DRAGON IN SPACE: IMPLICATIONS FOR INDIA

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If one side reinforces a shield, the other will reinforce its spear. It is all too easy to start a competition.

—Xu Guangyu, Director of China Arms Control and Disarmament Association

The beginning of the 21st century has been extremely eventful for China as regards its successes in the realm of space. As part of its policy of peaceful rise, China has made resolute investments in space technologies over the past five decades and is reaping the benefits of the same. The successful culmination of the first phase of its manned and moon missions have enhanced its return to greatness. Though the successful anti-satellite (ASAT) test on January 11, 2007, invited much international criticism on China's claims of using outer space for peaceful purposes, it also demonstrated China's counter-space capability, evoking concerns about space security. In 2007, China conducted its 100th space launch with a Long March rocket, commenced operations of the Beidou satellite navigation and positioning system and launched its Chang'e lunar orbiter. Further, the launch of the Tain Lian-1 (a tracking and data relay satellite) on April 25, 2008, on board its new Long March 3-C carrier rocket has catapulted China into a select league of nations having this niche capability of establishing inter-satellite communication links. China is making a concerted effort in its force modernisation drive to ensure seamless integration of its space capabilities into the war-fighting doctrines of its

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China is making a concerted effort in its force modernisation drive to ensure seamless integration of its space capabilities into the war-fighting doctrines of its land, naval and air forces.

land, naval and air forces. The revolution in military affairs (RMA) brought about by the Gulf War and its aftermath has been imbibed by China and enabled it to transform the People's Liberation Army (PLA) from one fighting a "people's war" to one that is capable of fighting "local wars under conditions of informationalisation."

Many attribute China's near-term focus on preparing for contingencies in the Taiwan Strait, including the possibility of US intervention, as an important driver of its modernisation efforts. However, analysis of China's military acquisitions and strategic thinking suggests Beijing is also developing capabilities for use in other contingencies, such as conflict over critical energy resources or disputed territories. The US advances on ballistic missile defence (BMD) and the successful interception of the US-193 by a modified SM-3 missile fired from an Aegis destroyer on February 20, 2008, is viewed by China as erosion of its nuclear deterrent capability against the US. Hence, China considers its space programme as the capability which will allow it to counter the US designs in the ultimate high ground. Apart from the US, China has catered India in its overall security calculus at the regional level and the fact is evident from the recent commercial satellite imagery revealing extensive missile sites in central China, with nearly 60 launch pads for medium-range missiles capable of striking Russia or India. The detection of a nuclear submarine base in Sanya, Hainan Island, in China, also points to the growing regional role China sees for itself in the near future. In the light of this, the aim of this paper is to study the military space and counter-space capabilities of China and its evolving space doctrine and their implications for India.

HISTORICAL PERSPECTIVE

The Chinese tryst with space began in 1956 as an offshoot of China's missile technology development efforts and was soon considered a national priority alongside the country's missile and nuclear programmes, together referred to under the rubric *liang dan, yi xing*"– two bombs (atom bomb, hydrogen bomb), one star" (i.e. satellite)[1]. An integral part of the programme was the development of aviation and rocket technology for the construction of the nuclear warhead delivery systems. As a result, China established the Fifth Academy of the Ministry of National Defence. The launch of Sputnik-1 on October 4, 1957, by the Soviet Union encouraged the Chinese to develop a satellite.

The US and USSR both helped China in furthering its rocket and space programme – the first by default and the second by design. Tsien Hsue Shen[2] who is credited with being the father of China's space and missile programme was deported to China post-Korean War as a result of the sweeping McCarthyism in the US. Tsien Hsue Shen was made the director of the First Rocket Research Institute. Meanwhile, the USSR supplied the resources (R-2 missile models, technical documents designs and technical expertise) which were deftly managed by Tsien Hsue Shen, enabling China to pursue its rocket and satellite programme in parallel. Thus, Project 1059 (October 1959) was initiated for rocket development and Project 581 (first project/first month of 1958) for development of an earth satellite. However, a resource crunch and the ensuing political upheavals forced China to shelve the satellite project a year later. The prevailing military considerations[3] forced China to press on with its rocket development programme, culminating in the successful launch of it's first rocket, a Chinese R-2, on November 5, 1960. It was named the Dong Feng-1 (East Wind).

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1. Jeff Kueter "China's Space Ambitions and Ours," *Atlantis Journal*, Spring 2007, http://www.thenewatlantis.com/publications/chinas-space-ambitions-and-ours
2. Tsein Hsue-Shen was a Chinese born American educated scientist. He founded the Jet Propulsion Laboratory in California and was a member of the team of scientists that entered Germany just behind the American lines under Operation "Paper Clip" which brought truckloads of V-2 rockets and their chief designer Wernher Von Braun to the US. The anti-Communist backlash in the US during the McCarthy era led to the arrest of Tsein Hsue-Shen in 1950 and his subsequent deportation to China in 1955.
3. The revelation of the US intentions to use nuclear weapons against China during the Korean War and the subsequent Taiwan Strait crisis meant China was desperate to have a means of delivery system for a nuclear weapon(a bomb which it was trying to procure secretively from the USSR). The Soviets' refusal to part with the bomb resulted in the Sino-Soviet split in 1960.

The decade of the 1960s witnessed China pursuing its missile programme in right earnest, culminating in a series of long range missiles like the Dong Feng-1 (DF-1), DF-2 and DF-3, and the nuclear capable DF-4 and DF-5. The resulting iteration of the medium range DF-4 missile was adapted into China's first satellite launch vehicle (SLV) – the Chang Zheng-1 (CZ-1) or Long March-1. Similarly, the DF-5 intercontinental ballistic missile (ICBM) became the LM-2. By the late Sixties, efforts had been put in for a national space tracking and control system as well as a manned space programme. The satellite programme also picked up pace in the mid- Sixties and China's launched its first satellite, the Dong Fang Hong[4] (DFH), on April 24, 1970, becoming the fifth nation to do so.

The decade of the 1970s witnessed China producing the Feng Bao-1 SLV, a derivative of CZ-2 and it was used to orbit the Ji Shu Shiyan Weixing (JSSW) electronic intelligence (ELINT) satellite series under Project 701[5]. The CZ-2 was also used for launches of the Fanhui Shi Weixing (FSW) photo reconnaissance satellite, with a recoverable reentry capsule, beginning in 1974. From the mid-1980s, China's space programme became increasingly dual natured with China concentrating on both military and civil space programmes with renewed vigour with a sense of restoring "techno-nationalistic pride" to its space programme. China launched 27 foreign-made and 47 indigenous satellites[6] between1985-2000. Altogether, four satellite series were developed in China, namely:

- The Fanhui Shei Weixing (FSW), recoverable test satellites.
- The Dongfanghong (DFH) telecommunications satellites.
- Fengyun (FY) meteorological satellites.
- Shijian (SJ) scientific research and technological experiment satellites.

However, the new millennium witnessed China's foray into dedicated military communication, reconnaissance and navigation satellites, along with the manned and moon missions. China's current space capabilities are examined in detail to provide the linkage between China's capabilities and its doctrinal percepts of space.

4. hhtp://www.astronautix.com/articles/china.htm
5. Brian Harvey, *China's Space Program: From Conception to Manned Space Flight* (UK: Praxis Publishing), ch. 4, p. 70.
6. White Paper on China's Space Activities, released in 2000 at http://www.china.org.cn/e-white/8/index.htm

CURRENT SPACE CAPABILITIES OF CHINA

Launcher Capability

China's satellite launch vehicle capability is an offshoot of its ballistic missile programme and features the Long March or the Chang Zheng (CZ) series of rockets. Barring an occasional failure in 1996 to launch the US Intel Sat, the Long March series has undertaken 67 successful orbital insertions since then, making a total of 107 successful launches, with the launch success rate being 93.5 per cent, at par with international standards. According to relevant statistics[7], the success rate of America's Delta carrier rockets is 94 per cent, of the European Ariane carrier rockets 93 per cent and of the Russian Proton carrier rockets, it is 90 per cent. The success rate of India's PSLV, with 11 out of 13 successful launches, is 84.6 per cent. Though China leads Asia in the number of launches a year, it is still behind the US and Russia, while closing in on the gap with the European Union, as can be seen from the data available over the last decade. The launch rates, however, do not reflect the number of satellites launched by these countries.

China stands to gain more commercially by providing a sound launch and satellite market for the increasing number of aspiring space- faring nations.

Table 1: China Launch Progress

Year	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008***
USA	37	34	27	28	21	17	27	17	16	22	16	06
Russia	26	24	26	20	25	25	24	15	15	23	25	12
EU	13	11	10	12	08	10	04	03	05	05	06	04
China	06	06	04	06	02	08	09	10	06	07	10	03
India	01	0	01	0	02	01	02	01	02	01	03	02

** Launch figures as of June 30, 2008.*

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7. Wang Qian, "Long-March Rocket Technology Meets International Standards," May 3, 2003, at www.china.org.cn

faring nations that do not have launch facilities[8]. Developed indigenously by the China Academy of Launch Vehicle Technology (CALT), the "Long March" carrier rockets fall into four series, with 11 working models.

The available launchers with their payload and launch success rates are as tabulated below (Table 1).

Table2: Prevailing Chinese Launch Vehicle Capabilities

Launch Vehicle	Payload (kg)			Launch Site			Reliability in %	Remarks
	LEO	Polar	GTO	Jiquan	Xichang	Taiyun		
LM-1D	900	300		✔			100	
LM-2C	2,000	700		✔			100	
LM-2D	300		1,250	✔			100	Used for FSW spacecraft
LM-2E	8,800		3,375		✔		71	
LM-2F	800		3,375	✔			100	Used for ShenZhou
LM-3	5,500		1,400		✔		77	
LM-3A	7,200		2,500		✔		100	
LM-3B	13,500		4,000		✔		86	
LM-3C			3,700				100	Maiden launch on May 25, 2008
LM-4A		2,200				✔	100	Built by SAST used for FY Series
LM-4B		2,500					100	Built by SAST

8. China announced agreements in 2004 and 2005 to export its first satellites. A contract was signed in December 2004 between the Nigerian government and the China Great Wall Corporation for China to build and launch the satellite, provide operating services, and train Nigerian technicians in its operation. The Nigerian communication satellite is based on the Dongfanghong-4 communication satellite and was launched on May 14, 2007. China also signed a similar agreement with Venezuela for a telecommunication satellite to be launched in 2008.

Next Generation Launchers

China's next generation of launch vehicles to support its manned and lunar exploration programmes are expected to offer increased reliability and adaptability and will be powered by more pollution free engines that will provide more thrust than the current generation of launch vehicles. These launchers will be able to lift a 1.5 to 25 ton[9] payload into low earth orbit (LEO) and a 1.5 to 14 ton payload into geosynchronous earth orbit (GEO). The first launch of the new rocket, the LM-5, is expected to take place in 2014.

Launch on Demand Capability

China is also pursuing efforts towards launch on demand capability by development of a smaller solid fuel road mobile rocket series, called the Pioneer (*kaituozhe*/KT), The KT-1 is a four-stage booster based on the military DF-21(used to launch the ASAT) and is designed to launch satellites weighing less than 100 kg into 300 km polar orbit while the KT-2[10], is based on the DF-31 ICBM capable of lifting up to three 100 kg or one 400 kg payload. After an unsuccessful first test in September 2002, KT-1 was successfully launched in September 2003. In addition, efforts are on since 2000 to develop an air launched variant of the KT-1. To be carried by a modified H-6 bomber, the KT-1 would be released at an altitude of 3 km to place a 50 kg payload into LEO.

Launch Centres

China has three modern[11] (but land-locked, thus, azimuth-restricted) launch facilities: at Jiuquan for LEO missions, Taiyuan for sun-synchronous missions and polar orbits missions, and Xichang for geostationary missions. A fourth one is under construction at Wenchang in the southern island province of Hainan[12] and is likely to be operationalised by 2013. China is constructing all its new generation launch vehicles at a new base located at the Binhai New Area in the

9. "China: Launch Capabilities," accessed at http://cns.miis.edu/research/space/china/launch.htm
10. "China Missiles and Launch Vehicles," at http://www.sinodefence.com/strategic/launchvehicle/kt1.asp
11. Dr Jesco Von Puttkamer "Asian Space Activities. Space Flight 2003,",http://spaceoperations.nasa.gov/2003/yearinrev/03asia.html
12. "Hainan to Build a Space Harbor in 2010," *Hainan Economic Daily* (Hainan Jingji Bao), October 12, 2005.

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northern port city of Tianjin[13] which will enable it to move the rockets by sea to its launch centre using a sea barge, overcoming the constraints of land mobility in difficult mountainous terrain. Like the Indian launch site at Sriharikota, the southern launch site would provide an additional eastward 'push' to enhance the payload performance of a rocket launched into orbit. The island site would also provide a variety of launch paths that would not overfly populated areas.

While China has an enviable record for flawless launches over the years, it remains to be seen whether it can replicate its success with its mobile and air launched variant in the years to come as the changing spectrum of warfare will place on China the demands of a more disguised, rapid and flexible response to launch micro satellites to ensure a redundant surveillance and warning capability for its nuclear and conventional forces.

SATELLITES

Earth Observation

China's attempts at earth observation prior to the new millennium were very limited and primitive compared other space-faring nations but they focussed on both military reconnaissance and earth resources and disaster monitoring. The People's Republic of China (PRC) today operates a constellation of nine satellites with various designations like FSW, Jiang Bing/Ziyuan, CBERS/ZiYuan, Haiyang and Yaogan/ Jiang Bing to confuse even the best informed in the field. Of these, the FSW, ZiYuan and Yaogan are for military use and are discussed below.

FSW. The FSW programme began in 1966. The first successful FSW mission (JianBing-1-01) was carried out in November 1975, with the satellite recovered two days after the launch. So far, five models have been introduced, with a

13. "China Developing New Heavy-duty Carrier Rockets," October 31, 2007, http://news.xinhuanet.com/english/2007-10/31/content_6984931.htm

cumulative launch of 22 satellites[14] – from 1975 to 2005. Of these, the later versions like the FSW-3 and FSW-4 are "high-precision photographic mapping satellites," equipped with a film camera with a higher resolution (10~15m), and a charge coupled device (CCD) camera with a lower resolution (~50m).[15] The films are developed on the ground after retrieval from the landed reentry capsule. However, the CCD camera can transmit its images to the ground in a near-real-time manner. This combination enables the satellite to use the lower-resolution CCD camera for wide-range scanning, and then use the higher-resolution film camera to only capture areas of interest, thus, avoiding the waste of film as a result of bad weather.

JiangBing-3/ZY-2. The ZY-2 is China's first high-resolution CCD military reconnaissance satellite. Despite being reported by the Chinese official media as the ZiYuan-2 (Resource) remote sensing satellite designed for civilian roles such as territorial and resources surveying, the satellite is, in fact, operated by the PLA for military imagery reconnaissance purpose. Equipped with CCD cameras and an infrared multi-spectral scanner, the ZY-2/JB-3 satellite[16] is capable of generating high-quality (<2m resolution) satellite images and transferring them to the ground in near real-time. A total of three satellites was launched till 2004. 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.

YaoGan WeiXing/Jiang Bing-5 Synthetic Aperture Radar. The remote sensing satellite launched on April 27, 2006, is believed to be China's first launch of a satellite carrying a space-based synthetic aperture radar (SAR)[17]. For over a decade, China had been planning to put a high-resolution SAR satellite in orbit for all-weather targeting applications, particularly the location of naval forces in the Taiwan Strait. China has also taken interest in the potential civil applications of such a system in the aftermath of the flooding, landslides, and typhoon damage in 1994. While China has used optical and infrared imaging space-based civil remote-sensing systems, there is particular

14. Analysis of data compiled by Wikipedia on Chinese launch records.
15. "Recoverable Satellite Program," at http://www.sinodefence.com/strategic/spacecraft/fsw3.asp
16. "Jiang Bing Reconnaissance Program," at http://www.sinodefence.com
17. Joan Johnson- Freese, "China's Space Ambitions", *IFRI Security Studies Centre*, Summer 2007.

The PLA views SAR satellite imagery as vital in its ability to achieve information dominance in future warfare.

interest in active microwave imagery that can penetrate southern China's constant cloud cover. It is believed that China's space-based SAR system development has benefited from its cooperation with Russia and Europe in this field, while Canada helped it to upgrade its existing image processing facilities for SAR image processing in 1993[18]. China launched a second SAR satellite named JB-5-2/YGW-3 on November 12, 2007, while the missing number in the series, the YGW-2, was launched in May 2007 and is purported to be the electro-optical component of the JB-5 series.

The PLA views SAR satellite imagery as vital in its ability to achieve information dominance in future warfare. Unlike the conventional passive optical imagery satellites, the space-based SAR system can see through clouds, rain, fog and dust in order to detect targets on the ground or underground, and at or under water. In addition, SAR satellites are extremely useful in tracking moving targets, and can be useful in satisfying military mapping requirements. Chinese engineers have been examining SAR satellites as a means to track enemy submarines in shallow waters.

In addition, China also operates three dual purpose China Brazil Earth Resource Monitoring Satellites (CBERS), with two more planned to be developed in the near future. These provide 20 metre resolution with a CCD camera. China is planning eleven satellites in the Huanjing microsatellite programme[19], capable of visible, infrared, multi-spectral, and synthetic aperture radar imaging. In the next decade, Beijing will most likely field radar, ocean surveillance, and high-resolution photoreconnaissance satellites. In the interim, China will probably rely on commercial satellite imagery to supplement existing coverage. The in-orbit details of China's information, surveillance, reconnaissance (ISR) satellites are as given below.

18. n. 6.
19. As quoted by the Ministry of Science and Technology, *Newsletter No. 339*, August 10, 2003.

Table 3: China's Earth Observation Constellation								
Satellite	**Launch date**	**Launch centre**	**Launch vehicle**	**Orbit**	**Perigee in km**	**Apogee in km**	**Period in min**	**Remarks**
Military Reconnaissance								
JB-3-01	Sep 01, 2000	Taiyuan	LM-4B	SSO	484.4	487.6	94.2	ZY-1
JB-3 -02	Oct 27, 2002	-do-	LM-4B	-do-	493.9	505.3	94.5	ZY-2, officially for disaster monitoring
JB-3-03	Nov 06, 2004	-do-	LM-4B	-do-	505.6	513.8	94.7	ZY-2A, for digital imaging
Dual Use								
CBERS-1	Oct 14, 1999	-do-	LM-4B	-do-	779.8	788.4	98.2	Not in use
CBERS-2A	Oct 21, 2003	-do-	LM-4B	-do-	779.5	782.7	100.3	Also known as ZY-2 to confuse with its military counterpart
CBERS-2b	Sep 19, 2007	-do-	LM-4B	-do-	779.7	781.8	100.3	-do-
Ocean Monitoring								
HaiYang-1A	May 15, 2002	-do-	LM-4B	-do-	793.2	806.8	100.7	Experimental
HaiYang-1B	Apr 11, 2007	-do-	LM-2C	-do-	789.7	821.0	100.8	Experimental HY-1C and 1D will be the operational satellites
Synthetic Aperture and Electro-optical								
YGW-1	Apr 27, 2006	Xichang	LM-4B	-do-				JB-5-01. Launch not notified to UN
YGW-2	May 25, 2007	Jiquan	LM-2D	LEO	636.2	664.1	97.6	JB-6-01. Officially a scientific research satellite
YGW-3	Nov-12, 2007	Taiyuan	LM-3B	SSO				Launch not notified to UN

One of the main focus areas in China's 11th Five-Year Plan has been the development and launch of communication satellites with increasing service life and enhanced bandwidth.

Signal Intelligence (SIGINT)

China's initial attempts for space-based ELINT gathering which commenced with operating a constellation of five Ji Shu Shyan Weixing[20] (JSSW) ELINT satellites was stopped after the death of Mao Zedong, who supported this technology. China, however, continued its SIGINT efforts by establishing a terrestrial infrastructure network which was considered one of the most extensive SIGINT networks in the Asia-Pacific region, consisting of a large number of ground stations, ships and submarines, and complemented by an airborne one consisting of modified AN-12s, PL-5s, HZ-5s, and Tu154 Ms. Hence, there has not been much emphasis on satellite-based SIGINT collection efforts. However, with increasing emphasis on information dominance, China has commenced according high priority to this aspect. All ShenZhou (SZ) missions since November 1999 were known to have performed military missions. The SZ-1 and SZ-2 carried an ELINT payload to monitor communication signals in the UHF band as well as radar transmissions[21]. Passive ELINT capabilities were reportedly to be integrated with the Hughes-built satellites for Asia-Pacific Mobile Telecom (APMT) but the sale of the satellites was scuttled by the Americans in the late 1990s. China still hopes to acquire the satellites in the future.

Military Communication Satellites

One of the main focus areas in China's 11th Five-Year Plan has been the development and launch of communication satellites with increasing service life and enhanced bandwidth, to cater to the increasing needs of its burgeoning civil and military customers. Presently, 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.

20. n. 6, The JSSW satellite series is not discussed in Chinese literature on the subject and, hence, not much is known about the payload and capabilities of these satellites.
21. K.K. Nair, "China's Space Programme: An Overview," *Air Power*, vol.1, no.1, Monsoon 2004, p. 154.

Post-Gulf War, with emphasis on force modernisation, the PLA perceived that secure, redundant communications are critical if the PLA is to achieve its stated objective of winning local wars under "informationalised" conditions. Though commercial communications satellite programmes may enhance military communications, they will not provide access to military-specific technologies such as jamming resistance and spread-spectrum transmission. Hence, in spite of having an extensive fibre-optic communication network and limited bandwidth on its DFH satellites for military use, the PLA proposed a network of five defence communication satellites (China Sat 21-25). The first one, launched in January 2000, was given the military designation of Feng Huo-1 (FH-1) and consists of the Qu Dian C4I (command, control, communications, computers and intelligence) system. This network would enable PLA commanders to communicate with their in-theatre forces in near real-time,[22] 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. 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.

Once fully deployed, the FH series constellation would establish space-based military tactical communication networks to support China's military operations and seamless tactical-to-strategic targeting capability.

22. John Pike, "The Military Uses of Outer Space," *SIPRI Yearbook 2002: Armaments, Disarmaments and International Security*. Also see Jhonson- Freese, n. 17.

Thus, once fully deployed, the FH series constellation would establish space-based military tactical communication networks to support China's military operations and provide its ballistic missiles, cruise missiles, aircraft and ships a seamless tactical-to-strategic targeting capability. Studies are under way to develop a Global Mobile Satellite Information System (GMSIS)[23], which would provide personal hand-held communications via 18 to 24 satellites in medium orbits. The details of China's military satellites are given in Table 4.

Table 4: China's Military Communication Satellites

Satellite	Launch Date	Launch Centre	Launch Vehicle	Position	Remarks
FH-1 (ChinaSat 22)	Jan 25, 2000	Xichang	LM-3A	GEO98°E	ZhongXing 22
FH-2 China Sat 20	Nov 14, 2003	Xichang	LM-3A	GEO 98°E	ZhongXing 20
ShenTong1 China Sat 22A	Sep 12, 2006	Xichang	LM-3A	GEO 103°E	ZhongXing 22A

China Tracking and Data Relay Satellite System (CTDRSS)

On April 25, 2008, China launched the Tainlian-1 tracking and data relay satellite to support China's human spaceflight programme[24]. The satellite's primary purpose is to ensure that the taikonauts of the upcoming Shenzhou-VII manned mission will remain in contact with ground control for more than 60 per cent of the time compared to the existing 12 per cent even when they are out of line of sight of the ground control. China plans to launch another satellite in the near future. The planned TDRS system comprising two satellites in GEO will be capable of relaying data from 5-10 satellites at a time, enabling the ground control to monitor over 85 per cent of the footprint of its LEO and MEO (medium earth orbit) satellites across the globe. This will enable near real-time transfer of ISR data, enabling quicker decision-making in the event of a conflict.

23. Mark A. Stokes, "China's Strategic Modernization: Implications for the United States," Strategic Studies Institute (SSI) Monograph, USA, September 1998 at http://www.fas.org/nuke/guide/china/doctrine/chinamod.pdf
24. "China Launches Data Relay Satellite," April 26, 2008, http://www.spacetoday.net/Summary/4174

Dual Use Weather Satellites

The FengYun 1 (FY-1) was China's first meteorological satellite. A total of four satellites in the first series was launched between 1988 and 2005. Since then, China has developed three series, namely, the FY-1, FY-2 and 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 attacks, apart from land operations. Four satellites are now in orbit, including two satellites launched specifically keeping the upcoming Beijing Olympics in view. On May 26, 2008, China launched the third generation[25] FY-3 which provides a spatial resolution of 250 metres compared to the existing 1.1 km on FY-2D which equals world standards. In addition to visible and infrared scanning radiometers, they carry microwave sensors and imaging devices capable of identifying highways from a height of 870 km[26]. 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. It is evident that with every launch, capabilities and performance will witness greater improvement. The details of the operational weather satellites are as given below (Table 5).

Table 5: Chinese Weather Satellites in Orbit

Satellite	Launch Date	Launch Centre	Launch Vehicle	Orbit
FengYun 2C (#04)	Oct 19, 2004	Xichang	LM-3A	GEO 105°E
Feng Yun 1D	May 15, 2005	Taiyuan	LM-4B	GEO
FengYun 2D (#05)	Dec 08, 2006	Xichang	LM-3A	GEO 86.5°E
FengYun 3A	May 27, 2006	Taiyuan	LM-4C	Polar

25. China launched the FY-3 as part of its efforts to ensure accurate weather forecasts during the 2008 Olympics. The FY-3 is able to carry out a three-dimensional, all-weather, multi-spectrum quantitative detection to acquire data from the ground surface, the ocean and the space, according to sources with the China National Space Administration.
26. n. 19.

Navigational Satellites (NavSats)

China currently operates a regional navigational and positioning (PNT) system called the Beidou consisting of two first generation and one second generation satellite in GEO and MEO orbits, as depicted in Table 6.

Table 6: Chinese Navsats

Satellite	Launch Date	Launch Centre	Launch Vehicle	Orbit	Remarks
Beidou-1A	Oct 31, 2000	Xichang	LM-3A	GEO 140°E	Not in use
Beidou-1B	Nov 11, 2000	Xichang	LM-3A	GEO 80°E	Experimental
Beidou-1C	May 25, 2003	Xichang	LM-3A	GEO 110.5°E	Operational
Beidou-1D	Mar 02, 2007	Xichang	LM-3A	GEO 86°E	Operational
Beidou-2A	Apr 14, 2007	Xichang	LM-3A	MEO	21,000 km

The Beidou provides PNT services within China and contiguous areas between Latitude 700 ~1400 E and from 5°N to 55°N with a positional accuracy of 100 metres which, Western sources claim, that by using ground correction stations, can be increased to 20 metres[27] whereas the Chinese claim that the system, coupled with their wide area augmentation system, can enable an increased accuracy of up to 12 metres[28].

In spite of its participation in the Galileo project with an investment of Euro 200 million in 2003, China still aspires to have an independent PNT system which will help it to have a global reach in future, consistent with its regional and other aspirations. In consonance with these ambitions, in 2007, China announced plans for a complete global positioning system (GPS) called "Compass" which would feature a total of 35 satellites[29], over the next several

27. Ibid.
28. Ministry of Science and Technology, *Newsletter No. 382*, dated October 20,2004.
29. Peter B. de Selding, "China Satellite Navigation System Planned for 2010," *Space News*. China's original application to the International Telecommunications Union (ITU) for Beidou radio frequencies clearly mentioned a future expansion to a 35-satellite system. But it appears that at the time, no one took it seriously.

years, at a cost of the US $ 2 billion. Thirty of these satellites will fly in MEO at around 21,000 km altitude, similar to that of the US GPS, while the remaining five will be equally spaced around the equator in WAAS-like geostationary orbits and perform a similar service.

Use of Beidou/ Galileo updates will enable China to make significant improvements in its missile guidance capabilities.

Navigation services (under the Compass system) open to commercial customers will provide users with positioning accuracy within 10 metres (33 feet), velocity accuracy within 0.2 m/s and timing accuracy within 50 ns. It is implicit that the Chinese military would have access to higher accuracies via encrypted signals. China has taken adequate steps to ensure that in the future, its PNT system is not subjected to intentional jamming by the US in a conflict scenario. Towards this, China's frequency filings with the International Telecommunications Union (ITU) indicate that its frequencies could overlay both Galileo's Public Regulated Service and the highly encrypted military GPS M-Code[30], where attempts to jam "Compass" would jam both the others.

Use of Beidou/Galileo updates will enable China to make significant improvements in its missile guidance capabilities. For example, the updates will provide the potential to significantly improve missile accuracy through in-flight real-time correction. Moreover, the use of such updates will increase the operational flexibility of China's newer mobile missiles and its ever increasing arsenal of precision-guided munitions (PGMs). Beidou's potential for use as a force-tracking mechanism (e.g. for logistics) could be vital in a future conflict[31]. There seems to be no doubt that China has the capability to develop its Compass system.

30. John Berthelsen, "GPS, Galileo and the China Factor," *Asia Times Online*, May 02, 2003; available at http:==www.atimes.com=atimes=Global Economy=EE02Dj01.html. Denial of the military specific Premium Regulated Services (PRS) as well as many commercial applications available to other European partners may eventually see China pulling out of the project.
31. The benefits of such a force-tracking mechanism were demonstrated during the opening stages of Operation Iraqi Freedom, when Coalition soldiers wore uniforms containing integrated GPS technology. Indicating the potential for such a military use, a recent report by Xinhua, the official Chinese state-run news agency, boasted that Beidou already was capable of tracking and monitoring vehicles transporting dangerous chemicals throughout the country.

Microsatellites (Microsats)

China realised the potential uses of microsatellites in both civil and military applications and joined the bandwagon of microsatellite development in the late 1990s and the first microsatellite, Tsinghua-1, was launched on June 20, 2000. The satellite also carried out in-orbit maneouvring and rendezvous with another nanosatellite SNAP-1 (Surrey Nanosatellite Applications Platform), enabling China to gain experience in precise tracking and orbital manoeuvring. The Tsinghua-1 is a precursor to a larger 07 satellite Tsinghua constellation aimed at providing high resolution imagery. Microsatellite efforts were later formalised and financed under the aegis of the 10th Five-Year Plan (FYP). Under the 10th FYP, a major project, "high performance microsatellite ground observation technology and associated applications" was approved. Beijing-1 or Tsinghua-2 was a product of the same project. The Tsinghua-2, launched in October 2005, has a resolution of 4 metres and a swath of more than 600 metres which is of significant military value.[32] Overall, China has the following microsatellites in orbit which are set to multiply as it progresses into its 11th FYP.

Developments of microsatellites could allow for a rapid reconstitution or expansion of China's satellite force in the event of any disruption in coverage.

These developments of microsatellites could allow for a rapid reconstitution or expansion of China's satellite force in the event of any disruption in coverage, given an adequate supply of boosters. The primary military appeal of microsatellites lies in the fact that they are expendable, cheap to produce and launch and are flexible and difficult to detect. In the years to come, microsatellites will increasingly become the mainstay for shaping the battlefield by providing a cheap and affordable option in an operationally responsive space environment for carrying out the entire spectrum of military space missions ranging from "force-enhancement" to "counter-space operations". Nevertheless, their gainful military utility demands a high degree of technological sophistication, precise tracking and orbital manoeuvring accuracy as well as commensurate launch capabilities which China is

32. Ministry of Science and Technology, *Newsletter No. 441*.

Table 7: Chinese Microsatellites in Orbit as on June 30, 2008

Micro-Satellite	Launch Date	Weight in Kgs	Role	Remarks
Tsinghua-1[a]	20 Jun 2000	50	Imagery	Res: 39 metres, 03 optical bands (NIR, green, blue) Swath: 600 km.
Tsinghua-2[b] (Also named as Beijing-1.)	27 Oct 2005	150	Imagery	Res: 04 metres panchromatic camera + 32 metres resolution 3-band multispectral camera. Swath: 600 km.
Tansuo-1	18 Apr 2004	150	Imagery	Carries 10 metres stereo resolution camera.[c]
Tansuo-2	18 Nov 2004	300	Imagery	Not Known (N/K)
Naxing-1	18 Apr 2004	25	N/K	N/K
Chuangxin-1	21 Oct 2003	100	Data relay	Launched piggy-back on CBERS-2.

a. Data on Tsinghua sourced from a variety of sources, weight sourced from site of SSTL, technical parameters from W.E. Stoney, "Guide to Land Imaging Satellites," *The American Society for Photogrammetry and Remote Sensing*, Updated February 2, 2006, available at http://www.saniita.com/pdf/Guide%20to%20Land%20Imaging%20Satellites.pdf

b. For details, see "Beijing-1 (China-DMC + 4, Tsinghua-2)...." Space News Feed, October 30, 2005, at http://www.spacenewsfeed.co.uk/2005/30October2005_25.html

c. Brian Harvey, *China's Space Program: From Conception to Manned Space Flight* (UK: Praxis Publishing), p. 162.

hoping to acquire through its mobile and air launched versions of the "Pioneer."

Benefits of Manned and Moon Mission.

China has demonstrated its high-tech capabilities with the successful completion of phase-1 of its manned and moon missions. These have accrued immense benefits to China, apart from national prestige. The military benefits from the manned mission accrue in areas such as in-orbit manoeuvring, mission management, launch on demand, miniaturisation, and computational analysis.[33] The lunar exploration programme, on the other hand, benefited China[34] in areas such as such as long

33. Johnson-Freese, n. 17.
34. Johnsin-Freese, Ibid.

Its space programme spans the entire spectrum of activities ranging from manufacture and launch of satellites, manned missions, space research, space applications and increasing deep space missions.

distance data transmission, telecommunication and sensor technology.

Analysis of China's Current Space Capabilities

From the foregoing, it is evident that China has a comprehensive, integrated and focussed space programme. Its space programme 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 the US and India, where 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. Although a civilianised Commission on Science, Technology and Industry for National Defence (COSTIND) sits at the apex of the Chinese defence-industrial complex, it is responsible to both the Central Military Commission of the Chinese Communist Party and the General Armaments Department of the PLA on whose behalf it coordinates the activities of the major aerospace holding companies, the principal research academies, and the third-line industrial organisations that perform work on contract to these institutions. In this context, the China National Space Administration is essentially a civilian front for international cooperation and liaison between the military and the Chinese defence industry. It is this dual nature and opacity of the space programme that also kept China from being a partner in the International Space Station (ISS), as any collaboration with China's "civilian" space programme inevitably ends up aiding its military. With a limited budget estimated at between US $ 1-5 billion[35], China realises that it cannot compete with the US nor achieve indigenously the requisite technical competence available with the US. Hence,

35. Ashley J. Tellis, "China's Space Capabilities and Their Impact on US National Security," Congressional Testimony, May 20, 2008.

China has focussed on goals that would allow it to garner benefits of space for socio-economic development while allowing it to retain the military edge over other Asian countries. Thus, China's real constraints notwithstanding, it is poised to become an international player at least in the launch services market and perhaps as a niche provider of low-cost satellites to other developing countries.

In order to ensure seamless integration of their armed forces, second artillery and space capability, the Chinese have been incorporating doctrinal changes into their concept of operations with a bias towards space and cyberspace predominance. These are examined below.

CHINA'S EVOLVING SPACE DOCTRINE

It is normal activity for strategists and war planners in any military to consider how advances in technology and weapons affect warfare and to explore how to adapt to these changes. The same is true in case of the People's Republic of China. Though China's overall doctrinal percepts underwent a change post-Gulf War, the modernisation drive was, in fact, fuelled by the announcement in the US of its Strategic Defence Initiative (SDI) programme in 1983 and a similar one by the Russians to counter the US. China feared its loss of nuclear deterrent and retaliatory capability in the face of the US SDI programme. By 1986, studies on the impact on China of such a move by the US came up with three responses to counter both the US and the USSR[36]. These were: expansion of offensive forces; development of counter-measures, such as shielding and spinning of ballistic missiles to penetrate BMD systems; and deployment of ASAT weapons to destroy space-based BMD systems. Thus, China embarked on a force modernisation of all its three Services. The 1991 Gulf War brought home the lessons and advantages of space assets in enhancing the success of conventional operations. Since then, China has undertaken a massive transformation drive in all aspects of its military. The transformation features new doctrine for modern warfare, reform of military institutions and personnel systems, improved exercise and training standards, and acquisition of advanced foreign and indigenous weapon systems. China's military expansion is already such that it is likely to alter the regional military

36. Stokes, n. 23.

China realises that the application of non-nuclear technologies can bring about strategic effects similar to those of nuclear weapons, and, avoid the great political risk of transgressing the nuclear threshold.

balance. China today is in the process of integrating space into its overall concept of operations. Though one cannot say authoritatively that the PLA has a well established space doctrine like those for land, air and naval operations, the increasing transparency and availability of research material by Chinese think- tanks in the public domain forces one to accept that the PLA is evolving a doctrine for space operations and this is a culmination of a careful study of the US' exploits of the ultimate high ground, specially in the last two decades. The PLA has modelled its doctrine at three levels, namely, strategic, environmental and operational. While the strategic doctrine encompasses the actions to be taken by all the three Services, the environmental and operational doctrines focus more on specific space missions.

Strategic Doctrine

China's overall doctrine appears to be premised on the fact that it cannot wrest control of space from the US during any future war. China realises that the US and its superior military power remains the biggest objective constraint on its ability to secure its own political interests, whether related to immediate concerns over the Taiwan crisis or more remote challenges of constructing a Sino-centric order in Asia and perhaps globally. China realises that the application of non-nuclear technologies can bring about strategic effects similar to those of nuclear weapons, and, at the same time, it can avoid the great political risk of transgressing the nuclear threshold. Hence, at the strategic level, the PRC's military doctrine advocates using asymmetric means to level the playing field against a technologically superior opponent like the US. Thus, China has graduated from the concept of "people's war" to "local, limited war" to "limited war under high-tech conditions" and now to "local wars under conditions of informatioalisation," in which the use of space and cyberspace is emphasised to seize the initiative. In the realm of space, the broad strategy pertains to employing anti-access and space denial means against the adversary. The elements of China's approach to asymmetric warfare can be seen in its heavy investment in ballistic and cruise missile systems, undersea warfare systems, including submarines and advanced naval mines, counter-space systems and computer network operations.

Doctrine at Environmental Levels

There is still no clear definition of where the medium of air ends and that of space begins in order to evolve a separate doctrine for the environment of space-based operations. And also, unlike the doctrines of land, sea and air which evolved with significant inputs of experience, technology and geographical characteristics, no hostilities have taken place in space in the last half decade of the space age. Hence, it is difficult to envisage an exclusive space doctrine in the case of emerging space-faring nations like China, India and Japan to name a few. Even the two superpowers came out with their doctrine largely based on theoretical and technological advances in the late 1970s and 1980s. The 1978 edition of the *Soviet Military Encyclopedia*[37] described "space war" as "military operations using space and anti-space resources with the aim of weakening the enemy's space forces or achieving supremacy in outer space." On the other hand, the first specific space doctrine of the US was released in 1982, identifying three roles for space power, these being to strengthen the security of the US, to maintain American space leadership, and to maintain space as an environment where nations could enhance the security and welfare of mankind. However, the existing and globally accepted operational space doctrine, after five decades of largely theoretical experience, largely builds on the premise that air and space comprise a unitary entity for the conduct of

The existing and globally accepted operational space doctrine, largely builds on the premise that air and space comprise a unitary entity for the conduct of military operations.

37. Michael Sheehan, *The International Politics of Space* (US: Routledge Publishers, 2007).

military operations. As a result, the entire spectrum of air operations, ranging from offensive counter-air operations to counter-surface force operations to defensive operations are replicated in the case of space into four broad missions as space support (e.g. launch and satellite maintenance); force enhancement (capabilities to increase the advantages of the war-fighter, such as precision guided munitions and C4); space control (the ability to use space when needed, and deny it to the adversary); and force application (space weapons). The Chinese have given their own interpretation to these terms while retaining the meaning, and for them, the spectrum ranges from[38]:

- **Space Safeguard Operations**. Roughly equivalent to space support operations but only including the launching and recovery of space vehicles and not operations involving satellite control.
- **Space Support Operations**. This mission area corresponds entirely to force enhancement missions or what China interprets as "power enhancement and support capabilities."
- **Attack Operations**. This mission area is very expansive and includes all elements of the mission areas of space control and force application. It includes the use of space-based weapons against terrestrial targets, the use of terrestrial weapons against space-based targets, and the use of space-based weapons against other space-based assets.

China's Operational Doctrine

At the operational level, China envisages the integration of air and space operations and the control of the space environment as the primary missions. China, for all its new found successes and technological prowess in space, understands that it still cannot dominate in space or even reach parity with the US because it doesn't feel it needs to. Hence, it is developing only those capabilities to retain its sovereignty and freedom of action on issues of critical national interest such as Taiwan, or at a more regional level, to fight its

38. The characterisations are based on thinking of Chinese authors as described by Kevin Pollpeter in "The Chinese Vision of Space Military Operations," in Mulvenon, David Finkelstein, *China's Revolution in Doctrinal Affairs*, Centre for Intelligence Research and Analysis Publications, available at http://www.defensegroupinc.com/cira/pubs.htm

adversaries over the future boundary disputes or energy resources. Hence, at the operational level, China yearns for a limited and temporal ability to control space. Though in most Chinese texts, the questions of sovereignty in space are treated as analogous to the extension of national sovereignty into the exclusive economic zone (EEZ) and are viewed as an inherent right of a nation, like the control of its air space, a most complete explanation of how space control is related to the PLA's military theory on outer space has been put forward by Cai Fengzhen and Tain Anping in their writing on aerospace operations[39]:

At the operational level, China envisages the integration of air and space operations and the control of the space environment as the primary missions.

> Space control is the capability of one belligerent in a state of war, in a specified period of time, in a defined area of space to carry out its own operations with freedom while hindering or preventing an enemy from carrying out its own operations or using space.

Hence, Chinese strategists realise that at the operational level, control of space and even cyberspace in a given theatre for a quantifiable time would let them realise their theatre specific integrated air land and sea operations.

China certainly appears to be putting its theories into practice, as witnessed by its burgeoning military space apparatus and the fast pace at which its air and space capabilities are growing in the new millennium. In addition to the space capabilities discussed, a broad examination of China's counter-space and cyber capabilities will provide a useful canvass to discuss the implications of China's space programme on India.

CHINA'S COUNTER-SPACE CAPABILITIES: IS CHINA FUELLING AN ARMS RACE IN SPACE?

Space deterrence has 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 C4ISR network and, thus, the ability to function in space. For

39. Larry M. Wortzel, "The Chinese People's Liberation Army and Space Warfare," American Enterprise Institute at http://www.aei.org/publications/pubID.26977/pub_detail.asp

deterrence to be credible, one must demonstrate the capability and, hence, the ASAT test in January 2007. The test drew much international criticism for the debris creating element as well the blatant attempt at "weaponising space." Though the ASAT does not fall within the purview of existing definition to be called a "space weapon," one needs to look at the test in a more pragmatic manner.

Space was "militarised" five decades ago and the "weaponisation" of space has already taken place. Though there are no weapons deployed in space, the satellites in space are integral to the weapon systems on earth.

Space was "militarised" five decades ago and the "weaponisation" of space has already taken place. Though there are no weapons deployed in space, the satellites in space are integral to the weapon systems on earth. For that matter, all the long range ballistic missiles in the world, as well as the Chinese ASATs are really "space weapons" because even though they may not be launched from space, they are launched into space and transit through space to their targets. In a broader sense, even tools for jamming satellite transmissions could be counted as "space weapons" as they unquestionably bring war to space. A year and half later, putting the ASAT test into perspective, it emerges that the test did not, in any way, change the geostrategic balance in Asia or globally, or challenge US space superiority. But the test did demonstrate the offensive missile technology and the limits of that technology by China. The US, which had prior information of the test, as borne out by Ashely Tellis,[40] chose to play along and did not lodge any international protest for its own self-serving purposes. The test helped the US galvanise support for its space-based ballistic missile defences and legitimised the shooting down of one of its own satellites, the US-193, in February 2008 in the garb of saving lesser mortals from the harmful effects of the hydrazine fuel carried by the satellite.

The kinetic ASAT test was not a one-off development but a carefully orchestrated plan to reinforce the beliefs of the vulnerabilities to US space assets, as articulated by the Rumsfeld Commission in 2001. Apart from this, the test was

40. Ashely Tellis, "China's Military Space Strategy," *Survival*, vol 39, issue 3, September 2007.

also an attempt by China to bring the US to the negotiating table for an arms control agreement which it has so far been unsuccessful in doing, along with Russia, at the United Nations. China gambled that it can stop the US from developing space-based weapons under the guise of arms control agreements while it can continue to do so, given the opaque nature its defence spending and research and development. The ASAT test and the dazzling of an American satellite by ground-based laser in 2006 are the only visible attempts by China to target space-based assets. If official policy statements are to be treated as indicators of government intent, then China has been discreetly shifting its position since 2002 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 2006 White Paper on space even omits reference to opposition to weaponisation of space, fuelling speculations about the intentions of the Chinese. 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 counter the US dominance of the high ground. These are examined below.

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.

Hard Kill Means

The means to be adopted for hard kill envisage:

- Co-orbital ballistic missiles.A strategic ballistic missile which is a multi-task, multi-role attack weapon capable of implementing random orbit transfer from earth orbits and can serve the functions of an intercontinental ballistic missile, an anti-satellite weapon, and an orbital bomber weapon.
- Orbital space mines which will detonate when they come in contact with

the adversary's satellite in their orbit.

- Development of ASAT weapons to be launched from submarines or surface ships to provide it a flexible option of destroying the adversary's space assets.
- Physical destruction of an adversary's ground control infrastructure.

Soft Kill Means

- Electronic jamming and blinding of satellites in orbit as part of temporary and reversible means through ground-based laser attacks.
- A thermo-nuclear explosion in LEO to disable the satellite by electro-magnetic pulse (EMP).
- The jamming of inter-satellite and satellite-to-ground station downlink/uplink which will degrade the C4ISR network of an adversary.

With the US moving ahead on its space-based ballistic missile defence-programme, a "counter-ASAT"[41] weapon called attack identification detection reporting system (Raidrs) Bloc 20 and the prompt global strike weapons, China can be expected to follow suit to enable it to maintain the space deterrence.

Hence, from the foregoing, the conditions exist to conclude that China is in fact fuelling an arms race in space, along with the US, notwithstanding its "histrionic" calls for demilitarisation of space along with Russia at the United Nations. But in spite of its advances in counter-space capabilities, China is found wanting in enhanced space situational awareness which is the prerequisite to conduct warfare in space.

Space Situational Awareness

The present telemetry, tracking and control (TT&C) infrastructure consists of eight domestic tracking sites[42], two sites on foreign soil (one in Kiribati in the South Pacific; one in Namibia), and six Yuanwang-class tracking ships. In addition, China has two S-band dish antennas[43], at Beijing and Kunming, to

41. Marko Beljac, " Arms Race in Space," April 1, 2008, at www.fpif.org
42. "China: Launch Capabilities: Tracking, Telemetry and Command Network," <http://cns.miis.edu/pubs/week/020722.htm#fnB8>
43. Bradley Perrett, Frank Morring, Jr. and Craig Covault, "China Hopes Chang'e Will Pave Way for Lunar Rover," *Aviation Week & Space Technology*, October 28, 2007.

support its deep space missions. These will not only help China in deep space tracking but also of its geostationary satellites.

China claims that its space control network has reached an orbiting accuracy at the metre level, which makes the flawless control and management of 85 orbiting vehicles possible.[44] It also claims to have developed software to enable it to orbit multiple satellites at the same time, with an accuracy reaching centimetre level. Trial applications show that the system has centimetre-level positioning accuracy, with an advanced function to orbit multiple satellites in multiple arcs at the same time[45]. 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.

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China is earnestly pursuing the acquisition of better technologies related to spacecraft navigation, attitude control, simulation, integrated rocket measuring and launching control some of which it has perfected with the successful launch of the moon orbiter.[46] However, China's present TT&C does not cover the entire globe. It continues to rely heavily on shared and leased space tracking facilities, which might not be available in the event of a conflict. The TT&C has obvious military implications, as evidenced by the ASAT test. China would require space-based tracking and early warning satellites like the US DSP constellation if it wishes to undertake more counter-space operations like putting objects in the

44. Ministry of Science and Technology, *Newsletter No. 370*.
45. Ministry of Science and Technology, *Newsletter No.397*.
46. Chinese engineers have perfected the technique to successfully keep the spacecraft's sensors facing the moon to collect their data, while communications antennas face the earth and the solar panels face the sun. "During the flight orbiting the moon, the three bodies of the earth, the moon and the sun [revolve] relatively, so the attitude control is a three-vector control process."

Increasing exploitation of space-based ISR by China. It allows China to monitor armed forces' activities across the vast expanse of the Indian landscape.

orbital path or aiming ground-based lasers for destroying sensors during overpass timings or taking deception, camouflage and concealment measures to deceive space-based surveillance.

IMPLICATIONS FOR INDIA

The cumulative consequences of China's space and counter-space capabilities for India's national security will manifest over the years in multiple ways, as discussed in the succeeding paragraphs.

The increasing exploitation of space-based ISR by China with hyper spectral and SAR payload will enhance its battlespace awareness. It allows China to monitor armed forces' activities across the vast expanse of the Indian landscape, irrespective of the time of the day and prevailing weather conditions. China will know in advance the preparations for deployment of troops, movement of the strike corps elements, squadrons, air defence radars, movement of naval fleet, mobility of short range ballistic missiles (SRBM) and intermediate range ballistic missiles (IRBMs) and the like. This will enable China to acquire precise coordinates of the location of these assets, both at the tactical battle area and the hinterland, thus, increasing its targeting capability. The use of its Beiodu (and subsequently Compass)/Galileo, will enable in-flight update of target coordinates for its PGMs and thereby increase their efficacy and destructive potential. By virtue of having good battlefield awareness and transparency, China will be able to prioritise target selection and carry out effect-based operations while prosecuting its air, land and sea campaigns

China's data relay satellites would enable the ISR satellites to download data in near real-time even when out of sight of the ground control, which will enhance its battle damage assessment functions and help in retargeting, if required; this will help it to shape the battlefield in consonance with its concept of operations(CONOPS).

As brought out earlier, the Beidou/Galileo will increase the navigation capabilities of China's air force, increasing its choice of ingress routes into the

Indian air space, forcing India to divide its scarce air defence resources for surveillance and targeting.

China has been investing in nuclear submarines and development of anti-ship ballistic missiles[47] as part of its anti-access and sea denial strategy. The use of these assets in combination with the space capabilities like accurate weather updates, SAR imagery, use of GPS for in-flight updates of cruise missiles will erode the Indian Navy's freedom of access to the sea lanes.

While these are some of the implications of China's exploitation of space for force enhancement operations, India needs to concentrate more on evolving counter-measures to overcome the impact of the counter-space capabilities of China.

The Indian armed forces, like the PLA, are undergoing a process of transformation with acquisition of sophisticated weapon systems to survive and dominate the net-centric battlefield of the future. China may or may not use the hard kill options like the kinetic ASAT to target India's limited but valuable satellites in space. However, that may be cold comfort to a nation whose dependence on satellites for prosecuting wars of the 21st century is set to grow at a steady pace. India has an array of ISR satellites, with only the TES claimed for military use. However, with sub-metre resolution payloads on board the CARTOSAT series and India's plans for a comprehensive ISR network planned to be completed by 2012, the dependence on space-based ISR capabilities will only increase. In a possible limited conflict scenario, China would not hesitate to blind or dazzle these ISR satellites selectively to degrade India's capabilities, denying India the much needed overall battlespace awareness.

In a possible limited conflict scenario, China would not hesitate to blind or dazzle these ISR satellites selectively to degrade India's capabilities, denying India the much needed overall battlespace awareness.

47. Annual Report to the Congress on Military Power of the People's Republic of China for the year 2008. China is developing an anti-ship ballistic missile (ASBM) based on a variant of the CSS-5 medium-range ballistic missile (MRBM) as a component of its anti-access strategy. The missile has a range in excess of 1,500 km and, when incorporated into a sophisticated command and control system, is a key component of China's anti-access strategy to provide the PLA the capability to attack ships at sea, including aircraft carriers, from great distances.

While China continues to improvise on its capabilities, indirectly it also makes Pakistan a "proxy space power".

The armed forces' exploitation of the existing INSAT network is limited but increasing bandwidth requirements will necessitate a dedicated military satellite. It is not clear whether the upcoming launch of GSAT -4 and GSAT-5 will meet the expectations and the need. However, with the operationalisation of networks like the army's Tactical Communication Network (TCS) slated to replace the Army Radio Engineering Network (AREN) and the IAF's Integrated Air Command and Control Network (IACCS), and Operational Data Links (ODL), for communicating between various airborne assets like the airborne warning and control system (AWACS), unmanned aerial vehicles (UAVs), air refuellers and multi-role aircraft, to name a few, the armed forces are set for network-enabled operations. The increasing reliance on satellites will make them vulnerable to soft kill approaches. China has the ability to disrupt data links between various airborne and space-based platforms which will be critical to the successful outcome of conflicts. The proposed fielding of India's regional navigation system (IRNSS), while enabling India with independent navigational services, will also make it vulnerable to attack by China.

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.

While the necessity for India to exploit space for military needs in an enhanced way cannot be underscored, there is need for a realistic threat evaluation, not only for its space-based assets but even for the ground infrastructure. With no launch capability of its own, Pakistan may not pose a major threat to our assets in space from the likes of ASAT but blinding or dazzling by laser attacks and/or jamming of uplink/downlink data cannot be ruled out. China has already demonstrated its capability and intent. Today, the

48. Geeta Vardhan, programme director (Special Projects) Indian Space Research Organisation (ISRO), speaking at a session on "Space Applications for Military Use in India," DRDO Bhavan, New Delhi on June 16, 2008.

major gaps for a credible Indian response to such an eventuality are in early warning and in space-based ELINT, as was evident in the Chinese ASAT test. India had to depend on the delayed US response to know that such a test had been conducted. India has announced plans for a monitoring facility[48] to protect its space assets against threats from ASATs and space debris. The plan involves a single GEO satellite that will detect threats to space assets and transmit them to the ground station, enabling the satellite to be steered to safety. While this may suffice in the near term for protection, India needs to expand the capability for increased space situational awareness. India has the means to deal with an airborne attack against the ground infrastructure but lacks the capability to deal with exo-atmospheric threats. Though India has taken toddler steps by its successful demonstration of exo-atmospheric and endo-atmospheric tests towards validating a BMD, it is still miles away from operationalising even a theatre-specific system. Further, the enormous costs of defending an area the size of New Delhi that have been estimated at more than US $ 512 million[49] (Rs 22,000 crore) would limit the inclination of the government to develop the system on priority. Notwithstanding the financial and political constraints, India needs to put in place a credible and limited BMD as well as pursue temporary and reversible measures to have offensive counter-space capabilities.

The most pressing requirement for India is to institutionalise an organisation for overseeing the entire gamut of militarisation of space with a national perspective.

The most pressing requirement for India is to institutionalise an organisation for overseeing the entire gamut of militarisation of space with a national perspective. The need for an Aerospace Command has been articulated since the beginning of the 21st century. However, it continues to be seen as a "need" and not a reality. Piecemeal actions like setting up Service specific "space cells" may enable them to understand the exploitation of space for Service specific use but the "cells" have to be integrated to complete the joint exploitation of the "new high ground."

49. Figure quoted by representative of DRDO, New Delhi, during CAPS Seminar on June 20, 2008.

CONCLUSION

China has taken its place at the forefront of space-faring nations. It joins only the US and Russia in operating an independent manned space programme. Moreover, its space programme is a full-spectrum, comprehensive concept. From microsatellites to manned space missions, from satellite and rocket design to launch capabilities, it spans both civilian and military requirements. The aims and principles of China's space activities are determined by their important status and function in protecting China's national interests and implementing the state's development strategy.

China's military modernisation programme is underscored by the need for space capability. Without it, China feels that it cannot credibly deter possible hostile military action, or threat of such action, from the United States. Chinese pursuit of counter-space capabilities also raises the spectre of increasing contests in the battleground of space. While the US responds to the Chinese threat by the development of various counter-measures, India needs to institutionalise its organisational structure for militarising space and accelerate its military space programme for more robust and comprehensive C4ISR capabilities in an integrated manner for force enhancement operations and also pursue non-lethal counter-space 'weapons of mass disruption'. This will enable India to achieve symmetry with China in ensuring the survivability of its space assets while developing means to degrade/deny China battlespace awareness, and, thus, erode its combat potential. India must realise that just as achieving air dominance was the central mission of the 20th century, securing space dominance is vital to operations in the 21st century.