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China's Military Space Capabilities

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China in the past two decades has ramped up its defence modernisation programme with particular emphasis on space based military systems. Their concept of informatisation relies heavily on space to give it an over arching reach around the globe to augment their terrestrial systems. China's comprehensive and integrated space programme has a distinct military bias which permeates the various arms of their space effort, unlike India which has a clear non-military slant. The PLA aims to utilise the entire gamut of their space based assets as a whole to achieve space dominance while at the same time preventing its opponents from achieving the same.

Introduction

In an era of full-spectrum combat operations, future wars will increasingly be controlled through space. The conflicts in the Gulf and Kosovo showcased the lethality of weaponisation of space and its potential to disintegrate command and control structures causing widespread panic and chaos. But it is only in the recent few years that the significance of ''space wars'' has been effectively brought home. And at the forefront of this revolution stands China.

China has evaluated the importance of the relatively new domain of space wars and has ramped up its defence modernisation programmes accordingly. There seems

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to be a realisation among Chinese leaders and policymakers that the traditional and mechanised methods will no longer work in the new integrated and systems-oriented environment, characterised as it is, by a rapidly changing time–space relationship. China has already taken concrete steps in developing capabilities to win local border wars under *informationised* conditions and is further expanding its reach to cover the globe. It is simultaneously enhancing its cyber warfare capabilities as can be seen from the number of intrusions around the world attributed to China. In its quest to acquire a global power status with muscle, it is developing space capabilities to give it an over-arching reach around the globe to augment its land and sea based systems.

While assets in space are force-multipliers and vital for conducting integrated or joint land, sea, air, and space missions, the domain, by it-self, is highly contested, with no assurances for dominance by any country. Therefore, while there are inherent advantages of space-warfare, they are also points of critical vulnerability. The central theme in Chinese military thinking is that if China ever has to defend itself, it should be prepared to conduct ''warfare beyond all boundaries and limitations.'' The principal plot is to strike in unexpected ways at the soft under-belly of their opponents.[1] As a consequence of their emphasis on information technology (IT) and networking, they have realised the importance of space as effective means to disrupt IT systems during peace, conflict or at war.

Space and Counter Space Capabilities

Space-force plays an increasingly critical role in providing defence forces with enhanced information superiority, situational awareness and targeting, and is a vital element in any form of combat. More importantly perhaps, it provides an instrument of persuasion that could prove decisive in both peace and conflict. Having realised this, Chinese military strategists and aerospace scientists have been quietly designing a blueprint for achieving space dominance for more than a decade. Chinese military scientists have contended that space warfare will become the core of future non-contact combat. The Chinese space programme has been described as ''a mystery within a maze.'' Some elements of the Chinese space programme are visible – for example, space launch vehicles, launch sites, and satellite systems although they are shrouded in secrecy and rarely available for scrutiny or are any information about

them available. Other dimensions of the space programme which are intangible in nature, such as its organisational structure, its directing and coordinating mechanisms, and the relationships between its constituent entities, can only be dimly perceived. This pervasive secrecy and compartmentalisation persists throughout the Chinese military–industrial complex affects not only the outside observers but also keeps the participants in the dark.[2]

China does not employ the term counter-space operations though many of their activities in space comport with what we might term as ''counter-space operations'' – a term borrowed from the American lexicon. In the Chinese glossary of terms, these operations as referred to as ''offensive'' and ''defensive'' space operations. Chinese writings on space warfare are not limited to bringing down systems in orbit, but establishing space dominance entails preserving the entire structure of terrestrial and space systems which includes orbiting satellites, space-related terrestrial facilities, and the data, communications, and telemetry links that tie all of these systems together.[3] For example, Chinese descriptions of space offensive operations include not only applying hard-kill capabilities against satellites, but also attacking launch bases and tracking, telemetry, and control facilities.[4] The offensive operations also include soft-kill techniques, such as jamming and dazzling satellites to minimise the generation of debris and the attendant physical and diplomatic consequences. Violent space operations are likely to involve cyber-attacks against the various data and communications links that transfer information and commands used to control satellites in orbit.

The notion of ''defensive operations in space'' also incorporates a range of information denial measures. These include passive steps, such as camouflage and deception, to prevent an opponent from using space-based systems to gather accurate information. Information denial also aims to protect against an opponent attacking Chinese space-related systems. Neutralising and suppressing the enemy's space infrastructure may include both kinetic and electronic means directed at the enemy's space-based systems, terrestrial facilities, and data and communications links. The entire gamut of space operations is sought to be employed in a unified manner to achieve space dominance, thereby ensuring that the People's Liberation Army (PLA) can exploit space at key, decisive times and places of its choosing, while preventing an opponent from doing so.

Significance of Space Capabilities

China has a comprehensive, integrated and focused space programme which spans the entire spectrum of activities ranging from manufacture and launch of satellites, manned missions, space research, space applications and increasing deep space missions. Unlike India, where a clear demarcation can be made between the military and civil organisational structures, the Chinese space programme has a strong military bias which permeates even the scientific, domestic, and commercial elements of the space effort.

China's space industry has benefited economically from its reinvigorated space programme in several ways. Conducting research and development on space systems, building various versions of missiles and guidance systems, satellite systems, space launch complexes, and operating and maintaining the space launch and control systems are all vital to a space programme and involve high-technology workers. So not only are jobs created, but also the ''pull'' from the space programme fosters better educational institutions and more graduates. Marketing this capability brings income into government agencies, which feeds further space development. They are, however, yet to develop cutting edge technologies which are the in the ambit of the United States. The Chinese are, however, attempting to overcome their huge technology gap by embarking on their calculated approach of ''buy, copy or steal'' or by uniting with other countries in joint ventures.

Beijing has, since the year 2000, promoted technical and economic cooperation and exchanges to jointly develop satellites and other space related articles with more than 70 countries and regions. China's international space activities in government-to-government agreements and business joint-ventures now include Australia, Brazil, Canada, Chile, France, Germany, Italy, Japan, Kazakhstan, Pakistan, Russia, South Korea, Sweden, and the United States. These relationships have ensured a constant source of revenue, speeded up the assimilation of new ideas and more importantly increased their access to cutting edge technologies.

Satellites

According to Qi Faren, former chief designer for Shenzhou spaceships, China plans to carry out more than 20 space missions this year (2011), in an effort to further

improve its space technologies.[5] This is a huge leap from the 15 space missions China conducted in 2010. China is next only to United States and Russia in the number of satellites in orbit. China has a total of 69 active satellites[6] in orbit as of 30 April 2011 compared to 443 of United States and 101 of Russia. These include a range of remote sensing, communications, weather, navigation, and scientific satellites. The various applications of China's satellites are discussed subsequently. The increasing dual nature use of satellites masks their purpose and exploitation by the PLA armed forces.

China Aerospace Science and Technology Corporation (CASC)

It is the large state-owned enterprise having a registered capital of $1.1 billion and 110,000 people. The corporation operates a constellation of satellites with various designations like FSW/Jiang Bing, Yaogan Weixng/Jiang Bing, Jiang Bing/ZiYuan CBERS/ZiYuan, and Haiyang. The Jaing Bing is the military designation given to reconnaissance satellites and is generally affixed to all intelligence, surveillance and reconnaissance (ISR) satellites to create confusion and mask their real purpose. Satellite series with military significance are discussed below.

FSW Series

Fanhuishi Shiyan Weixing (FSW), or recoverable test satellites, is a series of satellites launched by China between 1974 and 2006. The FSW satellites were designed for imagery intelligence (IMINT) and mapping roles, and had a secondary role for scientific research and experiments by using piggyback payload. The FSW satellite technology also served as the basis for China's ShenZhou manned spacecraft design.[7] A total of six variants of the FSW satellite were introduced, including five military IMINT variants FSW-0(JB-1), FSW-1(JB-1A), FSW-2(JB-1B), FSW-3(JB-2), and FSW-4(JB-4), and a scientific experiment variant ShiJian-8 (SJ-8). Of these, the later versions like the FSW-3 and FSW-4 are high-precision photographic mapping satellites. China has released no information concerning the design of the JB-3 or ZY-2 satellites or the imaging system they carry. They are believed to be equipped with CCD (charge-coupled device) cameras and an infrared multi-spectral scanner capable of generating high-quality ($\sim$3 m resolution) images and storing or transmitting them to the ground in real-time. The FSW series satellite has now

been replaced by the new generation digital and radar imaging ''remote sensing satellites'' (RSS) designated as YSW.[8] There has been a lot of speculation that JB-3 satellites are in reality spy satellites but have been given the name Ziyun-2 (ZY-2) (*Ziyun* means resource) and are being used at present to spy on forces in Asia and the United States. If the reports are accurate, such photo-reconnaissance satellites can be used for planning combat missions, setting up missile or prepare aircraft strikes. The sun-synchronous ZY-2 is China's largest and heaviest indigenous satellite, and its 3-axis stabilisation technology is the most advanced in China. The ZY-3 in this series is likely to be launched sometime this year.[9]

YaoGan WeiXing/Jiang Bing-5/RSS Series

For over a decade China had been planning to put a high-resolution synthetic aperture radar (SAR) satellite in orbit for all-weather targeting applications, particularly the location of naval forces in the Taiwan Strait. The first RSS in this series was launched on April 27, 2006.[10] China has launched a total of five SAR satellites and four electro-optical satellites in the YGW series (to complement the SAR satellites) as of March 5, 2010. These have been serially numbered as JB-5 to JB-13 (or JB-5 series for SAR and JB-6 series for EO (Electro-optical) payload[11]). The PLA views SAR satellite imagery as vital to its ability to achieve information dominance in future warfare due to its ability to see through clouds, rain, fog and dust in order to detect targets on the ground or underground, and at or under water/ocean.[12] In addition, SAR satellites are extremely useful in tracking moving targets an important military requirement. Chinese engineers have been examining SAR satellites as a means to track enemy submarines in shallow waters. It is believed that China's space-based SAR system development has benefited from its cooperation with Russia and Europe in this field. In addition China also operates three dual purpose China Brazil Earth Resource Monitoring Satellites (CBERS) satellites with two more planned to be developed in near future.

Dual Use Weather Satellites

Since 1988, China has developed three series of weather satellites (*Fengyun* series) namely the FY-1, FY-2, FY-3 with a fourth series the FY-4 under development.

Although designed for civil uses the satellites support the defence needs by providing accurate weather inputs during operations, which is an important variable in planning an amphibious strike or even concerted air and missile attack apart from land operations. A total of six satellites are in orbit now. Plans are afoot to launch another 22 meteorological satellites by 2020, including four more from the Fengyun-2 series, 12 from the Fengyun-3 series and six from Fengyun-4 series. The last launch of a weather satellite (FY-2-06) took place on December 23, 2008. It is evident that with every launch, capabilities and performance will witness greater improvement.

Military Communication Satellites

China operates a series of commercial satellites like China star, Asia sat, Apstar, Sino sat and the military series like the China sat or the Feng Huo. These are equipped with C, K Ka and Ku band transponders to cater to all communication needs of both civil and military users. Though commercial communications satellite programmes enhance military communications, they do not use military-specific hardening technologies such as jamming resistance and spread-spectrum transmission. Hence despite having an extensive fibre-optic communication network the DFH (*Dong Fang Hong* or ''the east is red'') has limited bandwidth on these satellites for military use. The PLA has, therefore, proposed a network of five defence communication satellites (China Sat 21-25). The first one launched in Jan 2000 was given a military designation of *Feng Huo*-1 (FH-1) and consists of the *Qu Dian* C^4I (command, control, communications, computers and intelligence) system. The *Qu Dian* C^4I network would enable PLA commanders to communicate with their in-theatre forces in near real time,[13] and also enable data transfer with all units under joint command in addition to providing the Chinese military with a high speed and real-time view of the battlefield thereby enabling effective command and control. The satellites would reportedly provide the military with both 'C' and UHF band communications. A total of three satellites have been launched.[14] Once fully deployed the FH series constellation would establish space-based military tactical communication networks to support Chinese military operations and provide its ballistic missiles, cruise missiles, ships and aircraft a seamless tactical-to-strategic targeting capability.[15]

Beidou Navigation System

China has two sets of Beidou navigation systems. The first was the Beidou1 system which was an experimental system to provide a two dimensional navigation. It has been in operation since 2000. The Compass Navigation Satellite Experimental System, or BeiDou 1 (BD-1) in its Chinese name, is the three-satellite constellation developed by China Academy of Space Technology (CAST). It is China's first space-based regional navigation and positioning network. The system provides all-weather, two-dimensional positioning data for both military and civilian users. The network covers most areas of East Asia region and has both navigation and communication functions. The satellite network comprises three BeiDou 1 satellites (two operational and one backup). The system began to provide navigation and positioning services in late 2001. The third satellite (backup) BeiDou 1C was launched on May 25, 2003, making the system fully operational. The navigation and positioning services became available to civilian users in April 2004. This has made China the third country in world to have deployed an operational space-based navigation and positioning network.

The next generation of the navigation is Beidou-2 (Compass Navigation Satellite System (CNSS)) system will be a constellation of 35 satellites, which includes five geostationary orbit (GEO)[16] satellites, for backward compatibility with BeiDou-1, and 30 non-geo synchronous orbit (GSO) satellites (27 in medium-Earth orbit (MEO) and three in inclined GSO (IGSO) that will offer complete coverage of the globe. The CNSS will provide two types of services:[17]

- free service to civilians will have a 10 metre location-tracking accuracy, will synchronise clocks with an accuracy of 50 ns, and measure speeds within 0.2 m/s; and
- the licensed service to Chinese government and military users will be more accurate than the free service, can be used for communication, and will supply information about the system status to the users.

The Beidou system is designed to provide navigation, time and short message services in the Asia and Pacific region by 2010 and will be capable of providing global navigation services by 2020. The system will initially be used to provide high-accuracy positioning services for users in China and its neighbouring regions, covering an area of about 120 degrees longitude in the Northern Hemisphere. The

long-term goal (2020) is to develop a global navigation satellite network similar to the GPS and GLONASS.

According to International Telecommunication Union (ITU) filings by China, Compass will broadcast on four frequencies centred at 1590 MHz, 1561 MHz, 1269 MHz, and 1207 MHz (rounded). These signals lie in the frequency band of GPS and Galileo signals. The Beidou provides PNT (Position Navigation and Timing) services within China and contiguous areas between Latitude70° ~140° E and from 5°N to 55°N. The Compass navigation signals are code division multiple access (CDMA) signals similar to the GPS and Galileo signals.

So far China has launched eight satellites in this series of which seven are functional. The eighth Beidou satellite launch marks the completion of basic function of Beidou (Compass) Navigation Satellite System and will collaborate with five navigation satellites launched last year to establish a navigating system of three GEO satellites plus three IGSO satellites. The system will be able to provide services to most regions in China after a period of orbiting running tests and system integration. CNSS satellites are based on the Dong Fang Hong 3 (DFH-3) satellite bus, with a designed life span of eight years.

Space Situational Awareness

Beijing Aerospace Command and Control Centre (BACC) is a spaceflight mission control centre located inside the Beijing Aerospace City in the northwest suburb of Beijing. The centre is primarily responsible for managing all manned spaceflight missions of the People's Republic of China (PRC), as well as the unmanned lunar probes during the orbital flight and re-entry phase of the missions. BACC is the nerve centre of a nationwide space telemetry, tracking and control (TT&C) network designed to support the human spaceflight and deep space exploration missions. The network includes a number of domestic and overseas space tracking stations, four space tracking ships, and data relay satellites (DRS). BACC can issue orders to and collect information from the flying spacecraft, space launch centres, and space tracking stations and ships in real-time via a communications network consisting of communications satellites, fibre-optic, and ultra-high frequency (UHF). The present TT&C infrastructure consists of eight domestic tracking sites,[18] two sites on foreign soil[19] and six Yuanwang-class tracking ships. In addition China has two S band dish

antennas,[20] at Beijing and Kunming, to support its deep space missions. These will not only help China in deep space tracking but also track its geostationary satellites.

The state of the art control centre is staffed by both civilian engineers and military personnel from the People's Liberation Army General Armament Department (GAD). China claims that its space control network has a metre level orbiting accuracy and a centimetre level positioning accuracy[21] with simultaneous control of multiple satellites (20) in different trajectories.[22] If the above claims made in the year 2005 are taken as accurate, then the possibility of China successfully undertaking satellite interception missions becomes enormously credible. It would have the requisite orbital data to calculate the proper path to the target, to launch the booster at the precise moment, the ability to track and plot the precise intercept course to the target and detonate, dock, rendezvous or inspect as need be.

China's Counter-Space Capabilities

Publicly, China opposes the militarisation of space, and seeks to prevent or slow the development of anti-satellite (ASAT) systems. Privately, however, China's leaders probably view ASATs, and offensive counter-space systems, as force multipliers. Besides, no country having the capability for ASAT operations can be expected to stay quiet when the opposing forces' space based systems are aiding terrestrial operations. Space deterrence has therefore been a major consideration behind Beijing's development of counter-space programmes. The goal of this deterrence is to ruin an opponent's economy, its C^4ISR (command, control, communications, computers, intelligence surveillance and reconnaissance) network and thus their ability to function in space. The ASAT test in 2007 and the dazzling of an American satellite by ground based laser in 2006 are only the small and visible attempts by China to target space based assets and inform the world of their growing capabilities. Since the turn of the century China has been discreetly shifting its position from opposing militarisation of space to opposing the weaponisation of space, thus removing the political hurdle to its own space use in such applications as reconnaissance, navigation and positioning for military purposes. The available Chinese literature on the subject points to the fact that China is actively exploring a variety of space weapons through theoretical, basic and applied research as part of 'attack operations' to achieve

dominance of the high ground. They plan to adopt both hard kill and soft kill means to achieve this objective.

Chinese aerospace scientists have compiled the following list of ''space-information countermeasures'':

- aim for the satellite's effective payload by applying suppression interference to cause overload in the satellite's receiving system, data processing system, and memory;
- target the satellite's remote control system by (a) establishing a space target monitoring system to acquire the satellite's technical parameters and character information, and (b) effectively detecting and analysing the satellite's operational system and down-link remote signal;
- attack the satellite's space-to-ground communication and command nodes to weaken the connection, link, mutual operation, and networking flexibility in order to degrade its operational effectiveness; and
- use high-energy and kinetic weapons to blind or destroy the reconnaissance satellite.

The sphere of action in space is not limited to anti-satellite operations but also has tremendous potential applications in:

a) detection, tracking and destruction of ballistic missiles;
b) disrupting communication links between satellites and ground stations by ''drowning out'' the signal with a more powerful ''fake'' signal or by targeting ground stations via physical attacks or computer hacking;
c) misdirecting or hijacking unmanned aerial vehicles (UAVs) especially those linked via satellites;
d) taking over enemy computers; and
e) disruption of PNT systems.

Space Weapons

China maintains a development and deployment programme for space weapons including programmes on direct ascent (DA) ASAT weapons, high energy laser (HEL) dazzlers and other types of jammers. The PRC is developing these weapons

and technologies as a way to counter US space superiority and to deny the use of space. China understands the United States' reliance on space for imagery, signals intelligence, communication, tracking of friendly forces and navigation. As such, they are developing the capabilities to deny the United States information at the time of their choosing. Additionally, the threat of space denial, such as through the testing of ASAT weapons, is also an effective counter-space strategy.

ASAT Weapons

In January 2007, China successfully tested a DA ASAT missile against a Chinese weather satellite, demonstrating their ability to attack satellites operating in low-Earth orbit (LEO). This test has been widely viewed as a direct challenge to US space superiority. In addition to ASAT, the PRC is researching methods of co-orbital interception to target satellites in LEO and MEO orbits. Co-orbital ASATs will provide China with a broad range of options beyond kinetic attack to counter space-enabled, information advantage. For example, in June 2010, China launched the Shijian-12 (SJ-12) satellite from Jiuquan Satellite Launch Center in north-central China. According to the State media service Xinhua, SJ-12's mission is to carry out "scientific and technological experiments." However, between June 20 and August 16, SJ-12 conducted a series of manoeuvres to rendezvous with SJ-06F, an older Chinese satellite launched in October 2008. SJ-12 made many close approaches with less than 984 feet between the two satellites. With this co-orbital dual-use[23] rendezvous China has tacitly demonstrated its ability to damage or interfere with satellites from other countries.

Mini- and Microsatellites

The first microsatellite *Tsinghua-1* was launched on June 20, 2000. The satellite also carried out in orbit manoeuvring and rendezvous with another nanosatellite SNAP-1 (Surrey Nanosatellite Applications Platform) enabling China to gain experience in precise tracking and orbital manoeuvring. Relevant to maritime surveillance are China's Huanjing disaster/environmental monitoring constellation, envisioned to contain 11 satellites capable of visible, infrared-red (IR), multi-spectral, and SAR imaging.[24] Two initial satellites in the series are the Huanjing-1A and-1B, launched in September 2008, which provide real time multi-and hyper-spectral imaging respectively, to a resolution of 30 m.[25] Huanjing-1C and -1D are reportedly

scheduled for launch sometime in 2011. The full constellation is designed to form a complete image on China every 12 hours. Militarily, small satellites, especially micro and nanosatellites hold tremendous potential as they can be used effectively in ASAT roles. Microsatellites carrying hard-kill or soft-kill payloads can be manoeuvred close to the target satellite and activated at the desired time. China is said to be developing ASAT systems using 'parasitic' satellites capable of attaching themselves to target satellites without detection and lying dormant till the need arises. The *Sing Tao Daily* reported in January 2001 that China had ground tested a potentially very potent satellite weapon called a ''parasite satellite.'' This microsatellite could attach itself to a targeted satellite with the intent of jamming or destroying it under command. Microsatellite constellations can be designed to support the entire spectrum of space-based C4ISR operations, such as surveillance, navigation, communications, remote sensing, electromagnetic intelligence (ELINT), and so on.

Space Object Surveillance and Identification

Implementation of ASAT options requires not only the weapons themselves, but also information about the physical characteristics and orbits of the satellites to be targeted and attacked. China currently is developing a space object surveillance and identification (SOSI) network to improve its space situational awareness. This network will give it the ability to track and identify most satellites for offensive actions while allowing for de-confliction with Chinese satellites. Beijing will continue to enhance its satellite tracking and identification network, as it is the first step in establishing a credible ASAT capability.

DEW Laser/HPM

Prior to hostilities, the Chinese would likely use directed-energy weapons (DEWs) such as HEL to dazzle or blind imagery satellites. This technique could negatively impact our ability to monitor Chinese military activities while maintaining a degree of deniability and reversibility for Beijing since these are not permanent kill weapons. China has placed a lot of emphasis on developing DEWs. Citing Washington's advances in the DEW arena China has embarked on a massive programme for developing HEL and other microwave weapons. China's laser weapons and application programmes are massive and sophisticated by any international standards and some estimates suggest that there are approximately 10,000 personnel including

3000 engineers involved with China's laser programme alone (40% of these are for defence applications alone).[26] China already possesses the capability to damage, under specific conditions, optical sensors on satellites that are very vulnerable to damage by lasers. However, given China's current level of progress in laser technology, it is reasonable to assume that Beijing would develop a weapon that could destroy satellites in the future. In addition, PRC officials have publicly indicated their intent to acquire radiofrequency (RF) weapons as a means of defeating technologically advanced military forces. Chinese writings have suggested that RF weapons could be used against C4ISR, guided missiles, computer networks, electronically-fused mines, aircraft carrier battle groups, and satellites in orbit. An ASAT mission is undoubtedly one of the most stressing RF weapon applications. Even if the Chinese commit significant resources to an RF ASAT development programme, they are unlikely to be able to deploy such a weapon for at least 15 years.

Conclusion

The nature of war has changed. Occupying territory by force is a thing of the past. An all out war between China and India is an extremely remote possibility because of the economic ramifications.

The PLA has recognised the importance of controlling space-based information assets as a means of achieving true information dominance, calling it the ''new strategic high ground,'' and many of its advocates consider space warfare to be essential for operating joint campaigns and for maintaining the initiative on the battlefield. Conversely, they view the denial of an adversary's space systems as an essential component of information warfare and a prerequisite for victory.

According to Chinese military writings for efficient and effective joint operations a military must be able to exploit space. Only the high ground of space can provide the opportunity to gather information; transmit it rapidly, securely, and reliably; and exploit it promptly. Space has been described as essential for reconnaissance and surveillance, communications, navigation, weather forecasting, and battle damage assessment. Space capabilities besides strengthening conventional forces enhance joint operations and keep unwanted forces at bay.

The increasing exploitation of space by China under all weather conditions will improve intelligence gathering and targeting capability across the vast expanse of the

Indian landscape. There is a risk that space-based communications of our nuclear arsenal could be neutralised by Chinese ASAT capabilities. China's counter-space capabilities are a threat to India's limited yet valuable ISR, communication and navigation satellites, through hard- and soft-kill options, degrading and denying India the much needed overall battle space awareness. While China continues to improvise on its capabilities, indirectly it also makes Pakistan a ''proxy space power'' given its penchant for proliferation of technology and capabilities. Exploitation of China's capabilities for use by Pakistan against India cannot be ruled out in any future conflict. The proliferation of new sensor and communication technologies in recent years has been so profound that warfare has now transcended from being terrestrial to the outer space. Satellites are playing an increasingly important role in achieving information dominance. In future, space power will play a very major role in deciding the outcome of conflicts. Security of space based assets will therefore have to be accorded the highest priority. China has an aggressive space and counter-space programme that is just one element of their comprehensive anti-access strategy to degrade, disrupt, deny or destroy our ability to exploit our in information-enabled military operations.

Continued Chinese investment in the design, development, deployment and employment of space counter-space and IT systems will dramatically reduce our freedom of action in the event of a conflict in the region. China also continues to acquire key technologies and manufacturing methods independent of formal contracts. Industrial espionage in foreign research and production facilities and illegal transfers of technology are used to gain desired capabilities. Where technology targets remain difficult to acquire, foreign investors are attracted to China via contracts that are often written to ensure Chinese oversight, with the eventual goal of displacing foreigners from the companies brought into China.

China persists in a systematic effort to obtain from abroad through legal and illegal commercial transactions dual-use and military technologies. Beijing has in recent years put considerable effort into acquiring new capabilities for mobility, power projection, and precision-strike. The PLA has made undeniable progress since the late 1990s in expanding its capabilities in several areas, particularly missile attack, power projection over sea and in the air, space, INEW (Integrated Network Electronic Warfare), directed energy weapons and precision-strike China's military transformation has, more than any armed force in the Asia-Pacific region, imitated

US transformation in terms of ambition and scope. Long-term trends in Chinese military modernisation have the potential to pose a credible threat to militaries in our region if they are not doing so already.

Notes

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9. ''China to Launch its First High Resolution Mapping Satellite: ZiyuanIII.'' http://www.chinatechgadget.com/china-to-launch-its-first-high-resolution-mapping-satellite-ziyuan-iii.html.
10. Joan Jhonson-Freese, ''China's Space Ambitions,'' IFRI Security Studies Centre, Summer 2007.
11. Craig Covault, ''China Accelerates Space Research and Development,'' *Spaceflight Now*, December 29, 2009. http://spaceflightnow.com/news/n0912/28china/ (accessed June 2011).
12. Synthetic aperture radar (SAR) is an active microwave instrument producing high-resolution imagery of the Earth's surface in all-weather, day/night conditions. A SAR instrument can measure both intensity and phase of the reflected microwave radiation, resulting not only in a high sensitivity to texture, but also in some three-dimensional capabilities. While conventional optical imagery intelligence systems are less effective in night and bad weather (e.g. cloudy) conditions, the SAR generates its own microwave radiation that can penetrate

cloud, haze, shallow water, or even ground surface to obtain high-resolution images of the Earth surface as well as underwater and underground.

13. John Pike, ''The Military Uses of Outer Space,'' *SIPRI Yearbook 2002: Armaments, Disarmaments and International Security*. http://www.sipri.org/yearbook/2002/files/SIPRIYB0211.pdf (accessed February 2011). Also see Jhonson-Freese, ''China's Space Ambitions.''
14. China launched a second satellite based on the advanced DFH-3 bus in November 2003 featuring a number of new technologies, including the first Chinese satellite to provide the Ku-band communication; the first to use the advanced multiple steerable spot beam antenna technology to enable ground users to communicate while on the move; the first to use secured uplink transmission for satellite antenna control; and the most powerful onboard data processing capability. A third in the series was launched in 2006.
15. ''China's Military Space Surge.'' http://www.andrewerickson.com/wp-content/uploads/2011/03/Chinas-Military-Space-Surge_AA_2011-March.pdf (accessed April 2011).
16. A geosynchronous orbit with an inclination of zero. To an observer on the ground this satellite would appear as a fixed point in the sky.
17. ''China Completes Basic Beidou (Compass) Navigation Satellite System,'' *Global Times*, April 10, 2011. http://business.globaltimes.cn/industries/2011-04/642763.html (accessed April 2011).
18. ''China's Space Capabilities and the Strategic Logic of Anti-Satellite Weapons'' http://cns.miis.edu/stories/020722.htm and ''China's Yuan Wang Class Tracking Ships'' http://defenceforumindia.com/military-multimedia/14326-chinas-yuan-wang-class-tracking-ships.html.
19. One in Kiribati in the South Pacific and another in Namibia.
20. Bradley Perrett, Frank Morring, Jr. and Craig Covault, ''China Hopes Change Will Pave Way for Lunar Rover,'' *Aviation Week & Space Technology*, October 28, 2007.
21. Ministry of Science and Technology, Newsletter-370.
22. Ministry of Science and Technology, Newsletter-397.
23. The capability is considered dual-use, in that the technology could also be used to help clear out space junk or inspect or fix satellites.
24. As quoted by the Ministry of Science and Technology, Newsletter No. 339, August 10, 2003.
25. ''Huanjing Series (China), Spacecraft – Earth Observation,'' Jane's. http://articles.janes.com/articles/Janes-Space-Systems-and-Industry/Huanjing-series-China.html (accessed April 2011).
26. ''High Energy Laser Directed Energy Weapons'' http://www.ausairpower.net/APA-DEW-HEL-Analysis.html#PLA.