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WORKING PAPER NO. 382

CHINA'S SIGNALS INTELLIGENCE (SIGINT) SATELLITE PROGRAMS

Desmond Ball

AUSTRALIAN NATIONAL UNIVERSITY

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National Library of Australia
Cataloguing-in-Publication entry:

Ball, Desmond, 1947-
China's Signals Intelligence (SIGINT) Satellite Programs
ISBN 0 7315 5447 7.

1. Electronic intelligence - China. 2. Military intelligence - China. 3. Artificial satellites - China. 4. Space surveillance - China. I. The Australian National University. Strategic and Defence Studies Centre. II. Title. (Series: Working paper (The Australian National University. Strategic and Defence Studies Centre); no. 382).

355.3432

Canberra
December 2003

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Series Editor: Meredith Thatcher
Published and distributed by:
Strategic and Defence Studies Centre
The Australian National University
Canberra ACT 0200
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Desmond Ball is a Professor in the Strategic and Defence Studies Centre at The Australian National University, Canberra. (He was Head of the Centre from 1984 to 1991.)

Professor Ball is the author or editor of more than 40 books or monographs on technical intelligence subjects, nuclear strategy, Australian defence and security in the Asia-Pacific region. His recent publications include *Signals Intelligence in the Post-Cold War Era: Developments in the Asia-Pacific Region; Presumptive Engagement: Australia's Asia-Pacific Security Policy in the 1990s* (with Pauline Kerr); *Burma's Military Secrets: Signals Intelligence (SIGINT) from 1941 to Cyber Warfare; Breaking the Codes: Australia's KGB Network, 1944-50* (with David Horner); and *Death in Balibo, Lies in Canberra* (with Hamish McDonald). He has also written articles on issues such as the strategic culture in the Asia-Pacific region and defence acquisition programs in the region. His latest SDSC Working Paper No. 380 (November 2003) is entitled *Security Trends in the Asia-Pacific Region: An Emerging Complex Arms Race.*

Professor Ball was elected a Fellow of the Academy of Social Sciences of Australia (FASSA) in 1986. He served on the Council of the International Institute for Strategic Studies (IISS) in 1994-2000, and was Co-chair of the Steering Committee of the Council for Security Cooperation in the Asia-Pacific (CSCAP) in 2000-2002.

Abstract

China has exhibited a spasmodic interest in development of an ELINT satellite capability since it began its military space program in the late 1960s. It has experimented with several different sorts of ELINT spacecraft and satellite configurations, including single, dedicated ELINT satellites, small doublets and triplets, and ELINT packages on large multi-mission satellites. It is likely that ELINT packages have been deployed aboard some PHOTINT, communications and 'experimental technology' satellites, as well as the *Shenzhou* spacecraft developed for China's manned space program.

This paper describes these Chinese SIGINT satellite programs, including the management and control structure, the satellite systems, and prospective developments.

Note
This paper is a revised and expanded version of Desmond Ball, 'China Pursues Space-based Intelligence Gathering Capabilities', *Jane's Intelligence Review*, (Volume 15, No. 12), December 2003, pp.36-39.

China's Signals Intelligence (SIGINT) Satellite Programs

Desmond Ball

China has exhibited a spasmodic interest in development of an ELINT satellite capability since it began its military space program in the late 1960s. The progress has been fitful, evidently encountering both technical and political problems. A continuous space-based SIGINT capability has enjoyed much less priority than satellite photographic intelligence (PHOTINT) or imaging intelligence (IMINT) systems (including both film capsule recovery and digital image down-link types). The costs of a space-based COMINT system (like the US *Rhyolite, Chalet, Magnum* and *Orion* geostationary satellites and their successors) are prohibitive. On the other hand, a limited ELINT capability, enabling occasional surveillance of radar systems to maintain electronic order of battle (EOB) tables and detect new radar developments, is relatively inexpensive.

China has experimented with several different sorts of ELINT spacecraft and satellite configurations, including single, dedicated ELINT satellites, small doublets and triplets, and ELINT packages on large multi-mission satellites. It is likely that ELINT packages have been deployed aboard some PHOTINT, communications and 'experimental technology' satellites, as well as the *Shenzhou* spacecraft developed for China's manned space program.

Control and management of China's military space program

The development, coordination and operational management of China's intelligence satellite programs is the responsibility of the Central Military Commission's General Armament Department (GAD), which ranks at the same level in the PLA High Command as the General Staff Department (GSD). The GAD was formed in April 1998 to provide 'comprehensive management' of the PLA's equipment programs, from research and development through production and logistical support. It was created largely by the incorporation of large parts of other military and non-military organisations, especially the GSD's Equipment Bureau and the military-related functions and assets of the Commission of Science, Technology and Industry for National Defence (COSTIND), including all the missile test and satellite launch and tracking facilities formerly managed by COSTIND.

Table 1

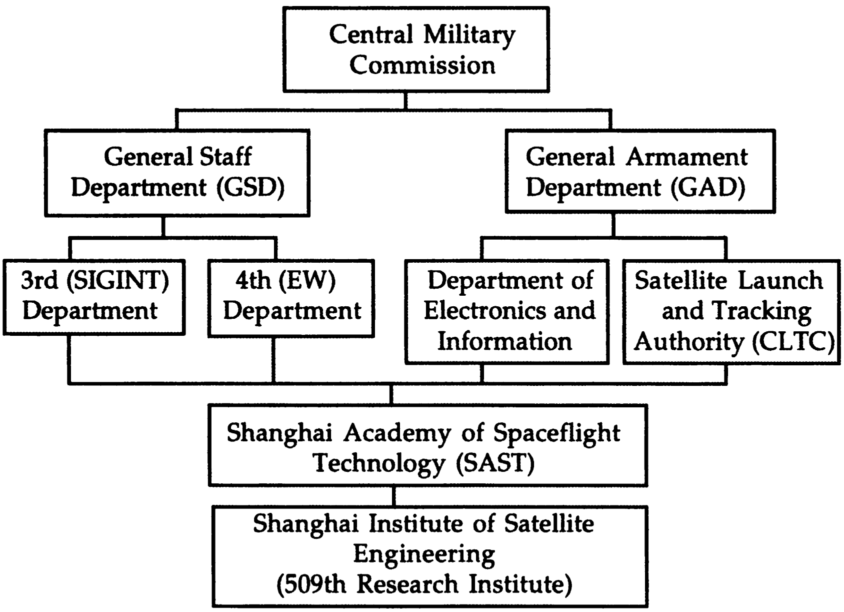
China's ELINT Satellites

Name	Int'l Designation	Launch Date	Launch Vehicle	Weight (kg)	Period (min)	Perigee (km)	Apogee (km)	Incl. (degrees)	Comments
JSSW-1	1975-70A	26 July 1975	FB-1	1,108	91.0	184	461	69.0	Re-entered 14 September 1975.
JSSW-2	1975-119A	16 December 1975	FB-1	1,108	89.9	187	380	68.9	Re-entered 27 January 1976.
JSSW-3 .	1976-87A	30 August 1976	FB-1	1,108	107.5	194	2,030	69.0	Re-entered 25 November 1978.
SJ-2A	1981-83A	19 September 1981	FB-1	257	103.0	232	1,598	59.4	Re-entered 6 October 1982.
SJ-2B	1981-83B	19 September 1981	FB-1	28	103.5	235	1,615	59.4	Radar calibration sub-satellite. Re-entered 26 September 1981.
SJ-2C	1981-83C	19 September 1981	FB-1	483	103.3	235	1,598	59.5	Re-entered 17 August 1982.
DQ-1A	1990-81B	3 September 1990	CZ-4A	4	101.7	789	811	99	Re-entered 11 March 1991.
DQ-1B	1990-81C	3 September 1990	CZ-4A	4	101.9	596	629	99	Re-entered 24 July 1991.
Shenzhou-1	1991-61A	19 November 1999	CZ-2F	7,600	89.8	196	324	42.59	Orbital module re-entered 27 November 1999.
Shenzhou-2	2001-1A	9 January 2001	CZ-2F	7,400	89.8	329	339	42.58	Orbital module re-entered 24 August 2001.
Shenzhou-3	2002-14A	25 March 2002	CZ-2F	7,800	91	331	337	42.4	Orbital module re-entered 12 November 2002.
Shenzhou-4	2002-61A	29 December 2002	CZ-2F	7,800	91.1	374	379	42.4	Orbital module re-entered 9 September 2003.

The inaugural head, General Cao Gangchuan, had previously been Director of COSTIND from November 1996 to April 1998 and presided over its dismemberment. He was also First Deputy Chief of the General Staff between 1992 and 1996, with overall responsibility for PLA equipment and weaponry. General Cao Gangchuan devoted much of his career to modernisation of the PLA and its acquisition processes, including involvement in China's military space program. In March 2003, he was appointed Minister of Defence and a Vice Chairman of the CMC. The new head of the GAD is General Li Jinai.[1]

Several departments of the GAD are involved in military satellite programs, including the Department of Service Arms Equipment, which has a staff responsibility, and the Department of Electronics and Information, which is involved in the R & D and even 'some actual manufacture' of military satellites.[2] The China Satellite Launch and Tracking Control Authority (CLTC), which manages the satellite ground stations, was transferred from COSTIND to the GAD in April 1998.[3]

Figure 1
Organisation of China's ELINT satellite program



The GAD and the GSD have close (if not smooth) working relationships. The Service Arms Department which remains in the GSD 'probably is charged with determining equipment and technical requirements', which are then issued as directives to the GAD.[4] The GSD's Third (SIGINT) and Fourth (EW) Departments must work with the GAD's Department of Electronics and Information concerning SIGINT and EW capability requirements and technical options, and with the CLTC with regard to the operation and tasking of space-based ELINT systems. These GAD departments must also work closely with the Shanghai Academy of Spaceflight Technology (SAST) and the Southwest Institute of Electronic Equipment (SWIEE) regarding the design, development and production of military intelligence satellites and ELINT collection systems. The GAD also maintains a working relationship with COSTIND, from which it was truncated, and which is actively involved in the acquisition of advanced aerospace and information technology from the West, including technology relating to space-based ELINT systems.

The central control station for China's intelligence satellites is the Xian Satellite Monitor and Control Centre (XCCS), also known as Base 26, which is located at Weinan (34°30'N, 109°30'E), some 60 km northeast of Xian, in Shaanxi province. In addition, the Beijing Aerospace Command and Control Centre (BACC) was constructed in 1994-97 specially to support the manned space program (Project 921), including the *Shenzhou* spacecraft and their intelligence collection activities. Nine tracking, telemetry and control (TT & C) stations are located at various sites throughout China, which track, receive telemetry from, and send control signals to, China's satellites. These are located at Weinan, which was built in 1972 and which is part of the XSCC complex; Changchun, in Jilin province, which is the only space tracking station located in the northeast part of China; Kashi, in Xinjiang, which was commissioned in the 1960s and which is the western-most of China's TT & C facilities, and which is also called the 'No.1' station because it is the first to detect satellites approaching China from the west; Nanning, in Guangxi, built in 1967, and used to support international satellite networks; Qingdao, in Shandong, built in the early 1990s, mainly for the manned space program; Guiyang; Minxi, in Fujian; Xiamen, in Fujian; and Yilan.[5] The station at Base 26 also has a control element from the Strategic Missile Forces which is responsible for the strategic early warning mission. This element works closely with the Third Department's SIGINT station at Lanzhou, which has the responsibility for strategic early warning of Russian missile attack by monitoring signal traffic associated with the missile launch sites.

In addition, the Chinese Academy of Sciences maintains the China Remote Sensing Satellite Ground Station (RSGS) at Miyun, at the foot of Yanshan Mountain, about 70 km northeast of Beijing. The RSGS was established in 1986, and its primary mission is to receive, process and distribute remote sensing data, including optical and radar imagery.[6] However, its high data rate reception capacity, using X-band antennas and 'high-density digital recording tapes',[7] is also extremely useful for supporting other technical collection satellite systems, including ELINT systems.

The Shanghai Academy of Spaceflight Technology (SAST)

The design, development and production of China's ELINT satellite systems has all been undertaken at the Shanghai Academy of Spaceflight Technology (SAST), a research and production complex headquartered in Shanghai, which employs some 30,000 people in 17 Institutes and eleven factories which produce rockets, satellites and tactical missile systems. Also known as the Eighth Academy, the SAST was established in 1961 as Shanghai No. 2 Bureau, or Shanghai No. 2 Bureau of Mechanic-Electrical Industry, and was later called the Shanghai Bureau of Astronautics (SHBOA), before being redesignated SAST in 1993. Its Institutes include the Shanghai Institute of Power Machinery, which produced the launch vehicles for the ELINT satellite programs in 1975-91; the Shanghai Institute of Satellite Engineering, also known as the 509th Research Institute, which has designed and produced the ELINT satellites, has more than 600 personnel, and is headed by Lu Zili; and the Shanghai Xinwei Electronic Equipment Research Institute, also known as the 809th Institute, which is involved in the development and production of military space projects. The director of the SAST is Mr Su Shikun.[8]

The *Ji Shu Shiyang Weixing* (JSSW) ELINT satellites

China's first ELINT satellites were the *Ji Shu Shiyang Weixing* (JSSW, or 'technical experimental satellites') series, developed by SHBOA in the early 1970s under its 701 Program. They weighed 1,108 kg and were launched from the Jiuquan Satellite Launch Centre (JSLC), also called the Shuang Cheng Tzu Missile Range (SCTMR), in the Gobi Desert, by the FB (*Feng Bao*, or 'Storm')-1 launch vehicle, also produced by the SHBOA, in 1975-76. Both the 701 Program and the FB-1 LV Program were officially authorised by Zhou Enlai on 14 August 1969. The FB-1 was also supposed to be used for launching recoverable PHOTINT satellites, but its success rate (60 per cent) was fairly poor.[9]

Three JSSW ELINT satellites were successfully launched. They would have provided a world-wide coverage of all radar transmitters, overflying them once a day, and would have proven particularly useful for collecting data on Soviet radars and associated air defence systems.[10] The first ELINT satellite (JSSW-1 or 1975-70A) was launched on 26 July 1975. It had a perigee of 184 km, an apogee of 461 km, an inclination of 69° and an orbital period of 91 minutes. It decayed to earth on 14 September 1975, after 50 days in orbit.[11]

The second JSSW ELINT satellite (1975-119A) was launched on 16 December 1975. It had a perigee of 187 km, an apogee of 380 km and an inclination of 68.9°, and decayed on 27 January 1976 after 42 days in orbit.[12]

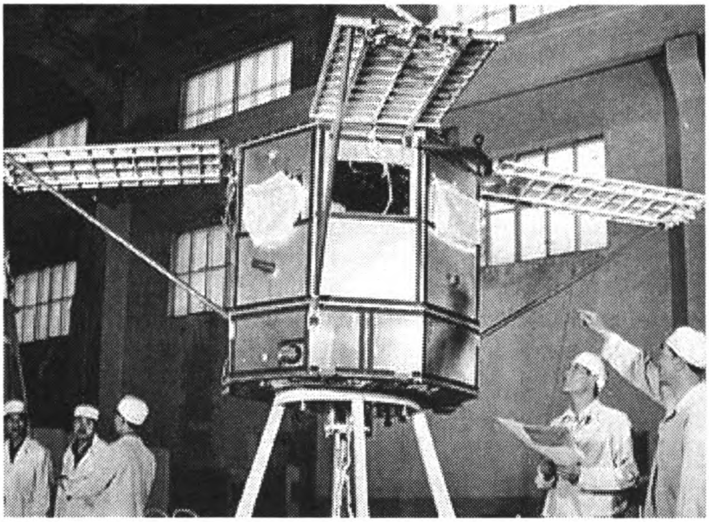
The third JSSW ELINT satellite (1976-87A) was launched on 30 August 1976. It had a perigee of 194 km and an inclination of 69°, but it was placed into an elliptical orbit with an apogee of 2,030 km, which greatly enhanced its utility for ELINT collection as well as its longevity. It decayed on 25 November 1978, after 817 days in orbit.[13]

The JSSW ELINT satellite program was cancelled after Mao Zedong's death in September 1976. The FB-1 launch vehicle was unreliable, but, more importantly, the Shanghai Bureau had become embroiled in the Cultural Revolution. It had been supported by Mao's wife Jiang Qing and the 'Gang of Four', who were arrested and given lengthy prison sentences in 1980. However, although production of the FB-1 booster and the JSSW satellites was stopped, the Shanghai Bureau remained active in related areas, being assigned development of the CZ-4 variant of the CZ-2 *Long March* LV as well as design and development of other space-based ELINT systems.[14]

The SJ-2 ELINT satellite program

China's second-generation ELINT satellite system involved the SJ-2 (also known as SKW-3) *Shi Jian* (or 'Practice') satellites, launched by an FB-1 LV (the last of these vehicles) on 20 September 1981. Three payloads were placed into similar orbits, with perigees of about 235 km, apogees of 1,600 km, inclinations of 59.4°, and periods of about 103 minutes. The primary satellite (SJ-2A or 1981-83A) was an octahedral prism, with a diameter of .615 metres through the middle, a mass of 257 kg, and four movable solar panels mounted on the top for generating electrical power, and equipped with numerous instruments for scientific research and technological experiments. It had an on-board data storage system capable of collecting data world-wide and then transmitting the stored data when passing over the ground control and data receiving stations in China. The telemetry was transmitted on 160.0 MHz. It re-entered the atmosphere on 6 October 1982, after a year in orbit. SJ-2B (1981-83B) was a 28 kg passive radar calibration payload. It consisted of a 4-metre diameter inflatable balloon which was covered with polyester aluminium for use as a guiding optical beacon, and was connected by a 600-metre silk rope to a 0.45-metre diameter metal ball used for radar calibration. The ground control and tracking station at Kashi tracked the ball and 'successfully carried out the radar calibration'. The duo decayed on 26 September 1981. The SJ-2C satellite was equipped with a beacon transmitter (which transmitted on 40.5 and 162 MHz) for measuring the impact of charged particles concentrations in the ionosphere on radio transmissions. It decayed on 17 August 1982. The constellation evidently provided a capability for determining the location of radio and electronic emitters as well as for recording the emissions. [15]

Figure 2
The SJ-2A Satellite



Source: 'SJ Series Scientific Experiment Satellite', *Chinese Defence Today*, 8 December 2002, at http://www.sinodefence.com/space/spacecraft/sj.asp.

The DQ-1 satellites

On 3 September 1990, China launched a pair of DQ-1 (*Da Qi*, or 'Atmospheric') mini-satellites, which are sometimes referred to as its third-generation ELINT satellite system. The doublet was launched together with a *Feng Yun* (or 'Wind and Cloud') meteorological satellite (with a mass of 881 kg) by a CZ-4 LV produced by SAST. The meteorological satellite and the DQ-1s were also designed and built by Shanghai Institutes. The three satellites were placed into fairly circular orbits, with perigees and apogees around 800-900 km, inclinations of 99°, and periods of about 102 minutes. The DQ-1s, called DQ-1A (1990-81B) and DQ-1B (1990-81C), which each had a mass of only about 4 kg, decayed on 11 March 1991 and 24 July 1991 respectively. The mass and orbital parameters of these satellites are consistent with 'ELINT applications'.[16]

The *Shenzhou* spacecraft

It is likely that the *Shenzhou* (variously translated as 'Magic Boat', 'Vessel of the Gods' or 'Divine Craft') spacecraft manufactured by the SAST under Project 921-1 for China's manned space program currently provide a substantial ELINT capability. These spacecraft, four of which have been launched since November 1999, are 8.65 metres long and have an overall mass of 7,800 kg, have been used for a wide variety of both civilian and military 'experiments'.

The *Shenzhou* spacecraft consist of three sections: an aft service/ propulsion module, 3.05 metres long, with four large engines and two large solar panels (2.0 metres by 7.5 metres each) capable of generating more than a kilowatt of electrical power; a re-entry capsule, capable of seating three crew, but so far used for testing life support systems as well as scientific experiments; and the forward Orbital Module, a cylindrical drum with a length of 2.8 metres, a diameter of 2.25 metres and a mass of 1,500 kg, and its own propulsion, solar power and control systems, which allow autonomous flight after the separation of the re-entry capsule. Two solar panels (2.0 metres by 3.4 metres) provide an average of more than 0.5 kw electricity.[17]

The first four *Shenzhou* spacecraft have had a fascinating equipment pallet mounted on the forward end of the Orbital Module. Scale models of the *Shenzhou* were distributed in 2000 which showed that it consisted of a rectangular box (0.95 metres by 1.13 metres by 0.8 metres) from which protruded three 0.4 metre extendable probes attached to the top, and a semi-circular ring with an inner diameter of 1.1 metres holding seven rectangular portals on the bottom (i.e., facing the earth), all of uncertain purpose.[18]

Figure 3
Model of *Shenzhou* satellite (forward end)

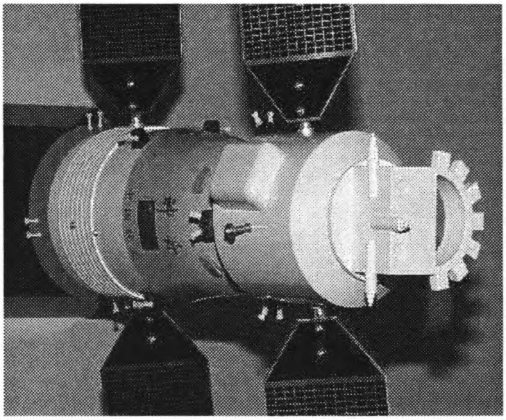


Figure 4 Model of *Shenzhou* satellite (top view)

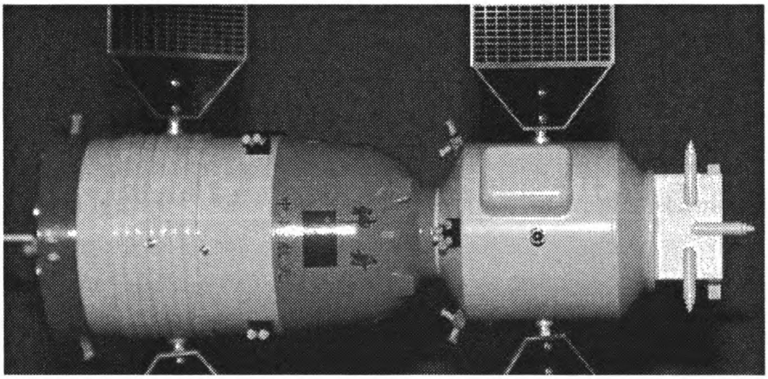
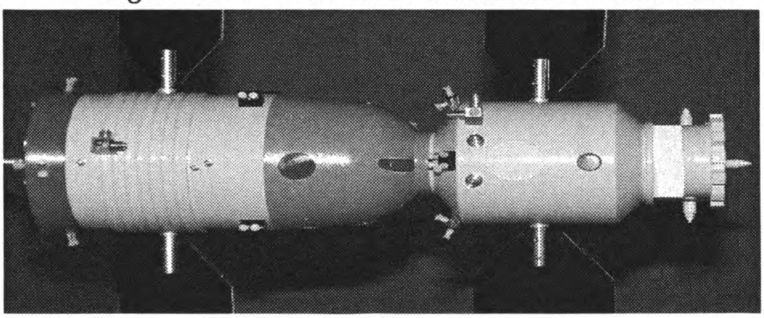
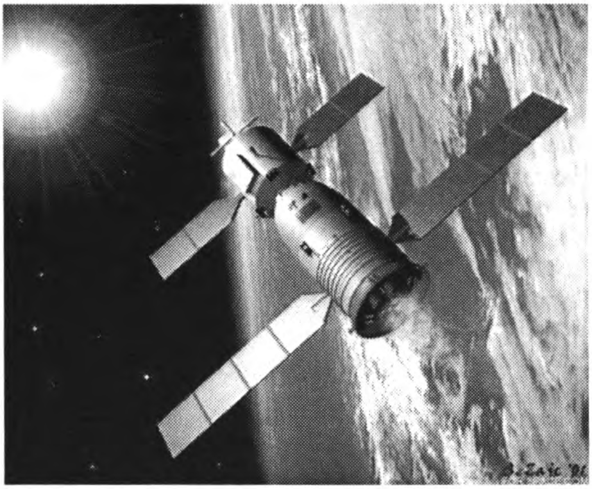


Figure 5 Model of *Shenzhou* satellite (bottom view)



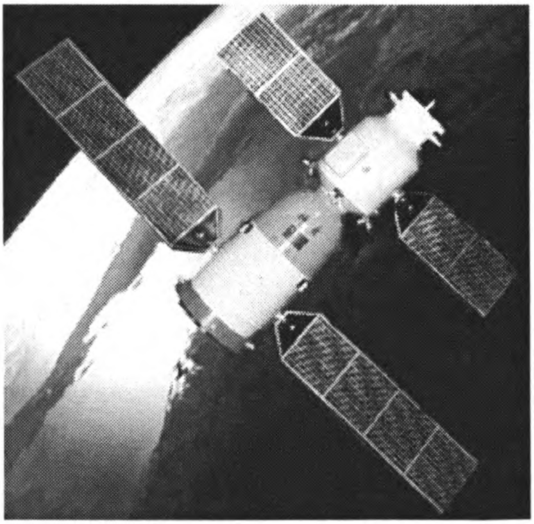
Source for Figures 3-5 : Steven S. Pietrobon, 'Shenzhou Model', 4 April 2002 at http://www.sworld.com.au/steven/space/shenzhou/index.html.

Figure 6 Artist's concept of *Shenzhou*-2 in orbit



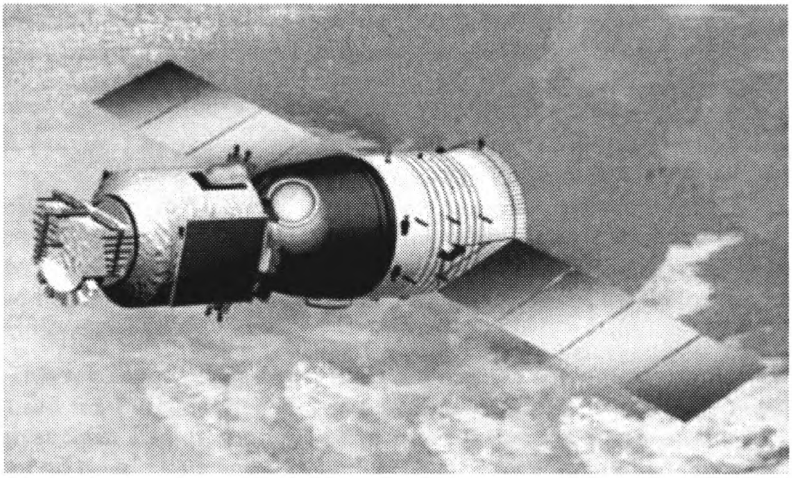
Source: Simon Zajc, in Leonard David, 'China Blasts Shenzhou Into Orbit', *Space.Com*, 9 January 2001, at http://www.space.com/missionlaunches/launches/china_launch-010109.html.

Figure 7 Artist's concept of *Shenzhou*-2 in orbit



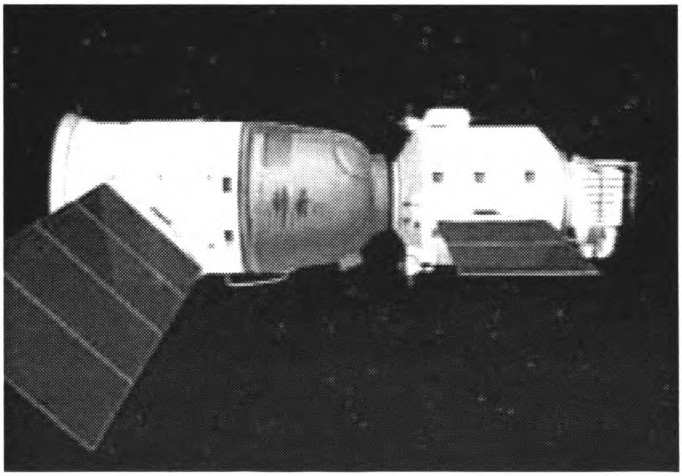
Source: Steven S. Pietrobon, in 'Shenzhou', *Encyclopedia Aeronautica*, 1 September 2003, at http://www.astronautix.com/craft/shenzhou.htm.

Figure 8 Artist's concept of *Shenzhou*-2 in orbit



Source: 'China's Astronauts', *Space Today Online*,
at http://www.spacetoday.org/China/ChinaTaikonauts.html.

Figure 9 *Shenzhou* spacecraft showing Yagi antennas



Source: Photo courtesy of Walter Ridgewell.

Figure 10 ***Shenzhou* Orbital Module with Yagi antennas extended**

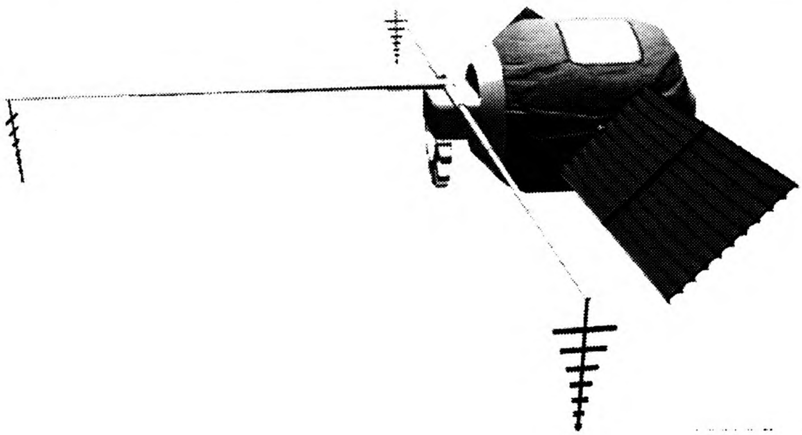
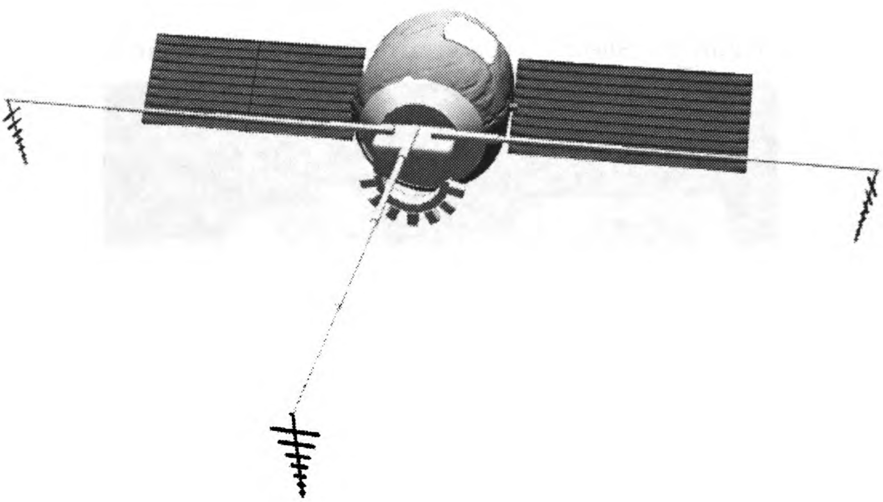


Figure 11 ***Shenzhou* Orbital Module with Yagi antennas extended**



Source for Figures 10 and 11: Michael Malloy, Prodgex, Canberra, 19 September 2003, at http://www.bur.st/~prodgex.

However, following the launch of the *Shenzhou*-2 spacecraft and the recovery of its re-entry capsule in January 2001, an animation of the spacecraft in orbit broadcast on Chinese television revealed that perpendicular 7-element log-periodic Yagi antennas, more than a metre long, and pointing down to the earth, were attached to the three booms at the top. Illustrations or 'artist's concepts' of the *Shenzhou*-2 released later in 2001 provided clearer details.[19] A similar 'artist's view' was published in the media on 26 March 2002, the day after the launching of *Shenzhou*-3. Moreover, also on 26 March, Chinese television showed an animation of the Orbital Module after separation from the other sections, which showed the three Yagi antennas actually extending from the booms out to about a metre or so beyond the length of the solar panels (i.e., about 4.5 metres from the Module).[20]

This revelation prompted speculation that the equipment complex could be used for ELINT collection. According to calculations by the Swedish analyst Sven Grahn, the longest element in the log-periodic antennas is about 0.5 metres long and the shortest about 0.15 metres, which corresponds to an operational frequency range of around 300 to 1,000 MHz. These antennas seem to be linearly polarised and to form some sort of direction-finding/triangulation array. One of them has its polarisation plane orthogonal to those of the other two, suggesting that the two co-planar antennas work as an interferometer, while the orthogonal antenna could be used to determine the polarisation of the incoming wave. The seven rectangular portals on the semi-circular arc could house an array of waveguide or electromagnetic feed horns for detecting (and locating and characterising) millimetric radar and other electronic transmissions. The two outermost portals point about 12° below the local horizontal plane, providing a limited over-the-horizon capability.[21]

These suppositions were reportedly confirmed by Zhang Houying, the head of Human Spaceflight Application Systems at the Chinese Academy of Sciences, in a lecture on the *Shenzhou* program in Beijing on 15 February 2003. According to a report by *Xinhuanet*, Zhang stated that the first four spacecraft carried 'devices for conducting signals intelligence through interception of radar and telecommunications traffic signals'.[22]

Shenzhou-1 (1999-61A) was launched from Jiuquan aboard a CZ-2F *Long March* launch vehicle on 19 November 1999. It was a prototype of the 921-1 spacecraft, intended to test the major spacecraft sub-systems and the launch, module separation and re-entry sequences. It was placed into an orbit with a perigee of 196 km, an apogee of 324 km, an inclination of 42.59° and a period of 89.8 minutes. Its re-entry capsule returned to earth the next day, landing in Inner Mongolia, after completing only 14 revolutions. The orbital module (1999-61E) was separated prior to retro-fire of the descent capsule, and continued in controlled flight for another week, re-entering the atmosphere on 27 November 1999.[23]

Shenzhou-2 (2001-1A) was launched on 9 January 2001. It was initially placed by the CZ-2F LV into an orbit with a perigee of 196.5 km and an apogee of 333.8 km, very similar to that of *Shenzhou*-1. However, three orbit-raising manoeuvres occurred over the next six days (on 10, 12 and 15 January), using the main propulsion system on the service module, which took the spacecraft into a roughly circular orbit with a perigee of 329 km and an apogee of 345 km. The re-entry capsule, which carried a monkey, a dog, a rabbit and six mice in a test of the spacecraft's life support systems, returned to earth on 16 January.[24] On 17 January, the Chinese media reported that, following the separation of the descent capsule, the orbital module 'has been switched to the working mode', 'has started normal operations', that 'currently all onboard systems, including power, attitude control, telemetry and data management systems are working well', and that the 'scientific payloads have also been turned on'.[25] Its flight was actively controlled over the next seven months. On 17 January, it was raised from its original orbit (329/345 km perigee/apogee) to 388/404 km. It was raised again on 20 February, and several more times over successive months, reaching a final orbit of 394/405 km before being allowed to decay, and re-entered the atmosphere over the southeast Pacific Ocean on 24 August 2001 after 226 days and 3,460 revolutions around the earth.[26]

Shenzhou-3 (2002-14A) was launched on 25 March 2002. It was initially placed into an orbit with a perigee of 197 km and an apogee of 326 km, with an inclination of 42.4°, but later on 25 March used its own propulsion system to raise its orbit to a near-circular 332/337 km perigee/apogee. Two subsequent manoeuvres occurred on 29 and 31 March. The descent module returned to earth on 1 April, after seven days in orbit. The orbital module remained in orbit, raising itself to a perigee of 373.7 km and an apogee of 381.1 km in June, before disintegrating in a fiery re-entry over the Indian Ocean on 12 November, after 232 days in space.[27]

Shenzhou-4 (2002-61A) was launched on 29 December 2002. It was initially placed into an orbit with a perigee of 198 km and an apogee of 331 km, but manoeuvred itself into a near-circular orbit with a perigee of 331 km, an apogee of 337 km and an inclination of 42.4°, before the orbital module separated and the descent capsule returned to earth on 5 January 2003. The orbital module (2002-61C) then manoeuvred itself into a higher operational orbit, with a perigee of 374 km and an apogee of 379 km. It was variously reported to have carried, among many instruments, 'a SIGINT electronic intercept payload', a 'microwave Earth observation' system, and equipment 'to make radar observations of the Earth'. It re-entered on 9 September 2003.[28]

The three *Shenzhou* orbital modules launched since January 2001 were each operational for about eight months; hence providing a sustained coverage of electronic transmissions within their purview for about two-thirds of the time over the last three years. On the other hand, the coverage of the *Shenzhou* modules is severely truncated by their relatively low altitudes and inclinations. At altitudes of around 350 km and inclinations of only 42.4°, even with some over-the-horizon ability, the ELINT receivers could not detect emissions from Russia or northern Japan, although the countries around China's western and southern borders, as well as Taiwan, could be thoroughly logged. The ELINT systems would also be able to keep track of US Navy ships, particularly carrier battle groups, operating in the western Pacific and Indian Oceans. Intercepts of electronic emissions by *Shenzhou*-4 during the war in Iraq in March-April 2003 would have been 'an intelligence windfall for the Chinese'.[29]

The *Shenzhou* spacecraft, including the autonomous orbital modules, were controlled from the Beijing Aerospace Command and Control Centre (BACC), which received an 'enormous amount [of] mission operation data' from the long-duration modules, and the Xian Satellite Control Centre (XSCC) at Weinan, which also received data from them.[30] The tracking stations at Qingdao, Xiamen and Kashi also tracked the modules.[31] The Kashi station, because of its extreme western location, has played an especially important role in tracking and supporting the *Shenzhou* vehicles.[32] The SIGINT complex at Kashi would have been the first recipient of any ELINT mission data collected by the *Shenzhou* orbital modules, both to clear the tape recordings and to process the data for any time-urgent intelligence. Zhang Houying of the Chinese Academy of Sciences also stated on 15 February 2003 that ELINT and other data from the orbital modules was down-linked to the high data rate China Remote Sensing Satellite Ground Station (RSGS) at Miyun in 10-minute bursts each time the modules passed overhead.[33]

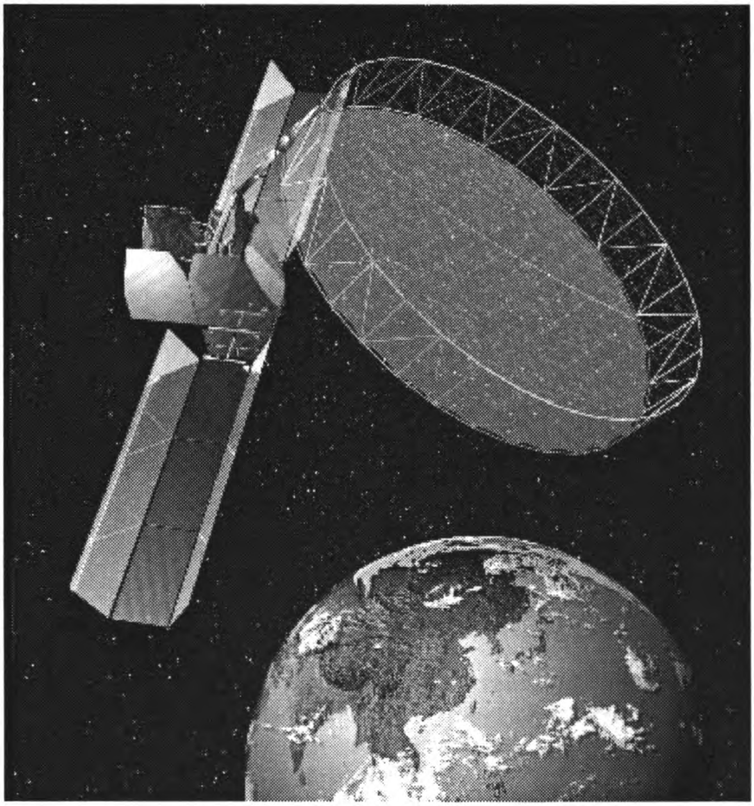
It is likely that all subsequent *Shenzhou* spacecraft, including the crewed missions expected to begin in the near future, will continue to be engaged in military intelligence activities. *Shenzhou*-5 is expected to carry an optical reconnaissance camera with a ground resolution of 1.6 metres.[34] The configuration of the forward end of the orbital module is also different from that of its predecessors, but ELINT equipment could be carried elsewhere in the module. PLA crew members can be expected to operate both ELINT and imaging systems, as well as other specialised technical intelligence collection equipment.

Secondary geostationary COMINT satellite capabilities

China has neither the technical capacity nor the fiscal resources to build and maintain a geostationary SIGINT satellite system. (The most recent US geostationary SIGINT satellites, the *Advanced Orions*, are estimated to cost US$1.5 billion to manufacture and place into orbit.) China must soon have the capability of producing SIGINT satellites with antennas of a few tens of metres in diameter, similar to the first US *Rhyolites* in the 1970s (which had 20-metre diameter parabolic dishes, as compared to the *Advanced Orion* satellites, whose primary intercept antennas are more than 100 metres in diameter). However, telecommunications satellites with fairly large antennas (10-15-metre diameters) have become available on the international commercial market, offering Chinese engineers and technicians both access to this technology and the potential of using the satellites themselves for intercepting particular sorts of telecommunications.

These possibilities were articulated in the concerns expressed in Washington in the late 1990s when a Chinese consortium of official aerospace and telecommunications agencies (including the China Satellite Launch and Tracking Control Authority) attempted unsuccessfully to procure two Asia Pacific Mobile Telecommunications (APMT) satellites from Hughes Space & Communications in California. In 1996, the consortium contracted with Hughes for the two HS-702 satellites (one spare), which were based on the HS-601 design, and supporting ground facilities, at a cost of US$650 million. The HS-702 satellites featured a 12.25-metre diameter L-band deployable antenna, and onboard digital signal processing and beamforming systems. They were to provide a satellite-based mobile phone system, capable of handling 16,000 voice circuits simultaneously, over some 22 countries, from Pakistan in the west to Japan in the North, and from northern China south to Indonesia.[35] However, critics argued that this would allow Chinese authorities to intercept the mobile phone calls of all APMT users across the whole region.[36] In a memorandum on 7 July 1998, a US Defense official noted that 'the Chinese sought configurations on the APMT satellite that would allow for eavesdropping', that 'the APMT satellite would give the Chinese military access to telephone intercepts in [some] 20 Asian countries', and that the PLA 'will be able to intercept business transactions' and use the information for 'economic advantage'.[37]

Figure 12
Proposed APMT HS-702 telecommunications satellite



Source: Hugh Space & Communications, 'Asian Mobile Satellite System', at http://www.boeing.com/defense-space/space/bss/hsc_pressreleases/photogallery/amss/98_05_08_amss.html.

These matters were investigated by the Cox Committee, which was set up by the US Congress on 18 June 1998 to 'conduct a full and complete inquiry' into a plethora of allegations about Chinese espionage in the US and the 'theft' of US nuclear, missile and space technologies, and which produced a Top Secret report for Congress on 3 January 1999. A declassified version was released on 25 May, which reported as follows:

> Unlike previous communications satellites, ... this satellite uses a very large antenna array, which has raised concerns that the satellite could be used not simply for telecommunications, but also for space-based signals intelligence (SIGINT) collection.
>
> This would give the PRC the capability to eavesdrop electronically on conversations not only in the PRC, but also in neighboring countries. ...
>
> The 40-foot antenna, which uses a truss-like outer ring and mesh reflector surface, is the unique aspect of the APMT satellite design. It has led to concerns that the PRC could use the APMT satellite for signals intelligence collection against a wide spectrum of communications.
>
> The satellite, however, is designed to collect and process only communications in the same bandwidth as is allocated to the handsets. Communications satellite antennas are designed to receive their own frequency and reject all others. To do otherwise would add unnecessary expense and complexity to the satellite.
>
> In an attempt to reduce interference from other satellites using the same frequency bands, the APMT satellite antenna will use 'left-hand circular polarization' which gives its signals a unique signature. The satellite will not collect other signals that use right, vertical, horizontal, or no polarization. These factors thus limit the satellite's ability to engage in signals intelligence to the collection of information transmitted by APMT system users. That volume of information, however, would be substantial.
>
> When the handsets in the proposed APMT system are used, even for handset-to-handset conversations that are not bounced off the satellite, copies of the transmissions are downloaded to a central ground station. This capability is typically required of most satellite communications systems. ... This downlink

> would allow the PRC to monitor the communications of APMT's users across the Asian region.[38]

It also noted the concern about Chinese exploitation of the technology for indigenous SIGINT satellite development.

> Yet another concern with Hughes' proposed APMT sale is that it could help the PRC learn about the deployment of large antenna structures. This could assist the PRC in the development of future [electronic] reconnaissance satellites. Mechanisms used to deploy large antenna systems have been protected from PRC scrutiny in the past. Visual access to the satellite, as well as the risk of unauthorized discussion with engineers ... could give the PRC access to this sensitive technology for the first time. ...
>
> Since the APMT satellite's antenna array is significantly larger than any that has been provided to the PRC by any Western nation, it is likely that the PRC would seek to exploit the APMT design for a future PRC SIGINT satellite....[39]

In February 1999, the US State Department formally denied Hughes an export licence for the APMT satellites, and the contract was cancelled.[40] However, China has continued to seek similar telecommunications satellites from European manufacturers, and should eventually acquire geostationary satellites with secondary capabilities for intercepting not only mobile phone calls but other telecommunications using these services.

Prospective developments

Since the mid-1990s, there have been several indications that the SAST has a new ELINT satellite development program underway, possibly with the Southwest Institute of Electronic Equipment (SWIEE) developing the ELINT receivers for installation aboard the satellites. The SWIEE produces ELINT pods and associated equipment for larger ELINT aircraft. There was a spate of technical articles on satellite-based ELINT systems published around 1995-96, which indicated a resurgence of research interest. For example, Yuan Xiaokang, 'a key engineer involved in space ELINT development from the SAST 509th Research Institute', published articles in 1996 on 'Satellite Electronic Reconnaissance', 'Antijamming' and 'Some Problems of Space Electronic Reconnaissance'.[41] An engineer from the SWIEE published an article on 'Development of Satellite-borne Precision Direction Finding Antenna Array' in the journal of *Electronic Countermeasure Technology* in 1995.[42] Some of this research may have related to the development of the

ELINT antennas and receivers deployed aboard the *Shenzhou* spacecraft, but other design efforts have evidently resurrected the earlier concepts of small dedicated ELINT satellites and constellations of mini-satellites. According to Richard Fisher of the Heritage Foundation, 'literature obtained' at China's Zhuhai aerospace show in November 1998 'strongly indicated' that China has 'an advanced electronic intelligence (ELINT) satellites [development] program', which would be 'useful for classifying hostile electronic emissions and assisting in targeting'.[43] And in 1999, a US Army analyst reported that 'At least one SAST design under evaluation is a constellation of small electronic reconnaissance satellites which can ensure precise location data and survivability'.[44]

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