China as a Military Space Competitor

James A. Lewis
Center for Strategic and International Studies
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Public recognition of China's long-standing and ambitious space program increased dramatically with the orbit of a taikonaut around the earth. The orbital mission was an assertive step into what many have lately seen as an American province. China's motives for going into orbit are similar to those that drove Russia and the U.S. to undertake manned missions – to gain national prestige, and to signal wealth, commitment and technological prowess.

Manned space flight is primarily a political act. While China gains real political benefit from orbiting a human, the military benefits are small. China is already among the leading space powers and is developing a full range of space capabilities. Its manned program is one of these capabilities and in some ways is the least interesting militarily. This paper puts Chinese military space efforts in perspective and considers how the U.S. might respond.

Manned platforms have little military utility. When Russia and the U.S. began manned space exploration, some thought that human space flight might provide military benefit and that a capsule and its pilots could act as an extension of air operations. This proved to be an illusion. The ability to put humans in space shows a level of technical proficiency, but a manned program provides only indirect benefits to national security. These benefits result from applying the abilities and the confidence that manned space flight brings to unmanned programs with greater military utility. In fact, by taking resources away from space programs with greater military utility, the manned space effort may slow China's progress in military space activities.

Since the 1970s, China's leaders have seen space programs as a tool to speed technological modernization and recognition of China as a great power. China's long-standing national space program is relatively advanced. It includes an indigenously developed family of liquid-fueled space launch vehicles that are competitive with western launchers, a large space research effort, and an extensive satellite industry. This satellite industry lags behind those of the U.S. and Europe, but joint ventures with foreign firms over the last decade have helped China improve its satellite manufacturing capabilities. China has made space remote sensing a priority and has developed its own communications and navigational satellites. The range of Chinese space-related activities indicates a commitment to self-sufficiency and, perhaps, a desire to play a leading role in space.

China has also identified space activities as an area where it could erode the U.S. military advantage. Beginning with the 1991 Gulf war and again in the recent conflicts in Kosovo, Afghanistan and Iraq, the Chinese learned that space power is essential for effective military action. China's leaders undoubtedly wish to no longer to depend on CNN to learn when U.S. carrier battle groups are approaching Taiwan. Given U.S.

reliance on space assets, the Chinese believe that space may be an area where the U.S. may be vulnerable. Public accounts of China's military planning indicate that it does not wish to leave the U.S unchallenged in the use of space in the event of a conflict.

However, the Chinese are not mirror-image competitors for the U.S. This could change as China's GDP increases and if relations between the two countries grow worse, but for now, China seems to want to avoid what some perceive as the Soviet error of spending themselves into bankruptcy in an arms race with the U.S. Reacting to a vigorous discussion in Chinese military journals, many analysts assert that what the Chinese seek, while upgrading their military capabilities, is asymmetric advantage, and to find areas where the U.S. and its style of warfare is more vulnerable to attack, an approach sometimes captured in a phrase used in PLA writings: "overcoming the superior with the inferior."

If China's goal is asymmetric advantage, some military space activities are more valuable for achieving this than others. Although China is exceptionally secretive about many aspects of its space programs (and this in itself helps generate suspicion), and although it frequently blurs the line between civil and military space activities, enough information about its programs has been made public to allow us to begin to assess the implications for U.S. military operations and national security. An initial conclusion from this information is that China does not concentrate its space efforts on the programs that could provide asymmetric advantage and it is not a competitor in military space.

A review of what China builds and launches suggests that China's military space efforts is often more a demonstration of technological prowess and sophistication across a broad range of space activities rather than an effort to build an operational military space capability. China has not assembled nor does it maintain the full range of capabilities in space needed for intelligence and military benefit. In some cases, China appears to build a satellite in order to show what it can do rather than to meet an operational need. A desire to demonstrate self-reliance (an important factor of Chinese policy in many areas beyond space) often seems to drive military space activities.[1]

For example, China and the European Union recently agreed that China would be one of the participants in the Galileo navigational satellite program (several other countries, including Canada and Israel are also participants). While technology transfer from Europe to China and input from China into Galileo's design and operation will be limited, cooperation will allow China to develop a more sophisticated understanding of navigational satellites. Press reports note that China has expressed interest in Galileo's 'Public Regulated Service,' which is intended for use by security services.[2] Galileo is another example of how China has used foreign partnerships to speed its indigenous space effort – not through the theft of technology, but by participating in and learning from the experience of other programs. But with access to Galileo, in addition to the access to Glonass and GPS signals, why China should build and launch three Beidou navigation satellites? Three satellites are not enough for effective military use and the funds spent on Beidou could probably have been better spent on other types of satellites that could provide asymmetric advantage.

Opaqueness on the part of the Chinese complicates analysis, but we can make some observations about Chinese military space activities based on observable and quantifiable data. It is next to impossible to hide many space activities, since launches and satellites are easily observed. This launch and satellite data provides the best insights into China's military space efforts and suggests that they are not concentrating on asymmetric advantage and instead are exploring the range of military space capabilities, albeit on a much lesser scale than the U.S. and at a much slower pace.

China has programs for communications, reconnaissance, navigation, anti-satellite (ASAT), and electronic intelligence (ELINT) collection.[3] If we take the most inclusive estimate for the classification of Chinese government satellites and assume that most have some military function, the distribution of launches does not differ greatly (except in ballistic missile early warning) from that found in the U.S. or in Soviet military programs.

Satellites Launched by Type (in percent)

	Com	Nav	Imagery	Sigint	EWarning	Other	Weather
US	17%	12%	41%	7%	7%	11%	6%
Russia	17%	12%	42%	11%	5%	9%	6%
China	23%	7%	44%	9%	0%	5%	12%

If the goal is to gain asymmetric advantage, China should invest primarily in those systems that pose a greater risk to the US or offer greater potential for asymmetric advantage. These include satellite reconnaissance, SIGINT, ASAT and microsatellites. Satellite navigation and communications increase the capabilities of Chinese forces; satellite reconnaissance and anti-satellite programs degrade the capabilities of U.S. forces. China over-invests in navigation and communications satellites. These programs pose less of a challenge to the U.S. and will create less of an advantage for Chinese forces than satellite reconnaissance and anti-satellite capabilities.

The major and crucial difference, however, is the on-orbit presence. China does not have a continuous military space presence equal even to what the Soviet or the U.S. were able to muster in the 1970s. In the last decade, the number of Chinese launches has totaled only about twelve percent of U.S. launches. In any given period, the Chinese operate no more than 6-10 satellites with most being communications rather than sensor platforms. The operational life of Chinese satellites, which press reports state is considerably shorter than those of comparable U.S. satellites, also reduce China's on-orbit military presence. While China's announced goal is to create a multi-satellite system for continuous operations, they have not committed the resources to achieve this.

Military Launches Per Year[4]

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	TOTAL
US	12	11	9	11	9	5	7	11	7	1	83
Russia	26	26	15	8	10	9	6	7	9	7	123
China*	1	2	2	3	6	6	4	5	1	4	34

*All non-commercial Chinese launches

Reconnaissance Satellites

A brief review of Chinese space programs reinforces a sense of unevenness in China's approach to military operations in space. Satellite reconnaissance is a clear example of this unevenness. For space programs with military applications, China has made the most progress in developing satellite reconnaissance capabilities, but these capabilities are still insufficient to provide military advantage.

Remote sensing technologies are a crucial element for building information superiority, and the Chinese military has identified them as a vital area for building its space capabilities.[5] China has built and flown numerous remote sensing and reconnaissance satellites, albeit on a sporadic and experimental basis. The first models were primitive, having poor image resolution (resolution refers to the level of detail in the imagery collected by the satellite) and relied on film- recovery to provide data. Over time, Chinese remote sensing efforts have become more sophisticated and the Chinese space remote sensing program is marked by a continuous degree of incremental improvement.

Building an effective satellite reconnaissance program has several phases. The first phase is the acquisition of the necessary technologies, their integration into functional satellites, and undertaking a successful reconnaissance operation. The second phase is to orbit a network of satellites, both reconnaissance and data relay, build ground stations and analytical centers to acquire and use the satellite imagery in a timely fashion and make satellite reconnaissance a routine activity. For military purposes, this must be accompanied by the creation of the capability to build remote sensing satellites and keep them continually in orbit to provide timely coverage.

Chinese reconnaissance satellites in the 1970s and 1980s (the FSW series) lagged far behind their U.S. and Soviet counterparts. The FY-1 series were an improvement, but still closer in capability to Landsat than to an intelligence satellite. The 1990s China-Brazil Earth Resources Satellite (CBERS) program still did not provide high-resolution imagery, but its multi-sensor payload and digital transmission capabilities showed considerable sophistication.[6] Recent remote sensing satellites, such as the ZY-2 (launched in 2000), use data links to relay electro-optical imagery back to earth by radio signal rather than film drop, providing a greater reconnaissance capability. The HY-1, launched in 2002, was designed for maritime surveillance and will carry improved optical sensors that may approach the capabilities of early 1990s western commercial sensors.

The third phase is the integration of satellites imagery with other kinds of intelligence and into military planning, first at the strategic level (which the U.S. and Soviet Union did in the 1960s) and then increasingly into tactical operations (initially as the provision of target packages to support individual air missions, later in the provision of near real-time data to commanders). This phase is, in some ways, more difficult as it requires re-conceptualization of strategy and tactics. An educated guess would put the Chinese somewhere early in phase two and movingly ahead at a stately if respectable pace, if the reports of PLA plans to have a constellation of four radar and four optical reconnaissance satellites in place by 2010 are accurate.[7]

China's primary weakness in building reconnaissance satellites is in sensors. Developing sensors capable of providing high-resolution imagery from space is a task that at one time only the U.S. and the Soviets had mastered. One of the changes in the last decade is that high quality space sensors are increasingly available from a range of other nations and on a commercial basis. China has sought to buy remote sensing technology from U.S., European, Russian and perhaps Israeli sources. Efforts by China for the covert or illegal acquisition of space sensor technology is more likely to be an espionage concern, rather than the space launch technology that preoccupied the U.S. Congress in the late 1990s.

High resolution is important for intelligence analysis— many details of weapons systems cannot be usually determined from 1-meter imagery—but it is less important for reconnaissance purposes. One-meter imagery is sufficient to identify ships, aircraft, and armored vehicles. Twenty meters would provide a limited capability to identify naval vessels. The type of sensor used to collect the imagery is another factor for assessing the value of this imagery for military and intelligence purposes. Multispectral satellites, which can use infrared radiation for imaging, are more useful and provide more information, but (at least for commercially available systems) do not have as good a resolution as visible light imagery. A decision to pursue a high-resolution radar imagery satellite would provide the capability to able to see through clouds and unmask decoys.

China has been working on an indigenous synthetic aperture radar satellite for at least a decade. A few recent reports suggest that the China's remote sensing program may have taken a great leap forward through the acquisition of advanced radar sensors with one-meter resolution from a Russian source (other reports put it at twenty meters).[8] If this is true, it would go far to solve the lack of advanced sensors that hampers the Chinese reconnaissance satellite program. Radar can see through clouds or rain and is particularly useful for maritime monitoring. This maritime mission is likely to be of high interest to the Chinese military, given the importance of Taiwan and the limits of their 'blue water' naval capability. Both the Russians and the Canadians developed radar satellites in order to monitor naval activity. China has some experience in the use of satellite data for ocean surveillance, as it has had access to Canadian RADARSAT data for several years and has operated a satellite maritime surveillance center for more than a decade.

Data relay satellites are essential for military space architecture. China has developed data relay satellites – special satellites that support reconnaissance by receiving signals from a reconnaissance satellite when it was out of range of a ground station – say over the eastern United States – and then relaying them back to China. Some sources say China plans to orbit two geo-stationary data relay satellites to support its other space sensor and military communications programs. These satellites reportedly form part of a larger command, control and intelligence effort being undertaken by the PLA.

What China has done on the ground is as important for satellite reconnaissance - and as limiting - as what it has done in space. Satellite reconnaissance depends on more than the possession of satellites. Countries seeking to use satellites for military purposes often overlook this terrestrial and expensive element of space power. Effective use of satellite services requires the development of a support infrastructure of analysts and operators and the integration of satellite data and services into military plans and operation.

China has several decades of experience with remote sensing programs and its access to data from foreign satellites could help develop the analytical capabilities needed for an effective military satellite reconnaissance system. Access to satellite data from foreign civil remote sensing satellites is important for understanding the pace at which China could develop its military capabilities. China has ground stations that receive data from France's SPOT, the European Unions ERS, the U.S. LANDSAT, Japan's JERS and the Canadian RADARSAT. Access to data from these satellites provides China with practical experience in analyzing and using satellite remote sensing data from optical, multispectral and radar sensors (on Chinese and foreign spacecraft).[9]

China has established five national-level centers for the analysis of space imagery, the most prominent being the China National Remote Sensing Center, which coordinates both civil and military satellite remote sensing efforts, and the Institute of Remote Sensing Applications.[10] China has been quick to recognize the usefulness of Geographic Information Systems (GIS).[11] The PLA General Staff Headquarters' Third Department, usually seen as primarily focused on SIGINT, reportedly also plays a role in analyzing satellite intelligence.[12]

Integration of imagery and other intelligence from space-based assets is a complex task. It requires a more flexible command structure and a greater emphasis on communications and the use of information at all levels of command. China lags behind in this area, where progress depends less on space programs and more on modernization of the PLA. China also lacks battlefield experience with tasking and integrating space data into military operations. Exercises can only go so far in remedying this. These problems can be overcome only through experience, suggesting that there will be a lag of some duration between China's acquisition of reconnaissance satellites and a functional military capability. In watching China's satellite reconnaissance program, we need to look not only for improvements in hardware and coverage, but for the changes in PLA organization and tactics that will indicate when space activities are becoming an integral part of China's military operations.

The Russians have used radar satellites for ocean reconnaissance since the 1960s. These maritime reconnaissance radar satellites provided data for long-range anti-ship missiles aimed at U.S. task forces, an option that would attractive to the Chinese military. However, radar satellites are only one part of an effective space maritime reconnaissance architecture. To be fully effective, they must be complemented by space-based SIGINT collection. In this regard, China's military space program does not seem to have put a high emphasis on SIGINT.

Signals Intelligence

SIGINT encompasses the interception of electromagnetic radiation to obtain two different forms of intelligence: communications intelligence (COMINT) and electronic intelligence (ELINT).[13] ELINT is an essential companion to imagery for reconnaissance, especially strategic and naval reconnaissance. China has a ground-based SIGINT network that has been described as 'the most extensive signals intelligence capabilities of all the countries in Asia."[14] This capability is based on ground stations, ships, and mobile platforms. China has acquired modern aircraft platforms, not satellites, to carry out its SIGINT missions. China also monitors international communications satellites from facilities in China.[15] The program is managed by the Third Department of the General Staff Headquarters, which is responsible for monitoring foreign and internal military communications and producing finished intelligence.

China's efforts at SIGINT and ELINT in space, however, have been sporadic. China had an experimental satellite ELINT program in the 1970s started at the behest of senior Chinese political leadership, but allowed the program to drop after a few years.[16] The SJ (Shi Jian) "Scientific Experiment" satellites have characteristics of SIGINT satellites.[17] The first SJ launch, in 1979, failed. A second launch in 1981 succeeded, but was followed by a long hiatus, with the next SJ not being launched until 1994.[18]

China also launched two DQ-1 satellites in 1990 that, although they were identified as being for atmospheric research, had many of the characteristics of ELINT satellites. Based on publications by Chinese scientists in technical journals, some observers believe that China has resurrected space ELINT research at several Chinese institutes with connections to the military. ELINT packages could piggyback onto other satellite payloads or they could be deployed independently.

The absence of dedicated ELINT satellites (and the resultant dependence on ground and aerial platforms) may be indicative of a territorial scope to China's ambitions. Alternatively, it could indicate a high degree of success in China's ability to covertly deploy SIGINT payloads. The clandestine nature of such programs and the paucity of public information make it hard to assess the degree of progress, but at least in one area, the program seems to be demonstrably deficient.

The Russian ELINT Ocean Reconnaissance Satellite (EORSAT) system provides direct tactical support to Russian air and naval forces by transmitting almost real-time targeting data. This targeting data can be sent directly to specially equipped ships (the Chinese do not appear to have such ships) or to ground stations for relaying to attacking naval forces. EORSAT, which used a constellation of satellites to provide coverage and, when ships were detected, to deliver data on multiple targets rapidly to weapons systems, was an essential part of Soviet planning to attack the U.S. Navy.

China's lack of a space ELINT capability is puzzling and suggestive given its purchase of long-range anti-ship missiles from Russia. The ability of these missiles to use satellite data, both ELINT and radar, to target ships is an essential component of their long-range capability. In particular, the SS-N-26 long range anti ship missile is made by the same Russian entity that is allegedly supplying China with space radar sensors, NPO Mashinostroyenia. NPO Mashinostroyenia has a long history of developing advance anti-ship cruise missiles and has considerable experience in using radar satellite data with the targeting of Western naval forces.[19] If China does not invest in space surveillance, the effect is to limit the effectiveness of their new purchases. Despite upgrades to their naval forces and weaponry, the Chinese do not seem to be in any rush to deploy supporting ELINT satellites. This may be only a temporary delay, it could reflect either satisfaction with current levels of collection or a conscious decision not to expend resources on ELINT, or it might be a failure to fully understand the interconnection between space assets and terrestrial force. The best way for foreign analysts to determine if China has increased its SIGINT capabilities in a naval context would be to look for new kinds of antennae on Chinese naval vessels or new kinds data relays coordinated with missile-firing exercises.

In the absence of dedicated SIGINT platforms, some observers in Congress and elsewhere suggested that China sought to acquire advanced western communications satellites for use as collection platforms. They argued that the APMT communications satellite, which used a large, sensitive antenna to provide telecommunications services in the Ku-band and had a design similar to U.S. signals intelligence satellites, could be used by China for intelligence collection. However, the only signals APMT could collect were mobile telephone signals from subscribers to APMT's mobile telephones. It could not listen to other signals, and since the Chinese had no opportunity to replace APMT's telecommunications components with equipment more useful for espionage, APMT would only have collected Chinese mobile phone calls that the PRC could intercept at much lower cost on the ground in China.

While U.S. fears over APMT were completely exaggerated, the continued Chinese preference for terrestrial rather than spaced-based interception is suggestive and may indicate a strategic outlook that is inward-focused and regional. Moving to a more aggressive space-based program would be a good indicator of a change in intentions.

Microsatellites

China's slow pace in developing robust space-based imagery and SIGINT capabilities that parallel those developed by the U.S. does not foreclose the possibility of asymmetric advantage. China could attempt to use micro-satellites to provide itself with electronic intelligence or other capabilities in space. In the past, micro-satellites would have not been the ideal platform for the full range of tasks involved in electronic intelligence collection or other military space activities. Successfully using microsatellites as a replacement for larger military platforms still requires a high degree of technological sophistication.

However, the continuing trend to reduce the size and weight of space-qualified components without sacrificing performance continues to reduce this disadvantage. It may also be possible to use constellations of microsatellites to mimic the collection performance of a single, large platform. The ability to launch multiple satellites at the same time, which China first performed in 1981, could make the use of such constellations easier. The U.S. has reportedly used clusters of relatively small satellites to perform maritime ELINT missions, and other reports suggest that the U.S. will use clusters of small satellites in future imagery architectures. A decision by China to push satellite ELINT based on microsatellites might provide a fast and inexpensive way to add this capability.

In 1998, Tsinghua University formed a cooperative research program with a company formed by the University of Surrey, a leading microsatellites research facility. The cooperative effort led to the successful launch by China of a micro satellite in May 2000. Surrey built a micro satellite named Tsinghua-1 under a "Know-How Transfer and Training" agreement. Tsinghua 1 was a demonstrator for an eventual constellation of five Chinese micro-satellites that would provide global, high-resolution imagery. Tsinghua-1 was also planned to carry out communications research in low Earth orbits. In part as a result of the cooperative program, Tsinghua can now build its own micro-satellites.

In April 2004, China launched a payload of two indigenously developed small satellites with potential military capabilities. The first was a 452-pound microsatellite, "Experiment Satellite I" and a 55-pound nanosatellite, "Nanosatellite I." Experiment Satellite I transmits remote sensing data for mapping. Nanosatellite I was designed to perform unidentified technology experiments.[20]

Micro-satellites could offer a range of military capabilities. Besides anti-satellite operations, small cheap satellites could provide a surge capability for crises.[21] As sensors continue to become smaller and cheaper, micro-satellites could be launched and deployed in swarms to provide in-depth, redundant coverage of a particular area. Using a number of micro-reconnaissance satellites in the right constellation could, for example, cover large portions of the Pacific Ocean and ease the burden of maritime surveillance.[22] Microsatellites could also provide on-demand enhancement of communications capabilities, or they could be used to jam the target satellites reception of commands from the ground.

Microsatellites may also be attractive from an investment and budget perspective. The return on investment for a military space program is greatest in its initial phase. Adding a military space element provides an immediate improvement for intelligence and planning. A military force that goes from having no satellite reconnaissance or ELINT capability to having some capability gains a tremendous advantage. Going from a 1990 to a 2000 collection capability does not provide the same increase in advantage. After this initial large pay-off, further investments and technical refinements provide declining returns.

This pattern of a large initial payoff followed by declining marginal returns would make micro-satellites attractive, as they lower the initial cost of entry into space. Small, cheap satellites could provide China with an easier path to attaining some space capabilities and provide the potential for asymmetric warfare in space. The cost advantage of micro-satellites could, if properly handled, allow China to compete at some levels with the larger and more expensive U.S. systems without having to match the U.S. dollar for dollar.[23] Test deployments by China of microsatellite systems for military communications, reconnaissance or SIGINT would indicate a decision to seriously pursue this approach to space power.

Anti-Satellite Capabilities

Public reports also suggest that microsatellites may play an important role in asymmetric anti-satellite efforts. China's close study of U.S. military tactics in the 1990 Persian Gulf War and the conflicts that followed showed the PLA how the U.S. military was increasing integrating space assets into its planning and operations. While effectively conceding that its conventional ground, air and naval forces do not yet challenge the U.S. military, China has looked for vulnerabilities where U.S. military effectiveness could be degraded. Attacking space assets is one such area and the Chinese have pursued research into anti-satellite capabilities.

Anti-satellite programs entail ground-based high-energy weapons, ground or air launched interceptor missiles, or 'hunter-killer' satellites that destroy their target through either explosion or ballistic impact. China has pursued all three types of anti-satellite efforts since the 1980s, and has claimed that it can use ground-based lasers to damage sensors on reconnaissance satellites. The U.S. Department of Defense estimates say that China could develop a ground launched "direct ascent" ASAT system within 2-3 years. Advanced space-based weapons (i.e. laser-carrying satellites) are not currently a part of China's anti-satellite efforts. The most immediate threat comes from attack satellites. China appears to be developing two kinds of attack satellites: conventional hunter-killer satellites and micro-satellites.[24]

Some unofficial Chinese sources claim that China has developed parasite satellites for anti-satellite purposes. These are small satellites that are carried into orbit by a mother satellite. The mother satellite closes with the target and releases the parasite, which, using radar or perhaps heat-seeking sensors, then attaches itself to the target where it then could detonate or wait passively for a later command from the ground. If this sort of program is feasible (and the final stage of the getting the parasite close enough, given fuel constraints and the need to avoid any damage or disruption to the host to avoid attracting attention, might be difficult), it could allow a quick strike at the beginning of any conflict to simultaneously disable many space assets.

China has also reportedly worked on the larger and more traditional co-orbital hunter-killer satellites. These are large satellites that are put in the same orbital track as the target and maneuvered from the ground to close with the target. At close range, some ASATs carry on-board sensors that would guide the satellite to within range. The hunter-killer would then launch either kinetic or explosive projectiles or explode itself. China's initial efforts in this area appear to reflect early work done by the Soviets.

China has a long-standing capacity to track objects in space. It is based on a number of ground stations (including two located outside of china) and four satellite tracking ships. The ability to track object in space is critical for space operations. China would need this capability in order to carry out manned missions as well as for orbiting satellites. However, it is also critical for anti-satellite operations, whether ground-based or for in-orbit attacks. Locating U.S. satellites is a necessary precursor to the successful conduct of anti-satellite operations. This combination of tracking capability and a range of experimental anti-satellite programs suggest that anti-satellite efforts could be the greater source of risk for the U.S. This concern needs to be tempered by the lack of actual ASAT tests by the Chinese. An operational ASAT program would test its weapons (as the U.S. and the Soviets did in the past) against space targets. Although there have been terrestrial tests ground of lasers that may have been for anti-satellite purposes,[25] the Chinese have not conducted tests against targets in space.

Paper Dragon or Fledging Competitor?

Secrecy and dissimulation complicates analysis of China's space efforts[26] and many questions remain about China's military space capabilities. China is actively pursing military, civil and commercial activities in space. China has built and launched a broad range (albeit with varying degrees of sophistication and performance) of military satellites and its space reconnaissance and ASAT programs could pose a challenge for the U.S. Despite this, China's military presence in space is sporadic. It does not have a coherent military space architecture. If an effective military space program entails continuous coverage by intelligence collection satellites and a network of communications satellites, China has not made the effort. This absence in space is not the result of a lack of technological capability, but reflects a national decision about how to spend resources for space.

China's space budget was a secret until 1994 and it is still not made public in any detailed fashion. Estimates place it variously between $1 billion and $3 billion per year, for both military and civil space programs.[27] Given the complexity of China's government accounting process and its legacy of a command economy, where not all costs are reflected in a program budget, this is likely an underestimate.[28] Even if the budget were two or three times as large as the public figures, it would still be small for the tasks China has set for itself.[29] China has publicly said that its space program will select "a limited number of projects that are of "vital significance" to the nation and concentrate its resources on them.[30] However, at first glance China's space effort would appear to be spread too thin to be optimally effective.

Possible rationales for Chinese military space programs fall into three categories: 'catch-up,' 'leap-frog,' or 'conspicuous consumption.' The first involves China trying to bring its space forces up to par with U.S. capabilities. Leap-frog scenarios have China taking advantage of new technologies and an information-oriented approach to warfare to surpass U.S. capabilities in unexpected ways.[31] This approach would mean that military space architecture for China could look very different from that used by the U.S. A "conspicuous consumption" rationale would involve activities in space done primarily to affirm or enhance China's prestige and influence rather than build a continuous operational presence. While there are elements of all three in China's military space efforts, judging from expenditures and payloads, 'leap-frog' and conspicuous consumption' seem to predominate.

A clearer understanding of Chinese intentions for military space activities needs to examine whether an asymmetric approach a short-term placeholder while the long-term plan is for China to match the US militarily in space or whether some programs are only to showcase technological prowess by a space program given broad discretion by China's political leaders. Uncertainty about the scope of military space activities provides benefits to China in that it complicates U.S. planning, but it is not a substitute for military capabilities. China's military space effort now appears fragmented, defensive and regional rather than offensive and global (albeit with the potential for change).

Since we are unlikely to see greater openness by China in the near term, a series of externally verifiable indicators can be monitored to reduce uncertainly about China's military space efforts. These include increases in the pace of launches, development of better launch on demand capabilities, expanded testing of microsatellites to provide a 'breakout' capability,' ASAT testing, and the appearance of new equipment or new exercises that reflect the integration of space assets into military planning and operations. Changes in the organization of space activities, such as the creation of an organization entity dedicated solely to military activities or the creation of a civil space agency, would also signal a change in emphasis.

For now, while uncertainty about Chinese intentions in space remains, the U.S. may want to consider how to respond to the potential for challenges from remote sensing or anti-satellite efforts. In each case, deployment is partial and sporadic, but there is enough uncertainty about intentions and rates of progress to raise concerns for U.S. forces and operations.

Implications for the U.S.

The major implication of these Chinese programs and the manned space flight program is that the U.S. can no longer regard military space as an "American lake.' For a brief period following the collapse of the Soviet Union, the U.S. was unchallenged in space. This is no longer the case and it is likely that a few nations, including China, are looking at how to use space to erode the overwhelming U.S. military advantage. While China is not a peer or near-peer in space, it is exploring options that will, without mirroring the U.S., eventually provide it with new military capabilities.

The task for the U.S. is to find means to counter the efforts to gain asymmetric advantage. For Chinese military space programs, and particularly for the reconnaissance and ASAT programs, which offer the greatest payoff to China, the U.S. needs to consider a number of steps. Military planning and operations will need to increase the emphasis on deception. Stealth programs or stealth considerations may need to be extended to include very large platforms that were not previously considered. ELINT and jamming efforts need to take into account the increasing potential of Chinese space sensors. This effort should not be limited to the development of new technologies to deceive Chinese space sensors or make U.S. assets stealthier, but to also change how U.S. forces operate.

Looking for ships or groups of ships on the open sea is a difficult task. Large areas must be surveilled on a regular basis and coverage must be arranged so that the time between overflights is less than the speed of the ships to move out of range. Monitoring a particular area of ocean is easier. China has sought to extend its surveillance capabilities, which have been limited to date by the need to use either ground or aerial platforms, and will probably use any new space-based assets to watch the sea areas around Taiwan. U.S naval forces could still retain an element of surprise the further away they are from the Island. This may require positioning ships further out and launching aircraft at a greater range, which will increase aerial refueling requirements and complicate aircraft recovery. Stealth is not an option for aircraft carriers, so the U.S. may also have to rely more on the use of submarine forces. Spoofing capabilities for ships or for battle groups may also be necessary. This could be the use of false radar signals to confuse satellite sensors and to degrade data (a spoof transmission might persuade a satellite that a carrier was several miles from its actual position, for example).

The United States may also have to pay greater attention to deception and decoys in its military activities. The Soviets described this support function as "maskirovka," the use of cover, concealment, camouflage and deception to defeat reconnaissance. The intent was to preserve surprise and increase survivability. While the U.S. has made considerable strides for some platforms in the use of stealth technologies to defeat radar, maskirovka has otherwise been a tertiary consideration for the military. This may need to be reconsidered as Chinese space reconnaissance capabilities mature. We can no longer assume strategic surprise for our operations.

The U.S. will also need to consider if there is sufficient redundancy for its space assets and how to ensure a surge capability. This involves not only stockpiling of space assets (an expensive proposition) but also ensuring that launch on demand capabilities can meet surge requirements. In part, the U.S. may want to consider moving from a reliance on only a few big, expensive platforms to developing small, cheap (i.e. micro satellite) platforms for reconnaissance, communications and ELINT in a crisis. While the large, expensive and capable platforms are more than adequate in peacetime, if they are damaged or disabled in a crisis the U.S. may want to have replacements ready. Swarms of small satellites are harder to target and eliminate. The U.S. expertise in sensors (both reconnaissance and ELINT) would give it an advantage over China in a micro satellite competition.

Redundancy can also be provided by the use of commercial services for imagery and communications. The U.S. has already made considerable strides in this regard. Redundancy obtained through the use of commercial services also provides diplomatic advantages, but foreign service providers may be reluctant to accept U.S contracts if they believe this will lead to the destruction of their satellites. The U.S. may need to consider programs that would reduce risk for commercial providers (i.e. insurance or some other form of compensation).

There are a number of measures that the U.S. can take in response to a Chinese ASAT capability. It is possible to harden future generations of satellites (although this imposes a weight penalty) and to make them stealthier – harder to detect and target. However, these steps do little for the very large number of existing satellites already in orbit. The U.S. could also upgrade (or restore) its surge capabilities to deploy replacement reconnaissance and communications satellites in the event of a conflict, or look for other methods to build in redundancy and complicate the Chinese task. China would be put in an awkward position, for example, if the U.S contracted with European satellite service providers. This would a potential attacker in the position of either not disrupting some U.S. military space activities or broadening the conflict by attacking third party satellites.

Some of the techniques that the U.S. may want to adopt in light of these Chinese ASAT programs include the use of stealth technology to reduce the radar signature, the use of decoys, or the use of constellations of smaller satellites (rather than a single, large, craft) to make targeting more difficult and to increase redundancy. 'Hiding' an intelligence satellite by orbiting it simultaneously with a more benign spacecraft could also complicate targeting.[32] The U.S., if it has not already done so, may want to expand its terrestrial surveillance of key U.S. military satellites in order to detect efforts to shadow them or attach parasites.

At first glance, it might also seem worthwhile for the U.S. to pursue negotiations with China to limit and control ASAT capabilities on both sides, as was done with the Soviets. In asking for negotiations, the U.S. may find itself at a disadvantage. Since the gain to China from ASAT capabilities is much greater than the gain to the U.S. of disabling Chinese satellites, China may be unwilling to make many concessions. However, the Chinese have a greater interest in limiting the U.S. ability to deploy space based weapons. A negotiation would likely involve a trade where China agreed to end its ASAT activities in exchange for a U.S. commitment not to weaponize space.

This means that an U.S. decision to initiate negotiations on ASAT weapons would require weighing whether the potential benefits of space weaponization outweigh the benefits of an agreement to secure space assets. The cost of negotiations could also be increased by China's negotiating style and expertise. China lacks a long experience of strategic arms control negotiations and their implementation and verification. In the past, it has often preferred to engage in multilateral fora (such as the UN General Assembly or the equally unwieldy Conference on Disarmament) rather than on a bilateral basis. This provides China both greater negotiating leverage and a 'fuzzier' outcome for security-related issues, but does not suggest any great seriousness of purpose.[33]

Negotiations could too easily formalize China as a potential opponent along the lines of the Soviets. In light of Chinese ground-based and space based ASAT efforts, U.S. needs might be best served in the near term not by negotiation but by ensuring that hardening, redundancy and surge capabilities are integral elements of its space planning. Trying to force China into the mold of a mirror-image competitor probably hampers US analytical efforts. If China is pursuing not duplication but asymmetric benefit, a program that looks very different from the U.S. may be adequate and may post unexpected threats. A mirror-image model could distort our understanding of Chinese programs.

In addition to these measures, the U.S. can counter Chinese military efforts in space by continuing to pursue information superiority in its own military planning and acquisitions. The improvements in response time, targeting and the incorporation of intelligence and information into tactical planning and operations that information superiority and aerospace assets can provide will increase the advantages the U.S. has over other military forces. Continued progress in building a cohesive architecture that combines space, aerospace and ground assets to expand information superiority will reduce the effect of Chinese efforts in space to degrade U.S. military effectiveness.

Finally, The U.S. may want to consider whether and how to cooperate in civil and commercial space efforts with China. The secrecy that surrounds many Chinese space activities and the blurring of civil and military space programs mean that one of the problems for U.S. policy is that it is difficult to distinguish between areas where cooperation poses little risk and offers benefits to the U.S. and areas where cooperation should be avoided. However, the U.S. and the Soviets were able to cooperate in space (until the invasion of Afghanistan) at a low level of visibility despite a much more confrontational relationship. Cooperation was driven in large measure by political considerations.[34] For China, the U.S. would need to weigh the benefits of encouraging an emphasis on civil space activities and the potentially greater insight into China's space programs and capabilities against the possibility of inadvertent technology transfer. Overall, however, cooperation in civil space, by reducing uncertainty about China's space programs, would be beneficial.

This latter concern may be overstated, given the progress we have seen to date in China's space efforts. The U.S. should reconsider its restrictions on satellite technology transfer. The extent and progress of Chinese military programs, which were the target of these restrictions, suggest that U.S. policy has been ineffective. The restrictions applied primarily to commercial communications satellites and their launch, and had little effect on military programs, where the technology is largely unrelated to communications satellites. In only a few areas, such as advanced space sensors, does it make sense to continue tight restrictions on satellite technology transfer from the U.S. To the extent that the restrictions damage U.S. firms (and there is evidence that suggests that they have driven many subcontractors out of the space business) and make it more difficult for U.S. research centers to cooperate with European or Japanese space programs, they actually do more harm to the U.S. than to China. The goal should be to accelerate innovation in the U.S. rather than continue efforts to slow innovation in China.

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[1] See the section on " Science, Technology, and Industry for National Defense" in "White Paper: China's National Defense in 2000" published by the Information Office of the State Council, Beijing, 16 October 2000

[2] BBC, "China Joins EU Satellite Network," http://news.bbc.co.uk/2/hi/business/3121682.stm; European Commission, Directorate General for Energy and Transportation, "Galileo: European Satellite Navigation System: Public Regulated Services," http://europa.eu.int/comm/dgs/energy_transport/galileo/programme/service_prs_en.htm

[3] The Chinese reported in their 2000 Space White Paper that "remote-sensing and telecommunications satellites account for about 71% of the total number of satellites developed and launched by China." The figures used in the chart show these categories accounting for 79%

[4] We used data from four sources (NASA, FAA, the Teal Group and the Air Force Association's Space Almanac to estimate the number of military launches. None of these sources agreed completely with each other. We used the most AFA numbers, which assign the smallest number of military launches to the US. Other sources, which posit an even higher number of US military launches, reinforce the argument that China is not making a comparable effort in space.

[5] MG Wang Pufeng, "The Challenge of Information Warfare," in China Military Science, Sprint 1995

[6] China provides 70% of CBERS funding, launch vehicles, and components such as the imaging cameras. China and Brazil plan to build additional satellites with 5-meter resolution instead of the 20-meter resolution for current CBERS. UN Office for Outer Space Affairs, "Highlights in Space Technology and Applications for 2000," http://www.oosa.unvienna.org/isis/highlights2000/sect8a.html; Ministry of Science and Technology (Brazil), "China-Brazil Earth Resources Satellite – A Chinese Brazilian Tribute to Our Earths Natural Resources," October 7, 2002, http://www.dgi.inpe.br/html/eng/cbers.htm

[7] This would seem to be modeled, of course, on the U.S. reconnaissance satellite constellation, which reportedly has 4 imaging and 2 radar satellites.

[8] Richard Fisher, "Report on the Zhuhai Airshow, November 3-8, 2002" Center for Security Policy, http://www.centerforsecuritypolicy.org/index.jsp?section=static&page=zhuhai2002

[9] See, for example, "China Remote Sensing Satellite Ground Station," Chinese Academy of Sciences, http://www.rsgs.ac.cn/english.htm; For an early account, see Wang Xinmin "China Remote Sensing satellite ground station and its research and development " Proceedings, Asian Conference on Remote Sensing 1990, http://www.gisdevelopment.net/aars/acrs/1990/H1/dip003.shtml

[10] The Chinese government lists the National Remote- Sensing Center, National Satellite Meteorology Center, China Resources Satellite Application Center, Satellite Oceanic Application Center and China Remote-Sensing Satellite Ground Station, as well as satellite remote-sensing application institutes under related ministries of the State Council, some provinces and municipalities and the Chinese Academy of Sciences.

[11] Peoples Daily, May 11, 2000, "China Accelerates Government GIS Project," http://english.peopledaily.com.cn/200005/11/eng20000511_40555.html

[12] A.V. Lele, "China as a Space Power," Strategic Analysis, April 2002

[13] The U.S. did not officially acknowledge a space-based Sigint capability until 1995. China does not seem to have a MASINT (Measurement and Signatures Intelligence) program, despite the increased attention this 'INT' is receiving in the U.S. See http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB23/14-01.htm

[14] Desmond Ball,

[15] http://www.fas.org/irp/world/china/pla/dept_3.htm

[16] Federation of American Scientists, "The experimental ELINT satellites of the late 1970s were discontinued for unknown reasons." http://www.fas.org/spp/guide/china/military/sigint/geo-sigint.htm

[17] Thompson, David J. and Morris, William R., "China in Space: Civilian and Military Developments," August 2001, Air War College, Maxwell Paper No. 24

[18] China Defense Today, "The SJ Series Scientific Experiment Satellite," December 8, 2002, http://www.sinodefence.com/space/spacecraft/sj.asp

[19] http://www.fas.org/spp/guide/russia/military/sigint/ref66

[20] Xinhua News Agency, "China Launches two new Satellites," April 19, 2004, http://news.xinhuanet.com/english/2004-04/19/content_1426357.htm

[21] A surge capability would also require improvement in china's ability to launch on demand. Chinese sources claim they have reduced the time for launch preparations from 90 to 20 or 30 days, according to Zhang Qingwei, President of China Aerospace Science and Technology Corp. China Daily, "Record number of satellites to lift off" November 14, 2003, http://www1.chinadaily.com.cn/en/doc/2003-11/14/content_281739.htm.

[22] For a discussion of the use of clusters of micro-satellites, see A. Wicks, A. Da Silva-Curiel, J. Ward, M. Foquet, "Advancing Small Satellite Earth Observation: Operational Spacecraft, Planned Missions and future Concepts," 14th Annual AIAA/USU Conference on Small Satellites, 2000, http://www.sdl.usu.edu/conferences/smallsat/proceedings/14/tsi/i-8.pdf

[23] Phillip Saunders, Jing-dong Yuan, Stephanie Lieggi, and Angela Deters, "China's Space Capabilities and the Strategic Logic of Anti-Satellite Weapons," Monterrey Institute of International Studies Center for Nonproliferation Studies, July 2002, http://cns.miis.edu/pubs/week/020722.htm

[24] U.S. Department of Defense, "Annual Report on the Military Power of the People's Republic of China," July 2003, page 36

[25] http://www.worldnetdaily.com/news/article.asp?ARTICLE_ID=18150

[26] For example, in May 2002, the head of China's lunar exploration program told the BBC that China would not be launching a manned mission to the Moon in the foreseeable future. Ouyang Ziyuan, chief scientist of China's Moon exploration program repudiated reports in the Chinese media that Beijing would put a man on the Moon by 2010 and establish a lunar soon thereafter. "We will explore the Moon certainly," he said, "but with unmanned spacecraft." More recently, Chinese defense officials confirmed that China indeed has plans to land on the moon by 2010 and establish a lunar outpost. BBC, "China denies manned Moon mission plans," May 21, 2003, http://news.bbc.co.uk/2/hi/science/nature/2000506.stm; BBC, "China Details Space Plans," October 6, 2003, http://news.bbc.co.uk/1/hi/world/asia-pacific/3166832.stm

[27] Joseph Kahn, "China's New Great Leap: Into Space," New York Times, March 15, 2003

[28] A god recent discussion of the issues in estimating Chinese military expenditures can be found in Richard A. Bitzinger, "Analyzing Chinese Military Expenditures," in Stephen J. Flanagan and Michael E. Marti, The Peoples Liberation Army and China in Transitions, National Defense University, 2003

[29] Charges that China's small space budget buys more than it would in the U.S. are true, but need to be put in perspective. The best estimates of a differential between U.S. and Chinese space activity, although dated, is in work done by USTR in preparation for trade agreements with China on commercial space launches found that Western launches might cost perhaps three times more than launches by China. Making a heroic assumption, this suggests at most the Chinese spend the equivalent of &$5 billion for all space activities.

[30] Space White Paper

[31] Mark A. Stokes, "China's Strategic Modernization: Implications for the United States," Strategic Studies Institute, Army War College, September 1999 for a discussion

[32] Walter Pincus, Smaller Spy Satellites May Give U.S. Stealth Capability Over Trouble Spots, Washington Post, P.A9, February 1, 1998

[33] State Council of the Peoples Republic of China, "White Paper on China's Space Activities", section on "Prevention of an Arms Race in Outer Space"

[34] Leonard David, "Space Cooperation: The China Factor," Space.com, January 5, 2003, http://www.space.com/news/china_space_020313.html