system. Personnel rotation, spare parts, and replacement weapons would all be impacted. The USAF would quickly revert to the days of having to open a crate to discover its content.

Today's concepts of situational awareness and reachback are also not possible without space superiority. Decreased situational awareness would inevitably lead to increased fratricide—of both ground forces and aircraft—and an overall decrease in airpower's effectiveness. Although land lines could potentially pick up some traffic to support the reachback mission, there is no way to use land lines to connect widely dispersed sites (many of them expeditionary sites located at bare bases). With limited reachback capability, the USAF would be forced to deploy more personnel into the theater, and the CAOC would lose vital connectivity to non-deployable centers of excellence.

Recommendations

This paper is focused on showing the impacts to achieving air superiority without having concurrent space superiority. The paper's intent is not to recommend detailed solutions. Some broad recommendations, however, are in order and deserve further research. First, the USAF is spending considerable resources to develop methods to defend its space systems. Unfortunately, "hiding" satellites from a potential adversary is quite difficult, especially when that adversary has the capability to locate and track satellites. A future, determined adversary will likely go to great lengths to degrade and/or destroy the USAF's space capabilities, knowing it will seriously impact the USAF's ability to wage war.

In addition to developing methods to "protect" its satellites, the USAF must develop systems and procedures for continuing the fight with the loss of some or all of its space-based systems. In particular, communications satellites have clearly become the USAF's Achilles' heel. Waging war without them seems unimaginable and a determined adversary will certainly attempt to degrade that capability. The USAF must continue its research and development efforts into small, tactical satellites that can launch on short notice and high-altitude balloons that can stay aloft for several weeks. Either way, the USAF must develop and field systems that are inexpensive, and potentially expendable, so that it can quickly replace the capability offered by its current space systems.

Chapter 6

Conclusion

This paper examined whether the United States Air Force could achieve air superiority against a robust, determined adversary without concurrent space superiority. Since Operation Desert Storm, the USAF has become increasingly dependent on space assets to accomplish its mission. From command and control, communications, and weather forecasting to missile warning, navigation, and precision targeting, the USAF now relies heavily on space. In fact, the USAF has become so dependent on space-based assets that it cannot gain and maintain air superiority in a timely manner without space superiority.

Potential adversaries are unlikely to challenge the United States without first trying to deny its military the clear advantages provided by space superiority. By examining several mission areas—striking fixed targets, striking time-sensitive targets, and command, control, and communications—this paper has demonstrated that the USAF now depends on space to accomplish the offensive counterair mission. The United States must be prepared for the loss of space superiority. It must develop systems and procedures for continuing the fight with the loss of some or all of its current space-based systems. Assuming those systems will always be available is a mistake. The USAF must be prepared to fight without them.

Appendix A: Acronyms

AAA	Antiaircraft Artillery
AFDD	Air Force Doctrine Document
ATO	Air Tasking Order
BDA	Bomb Damage Assessment
CAOC	Combined Air Operations Center
CAS	Close Air Support
CIA	Central Intelligence Agency
COP	Common Operational Picture
DMPI	Desired Mean Point of Impact
DMSP	Defense Meteorological Satellite Program
DoD	Department of Defense
DSCS	Defense Satellite Communications System
DSN	Defense Switching Network
DSP	Defense Support Program
GCCS	Global Command and Control System
GPS	Global Positioning System
IADS	Integrated Air Defense System
IMINT	Imagery Intelligence
ISR	Intelligence, Surveillance, and Reconnaissance
GBS	Global Broadcast Service
JDAM	Joint Direct Attack Munition
JFACC	Joint Forces Air Component Commander
Mbps	Megabytes/second
MILSTAR	Military Satellite Communications System
NATO	North Atlantic Treaty Organization
NIPRNET	Non-Secure Internet Protocol Router Network
SAM	Surface-to-Air Missile
SAR	Synthetic Aperture Radar
SATCOM	Satellites Communications
SIGINT	Signals Intelligence
SIPRNET	Secure Internet Protocol Router Network
SOF	Special Operations Forces
TOD	Time of Day
UAV	Unmanned Air Vehicle
UHF	Ultrahigh Frequency Radio
U.S.	United States of America
USAF	United States Air Force
VTC	Video-Teleconferencing Capability
WMD	Weapons of Mass Destruction

Notes

(All notes appear in shortened form. For full details, see the appropriate entry in the bibliography.)

[1] AFDD 2-1.1, 31.
[2] Ibid., 33.
[3] *OAF After-Action Report*, 65.
[4] *Conduct of the Persian Gulf War*, 180.
[5] National Reconnaissance Office, "NRO Fact Sheet."
[6] *Encyclopaedia Britannica*, 15th ed., s.v. "U-2."
[7] Chinoy and Wallace, "U.S. Surveillance Plane Lands in China."
[8] Zaloga, "Precision-Guided Weapons Rule," 173.
[9] Spires, *Beyond Horizons*, 257-258.
[10] *OAF After-Action Report*, 60.
[11] Ibid., 98.
[12] Spires, *Beyond Horizons*, 258.
[13] *OAF After-Action Report*, 86.
[14] Ibid., 91.
[15] Krepinevich, *Operation Iraqi Freedom*, 20.
[16] Spires, *Beyond Horizons*, 257.
[17] Krepinevich, *Operation Iraqi Freedom*, 9.
[18] *OAF After-Action Report*, 124.
[19] Tovrea and Pinker, "Contributions of the GPS."
[20] Harris Corporation, "HAVEQUICK I/II Radio Data Sheet."
[21] Lord, address to Air Force Association's C2ISR Summit.
[22] Haulman, *USAF Manned Aircraft Combat Losses*, 2.
[23] Ibid.
[24] Air Force Link, "DSP Fact Sheet."
[25] Lambeth, "The Synergy of Air and Space."
[26] Air Force Link, "DSP Fact Sheet."
[27] Krepinevich, *Operation Iraqi Freedom*, 17.
[28] McGee, "Predator's Success Ups Procurement."
[29] Ibid.
[30] Kaufman, "U.S. Air Force Reveals," 23.
[31] Air Force Link, "E-8C Joint STARS Fact Sheet."
[32] *OAF After-Action Report*, 95.
[33] Airforce-Technology.com, "Predator RQ-1/MQ-1/MQ-9 UAV."
[34] McGee, "Predator's Success Ups Procurement."
[35] Ibid.
[36] Amrine, "The Command of Space," 35.

[37] CAS push refers to the concept of launching CAS sorties to a pre-determined location without a pre-assigned target. During intensive ground operations, the USAF launches numerous CAS sorties to orbit points, where they hold until called in by joint terminal attack controllers.

[38] Kaufman, "U.S. Air Force Reveals," 23.

[39] Amrine, "The Command of Space," 35.

[40] Krepinevich, *Operation Iraqi Freedom*, 17.

[41] Ibid., 16-17.

[42] James, "Bringing Space to the Fight," 15.

[43] Amrine, "The Command of Space," 33.

[44] Dodgen, "Space – Enabling the Potential."

[45] Amrine, "The Command of Space," 33.

[46] James, "Bringing Space to the Fight," 15-16.

[47] Ibid., 16.

[48] Kaufman, "Iraq War Lessons Discussed," 46.

[49] Klausner, "Command and Control."

[50] Ibid.

[51] Defense Information Systems Agency, "What is the GCCS-J."

[52] Dodgen, "Space – Enabling the Potential."

[53] Ibid.

[54] *OAF After-Action Report*, 45.

[55] Leaf, "Providing Combat Effects," 4.

[56] *OAF After-Action Report*, 55.

[57] Klausner, "Command and Control."

[58] *OAF After-Action Report*, 124.

[59] Personal Experience. The author was deployed to the Combined Air Operations Center at Al Udeid Air Base, Qatar, from September 2004 to January 2005.

[60] *OAF After-Action Report*, 123-124.

[61] Personal Experience.

[62] Klausner, "Command and Control."

[63] *OAF After-Action Report*, 55.

[64] Lord, address to Air Force Association's National Air and Space Conference.

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