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China's Counter Space Capabilities

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"Build China into a space power in all respects".

—China's Vision Stated in 2016 White Paper on Space Activities

Key Points

- Global economy and commerce are increasingly dependent on space based capabilities—advanced militaries are also reliant on space based system.
- Existing international treaties do not particularly prohibit non-nuclear space based weapons.
- US, China and Russia have the most advanced counter space capabilities—DPRK, Iran and India are known to be developing this technology.
- China is growing rapidly into a global space power— second only to US in the number of operational satellites.
- China is pursuing a broad range of counter space capabilities—both kinetic and non-kinetic.
- Military applications of civil space based facilities cannot be ignored if India is to be a credible future military power, need to secure unrestricted access in space is a must.
- India must continue advocacy of demilitarisation of space, but also must actively protect its assets.

Introduction

The global economy and civilian population are increasingly dependent on space based systems. US as well as advanced militaries rely on space based systems for Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) to take informed decisions across the entire spectrum of conflict. Countries are aware of the advantages the space systems provide and hence, seek capabilities to deny them. Accordingly, space is getting increasingly militarised with advanced countries (US, Russia, China etc.) developing new space capabilities as also undertaking measures to reduce their dependence on space based systems. It is an established norm that the spatial expanses above the Karman line (100 km above sea level) are global commons as per the world order. Moreover, the largely ratified and acceded Outer Space Treaty (1967) and its supplementary treaty– the

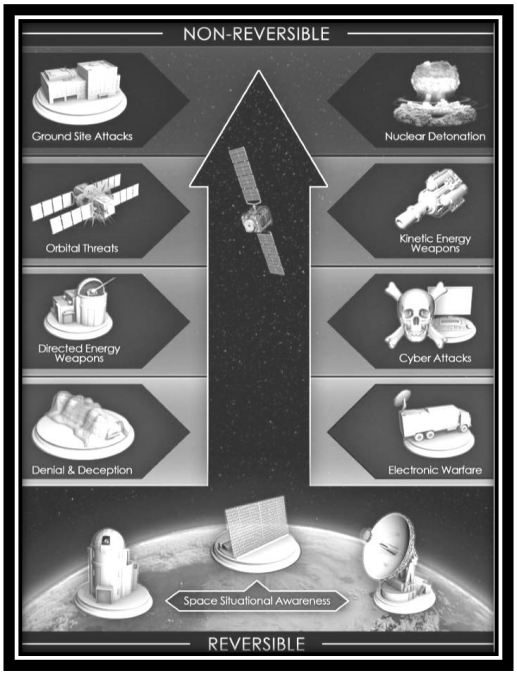
Prevention of Arms Race in Outer Space (PAROS) have been, to an extent, successful in curtailing the placement of weapons of mass destruction in outer space. However, there are no international treaties prohibiting non-nuclear space weapons that can degrade the adversary's space based assets.

The growing reliance on space for national security has led countries to develop their counter space capabilities. The importance of space (including counter space) as a domain of warfare is evident from the fact that most of the developed nations with modern militaries have established new space units since 2010 (France- Joint Space Command in 2010, Russian Space Force in 2015, PLA Strategic Support Force in 2015, Germany – Cyber and Information Domain Service in 2017, Japan – Multi Domain Defence Force in 2018, US Space Force in 2018 and Indian Defence Space Agency in 2019). Counter space capabilities have both offensive and defensive elements supported by Space Situational Awareness (SSA). Defensive counter space enables to protect own space assets from attack, while offensive counter space attempts to prevent the adversary from using their space assets. Offensive capabilities can be used to deceive, disrupt, deny, degrade or destroy any of the three elements of a space system— the satellite, the ground system or the communication link between them.The different categories of an offensive counter space capabilities are— Direct Ascent (DA) Weapons; Co-orbital Weapons; Directed Energy Weapons (DEW); Electronic Warfare (EW); and Cyber. [1]

China's Space Capabilities

China's space capabilities have grown remarkably in the past decade corresponding to the growth of overall Chinese power. Even during the global pandemic in 2020, China had achieved many accomplishments in its civilian space programme (the Chang'e 5 Moon Mission returned 4.5 pounds of Lunar regolith in December 2020; Yutu 2 rover is still operating on far side of the moon traveling over 600m on Lunar surface; Tianwen-1 [China's first Mars Rover] was launched in June 2020, which entered the Martian orbit in February 2021; and another notable achievement in 2020 was the launch and recovery of a space plane, similar to the US X37B space plane program) displaying its growing prowess as a leading space power.

Image 1: Non-Reversible and Reversible Space Based Capabilities[2]



Source: National Air and Space Intelligence Centre

Chinese White Paper on Military Strategy (2015) states "outer space and cyber space have become new commanding heights in strategic competition among all parties".[3] The statement represents China's formal designation of space as a war fighting domain for the first time. Accordingly, the PLA appears to be highly motivated to acquire a range of technologies to improve its counter space capabilities. As per Jane's assessment, counter space capabilities will be most important to China among the five advanced weapon systems[4] it is pursuing over the next decade. China's counter space program is diverse, consisting of robust Anti-Satellite (ASAT) weapons, co-orbital[5] 'Kamikaze' and 'Assassin' satellites, electronic, cyber and directed energy ASAT capabilities. Significantly, China has tested or demonstrated each of these capabilities over the last decade, including a highly controversial test of a DA-ASAT weapon against a defunct weather satellite in 2007.[6]

However, it has not publicly acknowledged the existence of any new program since then, while, PLA writings continue to emphasise the necessity of destroying, damaging and interfering with the enemy's reconnaissance and communication satellites, suggesting that such systems, as well as navigation and EW satellites could be among the targets of attacks designed to 'blind and deafen the enemy'.[7] There is credible evidence to suggest that, China has a sustained effort to develop a broad range of counter space capabilities. Also, it has started developing the policy, doctrine and organisational framework to support the integration of these capabilities into its military planning and operations, evident by the

creation of Special Security Force (SSF) with a Space System Department (number of PLA writings are clear about the importance of denying space to the adversaries— 'space is the commanding point for the information battlefield' and 'destroying or capturing satellites and other sensors ….will deprive the opponent of initiative on the battlefield and make it difficult for him to bring their precision guided weapons into full play'.[8] The development in each area of counter space capabilities of China is elaborated in succeeding paragraphs.

- ***Dual-Use Space and Counter Space Program.*** China has become a global power in space after decades of investment. The progress in its space program is mirrored in the developments in their counter space program. As per US DoD Annual reports to the congress "China possesses the most rapidly maturing space program in the world.[9] In parallel with its space program, China continues to develop a variety of capabilities designed to limit or prevent the use of space based assets by adversaries during a crisis or conflict, including the development of directed energy weapons and satellite Jammers". PLA has a strong influence on China's space program even though it is dual-use and leverages this for military purpose.[10] While, exploiting the civilian space for use by military, China aims to maximise the economic benefits by creating a niche market for high technology: development of 'spin-off' civilian technology; use of satellite technologies as also export of satellites and commercial launch services. The arrangement is an enabler of its counter space program growth, as it allows the civilian China National Space Administration (CNSA) and supporting research and industry infrastructure including China Aerospace Science & Industry Cooperation (CASIC) and Certificate Authority Security Council (CASC) to acquire technology and knowhow from western space program avoiding the sanctions/arms embargoes. Through CM1 and the dual-use nature of program, the technology will be used for military purpose later. Also, the dual-use nature of the program allows China to develop novel space and counter space capabilities under the cover of a legitimate civilian program, for example, the rapid launch satellite developed ostensibly for natural disaster response and can be used to augment surveillance infrastructure in times of crisis or conflict. Similarly co-orbital satellites can fix damaged satellites or damage working ones (the capabilities itself are benign; however its application determines the intent).
- ***Direct Ascent (DA) ASAT weapons.*** DA-ASAT weapons are launched from ground to hit and destroy a target satellite in space without the need to establish presence in space or go into orbit. China is developing three or more DA-ASAT systems (by modifying ballistic missiles and missile defence interceptors). [11] PLA has an

operational DA-ASAT missile intended to target LEO satellites (it has also formed military units that have begun testing ASAT missiles as per NASIC report of 02 Dec 2018).[12] China had begun testing these capabilities since 2005[13] indicating its serious intent / organisational effort (The DA-ASAT program has roots in several programs of 1960s-1980s i.e. program 640[14] initially tasked with development of ABM and SAM sites – later began a dedicated ASAT program in 1970). The first two tests were with Kaituozhe-1[15] (KT-1: 16.1m long, 1.7m diameter, solid propellant, three stages SLV likely to be smaller versions of DF-21) or known as SC-19 as also referred as Dong Neng-1(DN-1). There were two known tests in 2005 and 2006, both from Xichang[16] satellite launch centre and apparently were test of missile itself. On 11 January 2007, China carried out its first ASAT test using the SC-19/KT-1 (unconfirmed Chinese sources suggest that ASAT's Kinetic Kill Vehicle [KKV] is a modified HQ-19 warhead) to destroy an ageing Chinese Feng Yun 1C weather satellite at an altitude of 865 km, which created thousands of pieces of debris into space. The incident sparked international outrage and since then China has not destroyed a satellite in space. However, it has continued efforts to expand its DA-ASAT capabilities and the additional developments include:-

- China is exploring the feasibility of aircraft launched ASAT missiles.[17] In April 2019 issue of Aircraft Design, 601 institutes claimed that such an attack system is 'feasible and reasonable in the present stage'. The Shenyang Aircraft Corporation may have considered modifying J-11 fighter to carry an ASAT weapon.
- SC-19 was tested again on 11 January 2010[18] with a ground based mid-course missile interception test using a KKV.[19]
- In 2013, an ASAT test was carried out at an altitude above 30,000 km (almost reaching geo-synchronous orbit). The US DoD labelled this new rocket as DN-2[20] and estimated that it may reach operational status by 2020-2025.
- On 13 May 2013, China conducted a mid-course ballistic missile defence test with DN-2 missile in MEO. [21]
- On 23 July 2014, China conducted a non-destructive test of a missile designed to target satellite in LEO[22] officials claim that the test was for a missile defence system but the launch profile was similar to January 2007 test.

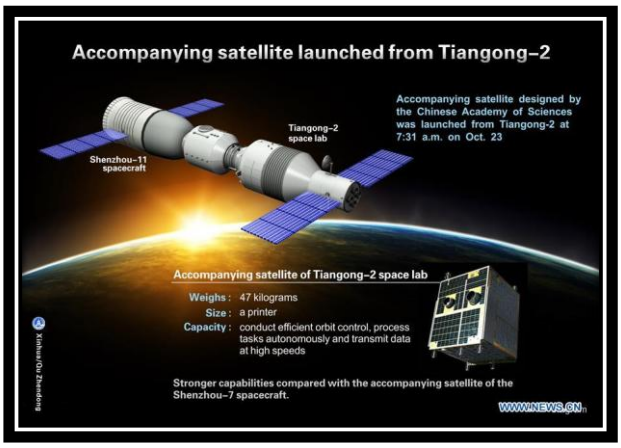
- Since 2014, evidence points to China having conducted at least three more tests as part of its DA-ASAT program. The DN-3 (KO-09 as per US) vehicle was reportedly used from Korea Missile Test Complex on 30 October 2015, 22 July 2017 and 05 February 2018.[23] However, it is not confirmed if DN-3 is a dedicated ASAT weapon[24] or is actually a mid-course missile defence system (akin to US SM-3 with latent ASAT capabilities).
- In February 2016, Jane's reported rumours of an ASAT version of the DF-31 (known as DF-31A), a 13m long, three stage solid propellant rocket with a range of 11,200 km. [25]
- Reports suggest that at least one of the systems, likely SC-19 is an operational DA-ASAT weapon with capability to target LEO satellites. A National Air and Space Intelligence Centre (NASIC) report in December 2018 assessed that military units of PLA have started training with ASAT missiles.
- Analysts also assessed that China may also have sea or air based capabilities that can be used as DA-ASATs. The JL-2 Submarine-Launched ballistic missile (SLBM) [26] may have an ASAT capability. Further, China may be developing an air launched DA-ASAT similar to US ASM-135 [27] or Russian Kontakt, though not much public evidence is available.

Co-orbital ASAT weapons

These are weaponised satellites that are placed in orbit and later can be activated to manoeuvre to strike its target. These satellites can be armed with explosives and DEW among other payloads to facilitate the possibilities of kinetic attacks by directly crashing into the enemy satellite (suicide satellites) or detonating close to it; or by navigating close enough to the target and release a robotic arm that can be used to damage or destroy the satellite ('assassin satellite') without creating debris and employment of lasers or other DEW. Also, there are substantial benefits of co-orbital ASATs as compared to kinetic kill ASAT weapons; the operational use is much less likely to engender uncontrolled escalation, debris is non-existent or minimal, and they can easily pass as dual-use vehicles as it is easy to claim that the primary purpose is to repair satellites rather than destroy them. China has carried out multiple tests of Rendezvous and Proximity Operations (RPO)[28] in both LEO and GEO that could lead to a co-orbital ASAT capability. Notable co-orbital satellites activities include:-

- In 2008, China navigated a Nano-Satellite Banxing-1 (BX-1)[29] or 'Companion Satellite' within 45 km proximity of the International Space Station without any warning. The small satellite was launched from Shenzhou 7 capsule which had just housed three 'taikonauts' for China's first successful spacewalk. It appeared to be a coincidence but it showed China's advancement in satellite manoeuvrability and satellite inspection (which could be used to plan a space based ASAT attack).
- People's Liberation Army Air Force (PLAAF) expressed interest in co-orbital ASAT platforms such as 'assassin satellites', 'laser interceptor satellites' and 'orbital bombers' as stated in a 21 November 2009 report by Chinese academic Jiang Feng, of the China Strategy Institute.[30]
- A SJ-12[31] satellite in summer of 2010 conducted orbital movements in close proximity of an older SJ-06F Chinese satellite (SJ-12 launched on 15 June 2010 was reportedly an ELINT satellite as no scientific research is known to have been published based on the work of this satellite, as claimed by the Chinese) both of which were in orbits between 600 km and 570 km SSO. Moreover, during the manoeuvres, the SJ–12 apparently bumped into the SJ–6F, causing it to drift slightly from its orbital regime.[32] Also, it is suspected that co-orbital jamming may have been tested in this operation.
- In September 2013, China announced that it had tested a co-orbital repair satellite with a robotic arm likely to be SY-7 or the SJ-15.[33] One of the satellites reportedly tested 'grabbing' of another satellite with a robotic arm which could also be used to damage a satellite.
- In June 2016, China launched Aolong1[34] known as Advanced Debris Removal Vehicle (ADRV) "roaming dragon" with the mission to improve safety in space i.e. use its robotic arm to clean up space debris in orbit by grabbing inactive satellites and other Junk and throwing them out of orbit to burn in the atmosphere.
- In 2016, China successfully tested its first satellite refuelling system, the Tianyuan-1.[35]
- In October 2016, BX-2[36] (the next version of 2008 satellite) was launched to co-orbit with Tiangong-2[37]; its 1.3 megapixel camera was used to monitor the space station and was another test of co-orbital capabilities.

Image 2: BX 2- Test of Co-Orbital Satellite[38]



- In November 2016, SJ-17 was launched and will use its optical-sensing payload to observe space debris from high orbit. The spacecraft could also be used to approach and identity other satellites as also test ion propulsion. After a period of inactivity lasting a year, SJ-17 carried out unusual movements in December 2019, from January to April 2020 in close proximity to Chinasat 6B,SJ-20 and GF-13 satellite (the closest SJ-17 and SJ-20 were to one another was under 5 km).
- In Dec 2018, another mission to GEO was launched which exhibited universal behaviour. The TJS-3 satellite[39] and a sub-satellite (object 43917) conducted RPO manoeuvres.
- The likely military utility of the capabilities demonstrated by these satellites is for on-orbit SSA and close up inspections. One potential use could also be to get a radio frequency jammer close to a satellite and thereby amplify its ability to jam the satellite's communication. Moreover, the onboard tracking and guiding systems used for RPO could be utilised to try and physically collide with other satellite to damage or destroy it.

Directed Energy Weapons (DEW)

DEWs include lasers, High Power Microwaves (HPM) radio frequency and particle beams.[40] The laser systems are more developed and prominent among the DEW threats. For counter space purpose they can permanently or temporarily affect a satellite and its systems. A laser can dazzle or blind a satellite's sensor for a limited period or a high powered laser can completely destroy the satellite's capacity to function. Chinese interest in directed energy as a counter space weapon started as early as December 1998, when a report stated that a Chinese deuterium fluoride chemical laser, capable of damaging sensors on a satellite in LEO, had become operational.[41] Recent claims by some analysts indicates massive

developments in Chinese ground based laser stations including identification of five suspected locations of such programs within China while some of these identified programs appears to be academic, one location being a military base known to conduct kinetic physical ASAT tests. Recent developments include:-

- In September 2005, the US Government claimed that, China jammed a US satellite with lasers (appears to be confirmed by a 2003 article in a journal where three Chinese researchers revealed that they had successfully blinded a satellite in 2005 using a 50-100 kw capacity mounted laser gun in Xinjiang province).
- In 2006, Chinese illuminated a US imagery satellite by using lasers[42] over its territory (US claimed that it did not damage the satellite's capability to collect information). However, China claimed that, it was only testing the laser for range finding, but it proved that it could locate foreign satellites and disable them. China reportedly has five laser range finders at fixed locations throughout the country.
- China has also indicated interest in developing High Power Microwave (HPM) Weapons for air and missile defence. In January 2017, the work of an expert Huang Wenhua, who developed a miniaturised HPM weapon capable of being deployed on a ship was debated. However, deploying a mobile HPM system in a satellite would require reduction in weight, size and power in addition to other integration challenges.
- China is also developing radio frequency weapons that can be used against satellites. Radio-frequency weapons using HPMs can be ground based, space based or employed on missiles to disable electronic components through over heating or short circuiting.

Electronic Warfare (EW)

Satellites are vulnerable to both uplink and downlink jamming (power requirements of downlink jamming being lesser). Since, it is difficult to detect and can be confused with accidental interference, it makes attribution and awareness more difficult. PLA is likely to have significant EW counter space capabilities against GNSS and satellite communications. China had acquired ground based satellite jammers from Ukraine in the late 1990s and has continued to develop the technology independently in the ensuing decades. China is assessed to have GPS jamming capabilities for the past decade, having developed both fixed and mobile systems. The known systems are downlink jammers which affect GPS receivers within a local area (there is no known system that targets uplink jamming of the GPS satellites themselves). Recent developments in EW are:-

- China Electronic Technology Group Corporation in a paper proposed solutions for overcoming the high power requirements for jamming US millimetre wave (MMW) satellite communications by using space based jammers hosted on small satellites in a 'David versus Goliath attack'.
- In April 2018, it was reported that military jamming equipment had been placed on the Mischief Reef of the disputed Spratly Islands in the South China Sea. The imagery revealed mobile jamming trucks that are designed to interfere with GPS or other Global Navigation Satellite System (GNSS) signals.
- A Chinese technical paper talks about plans by China to jam GPS signals used by US drones, such as RQ-4 Global hawk over the Spratly Islands and South China Sea.
- In November 2019, a report detailed multiple incidents of GNSS jamming and spoofing near the port of Shanghai. Analysis from the Center for Advanced Defense Studies found that jamming and spoofing of the GNSS signals used by the Automatic Identification System (AIS) to track the commercial shipping began in summer of 2018 and attacks culminated in July 2019.
- The US Defense Intelligence Agency's space and counter space report of 2019 states that China is developing jammers to target SATCOM over a range of frequency bands including protected extremely high frequency communications. It also states that it is developing jammers for targeting SAR aboard military reconnaissance platforms.

Cyber weapon

Cyber attacks can be carried out against the satellite command and data distribution networks which expose space systems, ground infrastructure, users and the links connecting these segments. China's 2015 Military Strategy White Paper states that space and cyber constitutes the "commanding heights of warfare". The overlap of the two domain areas — the use of cyber capabilities in space offers another opportunity to China to degrade, disable and destroy space based assets and infrastructure of its adversary without attribution that accompanies an ASAT missile strike and in most cases other types of counter space/ASAT attacks. PLA's cyber units like SSF could launch cyber attacks on satellite ground control stations as also infiltrate space information systems to steal, tamper with and delete computer codes to deceive or obstruct the adversary's operations. Some known incidents are:-

- Suspected cyber attacks originating from China[43] caused cyber interference for 12 or more minutes in the operation of American Landsat-7 in October 2007 and July 2008, but failed to control.
- In June and October 2008, hackers' attacked NASA's Terra Earth Observation satellite.[44] In all these attacks, the steps required to command the satellite were achieved but the hackers did not issue commands.
- In September 2014, the National Oceanographic and Atmospheric Administration's (NOAA) satellite information and weather service systems used by the US military and other government agencies was hacked. [45] The agency stopped the transmission of satellite images to the National Weather Service for two days while it responded to the intrusion.

Implications for India

India has made considerable progress in space technology, with the launch of its first indigenously built sounding rocket in 1967 from Thumba. This has contributed to rapid social and economic development. India has launched more than 100 satellites in the past four decades ranging from scientific and technological application, communication, meteorological, remote sensing with a primacy of civilian orientation, both in application and control. However, it is axiomatic that military application of the technology cannot be ignored, if India has to maintain itself as a credible military power in the coming century. Moreover, the increasing reliance on space assets make it incumbent to launch more satellites to meet the ever growing demand of civilian use as also military applications. While, it is necessary to have adequate space assets, it is also essential to develop counter space technologies/weapons as a deterrence against any threat to these space assets. The rapid advancement by China in counter space domain, albeit being the latest entrant in this field, erstwhile dominated by US and Russia makes it imperative for India to develop its own counter space capabilities. As the world discovers an increased use of space, a need to secure unrestricted access in space is a must and this imposes a requirement on India to protect its own space access and deny the same to an adversary when the need arises. Since, space is a strategic domain which is vital for military, economic/commercial and scientific programmes, India should be given an assured entry without any restrictions (aka NPT) whatsoever. While, India should continue to work for demilitarisation of space by active advocacy in various international foras, it should be conscious of the ineffectiveness of these treaties so far.

Conclusion

The Chinese vision of space warfare is not just about preventing use of space based critical infrastructure to its adversaries, but using space based combat platforms for interception of ballistic and cruise missiles, striking by space based systems on terrestrial targets as also targeting space assets i.e. platforms and command & control assets of its adversaries. The counter space program is an essential part of the space versus counter space competition (with the US) and poses a credible threat to space based architecture. While, China is developing these capabilities primarily to counter the US, the impact will also be felt in the Indo-Pacific (possible conflict over Taiwan, South China Sea, India and other neighbours). While China continues to claim that it is only pursuing peaceful uses in outer space, there is a growing concern among other countries about its recent advances in outer space because of the inherent risks. Official Chinese statements on space warfare and space weapon talks about "China always adheres to the principle of the use of outer space for peaceful purposes and opposes the weaponsiation of or an arms race in outer space". However, since 2015 other official writings indicate a more nuanced position and designation of outer space as a military domain for the first time. Also, in the same year, defence of China's interests in space was made legally binding in China's security laws. Moreover, in the last decade, China has demonstrated a functional capacity to hold at risk US satellites and reportedly used DEW and cyber capabilities against US assets in space. The breadth and depth of Chinese counter space capabilities could, in future, degrade the effectiveness of any space deterrence posture. Moreover, PLA could be expected to form a specialised brigade / unit weapons and operations under People's Liberation Army Rocket Force (PLARF) and SSF respectively.

End Notes

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[16] Ibid.

[17] N.5, p. 141.

[18] Brian Weedan,Anti-Satellite Tests in Space-The case of China", 18 May 2015. Available online at https://swfound.org/media/115643/china_asat_fact_sheet_may2015.pdf, Accessed on 01 May 2021.

[19] A KKV is small enough to be lightweight and agile and, therefore, carries a small aperture sensor. It demands an in-flight command update from the space surveillance network to navigate close to the target before switching to an on-board homing sensor. Secondly, the requirement of accurate and high-resolution tracking to engineer a rendezvous does not require elucidation. Thirdly, a LASER weapon will have a narrow beam and would have to be accurately aimed at the target. Thus, a high quality space surveillance and tracking network is mandatory for any of the ASAT missions.

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[24] Exo-atmospheric midcourse kinetic interceptors like China's DN-3 target an incoming ballistic target after its active flight phase has concluded and the missile is outside the earth's atmosphere, on its way toward descending at hypersonic speeds. This capability also makes the DN-3 a capable anti-satellite (ASAT) platform. The DN-3 is thought to be China's most capable midcourse hit-to-kill interceptor, but the country has other systems capable of exo-atmospheric ballistic and anti-satellite interception, including the DN-2, the HQ-19, and the ASAT-oriented SC-19.

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[42] N.40.

[43] N.30, p. 27.

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