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CHINESE SPACE SUPERIORITY?

CHINA'S MILITARY SPACE CAPABILITIES AND THE IMPACT OF THEIR USE IN A TAIWAN CONFLICT

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Abstract

The U.S. has had space superiority in every combat operation since the Gulf War. Joint Publication 1-02 defines space superiority as "the degree of dominance in space of one force over another that permits the conduct of operations by the former and its related land, sea, air, space and special operations forces at a given time and place without prohibitive interference by the opposing force." This paper looks at China's space capabilities to see if they are sufficient to enable "prohibitive interference" against U.S. forces during a Taiwan conflict. The paper provides a detailed look at the current state of Chinese space systems and examines how they might be used against the U.S. in anti-naval access and anti-air access campaigns. The paper concludes that current Chinese space capabilities do not provide enough force enhancement to allow "prohibitive interference" against U.S. forces; however, if the Chinese were to add an operational electronic intelligence satellite system to their current suite of space capabilities, they could successfully attack a U.S. aircraft carrier and other U.S. Navy ships approaching Taiwan. This case study underscores the importance of establishing space superiority in the early stage of future combat operations.

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Introduction

"The space of operations becomes all-dimensional and military action will be conducted simultaneously in many fields, on land, in the air, in outer space and in the electronic field."

General Fu Quanyou
Chief of General Staff,
People's Liberation Army, 20 Feb 1999[1]

Space is an integral part of U.S. combat operations. In the 1991 Gulf War, space played a significant role in combat operations, and in major U.S. operations since then space has played an ever increasing role. However, in all those conflicts, we have faced an adversary who had little or no space capability. Thus, we have had space superiority from the outset of operations. Joint Publication 1-02 defines space superiority as "the degree of dominance in space of one force over another that permits the conduct of operations by the former and its related land, sea, air, space and special operations forces at a given time and place *without prohibitive interference by the opposing force*."[2][Emphasis added] What if we engaged in combat operations and didn't have space superiority? What if we engaged an adversary who had enough dominance in space which allowed prohibitive interference by the opposing force? How would that dominance manifest itself? How would this impact U.S. combat operations? This paper will provide insight into these questions through a case study involving a U.S.-China dispute over Taiwan.

A Taiwan U.S.-China conflict is a practical case study for two reasons. First, the possibility is feasible.[3] While China and the U.S. both seek a peaceful resolution of the Taiwan issue, a conflict is a potential scenario. China's 2004 Defense White Paper described their relations with Taiwan as "grim" and made stopping Taiwanese independence a "sacred responsibility" for China's armed forces.[4] In addition, in March 2005, China's National People's Congress passed an "anti-secession" law providing legal justification for the use of force if Taiwan attempts to become independent.[5] Furthermore, the U.S.-Taiwan Relations Act says it is the U.S.'s policy that any non-peaceful actions to determine the future of Taiwan are considered a "grave concern," and the law requires the U.S. to maintain the capability to resist any force or other coercion which would threaten the people of Taiwan.[6] Together these two laws are the dilemma of Taiwan and make a conflict feasible, especially if there is a miscalculation by China, the U.S. or Taiwan as all parties seek peaceful resolution.

Second, a U.S.-China conflict is practical for case study since China has an impressive amount of space capability, some of which has been in use for decades, and they are continuing to grow their space capabilities every year. Although they are not a near-peer to the U.S. in space, they have significant space capabilities that potentially could challenge U.S. space superiority.[7] Thus, a Taiwan conflict would be the U.S.'s first combat operation in which an adversary with capability, know-how and experience used space systems actively against us. This paper will lay out the current Chinese space capabilities and investigate if these types of systems could potentially enable "prohibitive interference" by China against U.S. military operations in support of Taiwan. Thus, we might face the possibility of not having space superiority during combat operations. What are the space capabilities China possesses? What might be their impact on U.S. military capabilities during a Taiwan conflict? The next two chapters will look to answer those two questions in detail.

Chapter 2

Chinese Military Space Capabilities

China has an extensive array of space capabilities which range from satellite design and manufacture to launch services and on-orbit operations.[8] China's People's Liberation Army (PLA) has given three tasks to its space units: observation/intelligence, navigation/positioning and communications.[9] The following is a description of the major Chinese space systems that perform these tasks. The focus is on those space capabilities in which the Chinese have invested and have the possibility to improve the overall effectiveness of their armed forces. The information used to compile the following information is from open, unclassified sources.[10] Chinese space systems are summarized in Table 1.

Current Space Systems

Imagery

General Fu Quanyou, while he was the PLA's Chief of General Staff, wrote that commanders need to have a full picture of the battlefield, and China must "make energetic efforts to develop advanced means of intelligence-gathering and reconnaissance … and improve the ability to obtain and process information" to "thoroughly understand the enemy's situation."[11] Satellite imagery looks to meet these demands. China's program for satellite imagery, known as their *Jian Bing* ("Pathfinder") program, has been active since 1975. China is on the third and

Table 1 Current Chinese Space Systems[12]

Mission Type	Current Program	Last Launch	On-orbit Life	Characteristics
Imagery	ZY-2A (JB-3 1) ZY-2B (JB-3 2) ZY-2C (JB-3 3)	Sep 2000 Oct 2002 Nov 2004	2+ years 2+ years 2+ years	Data downlink; maneuverable; believed to have 2 m resolution
	FSW-3 5 (JB-4)	Aug 2005	18 days	De-orbited to develop imagery; maneuverable; 1 m resolution
ELINT	*Shenzhou*-4	Dec 2002	8 months	Data downlink; de-orbited upon mission complete
Comm	ZX-22 (FH-1) ZX-20 (FH-2)	Jan 2000 Nov 2003	8 years 8 years	Military sat comm; also known as *Feng Huo*; 24 C-band transponders
	APStar 2R APStar 5 APStar 6	Oct 1997 Nov 2004 Apr 2005	10+ years 13 years 14 years	27 C-band, 13 Ku-band transponders 28 C-band, 16 Ku-band transponders 28 C-band, 12 Ku-band transponders
	Asiasat 2 Asiasat 3S Asiasat 4	Nov 1995 Mar 1999 Apr 2003	13 years 15 years 15 years	24 C-band, 9 Ku-band transponders 28 C-band, 16 Ku-band transponders 28 C-band, 20 Ku-band transponders
	Chinasat 6 Chinasat 10	May 1997 May 1998	8 years 15 years	24 C-band transponders Chinasat 10 also known as Chinastar 1; 18 C-band, 20 Ku-band transponders
	SinoSat 1	July 1998	15 years	24 C-band and 14 Ku-band transponders. Services China's financial and air transportation systems, as well as the Shanghai Information Port project
Navigation	*Beidou*	May 2003	8 years	Two satellite constellation with on-orbit spare; regional system focused on China
Weather	FY-1D FY-2C	May 2002 Oct 2004	2+ years 2+ years	Odd-number FY spacecraft are in a sun-synchronous orbit; even numbered are in geostationary orbit
Remote Sensing	ZY-1 (CBERS)	Oct 2003	2+ years	China-Brazil Earth Resources Satellite; sun-synch orbit; 20 m resolution CCD camera; visible, IR spectral scanners
	HY-1A	May 2002	2+ years	Maritime surveillance satellite; 360 kg
Scientific	SJ-6A/B SJ-7	Sep 2004 July 2005	2+ years 3 years	Used for scientific experimentation; orbits and lifetimes vary based on mission
Small Satellites and Micro-satellites	Tsinghua 1 *Chuangxin* 1 *Shiyan*-1 *Naxing*-1 *Shiyan*-2 Beijing-1	Jun 2000 Oct 2003 Apr 2004 Apr 2004 Nov 2004 Oct 2005	6+ months	Earth observation, 30m res; 50 kg Low earth orbit comm sat; 100 kg Land Resource Mapping; 204 kg Technology development; 25 kg Remote sensing payload; 300 kg 4 m resolution imagery; 166 kg

fourth generation of this program, and the two current systems differ most distinctly by how the satellite data is obtained by the analyst.[13]

The *Jian Bing*-3 (JB-3) imagery satellite sends its images electronically, allowing the analyst to get the data in near real-time. The system is also known as *Zi Yuan-2* ("Resource", ZY-2), and it was first launched without prior announcement in Sep 2000.[14] The ZY-2 came from the ZY-1, the Chinese-Brazilian Earth Resources Satellite, a remote sensing satellite discussed later.[15] The Chinese announced the ZY-2 satellite was for civil purposes such as crop yield assessment; however, it is believed to be primarily used for military purposes.[16] The JB-3 is believed to have two-meter resolution capability using digital imaging technology.[17] The third satellite in the series was launched in November 2004, and when the Xinhua News Agency announced the November launch, it also mentioned the previous two satellites, launched in September 2000 and October 2002, were also operational.[18] The Chinese are also working to improve their capability. The *Shenzhou* 5 manned capsule the Chinese launched in Oct 2003 had a digital imaging experiment on board capable of 1.6 meter resolution.[19]

Jian Bing-4 (JB-4) is a film-based system which deorbits to allow the film to be developed and analyzed. The Chinese officially call the JB-4 the *Fanhui Shi Weixing*-3 ("Recoverable Satellite", abbreviated FSW), and it comes from a long line of satellites that have been launched and improved since 1975.[20] The previous version of the FSW-3 held over 2000 meters of film, and open source information reports the FSW-3 has one meter resolution.[21] On-orbit duration is either roughly 18 days or 26 days, depending on the altitude of the satellite with the lower orbit providing shorter on-orbit duration but better resolution imagery.[22] To supplement this indigenous imagery capability, China has reached agreements to receive imagery from numerous commercial imagery firms, including the U.S. LANDSAT, France's SPOT, Russia satellite imagery and Israel's EROS-A one meter resolution satellite.[23]

Currently, China has no indigenous synthetic aperture radar (SAR) imaging system; however, Chinese scientists have been working to develop a Chinese SAR system for at least a decade, and they plan to have four SAR systems on-orbit along with four optical reconnaissance satellites by 2010.[24] Despite the lack of a Chinese system, China has extensive experience using commercially available SAR systems. The Chinese have agreements to directly receive Canada's RADARSAT imagery as well as to receive data from two European Space Agency's (ESA) SAR payloads. China has had a RADARSAT ground receiving station in Beijing since 1998, and it is able to receive the data within 1-4 hours after the spacecraft acquires an image. The RADARSAT ground system is capable of not only producing images with a resolution of 7-10 meters and a revisit rate of 3 days, but it has special algorithms for ship detection by detecting the ships themselves as well as their wakes.[25] Likewise, the Chinese receive the ESA's ENVISAT's Advanced SAR data in Beijing and Hong Kong, and this system can also automatically perform ship and wake detection.[26] The ENVISAT is capable of imagery with a resolution of up to 6 meters with a revisit rate of every 6 days at Taiwan's latitude.[27] China also has access to the ESA's Earth Resources Satellite (ERS) SAR data via a direct downlink station in Beijing, and ERS can also perform ship and wake detection.[28]

An effective satellite imagery system relies on more than just having space-based imagery capability. It also depends on being able to process and analyze the data.[29] The Remote Sensing Ground Station near Beijing is the main center for China's imagery processing, and this station directly receives the data from the ZY-2 and other satellites.[30] China has been processing and analyzing their own and other nations' imagery for decades, starting with their FSW-1 program in 1975 up to today's improved FSW-3 and the real-time imagery from the ZY-2 program.[31] China has the facilities and the experience for imagery analysis, and they have integrated these capabilities into their joint military exercises.

Space capabilities cannot be effectively employed in military operations unless they are exercised with the combat forces ahead of time to develop effective tactics, techniques and procedures for use during combat. The Chinese realize this and have exercised their reconnaissance capabilities in their annual joint force exercise at Dongshan Island in the Taiwan Strait. In this joint exercise, 18,000 PLA forces practiced beach landings, establishing "air dominance", and attacking aircraft carriers using their Su-27s, Su-30s, SOVREMENNY-class destroyers, SS-N-22 supersonic anti-ship missiles, and various tactical and cruise missiles. One of the objectives specifically called out was "satellite reconnaissance and tracking."[32] In addition, China has developed means to counter satellite detection of their forces sufficient to mask detection from space assets.[33] China has been improving their counter-reconnaissance capabilities, and they continue to exercise it.[34] Specifically, exercising counter-reconnaissance techniques was one of the objectives for the 2004 Dongshan Island exercise.[35]

Electronic Intelligence

Like their imagery program, the Chinese have decades of experience with satellite-derived electronic intelligence (ELINT). China started their space-based ELINT program in 1975, and the last confirmed space-based ELINT satellite was on-orbit in 2002.[36] China has a strong ELINT program in terms of ground, air and ship-based ELINT collectors; however, its space-based ELINT capabilities have been limited and sporadic.[37] The *Shenzhou* program is primarily focused on China's manned space efforts, but prior to the manned missions the *Shenzhou* spacecraft also acted as a space-based ELINT collector. *Shenzhou* 1 though 4 all flew with an

ELINT payload with *Shenzhou* 2 through 4 carrying three antennas attached to booms at the front of the orbital module and seven feed horns on the bottom of the module.[38] These orbital modules remained on orbit for 18 months, and a Chinese official reported the purpose of the *Shenzhou* 4 ELINT payload was to intercept radar and telecommunication traffic signals.[39] The *Shenzhou* sent the data from the ELINT payload to the Remote Sensing Ground Station in Beijing.[40] However, little Chinese space-based ELINT activity has occurred since the *Shenzhou* 4.

Reviews of open literature on Chinese space programs reveal no ELINT collector currently on orbit; however, one on-line source believes the *Shijian* ("Practice") scientific satellite launched in Sep 2004 possibly has an ELINT mission, and previous *Shijian* missions have performed ELINT collection.[41] Regardless, China is interested in ELINT satellite programs and the ability to transmit data directly to mobile data reception equipment with deployed military units.[42]

The sporadic on-orbit ELINT capability, coupled with their strong terrestrial ELINT program, might be indicative of the regional nature of the Chinese ELINT program. Specifically, a periodic satellite ELINT capability enables occasional surveillance of worldwide radar and communication systems allowing the Chinese to detect new signals and update the databases of their regionally-focused terrestrial systems.[43] These updates as well as other ELINT products would come from the PLA General Staff Headquarters' Third Department which is the primary focal point for ELINT.[44]

While the current state of affairs shows no persistent space-based ELINT system, there could be one in the future. Articles from Chinese engineering journals show active interest in the area, including developing small ELINT satellites or constellations of small satellites capable of providing precise location data.[45]

Satellite Communications

China is a solid competitor in the commercial satellite communications market, and this capability, coupled with their dedicated military satellite communications capability, gives them a robust satellite communication network. Chinese industry has at least four commercial satellite communication networks (APStar, Asiasat, Chinasat, Sinosat -- see Table 1). Many of their communication satellites use the Chinese *Dong Fang Hong* ("East is Red" - DFH) satellite bus, but U.S. and European manufacturers developed the remaining spacecraft.[46] However, in 1998, China had allotted only limited channels to the PLA.[47] To correct this shortcoming and not take away revenue from the profitable commercial business, China started a new military satellite communication program, the *Feng Huo* program ("Fire and Smoke").[48] The Chinese launched the first *Feng Huo* satellite (FH-1) in January 2000 and followed it up with the FH-2 launched November 2003. FH-1 and FH-2 are also known as *Zhongxing*-22 and *Zhongxing*-20, respectively, since these two satellites were placed in geosynchronous orbital slots numbered 20 and 22 for the *Zhongxing* ("Star of China") commercial satellite communication spacecraft.[49] The FH-1 and FH-2 are part of the *Qu Dian* Command, Control, Communication, Computer, Intelligence (C4I) system that looks to provide theater forces with the capability to communicate and share information in near-real time.[50] Additionally, the Chinese are also looking into small mobile satellite communication reception stations that could be deployed into theaters of conflict.[51] The capability to receive data via satellite communication will be essential for theater commanders to exploit improved situational awareness provided by other space-based and intelligence platforms and to synchronize combat operations.

Satellite Navigation

China is deeply involved in projects to improve their satellite navigation capability. They have developed their own navigation satellite program; use GPS extensively throughout the country for a vast number of applications; are a partner with the European Union on Galileo, the European navigation satellite program; and Chinese firms are part of the contractor team developing Galileo.[52]

China does not want to be dependent on foreign systems; therefore, they are creating their own navigation satellite constellation.[53] The Chinese *Beidou* ("Big Dipper") system consists of two satellites and a spare in geosynchronous orbit and is intended only to provide regional coverage around China.[54] The first two on-orbit spacecraft were the first generation of their satellite navigation system, and the *Beidou*-3 satellite launched in May 2003 was the next step toward a second generation system.[55] According to the *Beidou*'s chief designer, the current system is intended "mainly to serve transportation, shipping, distribution of materials and other services" – namely, users on the ground.[56] In particular, a user must be on the surface of the Earth and must be in two-way communication with a central station. The user sends the central station its latitude/longitude and the central station provides the user its altitude by comparing the user's transmitted latitude/longitude with a detailed model showing local terrain altitudes.[57] However, using three satellites and advanced processing algorithms, it is possible for the current system to improve the accuracy of warheads in flight for 10 minutes or more (i.e. free flight time of 4200 kilometers or more) as long the warhead can maneuver or is on a bus which can maneuver.[58]

In addition to its own satellite navigation program, China uses and is heavily involved in developing other nation's satellite navigation programs. China is a partner with the EU, India and Israel on the Galileo satellite navigation program. While they will not have access to the Public Regulated Service encrypted signal, Beijing does expect working with Europe will boost Chinese satellite development and other aerospace technologies.[59] In addition, Chinese industry teams were on each of the two teams competing for the system contract.[60]

Finally, China is a heavy user of GPS in civil applications such as fishing, public bus and taxi monitoring, seismic monitoring, and telecommunication network timing.[61] Militarily, potential Chinese use of differential GPS in ballistic and cruise missiles offers significant accuracy improvements and increases their effectiveness as stand-off coercive weapons.[62] Overall, China is looking to improve the robustness of their satellite navigation capabilities – indigenously and using foreign systems.

Meteorological Satellites

China began its efforts to develop its own weather satellite in the late 1960s and launched its first meteorological satellite in 1988.[63] Today, the Chinese have two meteorological satellite systems. The *Fengyun*-1 ("Wind and Cloud" – FY-1) is a low earth orbiting system, and the *Fengyun*-2 (FY-2) is a geosynchronous system.[64] The FY-1's capabilities are similar to the U.S. LANDSAT, and it will be replaced by the FY-3 series with expected first launch in 2006.[65] China launched the newest FY-2 in 2004 highlighting that its developer designed and manufactured it independently of any foreign assistance. The satellite features additional meteorological sensors that the Chinese press reports put it on par with "international standards of new generation weather satellites."[66] Improved meteorological data leads to improved civil applications, but it also provides improved operational data that is vital when planning an amphibious attack or air strikes.[67]

Remote Sensing Satellites

Remote sensing programs are crucial for achieving the information superiority the Chinese military desires.[68] China has two indigenous remote sensing satellite programs: the *Haiyang* ("Ocean") system and a cooperative program with Brazil called the China-Brazil Earth Resources Satellite (CBERS).[69]

China launched the 365-kg *Haiyang*-1 (HY-1) satellite in 2002 in a tandem launch with the FY-1D satellite. The HY-1's mission is to provide China with a maritime surveillance capability without having to rely on foreign systems.[70] The spacecraft has an ocean water-color scanner with a resolution of 1.1 km and a visible light imaging system with a resolution of 250 m.[71] The maritime surveillance mission of the HY-1 involves observing sea conditions such as surface temperature, currents, silt, pollutants and sea ice.[72] China's National Ocean Satellite Applications Center has ground stations in Beijing and at Sanya on the southern tip of the island of Hainan; however, commands from these ground stations are sent to the Xian Satellite Monitor and Control Station (see below) for uplink to the satellite.[73] China plans to launch the next HY satellite in 2006.[74]

The China-Brazil Earth Resources Satellites (CBERS, also known as ZY-1) launched in 1999 and 2003 showed increasing sophistication with its multi-payload and digital transmission capability.[75] The payload included an infrared multi-spectral scanner and a visible light imager capable of 20 m resolution images, and the satellite can be controlled at ground stations in Brazil or China.[76] In September 2000, China and Brazil signed an agreement for two more CBERS satellites with 5 meter resolution and improved redundancy. In addition, they agreed to investigate building a joint geosynchronous weather satellite and a communication satellite.[77] The data from CBERS is processed in China at the Remote Sensing Ground Station along with data from Landsat (U.S.), ERS (European Space Agency), the Japanese Earth Resources Satellite, SPOT (France), Radarsat-1/2 (Canada), and the Indian Remote Sensing satellite.[78]

Command and Control of Space Systems

Effective command and control of space assets is critical to maintaining healthy satellite systems. To perform these functions, three things are required: operations centers to generate commands and monitor the spacecraft; stations to track the spacecraft, receive health and status data from the satellites, and send commands (also called tracking, telemetry and control, TT&C); and trained personnel to perform the command and control function. Within China, the main operations centers for spacecraft commanding and monitoring are the Xian Satellite Monitor and Control Center, located in the city of Weinan 60 km NW of Xian, and the Beijing Aerospace Command and Control center.[79] The Xian center performs the lion share of the command and control work for the Chinese space systems; however, the Beijing center is the focal point for the manned space missions.[80] The Xian center can perform command and control on several dozen spacecraft simultaneously.[81] Integral to the operations of these centers are seven fixed ground stations within China for sending and receiving TT&C data (see Figure 1).[82] In addition, China also has three mobile TT&C stations which it deploys throughout the country, one of which is dedicated to tracking the reentry of their spacecraft.[83]

The fixed and mobile ground tracking stations in China can only communicate with spacecraft visible from the Chinese landmass. China achieves worldwide command and control capabilities using three methods: ships, Chinese facilities built in foreign countries and access to foreign tracking networks. China operates a fleet of four tracking ships, the *Yuanwang* 1, 2, 3 and 4 (“long view”). These ocean-going ships provide full TT&C capabilities, including the ability to detect and correct spacecraft problems; however, they are expensive and affected by poor weather and sea conditions.[84] To counter these limitations, China has built three TT&C facilities in foreign countries: Namibia (near the city of Swakopmund), Kenya (near Malindi) and in Pakistan (near Karachi).[85] Finally, China has signed agreements with the privately owned Swedish Space Corporation to have access to their TT&C facilities around the globe in such areas as Alaska, Hawaii, Sweden, Norway and Australia.[86]

Figure 1 Chinese Fixed Satellite TT&C Stations[87]

Key: 1 – Kashi station (Xinjiang Province), also known as #1 station
2 – Weinan station (Shaanxi)
3 – Nanning station (Guangxi)
4 – Xiamen station (Fujian)
5 – Minxi station (near the city of Sanming, Fujian province)
6 – Qingdao station (Shandong)
7 – Changchun station (Jilin)

Space Situational Awareness

For a nation to operate in space, it needs to be aware of where their spacecraft are located as well as other objects in space. The Chinese space tracking system uses a number of ground stations inside and outside China and the four *Yuanwang* satellite tracking ships mentioned above.[88] China's space surveillance capabilities are limited; however, they are probably sufficient to track most U.S. satellites.[89] Reports in the Chinese technical press indicate their network can determine orbits to the "meter precision level."[90] Meanwhile, the ESA and China are cooperating to design a network which will provide satellite observation data, and China will continue to improve its satellite tracking network.[91] All this indicates the Chinese understand the need for a space object tracking system and they can keep track of their own spacecraft, debris which can threaten their manned and unmanned spacecraft and U.S. or other foreign systems which can observe actions within China.

Microsatellites

The Chinese have a very advanced indigenous microsatellite program, and they clearly see the future of microsatellites. Microsatellites are generally defined as satellites which weigh between 10 and 100 kg, and small satellites weigh between 100 and 500 kg.[92] As of early 2006, China has successfully gotten on orbit four small satellites, including the *Haiyang* maritime surveillance satellite discussed above, and three microsatellites (see Table 1). Missions for these microsatellites and small satellites include imagery, remote sensing, technology development and communication.[93] This accomplishment indicates a high degree of sophistication for their space program. This evolution in China's space program began when Tsinghua University joined with the U.K.'s Surrey Satellite Technology, Ltd to build the Tsinghua 1 satellite that was launched in 2000. This 50 kg microsatellite provided 30 meter resolution imagery, and this joint venture gave Tsinghua University the know-how to build microsatellites.[94] Tsinghua University followed up this success by independently building their own microsatellite, the 25 kg *Naxing* (*Naxing* is a shortened version of *Nami Weixing*, "Nanosatellite"; however, it weighed more than the nanosatellite defined upper weight of 10 kg). China launched the *Naxing* in April 2004 in tandem with another Chinese-built small satellite, the *Shiyan*-1 ("experiment') built by the

Harbin Institute of Technology.[95] The *Naxing* is especially noteworthy for some breakthrough microsatellite advances, such as being the smallest satellite capable of three-axis stabilization.[96] The Chinese continue to advance their small satellites and microsatellites. In Oct 2005, they launched Beijing-1, a satellite built by Surrey Satellite Technology. The spacecraft weighed 166 kg and is capable of 4m resolution imagery.[97] The reduced weight, and thus reduced launch cost, is what makes small and microsatellites an attractive means for gaining space capabilities. The drawback often is reduced capability, but a 4 m resolution imagery capability indicates China and the rest of the world's microsatellites are achieving increased sophistication and utility.

Anti-Satellite Systems

There is a significant amount of discussion in the open press about Chinese plans and development efforts for an on-orbit anti-satellite capability as well as anti-satellite ground-based lasers.[98] This paper will not consider these anti-satellite possibilities or other possible offensive counterspace capabilities for two reasons. First, the primary objective of this paper is to answer the question: are Chinese space capabilities sufficient enough to give them space superiority. Specifically, could their space systems be used in concert with their terrestrial-based forces to enable prohibitive interference to U.S. operations? Denying U.S. space capabilities through Chinese counterspace capabilities and then investigating the effects is a different type of analysis. Second, looking at the impacts of any Chinese anti-satellite operations could not be done in an unclassified manner. Eliminating or degrading U.S. space capability with offensive counterspace systems then looking at the impact of the lack of these capabilities on the U.S. military would lead to a classified analysis identifying any strengths or weaknesses of our current weapon systems or tactics. For these two reasons, Chinese anti-satellite systems fall outside the scope of this paper.

Limitations of China's Space Program

The space capabilities China possesses today can be used successfully for military operations. However, there are limitations to their current capabilities. First, they possess no space-based missile warning program. Both the U.S. and Russia view this as an essential capability with the both nations continuing to keep their constellation functional with some level of capability.[99] Yet, the Chinese do not have a space-based early warning system. Chinese writings have said China should pursue a space-based missile warning capability; however, they have not launched one as of early 2006.[100] This can indicate they do not see the need at all for space-based early warning, given the regional focus of their military or they are getting the data from another source similar to the manner the U.S. shares its early warning information with other nations.[101] Secondly, they lack a persistent ELINT capability. China's current lack of sustained space-based ELINT could indicate they do not value this capability highly or they have gotten very good at masking ELINT payloads as other systems or on other satellites.[102]

Given all the capability detailed above, China is a space power but not a near-peer to the U.S.[103] While China is looking to modernize, in early 2006 they have not yet realized their goal of "local wars under high-technology conditions."[104] Their goals in space currently do not seem to extend beyond the short term goal of modernizing their military.[105] One senior analyst at the Brookings Institute predicts it "is doubtful that trends in space capabilities or any other aspect of defense modernization will readily alter the basic military balance in the next decade or so."[106] If this prediction is correct, the question remains: what if the goal was not to acquire enough space capability to upset the balance but to acquire enough capability to enable the PLA, the

PLA Air Force and the PLA Navy to provide some level of prohibitive interference to the U.S. military? How much space capability would be required for that? Is today's space capability sufficient for these purposes? How much prohibitive interference could today's capabilities provide? What would their impact be on U.S. military operations? The next chapter will explore these questions in the context of a conflict over Taiwan.

Chapter 3

Chinese Military Space Capabilities During a Taiwan Conflict

Given the Chinese space systems in the previous chapter, how might the Chinese use their space capabilities in a scenario involving a conflict with the U.S. over Taiwan? Would the contributions from these systems be sufficient enough to give China space superiority and if so, what would be the impact of that space superiority on the U.S. military?

A crucial element of U.S. strategy during a Taiwan conflict will be projecting power into the region with the intent of opposing Chinese military actions. Unless we can apply military power at the point of engagement, Taiwan and the surrounding theater, our military forces will have little ability to impact the situation. Thus, when looking at the impact of the Chinese space capabilities, the paper will pay particular attention to the impact on U.S. power projection capabilities with particular attention to naval and air power. Michael O'Hanlon, a Brookings Institute senior analyst, stated, "Given trends in military reconnaissance, information processing and precision strike technologies, large assets such as aircraft carriers and land bases, on which the United States depends, are likely to be increasingly vulnerable to attack in the years ahead."[107] These attacks could be enabled by Chinese space capabilities.

Anti-naval Access Impacts

The U.S. intelligence community believes China will use a sea-denial strategy aimed at U.S. aircraft carriers and other naval forces approaching Taiwan.[108] Thus, a key component of a Chinese campaign against Taiwan would be to keep the U.S. aircraft carriers out of striking range of Taiwan with a critical task of finding and sinking carriers. ELINT systems, like those demonstrated on the *Shenzhou*, could track U.S. carriers operating in the western Pacific or Indian Oceans.[109] In addition, some of their anti-naval weapons could use space-based information. Specifically, one of China's primary weapons to strike U.S. naval assets will be the supersonic, sea-skimming SS-N-26 missile. In recent years, China has purchased the Russian SS-N-26 anti-ship cruise missiles; however, without space-based ELINT data which can locate and track naval assets, the Chinese ability to effectively use the SS-N-26 is undermined.[110] Michael O'Hanlon, a Brookings Institute senior analyst, states, "To attack a U.S. carrier, one needs not only periodic localization of the carrier, but real-time tracking and dissemination of that information to a missile that is capable of reaching the carrier and defeating its defenses."[111] Space systems are only one of the means to locate and track U.S. carriers, and it is unclear if China's current reconnaissance satellites have the capability to locate and target U.S. aircraft carriers.[112] However, as shown in the previous chapter, China has launched and operated ELINT systems in the past. If they did acquire a space-based ELINT system, how would they use it and the rest of their suite of space capability against U.S. naval forces?

Chinese discussions envision using space systems to track American naval forces, and ELINT systems enable this.[113] Space-based ELINT systems can be used to acquire maritime target location for Chinese naval forces.[114] China's improvements in satellite communication and space-based reconnaissance allow them to identify, target and track U.S. military activities deep into the Western Pacific providing maritime target locations directly to their forces.[115] In addition, ELINT systems can be used to provide general location of U.S. naval assets which the Chinese could then use to cue searches for U.S. naval forces using the Canadian RADARSAT and ESA's ERS-2 and ENVISAT synthetic aperture radar systems with their wake detection capability.[116] Using these systems, the Chinese could more precisely locate and determine heading and velocity of carrier battle groups. Once found, China could keep the carrier's location current using its full imagery suite: ZY-2, RADARSAT, ENVISAT, ERS, JERS, Israeli and Russian commercial sources and any microsatellite experiments on orbit (e.g. the Beijing-1). Of course, the indigenous imagery sources would not have the time delay which can occur with commercial systems.[117] However, the Chinese have ENVISAT, RADARSAT and ERS receiving stations in country for near real-time receipt of imagery thus minimizing the time delay between when the satellites obtain the imagery and when an analyst can process the data.[118] Thus, this suite of space-based capability – ELINT systems used in conjunction with imagery systems with satellite communications disseminating the data – could provide excellent target information for Chinese anti-naval weapon systems. Ultimately, some analysts believe the U.S. could lose a carrier or two during a Taiwan conflict.[119] If this were to happen, Chinese space systems would have played a role, and this would be a clear example of the "prohibitive interference" required by the definition of space superiority. Thus, this scenario provides one example of the impact of one instance of Chinese space superiority.

Anti-air Access Impacts

Space systems can also help with a Chinese anti-air access campaign, especially in the area of delaying or disrupting air assets in theater. Potential launch points for in-theater aircraft are bases on Japan, the Philippines, Singapore or Guam.[120] While access to these bases would depend on allied governments granting use, for analysis purposes, this paper will look at those fields as potential launch points. Focusing on airfields in these countries, China could develop detailed target sets from space-based imagery prior to a conflict and if hostilities seemed closer at hand, use its satellite imagery to monitor defense developments in Taiwan and other supporting countries.[121] With this satellite imagery, Chinese planners can determine very accurate locations of airfields, taxiways, and fuel and weapons storage facilities which would be very lucrative targets for long range attack.[122] As Figure 2 shows, the CSS-2 and CSS-5 have the range to reach many potential airfields. The Chinese have recently equipped the CSS-5 with a conventional warhead, and its reentry velocity makes it very difficult to intercept for current ground-based missile defense systems.[123] Thus, it would be well suited for attacks on airfields U.S. forces might use.

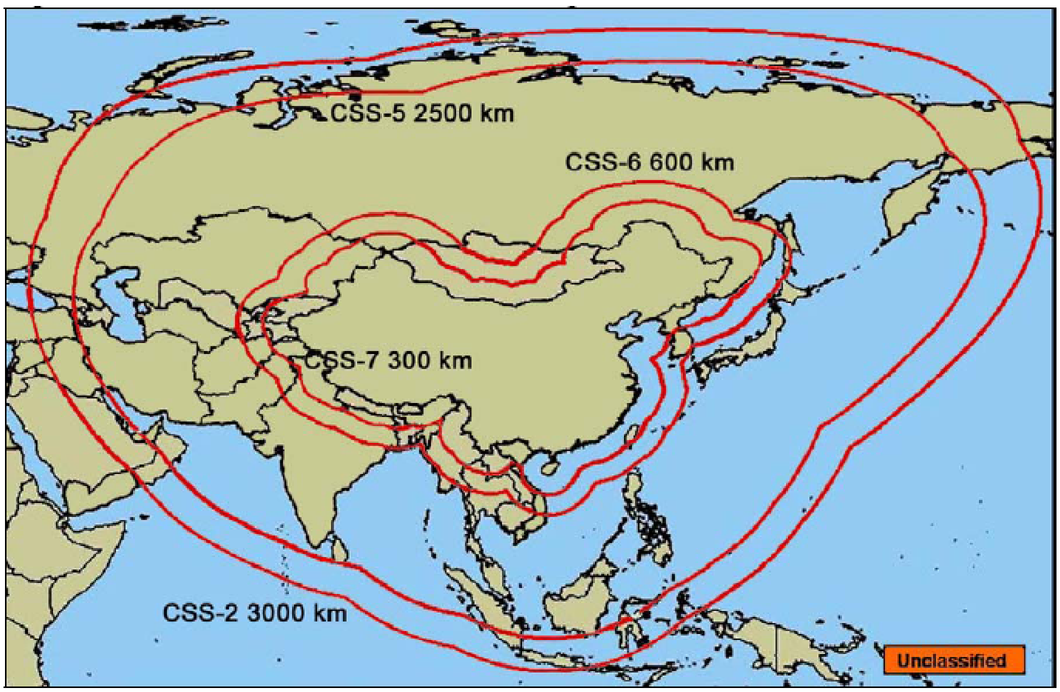

Figure 2. Chinese Short, Medium and Intermediate Range Missile Ranges[124]

Chinese ballistic and cruise missile attacks on airfields would not look to destroy the U.S. facilities, but suppress their ability to provide air and missile defense. Rear Admiral Eric A. McVadon (USN, Ret.), former Defense Attaché at the American Embassy in Beijing and expert on China's military, stated that once the Chinese suppressed U.S. air and missile defenses, it would conceptually "permit follow-on attacks, in relative safety, by the several new types of

Chinese aircraft using very modern cruise missiles."[125] This scenario is a great concern for the Asia-Pacific region. As one wing commander at Guam said, "[Chinese planes and missiles] would keep coming … I fear them numbers-wise," and one analyst predicts, "We can't expect that we can completely protect a carrier battle group when it got into theater."[126] Not only would these forces be looking to target carriers, they would look to target items which enable U.S. air power, and this targeting would be assisted by imagery derived from space systems. A former high-ranking Chinese official once said to be victorious in future combat, "We will have to gain air and sea superiority, but win information superiority first."[127] Gaining this information superiority, on the way to winning air and sea superiority, would be enabled by Chinese space systems.

This analysis shows that the contributions from Chinese space systems in the anti-air access battle would not be as clearly significant as the anti-naval access battle. The contribution in the anti-air arena primarily would be assisting in developing targeting sets, and this certainly would not constitute "prohibitive interference." Thus, Chinese space systems are insufficient to allow space superiority in an anti-air access scenario. How else could Chinese space systems aid their armed forces? Are their space systems capable of providing "prohibitive interference" in other manners?

Navigation

Current Chinese navigation capability will have mixed impacts to their warfighting capability. As discussed in Chapter 2, for the *Beidou* system to improve the accuracy of their missiles while in flight, they would need to travel at least 4200 km. As Figure 2 shows, the Chinese short, medium and intermediate range ballistic missile systems are not capable of the threshold 4200 km range. Thus, the current satellite navigation system is not capable of helping improve the accuracy of these warheads in flight. However, the Chinese indigenous satellite navigation system is capable of helping their military in two regards. First, for a mobile missile launcher or any missile launcher to accurately develop a solution to strike a target, you need to know the exact latitude, longitude and altitude of the launcher. Even today's *Beidou* system is capable of providing this; however, the system requires the users to transmit to a local receiving station, and military forces prefer to not transmit during hostilities to avoid being located by enemy ELINT systems. Therefore, the current system would not provide much utility to the mobile missile force or any user wishing to remain undetected during combat. However, the Chinese could use this system or GPS prior to a conflict to pre-survey launch locations for their mobile launchers. This would help provide the required accuracy for launch point location.

Secondly, the current *Beidou* system could also help during a conflict by acting as a timing source. Modern satellite communication networks use GPS to establish system time for the users of the network. China might question the reliability of the GPS signals they receive during a conflict; however, the Chinese could rely on their *Beidou* system to provide accurate timing for their networks.

In the future, the Chinese have ambitions to create their own navigation satellite system to free them from dependence on other nations. The Chinese have seen the need for a satellite navigation system as urgent and have studied constellations of five to seven navigation satellites.[128] Therefore, a second generation Chinese satellite navigation system could be used to correct warhead trajectories in flight and make their long-range, standoff systems even more accurate. Depending on the degree of accuracy improvement, this improvement in space capability could constitute "prohibitive interference" in the future; however, the current state of the Chinese satellite navigation system is not a challenge to space superiority.

Meteorological/Remote Sensing

Satellite remote sensing systems allow the Chinese to see the conditions of any candidate beachheads to determine if conditions at a particular location would allow an effective landing. Meteorological satellites can be used to assess and predict weather conditions during combat operations as well as to determine cloud cover over target areas for their optical imagery satellites. Also, the ground stations, data relay networks and analysis facilities for remote sensing satellite systems as well as the routine analysis of the data, provides capability and image processing expertise which can translate into an effective imagery exploitation system.[129] Thus, these weather and remote sensing systems would act in a force enhancement role; however by themselves, they would not constitute a space capability providing “prohibitive interference.”

In summary, this chapter has shown the current Chinese space systems do not provide enough capability to threaten U.S. space superiority. However, the addition of an operational ELINT system could provide China with space superiority, the consequence of which could be the sinking of a U.S. aircraft carrier or other U.S. Navy ships.

In general, what does this mean for U.S. planners and commanders? This case study has emphasized the importance of quickly establishing space superiority for U.S. and allied forces in any theater of combat operations. If you establish space superiority, you reduce the lethality of an adversary’s forces. If you allow an adversary space superiority, you will face an enemy at full capability, the impact of which would be the increased loss life for U.S. and allied forces. Thus, denying an adversary access to space information should be one of the initial tasks in the early phase of operations.

Chapter 4

Conclusions

China has demonstrated an impressive array of space capabilities in the fields of imagery, electronics intelligence, communication, navigation, meteorology, and remote sensing. They possess a robust satellite command and control architecture, and their space situational awareness allows them to keep their systems healthy and to remain aware of foreign space systems. In addition, their advances in small satellites and microsatellites clearly demonstrate their technological advancement as well as their intent to continue to improve their space systems. However, is all this space capability sufficient to provide them space superiority, especially as it relates to a conflict with the U.S. over Taiwan?

Using the JP 1-02 definition of space superiority, specifically that space capabilities allow the forces of one side to exert "prohibitive interference" over another side, China's current space systems would not provide space superiority for its armed forces in a conflict with the U.S. over Taiwan. This analysis has shown today's Chinese space systems are insufficient to provide a meaningful edge in executing an anti-sea or anti-air access campaign. In addition, the current state of the Chinese satellite navigation system does not permit a sufficient level of force enhancement to constitute space superiority for China. Finally, the contributions from their remote sensing and meteorological satellite programs do not markedly increase the ability of their armed forces to provide "prohibitive interference" to U.S. forces. However, if China were to field an operational ELINT satellite system, the space superiority equation could change dramatically. The combination of ELINT detection and location, the ability of synthetic aperture radar to find ships at sea, Chinese satellite imaging systems' capability to precisely locate U.S. Navy ships and the ability of their satellite communications systems to provide the data to shooters at sea would potentially provide a deadly targeting solution for China's long-range anti-ship missile systems. Together, these space systems could provide China with space superiority sufficient to allow the PLA, PLAAF and PLAN to successfully engage and potentially sink U.S. Navy vessels, even a U.S. aircraft carrier.

Thus, at the outset of a future Taiwan conflict, the U.S. could face a situation with which it has never before had to contend – the lack of space superiority. The consequences of this situation could be severe. Therefore, an objective in the early phase of any future combat operations must be to gain space superiority by denying an adversary access to space information. As space capabilities become increasingly important to the U.S. military and armed forces around the world, the requirement for establishing space superiority likewise increases and the impact of the lack of space superiority becomes correspondingly more somber.

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[97] Surrey Satellite Technology Ltd., "Beijing-1," http://www.sstl.co.uk/index.php?loc=121; also "Satellite observing Beijing sent into orbit," Xinhuanet, 28 Oct 2005, http://www.cast.cn/en/ShowArticle.asp?ArticleID=958.

[98] Department of Defense, *The Military Power of the People's Republic of China*, 36; Lele, "China: A Growing Military Space Power," 71; Phillip C. Saunders, "China's Space Ambitions: Implications for U.S. Security," *Ad Astra*, Spring 2005, 21, 23; National Defense University, "Dragons in Orbit? Analyzing the Chinese Approach to Space," (Washington DC: August 2001), 3 http://www.ndu.edu/inss/China_Center/CMA_Conf_Oct 00/paper10.htm; Rear Admiral (U.S. Navy, Retired) Eric A. McVadon, "Recent Trends in China's Military Modernization," Testimony to The U.S.-China Economic and Security Review Commission, 15 Sep 2005, 3, http://www.uscc.gov/hearings/2005hearings/written_testimonies/05_09_15wrts/mcvadon.pdf .

[99] NASA Office of Space Flight, "2004 Worldwide Space Launches," http://www.hq.nasa.gov/osf/2004/launch04.html; the Russians and the U.S. separately launched their latest early warning satellites in Feb 2004.

[100] Senior Colonel Ma Gaihe and Lieutenant Colonel Feng Haiming, "PRC: Military Journal on 'Comprehensive Integration' and RMA with Chinese Characteristics," *Beijing Zhongguo Junshi Kexue*, 20 Apr 2004, 5, FBIS CPP20030907000273. Note: Senior Colonel Ma is the director of the Armament Work Research Office under the General Armament Department's Comprehensive Planning Department.

[101] This program is called the Shared Early Warning System. With this system the U.S. provides tailored missile warning from its Defense Support Program satellites to partners and allies.

[102] James A. Lewis, "China as a Military Space Competitor," 7.

[103] Liao, "Will China Become a Military Space Superpower?" 205-206 .

[104] Michael E. O'Hanlon, *Neither Star Wars Nor Sanctuary* (Washington DC: Brookings Institute Press, 2004), 95.

[105]Johnson-Freese, "China's Military Modernization and Cross-Strait Balance," 9.

[106] O'Hanlon, *Neither Star Wars Nor Sanctuary*, 95.

[107] O'Hanlon, *Neither Star Wars Nor Sanctuary*, 97.

[108] Department of Defense, *The Military Power of the People's Republic of China*, 41.

[109] Ball, *China's Signals Intelligence Satellite Programs*, 15.

[110] Liao, "Will China Become a Military Space Superpower?" 209.

[111] O'Hanlon, *Neither Star Wars Nor Sanctuary*, 101.

[112] Johnson-Freese, "China's Military Modernization and Cross-Strait Balance," 8.

[113] National Defense University, "Dragons in Orbit?" 6.

[114] James A. Lewis, "China as a Military Space Competitor," 7.

[115] Department of Defense, *The Military Power of the People's Republic of China*, 12-13.

[116] MacDonald, Dettwiler and Associates, Ltd., "About RADARSAT-1 Network Stations," http://www.rsi.ca/partners/net_stat/net_stat_map.asp (accessed 29 November 05); Kongsberg Spacetec Company, "Hong Kong ENVISAT ASAR and MERIS Receiving Station Completed," http://www.spacetec.no/news_store/HongKong%20ASAR (accessed 29 November 05).

[117] Johnson-Freese, "China's Military Modernization and Cross-Strait Balance," 7.

[118] Harvey, *China's Space Program*, 185; James A. Lewis, "China as a Military Space Competitor," 6; European Space Agency, "The Applications of SAR Data – An Overview,"

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[119] O'Hanlon, *Neither Star Wars Nor Sanctuary*, 97.

[120] Colonel Lawrence M. Martin Jr., "Countering a Strategic Gambit," *Air and Space Power Journal*, No. 3, 19.

[121] Mowthorpe, *The Militarization and Weaponization of Space*, 93.

[122] Roger Cliff, "China's Military Modernization and the Cross-Strait Balance," Testimony to the U.S.-China Economic and Security Review Commission, 15 Sep 2005, 4, http://www.rand.org/pubs/testimonies/2005/RAND_CT247.pdf .

[123] McVadon, "Recent Trends in China's Military Modernization," 2.

[124] Department of Defense, *The Military Power of the People's Republic of China*, 13.

[125] McVadon, "Recent Trends in China's Military Modernization," 3.

[126] Robert Marquand, "Chinese Build a High-Tech Army within an Army," *Christian Science Monitor*, November 17, 2005 http://www.csmonitor.com/2005/1117/p01s03-woap.html, 1. The quote comes from Col Michael Boera, a wing commander in Guam. The analyst quoted is Mr. Dennis Roy of the Asia-Pacific Center for Security Studies.

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[128] Mowthorpe, *The Militarization and Weaponization of Space*, 94.

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