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TODAY, OF THE OVER 2,400 satellites in Earth orbit, only about one hundred are operated by nongovernmental organizations or private companies.[1] That situation is changing: in the next ten years as many as a thousand more commercial communication satellites will be placed into orbit.[2] These systems will provide on-demand, worldwide telecommunications. Commercial imagery satellites are being planned and launched that provide resolutions equivalent to those of state-operated imagery satellites.[3] Restrictions on the Global Positioning System's most accurate locating information are to be removed within ten years.[4] In short, commercially available satellite products, with capabilities rivaling those of U.S. military systems, are becoming widely available to anyone who can pay for them.

As these systems mature, the U.S. military must consider how to deal with their effect. For example, commercially available satellite imagery is used in some situations by the U.S. Air Force to support tactical mission planning and battle damage assessment.[5] In fact, the United States pledged itself in its 1996 space policy statement to use commercial satellite technology to augment its own capabilities as much as possible.[6] If the U.S. military can use commercial systems to augment its capabilities, so can an adversary with access to similar systems.

The purpose of this article is to provide an overview of commercial space endeavors having military applications, address current international law regarding the military use of commercial satellite systems, and offer some options

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and general considerations regarding how the military could approach commercial space-based systems.

The Commercial Potential

Commercial satellite imagery, communication, and navigation services will have an impact on the ability of the United States to conduct military operations over the next twenty years. In order to prepare for this impact, the nation needs to consider the strategic and operational potential such systems offer an adversary, as well as how—in broad terms—the United States could resist or counter hostile exploitation of commercial space capabilities. Then, the specific measures, techniques, and tactics that would be optimal to negate a commercial system in a deteriorating international environment could be devised and implemented. But first we must be clear about "the big picture."[7]

Imagery. Satellites can collect useful images of the Earth's surface through many means, active and passive, and in much of the electromagnetic spectrum, from shorter-than-ultraviolet wavelengths through thermal infrared and reflected radar waves. Many features may be considered in characterizing the usefulness of a satellite imaging system (inclination, revisit time, spectral sensitivity, and imaging capacity, for instance), but resolution is one of the most commonly invoked. Discussions of resolution can quickly become highly complex; for present purposes, however, it can be understood as the minimum separation between two similar objects needed for an imaging system to distinguish the objects as two rather than one. Presidential Directive 23 (PDD 23), issued in 1994, states that dissemination of imagery with resolution of one meter or less might be harmful to U.S. national security.[8]

In the past, the principal consumer of high-resolution imagery has been the military. While most of that imagery has been provided by national satellite assets, commercial imagery systems are now also being used. Much has been written about the U.S. military's use of commercial imagery during the Persian Gulf War.[9] Commercial systems have also provided detailed computer maps for flight crew training for Sarajevo, Bosnia-Herzegovina.[10] Even corps-level headquarters now have the ability to produce maps locally using satellite imagery.[11]

Commercial satellite imagery providers are intent on providing the highest-resolution images that money and technology allow.[12] They are rapidly driving their systems to one-meter resolution, but the reason they need such fine resolution is unclear. A case in point is the SPOT Earth Observation System, designed by the Centre National d'Etudes Spatiales (CNES), which already advertises ten-meter resolution—though its capability has been described as "actually closer to five meters than to the declared ten."[13] CNES lists a multitude of purposes for which one might want high-resolution images, including studies of deforestation, erosion, desertification, urban zones, and the planning of telecommunication systems.[14] When the Clinton administration announced in 1994 the easing of restrictions on the sale and export of commercial remote-sensing images, it presented a similar list of potential uses for high-resolution imagery.[15] Neither the French CNES nor the U.S. administration, however, discussed why one-meter resolution might be needed instead of the fifty-meter resolution that such systems as Landsat routinely provide. Do large-scale observations of areas for environmental study need to define individual trees to be useful? Urban planning might benefit from detailed photos, but it would be far more cost-effective to use conventional aerial methods to obtain them. Given the expense involved, there are only two reasons one might insist on high-resolution satellite photos: first, that one does not have access to the target area, and second, that one wants to obtain information without the knowledge of the area's owners. Otherwise, if traditional land-survey means are available, space-based high-resolution imagery does not make sense.

Nonetheless, as technology improves, the number of high-resolution imagery systems available increases. The resolution of systems being designed or tested today ranges between one and ten meters. The Russian KVR-1000 can provide less than five-meter resolution, while the Israeli EROS (previously a military system, now commercial) boasts a one-meter resolution in some applications.[16] Others planned for launch in the next few years will be operated by French, U.S., and Japanese companies.

With more systems becoming available that meet the U.S. definition of high-resolution, governments have begun to place controls on remote sensing. PDD 23 declares that the United States reserves the right to limit the collection and distribution of high-resolution imagery that might damage national security.[17] The directive applies to systems licensed for operation in the United States. France has taken a slightly stronger position, limiting the sale of high-resolution imagery from the French owned Helios-1 satellite to friendly governments and stipulating that the French government has the option of shutting down the system in case of a national emergency.[18] Not all nations have similar policies; for example, Israel is reportedly prepared to consider launching additional EROS-1 satellites and providing customers 100 percent control within a geographic region.[19]

Communications. Commercial communication satellite systems are the most successful space industry. The potential market is huge; investors and developers hope to open up China for mobile satellite telephone systems.[20] The U.S. military already uses leased "space" on commercial communication satellites to augment its own resources. For instance, the Leasat program leases bandwidth on a commercial system to handle low-priority communications.[21] Many U.S.

Navy warships are equipped with the Inmarsat commercial communication system, allowing voice communications nearly anywhere on the globe.[22]

The U.S. military is becoming increasingly dependent on commercial satellite communications to support operations and mission planning. For example, during the Gulf War, 20 percent of the total satellite communication capacity was obtained from commercial satellite providers.[23] More recently, commercial providers have set up secure, two-way voice and video communications in Bosnia. This experiment, called "Information Dominance for JOINT ENDEAVOR," uses a commercial broadcast satellite to provide weather, television, and imagery to field commanders. It also provides high-bandwidth, secure communications to set up an intranet (local Internet) for exchange of e-mail and video between headquarters and field commands.[24] The innovative use of commercial communication satellites has fueled the military's appetite for them. One observer noted that during the Gulf War the military was so dependent upon communication satellites that "every time a new bird [satellite] came on line, it was used up. It was an experience familiar to drivers in Los Angeles, where new highways never seem to relieve traffic congestion."[25]

The cost of deploying satellite communication systems has resulted in some interesting approaches to raising capital. At one time states pooled resources. The Inmarsat system, while commercial in nature, was initiated in 1979 by an international convention that established satellite communication operating procedures for mariners in distress. The Inmarsat Corporation is run by a council on which are representatives from the eighteen signatories having the largest investment stakes in the operation.[26]

A more recent approach is that of the Iridium communications system. Iridium is operated by a consortium of companies, including Motorola Corporation. The satellites are being launched by U.S. Delta II, Russian Proton, and Chinese Long March 2C/SD boosters.[27] Russia is also interested in a piece of the market for itself; in an attempt to attract U.S. investors, Russia is developing the Signal satellite communication system.[28]

These initiatives in worldwide satellite communication systems are being aided by relaxed national regulations. The Federal Communications Commission announced in 1997 that the United States would allow non-U.S.-licensed communication satellites to provide services in the United States, in accordance with the World Trade Organization's Agreement on Basic Telecommunications Services.[29] In order to gain access to growing markets in the United States, foreign governments are willing to allow U.S. companies to operate overseas, in exchange for reciprocity in the United States. This easing of regulations will most likely result in expanded capacity throughout the world as markets open to competition.

Navigation. The U.S. Global Positioning System (GPS) and the Russian Global Navigation System (GLONASS) have brought new meaning to the idea of knowing one's location. GPS became "indispensable" during the Persian Gulf War, allowing the U.S. Air Force to target Iraqi facilities with high accuracy.[30] The U.S. military has made "precision engagement," using GPS, one of its guiding operational concepts.[31] GPS has also increasingly become indispensable to the commercial market. Receivers are inexpensive; users range from shipping companies to airlines.[32]

One complaint about GPS has been that unofficial users cannot receive the extremely accurate locating data available to the U.S. military. Its "Selective Availability" feature introduces an error signal to prevent them from receiving the full benefit of the system; with the error signals, commercial users receive locating data with hundred-meter accuracy instead of the sixteen-meter (or better) performance of which GPS is capable.[33]

Law and Policy

Treaty law has little to say about space. The so-called "Outer Space Treaty" of 1967 provides that weapons of mass destruction may not be placed in orbit around the Earth or on celestial bodies.[34] The agreement does not ban the military use of space. In 1979, the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies attempted to expand limitations by declaring that space was to be used for "exclusively peaceful purposes."[35] This document was approved by acclamation in the UN General Assembly, but the only major space-faring nation to sign it has been France.[36]

The other significant instrument of space law is the Convention on Registration of Objects Launched into Outer Space, which came into force in 1976.[37] This short document established a registry and requires states that launch objects into Earth orbit or beyond to provide basic information to it through the UN Secretary-General. To date, there are twenty-five signatories and forty parties to the convention, including the United States, the European Space Agency, and the European Organization for the Exploration of Meteorological Satellites.[38]

Overflight by satellite systems, particularly imagery systems, has an interesting histoty in international law. As attempts to control the use and spread of nuclear weapons grew in the 1960s and 1970s, overflight by imagery satellites was considered necessary to verify treaties. The term "national technical means" and pledges not to interfere with them were included in such arms control agreements as the Anti-Ballistic Missile Treaty.

Commercial access to satellite images, however, was more complicated. During the Cold War, the Western nations argued that free access to and distribution of images from remote-sensing satellites should be allowed for all countries. The Soviet Union argued that this should be allowed only with the consent of the overflown country. By the mid 1980s, consensus had been reached that collection and distribution of remote imagery should not be restricted but that "sensed" nations should be guaranteed access.[39]

With improvements in the resolution of commercially available imagery, the line between remote sensing for economic and resource-management purposes and high-resolution imagery for military ends has blurred. It is unclear where the law is tending on the topic. As mentioned, some states are attempting to legislate controls on companies involved in imagery, but there is no unanimity.

Another legal problem is that there is no agreement on the definition of "space," at least with respect to where it begins. None of the treaties mentioned above defines it; space appears to be one of those concepts that everyone knows when they see it but none can characterize precisely. Not even the U.S. military can define space: the Department of Defense Joint Dictionary does not even attempt to do so.[40]

One treaty has tried to be specific in other ways, namely how space is to be used. The Inmarsat Treaty, which establishes the international corporation operating the Inmarsat system, provides that its governing organization is to act "exclusively for peaceful purposes."[41] The Inmarsat satellite system started service in 1982; over the years, it has become a prototype for worldwide telecommunications systems. It has been conspicuous in military operations, such as the Falklands War, though some believed that the Inmarsat convention was violated during those operations.[42] The Inmarsat governing organization commented on the matter in 1988:

> Looking at the ordinary meaning of the words "exclusively for peaceful purposes," . . . [Inmarsat] took the view that "peaceful purposes" are those which do not relate to armed conflict, acknowledging that "military uses" *per se* are not incompatible with peaceful purposes, but excluding uses in armed conflict or for self-defense pursuant to the UN Charter, Article 51, even though such uses may be deemed "non-aggressive."[43]

Despite this interpretation, Inmarsat's governing body did not attempt to deny military access to the system during the Persian Gulf War or during UN operations in Somalia and the former Yugoslavia. As a result, a former general counsel for Inmarsat has concluded that

> use of Inmarsat by armed forces (military use) not involved in armed conflict or any threat to or breach of the peace is consistent with [the Inmarsat] Convention, Article 3(3). Use of Inmarsat by UN peacekeeping or peacemaking forces acting under the auspices of the UN in implementation of a UN Security Council decision in order to maintain or restore international peace and security may be construed as consistent with Convention, Article 3(3), irrespective of such UN forces becoming involved in armed conflict in the accomplishment of their UN

mission. Involvement in armed conflict is a possibility implicit in the maintenance or restoration of international peace and security by UN forces.[44]

Although this interpretation applies specifically to the Inmarsat system, it is possible that this logic will be applied to future concerns over military use of commercial satellite systems, and to the Outer Space Treaty.

As regards policy, the United States has been cautious. PDD 23, which placed limits on dissemination of high-resolution imagery from commercial sources, was eventually incorporated into law, in the 1992 Landsat Act. In 1997 the United States promulgated a national space policy; although parts are classified, it provides for "separate national security and civil space systems *where differing needs dictate*."[45] The Department of Defense was appointed the lead agency to coordinate government space activities and to coordinate with commercial providers. The Defense Department was also tasked to ensure that a hostile force cannot frustrate U.S. use of space and that the United States can counter space systems used for hostile purposes.[46]

Space is still a generally unregulated area. Little agreement has been reached on just what space is, how it can and cannot be used, and who will enforce whatever law exists. Real regulation of space use is just now emerging at the national level. As long as the future is to be driven by the technology of commercial satellites, conflicts over access rights, overflights, and military uses are sure to continue.

Approaches

There are essentially three ways, from the military point of view, to deal with commercial satellites. They have been articulated in the debate over commercial imagery satellites, but the options apply to communication and navigation systems as well: "to promote the free flow of information; to attempt to negotiate agreed restraints; or to take direct countermeasures against satellites or their data-gathering."[47] Along with these three approaches are a number of other factors and considerations.

The Free Flow, or Free Market, Approach: The free market approach—to let sellers and buyers determine capabilities and access—is the option that the commercial satellite communications and navigation industries have taken. As noted earlier, the Federal Communications Commission recently opened U.S. mobile satellite communications to foreign competitors, provided they abide by World Trade Organization standards. The hope is that American firms will be able to gain greater market share overseas.

This general approach certainly results in a proliferation of systems available to the consumer and the military, which should thus be able to continue contracting for the communication capacity it needs. However, while the allure of additional bandwidth is considerable, there is no guarantee that the U.S. military will be able to use a system as it desires. For example, Iridium does not have the ability to provide priority service;[48] in other words, it operates on a first-come, first-serve basis. If the U.S. military were to rely on such a system during a crisis, it might find itself competing with CNN or even its adversary for use of the limited number of access channels. Market forces will probably drive providers to ensure all subscribers to a system have an equal chance at access. Giving priority service to any one subscriber, even if that user can pay for the luxury, would drive other customers away. Businesses would be reluctant to pay for a service that could be withdrawn at any moment in favor of a military client.

On the other hand, free access to the GPS system is now a given; if one has the appropriate receiver, one can obtain the locating data. In 1996 the Clinton administration announced its intention to discontinue Selective Availability by 2006.[49] This would allow anyone to obtain the very accurate locating information presently provided only to the military and certain other authorized users.

Of course, the free market encompasses a classic mechanism for restricting access to goods: that is, price. The U.S. government pays for the Global Positioning System and, having provided the data without charge up to now, enjoys a total command of the market; as a monopolist it could charge for the service and set rates high, or limit access to exclude rogue nations and nonstate actors. This is only a theoretical option, however; it is hard to imagine the United States cutting off free GPS operation. In any case, how could the United States assess charges, especially for ships, airliners, and even personal automobiles that have receivers (themselves inexpensive) already installed? It may be too late; the Western world is already addicted to Global Positioning, and the United States may have no choice but to keep it a no-charge proposition.

Free market imagery is a much more complex subject. While nations such as the United States and France agree that controls are needed on high-resolution images, the problem has been complicated by private high-resolution imagery satellites. For example, the SPOT imagery system was developed with not only French but also Swedish and Belgian capital.[50] Who owns it? Similarly, the stocks of the multinational corporations developing Iridium, for example, are widely traded, and the system's satellites have been launched from three different countries. The market has led satellite system entrepreneurs, such as Iridium, to seek any available launch facility in order to speed up deployment. The overall situation is analogous to the merchant marine: often ships are registered in one country, owned by a multinational corporation, crewed by nationals of several various countries, and operated in regions not under the jurisdiction of any one nation—that is, in international waters.

Space law has not caught up with the legal issues. For instance, exactly what "registry" of a satellite means—beyond who reports the launch to the UN registry—has not been defined. While parallels to ship registry have been suggested, the idea of "flag nations" has not been established for satellites. If it were, a country could approach the nation of registration to discuss possible restrictions on commercial services to a hostile power. Unfortunately, today's free market approach does not provide this avenue for such a request.

Ironically, the commercial satellite market itself might be used to control access. If an adversary were known to be using a commercial system to its advantage, one could attempt to deny access to the system by making the operator a better offer. For example, if the United States wanted to prevent a particular type of imagery from reaching an adversary, it could offer substantially more money for the exclusive access to that imagery during a crisis. Likewise, a satellite communication system that an adversary was using could (if the operator allowed) be "bought out" by the U.S. government, precluding hostile use through saturation.

One drawback to this approach is obvious: if there is a profit to be made, the market will react. If the United States were to buy up all the satellite imagery or use all the satellite communication capacity of a system, other providers certainly would enter the market. This type of market proliferation will become more likely as more commercial systems are fielded.

Another drawback to the free market approach to inhibiting or precluding an adversary's use of commercial satellite capabilities is that it requires very deep pockets. If a crisis were to continue for a great length of time, the free market exclusive-access option would become very expensive indeed. Finally, commercial providers might see an opportunity to increase profits by offering similar exclusive use to an adversary who has the ability to pay for it—inciting a "bidding war" to accompany a "shooting war."

Negotiate Restraints. If the free market seems too open, perhaps restraints could be implemented. Negotiated restraints would be desirable from the military point of view, provided the negotiated measures do not themselves jeopardize national security. Having some means of controlling access to satellite products, whether imagery or data, could keep them from an adversary during a crisis. The obvious problem is that the satellite "genie" is already out of the bottle. The United States has long held that no nation has the right to require prior consent for satellite overflight.[51]

If a country wanted to place restrictions on satellite imagery, one way would be to require that commercial satellite operators obtain permission (and presumably pay a fee) to fly their satellites over it. That nation would have to possess means to enforce overflight restrictions. Preventing a satellite from passing over, however, is no trivial matter. A more modest approach would be to place restrictions on the products that commercial satellite systems provide. But how? Tariffs on communication systems and GPS receivers might control satellite system access within a country, but nowhere else. Control of distribution and access to systems beyond one's own border would be extremely difficult if not impossible.

There is simply no impetus that brings commercial satellite system operators to the negotiating table; governments have neither a carrot nor a stick. If an oligopoly of commercial operators emerged in the satellite service market, nations might have a reason to restrict their operations; it is far more likely, however, that in such a case steps would be taken to keep open the market, with few restrictions, to prevent the price of services from rising.

Direct Action. Another option to control access to commercial satellite products would be to take direct action against the systems themselves, perhaps with antisatellite (ASAT) weapons, by jamming or spoofing signals from satellites, or by disrupting ground stations. Each method has consequences that need to be considered fully.

As far as any nation will admit, none has a deployed ASAT capability, though several have tested them. While the U.S. space shuttle could "grab" a low-Earth-orbit, low-inclination satellite out of orbit, it is hard to believe that, short of total war, the shuttle would be used that way.[52] As for shooting down a satellite, the problem is retaliation. If the United States declared it had an ASAT system and would use it, arms dealers would probably soon be dusting off their Cold War test platforms to provide a retaliatory option for potential victims.

Even if an active ASAT system exists, satellite systems typically involve whole constellations of units in orbit; shooting down enough satellites to cripple a system becomes difficult. If one were to shoot down all the low-Earth-orbit imagery satellites a company was using to survey one's territory, the resulting debris might interfere with or damage other satellites in similar orbits. An entire orbital plane could be temporarily made useless not only to potentially hostile systems but also to friendly ones. ASAT weapons using lasers or kinetic devices could eliminate a satellite without producing much debris, but they have yet to be fielded.

Another kind of direct action, one that was considered during the Cold War, is the idea of space "choke points." The concept takes advantage of the fact that a satellite being launched from the Earth must pass over a point on the opposite side of the planet from the launch facility on the way into orbit.[53] A ship in the South Pacific Ocean equipped with an ASAT system, for example, could have blockaded all Soviet launch facilities.[54] Today, however, the idea of space choke points has become less useful. As the number of commercial launch facilities grows, the number of locations needed to control them in this way grows. Russia, in a joint business venture with Boeing, Hughes, and Loral corporations, has even developed a floating launch site.[55] This mobile launch facility, called Sea Launch Mir, is designed to exploit the technical advantages of equatorial launches (allowing heavier payload lift) and make Russia able to launch commercial payloads with relatively small, inexpensive boosters. If the United States decides to pursue a seaborne ASAT capability as a direct-action option, it would have to deal with the possibility of these mobile sites, and thus moving choke points.

Jamming (the blocking of a transmitted signal by overpowering it with noise) and spoofing (the deliberate alteration or replacement of a signal with a false one) could be more readily available means of direct attack, but each has limitations. Ground station signals to satellites can be jammed, and the jamming might even be made to seem innocent interference. Preventing satellite signals from reaching ground stations or receivers is feasible, but effectiveness depends on the type of signal involved. For example, a GPS receiver obtains simultaneous signals from several satellites at once; jamming the signal from only one satellite would be insufficient—at best, one would lessen the accuracy of a fix. Jamming would have to be applied against all satellites in a GPS constellation "visible" to a receiver on or above the Earth—generally seven.[56] The advantage seems minimal when one considers that jamming GPS in an area denies the system not only to the adversary but also to friendly forces.

A more subtle possibility is to spoof the telemetry, tracking, and control (TT&C) signals from a ground station. These signals tell satellites when to turn on and off, when to conduct maintenance routines, and how to position themselves. A commercial satellite system could be rendered inoperative by simply manipulating the TT&C signal so as to instruct all satellites in a system to disable themselves.[57] Spoofing a satellite signal, however, can also be a low-payoff proposition, as shown once again by GPS, which is a special case in this respect. Commercial GPS is already, in effect, spoofed—that is, by Selective Availability, which deliberately produces a less accurate signal—but countermeasures are already available. A commercial system known as Differential GPS determines the induced error by reference to a known position on the Earth and transmits a correction to subscribers.[58] It is not likely that even a technologically unsophisticated adversary, already dependent on satellite positioning, would long be susceptible to the spoofing of a GPS signal.

Commercial imagery and communication signals are more likely to be susceptible to jamming and spoofing, but not wholly. Such systems are not designed to be resistant to jamming, but they must be flexible enough to avoid natural interference. While not "frequency agile" in the military sense, they are able to shift frequencies and store information if other signals are causing problems. Also, commercial communication satellite systems have to know who is calling in order to know whom to bill, and to be able to distinguish a paying user's signal from a false one; to that extent they are spoof resistant. Of course, however, localized jamming of communications and imagery downloads might be possible if one knows where to jam.

Imagery is susceptible to weather. Most imagery satellites use optical sensors that require fairly clear air to obtain usable images. Weather interference can be overcome by radar imaging, but such an alternative is costly and not always suitable.[59] Since launching and maintaining a commercial imagery system is still very expensive, the emphasis has been on systems that can provide a low-cost product. Accordingly, simple deception can lower the utility of commercial imagery. It can be made useless by effective camouflage, or smoke, or by moving activities underground; these traditional options are available to anyone wanting to avoid the gaze of a commercial or national imagery satellite. Additionally, an adversary using commercial imagery satellites to observe military activity needs the technical ability to interpret and evaluate the images received. Without that ability, all the images in the world are of no benefit.

Disruption of ground stations could be the most effective means of direct action against commercial satellite systems. The most straightforward way to disrupt ground stations is simply to destroy them. All satellite systems require some degree of control from the ground. Satellite positions must be determined, systems must be monitored, and maintenance routines must be conducted. Commercial systems generally use base stations to transfer data between the satellite and the customer; for example, communication satellite firms need a tie-in to local telephone systems. If these stations are destroyed, a system becomes useless—how quickly depends upon system design. A less ambitious method of disrupting ground stations, however, might be simply to cut power to the station.

Destroying ground stations controlling commercial satellites has obvious drawbacks. For instance, many newer systems use a single, centralized, and easily identifiable control station, and that station may be in the territory of a third, neutral party. A crisis could rapidly widen if one side decides to strike a third nation's territory to stop an adversary's access to a satellite system.

Other Factors and Considerations

Decision makers can, of course, simply ignore the impact of commercial satellite systems—at the risk of offering adversaries a way to counter directly the U.S. aim of "information dominance," that is, "knowing everything about an adversary while keeping the adversary from knowing much about oneself."[60] Ignoring the possibility that an adversary may be using the widespread capabilities of commercial satellite imagery, locating data, and communications would be reckless.

If ignoring the threats arising from an adversary's use of commercial satellite systems would be foolish, overestimating those threats might be equally so. Military thinkers tend to "build" an enemy that has a perfect ability to exploit all the advantages that might be available to it. This mindset is useful when imagining all the courses of action possible for an enemy, but rarely if ever can an enemy actually do each and every conceivable action. Thus, with regard to commercial satellite systems, although they can certainly provide substantial capabilities, an adversary must be able to exploit them. First of all, and obviously, an adversary must be able to afford the information available on the market. Specific imagery is expensive, and commercial mobile satellite communications are not free.

Next, if access can be obtained, an adversary must be able to interpret the product. Separating important military information from a mass of high-resolution imagery is highly arcane work. Long-range wireless communications, for their part, imply a suitable command and control system. Finally, precise locating data is of no use if one cannot get the information to a weapon that is able to strike the desired target before it moves outside the weapon's acquisition or kill radius.

Not all commercial systems are well suited to military applications. High-resolution imagery is not put on the market in real time. Some systems take weeks to overfly a desired target area, and then the weather might not be clear. A crisis may tax satellite communication capacity, as media, nongovernmental organizations, and others focus on an area. As has been pointed out with respect to the United States, an adversary reliant on satellites for command and control of military forces but without reliable access is likely to suffer. It may even be to the U.S. military's *advantage* for its adversary to have access to commercial satellite systems. One element of "Joint Vision 2010" is to convince an adversary that continued military action is futile.[61] Without reliable commercial satellite products the adversary may be denied the data necessary to reach that conclusion.

Nonetheless, even crude applications of commercial satellite technology may produce disproportionate, asymmetric advantages. Nation-states are not the only groups that can gain access to satellite systems. Terrorists can use satellite-based cellular phones to coordinate activities, and they can use even "time late" images to plan attacks. Inexpensive GPS receivers can be used to navigate through such areas as desert terrain to make an attack.

* * *

Commercial satellite systems have affected and will continue to affect U.S. military planning. These systems must be considered in order to exploit their capabilities and guard against their pitfalls. Their capability is growing at a rapid pace, and access is open to anyone who can pay for it. International law is lagging far behind their market-driven technological leaps. Issues of ownership, military use, and regulation are unresolved. In some cases, nations are backing away from regulation and controls on commercial satellite systems in order to expand quickly market share and access.

The U.S. military must take a serious look at the products provided by commercial satellite systems. Many of these products, from imagery to communications, are excellent and cost-effective tools a military—one's own or a potential adversary's—can use. Consequently, U.S. military planners must evaluate commercial satellite systems not only in terms of their capabilities for U.S. and allied forces, but also in terms of their value to an adversary. Once it is determined that an opponent has not only access to but also the ability to exploit a satellite product, the possibility of denying access arises. Any direct-action options against commercial satellite systems should be weighed against the practical ability of an enemy to use the product, what can be gained from it, and one's own reliance on it. Commercial satellite systems are quickly becoming indispensable to the U.S. military, and they are almost certainly growing more useful to potential enemy military, paramilitary, terrorist, and other unconventional forces.

This raises a final point that must be considered: the risks one's own dependence on commercial satellite systems presents. The U.S. military has pledged itself to use commercial satellite technology to augment its own resources capabilities as much as possible.[62] Can that reliance provide an advantage to an adversary? Has the U.S. military's reliance on theater Internet, broadcast intelligence, operational planning via video teleconference, and GPS fixes made it susceptible to direct counteraction? The U.S. military must be cautious about becoming dependent upon these capabilities. True, commercial satellite systems provide responsive imagery, worldwide communications, and the ability to exercise "precision engagement." U.S. commanders must anticipate that these systems will be denied to them in a crisis and begin now to develop effective responses at the strategic, operational, and tactical levels of war.

Planners must be specifically aware of and look for the Achilles' heel in their use of commercial satellite systems. They must not allow a single attack on a key ground station, satellite system, or communications link to cripple flexibility. They must be prepared, conceptually and procedurally, to function despite a skilled foe's purposeful degradation of friendly uses of commercial satellite capabilities.

As other militaries see the advantages these systems provide, more users are sure to follow. As the demand expands, capabilities are likely to expand. In the near future two camps will emerge: one that uses commercial satellite systems to augment their militaries, and one that works on ways to deny that advantage to adversaries. These camps may coexist, or they may diverge. The prudent planner will properly consider both arenas to make sure that commercial satellite systems are assets rather than threats.

Notes

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