Space weapons, fiction or reality

Report 1of 3: Co-Orbital ASAT

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On June 18, 2018, US President Trump announced, "We are going to have the Space Force." This announcement at the National Space Council was widely reported in the media as if it were something new. Nothing is less true. The United States 'Space Command', part of the United States Air Force, has served as a space army since the beginning of space travel and does everything such an army should do: surveillance of space, develop space weapons and destroy satellites in space. Creating a Space Force will only provide additional military power in name (and cost). For the rest, little will change. The announcement did provide extra attention for space weapons. This report is the first in a series of three providing an overview of the current situation in America, Russia and China.

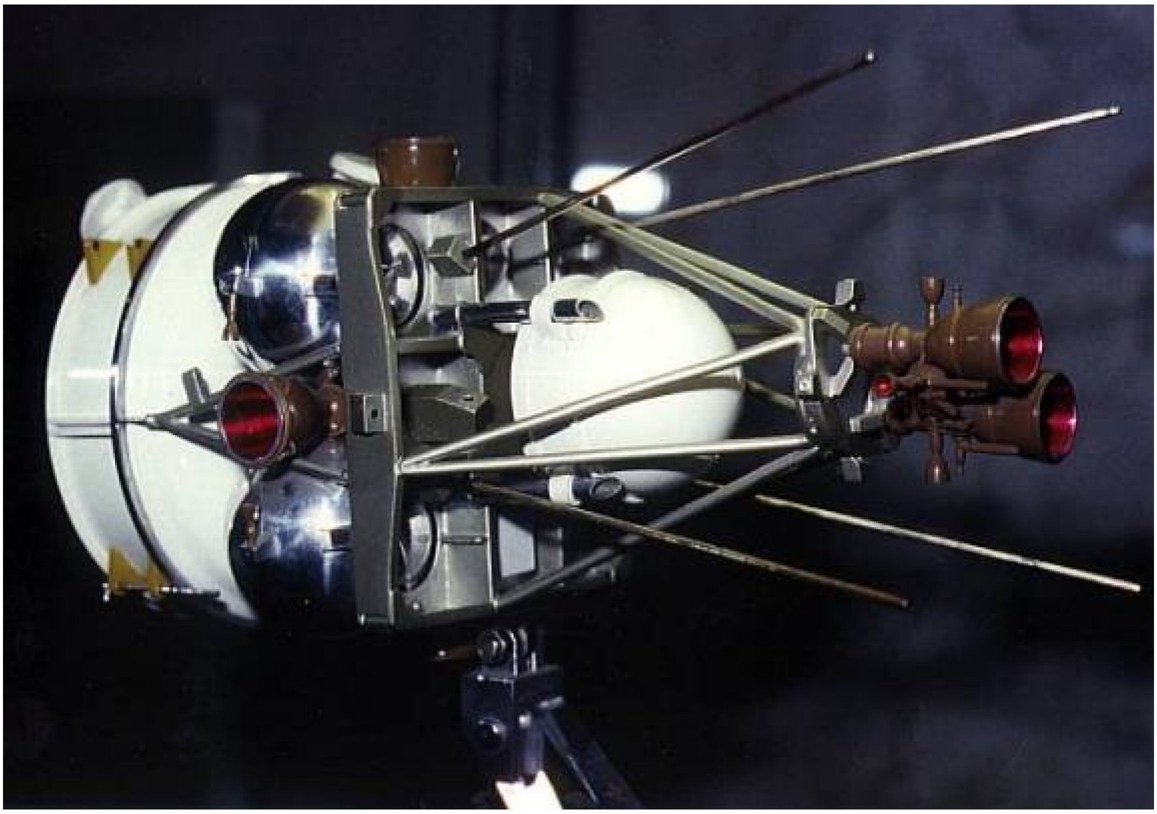
<u>Preface</u>. An increasing number of countries and commercial parties is making use of space for things like observation (meteorology, intelligence, exploration), communication, navigation and science. These matters are no longer reserved for the great powers. The increasing use and reliance on space-based assets for national security purposes has led to an increasing number of countries committed to defending those assets. What applies on earth also applies in space: ensuring that you can use your own space resources while ensuring that the opponent (no longer) cannot. Then you have *Space Superiority*. In order to achieve that, you need to know what is present in space and what is happening: *Space Situational Awareness*. Countries that understand the need for this are therefore developing counterspace activities and techniques. Defensive counterspace helps you protect your own resources while offensive counterspace must prevent your opponent from using his space resources. Offensive counterspace includes anti-satellite weapons (ASAT). This group of weapons can be used to decrease the opponent's space capabilities by applying disruption, deception, denial, degradation or even destruction of the three system elements of space assets: the satellite, the ground station and/or the communication between them. ASAT weapons can be divided into five types, of which only the first three will be discussed in the reports:

- Co-orbital (CO). Kinetic weapons brought into space by missiles and waiting for them to be guided to a target.
- Direct Ascent (DA). The use of rocket-launched interceptors that directly destroy a target with kinetic energy (collision or warhead).
- Directed Energy (DE). Weapons using concentrated energy (laser-, particle- or microwave beams) to reduce or stop the operation of a target.
- Electronic Warfare (EW). Weapons that use radio frequency energy to disrupt connections between system elements.
- Cyber Warfare (CW). Weapons that use software and networking techniques to compromise or disrupt computer networks, or even destroy computer systems.

<u>Co-orbital ASAT</u>. Co-orbital here is related to two masses that share the same or nearly the same orbit in space as part of the intercept profile of the ASAT weapon. This profile stipulates that the weapon can therefore only be launched if the target is (almost) in the same orbital plane as the ASAT ends up after launch. In the past, during testing (by Russia), the interceptor was first brought into a low-altitude parking orbit, after which it was maneuvered into an intercept orbit via a transition path. From this intercept orbit, the target could then be attacked by detonating a conventional charge relatively close to the target. The ASAT systems discussed here destroy their target by kinetic energy transfer (conventional chemical detonation or collision).

Russia

Polyot. The impetus for the development and construction of ASAT weapons by the former Soviet Union (SU) dates to the mid-1950s. In 1963 the SU conducted the first experiment with the Istrebitel Sputnik (IS, Satellite Fighter) CO-ASAT. This approximately 1400 kg interceptor was called Polyot. Polyot-1 made the first simulated interception test on November 1, 1963, mainly testing propulsion. Later, the satellites used in the ASAT program were given the generic designation Kosmos (K) with a serial number. Between October 1968 and June 1982, the SU conducted twenty (with different versions) ASAT tests on fourteen target satellites. On November 1, 1968, a target (K-248) was intercepted and destroyed for the first time by K-252. The attacked targets of the first ASAT system (IS) were in ranges from 230 km to 1000 km altitude. The tests resulted in a lot of space debris/waste. The system was declared operational in February 1973. Its successor, IS-M, intercepted targets between 150 km and 1600 km and was operational from 1976 through 1982. Although the Soviet unilateral moratorium on ASAT entered into force in 1983, the SU continued to develop offensive counterspace weapons.


Polyot-1 [spacerockethistory.com - Dietrich Haeseler]

Naryad. After decommissioning the Istrebitel Sputnik ASAT system, the Soviets maintained the launch logistics (silos) and designed a new system in the early 1980s to respond to the American Strategic Defense Initiative (SDI/Star Wars). This system was called Naryad (Guardian). The Naryad was designed to be launched into space with a silo-launched missile as a highly maneuverable missile stage capable of raising interceptors to an altitude of 40,000 km. This rocket stage was the later Breeze-K, which is being used commercially for geostationary satellites, among others. The first Naryad was launched on November 11, 1990 in a ballistic trajectory. The last launch was on December 26, 1994, on which occasion the Naryad exploded. Much has been documented about Soviet space, but little has been published about the Naryad. From time to time, information about Naryad's successors slips into the public domain. Also, after the ASAT actions by China (2007) and America (2008), the Russian government threatened to put ASAT systems back into production ("various programs that the country can use for ASAT purposes").

Breeze rocket stage (Proba launch) [P. Carril]

Proximity and rendezvous operations. Russia continues to conduct experiments with satellites that actively approach other satellites. On December 25, 2013, with a Rockot-Breeze launch combination, apparently routine, three Rodnik communication satellites were brought into space at an altitude of 1500 km. On May 5, 2014, Russia announced that a fourth object, hitherto cataloged as an inactive part of the launch, was an active satellite named K-2491. This satellite carried out maneuvers repeatedly and Dutch radio amateur Cees Bassa discovered S-band radio signals coming from this satellite. A similar launch took place on May 23, 2014, where K-2499 was the mysterious satellite and on March 31, 2015, with K-2504. The approximations and orbital behavior of these satellites can serve for testing technology for repair and/or refueling, or satellite inspections, but also for the testing of ASAT profiles, given the history of the Breeze rocket stage (Naryad). Russian comment: “They are not killer satellites. These satellites are designed for peaceful purposes.” What those purposes were, however, was not disclosed.

K-2519 | K-2521 | K-2523. On June 23, 2017, a Soyuz-2-1v launch vehicle was launched into space from Plesetsk Cosmodrome, bringing K-2519 in a 660 km high sun-synchronous orbit. The official Russian announcement spoke of a space platform that could accommodate different loads. On August 23, the Russians announced that a satellite, K-2521, had separated from K-2519. Both satellites then started to perform a series of maneuvers. This involved separation, return (up to 1 km) and a maneuver in which K-2521 distanced itself from K-2519 a complete orbit. On October 30, Russian officials announced that a new inspection satellite, K-2523, had disengaged from K-2521. These three satellites have performed at least ten, clearly separable from each other, maneuvers (until July 20, 2018).

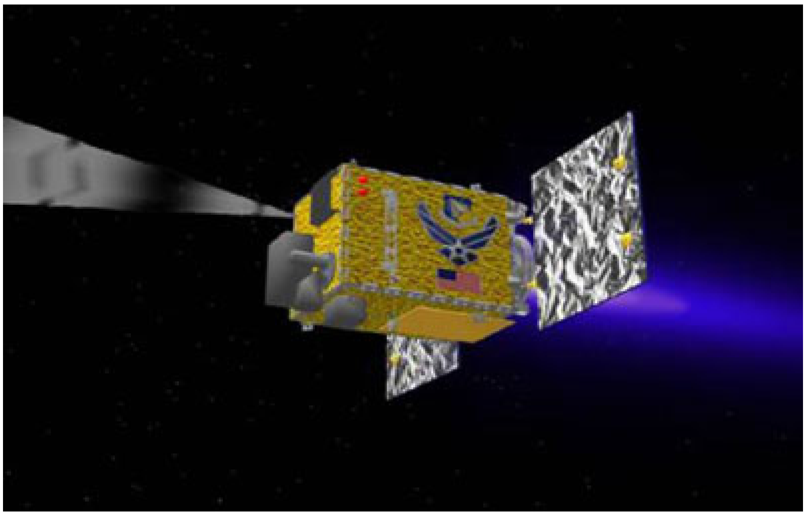
Olimp -K/Luch. On September 27, 2014, Russia launched a Luch (military) communications satellite into geostationary orbit. According to a Kommersant report, this satellite also fulfills an Elint (electronic intelligence) function and was therefore also designated Olimp-K. Other unconfirmed sources report that the satellite provides navigation correction signals for the GLONASS navigation system and that there is a laser communication system on board. What was noticeable were the unusual, constant maneuvers in the geostationary orbit during the year after launch. In June 2015, the satellite was temporarily parked between two operational Intelsat satellites. The question is whether these maneuvers were intended to test the Elint function, or to be able to approach other satellites in geostationary orbit in a counterspace function.

Conclusion. Activities described above did not explicitly test offensive counterspace activities or aggressive maneuvers. However, the tests and maneuvers performed can be used for this type of activity.

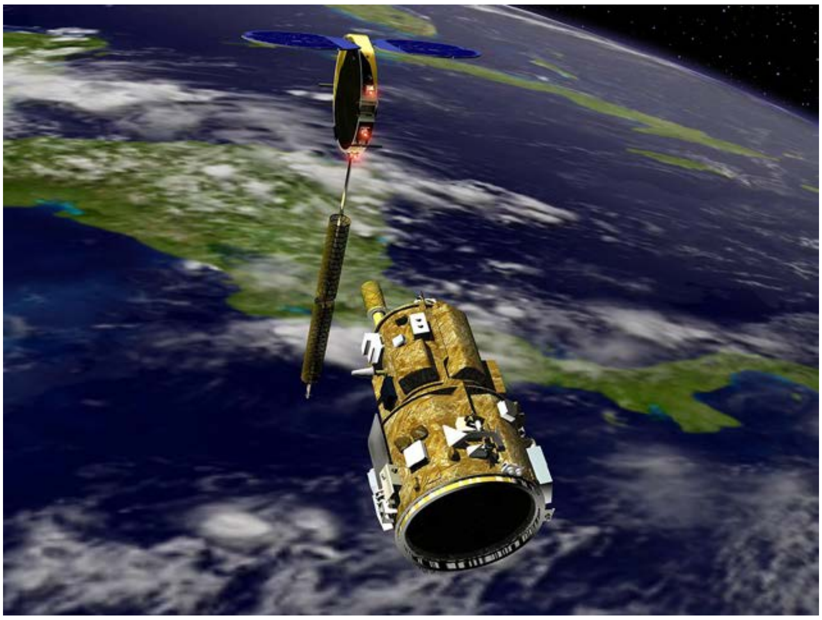
America

The United States of America (USA) have never had an officially recognized CO-ASAT program. The US has developed the necessary technologies for such a program as part of its missile defense program (SDI). The tests of midcourse interception technologies as part of this SDI program in the 1980s can very well be used to intercept satellites. On September 5, 1986, Delta 180/USA-19 was launched from Cape Canaveral. The purpose of this launch was to test the tracking, guidance and control of a space interception of an accelerating target. The experiment consisted of modifying the second stage of the Delta 2 rocket by incorporating a LIDAR (laser radar) and ultraviolet-, visible light- and infrared sensors (D2). The payload was a Payload Assist System (PAS) combined with a warhead and target finder from a Phoenix air-to-air missile. The D2 and PAS were placed in a 220 km high circular orbit, 200 km apart. 90 minutes after launch, the D2 observed an Aries missile launch from White Sands Missile Range. Another 115 minutes later, D2 and PAS started their engines and followed an intercept course that resulted in a collision with the Aries target which was destroyed.

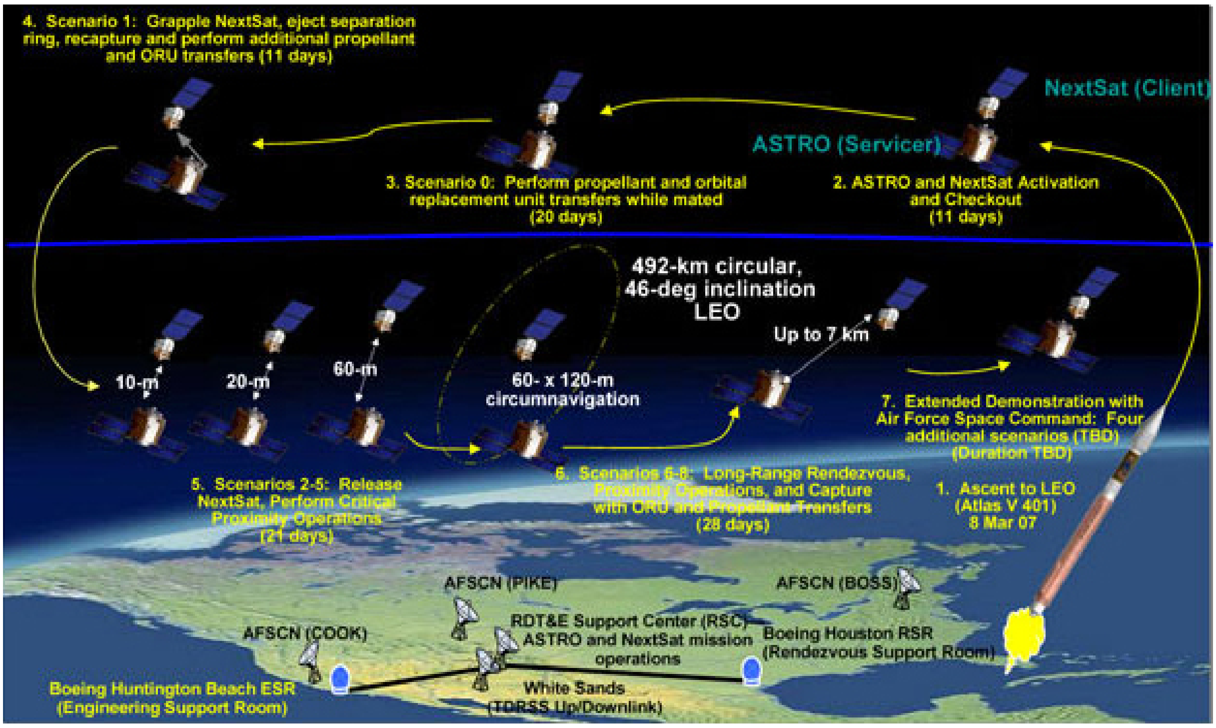
After the Cold War, the USAF, NASA and DARPA conducted tests and demonstrations (2003, 2005) of low orbit approach and rendezvous technologies. The Experimental Satellite Series (XSS) are the most important of these. Officially, the goal of XSS is to develop technologies for satellite-oriented space logistics and service (repair, refueling, in-situ inspection, etc.), but these technologies are of course also very useful for CO-ASAT operations. In 2005, NASA launched the DART satellite to create an autonomous rendezvous with the Navy's MUBLCOM communications satellite. These two satellites have been shown to collide. It is not clear whether this happened accidentally or whether this collision was programmed.



XSS-11 [Air Force Research Laboratory]


DART-MUBLCOM rendezvous [NASA]

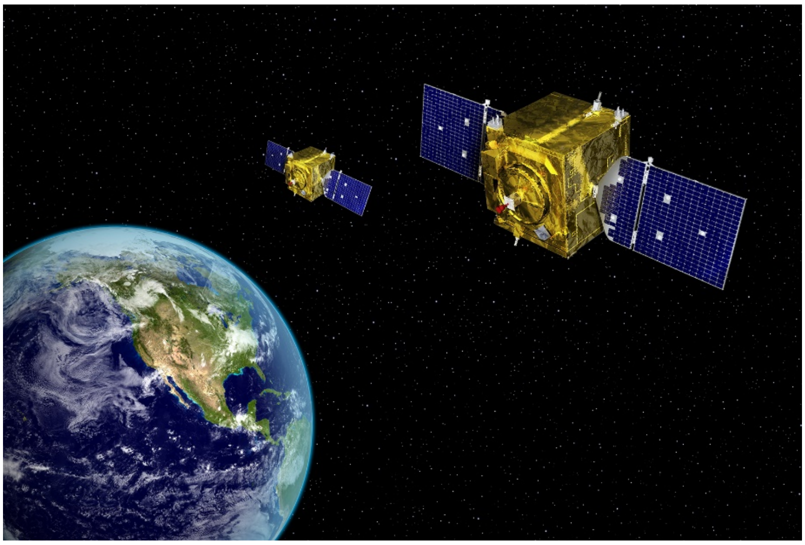
Orbital Express. The demonstration of Orbital Express connected a prototype service satellite (ASTRO) to a surrogate next generation satellite (NextSat) which should be serviced. Together they had to test the required robotics, autonomous operations, refueling and reconfiguration. This would demonstrate that in the future, the lifespan of satellites could be extended faster and less risky. It was recognized that the technologies were dual-use and could also be used for CO-ASAT. Participants included Boeing, NASA and the top of the American aerospace industry. Both satellites, along with four others, were launched on March 9, 2007, from Cape Canaveral with an Atlas 5 to a 500 km high orbit. The satellites successfully demonstrated fully autonomously, several times, separation, maneuvering and coupling (using a robotic arm), in-situ inspection, robot operations (exchanging components) and fuel transfer. Not everything went completely perfect, but in general it was a successful operation where 'a first time' could often be recorded.



Orbital Express timeline [Boeing]

Astro (right) and NextSat inspection [Boeing]

Geostationary operations. The first US related geostationary orbit activities took place in 1990. The Prowler inspection satellite is said to have been secretly launched from a space shuttle. America cataloged this object as a part (debris) associated with the shuttle launch. Research made clear that Prowler approached several Russian geostationary communication satellites, likely to determine their characteristics and capabilities. Prowler is said to have used stealth techniques to prevent the Soviets from discovering it. Obviously, the Americans never admitted Prowler 's existence. Since then, America has implemented several similar programs. The best known is the Micro-satellite Technology Experiment (MiTEx, 2006-2010). These programs eventually led to the current Geostationary Space Situational Awareness Program (GSSAP). GSSAP satellites support the US Air Force Space Command (AFSC) in data collection for better "tracking and characterization of man-made objects in space." It provides clearer information than when it is done from Earth. They operate near (below or above) the geostationary orbit and are capable of performing proximity and rendezvous operations. On July 28, 2014, the first two GSSAP satellites were launched with a Delta 4 launch vehicle from Cape Canaveral. Two additional satellites were launched into space on August 19, 2016. The AFSC fact sheets provide very little specific information about these satellites. Simultaneously with the first launch, a satellite from another similar program, Automated Navigation and Guidance Experiment for Local Space Program (ANGELS), was launched into space. The aim of ANGELS is to obtain a better environmental picture from American satellites in the geostationary orbit for the benefit of national security. Virtually no information is available about this specific secret program.



Geostationary Space Situational Awareness Program [US Air Force Space Command]

Conclusion. The most likely utilization of the programs described here is to improve environmental knowledge in space. Be aware of what is going on. It involves a consistent pattern of slow, methodical and careful approach and rendezvous with other objects in similar orbits. This pattern is also known from Russian and Chinese tests and demonstrations described in this report. However, the tests and maneuvers performed can also very well be used for CO-ASAT operations.

China

The People's Republic of China is motivated to develop counterspace capabilities, in addition to military space applications such as navigation, intelligence and reconnaissance, to strengthen its national security. This is evident from an every five-year published White Paper, and the tests that are performed. Over the past decade, China has shown in tests that it has aerospace capabilities that can be deployed as offensive counterspace weapons. At the same time, Chinese publications indicate that they have started developing a doctrine and associated organization to integrate counterspace into military operations.

SJ-12/SJ-06F. Two Shi Jian (SJ) satellites seem to be the harbingers of Chinese space rendezvous tests. SJ satellites are scientific satellites for space experiments, according to official Chinese communiqués. However, the orbital behavior of these satellites make that observers believe that the task of these satellites is to collect information, partly due to the fact that there are no known publications of the scientific results of these satellites. The mystery surrounding these tests reinforces the suspicion that these are CO-ASAT experiments. SJ-12 was launched on June 15, 2010, in the same orbit that SJ-06F (October 25, 2008) was located, namely a sun-synchronous orbit at 570-600 km altitude. From June through August 2010, the SJ-12 began a rendezvous with SJ-06F through a series of minor changes in its orbit. On August 19th they were closest to each other, ± 200 m. Because, around that time, there was a change in the orbit of SJ-06F, it is believed that the two satellites collided softly without causing significant damage and/or space debris.

SJ-15/SY-7/CX-3. In 2013 there was again a rendezvous between Chinese satellites. On July 19, China orbited three satellites in approximately the same sun-synchronous orbits at approximately 670 km altitude: Shi Jan 15 (SJ-15), Shi Yan 7 (SY-7) and Chuang Xin 3 (CX-3). The official press release spoke of scientific experiments for space maintenance technologies. Publicly available information indicated that a robotic arm was available on SY-7 and that SJ-15 had instruments on board that could track other satellites optically. CX-3 had to take care of the mutual communication. In August, SJ-15 began a series of maneuvers to get closer to the other two satellites. After passing a few miles above CX-3, SJ-15 first returned to its original orbit, followed by maneuvers involving another Chinese satellite (SJ-07) over the next eight months.

Aolong-1. This satellite (AL-1) was launched into space with the first launch of the Long March 7 launch vehicle on June 25, 2016, and was named Roaming Dragon. It is also referred to as an Advanced Debris Removal Vehicle (ADRV). The AL-1 had to demonstrate with a robotic arm that it was possible to capture and remove space debris. There was somewhat of a media hype, outside of China, about the dual-use potential of this technology. However, according to American military tracking data, the AL-1 has not had a rendezvous with another satellite, nor has it changed its orbit during its two-month stay in space.

First launch LM-7 including the Alolon-1 on June 25, 2016 [Xinhua]

Geostationary operations. China has also conducted rendezvous operations in the geostationary orbit. Known are those of the SJ-17 and Chinasat-5 in November 2016, where the SJ-17 orbited the communications satellite and stayed close to it for a month. The SJ-17 then demonstrated for several months that it was able to observe satellites in large areas of the geostationary orbit.

Conclusion. The operations of the SJ-12, SJ-15, and the SJ-17 are most similar to testing increasing the Space Situational Awareness and being able to inspect satellites closely and are similar to those of Russia and America as described here . However, they fall within the range of counterspace operations and can therefore be a precursor to CO-ASAT.

In Report 2 in this series, the Direct Ascent ASAT of Russia, America and China will be described.
In Report 3 in this series, Directed Energy Space Weapons from Russia, America and China will be addressed.