Fact Sheet

CHINESE MILITARY AND INTELLIGENCE RENDEZVOUS AND PROXIMITY OPERATIONS

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SUMMARY

Since 2008, China has conducted multiple tests of satellite technologies for robotic rendezvous and proximity operations (RPO) to support surveillance and inspection of other space objects in both low Earth orbit (LEO) and geostationary Earth orbit (GEO), most of which are related to military or intelligence operations. While these missions have been publicly acknowledged by China, most have few public details and a few remain shrouded in secrecy. None of the programs listed here have strong evidence to link them to co-orbital ASAT testing or deployment.

RENDEZVOUS & PROXIMITY OPERATIONS

Proximity operations are a series of orbital maneuvers executed to place and maintain a spacecraft in the vicinity of another space object on a relative planned path for a specific time duration to accomplish mission objectives. Rendezvous is a process whereby two space objects (artificial or natural body) are intentionally brought close together through a series of orbital maneuvers at a planned time and place. Taken together, RPO technologies enable a wide range of capabilities to support civil and commercial space activities such as on-orbit inspections, repair, refueling, assembly, and life extension. RPO capabilities can also be used for military and intelligence space activities such as intelligence, surveillance, and offensive weapons such as co-orbital anti-satellites. Since the late 2000s, China has conducted a series of robotic on-orbit demonstrations between different pairs of satellites.

CHINESE MILITARY AND INTELLIGENCE RPO MISSIONS IN LEO

The first known Chinese robotic RPO occurred in September 2008 when a Chinese human spaceflight mission Shenzhou 7 deployed a small satellite to practice on-orbit inspection and control system flying capabilities.[1] Some observers concluded that the BX-1 was a test of the capabilities required for a co-orbital anti-satellite (ASAT) attack[2] but the mission has not been linked to any such military program.[3]

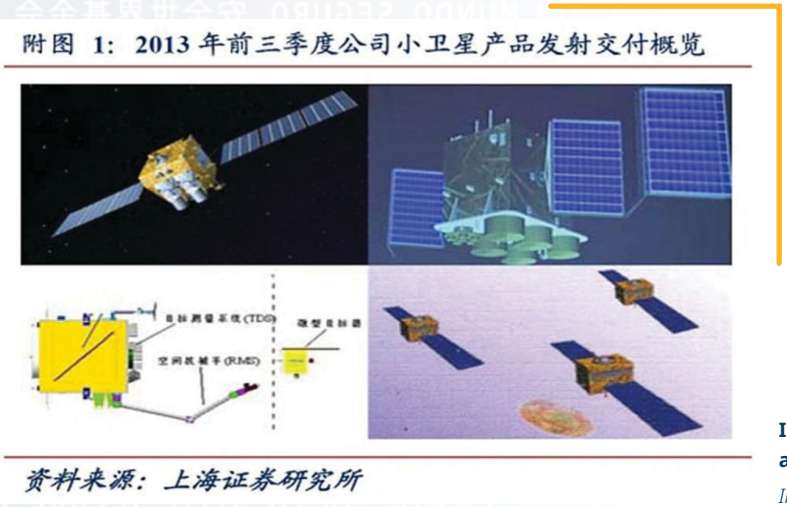


Image of the SY-7 (lower left, with robotic arm) and its small companion satellite.

Image credit: Liss

In the summer of 2010, the Chinese satellites Shi Jian (SJ)-12 and SJ-06F conducted a series of robotic RPO.[4] The mission of SJ-12, as stated by the State media service Xinhua, is to carry out "scientific and technological experiments."[5] In the summer of 2010,

the SJ-12 initiated a series of deliberate changes in its orbital trajectory to approach and rendezvous with the SJ-06F satellite.[6] The maneuvers occurred over several weeks between June 12, 2010, and August 16, 2010. On August 19, the two satellites came within 300 meters. A change in the orbital trajectory for the SJ-06F around that same time indicates that the two satellites may have bumped into each other, although there were no external indications of damage to either satellite or any debris created by the incident.

On July 19, 2013, China placed three payloads into roughly similar LEO orbits from the same launch — Shiyan[7] (SY-7), Chuangxin 3 (CX-3), and Shijian 15 (SJ-15)[7]. The SY-7 carried a teleoperated robotic arm while the SJ-15 was equipped with RPO capabilities. In August 2013, SJ-15 conducted an RPO of CX-3 within a few kilometers and another RPO with Shi Jian 7 (SJ-7), a Chinese satellite launched in 2005.[8] Anonymous U.S. officials claimed that the RPO was part of a "covert anti-satellite weapons development program," and that one of the satellites "grabbed" another,[9] although the satellite with the arm, SY-7, was not involved. On October 18, 2013, the SY-7 initiated a small maneuver to raise its orbit by several hundred meters and shortly thereafter released another object, Payload A, which orbited in relatively close proximity for several days. Some reports claimed the two objects may have physically joined with each other,[10] but the publicly available tracking was not accurate enough to confirm. Both objects occasionally conducted small maneuvers throughout 2014 and 2015, and the SJ-15 through 2016 as well.[11]

In April 2014, the SJ-15 began another series of small maneuvers to conduct proximity operations around the CX-3. Between April 12-14, the SJ-15 raised its orbit by several tens of kilometers, and then between May 12 and 14, Payload C lowered its orbit by several tens of kilometers. The effect of these maneuvers was to match orbital planes once again with the SJ-7, and on a trajectory that brought it above and then behind the SJ-7 at a range of around 150 km, with a vertical separation of a few kilometers.[12] Throughout the rest of May, the SJ-15 slowly decreased the distance to the SJ-7 to within a kilometer.[13] The SJ-15 continued to occasionally make changes to its orbit in 2015 and 2016, but the reasons for doing so were unclear. On May 6, 2016, the SJ-15 changed its altitude by several tens of kilometers, bringing it close to the CX-3 again.[14]

CHINESE MILITARY AND INTELLIGENCE RPO MISSIONS IN GEO

China has also conducted robotic RPO demonstrations in GEO. On November 3, 2016, China placed the SJ-17 satellite in GEO, which was publicly declared to be designed to test advanced technologies.[15] Several days after reaching GEO, the SJ-17 began maneuvering to place itself into the active GEO belt close to another Chinese satellite, Chinasat 5A, at a longitude of 162.9 E.[16] The SJ-17 made several small maneuvers to circumnavigate Chinasat 5A at a distance of between 50 to 100 km for several days, slowly closing in to within a few km on November 30, before returning to a 50 to 100 km standoff distance.[17] The two satellites remained close until December 29, when Analytical Graphics, Inc, (AGI) reported that Chinasat 5A was drifting away.[18]

The SJ-17 spent the next year drifting eastward then sharply westward until on March 20, 2018, it lowered its orbit to reverse its drift, indicating that it conducted a survey of the GEO region. Over the first half of 2018, the SJ-17 made additional unusual changes to its orbit. SJ-17's reversal in inclination and maneuvering to a drift orbit between late January and July of 2018 appears to be linked to an unexplained anomaly in the orbital trajectory of Chinasat 1C, a Chinese communications satellite launched in December 2015.[19] The sudden, large change in inclination suggests the SJ-17 has significant delta-v capability as plane change maneuvers are among the most energy-intensive. SJ-17 rendezvoused with Chinasat 1C, coming within 1.5 km on July 29. Ten days later, Chinasat 1C halted its drift and slowly drifted

back to its operational location. SJ-17 remained with Chinasat 1C until early August before departing, while Chinasat 1C arrived back at its original location on September 7. This strongly suggests that SJ-17 inspected Chinasat 1C to determine the source of the anomaly and then monitor the recovery attempt.[20] Additionally, in January 2020 and October 2020, SJ-17 made smaller changes to RPO with Chinasat 6B and SJ-20, respectively.

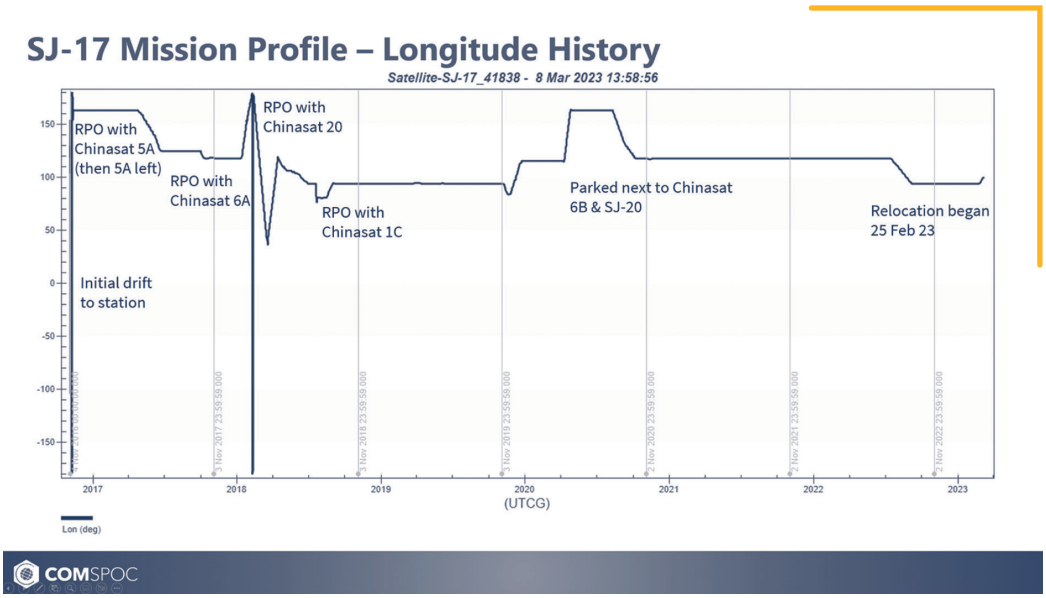
On December 23, 2018, China launched another mission to GEO that also exhibited unusual behavior. Like its predecessors, the Tongxin Jishu Shiyan (TJS)-3 satellite was launched from Xichang Space Launch Center into an elliptical geosynchronous transfer orbit (GTO). Chinese official media has described them as communications technology test satellites but observers believe they may also be testing missile warning sensors, deployable antennas, or other technology.[21] TJS-3 appeared to be similar in nature, and the U.S. military ended up cataloging two objects from the launch in GEO: the TJS-3 satellite and a second object that was assumed to be an apogee kick motor (AKM), a detachable rocket engine often used to circularize a satellite in GEO, as it was slowly drifting westward. However, shortly after the separation, object 43917 did a series of maneuvers to place it into a GEO slot at 59.07E, near TJS-3.[22] Object 43917 slowly drifted toward TJS-3 and, according to AGI exhibited photometry consistent with a stabilized object, indicating it was a functional satellite and not an AKM.[23] TJS-3 remained relatively close (within a couple of hundred kilometers) to multiple satellites, including USA 263 in July 2019 and USA 233 in October 2023. Given that distance, this activity is not technically a RPO but is still likely to generate concerns.

On October 24, 2021, China launched a classified satellite from the Xichang satellite launch center that it claimed was for a space debris mitigation mission.[24] The satellite, publicly named SJ-21, was placed into an initial GTO. By November 2, the SJ-21 used an apogee kick motor to circularize its orbit at about 156E and bring the inclination down to 8°, releasing the AKM as a piece of debris afterward. For a while, SJ-21 maintained close proximity to the AKM, which suggested it was conducting an RPO.[25]

On December 25, 2021, the SJ-21 rendezvoused with a defunct Chinese navigation satellite, Compass G2. The Compass G2 was a second-generation navigation satellite launched in 2009 as part of China's Beidou constellation and appeared to fail early in its orbital lifetime as it lost station keeping and began to drift both east-west and increase in inclination. Compass G2 also experienced a fragmentation event in 2016 that released at least six trackable pieces of debris.[26] While maintaining tight proximity to Compass G2 for several weeks, the SJ-21 docked to it at some point and then around January 21, 2022, used its onboard propulsion to pull both satellites to a higher altitude above the geostationary belt. By January 27, 2022, both objects were in an elliptical orbit ranging from 290 km to 3,100 km above the protected GEO zone, as observed by commercial trackers.[27] Shortly thereafter, SJ-21 reduced its orbital altitude back down to close to GEO.

On December 23, 2021, China launched a pair of satellites into GEO orbit as part of the Shiyan series, officially labeled Shiyan (SY)-12 01 and Shiyan (SY)-12 02.[28] The two satellites remained relatively close to each other in GEO, indicating that they had maneuvering capability and may have been conducting RPO. In late January 2022, USA 270 maneuvered to approach SY-12 (01) and SY-12 (02). According to tracking data collected by ExoAnalytic Solutions, SY-12 (01) and SY-12 (02) made significant maneuvers to split up and begin rotating around the GEO belt in opposite directions, with SY-12 02 apparently also getting an imaging opportunity on USA 270.[29]

On January 8, 2023, China launched a satellite identified as SJ-23 into a GTO. China state media described the satellite as being used for "scientific experiments and technical verification" but provided no further details.[30] Around January 15, the SJ-23 appeared to release another object, which was cataloged as an apogee kick motor but may be a functioning satellite.[31] Analysis of the orbital data suggests that the two objects got within 10 km of each other.



The longitudinal history of the SJ-17 satellite since launch in 2017, including major RPOs with other satellites.

Image credit: COMPSOC Corporation

DUAL-USE OPERATIONAL STATUS

The most likely military utility of the capabilities demonstrated by the SJ-12, SJ-15, SY-7, SJ-17, TJS-3 AKM, TJS-3, SJ-21, SY-12 (01) and (02), and SJ-23 satellites is for on-orbit space situational awareness (SSA) and satellite servicing. Their operational pattern was consistent with slow, methodical, and careful approaches to rendezvous with other space objects in similar orbits. The satellites the SJ-12 and SJ-15 approached were in relatively similar orbits, differing in altitude by a couple of hundred kilometers and slightly in inclination. They did not make huge changes to rendezvous with satellites in significantly different orbits. This behavior is similar to several US RPO missions to test and demonstrate satellite inspection and servicing capabilities such as the XSS-11. Notably, a counterspace assessment released by the Defense Intelligence Agency (DIA) in February 2019 stated that China is developing capabilities for inspection, repair, and space debris removal that may also be used as a weapon but did not specifically state that any Chinese RPO activities were a weapons test. [32]

The SJ-17's approach to Chinasat 5A was not inconsistent with the way other active satellites in the GEO belt relocate to different orbital slots. It is also not unusual for satellites to be co-located within several tens of kilometers to share a GEO slot, although it is rare for them to approach within 1 km as the SJ-17 eventually did. Such a close approach in GEO could be used for very detailed imaging or inspection of another satellite or to intercept radio frequency signals directed at another satellite from Earth. Likely examples of the latter are the activities of the US PAN satellite between 2009 and 2014, and the Russian Luch/Olymp satellite beginning in 2015.

While the known on-orbit activities of the SJ-12, SJ-15, SJ-17, TJS-3 AKM, TJS-3, SY-12 (01), SY-12 (02), SJ-21, and SJ-23 did not include explicit testing of offensive capabilities or aggressive maneuvers, it is possible that the technologies they tested could be used for offensive purposes in the future. One potential offensive use would be to get a radio-frequency jammer close to a satellite, thereby greatly amplifying its ability to interfere with the satellite's communications. While possible, to date there is no direct public evidence of such systems being tested on orbit, although there have been multiple research articles published in Chinese journals discussing and evaluating the concept. [33]

While some skepticism exists relating Chinese rendezvous and proximity activities with co-orbital ASAT testing, there is no strong publicly available evidence linking these missions and a defined defense program. However, at least one recent Chinese research paper suggests using RPO capabilities to plant small explosive charges in the nozzle of a spacecraft's engine.[34] To date, China has not conducted any confirmed co-orbital ASAT testing on orbit — only testing of ground-launched direct ascent ASAT weapons.

Summary of Known or Suspected Chinese Rendezvous & Proximity Operations in Space

Date	Systems	Launch Site	Result
Sep. 2008	SZ-7, BX-1	Jiuquan	BX-1 was deployed from SZ-7 and proceeded to orbit around the spacecraft, taking images
June - Aug. 2010	SJ-O6F, SJ-12	Jiuquan	SJ-12 moved to rendezvous with SJ-O6F and may have bumped into it
July 2013 - May 2016	Multiple SJ-15, SY-7, CX-3	Taiyuan Satellite Launch Center	SY-7 released an additional object that it performed maneuvers with and may have had a telerobotic arm. CX-3 performed optical surveillance of other in-space objects. SJ-15 demonstrated altitude and inclination changes to approach other satellites. In Dec. 2015, SJ-15 raised orbit to CX-3 demonstrating multi-orbit inspection
Nov. 2016 – Feb. 2018	SJ-17, YZ-2 upper stage	Wenchang Satellite Launch Center	YZ-2 upper stage failed to burn to the graveyard orbit and stayed near GEO. SJ-17 demonstrated maneuverability around the GEO belt and circumnavigated Chinasat 5A
Jan. - April 2019	TJS-3, TJS AKM	Xichang	TJS-3 AKM separated from the TJS-3 in the GEO belt, and both performed small maneuvers to maintain relatively close orbital slots. Both satellites then maneuvered away from each other
May 2019 – Feb. 2023	TJS-3, Luch, USA 233, USA 263, Chinasat 10, Chinasat 16, SJ-20, Chinasat 12	Xichang	TJS-3 drifted around the GEO belt, periodically stopping to conduct RPO with other satellites
Jan.-Oct. 2020	Chinasat 6B, SJ-17, SJ-20	Wenchang Satellite Launch Center	SJ-17 made smaller changes to RPO with Chinasat 6B in January 2020 and SJ-20, a new high bandwidth communications satellite launched in December 2019, in October 2020
Dec. 2021 – Jan. 2022	SJ-21, Compass G2	Xichang	SJ-21 maneuvered to dock with Compass G2 and pull it into a much higher orbit
Dec. 2021- Jan. 2022	SY-12 (01), SY-12 (02), USA-270	Wenchang Satellite Launch Center	USA 270 maneuvered to approach SY-12 (01) and SY-12 (02). SY-12 (01) and SY-12 (02) made significant maneuvers to split up and begin rotating around the GEO belt in opposite directions, with SY-12 02 apparently also getting an imaging opportunity on USA 270
Jan. - Feb. 2023	SJ-23, SJ-23 AKM	Wenchang Satellite Launch Center	Shortly after its launch, SJ-23 appeared to release an object, which was cataloged as an apogee kick motor but may be a functioning satellite. Analysis of the orbital data suggests that the two objects got within 10 km of each other
Nov. 2023	VENESAT-1, SJ-17	Wenchang Satellite Launch Center	SJ-17 made a brief RPO with VENESAT-1, a Venezuelan communications satellite built and launched by China in 2008

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