Monsters and shadows: left unchecked, American fears regarding threats to space assets will drive weaponization

Theresa Hitchens

It is clear that the United States Department of Defense, and the administration of President George W. Bush, is increasingly concerned by the perception of growing threats to American space assets. This threat perception is driving a concerted effort to develop a more aggressive American military posture regarding space, including the consideration of space-based weapons.

Indeed, Condoleezza Rice, Bush's national security adviser, in May 2002 launched a review of American space policies—the first since 1996—because 'space activities are indispensable' to American 'national security and economic vitality'.[1] It is quite possible that this review will result in overturning the traditional American restraint regarding deployment of space-based weaponry. This is especially true given the Bush Administration's current plans for missile defence, which envision space-based missile interceptors (both kinetic kill and laser) within the next decade or two.

While the 'space gap' between the United States and other countries is narrowing, there is some reason to ask whether the current American threat assessment is overly pessimistic. It also is clear that other space-faring countries, including the Russian Federation and America's European allies, are far less concerned about threats to their own assets—although perhaps this is because the United States remains more dependent on use of space for both commercial purposes and global military power projection.

According to the Stockholm International Peace Research Institute, the United States at the end of 2001 had nearly 110 operational military-related satellites, compared to 40 for the Russian Federation and 20 for the rest of the world combined.[2] The United States is also a global leader in the commercial uses of space, with the American military being a prime consumer of commercial satellite communications capabilities. Indeed, according to the French space agency, the United States devotes six times more government funds to space than Europe.[3]

Even if a reasonable case can be made that the current and potential future threats to American space assets require stronger military response measures, it is unclear whether space-based weapons are the right answer for either American or global security. Not only are there a number of direct protective measures available for American space assets short of the development of new weaponry, there are also arms control options that could be considered. Indeed, most members of the United Nations are interested in negotiating a treaty to ban the deployment of weapons in space.

In the light of the emerging policy direction in Washington, however, it is imperative that the international community seriously begin to consider the issues surrounding the weaponization of space. At a minimum, it would behove the space-faring nations of the world to actively start discussions with the United States regarding threat perceptions and risk management approaches, as well as future

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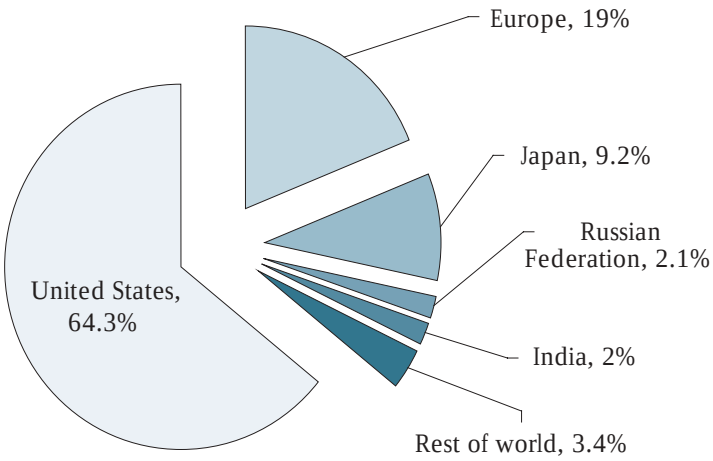
'rules of the road' for the use of space that take into account the growing importance of space-based assets for global prosperity and security. Waiting for Washington to decide a policy path regarding space-based weapons before beginning such discussions will be too late.

World government civil space budgets in 1999



Source: CNES, *2001–2005 Strategic Plan*

American threat perception—driven by vulnerabilities

American intelligence officials are convinced, and have said publicly, that the threat to American military dominance in space is growing. Navy Vice Admiral Thomas Wilson, director of the Defense Intelligence Agency, testified during a 19 March 2002 hearing of the Senate Armed Services Committee that potential adversaries would have significant means to disrupt American space systems by 2010—citing efforts abroad to explore directed energy weapons (lasers), methods of attacking satellite ground stations, jamming and computer attacks.[4]

During the same hearing, CIA Director George Tenet said the development of increasingly sophisticated reconnaissance satellites by countries such as China and India—as well as the growing commercial market in communications, navigation and imagery—is eroding the American military edge in use of space.[5]

In fact, concerns about threats to American space assets were highlighted very early in the current administration's tenure, with the January 2001 release of the report of the Commission to Assess United States National Security Space Management and Organization, better known as the Space Commission. The study, originally chaired by Donald Rumsfeld, the current American defence secretary, warned that the United States could face a 'Space Pearl Harbor' if a myriad actions were not taken to improve the security of space assets. Noting that the United States is more dependent on the use of space than any other nation, the Space Commission report stated:

> Assuring the security of space capabilities becomes more challenging as technology proliferates and access to it by potentially hostile entities becomes easier. The loss of space systems that support military operations or collect intelligence would dramatically affect the way American forces could fight, likely raising the cost in lives and property and making the outcome less secure. American space systems, including the ground, communication and space segments, need to be defended in order to ensure their viability.[6]

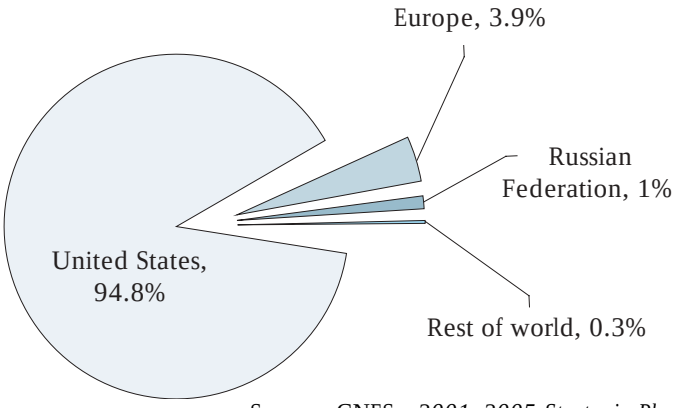
Dependence

The simple fact is that the American military could not operate the way it does today, on a worldwide basis, without the use of space. In particular, intelligence gathered via imaging and electronic eavesdropping satellites, instantaneous communications, and the use of satellite navigation tools to guide precision-weapons have totally reshaped the American way of war over the last decade. Indeed,

Rumsfeld has recently asked senior Pentagon officials to assess whether the military is *overly dependent* on space systems.[7]

The United States outspends the rest of the world by vast amounts in the military space arena, accounting for 94.8% of global military space budgets in 1999.[8]

World military space budgets in 1999



Source: CNES, *2001–2005 Strategic Plan*

And there is a nearly insatiable demand among the American military services for more bandwidth as networking the battlefield, from mobile forces in the field to strategic bombers at home, has become a key goal of the Pentagon effort to transform American military operations to better meet the challenges of global engagement in the post-Cold War world. For example, the demand for access to the radio spectrum in Afghanistan for use in such tasks as guiding unmanned aerial vehicles exceeded the bandwidth available. According to the House Government Reform Committee, 'Satellite bandwidth used in Operation Allied Force in Kosovo was 2.5 times that used in Desert Storm, while forces used were only one-tenth the size'—and the Pentagon's spectrum requirements for mobile communications are expected to grow by 90% by 2005.[9]

'Today, information gathered from and transmitted through space is an integral component of American military strategy and operations. Space-based capabilities enable military forces to be warned of missile attacks, to communicate instantaneously, to obtain near real-time information that can be transmitted rapidly from satellite to attack platform, to navigate to conflict area while avoiding hostile defenses along the way, and to identify and strike targets from air, land or sea with precise and devastating effect', states the Space Commission report.[10]

While many military satellites have built in certain types of protection, such as hardening against electro-magnetic radiation that would be emitted from a nuclear weapon burst, commercial satellites have little protection. In fact, a key concern for the American military is the vulnerability of communications satellites providing such services as television broadcasting, mobile telecommunications and Internet access. This is because the American military relies on commercial providers for about 60% of its communications needs.[11]

Furthermore, Tenet has just directed American intelligence agencies to use more commercial imagery for mapping, and other purposes.[12] This is in part because so-called national technical means, the nation's spy satellites, are being overtasked by the 'war on terrorism'.

More global access

Another simple reason for American military concerns is that there are a growing number of countries with space-based capabilities, numbering today at over fifty. There are about 600 functional satellites in Earth orbit, the vast quantity of them for commercial uses. The technologies involved, from telecommunications to satellite tracking to imaging, are becoming more sophisticated and more widely available.

According to a senior Air Force official, there are eight or ten countries seriously involved in using space assets for military purposes. These include the Russian Federation, China, France, the United

Kingdom, India, Japan, Israel and Brazil, among others, he said. Pentagon officials also assert that a number of these countries are also pursuing new types of space technology, such as microsatellites, that could be used as space-based weapons.

In addition, new commercial technology that could be put to military uses, especially high-resolution commercial imagery and satellite navigation/positioning equipment, is becoming widely available on the open market.

For example, in an unprecedented move, the Pentagon in late 2001 entered into an exclusive contract with American firm Space Imaging to buy up all the imagery of Afghanistan taken by the firm's Ikonos satellite to prevent global media firms from obtaining pictures of American bombing during Operation Enduring Freedom.[13] This move prompted discomfiture in some other parts of the world. Because the United Arab Emirates, a Space Imaging customer, was directly affected by the Pentagon buy, the six countries of the Gulf Cooperation Council are now considering buying their own imaging satellite rather than rely on American commercial providers.[14] Besides the United States, France, Israel and the Russian Federation already are in the imagery satellite business.

American military officials also are worried about the future availability of data from the European Union's planned Galileo navigation satellite network—and have been in discussions about the issue with European officials.[15] American officials have been trying to reach an agreement with the European Union that navigation and positioning data will be denied to certain parties if requested by the United States.

Many American military and political leaders are convinced that, given the dissemination of technology, warfare in space is unavoidable, and that it is thus necessary for the United States to be prepared to conduct and win wars in space.

'I believe that weapons will go into space. It's a question of time. And we need to be at the forefront of that', Pete Teets, undersecretary of the Air Force and director of the National Reconnaissance Office, told a 6 March 2002 conference in Washington.[16]

The prevailing wisdom in all branches of the services is that 'conflict in space is inevitable'.

While Teets, who is now the Pentagon's lead official for procurement of space programmes, was careful to say that no policy decision to put weapons in space has yet been made, his views reflect a consensus among top Air Force leaders—and indeed, among military officials across the board. Again, the prevailing wisdom in all branches of the services is that 'conflict in space is inevitable'.[17]

Vulnerabilities

The vulnerabilities of American military space assets and capabilities, and thus the *potential* threats, can be catalogued in several ways.

First of all, there are numerous types of military satellites in varying orbits—thus with varying vulnerabilities. Perhaps most vulnerable, simply because of their position in orbit, are those satellites in Low Earth Orbit (LEO), usually characterized as those below 1,000 miles (1,667km) above the Earth. There are at least twenty-four American military reconnaissance, electronic intelligence and meteorological satellites in LEO, according to Al Saperstein, a visiting scientist at the Union of Concerned Scientists and a physicist at Wayne State University.[18] Such satellites would be relatively easily reached by a ground-based anti-satellite weapon (ASAT) deployed on even an intermediate range ballistic missile. American military officials have also publicly worried about the possibility that a rogue state or sub-national actor could detonate a nuclear weapon in LEO, wreaking global havoc.

The American satellite navigation network known as the Global Positioning System (GPS), used for everything from setting atomic clocks to guiding precision weapons to targets, has its satellites parked in what is known as Medium Earth Orbit (MEO) at 12,865 miles (21,000km).[19] These have semi-synchronous orbits, passing over the same spot on Earth once a day. The Russian Glonass system also is in this orbital zone, as will be Galileo.

While higher up and thus harder to reach, the Pentagon (and Congress) is highly concerned about inherent vulnerabilities in the twenty-four satellite GPS network. For example, a September 2001 report by the United States Department of Transportation, *Vulnerability Assessment of the Transportation Infrastructure Relying on the Global Positioning System*, highlights the fact that the GPS network is easily disrupted in part due to its low power signals and because its characteristics are well known due to its civil uses.[20] The Space Commission noted that Russian-made, handheld jamming devices are already available that can block GPS receivers for up to 120 miles (193km). And, of course, the orbits of the individual satellites are stable and predictable. The GPS network is being improved to better protect it against jamming, and a newer model network is in the works, known as GPS III and expected to be fully deployed in the 2018 timeframe, that will have more satellites to improve redundancy.[21]

There are twenty-nine or more American military satellites in geosynchronous, or geostationary, orbit (GEO) around the Earth's equator at 22,300 miles (35,888km) in altitude. These pass over the same spot on Earth every twenty-four hours.[22] These include the hardened early warning satellites originally designed to watch for Russian nuclear missile launches. There are also numerous communications satellites used worldwide in this orbit. This orbit is harder to reach, but nonetheless China, France, India, Japan and the Russian Federation have launch vehicles that can place satellites in this orbit (and have done so), and thus could conceivably be used to launch ASATs.

The Space Commission report also includes extensive analysis (in an annex) of the possible vulnerabilities of American space assets, especially commercial satellites and communications grids. 'The reality is that there are many extant capabilities to deny, disrupt or physically destroy space systems and the ground facilities that use and control them'.[23]

Threatening technologies

The Space Commission annex, 'Threats to United States Space Capabilities', looks at threats based on types of technology available to potential adversaries. These are categorized as space object tracking and identification capabilities, and offensive counterspace operations.

Space object tracking and identification

'Foreign knowledge of U.S. space operations is a necessary precursor to the successful conduct of counterspace operations or camouflage, concealment, and deception activities', states the Space Commission annex.[24]

The annex cites a number of ways an adversary could track, and thus potentially target, an American satellite. These include the availability of tracking data by amateur satellite observers posting their findings on the Internet; the proliferation of air and theatre missile defence radar which can track satellites in LEO; and the increasing sophistication of sensor technology (radar, optical telescopes, passive radio frequency and even satellite signals intelligence receivers) and its wide commercial availability.

Offensive counterspace operations

The Space Commission threat annex defines offensive counterspace operations as 'the use of lethal or non-lethal means to neutralize an adversary's space systems or the information they provide.'[25] Using United States Department of Defense terms, it lists five major goals of such operations:

- deception—manipulate, distort or falsify information;
- disruption—temporary impairment of utility;
- denial—temporary elimination of utility;
- degradation—permanent impairment of utility; and
- destruction—permanent elimination of utility.[26]

There are basic types of attacks against satellites and satellite operations, according to the threat annex: 'denial and deception; attack or sabotage of ground segments; direct anti-satellite (ASAT) attack; and electronic attack on the communications, data, and command links of [either] the satellites or ground stations'.

Ground station attack

Currently, the simplest way to attack satellites and satellite-based systems involves ground-based operations against ground facilities. Many of these facilities are not heavily protected: a truck bomb would suffice, or an attacker could use computer network intrusion.

Hacking and jamming

The other relatively simply method is disruption of computerized downlinks between satellites and ground stations. Hacking and jamming also are the least expensive options for anyone interested in disrupting space-based networks, because they do not require putting anything into orbit. The high cost of space launch (ranging between US$5,000 and $10,000 per pound) is not a trivial matter, even for space-faring nations such as the Russian Federation and China, much less for 'rogue' states such as North Korea or non-state actors.

Incidences of computer hacking against American military, financial and industrial networks continue to rise and several countries, including China, are known to be exploring information warfare capabilities. Many countries already have developed military electronic jamming systems (including the Russian Federation, China, Iran, Cuba, Iraq and North Korea) and that technology is becoming widely available even on the commercial market.

Nuclear burst

With regard to the direct ASAT threat, there is broad agreement in the American expert community that the detonation of a low-yield nuclear weapon in LEO will kill nearby satellites through the electro-

magnetic pulse (EMP). Perhaps more troubling is that such an explosion would also degrade most others in LEO orbit over a few months time by seeding the Earth's Van Allen belts with highly charged electrons that increase the ambient radiation exposure of satellites passing through the belts to such a degree that their electronic components ultimately fail. Further, this excess radiation could linger in the Earth's magnetic field for years, so satellite replacement would be futile for some time.[27] Such an attack would be available to any country with intermediate range ballistic missiles and nuclear weapons, including India and Pakistan and possibly Iran.

Microsatellites

Pentagon officials also often cite the emergence of microsatellites and nanosatellites, using light-weight composites and high-speed computer chips, as a key potential threat. Microsatellites are usually defined as those weighing less than 100kg, nanosatellites as those weighing less than 10kg. 'These micro/nanosatellites, when employed as unacknowledged secondary payloads, can covertly rendezvous with other space assets to perform satellite inspection and other missions to disrupt, degrade or destroy space assets. Small, low-powered, ground-based lasers can be used to blind optical satellites in orbits out to GEO. With advances and proliferation in standoff weapons technologies, laser, radio frequency and particle beam weapons will likely be available to adversaries in the coming decades', the Space Commission threat annex states.[28]

According to the Space Commission report, companies in the United States, the United Kingdom, the Russian Federation, Israel, Canada and Sweden are involved in maturing microsatellite technology.[29]

The United Kingdom is a leader in microsatellite technology, and technology developed by the University of Surrey has been shared with a number of countries including China, Pakistan, Chile, Thailand and Malaysia, according to the Space Commission threat annex.[30] Indeed, Pentagon officials routinely cite Chinese press reports that Beijing is working on a nanosatellite ASAT system, although the Chinese government's official position is that ASAT weapons should be barred. There obviously is discussion of the issue in China. For example, a 5 July 2000 article in China's official news service in Hong Kong stated, 'For countries that can never win a war with the United States by using the method of tanks and planes, attacking the American space system may be an irresistible and most tempting choice. Part of the reason is that the Pentagon is greatly dependent on space for its military action'.[31]

ASAT interceptors

Besides emerging microsatellite technology, the Space Commission threat annex lists the following types of ASAT interceptors as possible and potentially available to those wishing to target American space assets directly: low-altitude direct-ascent interceptors, low-altitude short-duration orbital interceptors, high-altitude short-duration orbital interceptors, and long-duration orbital interceptors. 'These weapons are typically ground- or air-launched into intercept trajectories or orbits that are nearly the same as the intended target satellite'.[32] Obviously, low-altitude direct-ascent interceptors ground-launched or air-launched against LEO satellites would be the simplest, and cheapest, type of ASAT to develop.

The latter category of long-duration orbital ASATs, those that are launched into a 'storage' orbit for months or years (either on their own, or carried on a 'mothership' satellite), is further broken down to include the following concepts:

- Farsats—parked in a storage orbit some distance from their targets and manoeuvrable to engage on demand;
- Nearsats—deployed close to their targets to inspect and attack on demand;
- Space mines—deployed in orbits that intersect targets' orbits and detonated during a close encounter;
- Fragmentation or pellet rings—vast quantities of small, non-manoeuvring objects dispersed from one or more satellites to create a ring, so that any satellites moving through the ring would be damaged or destroyed; and
- Space-to-space missiles—rocket-propelled ASAT interceptors launched from an orbiting carrier platform to intercept their targets.[33]

Exotic ASATs

Finally, on the high-end of the scale for complexity and difficulty, the threat annex lists laser ASATs, radio frequency ASATs (both high power microwave and ultrawideband, also known as video pulse), and particle beam ASATs as potential future weapons. However, the threat annex is careful to categorize these technologies, for the most part, as difficult, expensive and far away from maturity.[34]

Threat assessment: more than capabilities

It is obvious that American space systems do have inherent vulnerabilities. It is also obvious that technologies for exploiting those vulnerabilities exist, or are likely to become available over the next several decades. However, neither vulnerabilities in American systems nor the potential capabilities of others necessarily translate into *threats*. In order to threaten American space assets, a potential adversary must have not only the technological *ability* to develop weapons and the *means* to develop and use them, but also the *political will* and *intent* to use them in a hostile manner. There is little evidence to date that any other country or hostile non-state actor possesses both the mature technology and the intention to seriously threaten American military or commercial operations in space—and even less evidence of serious pursuit of actual space-based weapons by potentially hostile actors. There are severe technical barriers and high costs to overcome for all but the most rudimentary ASAT capabilities, especially for development of on-orbit weapons. It further remains unclear what political drivers—outside of American development of space-based weaponry—would force American competitors, in the near- to medium-term to seriously pursue such technology.

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Moreover, there is little public concern voiced by other space-faring nations, including American friend and allies, about potential threats to their space-based assets—although China and the Russian Federation are uncomfortable with the possibility that the United States might deploy ASAT capabilities. This may be explained by the fact that no other nation's military and commercial operations are so space-dependent, but it also may be that these nations simply do not see the emergence anytime soon of a credible threat.

Indeed, most other countries are more concerned about the threats to global space systems from the possible *weaponization* of space, thus the widespread international interest in a space weapons ban. Key concerns include the creation of debris from testing or actual warfare, and space traffic

control as orbital positions become more crowded. Debris is considered perhaps the most critical near-term issue, according to many space scientists. Even tiny pieces of debris can damage or kill satellites, and there are several ongoing efforts to find ways to mitigate creation of space debris—in fact, the United States is a leader in this arena, having developed national guidelines for debris mitigation applicable to both commercial and military space activities.

As noted, there are scattered reports of Chinese interest in ASAT technologies, but evidence of actual progress is scant. The Russian Federation, like the United States, has explored ASAT technology since the beginning of the Cold War, but there is little reason to believe that Moscow has changed its policy against deploying such weapons (the Russian Federation has had a unilateral ban on ASAT testing for some time), especially given the current cash-starved state of the Russian space programme. No other country has shown visible signs of interest (although obviously any space-faring nation, such as India or Pakistan, has latent capability).

'[C]laims of adversarial space weapons are simply unfounded. Military futures studies often cite predictions of foreign space-based particle beams and other such technologies, but in reality they merely provide paranoid justification for U.S. space programs. … The overwhelming evidence suggest that, unprovoked, the rest of the world is simply *not* interested in space weaponization at this time', states former Air Force Lt. Col. Bruce M. DeBlois in a 1998 study.[35]

Similarly, a 1998 RAND study found that no 'nation possesses an operational ASAT capability that poses a significant threat to U.S. national security space systems'.[36] This has not changed in the past four years, despite rapid improvements in enabling technologies—especially for ground-based ASATs and computer-based disruption. Again, while these sorts of technologies are increasingly available, development of working ground-based ASAT systems would not be all that simple or all that cheap. Ballistic missiles are hard to operate and maintain, and they are easy for potential adversaries to keep an eye on. Hacking is more of a worry, but satellite networks (especially American military networks) are equipped with computer protections (and those are upgraded on a regular basis).

The barriers to development and deployment of actual space-based weapons are much, much higher, even for the American military. There are fundamental technical obstacles to the development of kinetic kill weapons and lasers both for use against targets in space and terrestrial targets, and the costs associated with launch and maintaining systems on-orbit are staggering.

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For example, problems with lasers include power generation requirements adding to size, the need for large quantities of chemical fuel and refuelling requirements, and the physics of propagating and stabilizing beams across long distances or through the atmosphere. Space-based kinetic energy weapons have major challenges, too, including achieving proper orbital trajectories and velocities, the need to carry massive amounts of propellant, and concern about damage to one's own forces from debris resulting from killing an enemy satellite. Space-based weapons also have the problem of vulnerability, for example, predictable orbits and the difficulty of regeneration.

A detailed discussion of the technology challenges is beyond the scope of this paper, but a good primer on the innumerable problems with developing space-based weapons is a September 1999 paper by Maj. William L. Spacy II, 'Does the United States Need Space-Based Weapons?' written for the College of Aerospace Doctrine, Research and Education at Air University, Maxwell Air Force Base, Alabama.

A new study by RAND's Project Air Force, *Space Weapons/Earth Wars*, also details technological challenges to various types of space-based weapons that might be used against terrestrial targets. The

study further lists several general limitations of space-based weapons and defences, explaining that space weapons face exactly the same vulnerability problems that satellite networks do.[37] The truth of the matter is that technology (not to mention cost) is a crucial limiting factor for the development of satellite networks, ASATs and space weapons—and explains why only a limited number of countries are now so capable.

Intent

As noted, in undertaking a threat assessment, there is also the question of intent of potential adversaries. It is not obvious, from unclassified sources at least, that any nation has any intention, or even incentive, to launch a war in space or attack American space systems. As noted, most countries, including China and the Russian Federation, have been urging a global ban on weapons in space. Many experts, including a number of Air Force strategists, persuasively argue that an American move to put offensive weapons in space could have the perverse effect of creating a new threat to American space assets because other countries would feel compelled to follow suit.[38]

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China

As noted above, there have been sporadic reports regarding China's interest in disruption of American space-based capabilities. At least in the open literature, there seems to be some argument among Chinese military officials and experts about the best course to chart regarding space. China has many fewer space assets than the United States, despite ambitious plans for the future of its space programme. China is the third nation to develop a manned civil space programme, albeit many decades after the United States and the Russian Federation. Many observers, however, believe China will emerge as a major space power. 'China is set to become a major space power pursuing regional and intercontinental objectives. It could be the world number two in space by 2020', according to the year *2001–2005 Strategic Plan* of France's space agency, the Centre National d'Etudes Spatiales (CNES).[39]

That said, China's official position regarding space weapons is that ASATs and space-based weapons should be banned under a multinational treaty. Indeed, China has been pushing for a treaty on the non-weaponization of outer space since the late 1980s, driven in part by the United States Strategic Defense Initiative and its follow-ons. Chinese military officials also expressed concerns following the Persian Gulf War about the American military's ability to use satellites to amplify American military superiority on the ground in a way not seen before. According to Li Bin, director of CDI-Tsinghua Program on Cooperative Security in Beijing, Chinese arms control officials say they believe space weapons would be detrimental to world security, not just Chinese security.[40]

In recent years, China has been a key proponent of negotiating such a ban within the United Nations Conference on Disarmament (CD), in talks known as PAROS (Prevention of an Arms Race in Outer Space). At the 7 June 2001 meeting of the CD in Geneva, Chinese Ambassador Hu Xiaodi said such negotiations are urgently needed because of American missile defence and space-control plans, and presented a working paper describing potential elements of such a treaty.[41]

That working paper, 'Possible Elements of the Future International Legal Instrument on the Prevention of the Weaponization of Outer Space', includes concepts such as: 'the prohibition of testing, deployment, and use of weapons and weapon systems and their parts and components in outer space; and the prohibition of testing, deployment and use of weapons, weapon systems and their parts and components from outer space against targets on land, sea and air', according to Cheng Jingye, deputy director of the Arms Control Department at the Chinese Ministry of Foreign Affairs.[42]

In 2002, China followed up with a joint paper with the Russian Federation, presented to the CD at the 28 June meeting.[43] According to Cheng, China strongly believes negotiations on such a treaty are urgently needed within the body. 'China is of the view that introducing weapons into space will not contribute to the goals of ensuring space security or reducing space vulnerabilities. Rather it will lead to an arms race in space, which will then be turned into another battleground, thus endangering our dependence on space'.[44]

At the same time, however, some influential thinkers in China have argued that the revolution in military affairs requires China to now consider its options in space. Some maintain that space warfare with a superpower should be a Chinese concern, and that China needs anti-ASAT technology, smaller satellites to reduce vulnerability and first strike capabilities in space.[45]

According to the Pentagon, China already has jamming technology and may be developing ASAT capabilities, including a ground-based high-energy laser and other lasers to blind optical satellites.[46]

However, as indicated, much of China's interest in space seems to stem directly from concerns about American military activities in space. According to the Nuclear Threat Initiative, China's worries about protecting its space-based assets are due to concern about American development of missile defences and future American global dominance as a result of American space power.[47] Indeed, at the 7 February 2002 meeting of the CD, Hu specifically mentioned American actions as a key reason that negotiations on the weaponization of space should commence quickly. 'Now that the ABM [Anti-Ballistic Missile] Treaty has been scrapped and efforts are being stepped up to develop missile defence and outer space weapon systems, there is an increasing risk of outer space being weaponized', he said.[48]

The Russian Federation

As a long-time space power, the Russian Federation is highly concerned about maintaining the integrity of both its military and commercial space capabilities. However, that concern emanates less from worries about external threats to its assets, and more from the fact that the Russian space programme has deteriorated due to lack of funding. In June 2001, Yuri Koptev, head of Russian space agency Rosaviakosmos, told the parliament that age and lack of funds were serious issues, with sixty-eight of the Russian Federation's ninety orbiting satellites near or at the end of their operational lives.[49] He further stated that many of the country's forty-three military satellites were simply too old to be considered reliable, and criticized the Russian Federation's meagre space budget of US$193 million as only half of what the agency needs.

Indeed, in May 2001, the Russian Federation for a short time lost its photo-reconnaissance capabilities, taking its last two satellites out of orbit (although a replacement 'Kobalt' satellite was launched in June 2001).[50] the Russian Federation's Glonass satellite navigation system (similar to the American GPS network) also is deteriorating; in March 2001, Koptev told parliament that only thirteen of the twenty-four satellites required for the network to fully function were working.[51]

Attempting to reverse the decline, the Russian Federation's Security Council moved in May 2001 to re-establish an independent military space force combining all its military space programmes as well as coordinating commercial ventures.[52] Still, the Russian Federation's space programme continues to be dogged by underfunding and decrepit equipment. This, rather dangerously, includes is missile warning satellite networks.

Russian Defence Minister Sergei Ivanov, in February 2002, said that the Russian Federation has 'been short of space assets and to build normal modern armed forces when you are blind and deaf is futile. … We plan to replenish the group of our satellites, notably for the purpose of information, communications and intelligence'.[53]

At the same time, since the dawn of the Cold War the Russian military has been interested in ASAT capabilities. The Soviet Union began work in the early 1960s on a non-nuclear co-orbital ASAT, and ran a number of tests on the system between 1968–1971. After a four-year hiatus, the Soviets restarted ASAT testing in 1976 and continued up until 1981, despite the launching of ASAT talks by the administration of American President Jimmy Carter in 1978.[54]

In addition, the Russian Federation (again, like the United States), has researched ground-based laser ASAT capabilities since the 1980s. According to the 2001–2002 *Jane's Space Directory*, 'For years, Western observers have held that the Sary Shagan and Dushanbe lasers may be capable of damaging passing satellites' sensitive components. Although weather and atmospheric beam dispersion may limit such ground-based lasers, they have the advantage of being able to refire and thus disable several satellites'.[55] An American congressional delegation toured Sary Shagan in 1989, however, and was told by the Soviets that the facility was used only for tracking, Jane's continues.

Despite the work on laser ASATs in the mid-1980s (and possible testing of the Dushanbe laser in 1986), the Soviets in 1983 declared a unilateral moratorium on deploying ASATs, provided no other country deployed. Post-Soviet Russia has reiterated this policy. The 2001–2002 *Jane's Space Directory* notes the status of the Russian ASAT programme as 'inactive'. Indeed, as noted above, the Russian Federation is a key supporter of the PAROS talks and a ban on both ASATs and weapons in space.

Russian military officials, however, have expressed concerns similar to those expressed by their Chinese counterparts about future plans of the American military. Col.-Gen. Anatoliy Perminov, appointed in 2001 as the commander of the new Russian Space Forces, said that the international community 'should be on guard regarding the American policy of the military utilization of outer space. The military-political leadership of the United States continues to have plans to … create a missile defense system using space-based elements, and launch a chemical laser into space'.[56] He also cites American military doctrine and space policy as 'reserving the right to employ force to conduct military operations in space, through space and from space', as of concern.

And certainly, the Russian space establishment is technically accomplished enough that, given sufficient funding—which is a very large if in the near- and medium-term—new research programmes could be brought up to par with American efforts. According to CNES, 'Russia has succeeded in maintaining most of its space systems skills base by entering the commercial marketplace. However, it is also continuing with the cutbacks in government programmes already well underway in the 1990s as it is forced to confront its enduring economic problems. We can nevertheless expect to see a renewed willingness to sponsor military space programmes in the decade ahead, particularly in response to U.S. ballistic missile defense initiatives'.[57]

Perminov, however, denied that the creation of the Russian Space Forces signalled the intent by the Russian military to mimic American space weapons aspirations. 'Russia has never had and does not have any plans to create and place in orbit any space systems with weapons on board'. Instead, he said, Russian Space Forces were 'dictated by the real rise in the role of national space complexes and

systems in providing information support for the activity of the armed forces of Russia, and is a highly important element for the further reinforcement of the country's defense and security'.[58]

Europe, Israel and other nations

Unfortunately, there seems to be little open research on other nation's threat assessments regarding space. One European defence official noted that while there has been some discussion at least in British military circles about concerns regarding hacking and jamming of space assets, there simply has not been much attention to the problem. A British official echoed that not only his nation but also the other European countries have much more pressing military needs and have simply not seriously addressed the issue of threats in space. Likewise, according to Yiftah Shapir of the Jaffee Center for Strategic Studies at Tel Aviv University, no one in Israel is addressing the question in open literature.[59]

Indeed, Europe's two major space powers, the United Kingdom and France, are primarily focused on civil space—indeed, the military in both nations is a secondary partner within the two nations' space agencies. As for the 'lesser' or 'emerging' space powers, it is interesting to note that while Israel has focused on satellite surveillance for military purposes, India has taken a strictly civil approach focusing on using space assets for support of national economic and social development, and mitigating natural disasters.

France

France is arguably Europe's major space power, and indeed, the driving force behind Europe's collective space endeavours under the European Space Agency and the European Community. France's CNES was formed forty years ago and serves both as a space agency and a technical centre. While primarily a civil agency, it is overseen by both France's Ministry of Research and the Ministry of Defence. Military space efforts are coordinated by the Space Coordination Group, chaired by the French chief of staff and with participation by the defence procurement agency, the DGA. France is active in a wide variety of space efforts, from launch (Ariane) to Earth observation (SPOT and the civil/military Helios) to telecommunications and space exploration, and is a major player in the European effort to build Galileo.

According to the *2001–2005 Strategic Plan*, France sees the military roles of satellites as:

> Gathering strategic and operational intelligence anywhere, in all weathers and at frequent revisit intervals, to provide information about current or nascent conflict situations. Such information is acquired by military and commercial optical and radar satellites serving a spectrum of applications spanning intelligence, imagery and awareness of the air, land and sea environment. Lastly, electro-magnetic intelligence, space surveillance and early-warning systems now offer the ability to prevent attacks on national territory and to identify forces projected to remote theaters of operation.
>
> Distributing information via geostationary satellites and constellations of low-Earth (LEO) and medium-Earth (MEO) satellites, to complement or back up terrestrial networks and undersea cables.
>
> Delivering continuous information services such as navigational and location aids, and providing a reference for timing and synchronization.[60]

Nowhere does the CNES strategy document discuss threats to space assets, although France and the European Space Agency are active on the issue of space debris. Indeed, the strategy seems primarily aimed at commercial aspects, especially the viability of the French and European space industry. This is similar to publicly available European Space Agency strategy documents—CNES states that while the American space strategy 'is geared towards military uses of space and human spaceflight', the European strategy is 'tailored more to supporting sustainable development, managing the environment, and social and economic spinoffs'.[61] Interestingly, while the strategy discusses the Chinese, Russian, Indian and Japanese space programmes, it is with an eye to both commercial competition and future cooperation—for example, noting the likelihood of growing international interdependence with regard to space launch because of the difficult market and the growing influence of international industry consortia.

While the American space strategy 'is geared towards military uses of space and human spaceflight', the European strategy is 'tailored more to supporting sustainable development, managing the environment, and social and economic spinoffs'.

Furthermore, in reviewing the American space programme, the document reflects little concern about vulnerabilities to American assets either, rather just the opposite, stating: 'The United States is indisputably the world's leading space power. … The United States possesses a panoply of space-based defense and national security assets that give it the ability to deploy forces with maximum security anywhere in the world. U.S. space systems are regularly renewed and capable of surviving most threats'.[62]

The United Kingdom

The United Kingdom is the second largest OECD user of space after the United States, with a very strong space science research programme, according to the British space agency, the British National Space Centre (BNSC). BNSC is a part of the Department of Trade and Industry, which 'is a good indication of how London views space—i.e., it's seen very much in commercial terms', said Mark Smith of the Mountbatten Centre for International Studies at the University of Southampton in the United Kingdom.[63]

The Ministry of Defence is, however, one of eleven government agencies partnering in BNSC, and the Ministry of Defence's research organization, DERA, plays a major role. According to BNSC, 'the United Kingdom's priorities in space are new initiatives in space science, Earth observation, satellite navigation and telecommunications, especially those that have an impact on the information-led economy'.[64]

In its most recent space strategy, *United Kingdom Space Strategy 1999–2002*, BNSC notes the following objectives for military space:

> To have sufficient assured access and capability to exploit space, in order to sustain optimum military effectiveness, cost efficiency and interoperability across defence programmes and in direct support of operations.
>
> To capitalize on the increasing synergy between military and civil developments in all sectors of the space market.[65]

By and large, the British military is seeking to use commercial capabilities whenever possible, for communications, imagery and weather surveillance, and even navigation and targeting requirements

where possible. In the communications arena, however, the military does intend to continue to own its own assets managed through public-private partnerships. And the Ministry of Defence currently relies on the American GPS network for navigation and timing, although it is also partnering in the Galileo effort.

Much like its French counterpart, the British space strategy does not make much mention of threats to space assets, with the exception of debris. The document notes that one of the objectives of the strategy is 'to coordinate with other agencies work on the threat to the Earth from space debris and near-Earth objects'. It goes on to note:

> Space debris is a particular concern for users of the popular Geosynchronous Earth Orbit (GEO), the Sun-Synchronous Earth Orbit (SSO) and the Low Earth Orbit (LEO). Designers of launchers and payloads must plan to produce little or no debris during normal launch and operational procedures and aim safely to de-orbit all elements as soon as possible after the end of their operational life. In addition, new space transportation devices and payloads must be designed to improve their survivability.[66]

The Ministry of Defence's most recent defence strategy paper, however, mentions the increasing importance of space-based assets to future military operations, and the risk from the wider availability of such technologies. The document, *The Future Strategic Context for Defence*, notes that the information technology revolution is changing how the military operates, adding: 'and the development of space-based systems, originally driven by the [United States] and others (notably Russia and China) for defense purposes, is now becoming a commercial activity, potentially bringing significant capability to a wider range of nations and organizations'.[67]

The document later notes that while the most potent threats in the next couple of decades will come from conventional capabilities such as attack helicopters and long-range indirect fire, that 'the future battlespace will be inherently joint and multidimensional, encompassing space, cyberspace and the electro-magnetic spectrum' and that 'the use of directed energy weapons' is seems likely to increase. Concern is also raised as to the possibility of asymmetric warfare: 'Adversaries may seek to exploit growing reliance on information systems through offensive information operations. Weaknesses or delays in decision-making processes and command and control structures will be exploited to the full'. In addition, '[c]ivilian infrastructure and information systems may be targeted and such attacks may not always be traceable'.[68]

While not directly referring to possible targeting of space-based assets, as noted above, British defence officials have been expressing some concern as to the potential threat from hacking and jamming satellite networks.

Still, there appears to be little discussion in the United Kingdom of a space threat, nor the possible need for space-based weapons.

Smith noted that because no European nation has the force projection responsibilities of the United States, the pressing need to protect space assets just has not arisen. In addition, Europe continues to rely on the United States as the leader in any coalition action and thus would be primarily dependent on American space-based command, control and communications. Smith explained that, in his view, the British position remains 'wait and see', with few strategic drivers for, and little enthusiasm for spending money on, space weaponization.

'The upshot is: we can't afford it, we may not need it, and, if we do need it, it will be in the context of a U.S. operation rather than because of any independent European intervention', Smith said.

Conclusion

American policy-makers and military officials are becoming increasingly agitated about potential threats to American space assets and are determined to address those potential threats. Although it is obvious that there remain questions as to the scope of those potential threats, their imminence and how best to address them, it is also obvious that the United States currently is on a pathway that—if not arrested—eventually will lead it to become the first nation to weaponize space. It should be clear that there is little to be gained from what seems to be the current *modus operandi* in the international debate: with others remaining content to simply denounce American disinterest in discussing the weaponization issue. If the international community is serious about preventing space from becoming a future battlefield, other space-faring nations must immediately begin serious efforts to understand the American position, undertake their own threat assessments, and find ways to work with Washington to achieve mutually agreeable solutions that both protect space-based assets and avoid creating future threats to the further development of space as a global commons. Risk management approaches, 'rules of the road' and transparency measures are all ideas that could be useful despite current American reluctance to sign up to a weapons ban. Creative thinking will be required; the sooner, the better.

There is little to be gained from what seems to be the current* modus operandi *in the international debate: with others remaining content to simply denounce American disinterest in discussing the weaponization issue.

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