Chapter 17:
Security and Spacepower

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Spacepower provides different ways to manage security concerns. Because of its matchless ability to gain global access and achieve global presence while delivering nearly ubiquitous capabilities, spacepower is playing an increasing security role in war and peace around the globe on a perpetual basis. This chapter examines the opportunities spacepower provides to secure the peace and to fight wars.

Spacepower and War Prevention

Spacepower is ideally suited for war prevention—securing the peace—as a matter of day-to-day statecraft. To put this in clearer terms, "the primary value of spacepower is *not* support to warfighters, rather it is that space capabilities are the *primary* means of war prevention."[1] Spacepower can provide both indirect and direct methods to achieve war prevention. Indirect methods involve cooperative interstate behavior to reduce security concerns without the use or threat of force. Direct methods involve the use of force or threats of force. For now, spacepower lends itself more toward indirect methods such as providing global and cislunar transparency and expanding broad international partnerships. Direct methods are more hard-power–centric and include those capabilities that deliver assurance, dissuasive, and deterrent effects, matched with careful diplomacy, in a cost/benefit calculus. As space weapons proliferate, spacepower will offer effective direct methods of preventing war. Each indirect and direct method is discussed below.

Indirect Methods

Transparency. Space-based reconnaissance and surveillance platforms, because of their global nature, contribute directly to reducing security concerns by providing insight into observable human activities around the globe and in the cislunar region. Insight into human activity in space, manned or unmanned, is every bit as important as observations of terrestrial activities. When considered together, such insights can alleviate unfounded fears and prevent miscalculations, as well as deliver warnings and indications of activities of genuine concern. This was obvious right from the start of the space age during the Cold War when the first successful American reconnaissance satellite, called Corona XIV, returned more imagery of Soviet nuclear forces from deep inside the Soviet Union than did all of the prior U–2 missions combined.[2] This new satellite-derived information caused a sharp downward revision in the estimate of Soviet intercontinental ballistic missile launchers from 140–200 to between 10 and 25.[3] Later, only six of the sites were determined to be operational.[4] This application of spacepower helped reduce the American security concern and allowed the Eisenhower and subsequent administrations to right-size their nuclear deterrent force against a much smaller threat than suggested by

estimates formulated without satellite data. Space was no longer merely a science project, but a real instrument of policy. True spacepower had arrived.

As the example above illustrates, spacepower provides transparency that reduces the *fog* during *peacetime*, increases the certainty of information, and allows contemplation of matters with a better approximation of the facts.[5] While this is entirely beneficial to the actor who possesses such information, the value of transparency has its limits. Some states feel increased security concerns if satellite-derived information about their observable affairs is distributed widely. China voiced this complaint shortly after the release of Google Earth, but accommodations were made to degrade the quality of images of areas sensitive to the Chinese government.[6] Such concerns must be addressed and dealt with directly, but accommodations can be made. Many states undoubtedly will change their conduct of military and other affairs to ways that are not observable by satellites. India, for example, avoided detection of its efforts to develop and test a nuclear device in 1998 by conducting activities when U.S. imagery satellites were not passing overhead and during times when sandstorms and intense heat could disrupt surveillance sensors.[7] Such nefarious workarounds can be eliminated by fielding a large constellation of several dozen reconnaissance and surveillance satellites owned and operated by suprastate or trans-state actors using multispectral technology. The point is that every inch of the Earth could be imaged several times a day using various techniques that can counter various many concealment efforts. Global transparency efforts are large and expensive and by their very nature will require a high degree of international partnering.

Partnering. Another opportunity that spacepower provides for managing security concerns is capitalizing on collaborative international security space arrangements to provide global transparency, space situational awareness, and space traffic management, to name just a few. Such partnerships need not be limited to security-related functions, but must cross into civil and commercial endeavors as well, such as space-based solar power, human missions to the Moon and Mars, space stations, space-based astronomy, and so forth. The goal is not only to accomplish something meaningful in space, but also to build mutual understanding and rapport among the participating states.

The American and Soviet joint venture on the Apollo-Soyuz mission in the mid-1970s is one such example. Although the tangible scientific benefits of the exercise are debatable, it demonstrated to both parties and to the international community that cooperation on a very challenging task is possible, even between the two Cold War antagonists with their widely divergent strategic cultures. This civil spacepower effort became a point of departure for other confidence-building gestures between the two and certainly eased tensions in the homelands and among the rest of the world as well, thereby reducing security concerns.

Partnering on spacefaring projects brings together more brilliant minds and resources to solve problems and to advance the art. It not only heightens the likelihood of success of those programs, but over time it also reduces the *friction* during *peacetime* between states, decreases the potential for cultural misunderstandings, increases the opportunities

for alliance, integrates aspects of each state's economic and industrial base, and fosters working relationships between governments.[8]

Partnering is not always easy, as the members of the International Space Station or the mostly European states belonging to the Galileo Consortium will attest. In fact, it can be frustrating and even maddening. Disparate economic strengths, distribution of resources, and talent give each state a different value as a potential partner. States that are rich in some areas will be highly sought after as partners. Poorer states will not. However, from a partnership perspective, all are valuable as prospective partners as part of a collaborative international security arrangement.

The opportunities that spacepower offers spacefaring and non-spacefaring states alike in the forms of global transparency and international partnering in order to prevent wars are entirely different from opportunities provided by operations in any other media. The strategic cultures of most states—especially weaker or developing ones that are not yet spacefaring—will find the indirect methods highly attractive and engender soft power to the leaders of such efforts.[9] These approaches may be sufficient for most states' space-related security needs while reducing their security concerns inside the terrestrial confines.

Direct Methods

Many states will not feel comfortable having their security rest on such idealistic constructs as the indirect methods alone. Some states, especially those with more militaristic strategic cultures, will likely seek space weaponry (overtly or covertly) in the form of defensive systems to protect their space assets from attack and offensive systems to prevent foes from exploiting space to gain a military advantage.

The focus here is on hard power and space weapons—weapons that create their effects in space against the space segment, regardless of where the weapons themselves are based. We will not be looking at spacepower's longstanding support to terrestrial forces that are continuously engaged in dissuasion and deterrence strategies. This is particularly the case with nuclear forces but is increasingly so with conventional forces as well.

Many factors contribute to space-related security concerns faced by states and directly correlate to their likely drive for space weaponry. Each state will perform its own threat-risk calculus and respond accordingly. There are some elements of the threat-risk calculus that must be kept in mind. For example, more advanced spacefaring states have the most at risk in space and therefore have greater incentives to field defensive weaponry. Less advanced states may build offensive weapons as an asymmetric means of countering the power of a space-reliant potential adversary. The proliferation of space weapons will drive the need for greater space defenses. The lack of sufficient space situational awareness for threat and damage assessment and attribution increases the sense of risk by all. Finally, every state, whether it is directly spacefaring or not, is a user of space services, and therefore all states are space actors and must consider their space threat-risk calculus.

Acquiring weapons is not a sufficient precursor to war, as the peaceful conclusion of the Cold War illustrates. In fact, the possession of hard power capabilities managed in a responsible and constrained manner enables the war preventive strategies of *assurance*, *dissuasion,* and *deterrence*, as were used to avert hostilities during the Cold War and beyond. There is an important point that must be made here. States can only practice assurance, dissuasion, and deterrence if they *openly* possess a credible force of space weapons.[10] There is no war prevention benefit gained by keeping space weapons a secret, other than avoiding a space arms race. A potential adversary must clearly perceive a credible space weapons capability for these strategies to work. There are no agreed definitions for these terms, so care will be given to explain exactly what is meant.

Assurances. The concept of assurances is borrowed directly from nuclear-related literature. It involves stronger and weaker states making guarantees (assurances) for the purpose of preventing proliferation of weapons of mass destruction and war. There are negative and positive security assurances. These concepts can be related to space weapons and warfare. Negative assurances would be guarantees by space weapons states not to use or threaten the use of such weapons against states that have formally renounced space weapons. Positive assurances would be the agreement between a space weapons state and a non–space weapons state that the latter would receive assistance if it is attacked or threatened by a state that uses space weapons against them.[11]

Presently, there are no known assurances between space weapons states and non–space weapons states in the international community beyond those in the Outer Space Treaty. This is a wide open area waiting for diplomatic engagement. Presumably, the threat posed by space weapons has not yet raised the level of security concerns among the international community to stimulate assurance-making among states.

As we have seen in the nuclear community, some states will give public assurances not to proliferate, only to work to acquire weapons covertly. There is always the risk of being hoodwinked, which highlights the need for greater transparency and other soft power–related means of securing the aims of policy. In addition, no state has yet come forward and declared itself a "space weapons state," even though we see evidence of testing and actual employment of such weapons with increasing frequency. The utility of space weapons–related assurances are questionable until it is clear who has space weapons and who does not.

Dissuasion. Dissuasion, like soft power, rests on the ability to shape the preferences of others so they behave in a certain desired manner.[12] But unlike soft power, where others choose a course of action you would like them to pursue simply because they find it attractive, dissuasion is really about *persuading* them *not* to do something that you would not like them to do. Dissuasion is a negotiation of sorts, where one party "talks" the other out of doing something by demonstrating to them that the costs outweigh the benefits, because the competition is so far ahead that it becomes either impossible or simply impractical to catch up.

Dissuasion is a method attempted by powerful, long-established nuclear states to persuade nonnuclear states from proliferating. They approach states before they proliferate and directly or tacitly attempt to dissuade them from proceeding with their program by convincing them that the cost of competing with the powerful established proliferator in the nuclear arena is just too great. The hope is for the state to decide on its own that joining in the nuclear competition is not in its interest.

As applied to spacepower, a state that demonstrates a robust defensive and offensive capability may tacitly dissuade others from attempting to compete against that state in space.[13] Conversely, if a state's overall power, especially military power, appears directly tied to its space-based assets—a center of gravity—but it has no visible means for defending them or denying other states from exploiting space for military gain, it almost baits potential adversaries into fielding space weaponry.

The evidence shows mixed results with dissuasion with regard to nuclear proliferation. Since the mid-1990s, India, Pakistan, and North Korea have acquired nuclear devices, and Iran may be well on its way. Libya may be a success story. Its leadership seems to have made a cost-benefit analysis that resulted in the shutdown of its nuclear program. Other states may have been dissuaded, but the evidence is not clear.

There is an important note to add regarding spacepower. A state that has overwhelming spacepower may successfully dissuade another actor from competing militarily in the space arena, but that actor might choose to pursue asymmetric and potentially more violent means of achieving its aims as a result.

Deterrence. When soft power, assurances, and dissuasion fail, spacepower plays a central role in deterrent strategies that may prevent wars. Deterrence is the prevention of war based on coercion by threat of damage.[14] It must be a credible threat of inflicting unacceptable damage on an opponent. This was the case during the Cold War standoff between the United States and Soviet Union.

During the arms race of the Cold War, U.S. and Soviet space systems became thoroughly integrated into their states' nuclear attack warning, command and control, assessment, targeting, planning, and most every aspect of finding, targeting, and potentially destroying each other. The end of the Cold War and the commensurate reduction of security concerns that followed allowed the focus of space systems to evolve rapidly away from purely support to nuclear forces toward support to all warfighting activities, conventional, covert, and otherwise. It remains clear, however, that spacepower assets, as deeply integrated as they are in all aspects of military operations among advanced spacefaring states, will continue to be the interconnecting glue making terrestrial deterrence more effective.

It may be possible to deter an advanced spacefaring adversary who is heavily reliant on space systems but who has taken few or no precautions to defend them. In this case, possessing a credible set of offensive space weapons may threaten the adversary into

avoiding confrontation. Sensing this, the adversary may initiate a crash program to acquire defensive capabilities or space weapons of its own.

Unfortunately, deterrence is based on an abstraction where there is no limit to the extreme of violence that can be threatened in retaliation. As Clausewitz noted, "Each side, therefore, compels its opponent to follow suit; a reciprocal action is started which must lead, in theory, to extremes."[15] This tendency can easily lead to arms racing.

Assurances are faith-based at best. Meanwhile, dissuasion and deterrence come with very real risks. Both presuppose that both sides of a potential confrontation are equally rational, have equal understanding of the stakes, and are using the same rational calculus to establish policy in an interactive fashion.[16] Given the differences in the strategic cultures of the players involved, these presumptions can never be the case in reality. As a result, there are margins of error associated with every calculation. A state that overtly builds offensive space weapons for the purpose of enabling dissuasive and deterrent strategies for war prevention may be misunderstood as having hostile intentions that trigger security concerns across the globe. The same is true for a state that may build what it considers to be a defensive system but that has an apparent dual application as an offensive system. China's test of a direct ascent antisatellite weapon in January 2007 may be a case in point.[17] A state may do its best to tailor its forces to support dissuasive and deterrent strategies and focus them at whatever it suspects the enemy holds dear, only to discover that the enemy reacts quite differently than expected. There are no guarantees.[18] A way to reduce the margins of error and the risk associated with direct hard power war prevention strategies is to include them within the policy-driven context of both indirect strategies suggested above: within the framework of global transparency and within broad international partnerships.

Spacepower and Warfare

We have arrived at what will undoubtedly be the most controversial part of this chapter, wherein we discuss spacepower and its nexus with warfare. It is controversial only because space has yet to be overtly weaponized or generally recognized as an arena of open combat. Many, if not most, want to keep it a weapons-free peaceful sanctuary, particularly the suprastate actors. Just because all other media are weaponized and used as arenas of combat does *not* mean that space will automatically follow suit.[19] Perhaps this generation will figure out how to keep the beast of war in chains short enough to prevent it from going to space. But the next (and each succeeding) generation must also keep the chains short. Unfortunately, the constant march of technology is making space more important to states at the same time it is making it easier to build space weapons.

In anticipating the future of spacepower for theoretical discussion, we can do little more than extract a roadmap from the history of human activity and extrapolate forward. The preponderance of evidence suggests that space will be no different than air, land, and sea regarding warfare. In the words of Colin Gray:

> It is a rule in strategy, one derived empirically from the evidence of two and a half millennia, that anything of great strategic importance to one belligerent, for that reason has to be worth attacking by others. And the greater the importance, the greater has to be the incentive to damage, disable, capture, or destroy it. In the bluntest of statements: space warfare is a certainty in the future because the use of space in war has become vital. . . . Regardless of public sentimental or environmentally shaped attitudes towards space as the pristine final frontier, space warfare is coming.[20]

The strategic value of space to states is not in question. Advanced spacefaring states are already reliant—and moving toward dependence—on space-derived services for activities across every sector of their societies. Spacepower is becoming critical to their styles of warfighting. Likewise, the injury that can be caused to such states by menacing their space systems can be considerable. Given these incentives, the beast of war will either break its chains all at once or stretch them slowly over time.[21]

Like war itself, space warfare, the decision to build space weapons, and whether or not to weaponize space are all matters of policy, not theory.[22] It is the job of theory to anticipate such developments given the template that history suggests. Land, air-, and seapower lend imperfect analogies to spacepower, but they are applicable enough to see that spacepower may have its own grammar, but not its own logic.[23] The logic of statecraft and warfare laid out in Sun Tzu's *The Art of War* and in Carl von Clausewitz' *On War* applies to spacepower as well as any other element of military power. A student of spacepower must become thoroughly familiar with both of these works.[24] War is a political activity and therefore a human activity with a long history that serves as a guide path. Spacepower is already part of the warfighting mix in the political and strategic unity of war, and this trend will continue.[25] Some predict that spacepower will make the greatest contributions to combat effectiveness in wars of the 21st century.[26]

War Extended to Space

War is an instrument of policy, and spacepower, as an element of the military instrument of power, is part of the policy mix that makes war, whatever form it may take.[27] Space generally has been treated as a sanctuary since the Eisenhower administration, and the use of space systems in warfare is limited to supporting terrestrial forces. This is not likely to change if the security concerns of states remain low. However, if states are confronted with intense security concerns, such as their survival, the weaponization of space and its use as an arena of conflict becomes far more likely.

Spacepower is a player at every point along the spectrum of conflict.[28] Covert operations often use space services with the same degree of reliance as the large joint military forces of advanced spacefaring states engaged in a conflict. In addition, space systems often support multiple military operations with varying intensities in different parts of the world simultaneously.

Spacefaring prowess is a common attribute of the dominant powers in the world today. Special attention must be paid to so-called rogue states that have access to space-related technology and may even be spacefaring but do not have the conventional forces to achieve their policy aims. Those aims tend to be very intense, and these players may seek space weapons as an asymmetric hedge against spacefaring adversaries who may try to coerce them.

The dominant military powers in the world, some of whom are potential adversaries, also tend to be the dominant spacefaring states. Because of the economic benefits and exponential enhancements that spacepower delivers to terrestrial warfighting, those states are under increasing pressure to defend their space systems and to counter those of their potential adversaries. This may lead to a space weapons race and an immediate escalation of hostilities to "wipe the skies" of enemy satellites should war break out between two or more dominant military space powers.[29]

When assessing the interplay between the spectrum of conflict and the spectrum of belligerents, it may be the case that war between two weak actors will not likely extend into space. However, if the power is perceived to be disparate, a weak actor is far more likely to use space weapons against a powerful state as an asymmetric defensive move.[30] A powerful state may counter the space systems in use by a weaker adversary, but it is likely to do so by placing diplomatic pressure on commercial vendors, or executing attacks on their ground stations, or launching highly selective covert attacks on the satellites they use by employing temporary and reversible means.

Should two dominant spacefaring powers go directly to war with each other with intense motives, both will find it critical to preserve their space systems and will consider it a dangerous liability to allow their enemy to exploit theirs. Given the ability of spacepower to cut the fog and friction of war while connecting military forces at the tactical, operational, and strategic level, it is likely that space systems will be primary targets that will be negated in the opening moves of war. The fight for space is likely to be intense and brief. Temporary means of negation will likely switch to permanent methods of destruction to remove doubt in the minds of commanders.

Offense and Defense

Twenty-six centuries ago, Sun Tzu pointed out, "Invincibility lies in the defense; the possibility of victory in the attack. One defends when his strength is inadequate; he attacks when it is abundant."[31] All warfare depends on interplay between the offense and the defense. They are "neither mutually exclusive nor clearly distinct. . . . each includes elements of the other."[32] Defense generally implies a negative aim of protection and of preserving the status quo in the face of an attack. Conversely, offense generally pursues a positive aim by inflicting damage on the adversary to coerce him into accepting terms. However, consider that there are defensive aspects resident in every attack. Warriors of old carried their shields into battle when they attacked with their swords to protect them from the thrusts of the defenders. The offense is also resident in every defense.

Remember that the Royal Air Force won the great defensive Battle of Britain by attacking the invading German bombers.

The general goal of offense is to inflict such damage on the adversary that they are *defensively culminated*, meaning they can no longer resist the attack and must either accept terms or be annihilated. Conversely, the goal of defense is to resist the attack and inflict such costs on the adversary that they are *offensively culminated*, meaning they can no longer attack and can only defend themselves. These concepts will come into play when we discuss space control and space denial.

It is often said that defense is the stronger form of warfare.[33] This is not true in space—today. Defending satellites and their data links is a difficult proposition at best. Satellites are delicate, fragile devices that can easily fall prey to any number of space weapons that currently exist, such as lasers, radio frequency jamming, brute force weapons, and surface-to-space missiles with kinetic kill vehicles—many of which are relatively small, mobile systems. While satellites in low Earth orbit are the most vulnerable to lasers and lofted kinetic kill vehicles, satellites all the way out in the geostationary belt and in highly elliptical orbits share a universal vulnerability to radio frequency jamming and electromagnetic brute force attacks. Satellites do not need to be physically destroyed to be rendered ineffective. Satellites are commanded (as applicable) and provide their services to ground stations and users via the electromagnetic spectrum. Hence, there is a rule: no spectrum means no spacepower. The rapid proliferation of jammers and electronic intrusion devices around the world in recent years occurred upon recognition of this rule.

Defenses to date are paltry at best.An adversary with robust space denial weapons may be able to negate all friendly space systems in a matter of hours; therefore, it is imperative for space powers to acquire the ability to find, fix, track, target, and destroy an adversary's space weapons very quickly. Such systems may reside on land, at sea, in the air, or in space. It will require close coordination with terrestrial forces to engage them against space weapons at the behest of the space commander.

In essence, today's space defense rests on the assurances in the Outer Space Treaty, which imperfectly implies that space is a peaceful sanctuary, although it only bans the basing of weapons of mass destruction in space. Does this mean all lesser threats are allowed? This is a hotly debated point. No one contests language in article 51 of the United Nations charter that gives states the inherent right of self-defense. Presumably, this includes self-defense from space weapons and space-based weapons. It can be argued that space weapons are a matter of the inherent right of self-defense. The slope to space warfare is slippery indeed.

Although offense is the dominant form of war in space today, this will not always be the case. Defense is possible. Three principles will likely guide the development of future space defenses.

First, *if you can't see it, you can't hit it*. Satellites are already getting smaller—too small for most space surveillance networks to detect and track. This trend will likely continue not only as a matter of cost savings, but also as a matter of stealthy defense. Avoiding detection includes maneuvering satellites to undisclosed wartime orbits.

Second, *all warfare is based on deception*.[34] Potential adversaries collect intelligence on each other's space systems and make their estimates based on their intelligence assessments. Action must be taken to deceive potential adversaries into underestimating the value of critical systems and overestimating the value of inconsequential systems. In addition, the use of wartime-only modes of operation, frequencies, and other unanticipated behaviors will further complicate an adversary's problems.

Third, *there is strength in numbers. The age of the capital satellites is over*. Employing only one or two large, very expensive satellites to fulfill a critical mission area, such as reconnaissance, is foolish. Future space systems must be large constellations of smaller, cheaper, and, in many cases, lower-fidelity systems swarming in various orbits that exploit ground processing to derive high-fidelity solutions. In addition, swarms improve global access and presence.

The best defense for a space system in the 21st century may be the dual-use system that is owned, operated, and used by broad international partners. A hostile foe may be deterred from attacking a satellite if doing so comes with the likelihood of expanding the war against their cause. This is also dependent on the hostile foe's policy aim. If it is intense, such as national survival or radical ideology, they may attack anyway.

The term *attack* is practically synonymous with *offense*, but it must be understood in a much more nuanced way regarding spacepower than is generally ascribed among those who hype the threat of direct kinetic kill antisatellite weapons that may smash satellites to bits. It must be remembered that space systems are comprised of space, ground, and user segments integrated through data links. Any of these segments or links can be targeted by an attack to gain the desired effect. A specific target within a space system is selected and a weapon is chosen to attack that target in a certain way to achieve the desired *level of negation*. The first includes temporary and reversible effects such as deception, disruption, and denial. The second includes permanent physical effects such as degradation and destruction. They can be described this way:

- *Deception* employs manipulation, distortion, or falsification of information to induce adversaries to react in a manner contrary to their interests.
- *Disruption* is the temporary impairment of some or all of a space system's capability to produce effects, usually without physical damage.
- *Denial* is the temporary elimination of some or all of a space system's capability to produce effects, usually without physical damage.
- *Degradation* is the permanent impairment of some or all of a space system's capability to produce effects, usually with physical damage.

- *Destruction* is the permanent elimination of all of a space system's capabilities to produce effects, usually with physical damage (called *hard kill* or, without physical damage, *soft kill*).[35]

Ultimately, the level of negation is chosen to achieve the desired effect that serves the objectives given to space forces in support of the overall strategy and operational plans of the war. A very low-intensity war is likely to involve covert use of the temporary and reversible levels of negation. Conversely, more intense wars will probably tend toward the permanent levels.

There is a drawback to temporary levels of negation. It is exceptionally difficult to determine if the application of the weapon is achieving the desired effect. Permanent levels of negation may deliver more easily observable confirmation of effects. This is somewhat analogous to the problems determining a tank kill in Operation *Desert Storm*. Some commanders considered a tank killed if its unit was attacked and the tank was no longer moving. Others did not agree with this. But all agreed that it was a kill if the tank had its turret blown off.

It must be kept in mind that a small number of powerful directed energy space weapons can quickly cause permanent levels of negation to dozens of satellites. On the other hand, it would take several dozen space weapons such as jammers that only cause temporary effects to negate the constellations of the larger spacefaring states. Since noise jammers are only effective when broadcasting, and broadcasting jammers are relatively easy to find and target, there are incentives to develop space weapons that cause permanent effects.

Spacepower in Warfare

The purpose of security spacepower is to provide capabilities to assist in achieving political and military objectives. It is an independent form of power that can be used alone or in concert with other forms of power to achieve desired ends. Space is a place where humans live and place uninhabited systems that help resolve problems. It begins above the Earth's surface at the lowest altitude where a satellite can sustain a circular orbit, albeit briefly, at approximately 93 miles and extends outward to infinity—excluding heavenly bodies.[36] Eventually, humanity will extend its interests fully across cislunar space and beyond, especially for economic development. Security spacepower will protect those interests, just as navies protect passage and commerce on the seas. Someday in the future, populations and their political entities will likely migrate into space as well. For now, however, humans live on the surface of the Earth, and contemporary spacepower in this context refers to the struggles occurring there, but this will evolve over time to include the cislunar region and the Moon.

The reason for going to near-Earth space for security purposes is to gain access to regions of the Earth where terrestrial forces either cannot go or cannot loiter as economically as some satellites. A relatively small number of similar satellites spread out in orbital space can survey the entire Earth's surface, which gives space-based constellations the ability to

perform missions on a global scale. States perform many missions in space. In the opening years of the 21st century, these missions are primarily informational—that is, providing command, control, communications, and computer (C^4) support; positioning, navigation, and timing; intelligence, surveillance, and reconnaissance (ISR); and weather support to terrestrial forces, among others. Air, land, and sea forces also perform missions like these, but only space systems (and some terrestrial cyber networks) perform them continuously on a global scale. These space networks create a global infrastructure that links together expeditionary forces deployed anywhere in the world and connects these forces with each other in all media, and with their leadership.

When War Prevention Fails

Five terms are presented below that may seem familiar to anyone who has read U.S. Air Force doctrine regarding space: *space control, space support, space denial, space logistics*, and *space attack*. However, these terms are used differently here, because the driving concepts are pulled apart and analyzed more closely to reveal greater nuances that have much further-reaching strategic implications than the relatively simple and coarse definitions offered in current doctrine.

Space control.The primary mission of space forces at all times is assuring relative space control, which means *securing the space medium to provide freedom of access to space and freedom of action in space for all lawful and nonhostile spacefaring activities*.Space control is that which provides security when freedom of access or action in space is contested.

Space control is not only for military purposes. It allows civil, commercial, and other space activities to continue uninterrupted around the globe. It provides the benign environment that is a necessary precondition for most spacefaring activities. The importance of ensuring uninterrupted space commerce cannot be overstated. All states are increasingly reliant on space systems for all matters critical to their economic well being.

Space control efforts must minimize disruptions to the flow of the global economy. During war, every effort should be made to limit the effects only to the belligerents. This minimizes the risk of a war expanding by drawing in other states seeking to protect their interests by force. Space control also requires preventing the creation of space debris, which becomes a hazard to spacefaring activities and denies freedom of action in space to all actors in the vicinity of debris fields. Such is the negative aim.

Achieving the negative aim of space control requires passively or actively defending space systems under attack. This may require attacks to suppress or destroy the adversary's offensive space weapons, which may be based in the air, on land, at sea, or in space. It may be necessary to drive a hostile foe all the way to offensive culmination in space to arrive at the security required to assure free passage of commerce and other activities. The policy, strategy, and situation will dictate the degree of offensive space control that is used. Factors to consider will be the time and place where space control must be gained, how rapidly it is needed, what parts of the adversary space system(s) are

vulnerable, the possibility of collateral damage, how long space control must be sustained, and the desired level of negation (for example, destruction, degradation, denial, disruption, deception). Space control does not need to be total in order to be effective. In fact, attempting to exact total space control over an adversary, to include dominating all decisive points and the equatorial chokepoint, would be counterproductive as preparations to do so would drain the budget and be highly wasteful.[37]

Space control also has a positive aim, which is to sustain the requisite degree of freedom of action to enable friendly space forces to continue or expand the missions of *space support* to friendly forces, *space denial* of adversary space capabilities (if required), and *space logistics* to sustain friendly operations on orbit, and it someday may include the mission of *space attack* of striking adversary targets from space. Each of these missions will have a priority dictated by the policy and strategy they support.

Space situational awareness is a most vital component of space control. Freedom of access to space and freedom of action in space require timely and reliable information about what is actually happening on orbit. It includes what could be called space traffic management and debris avoidance, in addition to characterization of threats and anomaly detection and attribution, as well as attack assessment. The ability to accurately characterize what is happening in space becomes more critical as the world becomes more space reliant, as the number and frequency of spacefaring activities increase, and as space weapons proliferate.

Competition for space control is not limited to warfare. Such competition also occurs during peacetime negotiations for treaties, laws, and rules of the road that in any way curtail the freedom of access to space or freedom of action in space. This is why some countries, such as the United States, are very cautious about entering into such negotiations. The long-term implications of various forms of agreements are difficult to anticipate. There is little doubt, however, that additional treaties, laws, and rules of the road are warranted to codify the appropriate and inappropriate behaviors of spacefaring actors. This will soon be critical to accommodate the rapidly increasing number of satellites on orbit, space tourism, space hotels, and lunar and asteroid resource development.

Space support. This includes all of the space force enhancements and information services that modern militaries have become accustomed to. The negative aim of space support includes providing all of the space services associated with the *surveillance strike complex*, which includes all those space sensors, communications links, and other space capabilities that allow terrestrial forces to defend friendly interests. It encompasses such things as warnings, tip-offs, indications, cueing, and assessments of attack by air, land, sea, or space forces. It includes all of those space systems used in any way to integrate passive and active defensive measures. An example is the missile warning network, which detects missile launches by satellite, routes the data into the fire control system of missile defense batteries, and sends it to commanders via communications satellites.

The positive aim of space support includes providing all the space services associated with the *reconnaissance strike complex*. The reconnaissance strike complex encompasses all those space sensors, communications links, and other space capabilities that allow terrestrial forces to attack the enemy. It includes the entire space-enabled ability to find, fix, track, target, engage, negate, and assess enemy targets. An example is a reconnaissance satellite finding an enemy tank, routing this data to a strike aircraft via communications satellite, and guiding the aircraft's munition to target via the global positioning system, while observing battle damage indications and other assessments from space.

The surveillance and reconnaissance strike complexes of most actors have many space-related elements in common. The global positioning system, for example, provides data that is typically critical to both complexes. Of particular note is the blending of commercial assets, such as communications satellite services, into the strike complexes of states and nonstate actors. Commercial space systems used by the enemy to advance its war effort, including the satellites on orbit, are valid military targets. Their likelihood of being attacked is directly related to the intensity of the war aims of the belligerents and their ability to strike the relevant commercial systems.

Here a moral dilemma arises. Is it better to attack a ground station with a high probability of killing human beings, or is it better to attack a satellite with no possibility of human death? No answer can be given here, for the answer is entirely dependent on the policy and strategy, both formed in the unique context of the situation.

Space denial. Denial of adversary space forces is as important as space control. Its essence is the use of space weapons to negate adversary space systems. Its negative aim is to defend friendly interests by negating the enemy's space systems associated with their reconnaissance strike complex, thereby increasing the fog and friction inherent to the enemy's offensive efforts to hasten its offensive culmination.

Space denial can be used for two positive aims. The first includes space denial attacks against adversary space systems associated with their surveillance strike complex to facilitate other attacks against them and to hasten their defensive culmination.

The second positive aim of space denial has received little attention. It involves negating adversary space systems simply to raise their costs in the war effort, in an attempt to coerce them into accepting terms. This can be done as part of an overall punishment strategy or risk strategy of imposing costs on the enemy with the promise of imposing even greater costs in the future.An interesting twist to this strategy might be limiting strikes only to satellites in orbit. Nobody dies, but there are tangible costs imposed. It might be possible to coerce a state that is heavily reliant on space services into accepting modest terms by negating only their satellites in orbit. Such prospects heighten the need for effective space defenses for highly reliant states. States that do not find themselves as dependent on space have far less of a need for space defenses and may become concerned when others merely discuss defensive systems, since the line between offense and defense is so easily blurred.

It is important to remember that an adversary's satellites are global assets. It may be politically untenable for a number of reasons to permanently damage an adversary's satellite. For example, while an imagery satellite may threaten to disclose friendly troop movements in one region, that same satellite might perform treaty verification on the opposite side of the globe or other missions that there is a friendly interest in preserving. In many scenarios, space denial might best be limited to very localized and temporary effects.

The best way to deny an adversary *access* to space is to destroy their space launch facilities, but we must also be aware that the adversary may contract their spacelift with other countries where they may have satellites in storage. The best way to deny space support to an adversary is to directly negate the satellites they use. While some satellite systems may be particularly susceptible to the destruction of their ground stations, this may have only limited effect on other satellite systems that may degrade gracefully in the absence of ground control. It is also likely that an adversary will employ mobile ground stations for tactically important space systems that require frequent ground contact. This not only makes targeting ground stations more difficult, but it also highlights the need to negate an adversary's satellites on orbit. It is also possible to attack the users of space support by jamming their receivers through a variety of techniques. This has the benefit of localized and temporary effects. In many scenarios, it is likely that a combination of attacks on all three segments of a space system (ground stations, satellites on orbit, and user equipment), as well as their linkages, will be required to achieve the desired effect.

Space control and space denial efforts will be complicated if an adversary is using third-party launch facilities, satellites, or ground control systems provided by commercial vendors, international consortia, or an ally. Diplomatic efforts will likely be required to eliminate third-party support to adversaries, but if the political will exists, friendly forces must be ready to expand the conflict by striking wherever adversaries receive space support. If diplomatic efforts fail and policy does not allow expansion of the conflict to strike third-party targets, then the adversary has a sanctuary they will likely exploit.

Space logistics. Space logistics are those activities to sustain satellites and their capabilities on orbit. It includes launching satellites to orbit, on-orbit check-out, maintenance, refueling, repair, and the like. With regard to wartime space logistics, it is imperative for spacefaring states to repair or replace lost satellite capabilities on orbit. The goal is to rapidly restore capabilities before they affect political, economic, and combat operations. Activating on-orbit spares, leasing commercial satellite services, launching new satellites to replace those lost through attrition, or gaining access to an ally's satellite services may do this. It is also essential to repair or replace lost satellite ground control systems. Methods for doing this may include transferring ground control responsibility to another location (fixed or mobile), leasing commercial support, or obtaining ground support from an allied state.

A word of caution is warranted regarding the launch of new satellites to replace those lost to enemy attack. Unless there is complete certainty that the adversary is offensively culminated and *all* adversary space weapons have been accounted for and successfully

negated, launching a satellite of the same design into the same orbit will be like throwing skeet in front of a shooter. In practice, there is no way to be absolutely certain that the threat is completely removed.

Space attack. It is possible that someone will put weapons on orbit that can attack terrestrial targets. Space attack could have a negative aim of striking an adversary's advancing forces or offensive systems as a matter of defending friendly interests and hastening the enemy's offensive culmination. Space attack could also have two positive aims. The first could be striking adversary forces or their defensive systems to expedite their defensive culmination. The next could be attacking their centers of gravity directly as part of the war-winning effort.

There are many good reasons for not putting weapons in space for the purpose of space attack. Among them are the enormous expenses of putting them in space and their vulnerability once there if they are left undefended. But there is a paradoxical logic to warfare that increases the likelihood of someone actually doing it: Because there are many good reasons not to put weapons in space, putting weapons in space makes little sense; no one is expecting weapons in space; therefore, an actor achieves the element of surprise by putting weapons in space!

Situational awareness has always been critical in diplomacy and warfare, but in the new era of precision targeting, situational awareness must be equally precise—a bomb is only as accurate as the coordinates used by the planner, the warfighter, and the munition itself. Precision targeting is well understood, but the need for precision surveillance and reconnaissance is not.

Multitudes of ISR sensors in all media characterize the modern battlespace. Some collect signals intelligence, while others collect photoreconnaissance data. Still others collect radar information. These sensors and their operators not only attempt to identify targets, but also try to determine each target's precise coordinates. The ability of different sensors to determine the precise coordinates of targets varies, but in general, terrestrial sensors are much better at this than space-based sensors for several reasons. First, space systems are typically much farther away from the targets. Second, satellites in the lowest orbits are moving very fast in relation to targets and have relatively short dwell times on targets compared to terrestrial systems, and satellites in higher orbits are much more distant and are generally less able to refine target coordinates as precisely. Third, satellite sensors degrade over time, and there currently is no effort under way to perform physical maintenance on them to keep them in prime condition. Finally, given the relatively few ISR satellites in low Earth orbit, continuous coverage of areas of interest from space with the most precise space-based sensors is currently impossible.

In sum, aircraft have several distinct advantages over spacecraft in regard to *theater* ISR collection, but space-derived surveillance and reconnaissance information is critical to diplomatic and military operations because it provides a "first look" into denied areas and at the battlespace and assists planners in finding and coarsely geolocating many targets before terrestrial forces move into the region. As a rule of thumb, today's space-derived

surveillance and reconnaissance is useful in finding 80 percent of the targets and is able to determine their location to roughly 80 percent of the accuracy required to conduct precision strikes. In some cases, space systems do better than 80 percent in finding and fixing targets, and in other cases, they do worse. What is important is the tremendous advantage space systems provide politicians and commanders by giving them a high-quality first look into the situation they face. With this information, they are able to make decisions about how to employ their limited terrestrial surveillance and reconnaissance assets (aircraft, ships, submarines, reconnaissance ground forces, etc.) more efficiently to refine the surveillance and reconnaissance picture to the quality they desire for the operations they are considering. In some cases, the first look from space may suffice, but usually terrestrial surveillance and reconnaissance assets are required. During combat operations, space-based surveillance and reconnaissance sensors continue to provide data, filling gaps in coverage by theater assets. Space-based surveillance and reconnaissance sensors also frequently cue terrestrially based sensors, as was the case during the Gulf War with missile warning satellites cueing Patriot batteries to intercept Iraq's inbound Scud missiles.

Perhaps most important of all, day in and day out, during war and peace, spacepower provides the 80 percent first look on a *global* scale. It allows analysts to watch the world and report tip-offs, warnings, and indications that give political and military leaders the freedom to employ their terrestrial forces more expeditiously and with greater confidence that another threat is not more pressing. Spacepower literally watches the backs of terrestrial forces to make sure no threat is sneaking up behind them. This allows greater concentration of terrestrial forces in theaters of combat operations because space-based surveillance and reconnaissance assets are sufficient to act as a kind of global sentry. This sort of mission is ideally suited to space systems because they have unimpeded access around the globe and relatively few assets are required to sustain surveillance and reconnaissance missions on a global scale.

Much more is possible. By increasing the number of low Earth orbiting sensors, continuously improving the quality of the sensors, and developing the means to service and repair them (either on orbit or by recovery and relaunch), the 80 percent rule of thumb will creep closer toward the 100 percent solution, despite the warfighter's demand for ever-increasing precision. As space systems becomes more capable, is it likely that they will replace terrestrial forms of surveillance and reconnaissance collection? No. Aerial reconnaissance did not eliminate the need for land and sea forces to conduct reconnaissance of their own. There is no reason to believe that space-based reconnaissance will replace any other form of reconnaissance either.

Spacepower does not usurp missions from other forces. Spacepower assets give a state new core competencies for its military order of battle. The ability to do anything continuously on a global scale is a new contribution to warfare made possible by spacepower. The various C^4ISR capabilities, including weather observation, missile warning, and navigation and timing broadcasts, give space-enabled forces a distinct asymmetric advantage over adversaries in the opening days of the 21st century. This

advantage will evaporate over time as other actors on the world stage develop, lease, or borrow similar capabilities.

Space forces do not compete with terrestrial forces for roles and missions. Airpower, land power, seapower, spacepower, and now cyberpower bring different capabilities to modern warfare. The armed forces of many nations train their warfighters in highly specialized ways with the objective of being able to dominate operations within their respective media. Operations in each media require centralized control by practitioners of that form of power, in close coordination with the other warfighters, to ensure the optimum management of resources and integration of efforts to achieve the objectives of strategy.

A great fallacy resulting from the prevalent budget-driven integration mindset is the oft-cited statement that "missions will migrate to space when it becomes reasonable to do so." This presumes that commanders in forward areas are willing to trade highly flexible organic terrestrial assets for less flexible (and often less capable) space systems that another commander will likely manage as global assets. Economic considerations may force such a compromise, but a more prudent approach is to develop robust space capabilities in addition to airpower, land power, seapower, and cyberpower assets. Remember, the difference between space systems and terrestrial systems is that space systems provide global access and global presence during both war and peace.

When space forces eventually obtain systems that can create physical effects at any location on the surface of the Earth (for example, conventional bombing), this will not replace the standing requirement for aircraft and missiles to be able to do the same thing, just as the bomber did not replace artillery. Space operations are expensive, and economic considerations may require air delivery of munitions. Exceptions include times when cost is not a consideration, such as combat in areas where aircraft are denied access, when aircraft cannot respond to a time-critical situation as quickly as spacecraft, when only a specialized weapon delivered from space will have the desired probability of killing a target, and when surprise is of the utmost importance.

There is unquestionably some overlap between the capabilities of spacepower and other forms of power, but this is a source of strength, not waste. Just as the triad of bombers, submarines, and missiles during the Cold War prevented either adversary from gaining a significant advantage should their opponent successfully counter one set of capabilities, today's redundancy prevents an adversary from gaining a significant advantage should they successfully counter space-based systems or other terrestrial forces. There will be some adjustments in force structures as space capabilities become more robust, but *no* mission in *any* service should *ever* move *entirely* to space. Under *no* circumstances should *all* of the eggs *ever* be placed in the space basket. Instead, there should be an integrated combined arms approach.

During time of peace, spacepower assets monitor the globe, helping to identify and characterize potential threats. When a threat emerges, political and military leaders may opt to send terrestrially based surveillance and reconnaissance sensors into the area of

interest to get a closer look. Should hostilities break out, space forces will gain whatever degree of space control is required and will contribute whatever they can to help friendly forces in theater in terms of space support to the surveillance and reconnaissance strike complexes, but they still must watch the rest of the world, in every other theater, looking for tip-offs, warnings, and indications of other threats.

Space attack will take many different forms, but it seems likely that space-based weapons will fill specific niches, ideal for only a handful of missions during certain phases of operations. No claim is made that spacepower by itself can be decisive in general conventional warfare, but in certain circumstances, it may help set the conditions for victory by friendly forces. Conversely, if space forces are defeated, this may turn the tide of the war against friendly forces and contribute to defeat. There may be certain forms of limited warfare where the coercive application of space systems may achieve the political and military aims of an operation. If this defines decision, then so be it.

Conclusion

The primary value of spacepower is war prevention, not support to warfighters. It does this by providing transparency into observable human activities around the globe and into space that removes uncertainties and security concerns or allows them to be addressed with a better approximation of the facts. Space also provides opportunities for cooperative ventures on spacefaring activities across all sectors. These ventures can become the framework of better international relationships and confidence-building maneuvers between potential adversaries. Powerful spacefaring states may be able to use martial space strength in traditional ways, such as providing assurances and using dissuasive and deterrent strategies, to prevent wars.

If history serves as a template for the future in space, then space will become a warfighting medium. It is already heavily militarized, with powerful spacefaring states using the medium to enable their surveillance and reconnaissance strike complexes in ways that accelerate the scale, timing, and tempo of combat operations exponentially beyond non-spacefaring actors' ability to cope. Weak actors are likely to employ space weapons in an attempt to counter the advantage space confers on powerful states. The most dangerous situation, however, occurs if two powerful spacefaring states go to war with each other. If the motives are intense, it is likely that they will be forced to counter each other's space systems in the very early stages. At present, there are inadequate defenses for space systems, but defense is possible. Space denial strategies of warfare are likely to evolve, wherein a belligerent merely attacks an adversary's space systems to inflict costs or to induce strategic paralysis on the enemy before offering terms. Finally, space is very much part of the military mix of all actors, state and nonstate, and it must be recognized that spacepower is not a replacement for terrestrial forces, but an additional set of tools that delivers unique capabilities.

Notes

1. The claim that the proper primary mission for spacepower is war prevention was first made to the author of this chapter by Brigadier General S. Pete Worden, USAF (Ret.), in the fall of 2005. He expands this to claim that spacepower is the primary means that states can use to prevent wars. See also chapter 30 in this volume by Worden, "Future Strategy and Professional Development: A Roadmap."
2. The security concern of facing the threat of a Soviet missile attack faced was so great that the Eisenhower administration tolerated 12 successive failures of Corona systems before the 13th actually delivered usable imagery. Described in William E. Burrows, *The New Ocean* (New York: Modern Library, 1999), 232–233.
3. A National Intelligence Estimate released in February 1960 assessed the Soviets as having as many as 140–200 ICBMs on launchers by mid-1961. Dwayne A. Day et al., *Eye in the Sky: The Story of the Corona Spy Satellite* (Washington, DC: Smithsonian Institution, 1998), 216–217.
4. Ibid., 217.
5. Carl von Clausewitz, *On War*, ed. and trans. Michael Howard and Peter Paret (Princeton: Princeton University Press, 1984), 140. In describing what he calls the "uncertainty of all information," Clausewitz describes the quality of information in war as affected by a kind of *fog*, which he claims "tends to make things seem grotesque and larger than they really are."
6. Google Earth is an Internet-based imagery database set in an easy-to-use imagery manipulation program that is expanding to show relatively high-quality images of the entire Earth.
7. Tara Shankar Sahay, "Pakistan Feels Let Down by U.S. Spy Satellites," *Rediff on the Net*, May 13, 1998, available at <www.rediff.com/news/1998/may/13spy.htm>; and Krishnan Gurswamy, "India Tricks U.S. Satellites," Associated Press, May 19, 1998, available at <http://abcnews.go.com/sections/world/DailyNews/India980519_nukes.html>.
8. Clausewitz, 119–121. Clausewitz, who limited his discussion only to war, described *friction* in this way: "Everything in war is very simple, but the simplest thing is difficult." This is also true of large organizations and partnerships. But like a machine, the more frequently the partners work together, the easier it becomes, as if the process has a way of lubricating itself. In this way, partnering may be difficult as first but will become easier with time; hence, it will reduce the friction.
9. Soft power defined by Joseph S. Nye, Jr., *Soft Power: The Means to Success in World Politics* (New York: Public Affairs, 2004), 5.
10. One may wonder if the successful Chinese antisatellite test conducted in January 2007 is an example of a state attempting to establish its dissuasive and deterrent powers against the leading spacefaring state at that time, the United States.
11. "Positive and Negative Security Assurances," available at <www.reachingcriticalwill.org/legal/NSA.htm>.
12. Derived from the definition of soft power found in Nye, 5.
13. This is part of the central thesis found in Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age* (London: Frank Cass Publishers, 2002).
14. Thomas C. Schelling, *Arms and Influence* (New Haven: Yale University Press, 1966), 3.
15. Clausewitz, 77.
16. Author interview with Michael Krepon, May 10, 2007.
17. Earlier ASAT tests by the United States and the Soviet Union from the early 1960s through the 1980s may also be examples of this phenomenon. It is by no means limited to the Chinese. See description of U.S. and Soviet ASAT tests in Clayton S. Chung, *Defending Space: U.S. Anti-Satellite Warfare and Space Weaponry* (New York: Osprey Publishing, 2006), 32–37.
18. Author interview with Jeffrey Lewis, May 27, 2007.
19. Karl Mueller, "Totem and Taboo," *Astropolitics* I, no. 1 (September 2003), 26–28.
20. Colin S. Gray, *Another Bloody Century: Future Warfare* (London: Phoenix, 2006), 307.
21. It has been postulated that the weaponization of space will occur in one of two ways, based on either a single trigger event or a slippery slope. See Barry D. Watts, *The Military Uses of Space: A*

Diagnostic Assessment (Washington, DC: Center for Strategic and Budgetary Assessments, February 2001), 98.

22. Clausewitz, 87. Clausewitz' famous dictum that "war, therefore, is an act of policy," serves as a central proposition for *On War*.
23. Extrapolated from Clausewitz, 605.
24. Sun Tzu, *The Art of War*, trans. Ralph D. Sawyer (Boulder, CO: Westview Press, 1994); Clausewitz, previously cited.
25. Clausewitz, 605–607.
26. Colin S. Gray, *Modern Strategy* (Oxford: Oxford University Press, 1999), 256–257.
27. Clausewitz, 87.
28. Brian E. Fredriksson, "Space Power in Joint Operations: Evolving Concepts," *Air and Space Power Journal* (Summer 2004), available at <www.airpower.maxwell.af.mil/airchronicles/apj/apj04/sum04/fredriksson.html>.
29. The urgency felt by powerful spacefaring states to "wipe the skies" is the thesis of a book by William B. Scott et al., *Space Wars: The First Six Hours of World War III* (New York: Forge, 2007), 7–16.
30. Ibid.
31. Sun Tzu, *The Art of War*, trans S.B. Griffith (New York: Oxford University Press, 1982), 85.
32. *Warfighting: The Marine Corps Book of Strategy* (New York: Currency-Doubleday, 1994), 30.
33. Clausewitz, 84; *Warfighting*, 30.
34. Sun Tzu, *The Art of War*, ed. James Clavell, trans. Lionel Giles (New York: Delacort Press, 1983), 11.
35. Air Force Doctrine Document 2–2, *Space Operations,* November 27, 2001, 13.
36. There is no universally agreed definition of where space begins and ends, but for this discussion, the author is only talking about space in terms of in Earth orbit and beyond. For a fuller discussion of debate of where space begins and ends, see M.V. Smith, *Ten Propositions Regarding Spacepower* (Maxwell Air Force Base, AL: Air University Press) 4, 38.
37. This point was brought out by Mahan with regard to command of the sea; total control is not necessary. This point is developed in relation to spacefaring activities in Dolman, 34.