Chapter 6

China's Missile Defense Capability

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I. Introduction

On February 4, 2021, the P.R.C. Ministry of National Defense announced the successful trial of ground-based midcourse anti-ballistic missile technology, which achieved expected goals. This accomplishment attracted international attention to China's development in anti-ballistic missile systems. The trial was China's fifth test of anti-ballistic missiles, with the preceding four tests in 2010, 2013, 2014, and 2018.[1] The U.S. Department of Defense supposed that the 2018 test was for the DN-3 interceptor while the 2021 test was for HQ-19 missile systems, both already in service and are considered anti-satellite (ASAT) weapons.[2]

II. China's Anti-Ballistic Missile Technology

1. Anti-ballistic Missile System

Midcourse anti-ballistic missile technology requires the interceptor missile to destroy ballistic missiles, usually in the atmosphere, before the latter fly midcourse

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1 "China Declared the Success of the Ground-based Midcourse Anti-ballistic Missile! Department of Defense: not Targeting Any Country," *Xinhua Net*, February 5, 2021, http://www.xinhuanet.com/mil/2021-02/05/c_1211012765.htm.

2 "China Testing the Ground-based Midcourse Anti-ballistic Missile U.S.: Anti-satellite Weapon," *Want Daily*, March 9, 2021, https://www.chinatimes.com/newspapers/20210309000712-260301?chdtv.

and when ballistic missiles reach the highest point in flight before arriving at the target zone. If struck down, the debris will not fall on the homeland. The longer early warning and response time means a larger defensible geographic area. However, the early warning system must be able to detect invading missiles as early as possible, which relies on long-range early warning radar, space early warning radar, or X-band radar, sufficient to identify missiles from decoys. The great height and speed for interception mean booster rockets of the high thrust are required for interceptor missiles—usually two-staged missiles—which are rather technologically challenging.

China began testing its anti-ballistic missile system as early as 2010. Some people say China used the interceptor missile based on the improved modeling of the DF-31 ballistic missile, which the U.S. thinks is the DN-1. However, the military media clarified that it was the HQ-19, with effects between Terminal High Altitude Area Defense (THAAD) and Standard Missile 3 Block II. On January 27, 2013, the P.R.C. Ministry of National Defense reannounced its successful testing of the ground-based midcourse anti-ballistic missile system. It is believed that China has demonstrated in its early warning satellite and early warning radar technology in this test, as its HQ-19 missile may have the capability to identify decoys. In 2014, China conducted another inception test, which the U.S. thinks may be a test on anti-satellites (ASAT).[3]

According to the U.S. website "Global Security", China's anti-ballistic system has multiple missiles, including HQ-9B, HQ-19, HQ-26, HQ-29, DN-1, and DN-2. The HQ-19's campaign capability is comparable to that of the U.S.'s THAAD. Nothing much is known about HQ-26 from the outside world. It is approximately equivalent to the U.S.'s Standard Missile 3 or PAC-3 Missile.[4] The HQ-29 is

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[3] "Beijing Released the News on the Ground-based Midcourse Anti-ballistic Missile What are the Differences of the Five Tests?," *HK 01,* February 10, 2021, https://www.hk01.com/%E5%9C%8B%E9%9A%9B%E5%88%86%E6%9E%90/584380/%E5%8C%97%E4%BA%AC%E6%B7%B1%E5%A4%9C%E7%99%BC%E5%B8%83%E9%99%B 8%E5%9F%BA%E4%B8%AD%E6%AE%B5%E5%8F%8D%E5%B0%8E-%E8%A7%A3%E6%9 4%BE%E8%BB%8D%E4%BA%94%E6%AC%A1%E8%A9%A6%E5%B0%84%E6%9C%89%E 4%BD%95%E4%B8%8D%E5%90%8C.

[4] "HQ-26 Anti-Ballistic Missile Interceptor," *Global Security.org*, https://www.globalsecurity.org/space/world/china/hq-26.htm.

considered equivalent to the PAC-3 Missile, DN-1, and DN-2 (i.e., the U.S.'s ground-based midcourse defense system). In 2018, China may have deployed the newly modeled DN-3 missiles, deemed the best-performing kinetic hit-to-hill midcourse interceptor missiles.[5]

2. China's Anti-Missile Defense Network

These different types of missiles consist of China's anti-missile defense network. The midcourse interception net as the first level comprises the D.N. Series missiles, responsible for missile interceptions outside the atmosphere. On the other hand, the second level is for the edges of the atmosphere, handled by the HQ-19 and HQ-26. The third level is the terminal interceptions within the atmosphere, performed by HQ-9B and HQ-29.[6] Table 6-1 summarizes China's types of anti-missiles and anti-satellites (ASATs) and the test timetables based on the publicly available information.

Table 6-1 China's Types of Anti-missiles and Anti-satellites (ASAT)

Model No.	Function	Height	Comparable U.S. system
Outside the atmosphere			
SC-19	ASAT		
DN-1	ASAT		Ground-based defense system
DN-2	ASAT		Ground-based defense system
DN-3	ASAT		
On the edges of the atmosphere			
HQ-19	Anti-missile		THAAD
HQ-26	Anti-missile		Standard Missile 3
Low levels			
HQ-9B	Anti-missile		THAAD
HQ-29	Anti-missile		PAC-3

[5] "Beijing Released the News on the Ground-based Midcourse Anti-ballistic Missile. What are the Differences of the Five Tests?," op. cit. 3.

[6] "Beijing Released the News on the Ground-based Midcourse Anti-ballistic Missile. What are the Differences of the Five Tests?," op. cit. 3.

Model No.	Function	Height	Comparable U.S. system
S300PMU2	Limited anti-missile capability		
S400	Limited anti-missile capability	Low altitude	

Source: Compiled by the author.

Table 6-2 China's Timetable of Anti-satellite and Anti-satellite (ASAT) Tests

	Date	Target	Type	Test
1	2005.07	None	SC-19	Rocket test
2	2006.02	Satellite	SC-19	Failed
3	2007.01	Satellite	SC-19	Successful interception
4	2010.01	Missile	SC-19	Successful interception
5	2013.01	Missile	SC-19	Successful interception
6	2013.05	None	DN-2	Experiment
7	2014.07	Missile	SC-19	Successful interception
8	2015.11	None	DN-3	Flight test
9	2018.02	Missile	DN-3	Successful interception
10	2021.02	Missile		Successful interception

Source: Compiled by the author.

(1) *HQ-19*

The test in February 2021 was suspected to be for HQ-19 missiles, with the target missiles being DF-21 medium-range ballistic missiles. Russia's reports stated that the HQ-19 might be in the early deployment stage, which can intercept India's Agni-2, Agni-3, or the more powerful Agni-4 and Agni-5 missiles. This progress will significantly undermine India's nuclear threat. While the U.S. withdrew from the Intermediate-Range Nuclear Forces Treaty (I.N.F.), its deployment of medium-range missiles is unlikely to be too speedy. Hence, China's missile defense system will be able to effectively counter the U.S. missiles.[7]

[7] "Expert: China is Approaching the Goal of Building Own Anti-missile Systems," *Sputnik*, February 8, 2021, https://big5.sputniknews.cn/opinion/202102081033053161/.

HQ-19 missiles were developed by China Aerospace Science & Industry Corp. Academy No. 2 in the late 1990s. They are two-stage missiles with N-15B solid-propellant rockets, carbon fiber-made missile bodies, and kinetic hit-to-kill warheads. The full HQ-19 system includes solid phased array radar for early warning. Its X-band radar is said to have a detection range of 4,000 kilometers, covering the vast area from the South Asian Subcontinent to the Tibetan Plateau. The tests in 2013 and 2014 successfully completed the interception of a simulated missile at a height of over 200 kilometers and a relative speed of 10,000 meters per second. In 2016, it seemed that the HQ-19 was first seen on China Central Television (CCTV). On that occasion, the media coverage disclosed for the first time the images of its ground-based midcourse anti-ballistic missile system and warhead. The HQ-19 adopts kinetic hit-to-kill warheads, with the infrared homing system on the side, similar to the THAAD, to reduce the influence of atmospheric friction and high heat on sensors and enhance the precision of attacks. This mechanism also accommodates lighter warheads to increase firing height. In 1999, China successfully completed the test flight of kinetic hit-to-kill warheads and became the world's second country to own the kinetic hit-to-kill technology.[8]

(2) *SC-19*

China uses similar missiles for anti-missile and anti-satellite (ASAT) tasks. Some reports indicate that China's tests for the development of missile defense systems are actually for anti-satellite (ASAT) weapons. The SC-19 missile may have multiple identities; for one, it is suspected as the DN-1 missile. The U.S. media "Popular Mechanics" indicated that the SC-19 is an anti-satellite (ASAT) missile developed from the DF-21C ballistic missile with five completed tests. China is developing at least three anti-satellite (ASAT) missile systems, and the SC-19 is already deployable.[9] The SC-19 missile uses KT-1 solid-propellant rockets, developed based on DF-21 medium-range ballistic missiles. China has

[8] "HQ-19 Anti-Ballistic Missile Interceptor," *Global Security.org*, https://www.globalsecurity.org/space/world/china/hq-19.htm.

[9] "Anti-Satellite Weapons Are Becoming a Very Real Threat," *Popular Mechanics*, April 1, 2020, https://www.popularmechanics.com/military/weapons/a32008306/anti-satellite-weapons/.

conducted at least six anti-satellite (ASAT) experiments. In 2007, it successfully destroyed a space satellite. Meanwhile, it successfully hit ballistic missiles in 2010 and 2017.[10]

The name "Shuangcheng" (S.C.) is probably from the launch of the Shuangchengzi Space and Missile Center in Gansu Province. The SC-19 is powered by a two-stage solid rocket, gyroscope inertial navigation, and radar navigation. The warhead is equipped with kinetic hit-to-kill technology and high-explosive ammunition for accurate destruction. Further, the SC-19 can also intercept satellites or other space vehicles in low or medium earth orbits.

According to the U.S.'s detection data on the 2010 test, an SC-19 launched from the Korla Missile Test Complex in Western China successfully intercepted the CSS-X-11 missile (i.e., B611 short-range ballistic missile [SRBM] for export) launched from the Shuangchengzi Space and Missile Center about 1,100 kilometers to the east of Korla. In January 2007, China used the SC-19 as a direct-ascent anti-satellite (DA-ASAT) weapon to intercept an invalid FY-1C weather satellite.[11] In the past, nothing much was known about China's anti-missile experiments. In January 2013, the second ground-based midcourse missile interceptor successfully completed the interception trial. It was also China's second official announcement of this type of experiment. The following experiments were conducted in July 2014 and December 2018.[12]

However, the outside world remains skeptical about China's relevant experiments. The space debris caused by the SC-19's destruction of a satellite in its first test attracted complaints from the international society. Hence, subsequent tests targeted ballistic missiles. U.S. expert Richard Fisher pointed out that China is carrying out anti-satellite (ASAT) and anti-missile experiments simultaneously, possibly with SC-19 serving as both an anti-satellite (ASAT) and an anti-missile.

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[10] "Foreign Media: SC-19 Succeeds in Six Consecutive Strike-Back Experiments. Hurray for Our Country," *kknew.cc*, January 24, 2017, https://kknews.cc/zh-tw/military/omlx3ko.html.

[11] "SC-19 Anti-Ballistic Missile Interceptor," *Global Security.org*, https://www.globalsecurity.org/space/world/china/sc-19-abm.htm.

[12] Hsi-fu Ou, "Comparison of China's and US's Missile Defense Systems," *National Defense and Security Bi-weekly*, Vol. 24, March 19, 2021, https://indsr.org.tw/Content/Upload/files/biweekly/24/6_SiFuOu.pdf.

If China possesses the anti-satellite (ASAT) capability, it will severely affect the U.S.'s freedom in space utilization and capability in military deployment. Further, the missile type used in the subsequent tests remains a question. U.S. experts think the third test was perhaps on a new missile—HQ-26 with a new solid rocket.

(3) *DN-3*

The U.S. think tank, "United States-China Economic and Security Review Commission", pointed out that China's SC-19 and DN-2 are both anti-satellite (ASAT) weapons. The tests in 2010, 2013, and 2014 were all on anti-satellite (ASAT) weapons in the guise of missile defense. The DN-1 was developed based on the C-19 and DN-2, while the ND-3 was developed from the DN-1. China's newest carrier rockets are the KZ-1 and KZ-11, and the DN-3's rocket was probably developed from the KZ-11. U.S. expert Richard Fisher mentioned that the U.S. currently does not have an anti-satellite (ASAT) system that can reach the same height as the DN-2 and DN-3.[13]

The first test on the DN-2 was carried out in April 2013—also China's third test on anti-satellite (ASAT). In October 2015, many people observed unusual flight trails in Korla City (Xinjiang), which looked like the final stage of a missile interception, airborne at the edge of the atmosphere. It was suspected to be the first test on the DN-3 missile, considered China's best performing hit-to-kill midcourse anti-ballistic missile system. In addition, the HQ-19 may have been deployed in service. As shown in the 2018 test, the DN-3 missiles may be gradually replacing the HQ-19 as the main force for midcourse interceptions.

(4) *HQ-26*

U.S. experts speculated that China is simultaneously developing a number of anti-satellite (ASAT) and anti-missile weapons. In addition to the aforesaid systems, the HQ-26 is a navy version of the missile defense system similar to the U.S.'s Standard Missile 3. It is aimed to be equipped on large surface vessels

[13] "US Media Says China Tests DN-3 Anti-Satellite (ASAT) Weapon, Ahead of the U.S.," *Global Times*, November 12, 2015, https://news.qq.com/a/20151112/038565.htm.

(possibly Type 055 destroyers) in the future.[14]

(5) *Low altitude: HQ-9B, S300, and S400*

The HQ-9B is a terminal missile defense system developed based on the HQ-9. China also purchases the S300 and S400 long-range anti-aircraft systems from Russia, with limited missile defense capabilities. It also constructs a massive missile defense network with these systems, including satellites, early warning radar, long-range and anti-aircraft missiles, possibly short-range anti-aircraft missiles, fighter aircraft, and anti-aircraft guns. A complex and multilevel air and space defense system is established by integrating all these anti-aircraft systems.

China's missile defense system primarily aims to protect the Bohai Sea Economic Zone centered on Beijing and later extends to other regions or key targets such as Shanghai or the Three Gorges Dam.[15] The HQ-9 is on a fully automated engagement, with target information from early warning radar. The search radar of the missile system searches for the target according to the directions shown by the early warning radar. The target is tracked as soon as it is captured. After the issuance of firing command, the fire-control radar provides relay homing to guide the missile seeker into the target range. When near the target, high-explosive fragment warheads are fired to destroy the target missile.[16]

III. Early Warning System (E.W.S.)

1. Early Warning Radar

In the past, China did not have early warning satellites dedicated to the missile defense system and could only rely on long-range early warning radar. After years of hard work, China has established a comprehensive anti-missile defense system

[14] "U.S. Media Says China's Anti-Missile Tests Are Perhaps for Multiple Anti-Missile Systems Based on HQ26," *Sina News*, January 28, 2013, http://mil.news.sina.com.cn/2013-01-28/1136714089.html.

[15] "Foreign Media Says China Creates a Defence Network by Imitating US's Anti-Missile System," *Sina News*, November 2009, http://mil.news.sina.com.cn/2009-11-04/0811572489.html.

[16] "Foreign Media Says China Creates a Defence Network by Imitating US's Anti-Missile System," *Sina News*, November 2009, http://mil.news.sina.com.cn/2009-11-04/0811572489.html.

by integrating satellites, early warning radar, and a midcourse and terminal anti-ballistic missile system. In the 2013 anti-missile test, China showcased its early warning satellites, early warning radar, and interceptor missiles for rapid response capabilities.[17]

In 1986, China started to deploy its first-generation over-the-horizon radar (O.T.H. radar). Currently, China has six early warning radar systems in operation. Among them, four extremely high-frequency O.T.H. radars face Taiwan, of which three systems are bistatic radars. These O.T.H. radar systems operate in different frequencies, with a detection distance of over 3,000 kilometers. China's O.T.H. radar usually detects long-range targets on the water surface to assist anti-ship ballistic missiles in identifying targets early and detecting targets in the air.[18] In 2017, China Central Television (CCTV) introduced a new large-scale phased array radar, known as "Chinese Pave Paws". Working in P-band, it is a meter wave radar that spots, tracks, and identifies targets in an extremely far distance. China's newly built P-band phased array radar adopts 12,000 T/R (transmitter/receiver) modules, the largest number in the world for phased array radar.

Meanwhile, China has built a number of large early warning radar systems, including X-band radar in Heilongjiang. It is based on single-sided fixed antennas, primarily to provide early warning in the direction for Alaska and feed accurate early warning information to the HQ-19 and DN-3 missiles. In addition, China has established large S-band phased array radars in Fujian and Xinjiang. The systems are on rotatable radar consoles for 360° detection capability, capable of detecting stealth planes.[19] The P-band radar was developed by China Electronics Technology Corp. (CETC) Academy No. 14 (Nanjing Academy). The unit electricity consumption is low for phased array radar operating in P-band. It can detect a long distance due to high wavelengths and low atmospheric attenuation, which provides

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[17] "Beijing Released the News on the Ground-based Midcourse Anti-ballistic Missile. What are the Differences of the Five Tests?," same as the previous note.

[18] "Eyes Gaze upon the Skies: China Builds Missile Early Warning Radar System 2," *MP News*, September 20, 2021, https://min.news/zh-tw/military/097c3143ad776c64f7cf4c10e3ae2cb9.html.

[19] "China's First high-profile Exposure of World-class Anti-missile Early Warning Radar, Previously Known to Anybody," *kknew.cc*, October 9, 2017, https://kknews.cc/military/rqaekrr.html.

great detection capabilities for stealth targets at the expense of some accuracy. Therefore, it is necessary to rely on more accurate X-band radar to detect decoys.[20]

China and Russia also work together for early warning. In 2019, Russian President Vladimir Putin indicated the assistance to China's development of missile early warning systems to improve China's early warning capabilities. This development assistance included Russia's Tundra early warning satellites and China's own early warning system based on Voronezh-DM long-range high-frequency early warning radar stations. Early warning radar provides the trail, speed, estimated flight time of the invading missile, and other data necessary for an interception. The Voronezh-DM radar detects a distance of up to 4,000-6,000 kilometers. If deployed in the Russian Far East, it will not have adequate detention depth. However, when deployed in China's coastal area, the radar spots targets early for both China and Russia.[21]

2. Early Warning Satellite

China began the development of early warning satellites as early as 2013. It started the launch of communications technology experiment satellites in 2017, also known as "FireEye", likely to serve as ballistic missile early warning and similar to the U.S.'s Infrared Astronomical Satellites. FireEye-2 was launched in January 2017, while FireEye-3 in December 2018. In 2020-2021, China launched FireEye-5, FireEye-6, and FireEye-7. While these satellites were claimed to be for the testing of communications technologies, it is believed that they are related to the detection of ballistic missile attacks. FireEye-2 is equipped with synchronous-orbit highly-sensitive infrared detection technology. If positioned above the Western Pacific, its detection covers the vast area from the Midway Atoll to East Africa and from the Arctic Ocean to the South Pole. Both the U.S.'s submarine-

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[20] "China's P-band Phrased Array Early Warning Radar can Spot Ballistic Missiles Thousands of Kilometers Away," *Sina Military Section*, February 8, 2021, https://mil.news.sina.com.cn/zhengming/2021-02-08/doc-ikftssap4752743.shtml.

[21] "China and Russia Cooperate in Early Warning, to Eliminate the Threat of U.S. First Nuclear Strikes," *BBC Chinese*, November 24, 2020, https://www.bbc.com/zhongwen/trad/world-55065435.

launched ballistic missiles and India's ballistic missiles are detection targets.[22]

IV. Conclusion

While China has constantly criticized the U.S.'s missile defense systems development, it has also been developing its own ballistic missile defense systems, anti-satellite (ASAT) capability, and midcourse anti-ballistic missile capability. Its anti-satellite (ASAT) capability has perhaps surpassed that of the U.S. In this competition of strong powers, China does not only want to reinforce the traditional military force but also to strengthen nuclear deterrence. Compared to the U.S.'s and Russia's nuclear triads, China still needs to enhance its deterrence force. Although "China's National Defense in the New Era" does not mention the tactical role of the PLA Air Force, the strategic requirement for the Rocket Force is to be prepared in carrying out "comprehensive deterrence and warfighting" operations with "both nuclear and conventional" capabilities, enhancing "credible and reliable nuclear deterrence and counterstrike capabilities" and "medium- and long-range precision strike capabilities", and contributing to "strategic balance" between China and its main strategic competitors". Meanwhile, the PLA Navy should "accelerate the transformation from near seas defense to far seas protection and strengthen tactical deterrence and counterstrike capabilities".[23] These suggest that the PLA Navy and Rocket Force are still the mainstays of China's nuclear deterrence. Compared to the U.S. and Russia, its strategic strike capability is still an underdog. Hence, China continues to enhance its strategic military power by developing new ballistic missiles and new missile launch facilities and constructing the missile defense

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[22] "China Successfully Launches FireEye-4, Possibly Related to Orbital Missile Early Warning," *HK 01*, October 18, 2019, https://www.hk01.com/%E5%8D%B3%E6%99%82%E4%B8%AD%E5%9C%8B/3 87504/%E4%B8%AD%E5%9C%8B%E6%88%90%E5%8A%9F%E7%99%BC%E5%B0%84%E9%80%9A%E4%BF%A1%E6%8A%80%E8%A1%93%E8%A9%A6%E9%A9%97%E8%A1%9B%E6%98%9F%E5%9B%9B%E8%99%9F-%E7%96%91%E8%88%87%E5%A4%A9%E5%9F%BA%E5%B0%8E%E5%BD%88%E9%A0%90%E8%AD%A6%E6%9C%89%E9%97%9C.

[23] "Expert: China Is Approaching the Goal of Building Own Anti-Missile Systems," *Sputnik*, February 8, 2021, https://big5.sputniknews.cn/opinion/202102081033053161/.

system to avoid the rapid destruction of its fragile nuclear strike system by the enemy in case of a war.

After completing the test in February 2021, China is close to accomplishing the goal for its own anti-missile system, which not only counters the U.S.'s deployment of medium-range weapons in Asia but also offsets India's threat of nuclear strikes. As the U.S.'s current development of medium-range missiles is not going too fast and there are many challenges in its Asian deployment, even the beginning of the hypersonic weapons is unlikely to intimidate China in the immediate future. Hence, China's anti-missile defense network should be able to effectively counter the U.S.'s military threats.