U.S Military and Intelligence Rendezvous and Proximity Operations in Space

Updated May 2022

Author: Brian Weeden, bweeden@swfound.org

swfound.org

Summary

Over the last forty years, the United States has developed significant capabilities for conducting robotic rendezvous and proximity operations (RPO) to support military and intelligence-related space activities. The United States military and intelligence services have flown multiple satellites to develop, practice, and utilize RPO technologies for close surveillance and inspection of other space objects as well as collecting signals intelligence. Some of these missions have been publicly acknowledged but most remain shrouded in secrecy, with a few completely unacknowledged publicly. 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 end of the Cold War, the U.S. Air Force (USAF), National Aeronautics and Space Administration (NASA), and Defense Advanced Research Projects Agency (DARPA) have all conducted tests and demonstrations of robotic close approach and rendezvous technologies in Low and Geosynchronous Earth Orbits (LEO and GEO).

U.S. RPO For Military and Intelligence Missions in LEO

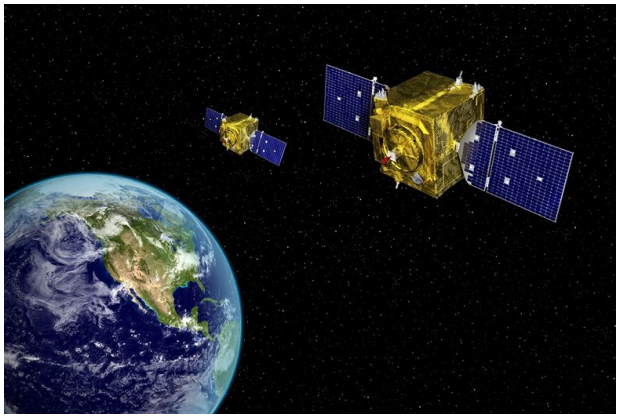
On January 29, 2003, the USAF launched the XSS-10 as a secondary payload on a Delta-2 rocket carrying a U.S. military GPS satellite. XSS-10 conducted a pre-planned series of RPO maneuvers near the Delta upper stage, eventually closing to within 50 m.[2] Similarly, XSS-11 was launched on April 11, 2005, and over the following 12 to 18 months, the spacecraft "conduct[ed] [RPO] maneuvers with several U.S. owned, dead or inactive resident space objects near its orbit."[3] However, it is impossible to verify whether or not these activities occurred, and whether or not XSS-11 visited any non-U.S. space objects, because the U.S. military did not publish any positional information for the XSS-11 while on orbit or since.

In 2007, DARPA conducted a demonstration of RPO technology in the context of satellite servicing with its Orbital Express mission. Orbital Express consisted of two spacecraft, the ASTRO servicing vehicle and the NEXTSat client vehicle that were launched together into a roughly 500 km circular orbit. ASTRO demonstrated the ability to autonomously transfer fluid to NEXTSat and use a robotic arm to swap out components. The two spacecraft then separated and spent the next few months demonstrating multiple rendezvous and capture scenarios, including the first-ever use of a robotic arm to autonomously capture another space object.[4] While the NEXTSat and ASTRO mission were primarily conducted for servicing research, its directive by DARPA leads to a possible dual-use, military RPO application. The two spacecraft were deactivated in July 2007. [5]

U.S. RPO for Military and Intelligence Missions in GEO

The earliest known example of U.S. RPO for military and intelligence mission is a satellite reportedly called Prowler.[1] According to analysis done by hobbyist satellite observers, Prowler was stealthily deployed by a 1990 military Space Shuttle mission into GEO. Prowler likely used optical camouflage techniques to maneuver close to multiple Russian satellites to collect intelligence on their characteristics and capabilities while remaining undetected by Russian optical space surveillance systems. To this day, the United States has never officially acknowledged the existence of Prowler and lists it as an extra rocket body from the Shuttle launch in its public satellite catalog.

In 2006, the USAF launched two small satellites, officially designated as Micro-satellite Technology Experiment (MiTEx), with the official mission to identify, integrate, test, and evaluate small satellite technologies to support and enhance future U.S. space missions.[6] In 2009, news reports revealed that they had been used to conduct "flybys" of the U.S. early warning satellite DSP 23, which had mysteriously failed on orbit shortly after launch.[7]



GSSAP satellites Image credit: U.S. Air Force.

In recent years, the USAF appears to have applied the lessons it learned with Prowler and MiTEx to an operational program known as the Geosynchronous Space Situational Awareness Program (GSSAP), which may have the internal codename of Hornet. GSSAP uses two pairs of small satellites deployed slightly above and below the GEO belt, these satellites drift east and west and provide close inspections of objects in the GEO region.[11] The first pair of GSSAP satellites were launched on July 28, 2014, and the second pair on August 19, 2016. A third pair was launched in January 2022.[12] Although the U.S. military did not initially provide any public data on the locations or maneuvers of the GSSAP satellites, other sources of tracking data show they are very active in the GEO region. Data collected by the ISON space surveillance network, managed by the Russian Academy of Sciences, indicates that the GSSAP satellites have conducted hundreds of maneuvers since 2014 and have conducted close approaches or proximity operations of more than a dozen operational satellites in GEO. In August 2020, USA 271 did an RPO with China's SJ-20 and in January 2022 USA 271 approached the SY-12(01) and SY-12(02).[13]

The launch of the first two GSSAP satellites included a satellite from another RPO program, the Automated Navigation and Guidance Experiment for Local Space (ANGELS) Program.[14] The goal of ANGELS was to provide a clearer picture of the local area around important U.S. national security satellites in GEO. The first ANGELS satellite stayed attached to the Delta 4 upper stage after it conducted a disposal maneuver to place it a few hundred kilometers above GEO. At that point, ANGELS detached from the upper stage and conducted a series of RPO maneuvers to close within a few kilometers.[15] Russian tracking sources indicate that during one close approach conducted on June 9, 2016, the Delta upper stage altered its orbit, suggesting it might not have been totally inert. ANGELS was decommissioned in November 2017.[16]

On April 14, 2018, the U.S. conducted another military launch that placed multiple small satellites in GEO, including at least one that has conducted rendezvous and proximity operations.[17] Alongside the USAF's Continuous Broadcast Augmenting SATCOM (CBAS) military communication relay satellite, the launch also included the Evolved Expendable Launch Vehicle (EELV) Secondary Payload Adapter (ESPA) Augmented Geosynchronous Laboratory Experiment satellite, known by the triple-nested acronym EAGLE but officially cataloged as USA 284. The ESPA ring is commonly used for deploying small satellites as secondary payloads, and the EAGLE concept converts the ESPA ring from part of the launch vehicle into an independent maneuverable satellite, allowing for more flexible deployment of multiple small satellites. [18]

On this first launch, the EAGLE separated from the upper stage in the GEO region and subsequently deployed at least three small satellites. One of these small satellites, Mycroft, separated from EAGLE in early May 2018 and conducted a series of close approaches to EAGLE. The USAF describes it as demonstrating "improved space situational awareness for space vehicles."[19]

In October 2019, the U.S. Air Force announced that Mycroft was being sent to inspect another U.S. satellite in the GEO region, S5.[20] S5 was an experimental satellite launched into GEO on February 22, 2019, to test new space situational awareness concepts, but it stopped communicating with ground controllers in March 2019.[21] The USAF stated that Mycroft would conduct a series of RPO maneuvers with S5 over a period of weeks to try and determine the status of the latter's solar arrays and antennas. Amateur observers noted that Mycroft was communicating using a largely "suppressed" carrier signal, making it more difficult to detect.[22]

U.S. RPO Activities to Support Intelligence Collection

Two additional mysterious satellites are also conducting RPO activities in GEO. Publicly known as Palladium at Night (PAN) and CLIO, they were launched in 2009 and 2014, respectively.[8] Neither was formally acknowledged by the United States but were discovered and tracked by hobbyist observers moving around the geosynchronous region and stopping near foreign communications satellites every few months. The available information suggests PAN and CLIO are likely being used for signals intelligence (SIGINT) collection of broadcasts being sent to other communications satellites.[9] Their behavior and likely mission is very similar to the Russian Luch/Olymp-K satellite that has been conducting similar activities in GEO since 2014.

Summary of Known or Suspected U.S. Military and Intelligence RPO Activities in Space

Date of Test	Target Satellite	Chaser Satellite	Notes
1990-1998	Unknown communications satellites	Prowler?	Maneuvered close to multiple Russian geosynchronous orbit satellites to collect intelligence but utilized optical stealth technologies to remain undetected
Jan. 29, 2003	Delta upper stage	XSS-10	Series of RPO maneuvers near the Delta upper stage
Apr. 2005 - Oct. 2006	Minotaur upper stage, multiple	XSS-11	XSS-11 conducted a series of maneuvers to bring it close to the Minotaur upper stage and then performed additional close approaches to other U.S. space objects in nearby LEO orbits over the next 12-18 months
Apr. 2005	MUBLCOM	DART	DART conducted a series of autonomous maneuvers to bring it close to the MUBLCOM satellite and accidentally bumped into it
March - July 2007	NEXTSat	ASTRO	DARPA demonstration of autonomous on-orbit techniques with two satellites including refueling
Dec. 23, 2008 and Jan. 1, 2009	DSP-23	MiTEx (USA 187, USA 188)	Inspection and close rendezvous with a failed U.S. satellite. Possibly other demonstrations and tests in geosynchronous orbit
2009 - 2013	Yahsat 1B, others unknown	PAN (USA-207)	Presumed to have conducted SIGNIT (signals intelligence) by parking next to other satellites
2014 - Present	Unknown	CLIO (USA 257)	Presumed to have conducted SIGNIT (signals intelligence) by parking next to other satellites
Jul 2014 - Present	Multiple Objects	GSSAP	Three pairs of GSSAP satellites have been performing RPO with various other objects in the GEO region
Jul 2014 - Nov 2017	Delta 4 R/B	ANGELS (USA 255)	ANGELS separated from the Delta 4 upper stage that placed the first GSSAP pair into orbit and then performed a series of RPO in the GSO disposal region.
May 2018	EAGLE	MYCROFT	Mycroft payload deployed from Eagle Satellite, in GEO region, then conducted satellite inspection
October 2019	S5	MYCROFT	Mycroft maneuvered to rendezvous with S5 after S5 ceased communications

Endnotes

1. Ted Molczan, "Unknown GEO Object 2000-653A/90007 Identified as Prowler," January 21, 2011, p. 12, http://satobs.org/seesat_ref/STS_38/Unknown_GEO_Object_2000-653A_-_90007_Identified_as_Prowler.pdf; Robert Windrem, "What is America's Top-Secret Spy Program? Experts Think Democrats Objected to Satellite Weapon," NBC News, December 9, 2004, http://www.nbcnews.com/id/6687654/ns/us_news-security/t/what-americas-top-secret-spy-program/.
2. Thomas M. Davis and David Melanson, "XSS-10 Micro-Satellite Flight Demonstration," Paper No. GT-SSEC.D.3: p.7. https://smartech.gatech.edu/bitstream/handle/1853/8036/SSEC_SD3_doc.pdf;jsessionid=906BB52FE69F848048883B704DB20F07.smart2?sequence=2.
3. "XSS-11 Micro Satellite," Fact Sheet: Air Force Research Laboratory, Space Vehicles Directorate, current as of September 2011, accessed March 22, 2018, p.1, http://www.kirtland.af.mil/Portals/52/documents/AFD-111103-035.pdf?ver=2016-06-28-110256-797.
4. "Orbital Express – Mission Updates," Boeing, Defense, Space & Security PhantomWorks, accessed March 22, 2018, https://web.archive.org/web/20121017163534/http://www.boeing.com/bds/phantom_works/orbital/updates.html.
5. Stephen Clark, "In-space Satellite Servicing Tests Come to an End," SpaceFlight Now, July 4, 2007, http://spaceflightnow.com/news/n0707/04orbitalexpress/.
6. Justin Ray, "Experimental Military Microsatellites Reach Orbit," Spaceflight Now, June 22, 2006, https://www.space.com/2529-experimental-military-microsatellites-reach-orbit.html.
7. Brian Weeden, "The Ongoing Saga of DSP Flight 23," TheSpaceReview.com, January 19, 2009, p.1, http://www.thespacereview.com/article/1290/1.
8. "Langbroek, Marco, "A Nemesis in the Sky," October 31, 2016, TheSpaceReview.com, https://www.thespacereview.com/article/3095/1
9. "Nemesis 1, 2 (PAN, CLIO / P360)," Gunter's Space Page, accessed June 28, 2020, https://space.skyrocket.de/doc_sdat/nemesis-1.htm
10. "CLIO Mystery Satellite," spaceflight101.com, accessed June 28, 2020, https://spaceflight101.com/spacecraft/clio/
11. Amy Butler, "USAF Reveals Sats to Offer Unprecedented Space Intel," Aviation Week & Space Technology, March 3, 2004, http://aviationweek.com/awin/usaf-reveals-sats-offer-unprecedented-space-intel.
12. "GSSAP 1, 2, 3, 4, 5, 6," Gunter's Space Page, accessed March 22, 2018, http://space.skyrocket.de/doc_sdat/gssap-1.htm.
13. Colin Clark, "U.S., China, Russia test new space war tactics: Sats buzzing, spoofing, spying," *Breaking Defense*, October 28, 2021, https://breakingdefense.com/2021/10/us-china-russia-test-new-space-war-tactics-sats-buzzing-spoofing-spying/
14. Stephen Clark, "Air Force General Reveals New Space Surveillance Program," SpaceFlight Now, February 25, 2014, http://spaceflightnow.com/news/n1402/25gssap/.
15. "Fact Sheet: Automated Navigation and Guidance Experiment for Local Space," Air Force Research Laboratory, current as of July 2014, accessed March 22, 2018, p. 1, http://www.kirtland.af.mil/Portals/52/documents/AFD-131204-039.pdf?ver=2016-06-28-105617-297.
16. Arielle Vasquez, "3rd SES Bids Farewell to ANGELS Satellite," 50th Space Wing Public Affairs, November 21, 2017, http://www.patrick.af.mil/News/Article-Display/Article/1378964/3rd-ses-bids-farewell-to-angels-satellite/.
17. Stephen Clark, "Multi-satellite payload hoisted into high altitude orbit by Atlas 5 rocket," Spaceflightnow.com, April 15, 2018, https://spaceflightnow.com/2018/04/15/multi-satellite-stack-hoisted-into-high-altitude-orbit-by-atlas-5-rocket/.
18. Air Force Research Laboratory, "ESPA Augmented Geosynchronous Laboratory Experiment (EAGLE)", ABW Public Affairs fact sheet, April 2018, https://www.kirtland.af.mil/Portals/52/documents/EAGLE-factsheet.pdf.
19. 88th Air Base Wing Public Affairs, "Successful launch for AFRL Eagle spacecraft experiment on AFSPC-11 mission," Schriever Air Force Base, April 18, 2018, https://www.schriever.af.mil/News/Article-Display/Article/1496633/successful-launch-for-afrl-eagle-spacecraft-experiment-on-afspc-11-mission/.
20. Rachel Cohen, "AFRL Dispatching Satellite to Examine Unresponsive Smallsat," Air Force Magazine, October 18, 2019, https://www.airforcemag.com/AFRLDispatching-Satellite-to-Examine-Unresponsive-Smallsat/.
21. Ibid.
22. Scott Tilley, tweet posted December 21, 2019, https://twitter.com/coastal8049/status/1208475681790627841?s=20