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YOU CAN'T SPELL SPACE CONTROL "ASAT" ANY MORE

by

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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College of the Department of the Navy.

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15. Abstract:

In the future, the success of U.S. military operations will depend, in part, on operational designs which overcome the enemy's capability to exploit the military utility of commercial space technologies. U.S. forces will find themselves constrained by traditional space control strategies focused on the destruction of space systems. The United States may have the capability to destroy these systems, but the strategy may not be feasible when U.S. forces are co-dependent on the system, or the system is owned by someone other than the adversary. The safe assumption will be that hostile forces will attempt to incorporate these technologies to the maximum extent possible.

It is imperative that planners understand not only the impact of commercial space systems exploitation, but also realistic means of countering it, if they hope to produce and execute viable operational plans. When strategic or diplomatic approaches prove inadequate, the operational commander must be fully aware of, and ready to employ his organic space control capabilities. The operational commander may find himself constrained by the inability to eliminate commercial space systems, but if he fails to address their potential capabilities in his operational design, the results could be devastating.

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Abstract

In the future, the success of U.S. military operations will depend, in part, on operational designs which overcome the enemy's capability to exploit the military utility of proliferating commercial space technologies. While the safe assumption is that nations will attempt to incorporate these technologies to the maximum extent possible, U.S. forces will find themselves constrained by space control strategies focused on the destruction of space systems. The United States may have the capability to destroy these systems, but the strategy may not be feasible when U.S. forces are co-dependent on the system, or the system is owned by someone other than the adversary.

The distinction between the realms of civil and military space is rapidly blurring. Declining budgets force the military to rely on dual use and commercial off the shelf technology, commercial imagery, and leased commercial satellite communications. Today, space-based capabilities with inherent military utility in the areas of surveillance, navigation, communications, and environmental monitoring are available on the open market.

It is imperative that planners understand not only the impact of commercial space systems exploitation, but also realistic means of countering it, if they hope to produce and execute viable operational plans. When diplomatic or strategic approaches fail to achieve desired results, the operational commander must be fully aware of, and ready to employ his organic space control capabilities. Although the operational commander may find himself constrained by the inability to eliminate commercial space systems, if he fails to address their potential capabilities in his operational design the results could be devastating.

Introduction

Desert Storm, declared "the first space war" by U.S. Air Force Chief of Staff Merril McPeak, is a benchmark testifying to the influence of space on the outcome of Battle.[1] Realization of the significance of space systems on modern warfare has not been limited to the DOD. Foreign governments and private corporations around the globe are leaping at opportunities to provide advanced space technology to support the national security needs of foreign nations.[2] The success of future U.S. military operations will depend, in part, on operational designs which overcome the enemy's capability to exploit the military utility of commercial space technology.

Much of what falls into the arena of operational art is relative--deploying faster than the enemy, operating inside the opponents decision cycle, outmaneuvering the opposing force, maintaining a higher operational tempo than the adversary. Access to space-based technology diminishes the relative operational advantage of U.S. forces when it is exploited by the adversary. Traditional space control strategies focused primarily on the destruction of space systems may not be appropriate when U.S. forces are co-dependent on the system, or the system is owned by someone other than the adversary. It is imperative that planners understand not only the impact of this technology, but also the means of countering it, if they hope to produce and execute successful operational plans. Insight into viable counters to proliferating commercial space technology will be obtained by reviewing recent proliferation trends, examining the military utility of commercial space technology, exploring the operational implications of proliferating space technology, and then drawing some broad conclusions.

Trends in Space Technology Proliferation

The emergence of the global market place is accelerating the commercial development of space and blurring the distinction between the realms of civil and military space.[3] The technology edge, traditionally the domain of the military, is being challenged, even surpassed in some areas, by commercial enterprises.[4] Faced with declining budgets, the military is choosing to increase its reliance on dual use and commercial off-the-shelf technology, commercial imagery, and leased commercial satellite communications capacity.[5] Commercial enterprises now use military satellite navigation, weather information, declassified imagery, and excess military space lift capacity. Technology advances have reduced the size and cost of satellites and precipitated corresponding reductions in launch costs. Declining costs combined with global competition between emerging economic and military powers have propelled space related technologies and capabilities beyond mere commercial viability into the realm of high growth industry.[6]

The international community can be divided into three tiers based on their space related capabilities.[7] The United States and Russia constitute the top tier--the only two nations with dedicated mature military space systems, and currently unparalleled in capability. The middle level consists of emerging space powers with satellites in orbit, including five countries (China, France, Japan, India, and Israel) capable of both producing and launching satellites, as well as twenty plus additional nations, commercial ventures, and international consortiums, without an organic lift capability who either produce or purchase their own satellites.[8]

The lowest tier is occupied by the remaining nations and non-state actors such as the Cali Cartel, Shining Path, and Hizballah, who gain access to space through the nations in the upper two tiers . Their space capabilities range from SPOT and Landsat ground stations, to hand held Global Positioning System (GPS) receivers.* Today, access to the ground side of space technology is gained by contract, mail-order, phone, internet, or a third party, and is guaranteed with either currency or credit.

Commercial technology currently available on the open market provides satellite navigation and positioning, mobile satellite communications (SATCOM), near-real-time satellite weather depiction, and high resolution imagery to anyone who can afford it. All indicators point toward exponential growth in the commercial space industry. Private companies are beginning to displace the commercial market share historically held by governments and international consortiums.[9] Over the next five years, half of the 1000 scheduled satellite launches will be small (less than 500 pounds) low-Earth-orbit (LEO) commercial communications satellites offering voice, data, messaging, and position information.[10] Three U.S. firms have already received licensing to launch private high resolution imaging satellite systems, and to market access to the systems or their imagery products in the international community.[11] While global access to one meter resolution imagery and hand-held SATCOM should be readily available by the turn of the century, the U.S. Government will struggle just to maintain its existing capabilities.[12]

* SPOT and Landsat are the most widely available commercial producers of space-based imagery, Landsat is an American system and SPOT is French.

Two satellite systems are currently available to provide anyone with world-wide navigation and positioning accuracy better than 100 meters: United States provided GPS and the Russian operated Global Navigation System (GLONASS). China, India, and western Europe are each trying to develop regional positioning systems (scaled back GPS-like systems) in order to reduce their reliance on the United States and Russia.[13] GLONASS and GPS operate on similar principles, on similar frequencies, with comparable accuracy, and although the systems are not interoperable, receivers capable of processing both signals independently or combined are currently under development.[14] Commercially developed Differential GPS (DGPS) overcomes the government imbedded inaccuracy broadcast on the civil satellite navigation signal by locally broadcasting GPS correction signals.[*] Military and civilian users around the globe, including the United States, are exploiting DGPS to obtain navigation accuracy significantly better than the protected U.S. military signal (1 meter for DGPS versus 16 meters for U.S. military GPS).[15]

The quality of world-wide weather data has seen significant improvement in the past two years. World-wide aviation weather reports and forecasts available from the World Area Forecast System (WAFS) provide better data faster than ever before. The information provided is more accurate, the transmission time for a complete global data set has been reduced from 5 hours to 34 minutes, and updates now occur every 6 rather than 12 hours.[16] The new Dartcom Winsat System developed in the United Kingdom is a terminal designed to

[*] Mark Hewish and J.R. Wilson, "GPS Meets New Challenges," *International Defense Review*, October 1995, pp. 60-62. DGPS uses a fixed receiver at a precise location to calculate and broadcast GPS error corrections to equipped receivers. Wide Area Augmentation System (WAAS) operates on the same principal, but adds a satellite in the loop between the ground station and the receivers in order to extend coverage beyond line of sight.

receive, store, and display near-photographic quality live images from geo-synchronous and polar orbiting satellites.[17]

Military Utility of Commercial Space Technology

The majority of nations find space neither essential, nor integral to their military operations--their access to space is a force multiplier, not a fundamental enabler. The capability of second and third tier nations to exploit space has been somewhat neglected, and what is written has been focused through a western lens. Economics force many nations to take a satisficing, rather than a maximizing approach toward space systems, and we tend to discount these nation's space capabilities because they appear crude, or are orders of magnitude less sophisticated than our own.[18] Because even limited access to space technology may increase threats to U.S. forces it is important to look at the utility of space technology with a pragmatic end user view, rather than a "what value would it have to the department of defense" perspective.

Although no one can accurately predict who the next major conflict will pit the United States against, some general assumptions can be made: the adversary will probably accept a higher level of collateral damage, a lower degree of target discrimination, and a higher percentage of casualties than the United States. Against the resources and military might of the United States, these nations are likely to choose a victory-denying rather than a war-winning strategy. They will not depend on space-based technology, but will exploit it as a force multiplier wherever able. The existing commercial marketplace provides access to space-based capabilities with inherent military utility in the areas of surveillance, navigation, communications, and environmental monitoring.[19]

Surveillance. High resolution imagery is the most widely written about commercial space-based technology with obvious military usefulness, and the only space-based surveillance capability readily available on the open market. Tasked and archived imagery products are available from a number of international resources, and include photographic (PHOTO), infrared (IR), multispectral (MSI), and radar (RI) imagery. The military value of these imagery products is influenced by three primary factors: spatial resolution, spectral coverage, and timeliness.[*] Improvements in technology, loosening of self-imposed marketing restrictions, and growing competition among suppliers is fostering significant improvement in all three areas.[20]

Each of the various sensors has benefits and drawbacks. While photographic imagery is easy to interpret and generally has the highest resolution, it is limited by daylight and weather. Infrared has reduced resolution, but can view at night weather permitting. Radar is unconstrained by weather, provides the ability to penetrate some forms of concealment, has good resolution, but is more difficult to interpret. Multispectral imagery provides additional information not available in a single spectrum: soil analysis, vegetation analysis, moisture content, water depth, and camouflage penetration.[21]

Until Desert Storm, military utility was thought to reside in resolutions better than 10 meters, but the Defense Mapping Agency's extensive use of Landsat and SPOT imagery demonstrated the value of resolution as low as 30 meters.[22] The existing market already provides imagery products suitable for map production, digital terrain mapping, military

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[*] Lee, pp. 13-18. Spatial resolution refers to the size of an object on the ground a sensor can distinguish. Spectral coverage refers to frequency of energy the sensors can detect, i.e. infrared, ultraviolet, visible light, x-ray, and radar. Timeliness has four principle components, time required to task the sensor, geographical revisit time, processing time, and delivery time.

planning, and fixed target analysis. Table 1 shows that the capabilities of SPOT, the current commercial leader, will be rapidly surpassed by emerging private companies..[23] Commercially available multispectral imagery can be used to identify mobility corridors, lines of communication, helicopter landing zones, military facilities and equipment, topographic features, military deployments, areas suitable for escape and evasion, rear area organization, and attempts at cover and concealment.[24]

Table I Current and Anticipated High Resolution Imagery Capabilities.[25]

System	Sensor	Resolution	Country/Company	Revisit Time	Notes
SPOT	PHOTO/MSI	10M/20M	France	4 Days	Civil
Helios-1	PHOTO	1M	France/Italy/Spain	-	Military
KH/Lacrosse	PHOTO/RI	25CM/1.5M	USA	-	Military
Helios-2	PHOTO/IR	<1M	France/Germany/Spain/Italy	-	2001/Military
Horus	RI	TBD	France/Germany/Spain/Italy	-	2005/Military
OFEK-3	PHOTO	1.5M	Israel	3 Days	Military
IRS-1C	PHOTO/MSI	5.7M/23.5M	India	5/24 Days	Civil
Early Bird	PHOTO	3M	Earth Watch, Inc.	5 Days	1996
Quick Bird	PHOTO/MSI	1M/4M	Earth Watch, Inc.	5 Days	1997
SIS	PHOTO/MSI	1M/4M	International Consortium	2 Days	1997
Orb View	PHOTO	1M	US Consortium	3 Days	1996
Eyeglass	PHOTO	1M	Orbital Sciences Corp.	-	2000/Real Time
Landsat	MSI	30M	USA	16 Days	Civil/Military
KVR	PHOTO	2M	Russia	2 Days	Civil
CBERS	MSI	20M	Brazil/China	-	Civil
RADARSAT	RI	10M	Canada	-	1996/Civil
ERS-1	RI	20M	European Space Agency	-	Civil
JERS-1	RI	18M	Japan	7 Days	Civil
ALOS	PHOTO	2.5M	Japan	-	TBD

Mobile ground receivers and data relay satellites will increase coverage, reduce the time delays associated with processing and dissemination, and improve the operational and tactical value of commercial imagery. High resolution imagery on the market later this year will provide targeting-quality imagery to adversaries willing to accept lower P_d, higher CEP, and "it might be" as a target acquisition criteria.* Within the next five years, potential adversaries may be able to depend on commercial overhead sensors for carrying out advanced target analysis, obtaining battle damage assessment, conducting detailed study of enemy

* P_d--probability of destruction, CEP--circular area probable.

fortifications and force disposition, or observing the 82 Airborne at Ft. Bragg preparing for deployment. One meter imagery available on a two-day revisit time will nearly eliminate the potential for operational, if not tactical, surprise.[26] Consequently, the famous Schwartzkopf left hook may become a maneuver of the past.

Navigation. Available space-based systems, with proven applications across the spectrum of warfare, provide precise navigation and positioning for land, sea, air, and space forces. In the shifting deserts of Iraq, GPS kept U.S. forces oriented in a featureless and changing desert landscape.[27] GPS technology can enhance weapon performance by providing terminal guidance or midcourse guidance for terminal seeker acquisition. It is only a question of time until someone marries commercial GPS/DGPS receiver technology with an inaccurate cruise or ballistic missile to produce a weapon of at least limited military capability, if not a precision guided munition.[28] In addition to positioning, GPS provides timing signals accurate to the millionth of a second.[29] Precise positioning and timing aids in achieving unity of effort, mass, maneuver, and simultaneity and allows for increased operational tempo.[30] The introduction of regional positioning systems to augment GPS and GLONASS, may provide potential enemies with more resilient systems that are harder to negate.

Communications. The proliferation of commercial satellite communications will enhance command and control (C2) for those nations who are able to exploit the technology. In the next decade, currently available briefcase-size systems with annoying synchronization problems will be eclipsed by less expensive systems with the portability, clarity, and simplicity of cellular phones.[31] High speed ruggedized computers, satellite communications transceivers, facsimile machines, and encryption devices available on the open market can provide secure voice and data communications. The systems are simple and small, making them easy to transport, hard to locate, and even harder to target. They can help to achieve unity of command, coordination of effort, and effective movement of reinforcements. Meshing effective communications with precision navigation and timely imagery intelligence will simplify the task of directing the fight against U.S. forces.[32]

Weather. Weather constitutes a significant portion of the terrain "T" in METT-T.* Accurate weather forecasts can assist in determining one's own and the enemy's courses of action, and in exploiting the limitations weather places on enemy weapons systems. Cloud cover is an effective means of concealment from most forms of overhead observation, and cloud cover predictions coupled with a rudimentary knowledge of satellite ground tracks and periodicity, could double or triple the length of time exploitable for operational or tactical surprise. Integrated with a knowledge of flood planes, trafficability, and mobility corridors, weather data can help predict where maneuver may be enhanced or inhibited by inclement conditions. The interaction of weather, terrain, and weapons systems is an elemental facet of warfare.[33]

Operational Implications of Space Proliferation

A first step in countering the proliferation of space, is to cast aside the existing paradigm that space is a strategic realm, solely the responsibility of the U.S. Space Command.[34] While Space Command is, in fact, responsible for space control, its ability to exercise said control may be limited by capabilities, competing demands, or other

* U.S. Army Field Manual 100-5, "Operations," June 1993, pp. Index-6. METT-T (Mission, Enemy, Troops, Terrain and weather, and Time available) is fundamental to U.S. Army planning and execution.

constraints.[35] When these limits are reached, it is imperative that the Commander is aware of the operational implications, and that he understands and exercises his organic space control capabilities.

Space control operations ensure our own freedom of action in space while denying freedom of action to the enemy and include the negation of enemy space systems.[36] If the enemy has access to a space system, who actually owns the system may have little bearing on its use and its influence in the outcome of battle. If the enemy can exploit the military utility of a space system, than we must be able to counter either the system or the enemy's exploitation of it.[37]

Three mission areas make up space control: space surveillance, space protection, and space negation.* U.S. Space Command is responsible for space surveillance. In addition to identifying, tracking, and cataloging all objects in space, space surveillance includes providing the operational commander with the following information: friendly and hostile space orders of battle, predictions of timing and orbital paths of satellites, information on the capabilities of foreign space systems, and information on classified space control capabilities.[38] The operational commander is dependent on U.S. Space Command for its surveillance role in order to exploit his organic space control assets.[39]

The operational commander should take an active role in space protection. Although commercial systems do not pose a threat to our own space systems, commanders may have to

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* Michael J. Muolo, *Space Handbook, A War Fighter's Guide to Space*, Volume One, December 1993, pp. 95-97. Space surveillance--the ability to surveil and monitor continuously all significant activity in space. The surveillance mission is necessary to execute space protection and space negation. Space protection--the ability to protect friendly space systems (defensive counterspace). Space negation--the ability to negate hostile space systems (offensive counterspace).

conduct operations to protect U.S. space systems from ground based threats. These operations could include strikes against hostile facilities capable of launching counter space weapons, destruction of ground based directed energy ASAT systems, and destruction of hostile electronic warfare capabilities that impede our use of space-based systems.*

Negation, or offensive counterspace, is the space control mission in which the operational commander has his broadest latitude and greatest capability. Destruction, denial, and deception are the principal military methods to negate space systems.[40] Recent DOD strategy reflects an important shift toward a more politically realistic approach to space negation--extending space control beyond the realm of direct attack on celestial assets, to attacking ground stations, interfering with satellite uplink and downlink signals, and applying diplomatic influence to limit access to space-based systems.[41]

Successful space negation demands understanding the potential for our adversaries to exploit space technology, their level and means of access, and the nodes or choke points impacting this potential, and then applying this understanding to counter their use of commercial space technology in battle.[42] At the lower end of the spectrum of conflict, military, political, and economic factors may limit the commander's ability to counter commercial and dual-use space systems and will probably drive his space control operations toward denial and deception rather than destruction.[43]

The commander's ability to counter commercial space surveillance may be limited to accepting that military operations will be observed from space. Critical assets can be

* Ground launch counterspace weapons could include ballistic missiles armed with debris or nuclear warheads.

concealed by structures, natural cover, and camouflage. The staff must develop plans which capitalize on gaps in satellite coverage, by relying on light, highly mobile forces to seize the initiative and create an operational tempo so fast that it negates the value of surveillance.[44] In addition to planning offensive operations which accept the enemy's surveillance capability, the commander can employ measures that exploit those same capabilities to support the operational deception plan. By displaying an apparent vulnerability or strength he may be able to lure the enemy's attention away from a decisive point or critical aspect of operations. The commander may also overtly conduct pre-hostility deployments hoping that their observation might demonstrate capability and resolve adequate to defuse a situation.[45]

Satellite communications can be jammed, but the commander must balance the value of denial against the value of communications intercepts and locating data. While current geo-synchronous satellites and ground based transceivers may be susceptible to jamming, hard kill capabilities are doubtful against either commercial satellites or small mobile transceivers.[46] The commercial push for highly populated LEO satellite constellations will exacerbate the problem and may limit negation to jamming of hand-held communicators.[*]

The dual-use nature of navigation and positioning systems presents a unique problem. U.S. forces, weapons systems, satellites, merchant ship, and the Federal Aviation Administration, are dependent on GPS for navigation to some degree. Local denial by jamming and spoofing may be the only real options available to the commander.[47] Local disruption of satellite navigation signals around U.S. lodgments may be necessary to prevent

[*] Caceres, pp. 112. The largest of these proposed systems is the Teledesic Network. Founded by Bill Gates and Craig McCaw the system will have 800 mini-satellites in LEO orbit.

GPS or GLONASS from being used for guidance in cruise and ballistic missiles.[48] These technologies, and the ability to protect our own GPS receivers are still in their infancies. The United States should maintain the ability to degrade system accuracy until these countermeasures reach initial operational capability, even though political and safety ramifications may prevent increased degradation from being exercised. The commander must also consider his own reliance on commercial GPS receivers--in both Desert Storm and Haiti, imbedded civilian inaccuracy was eliminated because of U.S. forces heavy reliance on commercial receivers.[49]

Conclusion

The global proliferation of space technology has significant ramifications on national security: the spread of missile and space technology in the Third World is forging new geopolitical relationships, the growing number of advanced space technology suppliers is eroding our market share and our political leverage, and the uneven spread of this technology may produce regional instabilities and draw us into conflict.[50] Acquisition of this technology by nations hostile to the United States will have an adverse impact on U.S. military operations in future conflicts.

Mere access to commercial space technology does not translate directly into military capability. Many nations, overwhelmed by the complexity of the systems they invest in, may not gain significant additional benefit, but a striking asymmetry is apparent when we witness live via satellite, a Chiapas Revolutionary dispatching a communiqué to his comrades via pack mule. The only safe assumption is that these nations will attempt to incorporate the available capabilities to the maximum extent possible.

The operational commander can no longer rely solely on U.S. Space Command to fight the space war. The commercialization of space almost ensures that our next adversary will have access to space-based surveillance, satellite communications, precision satellite positioning information, and near real time environmental data, and that space control will be a more complex issue than it was the early post-Cold War environment. Although the operational commander may find himself constrained by the inability to eliminate access to commercial space technologies, if he fails to address these potential capabilities or his ability to counter them in his operational design, the results will be devastating.

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