Space weapons, fiction or reality

Report 2 of 3: Direct Ascent ASAT

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On June 18, 2018, US President Trump announced at the National Space Council, "We are going to have the Space Force." This announcement provided extra attention in the media about space weapons. In Report 1 of a series of three, an overview of Co-Orbital ASAT was given on the current situation in America, Russia and China. This second report addresses Direct Ascent ASAT.

Preface. 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 addressed in the underlying 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.

Direct Ascent ASAT. Direct Ascent Anti-Satellite (DA-ASAT) weapon here is understood to mean a weapon that uses a surface-launched, sea-launched or air-launched missile with an interceptor on board. This interceptor is used to kinetically destroy satellites by collision or by a nearby explosion, without putting that interceptor into orbit.

Russia

The impetus for the development and construction of ASAT weapons by the former Soviet Union (USSR) dates from the mid-1950s. Although the Soviet unilateral moratorium on ASAT entered into force in 1983, there are strong indications that developments continued until the collapse of the USSR

(1991). In the past decade, Russia has made efforts to revive the Cold War capacity in counterspace weapons by removing old mothball systems (Kontakt) and developing new ones (Nudol and S-500). It is noted that tests that are carried out for the purpose of mid-course anti-ballistic missile systems, can be used very well in applications for DA-ASAT. Today's Russia must be considered capable of carrying out DA-ASAT operations on a limited scale against low orbit space capabilities of its enemies.

Kontakt. The Russian concept of a fighter-launched rocket to physically disable a satellite was developed under the 30P6 program in the mid-1980s. It became an interceptor missile that was carried into the air under a Mig-31 Foxhound jet (10-18 km altitude) and launched from there towards the satellite to be attacked. At least six MiG-31 aircraft were modified (MiG-31D) to launch two types of DA-ASAT missiles. The first rocket was a three-stage interceptor capable of destroying satellites at an altitude of 120-600 km. The second rocket had to be able to reach altitudes of 1,500 km. The public collective name of this interception program was Kontakt, but for the interceptor itself there are various indicators in circulation: 79M6, 95M6, RN-5. Ground support for these ASAT operations was provided by the 45Zh6 Krona space tracking radar in the North Caucasus. According to a Russian think tank, there took place only one test with Kontakt at that time, namely on July 26, 1991, with a MiG-31D/79M6. However, according to an ex-MiG test pilot, several tests were successfully conducted with the target satellite being dodged at the last minute to make the Americans no wiser and to not cause space debris. This would indicate an adult program for the radar in the aircraft, target allocation on the ground and command & control.

MiG-31D Foxhound fighter jet with a huge missile, which may be the new DA-ASAT system. [www.thedrive.com]

The program was resumed in 2009, but this can only be deduced from parallel developments in the interception of ballistic missiles. Whether this has led to a viable DA-ASAT system is as yet unclear. Meanwhile, the associated parts for an air-bound DA-ASAT system - detection, target assignment, tracking, and communication - are being expanded and new facilities are being built. For example, a new Krona space tracking radar has been built in Nakhodka (near Vladivostok and the Sea of Japan). After the ASAT operations of China (2007) and America (2008), senior Russian officials keep reporting about ASAT capabilities and that more money is being released for anti-satellite systems. In September 2018, a Russian MiG-31 Foxhound was spotted at the Gromov Flight Research Center at

Zhukovsky (Ramenskoye) airbase. The aircraft with number 81 (see photo) was loaded with what is believed to be the new DA-ASAT (95M6). According to janes.com, this aircraft is a MiG-31BM variant.

A-235/Nudol. The Soviet anti-ballistic-missile (ABM) defense system A-135/Gorgon, which became operational in 1978, had a very limited ASAT capability and has probably never been tested as such. The successor to the A-135 is the A-235, which has been under development since the 1980s. It was not until 2013 that this completely new ABM system as a whole was successfully tested without launching a missile. The corresponding missile for this system is the PL-19 Nudol, of which there are enough indications that it is being developed for DA-ASAT operations. Russian state-controlled press speaks of "... space intercept complex ..." when they talk about the Nudol. Six test flights (2014-2018) of this rocket are known, the last four of which were probably completed successfully. There are no images of the Nudol missile, but, looking at all the information, in the mobile version the missile is transported in a container and launched from a Transporter-Erector-Launcher (TEL). Almaz-Antey is the company that has the task for Russia to develop technologies for active space defense. This company reported the A-235 system in its annual report for 2011 and later shows on its company calendar (see image) an artistic representation of a mobile system that is supposed to be the TEL of the PL-19 Nudol. It is assumed that in the DA-ASAT role the A-235 system can only be used against satellites that it can 'see'. However, with ever-improving communication and space situational awareness, the visibility of this system is improving.

Artistic representation of the mobile A-235 ABM/DA-ASAT system [Almaz-Antey]

S-500 Prometheus. Russia has taken a new generation of ABM into production, with the first systems expected to be operational in 2022. This is the S-500 Prometheus, also referred to as the 55R6M Triomfator-M. There is still little information about this system and no photos have surfaced yet. The system was developed by Almaz-Antey and one of the missiles is an exo-atmospheric interceptor for destroying ballistic missiles before they return into the atmosphere, as well as 'objects in circulation'. The S-500 is not an improved version of the S-400, but a new design. The ABM system is said to contain a lot of new technology and is superior to the S-400. The S-500 can be loaded with a variety of missiles for various (strategic) targets, including ballistic missiles and satellites in space, as well as AWACS aircraft. The S-500 will replace the A-135 ABM system, which protects Moscow against attacks by ballistic missiles. The system is supported by various radar systems for target acquisition and battle management.

Conclusion. Given the above, it is likely that Russia has some DA-ASAT capability against satellites in low orbits. There are no indications that Russia is able to intercept satellites in higher orbits.

America

The United States of America (USA) does not have an officially recognized DA-ASAT program. However, they do have operational interceptors for ballistic missiles in space. In 2008, these interceptors demonstrated that they are able to destroy satellites in low orbit. In the past, the US has developed DA-ASAT with a nuclear option, launched both from the ground and from aircraft, including: 1959 - Bold Orion, 1962 - Thor, 1964 - Nike Zeus. These types of systems are no longer operational because the collateral damage caused by the electromagnetic pulse to own satellites and communication systems was assessed too great.

ASM-135 ASAT missile [Wikimedia Commons]

ASM-135. The ASM-135 was an aircraft-launched missile designed to respond to the Soviet Union's CO-ASAT capability without the use of the nuclear option. The missile, produced in 1984, was launched with a modified F-15A in a supersonic climb and was intended to destroy satellites in low orbit. A total of five tests were performed. The system was validated with its launch on September 13, 1985, destroying the Solwind P78-1 satellite at an altitude of 555 km. This was the only time (before 2008) that the USA has physically destroyed a satellite in space. The ASM-135 was able to cover a distance of about 650 km with a maximum speed of 24,000 km/h. The interceptor had an infrared target finder with an advanced guidance system. Originally, the U.S. Air Force would like to have 112 of these missiles operational on twenty modified F-15s. In the end, only fifteen of these missiles were produced and the system was phased out in 1988 for budgetary reasons.

MMDS. Because mid-range missile defense systems are intended to destroy long-range ballistic missiles - which travel at speeds and at heights comparable to those of satellites - in flight, these systems have inherent DA-ASAT capabilities. These systems are referred to as Midcourse Missile Defense Systems (MMDS). In fact, attacking satellites is easier because it is predictable where these satellites will be in space at a given time while there will be little time to determine the position of a ballistic missile in full flight in space. The U.S. currently has two MMDS that have DA-ASAT capability: ground-based interceptors (GBI) that are part of the Ground-based Midcourse System (GMD) and the ship-based Standard Missile 3 (SM-3) interceptor, part of the Aegis Ballistic Missile Defense System (BMDS). On February 20, 2008, during Operation Burnt Frost, an SM-3 was used to destroy a misfunctioning US satellite in space at 240 km altitude. SM-3s though, are not quite suitable for DA-ASAT. The maximum satellite interception altitude is approximately 600 km (maximum speed 4.5 km/s). However, because of the placement of the SM-3 on ships equipped with the Aegis BMDS, America is more flexible in deploying this system as DA-ASAT than the land-based GBIs.


SM-3 launch [Wikimedia Commons]


A Ground-Based Interceptor is loaded [MDA]

GBIs have the most potential to be used as DA-ASAT. These interceptors are stationed in Alaska and California. The maximum speed of these interceptors is 7-8 km/s where target heights of 6,000 km can be achieved. More than sufficient for all satellites in low orbits, but unsuitable for medium or geostationary orbits. The Exo-atmospheric Kill Vehicle (EKV) is guided to the predicted position by ground-based radars. The EKV uses infrared guidance for the terminal phase of its trajectory.

Conclusion. The SM-3 and GBI give the USA a DA-ASAT capacity that increases as these systems become more operational in the near future. If current US plans are implemented (Aegis on ships and Aegis Ashore in Romania, Poland and Japan, and GMD), the vast majority of Chinese and Russian satellites in low orbits will be threatened.

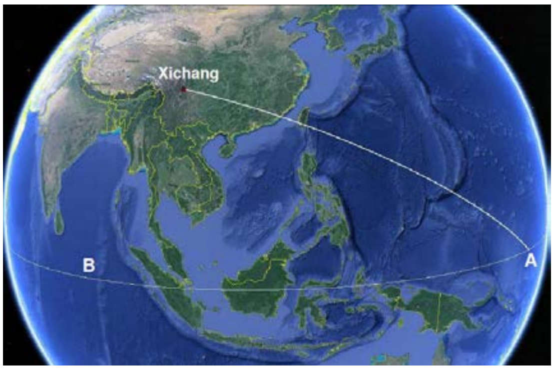
China

The People's Republic of China has at least one, but possibly even three programs suitable for DA-ASAT against low-orbit satellites. It is likely that the development of DA-ASAT started much earlier than that of the kinetic kill vehicle (KKV) project in 1995. Nevertheless, the development of a KKV, along with all kinds of related tests in the context of the HQ-19 ABM system, is an indication that China was seriously engaged in offensive counterspace projects. This is also evident from Chinese publications on the development of a doctrine and the associated organization to integrate counter-space into military operations.

SC-19. The first known Chinese system believed to be a DA-ASAT is known as SC-19 or DN-1 and has been tested at least five times since 2005. The first tests, of the rocket itself, took place from the Xichang launch center from which Long March 2 and -3 space launch vehicles are also launched. On January 11, 2007, at the third test from Xichang, an ancient Chinese meteorological satellite, Feng Yun 1C, was destroyed at an altitude of 865 km, creating thousands of pieces of space debris. China thereby proved what it was capable of. The following tests of the system were conducted from the Korla West missile test complex, successfully eliminating ballistic targets. Relocating to Korla West may indicate that the system is operational. No data is publicly available from the SC-19 missile, but flight data analysis shows that it is most likely based on the DF-21C ballistic missile adapted to the HQ-19 ABM system parameters. The DF-21 has a maximum operating distance of 2,500 km, which means that its ceiling is likely to be at an altitude of about 1,250 km, more than enough for low-orbit satellites. The parallel development of the Kaituozhe launch vehicle - which consists of missile stages of the DF-21 and DF-31 ballistic missiles - also indicates that the SC-19 was developed from one or more ballistic missiles.

DF-21 launch ready on Transporter Erector Launcher [China Sighnpost]

DN-2. The launch of a missile on May 13, 2013 from Xichang raises a number of questions. The Chinese Academy of Sciences said it was a scientific research mission at 10,000 km. A US military official said that the missile was flying on a ballistic trajectory near GEO and that no object (satellite?) was being brought into space that stayed there. The details of this launch were different from a standard satellite launch to GEO or from a sounding rocket. The Chinese NOTAM (Notice to Airmen) indicated a ground path for a GEO launch, but with a much more southern return point for the missile than usual. Also, the rocket came much higher than usual for a sounding rocket, there is no evidence of an emitted cloud of barium as claimed by the Chinese, and no scientific research results have been published afterwards. Launch site analysis data indicate that the launch must have occurred from a mobile launch vehicle because one fixed launch site at Xichang was occupied by a Long March 3B, while the other stationary launch site was under major maintenance at the time. Launching from a TEL is very unusual if not impossible for a standard GEO or sounding rocket launch. Theoretically, the rocket must have been at least 30,000 km high to be able to return to the area indicated by the Chinese in the NOTAM (see explanation below). Note that this flight path is larger than the SC-19 should be capable of.



The ground path (on a non-rotating earth) of the missile launch on May 13, 2013, from Xichang to the return point A on the equator (according the NOTAM). Because the rocket returned to point B, it must have flown at least 30,000 km high to give the Earth ample time to rotate from point B to point A. [allthingsnuclear.org]

The most plausible explanation for this launch is therefore a test of a missile (part) of a new DA-ASAT system for geostationary orbit, developed from a mobile-launched ballistic missile. Commercial space photography shows that at the time of the launch, a TEL was present at a prepared location on Xichang. There are no comparable launches.

LC2 and LC3 launch towers at the Xichang Satellite Launch Center, Sichuan Province, China

DN-3. Since 2015, there are indications that China has conducted at least three more tests that may be related to their DA-ASAT program. A launch on October 30, 2015 from Korla caused strange condensation trails that were widely shared on Chinese social media. Photos from another test on June 22, 2017 from Jiuquan launch center were posted by a Dutch pilot, JPC van Heijst flying a 747 over the Himalayas . This launch also showed strange condensation traces that are not reminiscent of a normal launch. Finally, on February 5, 2018, the Chinese state media stated that it had conducted a land-based mid-course missile interception test within its territory. At each of these three launches, anonymous U.S. officials stated that they were DN-3 tests considered DA-ASAT. However, there is no public evidence that these launches were ASAT tests or that the DN-3 is an ASAT weapon system. The DN-3 may simply be a mid-range missile defense system like the US SM-3, which may have inherent DA-ASAT capabilities.

Condensation track launch 30-10-2015
[guancha.cn]

Condensation track launch 22-06-2017
[jpcvanheijst.com]

Conclusion. Western analysts speculate that China must have DA-ASAT systems. There are suggestions that the JL-2 submarine-launched ballistic missile has a DA-ASAT capability. It is also suggested that China has a DA-ASAT system comparable to the American ASM-135 or the Russian Kontakt. However, these suggestions are not supported by publicly available information. This is without prejudice to the fact that China has demonstrated that it can destroy satellites and/or ballistic missiles in space with a KKV. However, this only applies to low orbits. This capacity is unlikely to exist for the geostationary orbit.

In Report 3 in these series, the non-kinetic ASAT programs of Russia, America and China will be addressed.
In Report 1 in these series, the Co-Orbital ASAT programs of Russia, America and China have been described.