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 wherein 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. Of the five missions, a majority have focused on the ability to maneuver and control satellites within close operations.

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. Some observers concluded that the BX-1 was a test of the capabilities required for a co-orbital anti-satellite (ASAT) attack but the mission has not been linked to any such military program.

In the summer of 2010, the Chinese satellites Shi Jian (SJ)-12 and SJ-06F conducted a series of robotic RPO. The mission of SJ-12, as stated by the State media service Xinhua, is to carry out “scientific and technological experiments.” 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. 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, nor any debris created by the incident.
On July 19, 2013, China placed three payloads into roughly similar LEO orbits from the same launch — Shiyian 7 (SY-7), Chuangxin 3 (CX-3), and Shijian 15 (SJ-15) — with a mission officially described as “conducting scientific experiments on space maintenance technologies.” The SY-7 carried a teleoperated robotic arm while the SJ-15 was equipped with RPO capabilities.

In August 2013, the SJ-15 initiated a series of maneuvers to alter its orbit and bring it close to two other satellites. Over the course of the month, 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. 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, 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, which orbited in relatively close proximity for several days. Some reports claimed the two objects may have physically joined with each other, but the publicly available tracking is not accurate enough to confirm. Both objects occasionally conducted small maneuvers throughout 2014 and 2015, although the separation distance between them never exceeded more than a few kilometers. In April 2014, the SJ-15 began another series of small maneuvers to once again 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, it lowered its orbit by several tens of kilometers. The effect of these maneuvers was to once again match orbital planes 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. Over the course of the rest of May, the SJ-15 slowly decreased the distance to the SJ-7 to within a kilometer. The SJ-15 continued to occasionally make changes to its orbit in 2015 and 2016.

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. 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. The SJ-17 made several small maneuvers to circumnavigate Chinasat 5A at a distance of between 50 and 100 km for several days, slowly closing in to within a few kilometers on November 30, and then returning to a 50 to 100 km standoff distance. The two satellites remained close until December 29, when Analytical Graphics, Inc. (AGI) reported that Chinasat 5A was drifting away. 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 was doing a fast 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. 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 slowed to rendezvous with Chinasat 1C, coming to within 1.5 km on July 29. Ten days later, Chinasat 1C halted its drift and began to slowly drift back to its operational location. SJ-17 remained with Chinasat 1C through the first week of August before departing, while Chinasat 1C arrived back at its original location on September 7. This strongly suggests that SJ-17 was used to inspect Chinasat 1C to determine the source of the anomaly and then monitor the recovery attempt. Additionally, in January 2020 and in 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 has 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. 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. Object 43917 slowly drifted toward TJS-3 and according to AGI exhibited photometry consistent with a stabilized object and not one that was tumbling. Thus object 43917 appears to be a subsatellite and not an AKM, and maintaining a relatively close distance (100 to 200 km) from TJS-3.

Dual-Use Operational Status

The activities of the SJ-12, SJ-15, SJ-17, and TJS-3 AKM are consistent with the demonstration of RPO technologies for the purpose of satellite servicing, space situational awareness, and inspection. 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 was a weapons test.

The most likely utility of the capabilities demonstrated by the SJ-12, SJ-15, SJ-17, and TJS-3 AKM satellites is for on-orbit space situational awareness and close-up inspections. 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 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 U.S. RPO missions to test and demonstrate satellite inspection and servicing capabilities such as the XSS-11. While some skepticism exists relating Chinese rendezvous and proximity activities with co-orbital ASAT testing, there is no strong publicly available evidence link between these missions and a defined defense program. To date, China has not conducted any co-orbital ASAT testing — only testing of ground-launched direct ascent ASAT weapons.

| Summary of Known or Suspected Chinese Rendezvous & Proximity Operations in Space |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
| Date                            | Target          | Chaser Satellite | 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 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 - Mar 2018              | Chinasat 5A, Chinasat-20 | SJ-17 | 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 19 2020                     | TJS-3 AGM       | TJS-3 AGM        | Xichang         | TJS-3 AGM separated from TJS-3 in GEO and both maneuvered slightly to stay within close orbits |
Endnotes


8. Due to the uncertainty regarding which payload was which, the public Space Track catalog has not identified which satellite was which. They are still labeled Payload A, Payload B, and Payload C.


16. Originally, this was reported as Chinasat 6A closing in with Chinasat 5A, due to the U.S. military mislabeling the SJ-17 as Chinasat 6A.


19. Analytical Graphics (@AGtweets), “ComSpOC has detected that Chinasat 5A has departed SJ-17 & is drifting 0.9 deg/day westward. SJ-17 remains at 163 deg,” Tweet, December 19, 2016, https://twitter.com/AGtweets/status/814513003798364161.


23. See discussion of this in the following thread on the NASA.spaceflight.com forums: https://forum.nasaspaceflight.com/index.php?topic=46903.0;all.

24. Ibid.

25. Ibid.