Chinese Anti-Ship Ballistic Missile (ASBM) Development: Drivers, Trajectories and Strategic Implications

By Andrew S. Erickson

The JAMESTOWN FOUNDATION

CHINESE ANTI-SHIP BALLISTIC MISSILE (ASBM) DEVELOPMENT: DRIVERS, TRAJECTORIES AND STRATEGIC IMPLICATIONS

By Andrew S. Erickson

May 2013

Jamestown's Mission

The Jamestown Foundation's mission is to inform and educate policymakers and the broader policy community about events and trends in those societies which are strategically or tactically important to the United States and which frequently restrict access to such information. Utilizing indigenous and primary sources, Jamestown's material is delivered without political bias, filter or agenda. It is often the only source of information which should be, but is not always, available through official or intelligence channels, especially in regard to Eurasia and terrorism.

Origins

Launched in 1984 by its founder William Geimer, The Jamestown Foundation has emerged as one of the leading providers of research and analysis on conflict and instability in Eurasia. The Jamestown Foundation has rapidly grown to become one of the leading sources of information on Eurasia, developing a global network of analytical expertise from the Baltic to the Horn of Africa. This core of intellectual talent includes former high-ranking government officials, journalists, research analysts, scholars and economists. Their insight contributes significantly to helping policymakers around the world understand the emerging trends and developments in many of the world's under-reported conflict zones in Eurasia.

THE JAMESTOWN FOUNDATION

Published in the United States by
The Jamestown Foundation
1111 16th St. N.W.
Suite 320
Washington, DC 20036
http://www.jamestown.org

The views expressed in this report are those of the contributing author and not necessarily those of The Jamestown Foundation. The report was edited by Peter Mattis, Editor of *China Brief* at The Jamestown Foundation.

For more information on this report or The Jamestown Foundation, email: pubs@jamestown.org.

"We are continentalists. Now guided missiles are well developed. Installed on shore, they can hit any target, and there is no need to build a big navy."

- Vice Premier Zhang Chunqiao addressing the Central Military Commission (1972)

"Whatever the enemy fears most, that is what we should develop."

- President Jiang Zemin as quoted by General Zhang Wannian (1999)

"When many carrier-borne aircraft are used in continuous air strikes against our coast, in order to halt the powerful air raids, the enemy's core carrier should be struck as with a 'heavy hammer'."

- *Science of Second Artillery Campaigns* (2004)

"Since the introduction of nuclear weapons, all the major nuclear powers have developed ballistic missile warning systems against possible nuclear attacks, and there has not been a single precedent of a major nuclear power attacking another with ballistic missiles."

- Huo Fei and Luo Shiwei, *Modern Ships* (2008)

"The queen of the American fleet, and the centerpiece of the most powerful Navy the world has ever seen, the aircraft carrier, is in danger of becoming like the battleships it was originally designed to support: big, expensive, vulnerable—and surprisingly irrelevant to the conflicts of the time."

- Captain Henry J. Hendrix, U.S. Navy (2013)

Table of Contents

List of Figures and Tables

List of Acronyms

A2/AD	Anti-Access, Area Denial
ASBM	Anti-Ship Ballistic Missile
ASW	Anti-Submarine Warfare
ASCM	Anti-ship Cruise Missile
AMS	Academy of Military Science
AWACS	Airborne Warning and Control System
BMD	Ballistic Missile Defense
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CASC	China Aerospace Science and Technology Corporation
CASIC	China Aerospace Science and Industry Corporation
CBERS	China-Brazil Earth Resources Satellite
CEP	Circular Error Probable
CMC	Central Military Commission
CNSA	China National Space Administration
CSG	Carrier Strike Group
CSIC	China Shipbuilding Industry Corporation
CSIS	Center for Strategic and International Studies
DMC	Disaster Monitoring Constellation
DOD	U.S. Department of Defense
DOT&E	Director, Operational Test and Evaluation (U.S.)

ELINT	Electronic Intelligence
EO	Electro-Optical
FOC	Full Operational Capability
GAD	General Armaments Department
GSD	General Staff Department
INF Treaty	Intermediate Nuclear Forces Treaty
ISR	Intelligence, Surveillance and Reconnaissance
IOC	Initial Operational Capability
KKV	Kinetic Kill Vehicle
MaRV	Maneuverable Re-entry Vehicle
MR	Military Region
MRBM	Medium-Range Ballistic Missile
NASIC	National Air and Space Intelligence Center
NOSS	Naval Ocean Surveillance System
NSB	National Security Bureau (Republic of China, Taiwan)
ONI	Office of Naval Intelligence (U.S.)
OTH	Over-the-Horizon
PLA	People's Liberation Army
PLAAF	People's Liberation Army Air Force
PLAN	People's Liberation Army Navy
PNT	Positioning, Navigation and Timing
RORSAT	Radar Ocean Reconnaissance Satellite

RV	Reentry Vehicle
SAR	Synthetic-Aperture Radar
SOC	*Science of Campaigns*
SRBM	Short-Range Ballistic Missile
SSAC	*Science of Second Artillery Campaigns*
SSBN	Ballistic Missile Submarine, Nuclear-Powered
SSGN	Guided Missile Submarine, Nuclear-Powered
SSN	Attack Submarine, Nuclear-Powered
TBM	Theater Ballistic Missile
TEL	Transporter-Erector-Launcher
UAV	Unmanned Arial Vehicle
UUV	Unmanned Underwater Vehicle

I. EXECUTIVE SUMMARY

China's DF-21D anti-ship ballistic missile (ASBM) is no longer an aspiration. Beijing has successfully developed, tested and deployed the world's first weapons system capable of targeting a moving aircraft carrier strike group (CSG) from long-range, land-based mobile launchers. The Second Artillery, China's strategic missile force, already has a capability to attempt to use the DF-21D against U.S. CSGs in the event of conflict, and therefore likely expects to achieve a growing degree of deterrence with it.

None of this should be surprising. Numerous ASBM data points have been emerging from Chinese sources as well as U.S. official statements and reports for years now, available to anyone willing to connect them. They offer a useful case study not only to those involved with Sino-U.S. strategic relations, but also to anyone conducting analysis under conditions of incomplete information.

The real surprise is how much "ASBM denial" there has been outside active governmental circles. Some individuals, including a few respected professionals with the highest levels of Cold War experience, assumed that any Chinese ASBM would have many of the shortcomings of failed Soviet *Industrial*-age design but would nevertheless be susceptible to U.S. *Information*-age ballistic missile defense systems. Other skeptics stated that a conventional ASBM was technologically unfeasible; still more said that there was no evidence that China could achieve such a capability. Physics, however, allows for an ASBM; physics is the same for the Chinese as it is for everyone else. China has many physics experts and engineers who have served their country. We are witnessing the results today as well as the ability of China's once-moribund defense industry to integrate existing technologies in innovative ways.

It may seem a cliché to cite Sun Zi's maxim that "in war, the way is to avoid what is strong and to strike at what is weak." This universally-accepted approach, however, does seem to correspond to China's military planning, particularly such developments as its ASBM program—one of several weapons designed to exploit relative Chinese military strengths against relative U.S. military weaknesses. An ASBM system of systems, if developed and deployed successfully, would be the world's first weapons system capable of targeting a moving CSG from long-range, land-based mobile launchers.

This could pose a new type of threat to the U.S. Navy. For the past several decades, the U.S. Navy has used aircraft carriers to project power around the world, including in and around the Taiwan Strait. Since the 1920s, the U.S. Navy has built its carrier forces around the idea that the air group represents the first and best line of defense for the carrier. The ASBM potentially bypasses the air group and removes it from the defensive equation. Only one other major system has ever offered the possibility of doing this: the submarine. While China is developing a potent fleet, it cannot today effectively conduct advanced anti-submarine warfare (ASW), while the U.S. can—using carrier-based aircraft. Defense against missiles, by contrast, potentially is an extremely difficult problem for any military.[1]

China is developing increasingly formidable naval platforms, aircraft and missiles that could hold U.S. Navy platforms and their supporting assets at risk in the Western Pacific. Central to maximizing Chinese ability to employ these systems—and hence to consolidating China's emerging aerospace combat capabilities over the Near Seas (the Yellow, East China and South China Seas)—are its emerging command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) capabilities. These systems will enable the Chinese military to strengthen cueing, reconnaissance, communications and data relay for maritime monitoring and targeting as well as for the coordination of Chinese platforms, systems and personnel engaged in these roles. Particularly important will be effective use of ISR, the collection and processing of information concerning potential military targets and the transmission of that information to both those who would make relevant decisions and those who would actually launch the ASBM.

The successful achievement of high-quality, real-time satellite imagery and target-locating data and fusion as well as reliable indigenous satellite navigation and positioning would facilitate holding enemy vessels at risk via devastating multi-axis strikes. As Chinese planners conceive of them, these strikes would involve precision-guided ballistic and cruise missiles launched from a variety of land-, sea-, undersea- and air-based platforms in coordinated sequence. Emerging space-based C4ISR capabilities, therefore, could increase greatly China's capacity to use military means to assert its interests along the

[1] For further analysis of the offense-defense aspects of carrier warfare, see Michael C. Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics* (Princeton, NJ: Princeton University Press, 2010), pp. 65-97.

contested Near Seas. Beijing has a clear strategic rationale for mastering the relevant components, particularly for what it calls "active defense" and "counter-intervention" operations, and the U.S. terms "anti-access/area denial" (A2/AD) operations, in and around the Near Seas. Doing so could finally enable the PLA to translate its traditional approach of "achieving military superiority in a specific time and area even in a context of overall inferiority" into the maritime dimension.

The bottom line is that the era of "ASBM denial" is over. China's ASBM is not science fiction. It is not a "smoke and mirrors" bluff. The DF-21D is not an aspirational capability that the United States can afford to ignore until some point in the future.

II. KEY JUDGMENTS

- **The DF-21D anti-ship ballistic missile (ASBM) has reached the equivalent of Initial Operational Capability.**

  The era of ASBM denial is over: China's DF-21D exists and has been deployed in small numbers. Additional challenges and tests remain before the DF-21D reaches its full potential; however, senior U.S. and Taiwan officials in the last two years have confirmed separately that the ASBM is in the field. Additionally, the basic support infrastructure is already sufficient to provide basic targeting capabilities against U.S. aircraft carriers operating in the Western Pacific (if countermeasures are not considered).

- **Analysts will not be able to identify a sharp red line between Initial Operational Capability and the full operational potential of the DF-21D.**

  The ASBM's physical threat to U.S. Navy ships will be determined by the development of associated information processing systems and capabilities. This is part of a larger analytical challenge in which Chinese "hardware" continues to improve dramatically, but the caliber of the "software" supporting and connecting it remains uncertain and untested in war. The missile components of the DF-21D already are proven through multiple tests, but China's ability use the missile against a moving target operating in the open ocean remains unproven. The supporting command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) technologies probably still lag behind the requirement to identify and track a U.S. aircraft carrier in real time under wartime conditions. Improving C4ISR capabilities, however, is a high priority in China's military modernization program. U.S. countermeasures are another matter entirely: there is every reason to believe that they are already formidable.

- **Beijing is developing and deploying ASBMs as part of a far broader effort to assert influence over its still-contested Near Seas island and maritime claims.**

  The DF-21D targets specific physics-based limitations in U.S. and allied military platforms, adding to China's growing complement of submarines, other ballistic missiles, cruise missiles and electronic warfare tools to restrict an adversary's ability to operate on China's periphery. The missile stands out from the already-potent anti-access/area denial (A2/AD) effort—what the Chinese call "counter-intervention"—because it draws on over half a century of Chinese experience with ballistic missiles, may be fired from mobile, highly concealable platforms and has the range to strike targets hundreds of kilometers from China's shores.

- **The 1995–96 Taiwan Strait crises drove the development of the ASBM program; however, it is a program with deep historical roots.**

  Chinese ASBM development dates at least to the 1995–96 Taiwan Strait crises, which underscored Chinese feelings of helplessness against U.S. naval power. Broad-based Chinese ASBM development effort since then suggests China will continue to make progress with the missile and its supporting infrastructure. Chinese leaders and strategists have been thinking of using land-based missiles to hit threatening targets at sea for over three decades. Beginning in the late 1970s, Chinese experts studied the U.S. *Pershing II* theater ballistic missile fitted with maneuvering reentry vehicles (MaRV), and appear to have incorporated, or at least emulated, some of its key technologies. China's space program has furthered overall capabilities that are useful to its ASBM program, including the missile's supporting architecture.

- **The ASBM is an organic extension of, and an innovation involving, existing Chinese technologies.**

  The DF-21D is not a novel idea or technology, but rather what Tai Ming Cheung terms an "architectural innovation," involving

a novel assembly of existing systems to yield a new use with unprecedented maneuverability and accuracy. The U.S. and Russia could have developed an ASBM before China, but remain proscribed from doing so to this day by the Intermediate-Range Nuclear Forces (INF) Treaty they signed in 1987, at which time they lacked the need for such a weapon. Still, military capabilities are determined by effectiveness with respect to objectives, not technical sophistication for its own sake. China's ASBM "Frankenweapon" is an exemplar of the kind of innovation that is potentially unpredictable and disruptive, especially as China's defense industry becomes more capable of meeting the People's Liberation Army's (PLA) needs across a variety of technical fields.

- **Open source discussions have consistently provided important insights into the ASBM program throughout its life cycle, including its technical challenges, potential integration into war fighting and operational scenarios.**

  Despite the sensitivity of China's ASBM program—which has only recently been explicitly acknowledged by Chinese officials—and the resulting gaps in publicly-available information, open sources have provided clues to Chinese intentions throughout the lifespan of the ASBM program. As the PLA has modernized its technology and doctrine, these changes spurred an outpouring of professional, technical, and generalist publications to debate and critique how the PLA should fight and with what equipment. The ASBM was no different, except during a two-year period (2004–06) when related publication dipped dramatically in a classic "bathtub"-shaped pattern. Chinese engineers were probably testing specific aspects of the ASBM then, heightening its sensitivity.

- **As the ASBM becomes more effective operationally, the capability may reinforce China's land-centric approach to defense.**

  The idea of developing ASBMs clearly appeals to the interests of many institutions—including the Second Artillery—and its deployment may reinforce visible strands of PLA thinking,

including the following: reinforcement of continental approaches to maritime security ("using the land to control the sea"); consolidation of centralized approaches to command; further emphasis on multi-axis saturation attacks (e.g. combining ASBMs and anti-ship cruise missiles); and greater confidence in China's ability to threaten and discourage U.S. Navy operations and to control escalation without matching U.S. capabilities at sea. To further its Near Seas interests, China's focus on developing an "Anti-Navy" based on such A2/AD weapons as ASBMs is a far more efficient approach than pursuing a blue water navy. Here, China's institutional predilections serve it well, and permit it to challenge U.S. forces severely, even as it spends far less on its military than does the U.S.

- **The DF-21D probably requires additional testing before Chinese leaders can be confident of its effectiveness under wartime conditions.**

  China must have conducted a rigorous program of tests sufficient to demonstrate that the DF-21D ASBM is mature enough for initial production, deployment, and employment. This likely would have entailed a variety of flight tests, albeit not yet fully integrated over water—perhaps because of a desire to avoid embarrassing failures in view of worried citizens of East Asia and a U.S. military increasingly refocused on the region.

- **Bureaucratic and technical pitfalls related to data fusion, coordination and "jointness" may limit the DF-21D's utility.**

  Progress aside, however, Chinese ASBM development nevertheless faces manifold challenges that may limit the missile's tactical and strategic effectiveness. Data fusion, bureaucratic coordination and "jointness" remain key limitations. A variety of organizations across the PLA, including the three services and one branch, as well as the General Staff Department control, task and exploit the sensors used the generate the ASBM's targeting information. How this information is integrated, including how different sensors are used to compensate for shortfalls in real time, remains both a concern for the PLA and a gap in the literature.

- **The ASBM poses a direct threat to the foundations of U.S. power projection in the Asia-Pacific, potentially undermining U.S. influence there.**

  While U.S. airbases around China already are vulnerable to Chinese ballistic and cruise missiles, the ASBM targets the last relatively uncontested airfield without requiring China to develop the naval resources necessary to challenge the U.S. Navy directly at sea. For the first time since the 1920s, the United States faces a direct threat to the platform that has represented the core of its naval power projection: the aircraft carrier strike group. U.S. policymakers must face the possibility that Beijing might decide to use ASBMs in the event of conflict, and that the PLA might be able to strike and disable one or more aircraft carriers if countermeasures proved inadequate.

- **Beijing may be seeking to leverage the ASBM capability for strategic communication about deterrence and the reliability of U.S. assistance.**

  Beijing is most likely using the existence and deployment of the ASBM to shape foreign perceptions of conflict scenarios involving China. By developing such abilities to hold U.S. and allied military platforms at risk, Beijing hopes to deter them from intervening in areas of sensitivity to China in the first place, and to persuade Taiwan, Japan, the Philippines, Vietnam and other regional actors that U.S. assistance will be neither dependable nor forthcoming. The significant and growing amount of Chinese ASBM literature appears to be part of a larger pattern in which Beijing is becoming increasingly "translucent" (if still not fully transparent) regarding selected capabilities in order to enhance deterrence.

- **The United States will need measures to reassure allies and to deter China in order to control the political-military effects of a working ASBM.**

  Washington has two basic strategic options for managing the political-military consequences of a deployed weapon capable of threatening the foundations of U.S. power projection in East

Asia: one, offering calibrated transparency about countermeasures that reassures allies that U.S. aircraft carriers can operate successfully within the range of the DF-21D while retaining the value of the countermeasures; and, two, shifting combat power to undersea and advanced long-range aerial vehicles that present less of a target to Chinese missiles.

The U.S. already enjoys proven undersea preponderance. While nuclear-powered ballistic missile submarines (SSBNs) are not directly relevant to the regional balance of power given their deterrence mission, which is not geographically-specific, it would be a grave error to allow numbers or deployments of nuclear-powered attack submarines (SSNs) or the equivalent capabilities of nuclear-powered guided missile submarines (SSGNs) to erode. Doing so while pursuing Asia-Pacific rebalancing would create the worst of both worlds, in which China's leaders felt targeted by rebalancing, but were emboldened by its hollowness.

III. CURRENT STATUS OF THE DF-21D ASBM

What seemed increasingly likely over the past several years has been confirmed. Top U.S. Navy officials and Taiwan's most senior intelligence official state that China's ASBM has reached the equivalent of Initial Operational Capability (IOC) and is deployed with at least one Second Artillery brigade—not a test or training unit. Open source analysts can also make a strong case for an operational ASBM based on organizational changes in the Second Artillery that occurred in 2010 and 2011. How effective the Second Artillery would be at employing the ASBM and related systems under realistic conditions, including against U.S. and allied countermeasures, remains difficult if not impossible to determine at this time.

The latest U.S. Department of Defense (DOD) report to Congress on Chinese military developments offers the clearest, most comprehensive statement to date on the ASBM's status. Issued May 6, 2013, the report asserts that "China continues to field" the DF-21D with its 1,500+ kilometer-range and maneuverable warhead, which "it began deploying in 2010." The DF-21D "gives the PLA the capability to attack large ships, including aircraft carriers, in the western Pacific Ocean." More broadly, "The PLA Navy is also improving its over-the-horizon (OTH) targeting capability with sky wave and surface wave OTH radars, which can be used in conjunction with reconnaissance satellites to locate targets at great distances from China (thereby supporting long-range precision strikes, including employment of ASBMs)." In a hint that Beijing may build ASBMs of varying ranges (including longer ranges) tailored to varied mission parameters, the report states "Beijing is investing in military programs and weapons designed to improve extended-range power projection…Key systems that have been either deployed or in development include ballistic missiles (including anti-ship variants)…"[2] What becomes clear from DOD's annual report is that not only has China deployed the DF-21D ASBM, but that the DF-21D is one part of a broader program to track and target ships at sea.

---

[2] Office of the Secretary of Defense, *Annual Report to Congress: Military and Security Developments Involving the People's Republic of China 2013* (Washington, DC: U.S. Department of Defense, 2013), p. 29 <http://www.defense.gov/pubs/2013_China_Report_FINAL.pdf>. Hereafter, the report and its annual iterations will be referred to as *China Military Power Report [Year]*.

The following two sections present the information available from Chinese and Chinese-language sources as well as from other unclassified foreign government assessments of the DF-21D's status.

Chinese Sources on Current Status

Chinese sources on the operational status are few and usually do not address the ASBM's status explicitly. The first known public Chinese government statement concerning ASBM development came on April 28, 2010. Addressing the Western Pacific Naval Symposium, Senior Captain Duan Xiaoxian, PLA Navy (PLAN), implied that Chinese ASBMs were controlled by the Second Artillery. He characterized them as solely defensive in nature, intended expressly to deter any moves by Taiwan toward independence and any support by foreign forces in that regard:

> "Regarding the issue of the ASBM:…ground-based assets do not belong to the Chinese Navy, so I do not know all the specific details, but I can speak to the larger issue. These ground-based weapons are solely defensive in nature. Its defensive scope is very limited. It would only be used to deal with Taiwan independence forces and those who sought to support them…Therefore, these missiles…so long as Taiwan does not pursue independence and foreign forces do not support Taiwan in pursuing independence, these missiles will not threaten any foreign party. So…do not be nervous or worry about these missiles."[3]

Duan must have been authorized to deliver a statement on such a sensitive issue in such an important forum. It was likely intended as a strategic communication to enhance deterrence while perhaps, from a Chinese perspective, offering transparency concerning intentions. When matched against subsequent Taiwan and U.S. government reports that China began deploying ASBMs in 2010, the timing of Duan's statement makes sense.

On July 11, 2011 PLA Chief of General Staff General Chen Bingde became the second Chinese government official to confirm publicly that China is

[3] Senior Captain Duan Xiaoxian [PLAN], "Remarks at Maritime Security Challenges Conference 2010," Western Pacific Naval Symposium, Victoria, Canada, April 28, 2010.

developing the DF-21D ASBM.[4] The following is a translation of General Chen's statement:

> Question: "I'm with the Associated Press and I have a question for General Chen…There's been much speculation about the operational readiness of the Dong-Feng 21-D, the so-called 'carrier-killer' missile…Can you give us some up-to-date information about these programs…"
>
> General Chen: "Thank you for—(inaudible)—your questions to me. As for DF-21D, in our meeting, Admiral Mullen talked about it. As for this type of weapons system, it is still under research-and-development process. It is not equipped yet. Even though we—if—even though if, in the future, we are successful in research and development of this kind of weapons system, it will, and remain, be a system for defense. And I expect that Chinese scientists will make some contributions in this aspect. However, for all kinds of high-tech weapons systems, as far as the research and development is concerned, that is not an easy thing to do, because it requires a huge amount of resources, timings, technologies and so on…"[5]

General Chen addressed the topic of Chinese ASBM development by telling Chinese reporters that it was one of the issues that he had discussed with his closest U.S. counterpart, Admiral Michael Mullen, Chairman of the U.S. Joint Chiefs of Staff. Chen took pains to emphasize, however, that China's ASBM is "still in the research stage" (*hai chuyu yanjiu jieduan*), and "has not yet achieved operational capability" (*shangwei xingcheng zuozhan nengli*). Specifically, "the DF-21D is undergoing research, development, and testing, has not developed into an operational capability [or developing into capability is not an issue at present]." *Xinhua* paraphrased General Chen as explaining that he "hopes Chinese experts can contribute in this regard, but this sort of high-technology advanced weapon is very difficult to bring to maturity." It quoted him directly once again as stressing that doing so "requires funding inputs, advanced technology, and high-quality talented personnel; these are all fundamental

---

[4] "Chen Bingde: Dong Feng 21D daodan haizai yanjiu zhong [Chen Bingde: Dong Feng-21D Missile Still in Development]," *Xinhua*, July 11, 2011 <http://www.china-embassy.org/chn/zmgx/t838436.htm>.

[5] "Press Availability with General Chen Bingde," Transcript of Remarks by Admiral Michael Mullen, Chairman of the Joint Chiefs of Staff and General Chen Bingde, Beijing, China, July 11, 2011 <http://www.jcs.mil/speech.aspx?ID=1626>.

factors constraining its development." The English-language *China Daily* article rendered this as "It is a high-tech weapon and we face many difficulties in getting funding, advanced technologies and high-quality personnel, which are all underlying reasons why it is hard to develop this."[6]

Additionally, in *YouTube*[7] and other footage of the press briefing on July 11, 2011 with Admiral Mullen, in which General Chen takes questions from reporters, it appears that he also uses the phrase "numerous difficulties" (*kunnan zhongzhong*) to describe the course of the missile's development. This tone could be interpreted to reflect a high level of uncertainly and ambivalence about the missile's immediate prospects, directed at a Chinese audience through Chinese media. Viewed in this light, the three factors General Chen outlines (funding, technology and talent) may be viewed as serious constraints, even bottlenecks, in the challenging task of successfully maturing and integrating an ASBM system of systems.

It is unclear, however, why General Chen would choose a prominent venue to raise the issue of such a controversial and provocative a weapon as China's ASBM only to say something that might undermine deterrence credibility—the equivalent of having "the onus without the bonus." As *Aviation Week*'s Bradley Perrett correctly points out, "The appearance of his statement in the *China Daily* is itself meaningful. The English-language newspaper's special role is to act as a government mouthpiece directed at the outside world. Its reports on sensitive subjects often show signs of being carefully written to deliver a message for Beijing. The DF-21D is one such sensitive subject."[8] Definitional issues aside, the bottom line is that General Chen would likely not be mentioning China's ASBM in public if the PLA were not confident that it was maturing effectively and already had reached the necessary development level to begin to credibly shape regional strategic thinking in Beijing's favor.

In contrast to Chen Bingde's more cautious comments about the ASBM's readiness, an article in the English-language edition of the Chinese newspaper

---

[6] Hu Yinan, Li Xiaokun, and Cui Haipei, "Official Confirms China Building Aircraft Carrier," *China Daily*, July 12, 2011 <http://www.chinadaily.com.cn/cndy/2011-07/12/content_12880708.htm>.

[7] "Chen Bingde: Dong Feng 21D haizai yanjiu zhong [Chen Bingde: Dong Feng 21D Still in Development]," *YouTube*, July 11, 2011 <http://www.youtube.com/watch?v=7uNdu38ovyE&feature=player_embedded>.

[8] Bradley Perrett, "Imbalance of Power," *Aviation Week & Space Technology* 18, No. 25 (July 2011), pp. 24–25.

Global Times on February 18, 2011 probably contained the most direct and authoritative mention outside of official media. Although the paper is not an official newspaper, it is produced under the auspices of the People's Daily Group, publisher of the official daily newspaper of the Chinese Communist Party's Central Committee. That article, quoting "a military source close to [ballistic missile] development," stated "the Chinese-made [DF-21D] missile… is already deployed in the army." The article also reported on foreign media efforts to understand the implication of the new weapon: "Foreign media have also speculated that the [DF-21D] is a 'carrier killer' and would prove to be a game-changer in the Asian security environment, where U.S. Navy aircraft carrier battle groups have ruled the waves since the end of World War II, the AP reported."[9]

The earliest indication that the ASBM was approaching deployment came in a May 2010 news release attributed to China Aerospace Science and Industry Corporation (CASIC). Citing Wang Genbin, deputy director of CASIC's 4th Department, the release stated the DF-21D can hit "slow-moving targets" with a CEP (Circular Error Probable, meaning half of the missiles fired will strike within that distance) of dozens of meters.[10] Mark Stokes, a noted expert at the Project 2049 Institute on the Second Artillery and related issues, stated on June 4, 2010 that "odds are what you're seeing now in terms of testing is… flight tests of the [DF-21D] motor itself and the airframe…the final step would be most likely going against a target at sea in a realistic environment."[11]

In a penetrating blog post based on Chinese sources via the Project 2049 Institute, Stokes suggested that China may have established its first ASBM brigade in Qingyuan City, Guangdong Province, in 2010:

---

[9] Song Shengxia, Zhang Han and Huang Jingjing, "New Missile 'Ready by 2015': Global Times," *People's Daily Online*, February 18, 2011
<http://english.peopledaily.com.cn/90001/90776/90786/7292006.html>.

[10] Wang Genbin, Deputy Director of the 4th Department under CASIC, as quoted in "Zhongyang guoduan chushou: jizhong youshi liliang fazhan xinxing shashoujian [Central Decisive Shot: The Concentration of Superior Forces to Develop a New Type of Assassin's Mace]," *Mi'er Junqing* [Military Mill], May 20, 2010
<http://www.junshijia.com/Article/zonghe/junqing/201005/20100520131732.htm>.

[11] Mark Stokes, "Evolving Aerospace Trends in the Asia Pacific Region," Panel Discussion: Implications of Aerospace Trends in Asia for the United States and the Region, Project 2049 Institute, Washington, DC, June 4, 2010
<http://www.youtube.com/Project2049Institute#p/u/2/yeaubuqmaoc>.

"The Qingyuan brigade, known by its cover designator of the 96219 Unit, is administratively subordinate to the 53 Base, which operates in Southern China. The Qingyuan brigade was formed as a regimental-level test and training unit as early as 2006. The unit was originally collocated with a DF-21A brigade in the Chuxiong area, west of Kunming…The test and training unit appears to have converted to an operational brigade as early as 2009. At the same time, the unit began the move to its permanent home in Guangdong Province. Elements of the brigade have been noted in Yingde City and Qingxin County, both within Qingyuan City's jurisdiction. A Second Artillery engineering regiment responsible for construction of pre-surveyed launch sites has been present in Yingde as recently as late 2010. Reliable sources indicate that between 10 and 12 missile rounds are available to the brigade's subordinate battalions for training and familiarization. In 2009, Second Artillery headquarters team certified a training simulation system developed by the test and training unit.

"The Qingyuan brigade is commanded by Senior Colonel Zhang Weimin, and its political commissar is Colonel Chen Zhihao. Key engineers responsible for technical aspects of the new missile variant's introduction into the operational inventory include Zeng Weidong and Hu Xianfeng, who in 2007 was credited with discovering design shortcomings in a new missile system. The brigade's Equipment Department, directed by Lu Kangwen, also likely played a key role in integrating the new missile variant. The operational test and evaluation team included battalion commander Li Shaogang, a graduate of Northwest Polytechnical University and the Second Artillery's only battalion commander with a PhD. Dr. Li carried out extensive liaison work with relevant [research and development] institutes and the manufacturer. The ASBM brigade appears to have conducted one of its first major field exercises at an unspecified joint training center in early Spring 2011.

"The specific organization of the brigade is unclear at the present time. However, if structured like other MRBM units, a Second Artillery ASBM brigade could have six launch battalions, a technical battalion, a site management battalion, a communications battalion, a technical service battalion, and an electronic countermeasures (ECM) battalion. The technical battalion would prepare the missile for

> launch, including inspection and testing of assemblies and components, mating, targeting, loading, launch control, and other tasks. Missile preparation work may be carried out in a fixed central depot, possibly an underground facility maintained by the site management battalion. The site management battalion could oversee as many as six subordinate companies. Responsibilities could include underground facility management, including power and electricity, water, air conditioning, and ventilation. A service battalion likely would provide support functions such as security, camouflage, concealment, and deception, as well as weather reporting. The ECM battalion or group would help defend brigade assets, especially the brigade's central depot and launch positions, against air strikes…"[12]

Stokes deserves great credit for addressing these complex organizational issues in a manner that is unmatched in open source analysis of Chinese ASBM development. In fact, it was he and his colleague Tiffany Ma who first uncovered the possibility of a Guangdong connection in August 2010. Based on sophisticated organizational analysis, Stokes and Ma suggested that the Second Artillery might then have been in the process of constructing ASBM missile brigade facilities in the northern Guangdong Province municipality of Shaoguan. They wrote: "If an ASBM is successful in passing the necessary design reviews and a sufficient sensor network is in place, the Shaoguan brigade [Unit 96166] could become the first in the PLA to field" one. This location near Hunan Province is close to the Nanling Mountains and the tunnels through them complicate foreign satellite surveillance: "it would enable the Second Artillery to…enforce territorial claims in the South China Sea, or strike targets in a Taiwan-related contingency without having to overfly Japanese territory." They pointed out "the establishment of a permanent deployment location often coincides with the design finalization of a new missile."[13]

A final important sign in Chinese sources was that CASIC probably has been producing DF-21D rocket motors since 2009. According to a website of the Hohhot Municipal Government in Inner Mongolia, the CASIC 6th Academy

---

[12] Mark Stokes, "Expansion of China's Ballistic Missile Infrastructure Opposite Taiwan," *AsiaEye Blog*, April 18, 2011 <http://blog.project2049.net/2011/04/expansion-of-chinas-ballistic-missile.html>.

[13] Mark Stokes and Tiffany Ma, "Second Artillery Anti-Ship Ballistic Missile Brigade Facilities Under Construction in Guangdong?" *AsiaEye Blog*, August 3, 2010 <http://blog.project2049.net/2010/08/second-artillery-anti-ship-ballistic.html>.

completed construction of the 359 Factory, also known as "Honggang," in August of that year. The city's Environmental Protection Bureau inadvertently outed the 1780-square-meter facility as part of its regular inspection of recently-completed construction projects.[14] Although this source is not conclusive about the ASBM's operational status, the completion of a factory to produce rocket motors suggests the program had become fruitful enough to warrant dedicated factory production of its component parts and gives credibility to the aforementioned reports.

U.S. and Taiwan Assessments

In addition to the Chinese sources and analysis of their details, U.S. and Taiwan officials have provided a steady stream of information about the ASBM program over the last decade and, most recently, authoritative statements about the ASBM's status. The U.S. government has discussed China's ASBM program publicly since 2004, when the Office of Naval Intelligence (ONI) included the missile as a future challenge to maritime operations.[15] The Pentagon followed one year later in its annual report on Chinese military and security developments, assessing that the PLA "is exploring the use of ballistic missiles for anti-access/sea-denial missions."[16] Since that time, unclassified analyses of the DF-21D appeared repeatedly in DOD annual reports and assessments from ONI, the National Air and Space

---

[14] "Guanyu 2009 nian diwu pijian shexiangmu huanjing baohu sheshi jungongyanshou gongzhong canyu de gongshi [Public Listing of the 5th Batch of Projects Completed for 2009: Inspection and Approval of Construction Programs for Environmental Projection-Related Facilities]," *Neimenggu Huhehaote huanjing baohuju* [Hohhot City, Inner Mongolia, Government Environmental Protection Bureau], August 20, 2009, <http://www.hhhthb.gov.cn/news/bzgg/2009/820/098201621187AFJHAAIH07I2DBEKACC.html>. For the "Zone 5" location, see <http://www.hhhthb.gov.cn/news/bzgg/2009/85/098593925A6D18GAFACK66J1A4K1J.html>. Both sites accessed September 10, 2009. Mark Stokes, "China's Evolving Conventional Strategic Strike Capability: the Anti-Ship Ballistic Missile Challenge to U.S. Maritime Operations in the Western Pacific and Beyond," *Occasional Paper* (Arlington, VA: Project 2049 Institute, September 14, 2009) <http://project2049.net/documents/chinese_anti_ship_ballistic_missile_asbm.pdf>.

[15] "Challenges…Antiship Ballistic Missiles," *World Maritime Challenges* (Suitland, MD: Office of Naval Intelligence, 2004), p. 22.

[16] In the 2005 report, the introduction (p. 4) states "China is exploring the use of ballistic missiles for anti-access/sea-denial missions." The main content (p. 33) adds "China is also researching the possibility of using ballistic missiles and special operations forces to strike ships or their ashore support infrastructure." See, *China Military Power Report 2005* <http://www.defense.gov/news/Jul2005/d20050719china.pdf>.

Intelligence Center (NASIC) and the Congressional Research Service.[17] Senior officials—among them, Secretary of Defense Robert Gates, Director of National Intelligence Dennis Blair and Chief of Naval Operations Admiral Gary Roughead—also made a number of statements expressing concern about the ASBM and its implication for the U.S. position in the Western Pacific.[18]

The statements of U.S. officials and government reports became more specific over time as the ASBM program progressed and U.S. officials became alarmed with the pace of Chinese progress. From the initial tentative conclusions that the PLA was "exploring," "researching," or "apparently investing," the Pentagon's annual report on Chinese military developments in 2008 concluded "China's emergent anti-access/area denial capabilities [are] exemplified by its continued development of…anti-ship ballistic missiles designed to strike ships at sea, including aircraft carriers."[19] That year also included the first "ASBM" entry in the report's glossary. The 2009 report showed elevated concern as information coming to DOD probably suggested the ASBM program was developing faster than anticipated:

> "One area of investment involves combining conventionally-armed [ASBMs] based on the CSS-5 (DF-21) airframe, C4ISR for geo-location and tracking of targets, and onboard guidance systems for terminal homing to strike surface ships. As described in an authoritative 2004 article for the Second Artillery Force, the ASBM could employ 'terminal-sensitive penetrating sub-munitions' to 'destroy the enemy's carrier-borne planes, the control tower and

[17] *Ballistic and Cruise Missile Threat* (Dayton, OH: National Air and Space Intelligence Center, April 2009), NASIC-1031-0985-09 <http://www.fas.org/programs/ssp/nukes/NASIC2009.pdf>; *The People's Liberation Army Navy: A Modern Navy with Chinese Characteristics* (Suitland, Md.: Office of Naval Intelligence, July 2009) <http://www.fas.org/irp/agency/oni/pla-navy.pdf>; Ronald O'Rourke, *China Naval Modernization: Implications for U.S. Navy Capabilities—Background and Issues for Congress* RL33153 (Washington, DC: Library of Congress, Congressional Research Service, March 21, 2013) with relevant information on pp. 9–11.

[18] Robert M. Gates, "A Balanced Strategy: Reprogramming the Pentagon for a New Age," *Foreign Affairs* 88, No. 1 (January/February 2009); Admiral Dennis C. Blair (U.S. Navy, Ret.), Director of National Intelligence, "Annual Threat Assessment of the U.S. Intelligence Community for the Senate Select Committee on Intelligence," Office of the Director of National Intelligence, February 2, 2010 <http://www.dni.gov/testimonies/20100202_testimony.pdf>; "Hearing to Receive Testimony on the Department of the Navy in Review of the Defense Authorization Request for Fiscal Year 2010 and the Future Years Defense Program," U.S. Senate Armed Services Committee, Washington, DC, June 4, 2009 <http://armed-services.senate.gov/Transcripts/2009/06%20June/09-40%20-%206-4-09.pdf>.

[19] China Military Power Report 2008, p. i.

> other easily damaged and vital positions.' This capability would have particular significance, as it would provide China with preemptive and coercive options in a regional crisis."[20]

In November 2009, ONI's Senior Intelligence Officer for China, Scott Bray, added to this concern, stating the "ASBM development has progressed at a remarkable rate…In a little over a decade, China has taken the ASBM program from the conceptual phase to nearing an operational capability…China has elements of an OTH [over-the-horizon] network already in place and is working to expand its horizon, timeliness and accuracy."[21] By this time, U.S. analysts already were aware how the PLA was building an ASBM. Unclassified assessments between 2006 and 2009 noted China was using a variant of the DF-21/CSS-5 medium-range solid propellant ballistic missile and equipping it with maneuvering reentry vehicles (MaRVs)[22] with radar or infrared seekers to adjust the trajectory as the missile approached the target.[23]

The most thorough public comments by a U.S. official to date indicate that the ASBM is operational and at least has the minimum support infrastructure to fire at large ships operating in the Western Pacific. In response to media queries on January 3, 2011, Deputy Chief of Naval Operations for Information Dominance Vice Admiral David Dorsett worked to clarify U.S. views of the ASBM's current operational status. He explained that, even though the effectiveness of the DF-21D itself was still uncertain, the PLA also

---

[20] China Military Power Report 2009, p. 21.

[21] Andrew Erickson and Gabe Collins, "China Deploys World's First Long-Range, Land-Based 'Carrier Killer': DF-21D Anti-Ship Ballistic Missile (ASBM) Reaches 'Initial Operational Capability' (IOC)," *China SignPost*, No. 14 (December 26, 2010) <http://www.chinasignpost.com/2010/12/china-deploys-world%E2%80%99s-first-long-range-land-based-%E2%80%98carrier-killer%E2%80%99-df-21d-anti-ship-ballistic-missile-asbm-reaches-%E2%80%9Cinitial-operational-capability%E2%80%9D-ioc>.

[22] Multiple independently targeted reentry vehicles (MIRVs) can be placed in different trajectories by a bus platform that changes position slightly as it launches them in succession. Even more sophisticated, MaRVs are capable of independently altering their trajectory even in terminal phase. See, He Yingbo and Qiu Yong, "THAAD-Like High Altitude Theater Missile Defense: Strategic Defense Capability and Certain Countermeasures Analysis," *Science and Global Security* 11 (2003), p. 179.

[23] "Seapower Questions on the Chinese Submarine Force," Office of Naval Intelligence, December 20 , 2006 <http://www.fas.org/nuke/guide/china/ONI2006.pdf>; *Ballistic and Cruise Missile Threat*, NASIC-1031-0985-09, p. 17. For a Chinese summary, see "Meiguo cheng Zhongguo meiyou Dong Fang 25 daodan fanjianxing DF21 shangwei bushu" [U.S. Declares that There is No DF-25 Missile, and that the Anti-Ship DF-21 is Not Yet Deployed], Dongfang Wang [Oriental Net], June 11, 2009, <http://military.people.com.cn/GB/42967/9455628.html>.

"likely has the space-based intelligence, surveillance and reconnaissance (ISR), command and control structure, and ground processing capabilities necessary to support DF-21D employment...[and also] employs an array of non-space based sensors and surveillance assets capable of providing the targeting information." [24] In a separate interview two days later, Vice Admiral Dorsett added to his remarks, stating "The Chinese have tested the DF-21D missile system over land a sufficient number of times that the missile system itself is truly competent and capable. The entire weapon capability, they have ISR, they have sensors on board ship that can feed into the targeting aspect of it. So could they start to employ that and field it operationally? Yes, I think so."[25] The larger questions about any extant capability, however, relate to the effectiveness of the personnel using the system and their ability to fuse targeting information from China's diverse sensors. The Second Artillery's ability to overcome this challenge, at least according to Vice Admiral Dorsett, remained unclear.

Vice Admiral Dorsett's interview appeared to be an attempt to clear up some of the ambiguities about the ASBM's status in a December 2010 interview with the Commander of U.S. Pacific Command Admiral Robert F. Willard. The interview offered significant new revelations: "The anti-ship ballistic missile system in China has undergone extensive testing. An analogy using a Western term would be 'Initial Operational Capability (IOC),' whereby it has—I think China would perceive that it has—an operational capability now, but they continue to develop it. It will continue to undergo testing, I would imagine, for several more years."[26]

What exactly does "IOC" mean? According to one authoritative U.S. open source, the *DOD Dictionary of Military and Associated Terms*, IOC is "The first

---

[24] "Deputy Chief of Naval Operations for Information Dominance (N2/N6): China Has Space-Based & Non-Space-Based C2 + ISR 'capable of providing the targeting information necessary to employ the DF-21D' Anti-Ship Ballistic Missile (ASBM)," *China Analysis from Original Sources*, January 4, 2011 <http://www.andrewerickson.com/2011/01/deputy-chief-of-naval-operations-for-information-dominance-n2n6-china-has-space-based-non-space-based-c2-isr-%E2%80%9Ccapable-of-providing-the-targeting-information-necessary-to-employ-the-df>; Tony Capaccio, "China Has 'Workable' Anti-Ship Missile Design, Pentagon Says," *Bloomberg*, August 25, 2011.

[25] "Transcript of Q&A; Vice Admiral David J. Dorsett Deputy CNO for Information Dominance," Defense Writers Group – Center for Media and Security, Washington, DC, January 5, 2011 <http://www.airforce-magazine.com/DWG/Documents/2011/January%202011/010511dorsett.pdf>.

[26] Yoichi Kato, "U.S. Commander Says China Aims to be a 'Global Military' Power," *Asahi Shimbun*, December 28, 2010 <http://www.asahi.com/english/TKY201012270241.html>.

attainment of the capability to employ effectively a weapon, item of equipment, or system of approved specific characteristics that is manned or operated by an adequately trained, equipped, and supported military unit or force."[27] The U.S. Defense Acquisition University website, the authoritative source perhaps most relevant in this case due to its specialized nature, states that IOC is "attained when some units and/or organizations in the force structure scheduled to receive a system (1) have received it and (2) have the ability to employ and maintain it."[28] Essentially, the ASBM is available and can be used, but it is not fully operational or necessarily fully tested.

China has different concepts and terms for various benchmarks and stages in its weapons research, development, and acquisition (RDA) cycle; this complicates comparisons with U.S. terms and encourages a more sophisticated look at the context of a weapon and its supporting infrastructure. It seems likely that the U.S. and Chinese militaries have different definitions of what it means for a weapon to be operational, with the PLA's definition in this case being more stringent, at least in certain respects. This probably explains Admiral Willard's careful choice of wording in this regard, which is not necessarily so different from General Chen's. Perhaps also whereas Admiral Willard was speaking of the U.S. concept of IOC, General Chen is alluding to a Chinese benchmark closer to the U.S. concept of Full Operational Capability (FOC)—a much higher standard to meet, and one that no U.S. official has claimed publicly that China's ASBM has achieved. In any case, this apparent discrepancy highlights the pitfalls of using U.S.-specific terms to describe foreign systems and capabilities. As in so many other areas, authorities on the respective sides of the Pacific may be talking past each other when in fact they are saying broadly similar things. It would be a mistake to let semantic issues obscure real Chinese progress with real strategic implications.

There may be other factors at play as well. General Chen may be downplaying Chinese capabilities to attempt to minimize foreign development of countermeasures to them. At the same time, the PLA may feel the need to meet a higher standard of testing before it can be confident of a novel weapon's effectiveness, because it lacks the U.S. military's years of experience in high-intensity combat, sophisticated testing, and simulation. It would be a

---

[27] "Initial Operational Capability," *Department of Defense Dictionary*, Defense Technical Information Center <http://www.dtic.mil/doctrine/dod_dictionary/data/i/4810.html>.

[28] "Initial Operational Capability (IOC)," *ACQuipedia*, April 19, 2005 <https://acc.dau.mil/CommunityBrowser.aspx?id=28937>.

mistake, however, to assume that China's DF-21D ASBM lacks what the U.S. military would consider to be lower-end "operational" capabilities just because it apparently does not yet meet General Chen's definition.[29]

In December 2011, further evidence of the seriousness of China's ASBM development emerged. In his annual report for FY2011, the U.S. Department of Defense's Director, Operational Test and Evaluation (DOT&E) stated, "A threat representative Anti-Ship Ballistic Missile (ASBM) target for operational open-air testing has become an immediate test resource need. China is fielding the DF-21D ASBM, which threatens U.S. and allied surface warships in the Western Pacific. Numerous Navy acquisition programs will require an ASBM surrogate in the coming years…."[30] The DOT&E Director Michael Gilmore added that "'Numerous programs will require' a test missile to stand in for the Chinese DF-21D, 'including self-defense systems used on our carriers and larger amphibious ships to counter anti-ship ballistic missiles.'"[31]

Taiwan's National Security Bureau (NSB) and military also played an important role in publicizing the operational status of the ASBM. The 2011 Republic of China National Defense Report has confirmed that "a small quantity of" DF-21D ASBMs "were produced and deployed in 2010," thereby (in the report's view) "increasing the difficulty of military maneuvers in the region for the U.S. Army." Specifically, the report noted the following:

> "Under the guidance to 'balance nuclear and conventional,' the PLA has continued the development of independently targetable intercontinental range ballistic missiles, strengthened strategic nuclear intimidation, nuclear counter strike and conventional precision strike

[29] Here a U.S. example may be relevant. The U.S. Air Force did not receive its first E-8 Joint STARS (Joint Surveillance Target Attack Radar System), an airborne battle management, command and control, intelligence, surveillance and reconnaissance platform, until June 1996—meaning that the aircraft officially did not achieve IOC until then. Two developmental aircraft, however, were employed operationally as early as 1991 in Operation Desert Storm even though the E-8 Joint STARS was still in test and evaluation at the time. "E-8 Joint STARS," U.S. Air Force <http://www.af.mil/information/heritage/spotlight.asp?id=123153608>.

[30] *Director of Operational Test and Evaluation: FY 2011 Annual Report*, U.S. Department of Defense, December 2011, p. 294 <http://www.dote.osd.mil/pub/reports/FY2011>.

[31] Tony Capaccio, "Navy Lacks Targets to Test U.S. Defenses against China Missile," *Bloomberg Businessweek*, February 29, 2012 <http://www.businessweek.com/news/2012-02-29/navy-lacks-targets-to-test-u-s-defenses-against-china-missile.html>; Christopher J. Castelli, "DOD IG Questions Realism of Targets Used to Simulate Enemy Missiles," *Inside Missile Defense*, March 21, 2012.

> capabilities, and deployed anti-ship middle range ballistic missiles (DF-21D guided missile), which is a weapon developed to strike aircraft carriers; a small quantity of the missiles were produced and deployed in 2010, increasing the difficulty of military maneuvers in the region for the U.S. Army."[32]

During an appearance before the Legislative Yuan's Foreign Affairs and National Defense Committee on March 16, 2011, NSB Director-General Tsai De-sheng restated a previous claim from August 2010 that the PLA already had tested and was deploying the DF-21D. *Defense News'* Wendell Minnick and Taiwan journalists afterward quoted Taiwan military sources giving estimates that between 12 and 20 DF-21Ds had been deployed by March 2011.[33] Most recently, Taiwan's Legislative Yuan has reportedly issued a report that mentions the ASBM, but its contents have not been reported publicly.[34]

Prior to the release of this year's aforementioned annual DOD report on China's military, two senior U.S. military officers—Samuel Locklear, Commander of U.S. Pacific Command, and Michael Flynn, director of the Defense Intelligence Agency—testified before Congress on the status of the ASBM, amplifying preceding statements about the danger of the ASBM. On April 9, 2013, Admiral Locklear characterized China's "initial deployment of a new anti-ship ballistic missile that we believe is designed to target U.S. aircraft carriers" as a "notable [example] of China's improving military capabilities."[35] On April 19, 2013, Lieutenant General Flynn described the DF-21D as one of a "growing number of conventionally armed, medium-range ballistic missiles...deployed opposite Taiwan."[36] That both officers included the ASBM

---

[32] National Defense Report Editing Committee, *2011 ROC National Defense Report*, Ministry of National Defense, (August 2011), p. 71 <http://2011mndreport.mnd.gov.tw/en/minister.html>.

[33] Wendell Minnick, "China Ramps Up Missile Threat With DF-16," *Defense News*, March 21, 2011; Russell Hsiao, "Taiwan's Intelligence Chief Warns about the PLA's Growing Strategic Weapon Systems," *Jamestown Foundation China Brief* 11, No. 5 (March 25, 2011) <http://www.jamestown.org/single/?no_cache=1&tx_ttnews%5Btt_news%5D=37695>.

[34] Rich Chang and J. Michael Cole, "China Aiming 200 More Missiles at Taiwan: MND," *Taipei Times*, September 4, 2012 <http://www.taipeitimes.com/News/front/archives/2012/09/04/2003541913>.

[35] Admiral Samuel J. Locklear, Commander, U.S. Pacific Command, "U.S. Pacific Command Posture," Senate Armed Services Committee, Washington, DC, April 9 2013, <http://www.armed-services.senate.gov/statemnt/2013/04%20April/Locklear%2004-09-13.pdf>.

[36] Michael T. Flynn, Lieutenant General, U.S. Army, Director, Defense Intelligence Agency, "Annual Threat Assessment," Statement Before the Senate Armed Services Committee, United

development as part of their annual briefing to the relevant Congressional oversight committee signifies that these officers (and their respective bureaucracies) believe the ASBM has become an operational reality that must be considered.

Concluding Thoughts on Status

Many open source analyses failed to foresee Beijing's momentous achievement in deploying an operational ASBM. China's recent satellite launch record, development of other surveillance architecture and the serious pursuit of its ASBM program more generally all suggested that a functional DF-21D was becoming increasingly likely. While the exact status of any Chinese capability in this area remains uncertain, the question of ASBM capability is less one of technical feasibility and more one of how well and how fast the Second Artillery can find, fix and fire on a potential target operating in China's Near Seas.

Any discussion of China's ASBM and its potential as a "game changer" requires one important caveat—countermeasures. Although the IOC status of the weapon may pose a real challenge to Washington's ability to back up U.S. security commitments in the region, the nature of that challenge cannot be determined only by looking at Chinese capabilities. The past nine annual DOD reports to Congress on Chinese military and security developments have devoted attention to the ASBM and its associated C4ISR support infrastructure, signaling high-level and persistent U.S. attention to the ASBM challenge. Such concern suggests the U.S. military has been developing countermeasures, e.g. both active "hard-kill" and passive "soft-kill" measures to break the ASBM's "kill chain," in parallel with China's progress on the DF-21D.[37] A range of top U.S. Navy officials have not only stated that their service has been making specific preparations to address Chinese ASBM development, they are confident that these countermeasures are feasible and effective.[38] In 2011, then-Chief of Naval Operations Admiral Gary Roughead

---

States Senate, 18 April 2013, <http://www.armed-services.senate.gov/statemnt/2013/04%20April/Flynn_04-18-13.pdf>.

[37] O'Rourke, China Naval Modernization, pp. 63–74.

[38] See, for example, Spencer Ackerman, "How to Kill China's 'Carrier-Killer' Missile: Jam, Spoof and Shoot," *Wired.com*, March 16, 2012 <http://www.wired.com/dangerroom/2012/03/killing-chinas-carrierkiller>; Alex Frangos, "U.S. Navy Commander Calls for Greater Dialogue," *Wall Street Journal*, China Real Time Report, November 9, 2011 <http://blogs.wsj.com/chinarealtime/2011/11/09/u-s-navy-commander-calls-for-greater-

stated, "even though the DF 21 has become a newsworthy weapon, the fact is our aircraft carriers can maneuver, and we have systems that can counter weapons like that."[39] When thinking of any potential conflict, assessing the effectiveness of those countermeasures is as important as knowing the status of China's ASBM.

In a landmark article, Dr. Thomas Mahnken, Deputy Assistant Secretary of Defense for Policy Planning from 2006–2009 and now a professor at the Naval War College and Johns Hopkins University, draws on historical examples of military innovation and its indicators to conclude that in its ASBM development China has moved from speculation to experimentation to implementation: "At this stage, one would expect to see the establishment of units to exploit new ways of war, the revision of doctrine to include new missions, the establishment of new branches and career paths within the military, changes to the curriculum of professional military education institutions, and field training exercises to practice and refine concepts."[40] Looking at the indicators discussed above, Dr. Mahnken's framework reinforces the assessment that the ASBM is entering the "implementation" phase but has not yet reached the equivalent of a fully-operational missile. As this paper looks back from the vantage point of the present to review ASBM program development, this framework also provides a useful lens through which to revisit Chinese motivations for, the literature on and the construction of the supporting infrastructure for a functional ASBM.

---

dialogue>; "'We're Not Gambling,'" *Aviation Week & Space Technology*, April 4, 2011, p. 66; Transcript of interview, as appended to Richard McGregor, "US Fleet Chief Voices Doubts on Chinese Navy," *Financial Times*, January 18, 2011 <http://www.ft.com/cms/s/0/288cd468-2331-11e0-b6a3-00144feab49a.html#axzz2Lh3BD9zZ>.

[39] Christopher P. Cavas, "Roughead Says Russian, Chinese Navies Growing," *Navy Times*, March 16, 2011, <http://www.navytimes.com/news/2011/03/defense-navy--cno-assesses-russian-chinese-navies-031611>.

[40] Thomas G. Mahnken, "China's Anti-Access Strategy in Historical and Theoretical Perspective," *Journal of Strategic Studies* 34, No. 3 (June 2011), p. 319.

Table 1. Potential Indicators of Chinese ASBM Innovation

Speculation	• Publication of concept papers, books, journal articles, speeches, and studies regarding new combat methods. • Formation of groups to study the lessons of recent wars. • Establishment of intelligence collection requirements focused upon foreign innovation activities.
Experimentation	• Existence of an organization charged with innovation and experimentation. • Establishment of experimental organizations and testing grounds. • Field training exercises to explore new warfare concepts. • Wargaming by war colleges, the defense industry, and think-tanks regarding new warfare areas.
Implementation	• Establishment of new units to exploit, counter innovative mission areas. • Revision of doctrine to include new missions. • Establishment of new branches, career paths. • Changes in the curriculum of professional military education institutions. • Field training exercises to practice and refine concepts.

Source: Thomas G. Mahnken, "China's Anti-Access Strategy in Historical and Theoretical Perspective," *Journal of Strategic Studies* 34, No. 3 (June 2011), p. 304.

IV. BACKGROUND AND MOTIVATIONS FOR THE ASBM PROGRAM

It is not hard to see why China is deploying an anti-ship ballistic missile (ASBM). Specifically, China's leaders strongly desire the ability to both deter advocates of independence on Taiwan and to prevent the United States from intervening effectively in the event of a future Taiwan Strait crisis or any other Near Seas conflagration. Beijing has defined its immediate strategic concerns clearly in this regard. More broadly, China is interested in achieving an ASBM capability because it offers the prospect of limiting the ability of other nations, particularly the United States, to exert military influence on China's maritime periphery, which contains several disputed zones of core strategic importance to Beijing. ASBMs are regarded as a means by which technologically limited developing countries can overcome asymmetrically their qualitative inferiority in conventional combat platforms. An article in the Chinese Society of Naval Architecture and Marine Engineering journal *Naval & Merchant Ships* summarized the perceived utility of ASBMs for China:

> "Since the end of the Cold War, the aircraft carrier has become a symbol of the might of a great power, while the ballistic missile has also become an effective weapon for developing countries around the world to safeguard their own security and challenge great powers. The might of an aircraft carrier is based on the disparity between the comprehensive powers of rich and poor states. The ballistic missile, on the other hand, seeks to exploit the temporal lag in the development of offensive and defensive technologies. What should be noted is that this…lag may well disappear in the not-too-distant future, but the economic disparity between rich and poor states can only be overcome after a long period. Therefore, although ASBMs are undoubtedly an effective means of deterring military intervention at the present, from a long-term perspective it will take the strengthening of the nation's economic powers and comprehensive improvements in the navy's counter-strike capabilities."[41]

[41] Dong Lu, "Dandaodaodan neng da Hangmu [Ballistic Missiles Can Be Effective Against Aircraft Carriers]," *Jianchuan Zhishi* [Naval & Merchant Ships] (December 2007), p. 20. For a similar conception, see Wang Wei, "Zhanshu Dandaodaodan dui Zhongguo haiyang zhanlue tixi de yingxiang [The Effect of Tactical Ballistic Missiles on the Maritime Strategy System of China]," *Jianzai Wuqi* [Shipborne Weapons], No. 84 (August 2006), pp. 12–15.

China's ASBM is part of a much larger pattern in which the development and proliferation of various weapons systems—such as ballistic and cruise missiles, submarines and naval mines—threatens to hold U.S. platforms at risk in vital areas of the global maritime commons. Today U.S. operations in the Western Pacific appear most threatened in this regard, but similar challenges are emerging in the Persian Gulf and might eventually materialize elsewhere. Chinese open source publications also provide strong indications that Beijing has been developing an ASBM since the 1995–96 Taiwan Strait crises. The deployment of the *USS Nimitz* and *USS Independence* Carrier Strike Groups (CSGs) in response to China's missile tests and military exercises in the Taiwan Strait was a move that China could not counter at that time. The U.S. moves probably convinced Chinese leaders to never again allow U.S. forces to intervene in what they consider to be a matter of absolute sovereignty.

"Transparency" has become a watchword in U.S.-China policy discourse; U.S. policymakers argue consistently that Beijing should be more "transparent" about its intentions. In many areas, however, China already is offering at least a degree of translucence. As M. Taylor Fravel explains, "Examination of [Chinese texts on military doctrine] suggests that China's objectives for the use of military power are more certain than many policy analysts maintain."[42] While China has not been truly transparent with respect to ASBM development, the different open-source voices do provide a relatively coherent picture about Chinese strategic interests and the problems that an operational ASBM can attempt to address. Academic journals are frank about the challenges, but optimistic that they can be solved; bloggers and military hobbyists are breathless about the system's promise. Most importantly, these voices have changed in interesting ways over time that have indicated a development program in progress.

Chinese officials, however, have yet to address their nation's ASBM development directly in an open public forum, save for the brief mention by Senior Captain Duan Xiaoxian on April 28, 2010 and the inconclusive statement made by General Chen Bingde on July 11, 2011. Not surprisingly, Chen used the opportunity to characterize China's ASBM as defensive in nature. In an English-language *China Daily* article, he is quoted as stressing that China's ASBM "will be used as a defensive weapon when it is successfully

[42] M. Taylor Fravel, "China's Search for Military Power," *Washington Quarterly* 31, No. 3 (Summer 2008), p. 126.

developed, not an offensive one."[43] China seeks not to wage war, but to have an effective conventional deterrent capability; and, in a worst-case scenario, to have a strike capability if deterrence failed. The associated goals are essentially twofold, involving deterrence and influence. First, Chen's statement implies China would like to push foreign aircraft carrier groups away from sensitive areas in the event of a crisis or conflict. Second, Beijing would like to influence the perceptions of people in Taiwan, Japan, and other parts of the region about the likelihood, and likely effectiveness, of any U.S. intervention therein. From a Chinese perspective, this appears inherently defensive; from the U.S. perspective and that of other regional actors, it may not appear "defensive" at all. Herein lies a substantial challenge for Sino-U.S. strategic relations even as the two great powers move to explore possibilities for mutually beneficial security cooperation in the future.

Other Chinese officials have made a variety of more general statements that would appear to be compatible with and to reinforce the above assessment of the drivers of ASBM development. On October 26, 2009, General Xu Caihou, then-Central Military Commission (CMC) Vice Chairman, delivered an address and entertained questions at the Center for Strategic and International Studies (CSIS) in Washington, D.C. *Bloomberg* reporter Tony Capaccio raised the ASBM issue with General Xu, stating "Many analysts in the United States, reviewing China's weapons, are wondering why China is developing anti-ship cruise missiles and anti-ship ballistic missiles to use against the United States Navy if, in fact, your goal is cooperation with the United States Navy." Xu did not respond directly, instead stating more broadly that ballistic and cruise missile development was necessary for mainland China to safeguard its interests vis-a-vis Taiwan:

> "Now I want to address the question related to suspicions about China's research and development of weapons and equipment. I want to make clear that the limited weapons and equipment of China is entirely to meet the minimum requirement for maintaining national security. The research and development of weapons and equipment, including that of our cruise missiles and ballistic missiles, some of which were on display on our [October 1, 2009] National Day military parade, is entirely for self-defense. In my meetings with

[43] Hu Yinan, Li Xiaokun and Cui Haipei, "Official Confirms China Building Aircraft Carrier," *China Daily*, July 12, 2011 <http://www.chinadaily.com.cn/cndy/2011-07/12/content_12880708.htm>.

> my foreign friends, both within China and on my overseas tours, I've heard similar suspicions or misgivings about China's effort in developing advanced weapons and equipment, so I want to add, here, that given the vast area of China, the severity of the challenges facing us and the heavy responsibility on the part of the PLA to guarantee national security, territorial integrity, it is—the limited capabilities and limited weapons and equipment is merely for the minimum requirement of national security. As you also know, *China has yet to realize complete unification*" [emphasis added].[44]

The Taiwan connection to the ASBM is strong and reviewing the development of China's missile program, especially as it relates to the ASBM, reveals four distinct threads of which Taiwan is one. The island served as a primary driver, especially the 1995–1996 crises that demonstrated China's inability to prevent U.S. naval interference in the Taiwan Strait. The second was the U.S./NATO 1999 bombing of the Chinese embassy in Belgrade, Yugoslavia. A perceived need to prevent such an attack in the future, combined with the military thinking of Jiang Zemin as he emerged as China's paramount leader, further increased emphasis on such asymmetric "assassin's mace" weapons as the ASBM. The third is continentalist thinking about defense, keeping land-based weapons systems ahead of or on a par with naval development as a way to safeguard China's security and advance its island and maritime claims. The final thread relates to key data points in the late 1990s and early 2000s suggesting that the technical problems related to deploying an operationally-effective ASMB could be overcome.

Taiwan: A Central Catalyst

Beyond the preliminary technical and exploratory analyses, the actual Chinese ASBM development program dates at least to the 1995–96 Taiwan Strait crises, which underscored Chinese feelings of helplessness against U.S. naval power. For the past several decades, the U.S. Navy has used aircraft carriers to project power around the world, including in and around the Taiwan Strait. In July–August 1995 and March 1996, concerns about President Lee Deng-hui furthering measures that it associated with Taiwan independence led Beijing to order missile tests and other military exercises near the Strait. U.S. President

---

[44] General Xu Caihou, "Statesmen's Forum: General Xu Caihou," Center for Strategic and International Studies, Washington, DC, October 26, 2009 <http://csis.org/event/statesmens-forum-general-xu-caihou>.

William Clinton turned to U.S. CSGs as the most logical deterrent measure, later remarking "When word of crisis breaks out in Washington, it is no accident the first question that comes to everyone's lips is: where is the nearest carrier?" The resulting U.S. dispatch of the *Nimitz* CSG through the Strait in December 1995 and of the *Independence* and *Nimitz* CSGs toward the region in March 1996 was a move that China could not counter. The PLAN "felt pain keenly" (*qiefu zhi tong*). It "could not build a steel Great Wall at sea to keep the enemy outside the nation's door, and could only serve as an auxiliary of the ground forces in defending a trifling twelve nautical mile territorial water line."[45]

How the events of 1995–96 affected the precise calculations of Chinese leaders—and what they instructed their subordinates to do—is not publically known at present. It is reasonable, however, to assume that this debacle starkly reinforced in their consciousness the idea that carriers would be a vital platform for U.S. power projection in any future Taiwan conflict in which Washington elected to intervene; they likely vowed such an action, which they perceived as a violation of China's sovereignty, should never be repeated. Leaders such as General Secretary, President and CMC Chairman Jiang Zemin reportedly instructed key defense industrial institutions to spare no expense in solving the problem.[46] Colonel Larry Wortzel (Ret.), U.S. Army Attaché in Beijing from 1995 to 1997, testified to the following:

> "The first time a senior Chinese military officer of the General Staff Department mentioned ballistic missiles attacking carriers was after our two carriers showed up, and he put his arm around my shoulder and said we're going to sink your carriers with ballistic missiles, and we had a long conversation about it. I don't know if they were doing research before that, but…the first time it got thrown in my face was 1996."[47]

---

[45] Qiu Zhenwei, "Zhongguo fanchuan dandao daodan fazhan yantao [A Discussion of China's Development of an Anti-Ship Ballistic Missile]," *Global Times Online*, Blogs, 2009 <http://blog.huanqiu.com/?uid-6885-action-viewspace-itemid-2009>.

[46] Author's conversation with Chinese arms control specialists, 2009.

[47] "Hearing on the Implications of China's Naval Modernization for the United States," U.S.-China Economic and Security Review Commission, Washington, DC, June 11, 2009 <http://www.uscc.gov/Hearings/hearing-implications-china%E2%80%99s-naval-modernization-united-states>.

At the behest of Jiang and other top leaders, PLA development in general, and PLAN development in particular, accelerated markedly. The presidency of Chen Shui-bian (2000–08), during which he made constant moves in the direction of what Beijing perceived to be *de facto* independence for Taiwan, likely helped to sustain this effort.

It would hardly be surprising, then, that the existing research relevant to ASBMs probably was thus advertised to China's leadership in the aftermath of the 1996 debacle as a potent basis for counter-intervention capabilities that could prevent a repeat of such military indignities in the future. In fact, there is specific evidence that a new impetus was given to ASBM-related research and development at this time.[48]

As a requirement that "suddenly became urgent" (*douran poqie*), ASBM development was reportedly accelerated and focused as part of this larger surge. One Chinese source maintains that such researchers as Dr. Xin Wanqing at China Aerospace Science and Technology Corporation (CASC) began ASBM feasibility studies and "concept demonstration work" (*gainian lunzheng gongzuo*) in 1996, particularly in the areas of guidance and control. Research work reportedly began the following year.[49] A sudden profusion of relevant technical papers by Xin and others starting in 1996 (and not typically citing Chinese sources dating before that year) would seem to support these assertions (See Appendix B for a sampling of these articles). A 2006 article, published originally on the *China Youth Daily* online portal and subsequently removed, claimed that in the late 1990s Xin "completed proof of concept work on anti-aircraft carrier ballistic missiles" (*wancheng le dandaodan gongji hangkongmujian de gainian lunzheng gongzuo*). Starting in 1996, the article stated, "he proposed and demonstrated the missile weapon system's multidisciplinary optimization and demonstration and verification technology. In 2000, he received the support of the state and became the person in charge of technology, taking responsibility for the planning and implementation of overall optimization and of the demonstration and verification laboratory."

---

[48] Qiu, "Discussion of China's Development of an Anti-Ship Ballistic Missile"; Chen Haidong, Yu Menglun, Xin Wanqing, Li Junhui [Beijing Institute of Aerospace Systems Engineering] and Zeng Qingxiang [Beijing Institute of Special Mechanical and Electronic Devices], "Zairu feixingqi gongji mansu mubiao de zhidao fang'an yanjiu [Study for the Guidance Scheme of Reentry Vehicles Attacking Slowly Moving Targets]," *Missiles and Space Vehicles*, No. 6 (2000), pp. 5–9; Richard D. Fisher, Jr., "China's Missile Threat," *Wall Street Journal*, December 30, 1996.

[49] Qiu, "Discussion of China's Development of an Anti-Ship Ballistic Missile."

Xin subsequently played a major role in ASBM development, winning many high-level awards in the process.[50]

Over the next few years, PLA scholars developed conceptual rationales for ASBM development. In 1999, China's National Defense University published a volume containing two chapters that outlined conceptually the use of TBMs against surface ships.[51] In 2002, the PLA's Academy of Military Science (AMS) published two volumes, focused primarily on Taiwan-related campaigns, containing passages advocating that ballistic missiles be used against carriers. The first, a textbook for midgrade to senior military officers attending PLA command colleges, offered a conceptual rationale for TBM use against CSGs:

> "When a carrier strike group is within the combat radius of our military aviation and tactical missiles, we can use various services and

[50] Specifically, "From 1997 to 2002, Xin advised a master's student and assisted a doctoral student in completing six degrees of freedom simulation research work for re-entry guidance law design and re-entry guidance attitude and trajectory. The research findings played an important role as the basis for preliminary research on the model. He proposed and demonstrated the missile weapon system's multidisciplinary optimization and demonstration and verification technology. He was also responsible for the planning and implementation of the overall optimization design (*zongti youhua she*) and demonstration and verification laboratory. He completed overall [missile]-engine integration design research topics, achieving the first steps toward the demonstration and verification of the missile segment installation (*daodan buduan anzhuang*), overall assembly, and docking process. He completed missile launch and flight process demonstration and verification, and operational performance simulation demonstration and verification. He organized preliminary key technology research on China's missile weapon systems' 'overall optimization and structural lightness' (*jiegou qingzhihua*) as well as plan development work. He used optimization design methods to overcome many difficulties and key technical points. After he assumed the position of deputy chief engineer of the model, he took on responsibility for overall design and research of the missile. Through over three years of arduous effort, he overcame a series of technical difficulties to achieve success during the maiden flight test." Through 2006, "in the area of overall optimization design, [Xin] completed research tasks in overall [missile]-engine integration design and is currently conducting overall integration optimization design research tasks. In the area of demonstration and verification, he has used virtual reality technology to achieve the first steps toward demonstration and verification of missile segment installation, overall assembly, and docking process. He also completed missile launch and flight process demonstration and verification as well as operational performance simulation demonstration and verification." See "Hangtian yiyuan wancheng dandaodaodan gongji hangmu gainian lunzheng gongzuo [China Aerospace Science and Technology Corporation First Academy Completes Proof of Concept Work on Anti-Aircraft Carrier Ballistic Missile]," *China Youth Online*, April 30, 2006.

[51] Ren Qiuke and Gao Jichao, "Zhanyi zhanshu daodan zai haishang fengsuo zuozhan zhong de yunyong [The Use of Campaign and Tactical Missiles in Sea Blockade Operations]," and Yao Haitao, "Changgui dandaodaodan ruhe dadi daxing jianting biandui [How to Strike Large Enemy Naval Vessel Formations with Conventional Ballistic Missiles]," in Hu Wenlong, chief ed., *Lianhe fengsuo zuozhan yanjiu* [Research on Joint Blockade Operations] (Beijing: Guofang Daxue Chubanshe [National Defense University Press], 1999), respectively, pp. 122–25, 126–28, respectively.

> service arms together to implement a joint attack against the foreign enemy carrier. Such a joint attack entails combining the tangible and intangible into comprehensive, multi-axis surrounding and annihilation."[52]

Belgrade Embassy Bombing: A Timely Accelerant

On May 7, 1999, a U.S. aircraft mistakenly bombed the Chinese embassy in Belgrade, Yugoslavia as part of a larger NATO operation. The accident only further reinforced a belief first struck home by *Operation Desert Storm* in 1991, and catalyzed further by the 1995–96 Taiwan Strait crises. In Beijing's view, U.S. technological superiority was such that it perhaps could attack Chinese assets *deliberately* without significant ability on the part of the Chinese to prevent the strike or to retaliate, because of the rough of equivalence of Chinese and Serbian equipment at the time. A perceived need to prevent such attacks in the future, combined with the increased influence of the already–well-developed military thinking of Jiang Zemin as he emerged as China's paramount leader, further increased emphasis on developing such "assassin's mace" (*shashoujian*)[53] weapons as the ASBM. China's impetus for building asymmetric weapons thus arose out of a broadly-held evaluation of U.S. capabilities and Chinese deficiencies in Beijing, but was accelerated by events in the 1990s politicizing weapons development and making it a national, emotional issue that Jiang Zemin and CMC Vice Chairman Zhang Wannian could harness to promote weapons programs that they perceived to be vital.

An electrical engineer by training who spent years rising through management in China's state-owned electronics industry, Jiang was well-placed to understand the requirements of modern warfare. From the early years of Jiang's leadership, he began to develop ideas about how China could develop best militarily despite its lingering weaknesses. Yet, as Deng Xiaoping's hand-picked successor and lacking any military experience, Jiang was limited in his ability to implement his own military policy effectively while Deng remained influential behind the scenes and his powerful protégés Liu Huaqing and Zhang Zhen served as CMC vice chairmen. Jiang's pre-existing military

---

[52] Senior Colonel Zhu Aihua and Sun Longhai, chief eds., *Jin'an daoyu fengsuo zuozhan* [Coastal Island Blockade Warfare] (Beijing: Junshi Kexue Chubanshe [Military Science Press], 2002), p. 131.

[53] "Assassin's mace" is a term commonly used in both PLA and less authoritative documents to describe weapons that match Chinese strengths with an enemy's weaknesses to achieve disproportionately powerful effects.

thinking only came to the forefront in conjunction with his consolidation of power after 1997, when Deng died and his protégés were replaced as CMC vice chairmen by the more junior Zhang Wannian and Chi Haotian.

Jiang's rise to power coincided with several key developments. The Soviet Union's dissolution in 1991 left the U.S. as the sole superpower. That same year, *Operation Desert Storm* demonstrated that, not only had the U.S. retained existing power projection capabilities, it also had made significant advances through the use of information-enabled weapons systems. The Taiwan Strait crises of 1995–96 further confirmed in Chinese leaders' minds their U.S. counterparts' willingness to use this military power in ways that were antithetical to Beijing's core interests. Then lacking a significant land- or sea-based long-range anti-ship strike capability, Chinese leaders began to consider conventional asymmetric weapon systems as a way to maintain deterrence in a world in which China could not yet compete with the United States symmetrically as a peer. Within this broader context, the Belgrade bombing acted as a clarion call to Chinese leadership to develop "assassin's mace" weapons quickly. The program established to develop such weapons, the 995 Program (*gongcheng*) in traditional Chinese government nomenclature, originated in May 1999.[54]

China previously had researched the possibility of using asymmetric weapons to gain advantage against more developed competitors. On the basis of his interpretation of Jiang's guidance, and in a possible indication of the influence of concerns vis-à-vis Taiwan, Zhang Wannian called for "assassin's mace" weapons development as early as 1995: "Whatever military combat requires, whatever the enemy fears most, that is what we must focus on developing."[55] In fact, in January 1999, even before the Belgrade Embassy bombing, Zhang relayed Jiang's instructions to major breakthroughs in developing "assassin's mace" weapons, akin to that achieved in China's storied "Two Bombs and One Satellite" (*liangdan yixing*) megaprojects of the Cold War.[56] In their most

[54] Tai Ming Cheung, "Science and Technology in Chinese Thinking on Security and Development: Techno-Nationalism and S&T Innovation as Seen Through its Technology Development Programs," Presentation at IGCC 2012 Summer Training Workshop on the Relationship between National Security and Technology in China, La Jolla, CA, July 10, 2012.

[55] "Zhang Wannian Zhuan" Xiezuozu [Biography of Zhang Wannian Writing Group], *Zhang Wannian Zhuan*, *Xia Ceng* [The Biography of Zhang Wannian, Final Volume] (Beijing: Jiefangjun chubanshe, 2011), pp. 164–166. The present author is indebted to Tai Ming Cheung for directing him to this source.

[56] Ibid., p. 169.

authoritative speeches and writings, particularly after the Belgrade bombing, Jiang and Zhang would cite repeatedly the "two bombs and one satellite" megaprojects as a model as they advocated further high-tech "assassin's mace" weapons development. In the official CCP Press-published reader on Jiang's thought concerning national defense and military construction, he linked the imperative to develop "assassin's mace weapons" via "Two Bombs and One Satellite"-style megaprojects explicitly to the events of 1999.[57]

Under the rubric of "firmly emphasizing doing some things while not doing others and concentrating forces on bringing forth key equipment," Jiang emphasized the importance of focusing initial investment on achieving breakthroughs concerning key technologies that promised disproportionate cost-effectiveness and military impact. Jiang "stressed the need to stand in the forefront of the world technological revolution, and to develop [China's] own sophisticated 'assassin's mace' weapons equipment aimed at developed countries, and form combat capabilities suited to 'winning' as quickly as possible."[58] In 1999, the only date mentioned in this context, Jiang made similar points at a General Assembly on the Recognition of Science and Technology Experts Who Have Made Outstanding Contributions to the Development of "Two Bombs and One Satellite."[59]

---

[57] Jiang Zemin, "Zai biaozhang wei yanzhi 'liang dan yi xing' zuochu tuchu gongxian de keji zhuangjia dahui shang de jianghua [Speech In The General Assembly on the Recognition of Science and Technology Experts Who Have Made Outstanding Contributions to the Development of "Two Bombs and One Satellite]," Speech given September 18, 1999, in Jiang Zemin, *Lun Guofang he Jundui Jianshe* [On National Defense and Military Construction] (Beijing: Jiefangjun chubanshe, 2003), pp. 401–9; Jiang Zemin, "Zhuajin junshi douzheng zhunbei, jiaqiang siling jiguan jianshe [Pay Close Attention to Preparations for Military Struggle, Strengthen Construction of Headquarters]," Speech given November 12, 1999, in Jiang, *Lun Guofang he Jundui Jianshe*, pp. 411–18.

[58] Jiang Zemin, "Zhongguo renmin jiefangjun guofang daxue 'shiwu' keyan guihua keti [China People's Liberation Army National Defense University Research and Planning Issues for the Tenth Five Year Plan]," in Zhongguo renmin jiefangjun guofang daxue jundui jianshe yanjiusuo [China People's Liberation Army National Defense University Military Construction Research Institute], *Jiang Zemin Guofang he Jundui Jianshe Sixiang Xuexi Duben* [A Study Reader of Jiang Zemin's Thought on National Defense and Military Construction] (Beijing: Zhonggongdangshi chubanshe, 2002), pp. 164–65.

[59] Ibid., p. 165; Jiang Zemin, "Zai biaozhangwei yanzhi 'Liang dan yi xing' zuochu tuchu gongxian de keji zhuanjia dahui shang de jianghua [Speech In The General Assembly on the Recognition of Science and Technology Experts Who Have Made Outstanding Contributions to the Development of 'Two Bombs and One Satellite']," Speech given September 18, 1999, in Jiang, *Lun Guofang he Jundui Jianshe*, pp. 401–09.

As the timing and content of Jiang's statements broadly suggest and as the more specific writings of Zhang Wannian demonstrate more clearly, it was the Belgrade incident that galvanized a united Chinese government's action to develop these types of weapons even more quickly in a manner that used both civilian and military resources across the board. As noted in his biography, following the Belgrade Embassy bombing of May 8 (Beijing time), Zhang quickly convened an enlarged meeting of the Central Military Commission. At the meeting he emphasized, as one of four directives, the need to "speed up development of 'assassin's mace' weapons systems" (*jiasu fazhan 'shashoujian' zhuanghei*). Subsequently top government bodies gave the military instructions to broadly expand the program immediately and to use all possible speed in producing viable weapons systems. At a CMC executive meeting that Zhang chaired and convened on May 11, drawing on Jiang's instructions to strengthen national defense, Zhang built on his previous emphasis with a call to "further intensify investment in and work toward such megaprojects as forging 'assassin's mace' weapons" (*gengjia jinzhang de tou ren dao lingdao duanzao 'shashoujian' deng zhongda gongcheng gongzuo zhong qu*).[60] On July 13, at a CMC executive meeting in which Zhang Wannian heard the General Staff's report on the Kosovo War, Zhang again invoked Jiang's guidance: "vigorously raise 'assassin's mace' armaments, [based on the principle that] 'Whatever the enemy fears most, that is what we should develop' (*yaobu dali ba 'shashoujian' zhuanghei gao shangqu, 'diren zui pa shenme, women jiu fazhan shenme*)".[61]

From Zhang's persistent emphasis on behalf of Jiang, and how it is portrayed in officially-sanctioned historical materials, it is clear that the incident had caused a sufficient stir to allow resources to be further prioritized for military modernization. Under Deng, the military had been the least-emphasized of the Four Modernizations and was forced to accept significant funding restrictions. The PLA, however, was allowed to engage in supplemental business activities, thereby diverting its focus considerably. Jiang's significant increases in defense-related spending, in exchange for ordering the PLA to abandon most non-military activities in 1998, helped China's defense industry to accomplish the hugely-expensive national project-level task of developing new "assassin's mace" weapons.

---

[60] Zhang Wannian Zhuan, Xia Ceng, pp. 416, 418.

[61] Ibid., p. 419.

In addition to outlining China's requirement for advanced weapons systems, Zhang also made another key point which helps explain why the Belgrade incident, perhaps more than other previous exhibitions of U.S. military power, served to push Chinese strategists toward asymmetric weapons: "The Kosovo War once again proves that the more high-tech the main battle equipment, the greater its dependence on comprehensive protection equipment." He also noted "The [forces of the] Federal Republic of Yugoslavia were always in the position of having to take a beating passively and completely lacked the power to fight back, [not only] because they lacked comprehensive and supporting weapons systems, but especially because they lacked 'assassin's mace' weapons systems."[62] In Zhang's view, the Belgrade incident posed a particular challenge in this regard; subsequently, he placed unprecedented emphasis on "assassin's mace" weapons development. [63]

Jiang and Zhang's emphasis reflects not only on the sense of national outrage at being bombed by the United States, but also on the strategic situation in Kosovo and, particularly, the vulnerability of Yugoslav forces. By this time, it was startlingly clear to China's leaders that they had to acquire a means of preventing the kind of airpower and accompanying firepower available during the Kosovo air war from being directed into or near China. The only sufficient solution, they concluded, lay in a combination of "comprehensive" high-tech weapon systems and asymmetric weapons, much like the overlapping submarines, advanced aircraft, air defenses, cruise missiles and ballistic missiles, such as the ASBM, that observers see coming to fruition today.

* * *

Regardless of the precise role played by each of the aforementioned incidents, what is undisputable is the emergence of many new platforms and weapons systems, beginning in the early 2000s and continuing to this day. Asymmetric in nature and anti-access in focus, they clearly match Chinese strengths with U.S. weaknesses to target a full spectrum of vulnerabilities inherent in U.S. CSGs and other power projection platforms. They are difficult to counter, in

---

[62] Zhang Wannian, "Diren haipa shenme, women jiu fazhan shenme [We Must Develop for Ourselves That Which the Enemy Fears]," Speech given November 5, 1999, in Zhang Wannian, *Zhang Wannian Junshi Wenxuan* [Selected Military Writings of Zhang Wannian] (Beijing: Jiefangjun chubanshe, 2008), p. 733.

[63] Zhang Wannian Zhuan, Xia Ceng, pp. 170, 421.

the view of the present author, because they target specific characteristics and limitations based on immutable laws of physics, and thus potentially place the United States on the 'wrong end of physics' in terms of the difficulty and expense in attempting to do so.

The ASBM is just one of a stunning array of new platforms and weapons systems China has been buying and building since the late 1990s—systems which, taken as a whole, will allow China to influence and assert control over its contested maritime periphery in ways it never could before. The ASBM, however, differs markedly from the quiet submarines, lethal anti-ship cruise missiles (ASCMs), and copious numbers of sea mines that China has been adding to its inventory. It draws on over half a century of Chinese experience with ballistic missiles, may be fired from mobile, highly concealable platforms, and possesses the range to strike targets hundreds of kilometers from China's shores.

Using the Land to Control the Sea

For over three decades—albeit with a slow and uncertain beginning—Chinese leaders and strategists have been thinking of using land-based missiles to hit threatening targets at sea. **Table 2** offers a timeline of these efforts. In the early 1970s, Vice Premier Zhang Chunqiao had significant influence over China's national decision making as one of the Gang of Four, a faction led by Chairman Mao Zedong's wife, Jiang Qing. On April 8, 1972, he attended an important administrative meeting of the Central Military Commission (CMC)—Beijing's supreme military decision-making body.[64] There, during a larger debate about the proper course for China's military-strategic development, he declared "We are continentalists. Now guided missiles are well developed. Installed on shore, they can hit any target, and there is no need to build a big navy."[65] By focusing on a specific missile technology, as

[64] In 1975, Zhang would become director of the PLA General Political Department.

[65] *Xinhua*, March 14, 1977, E1–E2; cited in John Wilson Lewis and Xue Litai, *China's Strategic Seapower: The Politics of Force Modernization in the Nuclear Age* (Stanford, CA: Stanford University Press, 1994), p. 223. Such thinking was not unique to China. During that era, a Soviet military school of thought emerged advocating a similar position. As leading naval strategist Admiral Sergei Gorshkov later recalled: "There were some influential authorities who considered that with the appearance of atomic weapons the navy had completely lost its value as a branch of the armed forces. According to their views, all of the basic missions in a future war allegedly could be fully resolved without the participation of the navy, and even in those circumstances when to do so would require the conduct of combat operations on the broad expanses of the seas and ocean. At that time it was frequently asserted that only missiles emplaced in ground launching sites were required for the destruction of surface striking forces and even submarines." Milan Vego, "Soviet

China had done so successfully since the 1950s, Zhang apparently believed, it would be possible to achieve a transformative strategic effect while devoting China's limited resources to more pressing priorities. Zhang's political career did not survive Mao's passing; he and his collaborators were arrested shortly after Mao's death in 1976, when it was feared that they would attempt to usurp the central leadership. In the ensuing decades China took significant steps toward building the "big navy" that Zhang decried, though only recently has its quality approached world standards.

Meanwhile, however, ballistic missile development (particularly with solid propellant) remained a key Chinese focus.[66] China's conflict with Vietnam over the sovereignty of the Spratly Islands in 1988 reportedly added impetus to DF-21 development to ameliorate power projection limitations.[67]

The PLA, however, really had only one missile to consider as an example: the U.S. *Pershing II* Theater Ballistic Missile (TBM)—deployed in 1983 with a maneuverable reentry vehicle (MaRV). Chinese analysts studied this missile intensively beginning in the late 1970s, even by the standards of China's burgeoning publications industry. Over 50 related articles covered the U.S. missile, gradually shifting from basic overviews and translations of foreign media reports to detailed program analyses and finally technical research by identified experts in Chinese government academies, which seemed to have potential application to China's own programs (See Appendix C for a sampling). In what may have been a one-sided "bathtub" effect, such articles faded from more serious technical publications by the early 1990s. Possible explanations include the *Pershing II*'s withdrawal and subsequent destruction following ratification of the INF Treaty in 1988 and efforts to avoid attention to any Chinese acquisition and applications of such technology thereafter.

Russia: The Rise and Fall of a Superpower Navy," in Andrew Erickson, Lyle Goldstein, and Carnes Lord, *China Goes to Sea: Maritime Transformation in Comparative Historical Perspective* (Annapolis, MD: Naval Institute Press, 2009), p. 218.

[66] "Central Decisive Shot: The Concentration of Superior Forces to Develop a New Type of Assassin's Mace."

[67] "DongFeng 21C (CSS-5 Mod-3) Medium-Range Ballistic Missile," *China Defense Today*, <http://www.sinodefence.com/strategic/missile/df21c.asp>.

Table 2: Chinese ASBM Development Timeline
1955 – Qian Xuesen returns to China, subsequently founds missile and space programs with Chairman Mao Zedong's support.
1955–56 – USSR provides China with R-1 and R-2 missiles, engineering documentation, equipment and specialists.
1956 – **May:** CCP Central Committee prioritizes development of strategic missiles and atomic bomb. Ministry of National Defense 5th Research Academy (China's first missile organization) established; Qian appointed head.
1960 – **August 12:** Soviet specialists leave 5th Academy as part of Sino-Soviet split. **September:** first launch of Chinese-made R-2.
1965 – August: Premier Zhou Enlai orders development of solid-propellant rocket technology. Design team formed within 4th Space Academy, single-stage ballistic missile design *Dongfeng*-61 (DF-61) proposed.
1966 – **July 1:** Second Artillery Force founded.
1967 – PLA decides to build its first SSBN, requires medium-range ballistic missile to be carried onboard; decided to abandon DF-61 design and develop two-stage solid-propellant submarine-launched ballistic missile (JL-1).
1970 – Design of JL-1 airframe reassigned to 1st Space Academy, while 4th Space Academy concentrates on solid-propellant rocket technology.
Early 1970s – China makes several major breakthroughs in developing solid-propellant rocket technology. Begins to explore developing land-based version of JL- 1.
1972 – Vice Premier Zhang Chunqiao advocates use of "guided missiles" to hit maritime targets.
1975 – Two parallel development programs underway based on same airframe and engine design: submarine-based JL-1 and land-based DF-21.

Table 2 Continued: Chinese ASBM Development Timeline
1976 – JL-1/DF-21 program reassigned to 2nd Space Academy (previously responsible for missile defense program). Huang Weilu appointed Chief Designer. 2nd Space Academy also assigned DF-21 support systems, e.g. development of transporter-erector-launcher vehicle, missile canister as well as missile testing and guidance.
1983–88 – U.S. deploys *Pershing II* MRBM.
1985 – **May:** First successful DF-21 flight from Base 25 (Wuzhai).
1987 – DF-21A development program initiated. Missile features 60 percent range increase. **May:** Second successful DF-21 flight from Base 25.
1988 – DF-21 MRBM certified for design finalization. U.S. retires *Pershing II* MRBMs per INF Treaty.
1991 – *Operation Desert Storm* demonstrates that sole superpower U.S. has advanced greatly in information-enabled weapons systems.
1993 – Second Artillery assumes conventional mission.
1995 – First successful DF-21A flight test from Base 25. **July–August:** Second Artillery fires SRBMs into sea near Taiwan during Taiwan Strait crises. General Zhang Wannian begins calling for "assassin's mace" weapons development based on his interpretation of Jiang Zemin's guidance.
1996 – DF-21A achieves IOC. **March:** Second Artillery fires SRBMs into sea near Taiwan, two U.S. carrier groups approach region. Senior PLA General Staff Department officer warns U.S. attaché that CSGs face future ballistic missile threat.
1997–2002 – Major Chinese ASBM conceptual studies published.

Table 2 Continued: Chinese ASBM Development Timeline
1998 – **December:** *Operation Desert Fox*, in General Zhang Wannian's view, is one of several 1990s events that "posed a series of major questions for the modernization development of the People's Liberation Army," which "had to be answered urgently [starting fundamentally] from a theor[etical basis]."
1999 – **March:** PLA National Defense University publishes ASBM concept chapters. **May 7:** U.S. aircraft mistakenly bombs Chinese embassy in Belgrade, Yugoslavia in larger NATO operation; confirms in leaders' minds American willingness and ability to use military power in ways inimical to Beijing's core interests. **May:** 995 Program initiated to develop "assassin's mace" weapons rapidly. Jiang and Zhang cite "Two Bombs and One Satellite" megaprojects as model. **July 13:** at CMC executive meeting Vice Chairman Zhang invokes Jiang's guidance: "vigorously raise 'assassin's mace' armaments" based on the principle that "Whatever the enemy fears most, that is what we should develop." **November 19–20:** *Shenzhou-1* spacecraft launched; orbital maneuvering tech demonstrated.
2002–06 – Limited number of Chinese ASBM studies published openly.
2003 – Second Artillery publishes ASBM feasibility study.
2004 – Second Artillery publishes doctrinal handbook, 2 pages devoted to ASBM use. ONI first mentions Chinese ASBM interest publicly.
2005 – First mention of Chinese ASBM exploration/research in U.S. DOD annual PLA report.
2006–Present – Major increase in Chinese ASBM publications.
2007 – Chinese ASBM development mentioned in testimony before U.S.-China Economic and Security Review Commission.
2009 – **August:** DF-21D rocket motor factory completed. **October 26:** CMC Vice Chairman General Xu Caihou answers question concerning why China is developing ASBM by emphasizing that "China has yet to realize complete unification." **November:** ASBM-focused program broadcast on *CCTV-7*. ONI's Scott Bray states ASBM "nearing an operational capability." ASBM begins to receive widespread attention in U.S.

Table 2 Continued: Chinese ASBM Development Timeline

2010 – **March 5:** *Yaogan 9-A/B/C* satellites placed in similar orbits in apparent three-satellite naval ocean surveillance system. **April 28:** Senior Captain Duan Xiaoxian tells Western Pacific Naval Symposium PLAN does not control Chinese ASBMs, which are ground-based and intended to deter Taiwan independence and foreign support for it. **May 20:** CASIC 4th Department Deputy Director quoted stating DF-21D can hit "slow-moving targets" with a CEP of dozens of meters. **July:** Second Artillery may be constructing ASBM missile brigade facilities in Shaoguan, Guangdong. **August:** Taiwan National Security Bureau director-general Tsai De-Sheng: PLA has tested, is deploying DF-21D. **August 24:** Admiral Robert Willard, Commander, U.S. Pacific Command: "To our knowledge, [China's ASBM] has undergone repeated tests and it is probably very close to being operational." **December:** Admiral Willard states that China's ASBM has reached the equivalent of IOC.

2011 – Top U.S. Navy officials state ASBM has reached equivalent of IOC. U.S. and Taiwan officials state that China already has begun to deploy DF-21D. One mainland source likewise claims missile already deployed. **January 3, 5:** Vice Admiral David Dorsett, Deputy Chief of Naval Operations for Information Dominance: China "likely has" both space-based and non-space-based ISR assets "necessary to support DF-21D employment…The Chinese have tested the DF-21D missile system over land a sufficient number of times that the missile system itself is truly competent and capable…But to our knowledge they have not test-fired this over water against maneuvering targets." **February 18:** *Global Times* quotes "military source close to [ballistic missile] development" as stating that "Chinese-made Dong Feng 21D missile…is already deployed in the army." **March 16:** Taiwan National Security Bureau director-general Tsai restates: PLA has tested, is deploying DF-21D. Taiwan military sources quoted estimating 12-20 DF-21Ds deployed. **July 11:** PLA Chief of General Staff General Chen Bingde becomes second Chinese government official to confirm directly that China is developing an ASBM. **August:** Republic of China National Defense Report: "a small quantity of" DF-21D ASBMs "were produced and deployed in 2010," thereby (in the report's view) "increasing the difficulty of military maneuvers in the region for the U.S. Army." **December:** Michael Gilmore, Director, Operational Test and Evaluation, DOD: "China is fielding the DF-21D ASBM, which threatens U.S. and allied surface warships in the Western Pacific…Numerous programs will require" a DF-21D-simulating test missile "including self-defense systems used on our carriers and larger amphibious ships to counter anti-ship ballistic missiles."

Table 2 Continued: Chinese ASBM Development Timeline

2012 – U.S. Navy officials continue to express confidence that the United States has, and is developing, sufficient countermeasures to defeat DF-21D. China continues to develop C4ISR architecture rapidly. In 19 launches, China orbits 26 domestic satellites/spacecraft: *Shenzhou-9* manned spacecraft; Six satellites for *Beidou/Compass* PNT constellation, which achieves regional coverage on schedule at year's end; Five *Yaogan* remote sensing satellites; *Chinasat 2A* (*Zhongxing 2A*) military communications satellite; *Chinasat 12/Zhongxing 12* commercial communications satellite; *Tianlian-I-03* data relay satellite; *Ziyuan 3*, China's first civil precision three-dimensional mapping satellite; *Tianhui-I-02* stereo mapping satellite; *Huanjing-1C* radar imaging satellite; *Fengyun-2F* meteorological satellite; *Fengniao 1-A/B* formation-flying microsatellites; *Tiantuo-1* nanosatellite; *Shijian*-9A/B experimental satellites; and *Xinyan-1* technology demonstration satellite. **November 25:** *Yaogan-16A/B/C* satellites placed in similar orbits in apparent three-satellite naval ocean surveillance system.

2013 – **April 9:** Commander, U.S. Pacific Command, Admiral Samuel Locklear characterizes China's "initial deployment of a new anti-ship ballistic missile" as a "notable [example] of China's improving military capabilities." **April 19:** Defense Intelligence Agency director Lieutenant General Michael Flynn describes DF-21D as one of a "growing number of conventionally armed, medium-range ballistic missiles" "deployed opposite Taiwan." **May 6:** DOD states ASBM under deployment since 2010 "gives the PLA the capability to attack large ships, including aircraft carriers, in the western Pacific Ocean"; suggests China will build variants of other (e.g. longer) ranges.

At any rate, the *Pershing II* inspired Chinese research and has been cited in Chinese sources as influencing the development of China's DF-15C, -21, and "-25" ballistic missiles. Following the *Pershing II*'s deployment, similar initial "research work" reportedly was completed in the early 1990s and incorporated into China's *Dongfeng* (DF) missiles in the form of "warhead that possesses terminal homing guidance and maneuvering control capability" (*dantou jubei moxun de zhidao he jidong kongzhi nengli*). [68] The DF missiles then were showcased—albeit with no evidence of MaRV capabilities—at the 1999 military parade commemorating the 50th anniversary of the founding of the People's Republic.[69]

The end of the Cold War removed the Soviet threat, eliminating what had been a potent rationale for U.S.-China cooperation; Beijing's 1989 Tiananmen crackdown and Taiwan's concomitant democratization further ruptured what had been a robust strategic understanding. Amid these two historic events, the PLA was awed by the U.S. military's precision strike capabilities during *Operation Desert Storm* in 1991, which underscored the PLA's relative backwardness. Perhaps largely motivated by these events, "At the beginning of the 1990s, the Chinese Communist Party Central Committee, the State Council and the Central Military Commission studied and sized up the situation according to the needs of the international military struggle and the development of Chinese weapons and equipment, scientifically making a strategic decision to speed up the development of new models of Chinese missile weapons."[70] Two decades later, in 2010, this decision would lead to the

[68] Qiu, "A Discussion of China's Development of an Anti-Ship Ballistic Missile"; "Special Dispatch: 'Aces' in 'Dongfeng' Family—Miniaturization, Solidification, and Mobility," *Ta Kung Pao*, October 2, 1999, FTS19991114000862; Chen Kejun and Zhao Hanyuan [National University of Defense Technology], "Yi zhong sheyongyu gongji dimian guding mubiao de zuiyou zairu jidongzhidaolu [Applying an Optimal Reentry Maneuver Guidance Law to Attack Fixed Ground Targets]," *Yuhang Xuebao* [Journal of Astronautics], No. 1 (1994), pp. 1–8.

[69] "When they saw the new-type intermediate-range missile in China's 'Dongfeng' family during the latest military parade held on the National Day, people would certainly like to compare it with the 'Pershing II' missile, wouldn't they? Insofar as its look is concerned, the new-type 'Dongfeng' intermediate-range missile has attained the level of the 'Pershing II' missile in terms of size, weight, launch mode, and so on. Insofar as the firing range is concerned, it is believed that it is not much inferior to the 'Pershing II' missile." "Special Dispatch: 'Aces' in 'Dongfeng' Family—Miniaturization, Solidification, and Mobility," *Ta Kung Pao*, October 2, 1999, FTS19991114000862.

[70] Headquarters of the Second Artillery Armament Department, "Changjianfeng zimo lichu—jianzheng mo xinxing daodan zhuangbei 'liang cheng liang li' jianshe [The "Long Sword" Owes its Sharpness to the Whetstone—A Witness's Account of the Build-Up of the Two Capabilities of a Certain New Type of Missile]," in Second Artillery Political Department, *Huihuang Niandai: Huigu Gai Gaige Kaifangzhong Fazhan Qianjin de Di'er Paobing* [Glorious Era: Reflecting on Second Artillery Development and Advances in the Reform and Opening Period, 1978–2008] (Beijing: Zhongyang wenxian chubanshe, 2008), pp. 681–82.

U.S. Department of Defense's assessment that "China has the most active land-based ballistic and cruise missile program in the world. It is developing and testing several new classes."[71] "Some [Chinese weapon] systems, particularly ballistic missiles, incorporate cutting-edge technologies in a manner that rivals even the world's most modern systems," asserts the Pentagon's 2011 report on Chinese military development. China favors missiles and space systems over other types of military systems in terms of resource allocation and production trends. The 2011 report assesses that "Many of China's primary final assembly and rocket motor production facilities have received upgrades over the past few years, likely increasing production capacity. In addition to supplying China's military, complete systems and missile technologies could also be marketed for export. Surge production for these systems could result in a significantly higher output of SRBMs and perhaps double the number of MRBMs per year."[72]

Since shortly after the Cold War's end, Beijing has sought to credibly hold at risk any U.S. military forces that might attempt to intervene in strategically vital areas along China's maritime periphery, particularly those surrounding Taiwan. Despite progress toward this end, however, Chinese naval and maritime analysts have written consistently that their nation's naval capabilities remain insufficient to address critical operational threats. Civilian leaders support substantial, growing naval development in keeping with China's commercial maritime revolution, but continue to prioritize national economic development over military expansion and wish to avoid emulating Soviet mistakes by devoting an unsustainable portion of national resources to the latter. For all these reasons, a widespread but targeted military modernization effort is under way that draws on earlier PLA traditions of pursuing military objectives from a position of relative weakness. As part of this larger effort, a more balanced version of Zhang's 'vision' of ground-launched anti-ship missile development is apparently being pursued. What must be emphasized is that the idea of striking a ship from land is not new and that the idea of "using the land to control the sea" (*yi lu zhi hai*) in this way is very appealing to China, given its geostrategic situation.[73] The concept of ASBM development has assumed new urgency as part of a larger effort to deter U.S. CSGs from

[71] China Military Power Report 2010, p. 1.

[72] China Military Power Report 2011, p. 42.

[73] For direct application of this concept to Chinese ASBM development, see, Wang Wei, "Zhanshu dandaodaodan dui Zhongguo haiyang zhanlüe tixi de yingxiang [The Effect of Tactical Ballistic Missiles on the Maritime Strategy System of China]," *Jianzai Wuqi* [Shipborne Weapons], No. 84 (August 2006), pp. 12–15.

intervening in a potential conflict emerged rapidly in later years in Chinese writings and even conversations with U.S. interlocutors. In 1995, Wang Zudian, director of the Naval Military Studies Research Institute (the PLAN's strategic think tank), opined that in the future "land-based arms will be sharply improved [and] will be able to powerfully strike and intercept formations at sea…"[74]

Breaching the Technical Barrier

With the idea of an ASBM firmly in mind as a means to prevent U.S. intervention and keep U.S. carriers away from Chinese shores, China's next step was to explore its technical feasibility. In many respects, the challenge required integrating already existing Chinese technology and improving upon it. As University of California – San Diego's Tai Ming Cheung explained in 2011, China's ASBM development is an example of "architectural innovation," which is potentially disruptive:

> "Incremental innovation is one of the primary pathways of innovation for the Chinese defense economy for the near-to-medium term because it is the most suited to its technological capabilities. Several defense sub-sectors, including the aviation, shipbuilding, ordnance, and electronics industries, have come out with new generations of weapons systems over the past decade that are subsequently updated on a regular basis.
>
> "As innovation capabilities become more sophisticated, the next stage of progress is architectural innovation. This refers to 'innovations that change the way in which the components of a product are linked together, while leaving the core design concepts (and thus the basic knowledge underlying the components) untouched.' The primary enablers are improvements in organizational, marketing, management, systems integration, and doctrinal processes and knowledge that are coupled with a deep understanding of market requirements and close-knit relationships between producers, suppliers and users.

[74] Shen Zhongchang, "A Rudimentary Exploration of 21st Century Warfare," *Zhongguo Renmin Kexue* [China People's Technology] No. 1 (February 20, 1995), p. 27, FBIS-CHI-95-113.

> "As these are also the same factors responsible for driving incremental innovation, distinguishing between these different types of innovation poses a major analytical challenge. While many of these soft capabilities enabling architectural innovation may appear to be modest and unremarkable, they have the potential to cause significant, even discontinuous consequences through the reconfiguration of existing technologies in far more efficient and competitive ways that challenge or overturn the dominance of established leaders…China's efforts to develop asymmetrical warfare doctrine and capabilities are also another example of architectural innovation..."[75]

Thus, as China's defense industries matured throughout the 1990s and changed their internal business practices, a workable ASBM design became more conceivable. Indeed, the second AMS volume published in 2002, *Research on Island Warfare*, suggested that developing ASBMs would be a realistic option for China, but that many technical tasks remained, especially systems integration:

> "Ballistic missile technology is mature, and missile types are relatively numerous. If ballistic missiles can be properly modified in terms of: integration into a maritime surveillance system, development of a terminally-guided warhead that can adapt to a moving target, and improvement of ballistic missile terminal maneuvering control systems, it will be a [potent] anti-carrier weapon."[76]

China's space program, which has both civil and military components, has furthered overall capabilities that would be useful to an ASBM program, and probably contributed to the sense that an ASBM was workable. With respect to timing issues, it is worth noting that some Chinese sources identify orbital maneuvering as a key technical challenge that was overcome in the *Shenzhou* manned space program.[77] The first *Shenzhou* launch (unmanned) was in 1999, and it is possible that once that obstacle was overcome, the concept was

---

[75] Tai Ming Cheung, "The Chinese Defense Economy's Long March from Imitation to Innovation," *Journal of Strategic Studies* 34, No. 3 (June 2011), p. 330.

[76] Chen Xinmin, Xu Guocheng and Luo Feng, chief eds., *Daoyu Zuozhan Yanjiu* [Research on Island Warfare] (Beijing: Junshi kexue chubanshe, 2002), p. 301.

[77] Wang, "The Effect of Tactical Ballistic Missiles on the Maritime Strategy System of China," pp. 12–15.

perceived to be significantly more realistic and was taken more seriously.[78] As one Chinese source claimed, "China's *Shenzhou* spacecraft successfully carried out orbital adjustments during its experimental flights. Therefore, we can assume that for China there will be no technological hurdles in controlled maneuvers for ballistic missiles in space."[79]

The Second Artillery, it seems, was poised to capitalize on any leadership support for ASBM development and almost certainly controls China's ASBMs today. In fact, it had assumed significant conventional missions for the first time sometime around 1993—perhaps as part of an effort to grow institutionally in an area that was not limited by arms control agreements or a civilian leadership concerned with China's international image with regard to nuclear weapons.[80] Notably, the service published what appears to be a conceptual feasibility study in 2003.[81] As will be explained later, various uses of conventional ballistic missiles to attack aircraft carriers were described explicitly in the high-level doctrinal textbook *Science of Second Artillery Campaigns* published in 2004. In 2004, Professor Xu Cheng, an anti-ship missile expert, advocated targeting carrier-based aircraft and stated that with respect to the idea of using ASBMs, "there are some people making such suggestions." He added that "If the guidance could be further refined and its precision improved greatly, the idea of using a ballistic missile to attack a carrier would not be idle talk at all."[82] The journal that interviewed Xu is published by the Sha'anxi Province Science and Technology Association in Xi'an, which appears to be a key location for ASBM studies given the presence there of the

---

[78] It is important to recognize that some Chinese experts dispute the technical feasibility of the application of *Shenzhou* technology to ASBM terminal homing. Author's interview with Chinese aerospace expert, Beijing, 2008.

[79] Wang, "The Effect of Tactical Ballistic Missiles on the Maritime Strategy System of China," pp. 12–15.

[80] A pre-1986 document written by Second Artillery's chief engineer, entitled "China's Nuclear Weapons Targeting Strategy and Weapons Development to the Year 2000," did not mention using ballistic missiles for targeting aircraft carriers, according to the author's interviews.

[81] Huang Hongfu [Scientific and Technological Committee of the Second Artillery], "Changgui dandaodaodan daji Hangmu biandui de shexiang [Conceptualizing the Use of Conventional Ballistic Missiles to Strike Aircraft Carrier Battle Groups]," *Keji Yanjiu* [Scientific and Technological Research] 1 (2003), pp. 6–8; Li Xinqi, Bi Yiming, Li Hongxia [Second Artillery Engineering College], "Haishang jidong mubiao de yundong yuce moxing ji jingdu fenxi [Movement Forecast Model and Precision Analysis on Maneuvering Targets on the Sea]," Huoli yu Zhihui Kongzhi [Fire Control and Command Control] 30, No. 4 (August 2005), p. 37.

[82] Dong Shihong, "Mubiao, dijian–fang fanjian daodan zhuanjia Xu Cheng jiaoshou [Target, Enemy Ships—An Interview with Anti-Ship Missile Expert Professor Xu Cheng," *Binggong Keji* [Ordnance Industry Science Technology], (August 2004), pp. 24–30.

Second Artillery Engineering College and high-level military industrial institutes—including those responsible for ballistic missile research and development. Collectively, these factors suggest that related concepts and technical solutions probably have been under development at the highest levels of the PLA and China's defense industry for over a decade.

As the PLA came to realize that an ASBM was a genuine possibility, the process of realization probably fed on itself, creating new thinking about how to use missiles against U.S. CSGs. Colonel Dennis Blasko (Ret.), U.S. Army attaché in Beijing and Hong Kong, 1992–96, made a compelling case that, while in the U.S. military doctrine has sometimes driven technological development, up to now the causal chain has been reversed for China. As Blasko wrote, "For the…PLA…most evidence from military sources indicates that 'technology drives doctrine' or, as the Chinese say, 'technology determines tactics' (but not necessarily strategy). Within an overarching Chinese strategic framework, tactics and doctrine will be developed appropriate for (a) the weapons and technologies that are actually in the Chinese armed forces and (b) the people who must operate and maintain them…Exactly how China fights in the future will be dependent upon the weapons and technologies available – and they will be employed within the parameters defined by active defense..."[83] Blasko's argument suggests that, once PLA leaders recognized the ASBM's technical feasibility and the probability that a dedicated program would field a working missile, they probably directed operational analysts to start exploring how a working ASBM could add to or change existing missile doctrine.

[83] Dennis J. Blasko, "'Technology Determines Tactics': The Relationship between Technology and Doctrine in Chinese Military Thinking," *Journal of Strategic Studies* 34, No. 3 (June 2011), p. 355.

V. DISCUSSIONS OF ASBMS IN THE CHINESE LITERATURE

Given the sensitivity of the issue, then, conclusive statements on ASBM status and capabilities by top Chinese leaders are currently unavailable. There are, however, ample data to consider at other levels. Chinese writings on ASBMs in the open-source literature can be divided into three broad categories. In descending level of obvious authoritativeness, these include:

- *PLA doctrinal publications describing how ASBMs might be used in operational scenarios*:

This first and most demonstrably authoritative category comprises official military doctrinal publications. These sources of directive guidance for PLA personnel illustrate how PLA analysts are thinking about using ASBMs in actual operational scenarios. They are typically written in a high register but with a bureaucratic tone by leading scholars at institutions of professional military education, under the editorial guidance of high-ranking active duty officers, or sometimes by retired officers themselves. Several doctrinal publications of the PLA as a whole and of the Second Artillery as an individual branch discuss with some sophistication a variety of ways in which to use conventional ballistic missiles to deter CSGs. This demonstrates that such a possibility is taken seriously by the PLA and suggests that relevant programs have been under development for some time, though it leaves unclear to what extent the PLA has mastered the necessary technical and operational capabilities.

- *Specialized technical analyses of specific aspects of such weapons and their supporting infrastructure*:

This second category consists of highly-specialized, narrowly-focused technical analyses of research efforts involving computer simulations, mathematical calculations and other technical endeavors regarding specific systems and operations both explicitly and potentially relevant to ASBMs. Examples include calculations of the maneuvering range of re-entry vehicles[84]

[84] One technical study determined that if the altitude at which terminal guidance begins is sufficiently high, the range of maneuverability can be as large as 100 kilometers. It would be feasible for such a missile to strike with precision a slow moving target such as an aircraft carrier

and the suppression of sea-surface backscatter for maritime surveillance radars.[85] These are written in a high register with a dispassionate tone by military and civilian technical analysts, whose names and institutions are typically identified, for an audience in their relevant subfield. Compared to articles on other existing weapons systems (e.g. anti-ship cruise missiles/ASCMs),[86] these tend to be theoretical papers utilizing stylized mathematical models and containing equations and diagrams that are impenetrable to those without a technical background. It is unclear how readily they can be translated into concrete engineering solutions. Some analysts, however, do claim that the theories involved have indeed been proven correct, and actual solutions may be contained in other documents. Moreover, analyses appear to have become more detailed, specific, and sophisticated over time. Together, these first two categories of sources offer

---

that "cannot effectively escape an attack within a short period of time." Tan Shoulin and Zhang Daqiao [Second Artillery Engineering College]; Diao Guoxiu, [PLA Unit 96311], "Dandaodaodan daji hangkongmujian mozhidao youxiaoqu de queding yu pingu [Determination and Evaluation of Effective Range for Terminal Guidance Ballistic Missile Attacking Aircraft Carrier]," *Zhihui Kongzhi yu Fangzhen* [Command Control & Simulation] 28, No. 4 (August 2006), p. 9. See also, Sun Peng, Zhang Hexin and Meng Fei, "Research of the Optimal deceleration Speed of the Reentry Vehicle," *Daodan yu Hangtian Yunzai Jishu* [Missile and Space-lift Technology] (April 2006).

[85] One largely theoretical discussion of a satellite maritime surveillance system from a systems engineering perspective concludes that "at the present phase, each type of satellite is dispatched independently. To this end, a more detailed and practical model needs to be established for the execution process for the purpose of planning and coordination of different satellite tasks to better complete such a complicated task." The authors appear to remark that at present China is still facing challenging issues in the coordination of its satellite surveillance system. Qiu Dishan, Zhang Lining and Zhu Jianghan [College of Information System and Management, National University of Defense Technology], "Study of Maritime Maneuvering Target Surveillance Process and Its Modeling," *Junshi Yunchou yu Xitong Gongcheng* [Military Operations Research and Systems Engineering] (December 2007), pp. 72–75. For related studies, see Zhou Ping, Zhang Xinzheng, Huang Peikang and Lin Guiseng. "Results of Airborne Measurement of Sea Surface Backscattering Analysis," *Xitong Gongcheng yu Dianzi Jishu* [Systems Engineering & Electronic Technology] (March 2006); Jin Yaqiu and Li Zhongxin, "Numerical Simulation of Radar Surveillance for Ship Target in Oceanic Clutter," *Chinese Science Bulletin* (November 2002); Zhang Guohua, Yuan Naichang and Zhuang Zhaowen, "Calculation of the Radar Cross Section of an Aircraft Carrier Based on the Plate-Element method," *Guofang Kexue Jishu Daxue Xuebao* [Journal of National University of Defense Technology] 23, No. 5 (2001), pp. 79–83.

[86] Technical articles on anti-ship cruise missiles appear in general to be more concrete, more connected to actual engineering problems and more directly relevant in generating specific solutions. See, for example, Zhou Weimin [Nanjing Naval Command College], "Cong tixi duikang tanxi fanjiandaodan tufang ji duice [Exploration of Anti-Ship Missile Penetration and Its Countermeasures From the Perspective of System Warfare]," *Feihang Daodan* [Winged Missiles Journal] 12 (December 2009), pp. 26–29; Sun Mingwei et al., "Trajectory Design Research on Anti-Warship Missile," *Modern Defense Technology* (February 2007); Zhao Hongcha, Wang Fenglian and Gu Wenjin, "Variable Structure Midcourse Guidance Law with Angle Constraint for Anti-Ship Missile," *Zhanshu Daodan Kongzhi Jishu* [Tactical Missile Control Technology] (January 2006).

good indicators that China has pursued ASBM development seriously and made significant progress.

- *Generalist deliberations and didactic discussions on the technical and operational feasibility of such weapons*:[87]

The third category consists of generalist deliberations designed to appeal to a broad audience, usually concerning the feasibility and effectiveness of ASBMs. They do not typically report the results of new research; instead, they acquaint a general reader with a topic. The topic itself may be technical, but no special technical knowledge is necessary to understand the material presented. Generalist articles generally are written in a lower register and also may contain more passionate, breathless language than a technical article on the same subject. These are written by a variety of naval and maritime analysts (many unidentified), for a broad range of military, defense industrial and popular audiences. Some are perhaps written for educational purposes, and they display varying extents of doctrinal discussion. Tremendous disagreement can be encountered in these sources, even on fundamental issues. More than a few contain technical errors and mistaken assumptions; many, however, offer very specific details.[88] The authoritativeness of these sources is frequently difficult to determine, although many of the commentators are clearly technical experts.[89] Instructive discussions in publications sponsored by China's Navy, such as the journal *Modern Navy*, are more demonstrably authoritative and are sometimes written by recognized PLAN experts. Articles published by magazines sponsored by China's state shipbuilding industry tend to be less demonstrably authoritative. Their authors are rarely identified by institutional affiliation, and many names appear to be pen names based on their disproportionate use of such characters as those for "sea" and "military." These articles may be written by informed observers; however, the lack of an institutional acknowledgement and imprimatur signals the personal nature of these views.

---

[87] This study avoids citing Chinese articles that are largely or merely translations of English-language sources. Some generalist print articles and many online media sources and blogs fall into this category.

[88] Wang Hui, Tian Jinsong and Zhang Liying [Langfang Army Missile Institute], "Jiyu feixingshijian de dandaodaodan huoli kongzhi [Research on Fire Control of Ballistic Missile Based on Flight Time]," *Huoli yu Zhihui Kongzhi* [Fire Control and Command Control] 30, No. 2 (April 2005), pp. 85–87, 91.

[89] While some of these sources are official publications of the PLAN, others are affiliated with China's state shipbuilding industry and other non-PLA organizations.

Table 3: Principal Chinese Generalist Publications Surveyed

Name	Type	Sponsor[a] (*zhuguan danwei*)	Publisher (*zhuban danwei*)	Authoritativeness	Closest U.S. Equivalents[b]
China Military Science (*Zhongguo Junshi Kexue*)	Bimonthly journal	PLA Academy of Military Science	China Military Science Association and PLA Academy of Military Science	Academically rigorous military intellectual articles on doctrine and strategy, future warfare concepts, military history and political issues. Members of the Academy of Military Science constitute editorial board. Authors are identified and include many PLA officers. Targeted audience is PLA officers, academics, and students.	Joint Force Quarterly, Parameters
People's Navy (*Renmin Haijun*)	Official PLAN thrice-weekly newspaper	PLAN Political Department	People's Navy Press	Provides Chinese government policy guidance to PLAN officers and enlisted personnel. Surveys their progress in implementing policy for didactic purposes. Staff reporters write majority of articles; important PLAN and CCP speeches are included as well.	Navy Times

Table 3 Continued: Principal Chinese Generalist Publications Surveyed

Name	Type	Sponsor[a] (*zhuguan danwei*)	Publisher (*zhuban danwei*)	Authoritativeness	Closest U.S. Equivalents[b]
Modern Navy (*Dangdai Haijun*)	Monthly magazine	PLAN Political Department	People's Navy Press	Writing is often concrete and revealing of important capabilities, initiatives, exercises, etc. Many articles have also been published in *People's Navy*. Staff writers write a portion of the articles, but identified PLAN officers contribute as well.	Proceedings
Naval and Merchant Ships (*Jianchuan Zhishi*)	Semi-technical monthly magazine	Chinese Society of Naval Architecture and Marine Engineering	Naval and Merchant Ships Publishing Office	Retired PLAN admirals (e.g. Rear Admiral Zheng Ming, formerly head of the PLAN Equipment Department) are directly involved in publication activities. In 2006 an active duty PLA Navy admiral's article was published. Many articles have also been published in *People's Navy*.	Jane's Navy International

Table 3 Continued: Principal Chinese Generalist Publications Surveyed

Name	Type	Sponsor[a] (*zhuguan danwei*)	Publisher (*zhuban danwei*)	Authoritativeness	Closest U.S. Equivalents[b]
Modern Ships (*Xiandai Jianchuan*)	Twice-monthly magazine	China Shipbuilding Industry Corporation (CSIC). State-owned. China's largest designer, manufacturer, and trader of military and civilian vessels and related engineering and equipment.	China Ship Information Center	Offers scientific and technical information on military vessels. Published by a large professional publisher that has four periodicals and four editorial offices. Target audience is diverse and includes shipbuilding industry professionals.	Sea Power
Shipborne Weapons (*Jianzai Wuqi*)	Monthly magazine	China Shipbuilding Industry Corporation (CSIC)	Zhengzhou Mechano-Electrical Engineering Research Institute (*Zhengzhou Jidian Gongcheng Yanjiusuo*) in Zhengzhou, Henan	Target audience is diverse and includes shipbuilding industry professionals. Affiliated with the military enthusiast website "War Sky" (*Huhuan Junshi Tiankong*) www.war-sky.com, a collection of online forums.	Sea Power

a. Unless otherwise specified, all sponsors and publishers are located in Beijing.

b. These notional designations are designed to suggest that even Chinese publications without "authoritative" content may be influential in naval circles, as are a variety of U.S. publications. The correspondence is not exact and must be interpreted with caution.

Doctrinal Sources

Apparently authoritative doctrinal writings already describe in some detail how ASBMs might be employed, most likely to deter CSGs though demonstrated capabilities; or, in a worst-case scenario, used operationally. Such references largely were ignored in Western scholarship for several years after their publication; this was a case of potentially important information hiding in plain sight. There are volumes devoted to missions for the Second Artillery as part of PLA joint doctrine. Some Western analysts have speculated that ASBMs might be launched not only from land-based transporter-erector-launchers (TELs) controlled by the Second Artillery, but also launched from PLAN submarines.[90] The present author, however, was unable to find any doctrinal writings suggesting that services other than the Second Artillery would be responsible for using conventional ballistic missiles to strike targets at sea.

Two volumes deserve special scrutiny as perhaps the most authoritative writings available on PLA doctrine concerning the use of ballistic missiles in operational and tactical scenarios.[91] The headquarters of the PLA General Staff declares *The Science of Campaigns* (hereafter, SOC) and *The Science of Second Artillery Campaigns* (hereafter, SSAC) have been "printed and distributed to all military forces, colleges, and universities as a training and learning reference."[92] They represent, respectively, the efforts of the PLA as a whole and the Second Artillery to operationalize their roles vis-à-vis the "New General Operations Regulations" approved by President Jiang Zemin in 1999, which were themselves based on the "National Military Strategic Guidelines for the New Period" assigned the PLA in 1993.[93] These guidelines are distilled

---

[90] Regarding the "Type 043" submarine, *Jane's* states "There is speculation that the boat also may be used to test the DF-21D anti-ship ballistic missile." See, "Qing Class," *Jane's Fighting Ships*, February 12, 2013.

[91] Based on the methodology for determining authoritativeness developed by analysts in the Center for Naval Analyses (CNA)'s China Studies Division, a highly-authoritative volume will be published by the PLA Press, on a topic well within its purview, for the purpose of distribution throughout the PLA as high-level teaching material. The volume also will have received inputs and review from across the PLA. The author thanks CNA's David Finkelstein for his guidance concerning these issues.

[92] Statement by the headquarters of the PLA General Staff, *Science of Second Artillery Campaigns* (Hereafter, *SSAC*), p. 3.

[93] "Earnestly Implement Operation Decrees and Continue to Enhance Capacity to 'Win Wars'," *PLA Daily*, February 25, 1999, FTS19990318002173; David M. Finkelstein, "Thinking About the PLA's 'Revolution in Doctrinal Affairs,'" in James Mulvenon and David Finkelstein, eds., *China's Revolution in Doctrinal Affairs: Emerging Trends in the Operational Art of the Chinese People's Liberation*

in at least six manual-like "outlines" (*gangyao*) publications that are authoritative but unavailable to scholars. *SOC* is based on "The Essentials of Joint Campaigns of the People's Liberation Army" (*lianhe zhanyi gangyao*); *SSAC* is based on this and "The Essentials of Campaigns of the People's Liberation Army Second Artillery Force" (*di'erpaobing zhanyi gangyao*), and on the Second Artillery's core mission of "dual deterrence and dual operations" (*shuangchongweishe, shuangchongzuozhan*).[94] These volumes thus offer irreplaceable insights into critical PLA documents.

SOC was written by researchers at China's National Defense University. The 2006 edition, more sophisticated and joint in orientation than its 2000 predecessor, offers a basic overview of conditions under which conventional ballistic missiles might be used to "implement sea blockades" and "capture localized campaign sea dominance" by "implementing missile firepower assault or firepower harassment attacks against important targets on which the enemy depends for...sea-based maneuvering." This would typically be done as part of a joint campaign involving such services as the PLAN and the PLA Air Force (PLAAF), with which there is supposed to be "extremely close coordination," although in unspecified contingencies the Second Artillery might operate independently. Practical aspects, such as the imperative to "react rapidly" and "control the rate of missile consumption," are emphasized to support a nuanced strategy aimed at "apply[ing] great psychological pressure on the enemy" and making him think "that no rules apply, thereby achieving the maximum effectiveness…"[95]

Even more relevant and sophisticated is *SSAC*, which was published by the PLA Press in March 2004. It probably serves as a high-level professional military education handbook for campaign-level command personnel in the Second Artillery and the PLA in general. Its chief editor and his deputy chief editor have a high level of credibility and expertise as top PLA officials. At the time of publication, Lieutenant General Yu Jixun was a Second Artillery

---

Army (Alexandria, VA: Center for Naval Analyses, 2002), pp. 10–18; Brad Roberts, "Strategic Deterrence Beyond Taiwan," in Roy Kamphausen, David Lai, and Andrew Scobell, eds., *Beyond the Strait: PLA Missions Other Than Taiwan* (Carlisle, PA: Army War College, 2008), pp. 174–77.

[94] *SSAC*, p. 404.

[95] Zhang Yulang, chief ed., et al. "Chapter XXXI – Gaishu [Introduction]," *Zhanyi Xue* [The Science of Campaigns] (Beijing: Guofang daxue chubanshe, May 2006), pp. 616–28; Zhang et al. "Chapter XXXII – The Second Artillery Conventional Missile Assault Campaign," *The Science of Campaigns*, pp. 629–36. Yet for all these hints of what the Second Artillery might wish to achieve, these chapters—and the volume as a whole—read like a litany of aspirations rather than an objective assessment of how to achieve PLA goals and execute these operations.

Deputy Commander and Major General Li Tilin was Commandant of the Second Artillery Command College. This was clearly not their personal opinion, but rather the collective institutional viewpoint of the Second Artillery and the "PLA Second Artillery"—not their names—appears on the book's front cover and spine. The foreword by the headquarters of the PLA General Staff further indicates that this book is the institutional position of the PLA as a whole.

How does the Second Artillery conceive of using ASBMs in operational scenarios? The 406-page document represents the best theoretical work yet available by the PLA's foremost thinkers on this subject. It describes the use of ASBMs against carriers in some detail and without suggesting that such an approach is beset with insurmountable difficulties. In fact, in introducing the section describing their potential employment, it states that "conventional missile strike groups" should be used as an "assassin's mace."[96] This suggests that, at least at the conceptual level, the Second Artillery is thinking seriously about ways to use ASBMs against U.S. CSGs and that, consequently, related research and development has at least tacit high-level approval from China's military and civilian leadership.

SSAC states that China's strategic rocket forces will work with the PLAN to "execute focused naval blockades" and "achieve command of the seas."[97] Approaching enemy CSGs are envisioned to be the principal maritime targets, but "large vessels or large ship formations" more broadly are mentioned as well.[98] Coordination and precision are seen as essential for "deterring and blocking enemy carrier strike groups"; such "operational activities need to be coordinated without the slightest difference in time."[99] Coordination with the PLAN also is emphasized in the location of sea targets as well as with regard to the notification and demarcation of blockade areas: "the naval intelligence department should "relay promptly" (*jishi tongbao*) the information obtained by its reconnaissance about enemy ship activities to the Second Artillery campaign large formation."[100] In particular, "information regarding carrier

[96] *SSAC,* p. 395.

[97] Ibid., pp. 140, 320–21; for "execute focused naval blockades," pp. 140, 320–21; for "achieve command of the seas," pp. 140, 317–18.

[98] Ibid., p. 141.

[99] Ibid., pp. 392, 191, respectively.

[100] Ibid., p. 160.

battle groups…should be gathered on a real time basis" (*shishi huoqu*)."[101] Potential sources of "real-time target intelligence" (*shishi mubiao qingbao xinxi*) include "military reconnaissance satellites, domestic and foreign remote sensing satellites, and established satellite reconnaissance target image information processing systems." [102] While ASBMs are not mentioned explicitly in this context, the need for "further real-time intelligence on the dynamic target (*dongtai mubiao*)" to be obtained through "various measures and multiple channels" is recognized vis-à-vis cruise missiles.[103]

SSAC seems to assume that the Second Artillery would have a ballistic missile inventory sufficient to permit numerous warning shots. This would imply having a significant number of DF-21D ASBMs; although for some of the warning shots described, which are designed not to hit moving ships but rather to warn them by striking some distance away, cheaper and more numerous DF-21 variants, e.g. the DF-21C, might not only be seen as more expendable but also might be better equipped to strike a specific location and *not* home in on the CSG itself. Geographic or horizontal escalation in the short run as CSGs approach China's maritime periphery*, SSAC* argues implicitly, can achieve de-escalation in the long run. Although the Second Artillery's interpretation is that such tactics would be effective, however, without advance warning that these were merely warning shots, they could easily be misinterpreted as failed attempts to strike the target. Thus, the "missed" strikes could result in escalation rather than de-escalation—the exact opposite effect of China's intent. This potential problem is addressed after a fashion, calling for "very precise missiles" to avoid errors that "could cause the nature of deterrence to change, giving the enemy an excuse to use force or make follow-up deterrence in a passive situation."[104]

The Second Artillery's vision of ASBM strikes fits within China's "Active Defense" military doctrine. Active Defense is a concept under which limited offensive measures may be employed as necessary to safeguard core strategic interests, even though those strategic goals are viewed as inherently defensive—such as protecting China's maritime periphery. They also fit within the PLA concept of "non-linear, non-contact and asymmetric" (*san fei*) operations. The first, non-linear operations, involves launching attacks from

[101] Ibid., p. 218.

[102] Ibid., p. 218.

[103] Ibid., pp. 218–19.

[104] Ibid., p. 293.

multiple platforms across the operational and strategic depth of an adversary. The ASBM, in concert with cruise missile raids, could play a valuable role. The second, non-contact operations, involves targeting an opponent's platforms outside the enemy's range for striking back. The DF-21D has at least a 1,500 kilometer range, outranging unrefueled carrier aircraft (e.g. the 1,110-kilometer unrefueled range of a carrier-based F-35).[105] Moreover, the missile can be launched from mobile TELs, making it difficult to identify the launchers prior to an ASBM strike. The third, asymmetric operations, involves exploiting physics- or technology-based limitations of an opponent. The ASBM targets the crown jewel of U.S. power projection as the aircraft carrier is one of the key platforms for U.S. operations in the Western Pacific, yet also suffers significant vulnerabilities.

Technical Sources

In addition to the doctrinal literature surveyed above, Chinese authors have produced a large literature examining the technical challenges and possible approaches to overcoming those challenges in developing an ASBM and their supporting systems to a level that might qualify in U.S. terms as "Full Operational Capability" (FOC). These technical assessments are written predominantly by authors associated with the Second Artillery, implying that it controls Chinese ASBM programs; and, of those, the vast majority by individuals associated with the Second Artillery Engineering College in Xi'an. Such dominance in the field of ASBM research suggests this institution may play the key role in developing ASBM-related programs. Xi'an is also, more generally, a major defense industry hub, and other technical analyses come from civilian institutions there, indicating some division of intellectual labor.[106] The Second Artillery Equipment Department and the Second Artillery Equipment Research Institute are the second most prominent batch of

---

[105] Captain Henry J. Hendrix [U.S. Navy], "At What Cost a Carrier?" *Disruptive Defense Papers* (Washington, DC: Center for a New American Security, March 11, 2013), p. 8, <http://www.cnas.org/files/documents/publications/CNAS%20Carrier_Hendrix_FINAL.pdf>.

[106] Ma Yujie, Li Yachao and Xing Mengdao [National Laboratory of Signal Processing, Xi'an Electronic Technology University], "Jizai leida dui duo chuanbo mubiao de chengxiang fangfa yanjiu [Research on Airborne SAR/ISAR Imaging of Multi-Ship Targets]," *Leida Kexue yu Jishu* [Radar Science and Technology] 6, No. 4 (August 2008), pp. 261–67; Wu Chao, Gong Cuiling, Song Wanjie and Wu Shunjun [National Laboratory of Signal Processing, Xi'an Electronic Technology University], "Chuanbo mubiao shishi yiwei juli xiang yanjiu [A Study of the Real-Time Range Profile of Maritime Targets]," *Xiandai Leida* [Modern Radar] 30, No. 7 (July 2008), pp. 56–59.

contributors. Their involvement could indicate procurement or procurement planning is underway.

Earlier studies were simpler and more theoretical in nature. Chinese researchers have studied intensively the problems of target tracking and terminal guidance associated with ASBMs.[107] Technical studies, such as a paper on using synthetic-aperture radar (SAR) to detect surface ships produced outside the PLA, suggest China's expertise with this hardware now goes beyond the strictly military.[108] Researchers at the Dalian Naval Academy offer a battery of tests related to data fusion in support of "monitoring and identifying ships in large-scale sea areas by using space-borne optical sensors."[109] A separate paper by Second Artillery-associated analysts simulates terminal targeting of a moving aircraft carrier using adjoint equations and nondimensional analysis but states that guidance precision-enhancing technologies still need to be developed.[110] Even if there is no explicit evidence of extant Chinese capabilities, a mathematical study by researchers at the Second Artillery Engineering College appears to demonstrate conceptual feasibility.[111]

---

[107] Jiang Jinlong, Yan Zuming and Zhou Hai [Design Institute, China San Jiang Space Group, Wuhan], "GPS/SINS/SAR zuhe xitong zai dandaodaodan mozhidao zhong de yingyong [Application of the GPS/SINS/SAR Integrated Navigation System in Terminal Guidance of Ballistic Missile]," *Feixingli Xue* [Flight Dynamics] 26, No. 5 (October 2008), pp. 78–81; Qin Zhaowei, Huangqing and Hou Yan [Southeast University, Radio Engineering Department], "Jiyu shipin fenxi de dongmubiao jiance jishu [Moving Target Detection Technology Based on Time-Frequency Analysis]," *Zhongguo Keshu Xinxi* [China Science and Technology Information], No. 24 (2005), p. 31.

[108] Wang Juan, Yang Jinsong, Huang Weigen, Wang He and Chen Peng [State Key Laboratory of Satellite Ocean Environmental Dynamics, Second Institute of Oceanography, State Oceanic Administration], "Duoshi chuli dui SAR chuanzhi tance de yingxiang [The Impact of Multi-Look Processing on Synthetic-Aperture-Radar Ship Detection]," *Yaogan Xuebao* [Journal of Remote Sensing] 12, No. 13 (May 2008), pp. 399–404.

[109] Zhang Yu, Zhang Yonggang, Wang Hua and Zhang Xu [Department of Military Oceanography, Dalian Naval Academy], "Liang lei shuiti zhong chuanbo hanqi paowei jihaishui biaoguanguang xue texing de celiang yu fenxi" [Measurement and Analysis of Seawater Apparent Optical Properties of Ship Wakes with Bubbles in Case-II Waters], *Yaogan Xuebao* [Journal of Remote Sensing] 12, No. 1 (January 2008), pp. 15–22.

[110] Zhang Hong, Qi Zaikang and Liu Xiongfei [Beijing Institute of Technology, School of Aerospace Science and Engineering] and Miao Jiansong [Military Representative Office, Factory 247, Taiyuan], "Zhanshu dandaodaodan daji hangmu de mozhidao jingdu yanjiu [Research on Terminal Guidance Precision of Tactical Ballistic Missile(s) Attacking Aircraft Carrier(s)]," *Danjian yu Zhidao Xuebao* [Journal of Projectiles, Rockets, Missiles and Guidance] 28, No. 5 (2008), pp. 1–4.

[111] Li Xinqi, Bi Yiming and Li Hongxia [Second Artillery Engineering College], "Haishang jidong mubiao de yundong yuce moxing ji jingdu fenxi [Movement Forecast Model and Precision Analysis on Maneuvering Targets on the Sea]," *Huoli yu Zhihui Kongzhi* [Fire Control and Command Control] 30, No. 4 (August 2005), pp. 35–37.

Researchers at the Second Artillery Engineering College and Second Artillery 55th Base offer a theoretical exploration of the ability of TBMs with terminal-phase guidance and maneuvering capabilities to attack aircraft carriers. The focus of this simulation is the effective maneuvering range of a maneuverable terminal RV. Once again, there is no specific information regarding the type or specific capabilities of the vehicle being modeled except that it is equipped with control fins. The general feasibility study presents some unsurprising findings, e.g. the higher the altitude that terminal maneuvering begins, and the smaller the angle of reentry, the greater the effective range of maneuverability. Unfortunately, the paper does not present the actual numbers from the simulations, except to say that under optimal conditions, the range of maneuverability approaches 100 kilometers, which is more than enough to cover whatever evasive maneuvers the carrier would undertake.[112]

Terminal guidance precision, however, goes unaddressed in these studies and is left for researchers at the Second Artillery Engineering College and the National Defense Science and Technology University. They offer a mathematical model for terminal guidance, based on a prediction model of a carrier's movement, in which the warhead is directed toward the carrier's projected, rather than its current, position. This constantly is updated and recalculated as new information about the current position of the carrier is received.[113] By using this approach, the precision can be increased significantly to reach a circular error probability (CEP) of roughly 12 meters under the most ideal conditions. This again is a theoretical calculation and nothing is said about the limitations of present Chinese capabilities.[114]

In a related paper, researchers at the Second Artillery Engineering College and the Second Artillery Equipment Department present a model for predicting the "firepower control zone" of an approaching CSG, which would allow land-based TBM batteries to undertake whatever evasive actions are necessary. As the "firepower control zone" or ideal strike distance of a CSG is essentially

---

[112] Tan et al., "Determination and Evaluation of Effective Range for Terminal Guidance Ballistic Missile Attacking Aircraft Carrier," pp. 6–9.

[113] This homing method, called "proportional guidance" is commonly employed by air-to-air missiles, such as the U.S.-manufactured AIM-9 Sidewinder.

[114] Tan Shoulin, Zhang Daqiao and Xie Yu [Second Artillery Engineering College], "Dandaodaodan daji Hangkongmujian mozhidaoxun de fangfa yanjiu [Research on Terminal Homing Guidance of a Ballistic Missile Attacking an Aircraft Carrier]," *Zhihui Kongzhi yu Fangzhen* [Command Control & Simulation] 28, No. 5 (October 2006), pp. 1–5.

a donut-shaped circle centered on the CSG, the core result is a model for predicting a CSG's movement that can provide targeting information for ground-based TBMs. The model is to be calculated by "combining the gray model with a time series auto-regression." The article emphasizes that as large vessels like carriers are relatively un-maneuverable, it is feasible to predict their movements within a relatively short timeframe. For targeting, the researchers suggest precision measured in kilometers within a timeframe of "tens of minutes" would be sufficient. Even though this is a stylized model with many simplifying assumptions, the paper demonstrates the feasibility of such a forecast system. The problem, as the authors point out in the conclusion, is that constructing an actual forecast system would require addressing many other software engineering issues.[115]

Causing maximum damage to an aircraft carrier is another common research topic.[116] For example, Second Artillery Engineering College graduates students offer a theoretical model for calculating damage effects on large targets with many components—i.e. a U.S. CSG.[117] Although the authors speculate that different types of damage would affect the overall effectiveness of the target in different ways, no specific results are given. The delivery of submunitions is a frequent topic and the analyses are sophisticated. Many of these technical articles focus on disabling or disrupting flight operations from carriers and/or runways at air fields, such as those on Taiwan or Okinawa. The Second Artillery already has developed considerable competence concerning the latter mission, according to the evidence presented in a path-breaking article by William S. Murray.[118]

---

[115] Tan Shoulin, Li Xinqi and Tang Baoguo, "Zuhe jianmo de hangmu zhandouqun weixie yujing fangfa [Threat Precaution Simulation of the Carrier Battle Group on the Sea Based on the Combination Model-Building Method]," *Huoli yu Zhihuikongzhi* [Command Control and Simulation] 31, No. 12 (December 2006), pp. 83–86.

[116] Li Xinqi and Wang Minghai [Operations Safeguard Department, Second Artillery Command College], "Dandaodaodan dui daxing shuimian jianting de huishang pinggu moxing [An Evaluation Model of Damage to Large Surface Vessels by Ballistic Missiles]," *Dianguang yu Kongzhi* [Electronic Optics and Control] 15, No. 1 (January 2008), pp. 51–55; Tan Shoulin, Li Xinqi and Li Hongxia [Second Artillery Engineering College], "Dandaodaodan dui Hangkongmujian daji xiaoguo de jisuanji fangzhen [Computer Simulation of Damage Efficiency for Attacking an Aircraft Carrier with Tactical Ballistic Missiles]," *Xitong Fangzhen Xuebao* [Journal of System Simulation] 18, No. 10 (October 2006), pp. 29, 48–51.

[117] Li Xinqi and Lu Jiangren [Second Artillery Engineering College], "Xinxi mubiao huishang xiaoguo zhibiao jianmo fangfa tantao [Study on Modeling of Damage Effect Index of System Target(s)]," *Zhihui Kongzhi yu Fangzhen* [Command Control & Simulation] 29, No. 5 (October 2007).

[118] William S. Murray, "Revisiting Taiwan's Defense Strategy," *Naval War College Review* 61, No. 3 (Summer 2008), pp. 13–38.

Many Chinese researchers also see circumventing or defeating U.S. Ballistic Missile Defense (BMD) as essential to attacking a CSG successfully. This has attracted considerable study and even original thinking.[119] One of the more novel ideas is an "anti-intercept interceptor" suggested by a graduate student at the Second Artillery Engineering College. Although developing and miniaturizing kinetic kill vehicle (KKV) necessary to strike U.S. anti-ballistic missile KKVs is "a relatively new topic for China," the author expresses confidence that this is approach is viable.[120] Perhaps a more practicable solution advanced by researchers at the Second Artillery Engineering College uses a theoretical model of RV maneuvering using "moving mass center" control methods. This involves changing the center of gravity of a warhead modifying its atmospheric flight path by adjusting movable masses within the warhead. The warhead's aerodynamic profile would remain unchanged, and the method can be used in conjunction with fins and other conventional control surfaces. The model demonstrates the mathematical feasibility of such a system, but does not address the potential engineering problems.[121]

More recently, research has become more comprehensive and sophisticated in ways that would be in keeping with DF-21D development progress. There are already many indirectly-relevant analyses on detecting surface ships and threatening them with "anti-ship missiles" of unspecified nature. A net assessment by a ship defense expert at PLAN South Sea Fleet headquarters stands out for its direct consideration of ballistic missiles' ability to penetrate a ship formation's countermeasures. It employs simulation models and

---

[119] Hu Tian and Wu Jing [Missile Institute, Air Force Engineering University], "Zhanshu daodan gongfang duikang dandao fangzhen yanjiu [Trajectory Simulation on Attack-Defense Countermeasure of Tactical Ballistic Missile]," *Jisuanji Celiang yu Kongzhi* [Computer Measurement & Control], 16, No. 8 (2008), pp. 1132–35; Zhu Qingguo, Liu Gang and Xian Yong [Second Artillery Engineering College], "Zhanshu dandaodaodan fangyu zhong de hongwai tance yujing fenxi [Analysis of Infrared Detection and Early Warning to Tactical Ballistic Missile Defense]," *Hongwai* [Infrared] 27, No. 11 (November 2006), pp. 15–18; Cao Xizheng, Guo Lihong and Yang Limei [Changchun Institute of Optics, Fine Mechanics and Physics, the Chinese Academy of Sciences], "Zhanshu Dandaodaodan zairuduan hongwai fushe texing fenxi [Infrared Radiation Characteristics Analysis of Tactical Ballistic Missiles During Reentry]," *Guangdian Gongcheng* [Opto-Electronic Engineering] 33, No. 9 (September 2006), pp. 23–26.

[120] Ibid, pp. 23–26; Wang Dingchao [Second Artillery Engineering College], "Fandongneng lanjieqi lanjie fangan sheji [Planned Design for an Anti-Intercept Interceptor]," *Sichuan Binggong Xuebao* [Sichuan Ordnance News] 29, No. 5 (October 2008), pp. 36–37, 45.

[121] Tang Jian and Zhang Hexin [Second Artillery Engineering College], "Bianzhixin dandaodaodan gongji hangmu fenxi [Analysis of Attacking an Aircraft Carrier with a Moving Mass Center Surface-to-Surface Missile]," *Zhihuikongzhi yu Fangzhen* [Command Control and Simulation] 29, No. 5 (October 2007), pp. 41–43.

algorithms to consider such factors as high spectral density, sea states, and levels of sea clutter.[122]

Reentry optimization for "boost-glide missiles" has become a major research topic. Studies published by three major defense industry centers in 2012 alone suggest a broadening and possible coordination of efforts. One such study is funded by the 863 Program and coauthored by Second Artillery Engineering College researchers and an expert in the Second Artillery Military Representative Office in Beijing's 211 Factory. It employs mathematical and aerodynamic models to optimize ballistic missile reentry trajectory during a 3-4 second timeframe. [123] Specialists at National University of Defense Technology's Aerospace and Materials Engineering Academy offer suggestions regarding trajectory optimization and parameter analysis. [124] Researchers at Northwest Polytechnic University's Key Laboratory for Space Flight Dynamics suggest range management techniques.[125]

These technical analyses are narrowly focused on ensuring an operationally-effective ASBM, including its supporting targeting infrastructure. Were these assessments to go up through the system to China's political-military leaders, the technical articles surveyed here would not be of much assistance in helping them to understand the strategic ramifications of using an ASBM. Even if the doctrinal and technical ASBM literature does not enter the Chinese leadership's calculations directly, however, other commentators in various publications have discussed the merits and implications of the ASBM. Even if these public discussions are not the products of those directly engaged in the policy process, their ideas could influence those who are, could reflect parallel debates in official circles or, lastly, could be designed to help justify establish policy related to the eventual deployment of a fully-functional ASBM.

---

[122] Tao Jianmin, "Dandaodaodan dui jianting biandui de jufang gailü jisuan ji fangzhen yanjiu [Simulation and Calculation of Probability of Ballistic Missile to Penetrate Surface Ship Formation]," *Jianchuan Dianzi Gongcheng* [Ship Electronic Engineering] 31, No. 11 (November 2011), pp. 79–81, 88.

[123] Zhao Xin et al., "Zhutui-huaxiang daodan zairu dandao kuaisu youhua [Rapid Re-Entry Trajectory Optimization for Boost-Glide Missile]," *Guti Huojian Jishu* [Journal of Solid Rocket Technology] 35, No. 4 (2012), pp. 427–33.

[124] Liu Xin, Yang Tao and Zhang Qingbin, "Zhutui-huaxiang daodan dandao youhua yu zongti canshu fenxi [Trajectory Optimization and Parameter Analysis for Boost-Glide Missiles]," *Dandao Xuebao* [Journal of Ballistics] 24, No. 3 (September 2012), pp. 43–48.

[125] Wang Chenxi and Li Xinguo, "Zhutui-huaxiang dandaodaodan shecheng guanli jishu yanjiu [Research on Range Management Technology for Boost-Glide Missiles]," *Guti Huojian Jishu* [Journal of Solid Rocket Technology] 35, No. 2 (2012), pp. 143–47.

The Generalist Literature

The available doctrinal literature should clearly be seen as the most demonstrably authoritative category of open-source writings, and the technical literature often roughly equivalent. Doctrinal publications are written by identifiable Second Artillery officers, other PLA professionals and individuals associated with the highest levels of the military education establishment, implying some minimum degree of institutional endorsement. By virtue of their institutional authorship, *SOC* and *SSAC* have been vetted at a higher joint level and, thus, can be seen as reflective of PLA planning. Nevertheless, Chinese doctrinal publications often discuss theoretical capabilities as though the PLA already fielded them—something that U.S. joint publications typically do not—and, therefore, it is not safe to extrapolate extant capabilities from these otherwise authoritative sources on Chinese thinking.

The uncertainty created by the PLA's willingness to include aspirational or theoretical capabilities in its publications makes it useful to examine the less-than-clearly-authoritative but more diverse generalist literature. This set of Chinese-language articles covers a range of ASBM-related topics, including development and employment as well as challenges and dilemmas that China might encounter. These opinions matter—irrespective of the actual status of the ASBM program—because perfecting and fully deploying the DF-21D entails resolving a broad set of challenges and policy considerations that transcend many organizational boundaries. The technical challenges of data fusion for targeting may pale in comparison to the inter-organizational data fusion needed to make the ASBM a functional weapon that operates within the bounds of Chinese strategic intent.

Strategic Rationale and Scenarios

This third set of literature concerning the operational effects of ASBMs and their potential value for Chinese strategy is in broad, albeit not complete, agreement. The promotion of ASBMs feeds several strategic needs. The first is that they are a means to overcome conventional inferiority by exploiting technological asymmetry. This helps to afford China a credible deterrent against intervention, more political maneuvering space and an additional measure for escalation control. These points of leverage make the ASBM an "assassin's mace" for victory if deterrence breaks down.

Of supreme importance to Beijing is Taiwan's political status. At the strategic level, Beijing seeks to deter Taipei from declaring independence, while progressively constraining its political space, and encouraging eventual reunification, with a wide variety of hard- and soft- power tools. TBMs are thought by one analyst to offer China a "third" alternative to the risk of engaging in outright attack, on one hand, and the limitations of restricting actions to rhetoric and diplomacy, on the other. Termed "attacking without entering," a TBM campaign is seen by this observer as increasing mainland China's strategic options while limiting Taiwan's.[126] In addition to their psychological and deterrent effects, ASBMs (as a type of TBM) are believed to offer China a way to exert hard-power pressure and convey strategic signals in scenarios that do not rise to the level of war. This would seem in concert with Chinese strategic writings, which often express considerable confidence that China can manage escalation in measured increments with a high degree of certainty. At the operational level, facing the possibility of intervention by a technologically more advanced navy in the event of a Taiwan conflict, the PLA seeks an asymmetric "silver bullet" that will (ideally) forestall such intervention from occurring in the first place; or, in a worst-case scenario, offer the ability to attack platforms that are perceived to threaten China. ASBMs promise to further this strategy at far lower cost than force-on-force approaches. Three PLA officers from the Second Artillery Command College declare that "guided missile forces are the silver bullet in achieving victory in limited high-technology war."[127] A professor and student at the PLAAF Engineering Academy evoke an analogous concept when they write that ballistic missiles enjoy a higher probability of penetration than other anti-access weapons: TBMs have become "the 'poor country's atomic bomb.'"[128] One article goes so far as to project the following:

---

[126] Wang, "The Effect of Tactical Ballistic Missiles on the Maritime Strategy System of China," pp. 12–15.

[127] Ge Xinliu, Mao Guanghong and Yu Bo, "Xinxizhan zhong daodanbudui mianlin de wenti yu duice [Problems Faced by Guided Missile Forces in Information Warfare Conditions and Their Countermeasures]" in Military Science Editorial Group, *Wojun Xinxizhan Wenti Yanjiu* [Research Questions about Information Warfare in the PLA] (Beijing: National Defense Univ. Press, 1999), pp. 188–89, cited in Larry Wortzel, "PLA Command, Control, and Targeting Architectures: Theory, Doctrine, and Warfighting Applications," in Roy Kamphausen and Andrew Scobell, eds., *Right-Sizing the People's Liberation Army: Exploring the Contours of China's Military* (Carlisle, Pa.: U.S. Army War College, 2007), p. 211.

[128] Zhao Jiandong and Zhao Yingjun [Missile Science Institute, Air Force Engineering University], "21 shiji fangkong de guanjian—fandao [The Key to Air Defense in the 21st Century: Antimissile]," *Feihang Daodan* [Winged Missiles Journal] (June 2007), pp. 12–16.

> "The primary form of future sea combat will be the extensive use of precision guided ballistic missiles in long range precision attacks…We must view…long-range sea-launched precision-guided ballistic missiles as the priority of our weaponry building…we have to greatly reinforce [their] development. When developing [them], we have to pay attention to multiple uses and universality, in order to make them able to attack land as well as sea-surface targets."[129]

One of the most nuanced strategic analyses on the issue, an article published in the China Shipbuilding Industry Corporation (CSIC) journal *Shipborne Weapons*, states that ballistic missiles "provide China with more maneuvering space for military and political strategic operations on its eastern, maritime flank."[130] More specifically, the article argues the following:

> "[The creation of a] tactical ballistic missile maritime strike system…will establish for China in any high-intensity conflict in its coastal waters an asymmetry, in its favor, in the deliverance of firepower and so will remedy to some extent China's qualitative inferiority in traditional naval platforms. Further, the existence of this asymmetry would set up for both sides a psychological 'upper limit' on the scale of conflict. This would enable both parties to return more easily 'to rationality,' thereby creating more space for maneuver in the resolution of maritime conflicts."[131]

How Chinese strategists assess the impact of ASBMs for various conflict scenarios is far more difficult to evaluate. Few articles address this topic. One that does states that "the PLA must use all of its electronic warfare and reconnaissance assets properly, must neutralize enemy antimissile systems and missile sensor systems, and should use electronic jamming on the enemy fleet. Such combined kinetic and electronic attacks help the PLA attack an enemy fleet...with a combination of explosive, anti-radiation, and fake warheads to deceive enemy radar and sensor systems and defeat a deployed battle group or one in port."[132] In any case, the concept hinges on technical feasibility (the

---

[129] Wang Zaigang, "Chaoji hangmu biandui de kexing [The Nemesis of Super Aircraft Carrier Battle Groups]," *Jianchuan Zhishi* [Naval and Merchant Ships], (January 2005), pp. 24–27.

[130] Wang, "The Effect of Tactical Ballistic Missiles on the Maritime Strategy System of China," pp. 12–15.

[131] Ibid.

[132] Ge Xinliu, Mao Guanghong and Yu Bo, "Problems Faced by Guided Missile Forces," cited in Wortzel, "PLA Command, Control, and Targeting Architectures," p. 210.

subject of the next section of this study). Chinese discussions of ASBM employment typically center on their use to deny U.S. CSGs access to waters relevant to a Taiwan conflict, presumably to the island's east, and hence to the airspace over the strait and even over the island itself. The idea seems to be to hold carriers back through deterrence and to attack them if they come forward.

At the same time, ASBMs are recognized to have significant limitations, even potential dangers. According to one analyst, they "cannot replace aircraft carriers, submarines, and other traditional naval weapons": they "can be used to destroy enemy forces at sea but not to achieve absolute sea control, let alone to project maritime power."[133] Two writers in the CSIC publication *Modern Ships* go much farther, declaring that while ASBMs are technically possible, their employment in practice is fraught with difficulties: they offer limited power-projection capabilities, are highly escalatory if employed, and might in fact trigger nuclear retaliation.[134] These challenges can be surmounted, in their view, if one is dealing with a minor power, but not with a superpower like the United States. One claim they make, as have others, is that reducing the speed of the warhead in the terminal reentry phase in order to operate its guidance radar makes it more vulnerable to anti-ballistic missile (ABM) interceptors. To some extent this depends on one's assessment of the maneuverability of the warhead in its terminal entry phase, but the authors of the *Modern Ships* article are highly skeptical. They acknowledge that the problem may be overcome to some extent in a saturation attack, but they insist that the *Aegis* defense system is designed to deal with precisely such a challenge. They also point to the relatively high costs of ballistic missiles. Further, they suggest that the use of ballistic missiles in a saturation attack would "likely lead to the scenario described by ancient Chinese strategists, in which the weapon in question becomes unusable in practice" because its use would be highly escalatory: "Apply little force, and no real harm can be done to the enemy; apply great force, and the first harm is done to the self."

Even if ASBMs were indeed developed successfully, by virtue of an overwhelming investment of resources and energy, the *Modern Ships* authors contend, a critical problem would remain: whether anyone would dare use

---

[133] Wang, "The Effect of Tactical Ballistic Missiles on the Maritime Strategy System of China," pp. 12–15.

[134] Unless otherwise specified, all data in these two paragraphs are derived from Huo Fei and Luo Shiwei, "Wugongzhijian—Fanhangmu dandaodaodan xiaoneng ji shiyonghua pinggu [Arrows without Bows—An Evaluation of the Effectiveness and Employment of Anti-Aircraft-Carrier Ballistic Missiles]," *Xiandai Jianchuan* [Modern Ships], No. 325 (April 2008), pp. 27–28.

such weapons in an actual conflict scenario. The authors seem to suggest that while conventional TBMs could be used against Taiwan with little risk, their employment against U.S. carriers would immediately create a grave political problem: "Since the introduction of nuclear weapons, all the major nuclear powers have developed ballistic missile warning systems against possible nuclear attacks, and there has not been a single precedent of a major nuclear power attacking another with ballistic missiles." As no technology today is capable of distinguishing between a conventional and a nuclear warhead prior to detonation upon impact, the authors worry that any ballistic-missile attack against another nuclear power might activate its strategic retaliation mechanisms and thereby instigate a nuclear conflict. The *Modern Ships* authors emphasize that in any escalation scenario, the extreme psychological duress to which the military personnel of both sides would be subjected would make it particularly dangerous to employ ballistic missiles, as any small mistake in judgment might trigger a nuclear Armageddon.

Even absent any misperception, it must be emphasized, sinking or disabling a ship that is a symbol of American power and has a crew of thousands could provoke an extremely serious response. Of course, elements of the PLA, and even their civilian leaders in a crisis, might be less cautious than these analysts. Another writer, having reviewed their performance in battle since the 1960s, concludes that TBMs are an indeed, as others have argued, an "assassin's mace."[135] A Chinese interlocutor has told the present author that the Second Artillery is itself considering placing nuclear and conventional warheads interchangeably on the same types of missiles—for example, the DF-21—so that they will "possess both nuclear and conventional [*hechang jianbei*] capabilities." This last may be evidence of open debate, of manipulation of American opinion, or of sensitizing the United States to operational implications. If the last, there is a clear risk of misperceptions in the event of launch in a conflict.

The question of operational control is not addressed directly in the open sources, but the content of doctrinal publications, the large number of Second Artillery officers writing on the topic, and the current responsibility of that service for the vast majority of nuclear and conventional ballistic missiles suggest that the Second Artillery is likely to have sole responsibility for

---

[135] Anonymous, "Zhenhan Zhangchang de 'Paowuxian gongji'—Zhanshu dandaodaodan zai shijizhan zhong de biaoxian [The 'Parabolic Attack' of the Shock Battlefield]," *Xiandai Bingqi* [Modern Weapons] (May 2001), pp. 38–40.

ground-based ASBMs. (The possibility of rivalry and divergence of viewpoints that may result between the Second Artillery and the PLAN will be addressed later in this study.)

Open Source Timeline

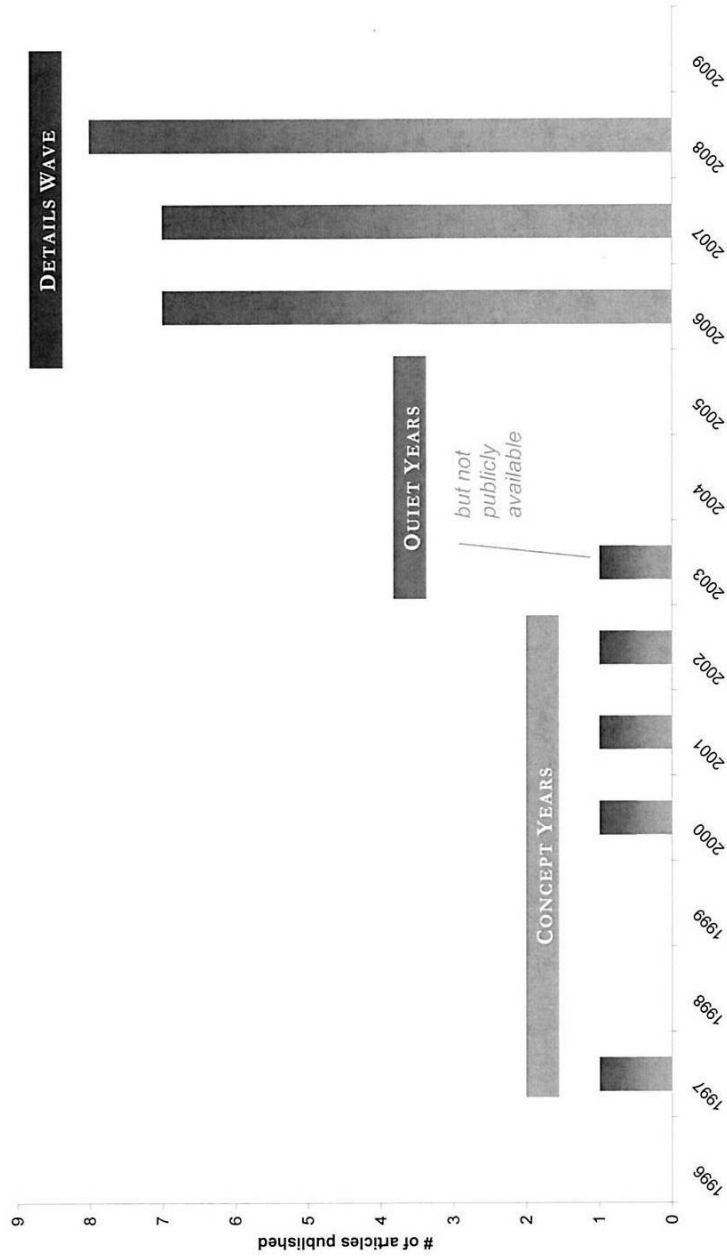
Chinese authors have written—and Chinese censors have permitted—two major phases of discussion about the ASBM.[136] The first phase, which might be termed the "Concept Years," began as early as 1997 and lasted until 2002. The second phase, which might be termed the "Details Wave," began around 2006 and continues to the present. The period in between—approximately 2002 to 2006—might be termed the "Quiet Years." **Figure 1** (below) depicts the relative incidence of selected articles during these periods.[137]

---

[136] This section is based on detailed examination of twenty-seven Chinese-language sources which take the ASBM as their primary topic. For the purpose of formulating a meaningful timeline, two major types of articles were excluded. First, articles were excluded that mention the ASBM in a broader discussion that generally lists options for attacking CSGs. Such sources typically rely in turn on those sources that deal with the ASBM as their primary topic, and hence do not add new information to the discourse. Second, articles were excluded that discussed key enabling technologies for not only ASBMs but also other weapons systems. Of these, the two most-discussed themes are the C4ISR capability to detect and track a CSG, and the ballistic missile's ability to penetrate a defended area. Although these two capabilities are critically important to a successful ASBM attack, they are also necessary to support a broad range of military options that have nothing to do with the ASBM. With or without an ASBM, China needs to be able to see and track CSGs for strategic warning and to use any long-range weapon, whether surface-, submarine-, or air-launched. In the same way, any modern ballistic missile that does not implement defense penetration measures will be irrelevant if BMD is successful. Maritime surveillance and defense penetration capabilities, then, are best seen as necessary but not sufficient conditions for an ASBM program; it is conceivable that China might have developed these technologies but still decided not to field an ASBM (though this theoretical possibility has been overtaken by events).

[137] The figures in this section plot twenty-seven ASBM-specific Chinese-language articles in time. The X-axis represents time, proceeding from left (earlier) to right (later), with the month and year noted at the top of the chart. The Y-axis does not represent a scalar quantity; each article is simply given a row of its own. Up to three interesting milestones in the life of the article are plotted; first, if the date the article was submitted to the journal is known, the month of submission is colored light gray; second, if the date the article was edited for the journal is known, it is plotted in dark gray. Finally, for every article, the month of publication is plotted in black. The Chinese title of the article appears to the left of the first interesting time-event; the English title of the article—generally, the one offered by the journal itself—appears to the right of the last interesting time-event. In some cases, particularly those toward the left or right edge of the graphs, the titles are necessarily abbreviated.

Figure 1: ASBM Publications by Year, 1996–2009



1997–2002: The "Concept Years"

Beginning at least as early as December 1997 and lasting until about 2002, the concept of adapting China's ballistic missile systems to attack aircraft carriers appeared openly in print. In the quarterly *National Defense Science & Technology*, three researchers at China's National University of Defense Technology in Changsha proposed to "open a new line of thinking, researching the application of a new weapons system, in order to satisfy our [China's] military's future requirement for anti-carrier warfare." They maintained, "Developing mid-course and terminal guidance technologies for ballistic missiles are not only the natural development trends for ballistic missiles…it also has a very great military value."[138] Examination of the ASBM concept proceeded in other, more-technical journals, considering the requirements for mid-course maneuver and terminal guidance already suggested by the researchers in Changsha. During the "Concept Years," all authors frankly addressed the difficulties inherent in engineering the ASBM, but were optimistic that the problems could be solved.

As **Figure 2** indicates, at least four articles were published arguing that China should adapt its ballistic missiles to the anti-carrier mission.[139] These articles have several themes in common:

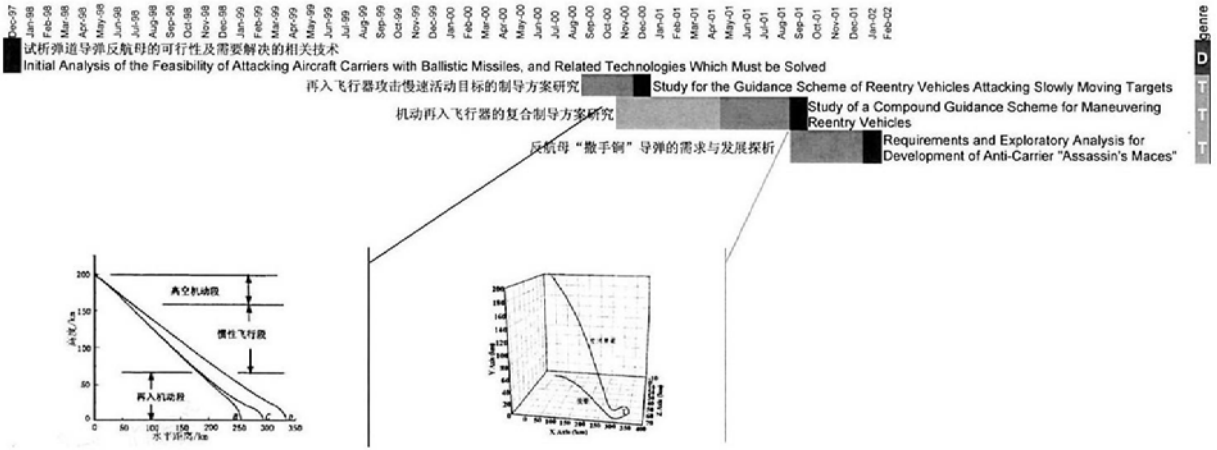
- The capability to defend China against attack by U.S. aircraft carriers is a national imperative;
- China's ballistic missiles are a particularly advanced area of its military, and are well-suited to the anti-carrier mission;
- The C4ISR problem—locating, tracking, and engaging the aircraft carrier—is the principal technical challenge;

---

[138] Xu Minfei, Zhu Zili and Li Yong, "Shixi dandaodaodan fanhangmu de kexingxing ji xuyao jueding de xiangguan jishu [Initial Analysis of the Feasibility of Attacking Aircraft Carriers with Ballistic Missiles, and Related Technologies Which Must be Solved]," *Guofang Keji Cankao* [National Defense Science & Technology Reference] 18, No. 4 (December 1997), pp. 126–30.

[139] Ibid.; Chen Haidong, Yu Menglun, Xin Wanqing and Li Junhui [Beijing Institute of Astronautical Systems Engineering] and Zeng Qingxiang [Beijing Institute of Special Mechanical and Electronic Devices], "Zai ru fexingqi gongji mansu mubiao de zhidaofanan yanjiu [Study for the Guidance Scheme of Reentry Vehicles Attacking Slowly Moving Targets]," *Daodan yu Hangtian Yunzai Jishu* [Missiles and Space Vehicles], No. 6 (2000), pp. 5–9; Chen Haidong and Yu Menglun [Beijing Institute of Astronautical System Engineering], "Jidong zairufeixingqi de fuhe zhidao fanganyanjiu [Study of a Compound Guidance Scheme for Maneuvering Reentry Vehicles]," *Yuhang Xuebao* [Journal of Astronautics] 22, No. 5 (September 2001), pp. 72–76; Huang "Conceptualizing the Use of Conventional Ballistic Missiles to Strike Aircraft Carrier Battle Groups," pp. 6–8. A fifth source is a doctrinal piece that was published internally.

Figure 2: Selected ASBM Articles, 1997–2002



Time-event legend:

- submitted to publication *(not available for all articles)*
- edits received by publication *(not available for all articles)*
- published

In the rightmost column of each of the following three charts, the genre, or 'voice' of the article is categorized as doctrinal, technical, or generalist.

Genre legend:

- D doctrinal
- T technical
- G generalist

- Making the warhead maneuverable enough to engage a moving target is the second technical challenge;
- The operational system will exert a deterrent effect on the United States.

2002–2006: The "Quiet Years"

Conclusions drawn from the absence of evidence are intrinsically weak; it is thus with some reservations that the years from 2002 to 2006 are termed the "Quiet Years"—a time when technical articles dedicated to the ASBM were apparently not published openly in significant numbers after January 2002. This is not to say that all publically-available research on the ASBM ceased. In 2002, an M.A. candidate at the Second Artillery Engineering College submitted a dissertation on the subject.[140] Moreover, it is certainly possible that this targeted literature review has been incomplete and missed a gradual and continuous evolution in China's ASBM discourse. Even if this research to date has missed some sources that would make the period between 2002 and 2006 seem less "quiet," however, there is no doubt that beginning in 2006, articles on the ASBM changed in tone, scope and quantity—a shift accordingly termed the "Details Wave."

2006–Present: The "Details Wave"

Beginning in mid-2006, topical articles (some of which had been submitted as early as spring 2005) began appearing that each focused on a specific element of the ASBM employment problem. The arguments that an ASBM was strategically imperative and technologically feasible for China—arguments that had occupied entire articles during the "Concept Wave"—appear condensed into single sentences and paragraphs as introductions to articles with a principal line of inquiry into the details of an ASBM system. These include how to detect and track a carrier, how large the reentry vehicle's (RV) maneuver footprint could be, how the carrier's early warning system and evasive maneuvers would affect ASBM engagement as well as how much

[140] Wang Yanfeng, "Changgui daodan gongji Hangmu yunyong Yanjiu [Applied Research on Conventional Ballistic Missiles Attacking Aircraft Carriers]," M.A. Thesis, Second Artillery Engineering College, 2002.

damage submunitions could do to a targeted carrier's systems. In addition, generalist voices joined the discussion in a more routine fashion.[141]

The beginning of the "Details Wave" dates to 2006. Just as waves have their genesis some distance offshore, journal articles are likewise based on research conducted before their publication. Fortunately for foreign analysts, Chinese technical journals routinely publish the date a manuscript was received, and sometimes also provide a date when the manuscript was edited.[142] As depicted in **Figure 3**, these dates make clear that a number of the articles published in 2006 and 2007 described research actually conducted and written up in 2005.

What explains this wave pattern? As ASBM writings moved from the conceptual to the active research stage, it is only natural that they would proliferate. The real puzzle is why there was such a deep "bathtub"-shaped "trough" in between the two "waves." The answer may lie at least partially in the aforementioned publication delays. Following the completion of high-level Second Artillery studies in 2003, ASBM development may have become a more sensitive issue, pushing the subject away from public view. Only by 2006, as policy clarity and research results probably solidified, did most publications see fit to release articles on the subject.

Areas of Agreement in the Open Source Literature

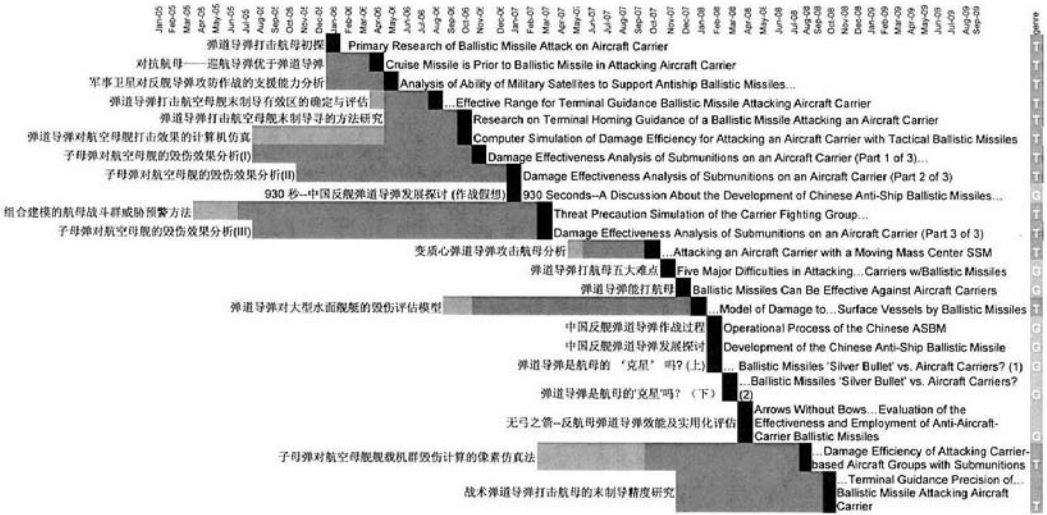
Chinese assessments generally concur that ASBMs, if deployed effectively, would offer a variety of operational effects and value for Chinese maritime strategy—particularly vis-à-vis Taiwan. If this vision were achieved, it could impose significant restrictions on U.S. naval operations during a Taiwan crisis, especially as there are complementary discussions in Chinese writings about holding U.S. land bases in theater at risk. Chinese observers further believe that acknowledgement in Taiwan and the United States of such a change in the military balance would deter Taiwan independence and encourage cross-Strait integration on Beijing's terms.

---

[141] See, for example, Li Jie [Navy Military Arts Research Institute], "Dandaodaodan shi kangmu de 'kexing' ma? (shang) [Are Ballistic Missiles a 'Silver Bullet' Against Aircraft Carriers? (Part 1 of 2)]," *Dangdai Haijun* [Modern Navy] (February 2008), pp. 42–44; Li Jie, "Dandaodaodan shi kangmu de 'kexing' ma? (xia) [Are Ballistic Missiles a 'Silver Bullet' Against Aircraft Carriers? (Part 2 of 2)]," *Dangdai Haijun* [Modern Navy] (March 2008), p. 51.

[142] Unfortunately, generalist publications do not provide this information.

Figure 3: Selected ASBM Articles, 2006–2008



Time-event legend:

- submitted to publication *(not available for all articles)*
- edits received by publication *(not available for all articles)*
- published

In the rightmost column of each of the following three charts, the genre, or 'voice' of the article is categorized as doctrinal, technical, or generalist.

Genre legend:

- D doctrinal
- T technical
- G generalist

While there are clearly differences among Chinese ASBM writings, it is important to examine the areas that they have all collectively treated as conventional wisdom, issues on which there is no disagreement regardless of forum, institutional affiliation or individual viewpoint. There are several points of general consensus among a variety of sources; not all share these assertions, but few, if any, dispute them. Chinese commentators agree that an ASBM would be based on an upgraded version of an existing Chinese medium range ballistic missile, such as the DF-21/CSS-5.[143] A "DF-21D variant" is reportedly closest to an anti-ship version; some Chinese writings say this of the "C" version; others refer to future modifications as well (e.g. a "DF-21E").[144] Still other Chinese analysts imply that "C" and "D" versions would be used in combination—though it is not clear that both would in fact operate as ASBMs as opposed to non-homing missiles (see the present author's speculation in the preceding "Doctrinal Sources" section that DF-21C missiles might potentially be used for warning shots designed explicitly *not* to strike CSGs).[145]

The prototype for China's ASBM is generally held to be the *Pershing II* ground-to-ground TBM deployed from 1984 to 1988—this is an unusual instance in which Chinese analysts do not regard Russia as a model for weapons development.[146] The United States does not have an ASBM. It did have an emerging capability in this area in the form of the *Pershing II*. Washington, however, relinquished this capability when it ratified the INF Treaty with Moscow on May 27, 1988. The INF Treaty prevents both the United States and Russia from possessing ground-launched ballistic and cruise missiles with ranges of 500 to 5,500 kilometers. As two contributors to the CSIC journal *Modern Ships* pointed out, the *Pershing II* was the first ballistic missile to be equipped with terminal guidance technology, which allows the missile to improve its CEP to approximately 37 meters from the 370 meters of the

---

[143] Some sources also mention the DF-15.

[144] Huo and Luo, "Arrows without Bows," p. 23; Qiu Zhenwei and Long Haiyan, "930 miao—Zhongguo fanjiandandaodaodan fazhan tantao (zuozhan jiaxiang) [930 Seconds—A Discussion About the Development of Chinese Anti-Ship Ballistic Missiles (Combat Scenario)]," *Xiandai Jianchuan* [Modern Ships] (January 2007), pp. 27–34.

[145] Author's Interview with Chinese expert, 2010.

[146] They generally view the Soviet R-27K/SS-N-13 as being too imprecise, as it was nuclear-armed, only had a 370m CEP, and never became operational. For a rare exception to relatively low Chinese coverage of Soviet/Russian TBMs, see Zhang Changwei, Zhou Ming and Zhang Qi, "'Yisikande'er' daodan—xiandai zhangchang shang de 'dianxuegaoshou' ['Iskander' Missile—'Chakra Point Pressing Master' in Modern Battlefields]," *PLA Daily*, March 15, 2010 <http://chn.chinamil.com.cn/xwpdxw/wqzbxw/2010-03/15/content_4153819.htm>.

Pershing I against a fixed target, despite a range some 2.5 times that of its predecessor.[147] Based on the *Pershing II*, the authors describe a feasible ASBM as having a range between 1,500 to 2,000 kilometers with a warhead weighing around 1,500 kg. It would be equipped with terminal guidance and terminal stage maneuvering capabilities, and its conventional payload would weigh no less than 500 kg.[148]

As noted above, some Chinese sources state that previous advances in the now-abandoned *Pershing II* program inspired Chinese research and development relevant to an ASBM. Chinese sources also state that the DF-15/CSS-6 missile is based on the *Pershing II*, which has adjustable control fins for terminal maneuver on its RV. While some DF-15 versions lack RVs with control fins, one with an RV virtually identical to the *Pershing II*'s may be found on the *China's Defence Today* website.[149] Unfortunately, positively identified photos of a DF-21 outside its canister are not known to exist. Pictures of the DF-15's RV, however, do bear a striking resemblance to the *Pershing II*. Since the DF-15 resembles the *Pershing II*, it is reasonable to suppose that the related DF-21 does as well, and that both employ similar adjustable fins that permit terminal maneuver. As Internet photos of the DF-15 indicate, China has such an RV, which could easily be mounted atop the DF-21 booster and thereby produce part of the basis for an effective ASBM. RV control fins have been depicted in a schematic diagram of ASBM flight trajectory with mid-course and terminal guidance published by individuals affiliated with the Second Artillery Engineering College and a Second Artillery Base in a Chinese technical journal. This was later reprinted by the U.S. Defense Department.[150] These are strong visual signs that China, at the very least, emulated *Pershing II* technology.

---

[147] Huo and Luo, "Arrows without Bows," p. 23. It should be noted that the range difference is irrelevant today, because China may use satellite navigation, which is capable of updating, whereas inertial navigation (INS) experiences drift over time and distance.

[148] Ibid., p. 26.

[149] See "DF-15," *China's Defence Today* <http://www.sinodefence.com/strategic/missile/df15.asp>. This could be a case of convergent evolution; it is possible that the RVs look alike because they solve similar problems.

[150] Tan et al., "Determination and Evaluation of Effective Range for Terminal Guidance Ballistic Missile Attacking Aircraft Carrier," p. 7. Republished in *China Military Power Report 2009*, p. 21.

Finally, there is also general agreement over the identification of the key technical challenges, including target acquisition and terminal guidance.[151] To be sure, there has been little discussion in the more demonstrably authoritative Chinese literature about specific Chinese capabilities in these areas, except general statements of feasibility and implicit assumptions in doctrinal publications that ASBMs are available for use or will be soon—though the Chinese blogosphere has erupted with rampant speculation in recent years.

[151] Li "Are Ballistic Missiles a 'Silver Bullet' Against Aircraft Carriers?" [both parts]; Norman Polmar, "Anti Ship Ballistic Missiles… Again," *U.S. Naval Institute Proceedings* 131, No. 7 (July 2005), pp. 86–88.

VI. CONSTRUCTING A SYSTEM OF SYSTEMS

Central to maximizing Chinese ability to employ its ASBMs—and hence to consolidating China's aerospace combat capabilities over the Near Seas—are its emerging C4ISR capabilities. These systems will enable the Chinese military to strengthen cueing, reconnaissance, communications and data relay for maritime monitoring and targeting; as well as for the coordination of Chinese platforms, systems, and personnel engaged in these roles. Particularly important will be effective utilization of ISR, the collection and processing of information concerning potential military targets.

While doubtless an area of continuous challenge and improvement, the DF-21D's C4ISR infrastructure must be sufficient to support basic CSG-targeting capabilities. This ASBM system of systems, however, is substantially more than the technical capability for targeting and involves integrating a geographically- and bureaucratically-disparate set of C4ISR resources. Beyond fielding the C4ISR hardware as well as integrating its use and exploitation in a technical sense, the PLA also must coordinate the ASBM system of systems across the PLA's services and departments. According to China's defense white papers, the PLA is optimistic about strengthening the quality of its personnel and management processes. Nevertheless, the difficulties inherent in such a complicated exercise suggest this is one of the key areas in which to assess the probable operational effectiveness of the ASBM.

At a background briefing on August 16, 2010, a senior DOD official indicated that China still needed to successfully integrate its ASBM with C4ISR in order to operationalize it: "the primary area…where we see them still facing roadblocks is in integrating the missile system with the C4ISR. And they still have a ways to go before they manage to get that integrated so that they have an operational and effective system."[152] Various obstacles could limit China's ability to employ ASBMs effectively, particularly in the areas of detection, targeting, data fusion, joint service operations and bureaucratic coordination. The exact status of this progress still remains unclear, but to achieve IOC, it

[152] Senior Defense Official, U.S. Department of Defense, Office of the Assistant Secretary of Defense (Public Affairs), "DOD Background Briefing on Military and Security Developments Involving the People's Republic of China," August 16, 2010 <http://www.defense.gov/Transcripts/Transcript.aspx?TranscriptID=4674>.

would seem that the DF-21D and its supporting systems would have had to address at least some of the most basic problems.

China is working to develop capabilities to hold enemy vessels at risk via devastating multi-axis strikes involving precision-guided ballistic and cruise missiles launched from a variety of land-, sea-, undersea- and air-based platforms in coordinated sequence. The successful achievement of high quality real time satellite imagery and target-locating data and fusion as well as reliable indigenous satellite positioning, navigation and timing (PNT), would facilitate these efforts considerably. China's capacity to assert its interests militarily in, over, and beneath the Near Seas could thus be enhanced significantly by emerging space-based C4ISR capabilities. Particularly for "counter-intervention" operations in and around the Near Seas, Beijing has a clear strategic rationale for mastering the relevant components. Achieving such progress could finally enable the PLA to translate its traditional approach of achieving military superiority in a specific time and area even in a context of overall inferiority into the maritime dimension.

China has many ways to mitigate its limitations in C4ISR and target de-confliction for kinetic operations within the Near Seas and their immediate approaches, and potentially for non-kinetic peacetime operations further afield. Conducting high intensity wartime operations in contested environments beyond the Near Seas, by contrast, would require major qualitative and quantitative improvements, particularly in aerospace, and impose corresponding vulnerabilities.

Growing C4ISR Infrastructure

The PLA decided that it was necessary to develop "an integrated C4ISR system" in the early 1990s.[153] This was motivated by observations of U.S. prowess in *Operation Desert Storm*; the U.S. role in the 1995-96 Taiwan Strait crises, the 1999 Belgrade Embassy bombing and concomitant U.S. development of network-centric warfare added further impetus. Chinese C4ISR capabilities have improved markedly since the late 1990s, facilitated in part by civilian information technology and telecommunications industry

[153] Kevin Pollpeter, "Towards an Integrative C4ISR System: Informationalization and Joint Operations in the People's Liberation Army," in Roy Kamphausen and David Lai, eds., *The PLA at Home and Abroad—Assessing the Operational Capabilities of China's Military* (Carlisle, PA: U.S. Army War College and National Bureau of Asian Research, 2010), p. 196.

development, as part of a larger effort at informatization. The PLA aspires to establish a foundation for informatization by 2010, achieve major progress by 2020, and realize informatization by 2050. More broadly, developing a "High-resolution earth observation system," "Airborne remote sensing system" and "National satellite remote sensing (ground) network system" is one of 16 national megaprojects prioritized in China's Eleventh Five-Year Plan (2006–10) and the Outline of National Medium- and Long-Term Science and Technology Development (2006–20).[154] This guarantees top leadership support and tremendous institutional, financial, and human resources.

In 2000, the PLA issued a manual-like "outline" (*gangyao*) detailing the construction of "command automation systems," or "military information systems that possess command and control, intelligence and reconnaissance, early warning and surveillance, communications, electronic countermeasures, and other operational and information support capabilities with computers as the core."[155] Over the next decade, "the PLA began to develop and field airborne and space-based ISR technologies, and it was during this time that Chinese military analysts began to consider the requirements and applications of C4ISR systems to be used by the PLA."[156] PLA experts have studied U.S. systems thoroughly, and seek to both emulate them and target their vulnerabilities.

According to DOD, "China has accorded building a modern ISR architecture a high priority in its comprehensive military modernization, in particular the development of advanced space-based C4ISR and targeting capabilities."[157] As Kevin Pollpeter explains, the PLA sees "a networked C4ISR system capable of locating and tracking targets and fusing intelligence into a coherent battlefield picture as essential to carrying out the long-range precision strikes necessary to attack Taiwan and keep the U.S. military at bay."[158] "In line with [the PLA's] strategic objective of building informationized armed forces and winning informationized wars," China's 2010 Defense White Paper maintains the following:

---

[154] Huadong Guo and Ji Wu, eds., *Space Science & Technology in China: A Roadmap to 2050* (Beijing: Science Press, 2010), p. 37.

[155] Pollpeter, "Towards an Integrative C4ISR System," pp. 196–97.

[156] Ibid., pp. 196–97.

[157] China Military Power Report 2006, p. 31.

[158] Pollpeter, "Towards an Integrative C4ISR System," p. 193.

> "Significant progress has been made in building information systems for reconnaissance and intelligence, command and control, and battlefield environment awareness. Information systems have been widely applied in logistics and equipment support. A preliminary level has been achieved in interoperability among command and control systems, combat forces, and support systems, making order transmission, intelligence distribution, command and guidance more efficient and rapid."[159]

In 2012, DOD stated in its annual report that "the PLA is focused on developing C4ISR systems that will allow the military to share information and intelligence data, enhance battlefield awareness, and integrate and command military forces across the strategic, campaign, and tactical levels. A fully integrated C4ISR system, as envisioned by PLA leaders, would enable the PLA to respond to complex battlefield conditions with a high level of agility and synchronization."[160]

Near real-time C4ISR is facilitated increasingly by China's integrated military C4ISR system (known by its Chinese name, *Qu Dian*), which enables civilian and military leaders to communicate with forces in theater using secure fiber optic cables, high frequency and very high frequency communications and microwave systems as well as related wireless networks and data links. These include airborne radio and communications relay and secure PLA voice/data communications provided by *Fenghuo/Zhongxing/Shentong* communications satellites. According to China's 2010 Defense White Paper, "The total length of the national defense optical fiber communication network has increased by a large margin, forming a new generation information transmission network with optical fiber communication as the mainstay and satellite and short-wave communications as assistance."[161] This system may be the equivalent of the U.S. Joint Tactical Information Distribution System (JTIDS); China has developed, and possibly deployed, a related Triservice Tactical Information Distributed Network.[162] These capabilities currently are structured to support

---

[159] *China's National Defense in 2010* (Beijing: Information Office of the State Council of the People's Republic of China, March 31, 2011) <http://www.china.org.cn/government/whitepaper/node_7114675.htm>.

[160] China Military Power Report 2012, p. 8.

[161] China's National Defense in 2010.

[162] Pollpeter, "Towards an Integrative C4ISR System," p. 204.

Near Seas operations and extending them much beyond the Near Seas is far more difficult.

A Vast C4ISR System to Integrate

An emerging network of air- and space-based sensors promises to improve radically the targeting capabilities of China's Second Artillery and other services with which it may operate, such as the PLAN. This critical linchpin, long limited by Beijing's lack of relevant sensor platforms, promises to give the PLA unprecedented ability to monitor surface vessels in the Near Seas and thereby facilitate the precise targeting of them with cruise and ballistic missiles, potentially in combination—a devastating multi-axis saturation approach envisioned widely by Chinese analysts. Coordination is key: PLA doctrine "emphasizes mobility, speed, and long-range attack, plus synchronized combined arms and joint operations through the full spectrum…all while relying heavily upon extremely lethal, high-technology weapons."[163] Larry Wortzel made the following assessment in 2007:

> "The PLA has solved the over-the-horizon targeting problem conceptually. It has solved it mathematically and in simulation. It has built much of the hardware necessary to underpin a modern military force. It is also very close to fielding the full C4ISR architecture to fight a campaign out to about 2,000 kilometers from China's coast. However, it is not clear how the PLA will put such a system together, engineer it, or use it."[164]

To achieve its Near Seas operational objectives, the PLA thus must coordinate multiple sensors and weapons among multiple services to provide comprehensive communications and a common operational picture.

These advances are improving China's ability to monitor and threaten force deployments on its Near Seas greatly. According to then-Vice Admiral David Dorsett, "Ten years ago if you looked at their C4ISR capabilities they didn't have an over-the-horizon radar. They had virtually…no ISR satellites. They've now got a competent capability in ISR and over-the-horizon radars, but [in

---

[163] Kevin M. Lanzit and Kenneth Allen, "Right-Sizing the PLA Air Force: New Operational Concepts Define a Smaller, More Capable Force," in Scobell and Kamphausen, eds., *Right Sizing the People's Liberation Army*, p. 439.

[164] Wortzel, "PLA Command, Control, and Targeting Architectures," p. 221.

coming years] we expect a much greater increase in the numbers of satellites they have in orbit and their capability to fuse information."[165] Specifically, DOD added in its 2010 China report, "The PLA Navy is improving its over-the-horizon (OTH) targeting capability with Sky Wave and Surface Wave OTH radars. OTH radars could be used in conjunction with imagery satellites to assist in locating targets at great distances from [Chinese] shores to support long range precision strikes, including by anti-ship ballistic missiles."[166] A wide range of Chinese technical sources concur with DOD's assessment. According to two researchers affiliated with the PLAN Aviation Engineering Academy, "Through the integration of the data obtained via a number of different satellites, and with the addition of processing and data fusion, [one could] guarantee missile guidance requirements for all types of target information for a long-range ASBM strike."[167]

Satellites are already a key emerging link in ISR architecture that the PLA needs to detect, track and—in a worst-case scenario—strike foreign surface vessels on the contested Near Seas. The ASBM, like China's other precision weapons, would benefit greatly from improved ISR capabilities. According to Dorsett, while data fusion probably remains a challenge and China's ASBM has yet to be tested against sea-based maneuvering targets, "China likely has the space based intelligence, surveillance and reconnaissance (ISR), command and control structure, and ground processing capabilities necessary to support DF-21D employment. China operates a wide spectrum of satellites, which can provide data useful for targeting within its maritime region." Moreover, Dorsett stated, "China's non–space-based ISR could provide the necessary information to support DF-21D employment. This includes aircraft, UAVs, fishing boats and over-the-horizon radar for ocean surveillance and targeting."[168] This is significant, as many previous Chinese and foreign open

---

[165] "Transcript of Q&A; Vice Admiral David J. Dorsett Deputy CNO for Information Dominance," Defense Writers Group – Center for Media and Security, Washington, DC, January 5, 2011 <http://www.airforce-magazine.com/DWG/Documents/2011/January%202011/010511dorsett.pdf>.

[166] China Military Power Report 2010, p. 2.

[167] Pan Changpeng, Gu Wenjin and Chen Jie, "An Analysis on the Capabilities of Military Satellites to Support Anti-Ship Missiles in Offense and Defense Operations," *Winged Missiles Journal*, No. 5 (2006), p. 13, cited in Ian Easton and Mark Stokes, "China's Electronic Intelligence (ELINT) Satellite Developments," *Occasional Paper* (Arlington, VA: Project 2049 Institute, February 2011) <http://project2049.net/documents/china_electronic_intelligence_elint_satellite_developments_easton_stokes.pdf>.

[168] "Deputy Chief of Naval Operations for Information Dominance (N2/N6): China Has Space-Based & Non-Space-Based C2 + ISR 'capable of providing the targeting information necessary to

source assessments claimed that the lack of satellite/C4ISR infrastructure precluded effective ASBM employment.[169] Demonstrated Chinese ASBM capability to strike a moving maritime target would not only suggest the potency of a new, unique weapons system, but also serve as a leading indicator of emerging C4ISR-supported counter-intervention capabilities.

Satellite-based ISR will improve the ability of Chinese ballistic and cruise missiles to strike moving maritime targets. For instance, a DF-21D ASBM might be launched on a ballistic trajectory aimed roughly at the position of a CSG based in part on satellite data. Satellites might also be used to track and target the CSG, e.g. by supplying position updates.[170] If engaged in air operations, the CSG would have a large electromagnetic signature. Initial detection systems include China's existing land-based sky wave and surface wave OTH radars, which could detect aircraft Doppler.[171] Such near-space vehicles as airships/aerostats are credited by Chinese analysts as offering large early warning surveillance areas, good concealment and survivability, good dwell time and persistent coverage; and low launch and operating costs; they might eventually play a similar role.[172] Inputs from these systems, in turn, could be used to task imaging satellites to search small areas to confirm identification of the CSG.[173]

---

employ the DF-21D' Anti-Ship Ballistic Missile (ASBM)," *China Analysis from Original Sources*, January 4, 2011, <http://www.andrewerickson.com/2011/01/deputy-chief-of-naval-operations-for-information-dominance-n2n6-china-has-space-based-non-space-based-c2-isr-%E2%80%9Ccapable-of-providing-the-targeting-information-necessary-to-employ-the-df>.

[169] See, for example, Li "Are Ballistic Missiles a 'Silver Bullet' Against Aircraft Carriers?" [both parts]; Gao Hui, "Dandaodaodan da kangmu wu danan [Five Major Difficulties in Attacking Aircraft Carriers with Ballistic Missiles]," *Jianchuan Zhishe* [Naval & Merchant Ships] (December 2007), pp. 15–16; Huo and Luo, "Arrows without Bows," p. 23.

[170] This could be a difficult process, because the CSG probably would be moving unpredictably over a broad area and could employ a variety of countermeasures.

[171] Any Chinese ELINT satellites that China develops might detect such radiation.

[172] Wendell Minnick, "Chinese See Intel, Surveillance Role for Airships," *Defense News*, May 31, 2010 <http://www.defensenews.com/print/article/20100531/DEFFEAT06/5310306/Chinese-See-Intel-Surveillance-Role-Airships>; Stokes, "China's Evolving Conventional Strike Capability," p. 17.

[173] In descending level of utility for maritime target detection, imaging capabilities can be derived from radar, e.g., SAR; and multi- and hyper-spectral, IR and EO imaging. China has satellites with all such sensors; SAR in particular offers wide coverage at sufficient resolution (possibly as fine as 0.5 meter for China's *Yaogan* satellites) to detect a carrier with its large deck—as much as four acres in area—or its wakes, which suggest its speed and direction under a wide range of conditions.

The *Beidou/Compass* navigation satellite system also can be used to improve the precision of Chinese ballistic missiles. Perhaps China's combination of land-based radars and satellites—possibly augmented temporarily with deployment of unmanned aerial vehicles (UAVs) and microsatellites—might be sufficient to track and target CSGs within a certain zone off China's proximate waters from which it believed essential to exclude them in combat.[174]

As the "kill chain" progressed from mid-course maneuvers to terminal homing, accuracy requirements would increase. At that point sensors potentially become more important in directing terminal effects. These sensors include ground-based OTH radars and air-, ground-, sea- and sub-sea-based sensors for ELINT—both sets can augment China's space-based sensors. According to a detailed Project 2049 Institute study, "It appears that selected Second Artillery units are equipped with UAV systems that could provide direct targeting support for conventional ballistic and land attack cruise missile operations. UAV systems may be a critical enabler for cueing, target acquisition, and battle damage assessment (BDA) missions in support of anti-ship ballistic missile (ASBM) operations."[175]

Imaging satellites, which must be based in low-earth orbit, remain in constant motion, and thus take snapshots of pre-designated areas at periodic and predictable revisit times. Shifting orbits could temporarily improve coverage slightly, but would consume precious fuel. Hence, a basic sense of coverage may be gained by examining satellites' orbits, inclinations, and periods. By 2009, China had approximately 22 imaging satellites with sufficient resolution to play a role in detecting and tracking a CSG.[176] Though this was insufficient

---

[174] Moreover, given the likely duration of an ASBM engagement, an ASBM might not even need to "track" in a strict sense of the term, depending on the scale of search parameters. If it were known that a CSG were within a given area and the seeker window were larger than the maximum radius that the CSG could escape in the time between detection of its position and ASBM launch, real-time target tracking prelaunch and data relay thereafter might not be so important. This could simplify things immensely; the seeker could cover everything via terminal homing.

[175] Ian M. Easton and L.C. Russell Hsiao, *The Chinese People's Liberation Army's Unmanned Aerial Vehicle Project: Organizational Capacities and Operational Capabilities* (Arlington, VA: Project 2049 Institute, March 11, 2013), p. 11, <http://project2049.net/documents/uav_easton_hsiao.pdf>. In addition to identifying possible Second Artillery units, the authors cite a theoretical study by a researcher at Zhongguo Guofang Keji Xinxi Zhongxin [Chinese National Defense Science and Technology Information Center]: Qin Zhilong and Wang Hua], " Liyong wurenji xiezhu fanjian dandaodaodan daji hangmu de shexiang [The Notional Use of Unmanned Aerial Vehicles to Assist Anti-Ship Ballistic Missile Attacks on Aircraft Carriers]," *Feihang Daodan* [Winged Missiles Journal], (November 2010), pp. 44–47.

[176] Eric Hagt and Matthew Durnin, "China's Antiship Ballistic Missile: Developments and Missing Links," *Naval War College Review* 62, No. 4 (Autumn 2009): pp. 87–115, A1–2.

for continuous satellite coverage based on revisit times for specific ocean areas, China has added eight electro-optical (EO), five synthetic aperture radar (SAR) and two ELINT *Yaogan* satellites over the past four years. In 2009, civilian experts estimated China would launch sufficient satellites to achieve coverage regionally (8–12 civilian, plus additional military) by 2015 and globally (a further 8–12 civilian satellites plus additional military ones) by 2020; these estimates may require adjustment given recent launch numbers. [177] Even before then, China's emphasis on small satellites and small solid-fueled rockets may allow it to achieve a satellite surge capability. China's low-cost launchers (e.g. the *Kaituozhe*) may offer a combination of rapid turnaround and efficiency to replace the country's space assets if they are disabled in a conflict. The development of Wenchang Satellite Launch Center (China's fourth, scheduled to open in 2013) indicates a commitment to developing cutting-edge facilities.

Space-Based ISR

Space capabilities underpin China's current naval and other military capabilities for the Near Seas. Given their potential for high resolution and accuracy, satellites will enhance Chinese ISR competency. Ongoing concerns about U.S. ability to intervene militarily (e.g. in a Taiwan Strait crisis) make Beijing likely to support relevant programs. The successful achievement of reliable indigenous satellite navigation and high quality real time satellite imagery and target-locating data will strengthen PLA capacity greatly.

While still purchasing supplementary imagery, Beijing is combining foreign knowledge with increasingly robust indigenous capabilities to produce significant advances in maritime C4ISR. China has developed a full range of military, civilian, and dual-use satellites of various mission areas and sizes. China's first three data relay satellites, *Tianlian*-I, -I-02, and -I-03 facilitate near-real-time communication among satellites and ground control.[178] China's second data relay satellite, *Tianlian*-1-02/B, provides "near real-time transfer of data to ground stations from manned space capsules or orbiting satellites."[179] China's three operating *Yuanwang* space event support ships and more than 19

[177] Ibid, pp. 102–103.

[178] Dong Yingsun, "Wo zhongji weixing xitiong chubu shixian luhaikongtiandian duowei yingyong [Our Relay Satellite System Tentatively Realizes Land, Sea, Air, Outer Space, and Electron Multi-Dimensional Applications]," *Zhongguo Jungonghao* [China Defence Industry News], November 3, 2012, p. 1.

[179] China Military Power Report 2012, p. 9.

tracking/tracking and control stations (not including mobile TT&C), one of which is also a satellite launch center (Taiyuan), add important telemetry, tracking and command (TT&C) capacity. China today has only four overseas ground stations, but by 2030 plans to establish "network nodes" at the North and South Poles and in Brazil as part of a "Digital Earth Scientific Platform."[180] China possesses dedicated electronic intelligence (ELINT) and signals intelligence (SIGINT) satellites.[181] The *Fenghuo*-1 communications satellite and its identically-named follow-on reportedly support military operations.[182] China has made great progress in small satellite development, with satellites under 500 kg now boasting high performance in addition to low weight. The 9.3 kg *Tiantuo*-1 nanosatellite, launched on May 10, 2012, receives signals from China's indigenous land- and ship-based Automatic Identification System (AIS), which is under testing for tracking and locating ships at sea.[183]

Maritime Surveillance Satellites

China's reconnaissance-capable satellites include EO, multi- and hyper-spectral as well as radar, especially SAR. Maritime-relevant variants include *Fengyun* (FY), CBERS, *Ziyuan* (ZY), the Disaster Monitoring Constellation (DMC) satellite *Beijing*-1, *Haiyang* (HY), *Huanjing* (HJ) and *Yaogan* (YG) satellites. Given China's continued pursuit of military astronautics, Chinese sources categorize the *Shenzhou* (SZ) manned spacecraft and *Tiangong* (TG) space laboratory/station similarly; they remain as orbital modules after their crew returns to earth.[184] *Fengyun* weather satellites provide visible, IR and

---

[180] "XSCC-Xian Satellite Control Centre," *Jane's Space Systems and Industry*, September 12, 2012; Huadong Guo and Ji Wu, eds., *Space Science & Technology in China: A Roadmap to 2050* (Beijing: Science Press, 2010), p. 76.

[181] Statement by Deputy Undersecretary of Defense for Policy, Richard P. Lawless, "Hearing on U.S.-China Relations: Status of Reforms in China," Senate Foreign Relations Committee, Subcommittee on East Asian and Pacific Affairs, Washington, DC, April 23, 2004.

[182] "FengHuo 1 (ChinaSat 22/A) Tactical Communications Satellite," *China's Defence Today*, <http://www.sinodefence.com/space/spacecraft/fenghuo1.asp>.

[183] Liu Jun and Wang Wowen, "Guofang Keda zai weixiao wexing yanzhi lingyu qude zhongyao tupo [National University of Defense Technology Gains Important Breakthroughs in the Field of Microsatellite Research and Development]," *PLA Daily*, May 10, 2012 <http://jz.chinamil.com.cn/newscenter/yuansuo/content/2012-05/10/content_4858039_7.htm>.

[184] *Beijing-1* is part of an international Disaster Monitoring Constellation (DMC) of satellites constructed by UK-based Surrey Satellite Technology Limited that provides highly-responsive Earth imagery through coordinated satellite coverage. He Mingxia, He Shuangyan, Wang Yunfei and Yang Qian [Ocean Remote Sensing Research Institute, Ocean University of China]; Tang Junwu [National Satellite Oceanic Application Center]; and Hu Chuanmin [Ocean Remote

microwave imaging. The CBERS near real-time EO satellites, with 2.7 meter resolution, are used for military observation. Three satellite series are particularly relevant to maritime monitoring. *Yaogan* satellites are already so numerous that they will be addressed in the next section.

Ocean surveillance, a significant focus of Chinese satellite development, has been prioritized at the national level as one of eight key areas in China's 863 State High-Technology Development Plan. China launched its first three *Haiyang* maritime observation satellite in 2002 (no longer operational), 2007 and 2011. More than a dozen additional *Haiyang* ocean monitoring satellites are planned, in three sets over the next decade.[185] China's *Huanjing* visible, IR, multi-spectral and SAR imaging Environment and Disaster Monitoring Small Satellite Constellation is designed to form a complete image of China every 12 hours after eight additional satellites join the three already in orbit.[186]

High-Resolution Reconnaissance, Possible ELINT: Yaogan Satellites

"Operating from near-polar, Sun-Synchronous Orbits (SSO)," China's *Yaogan* series of 18 advanced, paired SAR and EO remote sensing satellites "may provide multi-wavelength, overlapping, continuous medium-resolution, global imagery of military targets."[187] The series was reportedly "implemented" (*shishi*) by China National Space Administration (CNSA), though this nominally-civilian organization lacks the institutional autonomy of its U.S.-equivalent NASA.[188] With its high-resolution 5 meter L-Band SAR, *Yaogan*-1 was China's first SAR satellite. SAR *Yaogan*s are optimized for monitoring "ocean dynamics, sea surface characteristics, and coastal zones" (*haiyang dongli*, *haibiao tezheng*, *hai'an dai*) as well as "observing sea-surface targets and shallow water

---

Sensing Research Institute, Ocean University of China and University of South Florida], "Zhongguo weixing haiyang guance xitong ji qi chuangan qi (1988–2025) [Chinese Spaceborne Ocean Observing Systems and Onboard Sensors (1988–2025)]," *Zhongguo Haiyang Daxue Xuebao* [Periodical of Ocean University of China] 41, No. 12 (December 2011), pp. 93–95.

[185] Hagt and Durnin, "China's Antiship Ballistic Missile," pp. 87–115, A1–2; "Chinese Launch Record (1964–present)," Small World Communications <http://www.sworld.com.au/steven/space/china-rec.txt>.

[186] "Satellites Will Help Predict Disasters," *China Daily*, March 31, 2009 <http://english.peopledaily.com.cn/90001/6626007.html>.

[187] "Yaogan Series," *Jane's Space Systems and Industry*, December 20, 2012.

[188] He Mingxia et al, "Chinese Spaceborne Ocean Observing Systems and Onboard Sensors (1988–2025)," p. 92.

bathymetry" (*haimian mubiao*, *qianhai dixing deng guance*).[189] EO *Yaogan*s appear to be based on the CAST-2000 small satellite bus and monitor land and sea areas, including "coastal zones" (*hai'an dai*) with as fine as 0.5 meter resolution.[190]

Sometimes using orbit maneuver capability, *Yaogan*s have attained a variety of orbits, including lower than 500 kilometers to increase resolution.[191] A major Chinese study on China's remote sensing satellites states that Yaogan satellites are "very useful for monitoring dynamics of the ocean environment and maritime monitoring" (*duiyu haiyang dongle huanjing he haiyang jianshi jiance shifen youyong*).[192]

The *Yaogan* 9- and 16-A, B, and C tri-satellite constellations may constitute a vital part of a larger long-range ship tracking and targeting ISR network. Flying in triangular formation in similar orbits at identical inclination, each apparently contains "an electro-optical surveillance satellite, a Synthetic Aperture Radar (SAR) satellite, and possibly an electronic/signal intelligence satellite. Designed for location and tracking of foreign warships, the satellites collect optical and radio electronic signatures of naval vessels that are used in conjunction with other information by the Chinese Navy…They are thought to be able to find and track large Western warships, providing accurate positioning data for targeting by land-based anti-ship ballistic missile systems."[193] This is similar to the first and second generations of the U.S. Navy's White Cloud Naval Ocean Surveillance System (NOSS), which reportedly detected surface vessels by sensing their electronic emissions and locating them using time distance of arrival.[194] The *Yaogan*-9 system has likely largely been superseded by the -16 system, as *Yaogan*-9B has apparently fragmented into two pieces.[195] In addition, *Yaogan*-11 reportedly was launched

---

[189] Ibid., pp. 100, 101.

[190] Ibid., p. 97; "Yaogan Series," *Jane's Space Systems and Industry*, December 20, 2012.

[191] "Yaogan Series," *Jane's Space Systems and Industry*, December 20, 2012.

[192] He Mingxia et al, "Chinese Spaceborne Ocean Observing Systems and Onboard Sensors (1988–2025)," p. 93.

[193] "Yaogan Series," *Jane's Space Systems and Industry*, December 20, 2012.

[194] Ibid. For Chinese analysis of White Cloud, the Soviet Cosmos satellite system and maritime monitoring satellites more broadly, see Huang Hanwen, "Haiyang mubiao tiandi jidi zonghe gan he jishu [Space-Based Comprehensive Awareness Technology for Marine Targets]," *Hangtian Dianzi Duikang* [Aerospace Electronic Warfare] 27, No. 6 (November 2012), pp. 11–13, 48.

[195] "Real Time Satellite Tracking," *ITPROSTAR* <http://www.n2yo.com/satellite/?s=36414> and <http://www.n2yo.com/satellite/?s=38303>.

Table 4: *Yaogan* Satellites Launched to Date—Notional Specifications

Yaogan Number	Military Designation	Int'l Code	Contractor	Launch Date and Time (GMT)	Launch Vehicle	Orbit (Perigree X Apogee (km), Inclination(°), SSO Time on Descending Node	Transmission Frequency (MHz)	Mass (kg)	Type
1	JB-5-1	2006-015A	SAST	2006.04.27 22:48	CZ-4B	627 × 629, 97.8, 06:00 (*satellite fragmented into 8 pieces February 4, 2010*)	2,212.8/2,295.65	2700	L-Band SAR
2	JB-6-1	2007-019A	DFH / CAST 508 Institute	2007.05.25 07:12	CZ-2D	631 × 655, 97.8, 13:30	2,216.527	800?	EO; HR, PAN-MS
3	JB-5-2	2007-055A	SAST	2007.11.11 22:48	CZ-4C	627 × 629, 97.9, 06:00	2,212.809	2700	L-Band SAR
4	JB-6-2	2008-061A	DFH/CAST 508 Institute	2008.12.01 04:42	CZ-2D	640 × 660, 97.9, 11:00	2,216.525	800?	EO; HR, PAN-MS
5	JB-8-1	2008-064A	DFH/CAST 508th Institute/Xi'an Institute of Optics and Precision Mechanics	2008.12.15 03:22	CZ-4B	488 × 495, 97.4, 10:30	2,220.5	2700	L-Band SAR

Table 4 Continued: *Yaogan* Satellites Launched to Date—Notional Specifications

Yaogan Number	Military Designation	Int'l Code	Contractor	Launch Date and Time (GMT)	Launch Vehicle	Orbit (Perigree X Apogee (km), Inclination(°), SSO Time on Descending Node	Transmission Frequency (MHz)	Mass (kg)	Type
6	JB-7-1	2009-021A	SAST	2009.04.22 02:55	CZ-2C	511 × 513, 97.6, 10:00	?	2000?	L-Band SAR
7	JB-6-3	2009-069A	DFH/CAST 508 Institute	2009.12.09 08:42	CZ-2D	630 × 666, 97.8, 15:00	2,216.527	800?	EO; HR, PAN-MS
8	JB-7-2?	2009-072A	SAST / Changchun Institute of Optics, Fine Mechanics and Physics (CIOMP)	2009.12.15 02:31	CZ-4C	1,200 X 1,211, 100.5, 09:30	2,266.3	1040	L-Band SAR
9 A/B/C	?	2010-009A, 2010-009B/G, 2010-009C	DFH / CAST 508 Institute	2010.03.05 04:55	CZ-4C	(9A) 1,089 × 1,106, 63.4°. (9B) 1,060 × 1,076, 63.4°. (9C) 1,089 × 1,107, 63.4°.	2,218 (9B)	1000? (9A)	EO; HR, PAN-MS/SAR/ELINT?

Table 4 Continued: *Yaogan* Satellites Launched to Date—Notional Specifications

Yaogan Number	Military Designation	Int'l Code	Contractor	Launch Date and Time (GMT)	Launch Vehicle	Orbit (Perigree X Apogee (km), Inclination(°), SSO Time on Descending Node	Transmission Frequency (MHz)	Mass (kg)	Type
10	JB-5-3	2010-038A	SAST	2010.08.09 22:49	CZ-4C	615 × 629, 97.8, 06:00	?	2700	L-Band SAR
11	JB-6-4	2010-047A	DFH / CAST 508 Institute	2010.09.22	CZ-2D	627.3 × 657.4, 98.01, 09:00	2,216.527	800?	EO; HR, PAN-MS
12	JB-8-2	2011-066B	DFH / CAST 508 Institute / Xi'an Institute of Optics and Precision Mechanics	2011.11.09 03:21	CZ-2D	488 × 498, 97.41, 10:29	?	2700	EO
13	JB-7-2	2011-072A	SAST	2011.11.29 18:50	CZ-2C	504 × 511, 97.11, 01:56	?	2000?	SAR
14	?	2012-021A	CAST 508 Institute / Changchun Institute of Optics	2012.05.10 07:06	CZ-4B	472 × 479, 97.2, 14:14	?	2700?	EO

Table 4 Continued: *Yaogan* Satellites Launched to Date—Notional Specifications

Yaogan Number	Military Designation	Int'l Code	Contractor	Launch Date and Time (GMT)	Launch Vehicle	Orbit (Perigree X Apogee (km), Inclination(°), SSO Time on Descending Node	Transmission Frequency (MHz)	Mass (kg)	Type
15	?	2012-029A	CAST 508 Institute / Changchun Institute of Optics	2012.05.29 07:31	CZ-4C	1,201 × 1,206, 100.1, 14:30	?	1.040	EO
16 A/B/C	?	2012-066A, 2012-066B, 2012-066C	DFH/CAST 508 Institute	2012.11.25 04:06	CZ-4C	(16A): 1,080 × 1,089, 63.38, 106.93 min (16B) 1,078 × 1,090, 63.38, 106.93 min (16C): 1,032 × 1,081, 63.38, 106.33 min	?	1000? (16A)	EO/SAR/ELINT?

Sources: "Yaogan Series," *Jane's Space Systems and Industry*, December 20, 2012; "Real Time Satellite Tracking," *ITPROSTAR* <http://www.n2yo.com>; He Mingxia et al., "Chinese Spacebome Ocean Observing Systems and Onboard Sensors (1988–2025)," p. 95; "Yaogan (Jianbing 5/6/7)," *China's Defence Today*, <www.sinodefence.com/space/military/yaogan.asp>.

with two picosatellites that would co-orbit with it for three months.[196] Ian Easton at the Project 2049 Institute estimates "that it is a test-bed for something like a RORSAT [Radar Ocean Reconnaissance Satellite]-style carrier-hunting platform or something similar that combines electronic intelligence and SAR." [197] *Yaogan* -12 was reportedly launched with the *Tianxun*-1 picosat with a 2.5 kg CCD camera with 30 meter resolution for "technological verification tests."[198]

Supporting Positioning, Navigation, and Timing (PNT): Beidou/Compass Satellites

By offering reliable location signals, PNT facilitates command and control as well as monitoring of friendly forces and targeting of enemy forces. Chinese sources reportedly believe that two DF-15 missiles failed to reach their targets on March 8, 1996 during an exercise as part of the Taiwan Strait crises because of U.S. denial of GPS.[199] Fearing that it might lose access to PNT provided by U.S. GPS and Russia GLONASS systems in the future and having been denied access to the military mode of Europe's nascent Galileo system, China is developing its own system. [200] China Satellite Navigation and Locating Applications Management Center Director Yang Baofeng terms it "the largest scale, most complex, most technically demanding, and most widely applicable

---

[196] "Yaogan-11 Launches Atop CZ-2D Chinese Rocket," <http://www.youtube.com/watch?v=7ClxFcBVIIo>.

[197] Author's correspondence with Ian Easton, December 2010.

[198] "Tianxun Series," *Jane's Space Systems and Industry*, January 10, 2012.

[199] "Beidou a Milestone in Decreasing Dependence on US: Global Times," *Want China Times*, January 1, 2013 <http://www.wantchinatimes.com/news-subclass-cnt.aspx?id=20130101000055&cid=1101>; Minnie Chan, "'Unforgettable Humiliation' Led to Development of GPS Equivalent," *South China Morning Post,* November 13, 2009 <http://www.scmp.com/article/698161/unforgettable-humiliation-led-development-gps-equivalent>.

[200] Wu Xuan [Academy of Space Technology, China Aerospace Science and Technology Corporation], "Beidou daohang bada zhanlue yiyi–fazhan beidou weixing daohang xitong, jiangjin yi bu tuidong hangtian qiangguo jianshe, ye wei zhongguohangtian de houxu fazhantigong xiangying de jishu xubei [Eight Major Strategic Significances of the Beidou Satellite Navigation System—Developing the Beidou Satellite Navigation System Will Give Greater Impetus to Construction of China Into a Space Power and Will Prepare Relevant Technical Reserves for Subsequent Development of China's Spaceflight Industry]," *Liaowang* [Outlook Weekly], No. 44, October 29, 2012, pp. 8–10. For relevant Chinese training, see Lou Yongjun and Wang Jun, "Shenkong hangkongbing jituan fuza diancihuanjingxia lian gongfang [Shenyang Military Region Air Force Air Regiment Practices Offense and Defense in Complex Electromagnetic Environments]," *Kongjun Bao* [Air Force News], May 26, 2010, p. 1.

space-based system in Chinese aerospace history."[201] *Beidou/Compass* offers PNT to an accuracy of 10 meters, as well as "differential" and "integrity" services.[202] Unlike other PNT systems, which transmit signals directly, it initially transmitted signals indirectly through a central ground station, though the PLA General Armament Department's newspaper recently reported that "After providing passive navigation and locating service, Beidou became more and more like the GPS system…"[203] It also boasts a unique short-message communications system.[204] A Chinese aerospace expert contends that the system affords China numerous civil and military benefits, and constitutes "an important measure to grab and retain favorable orbital position resources…for the purpose of 'carving up the domain before other competitors do' (*ye shi 'zhanwei' de xuyao*)."[205]

Twenty satellites have been launched thus far; 16 remain fully operational. An initial two-satellite constellation was launched in 2000. Regional navigation and communications coverage—encompassing mainland China, neighboring countries such as Pakistan (where it has been tested), and the Near Seas—was achieved in 2012. Full service commenced in early 2013 and, starting in 2014, a second series will be launched.[206] By 2020, a 35-satellite constellation (five geostationary [GEO], 27 inclined medium earth orbit [MEO], three inclined

---

[201] Yang Zhiyuan, "Zhongguo beidou yao xingkong–xie zai zhongguo beidou daohang xitong zoujin baixing shenghuo zhi ji [China's Beidou Glitters in the Starry Sky: China's Beidou Satellite Navigation System Enters the World of Ordinary People]," *Zhongguo Jungongbao* [China Defense Industry News], January 3, 2013, p. 3. For further documentation of complexities involved, see Li Xiaomei, "Gao weiguang: xinxi beidou buliaoqing [Gao Weiguang: Forever Dedicates Heart and Soul to Beidou]," *Zhongguo Jungongbao* [China Defense Industry News], December 1, 2012, p. 3. For progress in related research and programs, see Wei Jinwen, "10 xiang guanjian jishu zhuli 'Beidou' wexing daohang xitong zuwang [10 Key Technologies Assist in "Beidou" Satellite Navigation System Networking]," *Zhongguo Jungongbao* [China Defense Industry News], November 3, 2012, p. 1; Zhan Xianlong, Liu Ruihua and Yang Zhaoning, "Beidou xitong ge wangdian lichengyanchi suanfa yanjiu [A Study on the Grid Ionospheric Delay Algorithm in Beidou]," *Hangtian Kongzhi* [Aerospace Control] 30, No. 1 (February 2012), pp. 15–19.

[202] "The 16th Beidou Navigation Satellite Was Sent into Space by a Long March-3C [Changzheng-3C] Carrier Rocket Launched At 2333 Yesterday from Xichang Satellite Launch Center," *Junshi Baodao* [Military Report], *CCTV-7* (Mandarin), 1130 GMT, October 26, 2012.

[203] Yang, "Zhongguo beidou yao xingkong [China's Beidou Glitters in the Starry Sky]," p. 3.

[204]Cheng Yingqi, "Navigation System Set to Soar," *China Daily*, February 20, 2013 <http://www.chinadaily.com.cn/china/2013-02/20/content_16238601.htm>.

[205] Wu, "Beidou daohang bada zhanlue yiyi [Eight Major Strategic Significances of the Beidou Satellite Navigation System]," p. 10.

[206] Jiang Lianju and Yang Baofeng, "China's Beidou Satellite Navigation System Goes Global," *PLA Daily*, November 23, 2012 <http://english.peopledaily.com.cn/90786/8035668.html>; Yang, "Zhongguo beidou yao xingkong [China's Beidou Glitters in the Starry Sky]," p. 3.

Table 5: *Beidou*/Compass Satellites Launched to Date—Notional Specifications							
Satellite	**NORAD ID**	**Int'l Code**	**Launch Date and Time (GMT)**	**Launch Vehicle**	**Orbit**	**Capabilities**	**Status**
Beidou-1A	26599	2000-069A	2000.10.30	CZ-3A	GEO, 140°E to 59°E to retirement orbit	20 m positioning accuracy	Retired 2011.11.21
Beidou-1B	26643	2000-082A	2000.12.20	CZ-3A	GEO, 80°E to retirement orbit	20 m positioning accuracy	Retired 2011.11.21
Beidou-1C	27813	2003-021A	2003.05.24	CZ-3A	GEO, 110.5°E	20 m positioning accuracy	Operational
Beidou-1D	30323	2007-003A	2007.02.02 16:28	CZ-3A	GEO/Experimental 144°E, 35,662.3 X 36,428.3 km, 4.5°, period 1,449 min.; maneuvered off-station	20 m positioning accuracy	Abandoned after reported engine explosion, drift; no longer operational

Table 5 Continued: *Beidou*/Compass Satellites Launched to Date—Notional Specifications							
Satellite	**NORAD ID**	**Int'l Code**	**Launch Date and Time (GMT)**	**Launch Vehicle**	**Orbit**	**Capabilities**	**Status**
Beidou-2/Compass-M1	31115	2007-011A	2007.04.13 20:11	CZ-3A	MEO/Experimental 21,519 X 21,545 km, 55.3°, period 773.4 min. By 2010.03: 21,524.7 X 21,553.5 km, 56.1°, period 773.4 min.	Signal transmit carrier frequencies: 1,195.14-1,219.14 MHz, 1,256.52-1,280.52 MHz, 1,559.05-1,563.15 MHz and 1,587.69-1,591.79 MHz.	Experimental; 1st MEO satellite in series
Beidou-2B/ Compass-G2	34779	2009-018A	2009.04.14 16:16	CZ-3C	GEO, 85°E Initial transfer orbit 217.1 X 35,863.7 km, 20.5°, period 632.6 min. Now 35,597 × 36,035 km, 1.36°, period 1,437.6 min.		Abandoned after drifting off station 2009.06

Table 5 Continued: *Beidou*/Compass Satellites Launched to Date—Notional Specifications							
Satellite	**NORAD ID**	**Int'l Code**	**Launch Date and Time (GMT)**	**Launch Vehicle**	**Orbit**	**Capabilities**	**Status**
Beidou-2C/ Compass-G1	36287	2010-001A	2010.01.16 16:12	CZ-3C	GEO, 140°E Initial transfer orbit 196 × 35,620 km, 20.5°		Operational
Beidou-2D/ Compass-G3	36590	2010-024A	2010.06.02 15:53	CZ-3C	GEO, 83.8°E Initial transfer orbit 205 × 35,647 km, 20.5°		Operational
Beidou-2/ *Compass*-IGSO-1	36828	2010-036A	2010.07.31 21:30	CZ-3A	35,674.5 × 35,901.5 km, 55.1° GSO, period 1,435.8 min. Mean longitude of sub-satellite ground point 118° E		Operational

Table 5 Continued: *Beidou*/Compass Satellites Launched to Date—Notional Specifications

Satellite	NORAD ID	Int'l Code	Launch Date and Time (GMT)	Launch Vehicle	Orbit	Capabilities	Status
Beidou-2E/ Compass-G4	37210	2010-057A	2010.10.31 20:10	CZ-3C	GEO 159.9°E		Operational
Beidou-2/ *Compass*-IGSO-2	37256	2010-068A	2010.12.17 20:20	CZ-3A	35,714 × 35,856 km, 55.24° GSO, period 1,436 min. Mean longitude of sub-satellite ground point 118° E		Operational
Beidou-2/ Compass - IGSO-3	37384	2011-013A	2011.04.09 20:47	CZ-3A	35,721 × 35,880 km, 55.3° GSO, period 1,435.9 min. "Figure 8" ground track centered over 118° E	Completed IGSO coverage with 3 satellites in equally spaced planes. Marked establishment of basic PNT network	Operational

Table 5 Continued: *Beidou*/Compass Satellites Launched to Date—Notional Specifications

Satellite	NORAD ID	Int'l Code	Launch Date and Time (GMT)	Launch Vehicle	Orbit	Capabilities	Status
Beidou-2/Compass-IGSO-4	37763	2011-038A	2011.07.26 21:44	CZ-3A	35,706 × 35,878 km, 55.2°, GSO, period 1,436.0 min. "Figure 8" ground track with intersection node over 95° E		Operational
Beidou-2/Compass-IGSO-5	37948	2011-073A	2011.12.01 21:07	CZ-3A	35,704 × 35,866 km, 55.18° GSO, period 1,436.02 min. "Figure 8" ground track	*Beidou* system's basic structure established; tests; trial service began 2011.12.27	Operational
Beidou-2/Compass-G5	38091	2012-008A	2012.02.24 16:12	CZ-3C	GEO, 58.68°E		Operational

Table 5 Continued: *Beidou*/Compass Satellites Launched to Date—Notional Specifications							
Satellite	**NORAD ID**	**Int'l Code**	**Launch Date and Time (GMT)**	**Launch Vehicle**	**Orbit**	**Capabilities**	**Status**
Beidou-2/Compass M3	38250	2012-018A	2012.04.29 20:50	CZ-3B	MEO, 21,460 × 21,594 km, 55.16°, period 773.2 min.		Operational
Beidou-2/Compass M4	38251	2012-018B	2012.04.29 20:50	CZ-3B	MEO, 21,456 × 21,601 km, 55.11°, period 773.21 min.		Operational
Beidou-2/Compass M5	38774	2012-050A	2012.09.18 19:10	CZ-3B/E	MEO, 21,462 x 21,592 km, 55°, period: 773.2 min. Revs/day: 1.9		Operational

Table 5 Continued: *Beidou*/Compass Satellites Launched to Date—Notional Specifications

Satellite	NORAD ID	Int'l Code	Launch Date and Time (GMT)	Launch Vehicle	Orbit	Capabilities	Status
Beidou-2/Compass M6	38775	2012-050B	2012.09.18 19:10	CZ-3B/E	MEO, 21,476 x 21,573 km, 55.1°, period: 773.1 min. Revs/day: 1.9		Operational
Beidou-2/Compass G6/G2R	38953	2012-059A	2012.10.25 15:33	CZ-3C	GEO, 80.1°E	Completed regional network; service commenced	Operational

Sources: "Beidou/Compass," *Jane's Space Systems and Industry*, November 20, 2012; "Real Time Satellite Tracking," *ITPROSTAR* <http://www.n2yo.com>; National Space Science Data Center, U.S. National Aeronautics and Space Administration <http://nssdc.gsfc.nasa.gov/nmc/SpacecraftQuery.jsp>.

geostationary orbit [IGSO]) will provide global coverage.[207] IGSO satellites' high-inclination orbits improve coverage at high latitudes. Satellites launched thus far are manufactured by CAST, typically 2,300 kg at launch and 1,150 kg on station after maneuvering to initial orbit with a liquid apogee motor. Three-axis-stabilized, they have twin solar arrays. Initial satellites were based on the DFH-3 bus; this changed to the -3A variant from *Beidou*-G2 on and the -3B variant from -M3 on. All satellites have been launched from Xichang, specifically from its Launch Complex 2 starting with *Beidou*-2/Compass M3.

The Second Artillery already is using China's PNT system extensively. During long-distance exercises, Second Artillery units employ *Beidou* to track vehicles and communicate.[208]

The Challenge of Bureaucratic Coordination

To target mobile maritime platforms, China will have to correlate and fuse real-time sensor inputs before disseminating situation reports and targeting packages to commanders and shooters—a tremendously complex and difficult process. Even with complete coverage of relevant maritime zones, data transmission (i.e. from satellites to ground stations), imagery readouts by analysts (increasing in time consumption with size of area examined) and sending targeting data to the shooter will impose time delays. Software and data management requirements will be complex. Command and control almost certainly will pose a particular challenge. The PLA will have to coordinate both among the many service elements that "own" various ISR sensor and ground station architecture as well as within the chain of command that would authorize their prioritization and use as well as the release authority

---

[207] An Puzhong, "Fan Changlong zai jiefang jun weixing daohang dingwei zongzhan kaocha shi qiangdiao, Fang Fenghui yitong kaocha, tuidong Beidou weixing daohang xitong xiang genggao cengci genggao shuiping fazhan [Fan Changlong, Accompanied by Fang Fenghui, Inspects PLA Satellite Navigation and Positioning General Station, Calling for Developing the Beidou Satellite Navigation System to a Higher Standard]," *PLA Daily*, December 29, 2012; "Beidou/Compass," *Jane's Space Systems and Industry*, November 20, 2012.

[208] Li Dequan and Feng Jinyuan, "Chexing qianli 'yi xianqian' ['Tethered' on the Whole of a Thousand Mile Drive]," December 4, 2012, p. 3; Dong Zhiwen and Feng Jinyuan, "Mo you zhengjianzhi yuancheng jidong chuilian yingji nengli [Brigade Tempers Its Whole-Unit, Long-Distance Movement Contingency Capabilities]," *Huojian Bingbao* [Rocket Forces News], October 9, 2012, p. 2; Zhou Chuangang, Chen Cai, Chen Haijun and Ge Song, "Jintie shixianzhan goujian xinxi pingtai–erpao budui qiangli tuijin tongxin zhanbei nengli jianshe sheji shi zhi er [Building Information Platforms With Close Adherence to Actual Combat—Part Two of Record of Second Artillery Units Forcefully Advancing Communications Combat-Readiness Capability Construction]," *Huojian Bingbao* [Rocket Forces News], December 12, 2012, pp. 1–2.

for the weapons systems that would employ their inputs.[209] China's 2010 Defense White Paper maintains this a serious issue, but one in which the PLA has made steady progress:

> "Strategic planning, leadership and management of informationalization have been strengthened, and relevant laws, regulations, standards, policies and systems further improved. A range of measures, such as assembly training and long-distance education, have been taken to disseminate knowledge on information and skills in applying it. Notable achievements have been made in the training of commanding officers for joint operations, management personnel for informationalization, personnel specialized in information technology, and personnel for the operation and maintenance of new equipment. The complement of new-mode and high-caliber military personnel who can meet the needs of informationalization have been steadily enlarged."[210]

Despite the military's optimism as expressed in the white paper, there is reason to believe that this is a difficult, ongoing challenge for the PLA. There are already real-life examples of these difficulties as well as some surmounting of them.

Case Study: Wenchuan Earthquake (2008)

China's response to Sichuan's Wenchuan Earthquake on May 12, 2008 offers the most comprehensive case-study available to date concerning real-time C4ISR capabilities under emergency conditions. Beijing was able to use satellites and related infrastructure to compensate for land-based telecommunications disrupted by the disaster and to furnish information (e.g. concerning hazards to avoid) to facilitate direction and coordination of relief operations. Simultaneously, however, Beijing also requested and relied on foreign satellite equipment and remote sensing data, suggesting that it did not

---

[209] In addition to the Second Artillery (which controls most ballistic missiles), this will include the ground forces, which apparently have been given some ballistic missiles and which may face further organizational challenges if they restructure away from their present seven-Military-Region organization; the PLAN (which controls sea, undersea and some air assets); and the PLAAF (which controls most air assets).

[210] *China's National Defense in 2010* (Beijing: Information Office of the State Council of the People's Republic of China, March 31, 2011) <http://www.china.org.cn/government/whitepaper/node_7114675.htm>.

yet consider its extant space-based C4ISR architecture to be complete or reliable.

In terms of personnel and hardware deployed, Beijing's response was relatively rapid and comprehensive. Within 24 hours, the leadership of the PLA General Staff Department (GSD)'s Communications Department implemented an "emergency response communications plan" that entailed substituting "satellite, shortwave and other communications means" for "fixed-line communications in disaster areas."[211] China Unicom sent technicians with Very Small Aperture Terminal (VSAT) sets and maritime satellite phones.[212] Within two days, by May 14, the GSD had provided rescue and relief troops forces with more than 2,000 satellite phones.[213] These were followed by thousands of satellite phones with hundreds of VSAT sets and Intralink Digital Radio (IDR) base stations Chinese state and commercial organizations.[214] On May 15, the PLAAF inserted 15 PLA paratroopers into the area. They used two International Maritime Satellite Organization (INMARSAT)-enabled phones to maintain contact with headquarters.[215]

Beidou provided both navigation support and text communications. On May 15, a "General Staff Department Emergency Response Communications Team" was dispatched by the "Beidou Satellite Navigation and Positioning

---

[211] "Wenchuan, Beijing zai huhuan [Wenchuan, Beijing is Calling!]," *PLA Daily*, May 22, 2012 <http://cpc.people.com.cn/GB/64093/82429/83083/7278512.html>.

[212] "Quake Paralyzes Phone Networks in SW China," *Xinhua*, May 12, 2008 <http://news.xinhuanet.com/english/2008-05/12/content_8154055.htm>; State-owned Assets Supervision & Administration Commission of the State Council, People's Republic of China (SASAC), "The Central SOEs Launched An All-Out Effort to Relieve the Damage of the Earthquake," *Zhongguo Wang* [China Net], May 21, 2008, <http://www.sasac.gov.cn/n2963340/n4518587/4674082.html>; Lin Hongmei, "Zhongguo Jiaotong Tongxin Zhongxin yiwei kangzhen jiuzai tigong jin 400 tai haishi xingwei shebei [China Transportation and Communication Center Provides 400 Pieces of Maritime Satellite Equipment for Quake Relief Purposes]," *Xinhua*, May 16, 2008 <http://news.xinhuanet.com/newscenter/2008-05/16/content_8189444.htm>.

[213] "Wenchuan, Beijing is Calling!"

[214] "MIIT Materials on Disaster Relief in Quake-hit Sichuan," *Zhongguo Wang* [China Net], May 19, 2008 <http://www.china.org.cn/e-news/news080519-3.htm>; "Communications Gradually Restored in Quake-Hit Areas: Ministry," *Xinhua*, May 13, 2008 <http://info.xinhua.org/en/security/detail.do?sw=Communications+Gradually+Restored+in+Quake-Hit+Areas%3a+Ministry&docId=108155474&libId=2&docType=1&cid=&ct=0>.

[215] Shen Jinke, Sun Maoqing and Xu Zhuangzhi, "15 yongshi 4999 mi gao kong sanjiao Mao xian suxie [15 Warriors Jump at an Altitude of 4,999 Meters, Land by Parachute in Mao County]," *Xinhua*, May 15, 2008 <http://big5.xinhuanet.com/gate/big5/news.xinhuanet.com/newscenter/2008-05>.

Management and Operations Center." They used the *Beidou* terminals they brought with them (which totaled more than 1,000 by May 18) to maintain contact with PLA general headquarters.[216] In this regard, Chengdu MR unit commander Zhao Jinsong described Beidou as "an effective bridge between command posts at all levels and the officers and men on the front lines of disaster relief."[217]

Remote-sensing satellites were tasked to survey earthquake damage. On the evening of May 12 calls from the State Commission for Natural Disaster Reduction, the State Meteorological Center and the Beidou Satellite Position Center prompted Xi'an Satellite Control Center (XSCC) to adjust its daily remote satellite control plan. As China's launch and satellite TT&C center, XSCC controls fixed, mobile, sea-based and overseas stations.[218] Within nine hours of the disaster at 23:15 CST, the first Chinese satellite entered range of Chinese territory and transmitted telemetry. XSCC subsequently employed "15 satellites of nine types, including *Fengyun*, *Ziyuan*, and *Beidou* navigation satellites" to provide "meteorological photography, satellite communications, topographic survey and other emergency and support services to the disaster area."[219] *Beijing-1*, "the world's most advanced EO small satellite when

---

[216] "'Beidou yi hao' xingwei daohang xitong zai kangzhen jiuzai zhong fahui zhongyao zuoyong ['Beidou-1' Satellite Navigation System Plays an Important Role in Quake Resistance and Disaster Relief]," *Xinhua*, May 18, 2008 <http://news.xinhuanet.com/newscenter/2008-05/19/content_8203459.htm>; Li Ge, "Beidou hujiao: 'Zhe li weiji! Xiang wo kaolong!' [Beidou Calls Out: 'It's Dangerous Here! Move Toward Me!']," *Renmin Wang* [People's Net], May 16, 2008 <http://military.people.com.cn/GB/8221/74407/122512/122519/7252632.html>.

[217] Liu Yonghua and Wang Yitao, "(Kangzhen jiuzai) Zhongguo zizhu yanzhi de beidou weixing daohang xitong shixianzaiqu quanshi kongxinxi goutong [(Earthquake Rescue and Relief) Chinese-Developed Beidou Satellite Navigation System Achieves Full-Time, Full-Range Information Communication]," *Xinhua*, May 21, 2008 <http://news.xinhuanet.com/newscenter/2008-05/21/content_8220147.htm>.

[218] "XSCC-Xian Satellite Control Centre," *Jane's Space Systems and Industry*, September 12, 2012.

[219] XSCC "gathered its core and professional monitoring and control experts to form an emergency contingent, adjusted the monitoring and control plan according to the demand of satellite clients, increased the number of tracking cycles, and completed the processing of large amounts of data. In the four days following the quake, the center continuously and accurately input more than 10,000 emergency application orders into the various types of satellites to ensure that the satellites provided continuous, fast, and accurate cloud pictures, satellite communications, and other information and data to meet the demand of the disaster areas. As of May 16 [2008], all of China's orbiting satellites had worked normally, and the operations of the satellites for emergency applications had been secure and effective." Sun Haixia, "Wo 9 zhong xinghao 15 ke weixing wei kangzhen jiuzai tigong zhiyuan [China's 15 Satellites of Nine Types Provide Support for Dealing With the Quake and Providing Relief to Disaster Victims]," *Xinhua*, May 16, 2008 <http://news.xinhuanet.com/newscenter/2008-05/16/content_8184987.htm>.

launched in 2005," was used for "disaster interpretation" and analysis.[220]

Despite this large-scale effort, limitations in quality and quantity of imagery from Chinese satellites, and integration challenges involving software processing as well as data management and transfer reportedly plagued the PLA and other government organizations involved. For example, probably because of a lack of operational data relay satellites with China's first having been launched only on April 25, at XSCC "new remote sensing commands were prepared swiftly. Due to technological reasons, however, these commands could be transmitted to these satellites only when the satellites moved into the space over the Chinese territory."[221]

To compensate, China used domestic aerial imagery and foreign satellite data. On May 14, China's disaster relief authority asked "the European Space Agency, the United States Geological Survey, the Canadian Space Agency, the Japan Aerospace Exploration Agency and the Indian Space Research Organization" and commercial satellite imagery suppliers for "quake-related data." Japan furnished imagery that day, and Canada scheduled a satellite flyover of the affected area for May 16.[222]

A researcher at China's Remote-Sensing Satellite Ground Station reportedly stated that two Chinese-owned civilian earth observation satellites camera and infrared devices proved unable to "penetrate" a "huge and thick" cloud above Wenchuan, prompting officials to ask Canada and the European Union "to use their satellites which are equipped with high definition Synthetic Aperture Radar (SAR) that can see through the clouds." The researcher was quoted as stating that Chinese SAR satellite quality "may be too poor to be of any use to the rescue effort."[223]

---

[220] "Beijing-1 Small Satellite System & Its Application," Beijing Landview Mapping Information Technology Co. Ltd. (BLMIT), February 10, 2011 <http://www.spaceconference.co.uk/links/Beijing-1%20Satellite%20Applications,%20BLMIT.pdf>.

[221] "15 Chinese Satellites in Space Help With Quake Relief Efforts."

[222] "China Asks for Int'l, Domestic Help in Disaster Monitoring from Space," *Xinhua*, May 14, 2008 <http://news.xinhuanet.com/english/2008-05/14/content_8169751.htm>; Stephen Chen, "Canada to Provide Satellite Images This Week," *South China Morning Post*, May 14, 2008 <http://www.scmp.com/article/637480/canada-provide-satellite-images-week>.

[223] Ibid. Guo Huadong, head of the Chinese Academy of Sciences Centre for Earth Observation and Digital Earth's Task Force on Earthquake Disaster Evaluation through Remote-Sensing Technology, stated "We appreciate the help of the U.S. Government and the U.S. Geological Survey, which has provided two groups of satellite data, although they are not very useful so far because of their quality." Shi Jiangtao, "Cloud Mars Satellite Images of Quake Zone," *South China*

In addition to dispatching an AWACs aircraft to coordinate air traffic, the PLA deployed a ground-mapping radar aircraft and a UAV to survey damage.[224] On May 14, the PLAN dispatched a remote-sensing aircraft from Beijing. It furnished "the most precise data and information possible for the emergency disaster relief effort," taking precision photographs of 400 square kilometers over 33 hours.[225] On May 15, "photoplanes performed extreme low-altitude flight for four hours and collected clear aerial photographical data."[226]

Despite these apparently serious limitations in 2008, the PLA's response to the less-challenging 2010 Yushu Earthquake apparently reflected significant "lessons learned." For instance, the Chinese Academy of Sciences's State Key Laboratory of Remote Sensing Science used "Beijing-1 microsatellite data, with moderate spatial resolution and large sensor ground width…to analyze the environment background for the earthquake."[227] While China still uses imagery from foreign as well as domestic satellites, the present author could find no indications of problems similar to those experienced in 2008. Based on the large number of increasingly advanced satellites of many categories that China has since launched as well as its strong motivations to develop and integrate the relevant C4ISR architecture, there is reason to believe that its capabilities are now far greater. In January 2013, *China Daily* went so far as to claim that "China's first high-resolution, stereo mapping satellite Ziyuan III,"

Morning Post, May 21, 2008 <http://www.scmp.com/article/638456/cloud-mars-satellite-images-quake-zone>.

[224] "Armed Forces, China," *Jane's Sentinel Security Assessment - China and Northeast Asia*, October 15, 2010; "Air Force, China," *Jane's Sentinel Security Assessment - China and Northeast Asia*, August 3, 2010; Martin Andrew, "New Advances in PLA Battlefield Aerospace and ISR," *Jamestown Foundation China Brief* 9, No. 2 (January 22, 2009) <http://www.jamestown.org/single/?no_cache=1&tx_ttnews%5Btt_news%5D=34390>.

[225] Ying Ni, "Wenchuan da dizhen jiuyuanzhong de wu da jingsuo 'wuqi' [Five Excellent "Weapons" Used in Wenchuan Earthquake Rescue and Relief Effort]," *Zhongguo Wang* [China Net], May 16, 2008 <http://www.china.com.cn/info/txt/2008-05/17/content_15287372.htm>.

[226] Liu Jihong and Ma Dong, "Aerial Surveying and Mapping Offers Precise Geographical Information," *PLA Daily*, May 22, 2008.

[227] Wang Futao, Zhou Yi, Wang Shixin, Wang Litao and Wei Chengjie, "Investigation and Assessment of Seismic Geologic Hazard Triggered by the Yushu Earthquake Using Geospatial Information Technology," *Disaster Advances* 3, No. 4 (October 2010), p. 3 <http://www.slrss.cn/download/2010/%E7%8E%8B%E7%A6%8F%E6%B6%9B.pdf>. See also Zheng et al., "Assessment of the Degree of Building Damage Caused by the 2010 Yushu, China Earthquake Using Satellite and Airborne Data," *Geomatics, Natural Hazards and Risk* 2, No. 2, pp. 141–57 <http://dx.doi.org/10.1080/19475705.2011.553968>.

launched on January 9, 2012, "meets international standards, ridding the country of its reliance on imports of satellite images.[228]

Nevertheless, China's ISR coordination challenge is illustrated by the present organization of its satellites as well as the PLAAF's efforts to assume control over them. Peacetime ownership and operational control of some satellites and applications are divided among more than a dozen government, university and civil organizations. 75 percent of satellites normally are run by nonmilitary organizations, and wartime authority transfer dynamics remain unclear. Even given ability to transition smoothly to military control in wartime—a significant assumption—China's satellites and other space assets face uncertain service jurisdiction.[229] A new Space Force is rumored to be in development, and the PLAAF appears to be best placed to assume authority over space assets for now.[230]

The PLAAF has developed extensive space-related theoretical research and has an officially approved doctrine of "integrated air and space operations, simultaneous offensive and defensive operations (*kongtian yiti, gongfang qianbei*)."[231] A 2006 book with forewords by PLAAF commander General Qiao Qingchen and political commissar General Deng Changyou states that "the PLAAF is the leading organization for 'integrated air and space,' the PLAAF is…the leading organization to manage China's military space force, and the PLAAF is the primary force for [air and space] combat." Specifically, the book advocates the establishment of an "Air Force Space Organization" (*kongjun hangtian jigou*) and "Air Force space units" (*kongjun hangtian budui*).[232]

---

[228] "China No Longer Reliant on Satellite Image Imports," *Xinhua*, January 10, 2013 <http://www.chinadaily.com.cn/business/2013-01/10/content_16101933.htm>.

[229] These include GAD (responsible for launch facilities and on-orbit command and control), the General Staff Department (GSD) (responsible for their military operations); such nonmilitary organizations as the State Oceanographic Administration, China Meteorological Agency, National Committee for Disaster Reduction, Ministry for Land and Resources, Science and Technology Ministry; such state-owned enterprises as ChinaDBsat, APTgroup, Asiasat; and such civilian universities as Tsinghua and Zhejiang. Hagt and Durnin, "China's Antiship Ballistic Missile," pp. 87–115, A1–2.

[230] For an apparent official Chinese denial of this possibility, see "China Grounds 'Space Force' Talk," *People's Daily Online*, November 6, 2009 <http://english.peopledaily.com.cn/6805305.html>.

[231] "China's PLA Eyes Future in Space and Air: Air Force Commander," *People's Daily Online*, November 2, 2009 <http://english.peopledaily.com.cn/90001/90776/90786/6799960.html>.

[232] Cai Fengzhen and Tian Anping, eds., *Kongtian yiti zuozhan xue* [The Science of Integrated Air and Space Operations] (Beijing: Liberation Army Press, 2006), pp. 299–301, cited in Lanzit and Allen, "Right-Sizing the PLA Air Force," pp. 453–54.

The "integrated air and space" component of its strategy, however, has generated little public clarification, with one CMC general office member stating "There is no consensus on what '*yi ti hua*' [lit. integrated] means in China."[233]

Moreover, the PLAAF currently is not known to control any space assets. Indeed, the General Armaments Department (GAD), the General Staff Department (GSD) and even the Second Artillery and the PLAN to some extent, may be resistant to such a transfer of authority to the PLAAF, however, and institutional rivalry may complicate matters.[234] GAD controls all orbital satellite operations, yet lacks a combat role. The PLA already controls launch sites, the Second Artillery is heavily involved in missile programs, and various technical institutes are responsible for satellite development, so there probably will be extensive debate and negotiation within the PLA and civilian leadership concerning the ultimate control of various space assets (a process that took place earlier in the United States). Furthermore, there is not yet any clear evidence in open publications that the PLA has formally adopted space theory, doctrine, missions or regulations; so what would govern the actions of whatever organization ultimately consolidates control is likewise unclear.

Doctrine and regulations flow downward and technology upward, but there lateral movement in PLA bureaucratic processes remains limited. Technological incompatibility remains a challenge due to decentralized development, but software problems are even more significant than hardware problems. Institutional stove-piping remains a major barrier to integration and joint operations, neither of which has been fully achieved. The PLA's joint organizational structure is still under development and still does not penetrate effectively to lower levels. Lingering ground force dominance is a significant impediment; the gradual rise in funding and status of the non-ground forces helps to remedy this, but is proceeding slowly. Training is not yet sufficiently joint, and there is no permanent joint training structure. The lack of a permanent joint organization at the military region level exacerbates these

---

[233] Liu Jiangjia, "Yitihua lianhe zuozhan jiazhilun [Discussion on the Value of Integrated Joint Operations]," *Zhongguo Junshi Kexue* [China Military Science], No. 1 (2006), pp. 1–33.

[234] A group of 500 Second Artillery researchers has studied "outer space security strategy" and "space operations," according to Second Artillery Command College, "Xinshiji yuanxiao jiaoxue gaige huigu [Reflecting on Reform of Teaching at Academies and Schools in the New Century]," in Second Artillery Political Department, *Huihuang Niandai* [Glorious Era], p. 578.

problems.[235] Finally, PLA commanders are tempted to use technology and command automation to centralize operations further than they already are. Ironically, this is precisely the opposite of making efforts to empower lower-level officers to make decisions in real time, a reform regarded as essential by many militaries that have actually fought "local limited wars under informatized conditions"—an experience that China lacks entirely. These factors, and not the technical parameters of satellites and other sensors themselves, probably will constitute the primary limitations on the effectiveness of Chinese ISR system employment. The place to watch for institutional innovation may be the Jinan military region, which is a logical "joint reform test bed" because it has all services represented as well as a Fleet Headquarters, yet lacks the Nanjing and Guangzhou MRs' strategic urgency.[236]

In sum, China's air- and space-based C4ISR—together with their supporting infrastructure, human and otherwise—are improving rapidly, particularly with respect to hardware, but remain incomplete and are experiencing growing pains. Institutional wrangling for control of China's space assets continues. The sprawling, stove-piped nature of the many military services and organizations that control satellite/C4ISR architecture further complicates the horizontal/vertical inter-service, inter-level and military-civilian bureaucratic coordination necessary for real time data fusion to support kinetic operations. While China may be able to employ a variety of strategies to conduct centralized non-space-based C4ISR operations near its territory, it may find it difficult to attain similar results further afield, where information assurance is more elusive.

Despite these ongoing challenges, counter-intervention affords China a strategic defensive posture along interior lines, and a different and considerably easier C4ISR task than that of the U.S. The PLA can mitigate ongoing limitations in jointness and challenges in command and control and target de-confliction by employing land lines, high-power line-of-sight communications, advanced planning, and geographic and temporal segregation. China's emerging C4ISR capabilities are already undergirding growing Chinese counter-intervention capabilities that are changing the balance of military power on China's maritime periphery. With respect to the

---

[235] Kevin Pollpeter, "Towards an Integrative C4ISR System: Informatization and Joint Operations in the People's Liberation Army," in Roy Kamphausen, David Lai and Andrew Scobell, eds., *The PLA at Home and Abroad: Assessing the Operational Capabilities of China's Military* (Carlisle, PA: U.S. Army War College, 2010), p. 207.

[236] Ibid., p. 218.

Near Seas and their immediate approaches, at least, China's military awareness, coordination, and ASBM targeting capabilities warrant careful attention.

VII. CONCLUSION

The mounting evidence and statements from senior U.S. and Taiwan defense officials must be taken seriously by foreign observers and militaries. Previously, a few naysayers stated that an ASBM was technologically impossible; more said that there was no evidence that China could achieve such a capability. Physics, however, allows for an ASBM, and everyone operates with the same physics-based constraints and opportunities. Now that relevant U.S. and Taiwan authorities, with their information access and operational judgment, have weighed in definitively, those positions have become untenable. China's ASBM system must be viewed as viable and taken into account operationally. This system is not a "smoke and mirrors" bluff and it is not an aspirational capability that the United States can ignore until some point in the future.

The question, then, is not whether the DF-21D exists, but rather what level of operations can China achieve and how soon? More broadly, from a strategic perspective, how will this influence regional deterrence dynamics and what will it mean for U.S. strategy, operational concepts, and force development plans? Even China's Second Artillery itself cannot know exactly how the DF-21D would function under actual combat conditions. Nobody will know for certain if this ASBM actually works as intended unless it is actually used—a prospect, it is to be hoped, that will never be realized in practice.

Mastering detection, targeting and bureaucratic coordination probably will represent an ongoing challenge. When it comes to targeting a CSG, there will not be a sharp red line between IOC and full capability as the PLA's C4ISR architecture improves steadily. Some Chinese writers believe that even the significant likelihood of a capability may have a large deterrent effect. When assessing possible ASBM futures, the following bears remembering: China has prioritized ballistic missiles for decades, enjoys a formidable science and technology base, and can be expected to devote considerable resources and expertise to ASBM development. A fully-functional and well-supported Chinese ASBM may appear relatively soon and could have significant implications for U.S.-China strategic relations. The DF-21D's existence and deployment already is prompting regional concerns.

The Counter-Intervention or A2/AD Context

At the same time, the ASBM is not a stand-alone system. It is connected to an extensive targeting architecture involving satellites, land-based radars, ships, aircraft, and UAVs. It is part of a system of systems of other platforms that includes submarines, strike aircraft, and even surface vessels. Thus, even if the weapons system has flaws that can be countered, it represents one more problem that U.S. forces would have to deal with in a crisis scenario in the Western Pacific. The Battle of Midway in June 1942—one of the World War II Pacific Campaign's, and of that war's, most decisive naval engagements—is instructive in this regard. It concluded with Japanese defeat when three squadrons of U.S. carrier-based dive bombers took Japanese carriers *Soryu*, *Akagi* and *Kaga* out of action, forcing their eventual abandonment and scuttling. Prior to that, however, the Japanese carrier force was subjected to attacks from two groups of U.S. land-based dive bombers, two groups of land-based torpedo bombers, one group of land-based high-altitude bombers, three squadrons of carrier-based torpedo bombers, and one submarine.

No individual platform or weapon succeeded in causing significant damage to the Japanese carrier force and the U.S. forces took heavy casualties in general, but in aggregate they succeeded in preoccupying the Japanese air defenses and in confusing Japanese commanders regarding how to prosecute the battle. This ultimately helped the dive bomber squadrons break through. Therein lies the larger point—even if U.S. forces could counter China's ASBM, would doing so divert attention from another threat (i.e. a submarine) that could sneak in and fire a shot? While that question is unanswerable at present, the ASBM should not be viewed in isolation from other capabilities.

The core implication of the DF-21D's IOC status is that certain possibilities now have to be taken into account as never before. With the ASBM, the uncertainty arguably works in China's favor with regard to deterrence. In a crisis or combat situation, U.S. operators would have to draw a range ring for the DF-21D and then decide whether or not to risk sending CSGs into that range ring. This operational uncertainty evokes the 1971 crime thriller *Dirty Harry*, in which San Francisco Police Department Inspector Harry Callahan (Clint Eastwood) challenges a bank robber:

> "I know what you're thinking: "Did he fire six shots, or only five?" Well, to tell you the truth, in all this excitement, I've kinda lost track myself. But being this is a .44 Magnum, the most powerful handgun in the world, and would blow your head clean off, you've got to ask yourself one question: 'Do I feel lucky?'"

In that particular case, it later turns out that the gun was empty, but the robber surrendered because he was unwilling to risk being killed. In the film's climactic scene, faced with a similar choice, the serial killer "Scorpio" (Andy Robinson) makes the opposite decision and ends up dead from a chest wound. In an actual combat situation, the relevant U.S. commander would have to make a decision as to how much risk s/he was willing to tolerate, and act accordingly. In a similar vein, U.S. policymakers also will have to consider the risk to U.S. forces when making decisions about military deployments in the western Pacific.

Potential Pitfalls May Have Strategic Consequences

Chinese ASBM development nevertheless faces various challenges that may limit the missile's tactical and strategic utility. For example, China will need to develop an ASBM firing doctrine, including deciding on objectives of target destruction; what to shoot at, and when; decide whether to fire one ASBM, several, or a large salvo; select warheads; and determine whether to co-ordinate with other munitions and services. Various other obstacles could limit China's ability to deploy ASBMs effectively, particularly in the areas of detection, targeting, data fusion, joint service operations and bureaucratic coordination as noted above.

On a more disturbing note, authoritative PLA sources reveal overconfidence in China's ability to control escalation, which is itself an extraordinary danger. Historically, however, deterrence has been difficult to achieve even for nuclear-armed states; compellence even more so. China's belief that it can achieve a better strategic track record may be proven wrong, but not before it may pose great problems and risks in the process.

"Deterrence" entails trying to prevent an adversary from doing something that it otherwise might want to do. "Compellence" entails trying to force an adversary to do something that it otherwise might not want to do.[237] Because of politically-motivated desire minimize the possibility that Chinese rhetoric and behavior might be perceived as "threatening," Chinese official statements and documents only use the term "deterrence."[238] Yet the Chinese term

---

[237] Thomas C. Schelling, *Arms and Influence* (New Haven, Connecticut: Yale, 1966), pp. 69–78.

[238] The author has been told that Chinese representatives in the Committee on the U.S.-China Glossary of Nuclear Security Terms flatly refuse to allow coverage of such operationally

"*weishe*"—*translated* for an English-reading audience as "deterrence" by official Chinese sources—is sometimes used *conceptually* in a way that encompasses both deterrence and compellence, as they are typically defined in Western political science literature.[239]

In a worst-case scenario, China might attempt to use the threat of ASBM strikes not simply to *deter* the United States from taking certain measures against Chinese forces, but also to *compel* it to act in ways that it otherwise would not—perhaps to include actively restraining the militaries of Taiwan and other regional actors. PLA doctrinal publications mention firing "warning shots" in front of carriers, but it is unclear whether U.S. naval operators or decision makers would consider this a warning shot or simply a miss or failure. The difference in U.S. perception between an intentional deterrent and an unintentional failed strike could have significant repercussions and incite Washington to retaliate and even launch operations against Chinese targets more directly.

Chinese writings concerning "escalation and escalation management appear to be under-theorized and still under development."[240] To the extent that it is even articulated, the basis for Chinese optimism concerning escalation management "is that conflict is far more transparent in a globalized world, and, thus, it is subject to national and international limits—some of which constrain China and others that China would seek to use to its advantage during conflict. Chinese strategists also argue that most nations possess the material ability and political will to control warfare."[241] Chinese strategists seem particularly enamored with suggestive escalation, or "deliberately escalatory actions are taken not because of the direct results expected from them but, rather, to send a signal to the opponent (or to a third party) about what further escalation will or might occur in the future."[242] Chinese writings

---

important phrases as "key point strikes"—mentioned as "*zhongdian daji*" in *SSAC*, p. 304; and as "*zhongdian tuji*," pp. 305, 306—likely because of a similar semantic calculus.

[239] For example, see Peng Guangqian and Yao Youzhi, *The Science of Military Strategy* (Beijing: Military Science Press, 2005), p. 491, and any of the Chinese white papers on national defense between 2002 and 2010. For a more thorough analysis, see Dean Cheng, "Chinese Views on Deterrence," *Joint Force Quarterly* 60, No. 1 (2011), p. 92.

[240] Forrest E. Morgan, Karl P. Mueller, Evan S. Medeiros, Kevin L. Pollpeter and Roger Cliff, *Dangerous Thresholds: Managing Escalation in the 21st Century* (Santa Monica, CA: RAND, 2008), p. 49, <http://www.rand.org/content/dam/rand/pubs/monographs/2008/RAND_MG614.pdf>.

[241] Ibid., p. 53.

[242] Ibid., p. 31.

emphasize the following "military actions that seek to shape (*zaoshi*) the overall situation in China's favor":

- Maximizing military intimidation and deterrence through military force deployment and preparation;
- Ensuring that military actions support a clear political objective;
- Selecting military targets appropriately;
- Fine-tuning military operational parameters;
- Aligning operational techniques closely with political objectives;
- Controlling conflict tempo and intensity;
- Controlling war termination;
- Controlling the strategic environment post-conflict.[243]

There is no significant acknowledgement of difficulty, complexity, fog of war, possibility of misperception or misinterpretation, collateral damage or unintended consequences.[244] In particular, the strategic benefits of preemption are stressed, but not the risks.[245] The epitome of this is the concept of employing nuclear counter-strikes to deescalate and terminate conflict.[246] As a landmark RAND study points out, "Because escalation is an interactive phenomenon, one in which any party to a conflict can play a role, it can rarely, if ever, be controlled, in the normal sense of the word."[247] Indeed, it maintains, "Even after decades of deliberation about escalation, U.S. analysts cannot predict with certainty how their own government would be likely to react to many sorts of potential attacks…Nor, in many cases, can U.S. leaders themselves know how they would respond until they are actually presented with such contingencies."[248] Moreover, escalation dominance is difficult for any nation, even the United States, to achieve in a high-end confrontation, and escalation can erupt vertically, horizontally and politically in unexpected

---

[243] Ibid., p. 54–56.

[244] Kevin Pollpeter, "Controlling the Information Domain: Space, Cyber, and Electronic Warfare," in Ashley J. Tellis and Travis Tanner, eds., *Strategic Asia 2012–13: China's Military Challenge* (Seattle, WA: National Bureau of Asian Research, 2012), p. 190.

[245] Morgan et al., *Dangerous Thresholds*, p. 57.

[246] Kang Zhanke, Li Gen'an and Li Pengfei, eds., *Junbingzhong zhishi yu yunyong* [Knowledge and Application of the Military Services and Arms] (Beijing: Junshi kexue chubanshe, 2004), pp. 139–41; *SSAC*, p. 293.

[247] Morgan et al., *Dangerous Thresholds*, p. xii.

[248] Ibid., p. 14.

ways. [249] While problems in Chinese civil-military relations have been exaggerated by some foreign observers, failure to consider these dangerous uncertainties adequately raises the risk of a perception gap concerning doctrinal and political imperatives erupting between China's civilian and military leadership in the event of a serious crisis or conflict.

Possible explanations for absence of publicly documented consideration of these factors by Chinese strategists include the lack of experiences to impress them with these realities directly. Perhaps the Second Artillery is overconfident because it has "never had any actual combat experience," let alone the sobering experience of something like the Cuban Missile Crisis. [250] Such crises have impressed other national leaders with the realities of the "fog of war" and the potential for misperceptions and unintended, potentially disastrous consequences—which, in this case, could include preemptive strikes against precious Chinese assets or retaliatory strategic strikes.[251] In any case, Chinese ASBM deployment could increase bilateral and regional tensions and may only prompt U.S. forces to deploy countermeasures rather than prevent CSG employment.

Strategically, the ASBM also may fail to achieve the broader goal of preventing U.S. intervention. The ASBM's very deployment could itself concern the U.S. that a successful attack on one or more CSGs was possible and, hence, encourage Washington to destroy or disable missiles or supporting assets preemptively in the case of conflict.

While probably intended with U.S. CSGs specifically in mind, Chinese ASBM development could have deeply destabilizing consequences that would reverberate far beyond U.S.-China strategic relations. A demonstrated Chinese ASBM could undermine the 1988 INF Treaty between Washington and Moscow, which prevents both nations—to this day—from possessing conventional (and nuclear) ground-launched ballistic (and cruise) missiles with

---

[249] Ibid., p. 16.

[250] Headquarters of the Second Artillery Logistics Department, "Zhanshi houqin baozhang lilun he shijian de xin tansuo [A New Exploration of the Theories and Practice of Logistics Support in Wartime]," in Second Artillery Political Department, *Huihuang Niandai* [Glorious Era], p. 638.

[251] Greg Torode, "Is China's Rocket Science All Its Cracked Up to Be, Experts Ask," *South China Morning Post*, January 3, 2010.

ranges of 500 to 5,500 kilometers.[252] The United States developed a capability distantly related to today's Chinese ASBM—the *Pershing II* MRBM—but retired all such missiles voluntarily following ratification of the INF Treaty. In a demonstration of significant strategic restraint, the world's two military superpowers voluntarily refrained from developing sub-strategic missiles within these parameters. For more than two decades, Washington and Moscow have maintained their self-discipline, even as China has moved rapidly to develop the world's most formidable sub-strategic missile force.

Restraint may erode if it is clearly being exploited by another party. Various Russian civilian and military leaders have recently questioned the treaty's relevance to their nation's interests, motivated in part by growing Chinese nuclear MRBM capabilities (e.g. the DF-21 variants). [253] Chinese demonstration of the strategic value of missiles with precisely the parameters banned by the treaty could conceivably eventually generate considerable pressure in Moscow and even in Washington for its revision or outright abandonment. Even more likely, other nations might be motivated to develop ASBMs or related capabilities of their own. Japan, for instance, feels increasingly vulnerable strategically yet remains reluctant to develop nuclear weapons.

Chinese ASBM development also probably renders Washington unwilling to accept a binding space security agreement (in the unlikely event that Beijing was open to one) because it could tie the U.S. military's hands significantly regarding approaches to preserve the ability of U.S. forces to operate in the Asia-Pacific without being held at risk prohibitively. Given growing challenges to surface ships and air bases from China's development and deployment of the DF-21D, anti-ship cruise missiles and other weapons systems requiring over-the-horizon targeting, U.S. planners would insist on retaining counterspace means to degrade China's ISR capabilities in the unfortunate event of conflict. This, in turn, raises further cause for concern. As a major RAND study documents:

---

[252] "Treaty between the United States of America and the Union of Soviet Socialist Republics on the Elimination of their Intermediate-Range and Shorter-Range Missiles," entered force June 1, 1988 <http://www.state.gov/www/global/arms/treaties/inf1.html#treaty>.

[253] For evidence that "China's modernization of its theater nuclear missiles systems is a key factor in Russia's case for withdrawal from the INF treaty," see, Brad Roberts, "Strategic Deterrence Beyond Taiwan," in Kamphausen et al., eds., *Beyond the Strait: PLA Missions Other Than Taiwan*, p. 192.

> "Operational military doctrines in both China and the United States emphasize surprise, speed, and deep strikes to seize the initiative and achieve dominance. Neither body of doctrine appears to consider how an adversary might react to such operations in a limited war—indeed, each seems to assume that it will suppress enemy escalation by dominating the conflict. Consequently, a Sino-American confrontation would entail significant risks of inadvertent escalation if military forces were permitted to operate in keeping with their doctrinal tenets without regard for escalation thresholds."[254]

At very least, the resulting strategic tension would generate additional military procurement and energize long-term investment to counter or balance against Chinese ASBM capabilities in some fashion, a phenomenon that would leave all parties worse off than before.

At the political level, then, Washington must emphasize to Beijing that ASBM development on its part would have implications inimical to both U.S. and Chinese interests. Chinese open source discussions of ASBMs are significant and must be addressed. Chinese public intellectuals are often tasked by their government with making unofficial statements to gauge international response to potential initiatives. If some Chinese are currently sending such trial balloons with regard to ASBM deployment and posturing, but U.S. interlocutors appear to be unaware, distracted or indifferent, this will only strengthen the hand of those promoting such efforts. Measured expression of U.S. concern and resolve, on the other hand—supported by balanced but substantive actions—might influence Chinese decision-making regarding ASBM development in a more positive direction (e.g. by informing and empowering the voices of government organizations with more to lose than the Second Artillery in provoking the United States). Just as U.S. policymakers must now discuss how to prepare for this potential capability, they should work to ensure that their Chinese counterparts have an analogous policy debate—in parallel to the ongoing debate in open sources regarding whether China should develop and deploy an ASBM, and the doctrinal and usage implications if it does. While China will ultimately keep its own counsel, like any nation, such efforts should at least ensure that any decisions in favor of ASBM development are made with full awareness of the contingent costs, risks, and consequences.

---

[254] Morgan et al., *Dangerous Thresholds*, p. 169.

Reactions and Countermeasures

Whatever the ASBM's operational readiness and the effectiveness of Chinese C4ISR, Chinese capabilities tell only half the story. The U.S. Government has been aware of Chinese ASBM development for years now and has monitored it closely. As discussed earlier, official U.S. revelations about the ASBM program began in the mid-2000s and steadily increased in specificity about the program as well as U.S. concerns. The U.S. military has undoubtedly used this long lead-time to develop a variety of countermeasures.

Tellingly, senior U.S. policymakers and military officers have revealed as much. On January 8, 2011 while en route to Beijing, then-Secretary of Defense Robert Gates took questions on Chinese military modernization. Responding to a question about the ASBM, Gates said "We've been watching these developments all along. I've been concerned about the development of the anti-ship cruise and ballistic missiles ever since I took this job [in 2007]...They clearly have the potential to put some of our capabilities at risk and we have to pay attention to them, we have to respond appropriately with our own programs." In fact, he elaborated, "some of [DOD's] higher priority areas for investment are focused on some of these anti-access programs."

Separately, a statement by the commander of the U.S. 7th Fleet made in mid-February 2011 indicates that the U.S. Navy is taking a proactive, measured approach to Chinese ASBM development. "It's not the Achilles heel of our aircraft carriers or our Navy—it is one weapons system, one technology that is out there," Vice Admiral Scott van Buskirk declared in an interview on the bridge of the USS *George Washington*, the only U.S. carrier home-ported in the western Pacific. He added, "Any new capability is something that we try to monitor." Pointing out that the DF-21D's capabilities remain unproven, Van Buskirk noted, "If there wasn't [the ASBM] to point to as a game changer, there would be something else. That term has been bandied about for many things. I think it really depends in how you define the game, whether it really changes it or not. It's a very specific scenario for a very specific capability—some things can be very impactful."[255]

---

[255] Eric Talmadge, "3-Star: Anti-Carrier Missile Won't Stop Navy," *Navy Times*, February 15, 2011 <http://www.navytimes.com/news/2011/02/ap-us-admiral-chinese-missile-wont-stop-us-navy-021511>.

Van Buskirk emphasized that the U.S. Navy will continue to "operate in the seas around Japan, Korea, the Philippines and anywhere else it deems necessary...We won't change these operations because of this specific technology that might be out there. But we will carefully monitor and adapt to it." Van Buskirk suggested how Beijing might allay concerns the region about its military developments: "It goes back to transparency. Using the United States as an example, we are very clear about our intent when conducting routine and normal operations in international waters…That is what you might expect from other nations that might operate in this region."[256]

In a series of interviews in spring 2011, then-U.S. Chief of Naval Operations Admiral Gary Roughead downplayed the impact of China's ASBM. Admiral Roughead explained "You have to look at the total employment of the weapon. You have to look at the nature of being able to first locate, then target, and then engage a moving seaborne target at range...I really do think it is not the game-changer people have played it up to be." As he elaborated, the goal of the U.S. Navy is "to not be denied ocean areas [where we] can operate, or not be restricted in our ability to operate." Most importantly, Roughead stated unequivocally "we have systems that can counter weapons like [the DF-21D]."[257]

There is every reason to believe that the confidence of senior U.S. military officers is warranted given the countermeasure options available. What is worth noting, however, goes beyond U.S. options and reinforces the points made above about the ASBM's effectiveness being related to the effectiveness of the PLA's C4ISR architecture. Congressional Research Service naval expert Ronald O'Rourke's adeptly summarizes the key points and illustrates in reverse how Chinese capabilities should be evaluated:

> "Although China's projected ASBM, as a new type of weapon, might be considered a 'game changer,' that does not mean it cannot be countered. There are several potential approaches for countering an ASBM that can be imagined, and these approaches could be used in combination. The ASBM is not the first 'game changer' that the Navy has confronted; the Navy in the past has developed counters for other new types of weapons, such as ASCMs, and is likely exploring various approaches for countering ASBMs. …

---

[256] Ibid.

[257] O'Rourke, China Naval Modernization, pp. 67–69.

"Countering China's projected ASBMs could involve employing a combination of active (i.e. 'hard-kill') measures, such as shooting down ASBMs with interceptor missiles, and passive (i.e. 'soft-kill') measures, such as those for masking the exact location of Navy ships or confusing ASBM reentry vehicles. Employing a combination of active and passive measures would attack various points in the ASBM 'kill chain'—the sequence of events that needs to be completed to carry out a successful ASBM attack. This sequence includes detection, identification, and localization of the target ship, transmission of that data to the ASBM launcher, firing the ASBM, and having the ASBM reentry vehicle find the target ship.

"Attacking various points in an opponent's kill chain is an established method for countering an opponent's military capability. A September 30, 2011, press report, for example, quotes Lieutenant General Herbert Carlisle, the Air Force's deputy chief of staff for operations, plans, and requirements, as stating in regard to Air Force planning that 'We've taken [China's] kill chains apart to the "nth" degree.'

In an interview published on January 14, 2013, Admiral Jonathan W. Greenert, the Chief of Naval Operations, stated: 'In order for one to conduct any kind of attack, whether it is a ballistic missile or cruise missile, you have got to find somebody. Then, you have got to make sure it is somebody you want to shoot. Then, you've got to track it, you've got to hold that track. Then, you deliver the missile. We often talk about what I would call hard kill—knocking it down, a bullet on a bullet—or soft kill; there is jamming, spoofing, confusing; and we look at that whole spectrum of operations. And frankly, it is cheaper in the left-hand side of that spectrum.[258]

"To attack the ASBM kill chain, Navy surface ships, for example, could operate in ways (such as controlling electromagnetic emissions or using deception emitters) that make it more difficult for China to detect, identify, and track those ships. The Navy could acquire weapons and systems for disabling or jamming China's long-range

[258] "Interview: Adm. Jon Greenert," *Defense News*, January 14, 2013, p. 30. O'Rourke notes, "The reference to 'the left-hand side of that spectrum' might be a reference to soft kill measures."

> maritime surveillance and targeting systems, for attacking ASBM launchers, for destroying ASBMs in various stages of flight, and for decoying and confusing ASBMs as they approach their intended targets. Options for destroying ASBMs in flight include developing and procuring improved versions of the SM-3 BMD interceptor missile (including the planned Block IIA version of the SM-3), accelerating the acquisition of the Sea-Based Terminal (SBT) interceptor (the planned successor to the SM-2 Block IV terminal-phase BMD interceptor), accelerating development and deployment of the electromagnetic rail gun (EMRG), and accelerating the development and deployment of shipboard high-power free electron lasers (FELs) and solid state lasers (SSLs). Options for decoying and confusing ASBMs as they approach their intended targets include equipping ships with systems, such as electronic warfare systems or systems for generating radar-opaque smoke clouds, that could confuse an ASBM's terminal-guidance radar. One observer has argued that active defenses alone are unlikely to succeed, and that the U.S. Navy should place stronger emphasis on passive defenses."[259]

This is a broad-based, long-term challenge, and hence the U.S. military has been developing, and will continue to develop, an appropriate set of responses. The long-anticipated development of China's ASBM reaching the equivalent of IOC is merely one part of a much broader set of A2/AD capabilities that China is developing to hold at risk key U.S. military platforms.

Fortunately, U.S. ships will not offer a fixed target for such "asymmetric" weapons, including Chinese ASBMs. U.S. military planning documents, including the March 2010 *Joint Operating Environment* and February 2010 *Quadrennial Defense Review* (QDR)—the Pentagon's guiding strategy document—clearly recognize the growing "anti-access" challenge. The QDR also charges the U.S. military with multiple initiatives to address it. For example, the U.S. Air Force and Navy are pursuing Air-Sea Battle, a new operational concept designed to preserve U.S. power-projection capabilities in an era of increasing aerospace-maritime battlespace fusion, jointness, tightening budgets as well as Chinese and Iranian A2/AD capabilities.

In a world where U.S. naval assets will often be safest underwater and in more dispersed networks, President Obama's defense budget has supported

[259] O'Rourke, China Naval Modernization, pp. 63–64.

building two submarines a year and investing in a new ballistic-missile submarine as well as a variety of missile defense systems—even if the budget situation has since changed.[260] The U.S. Navy has moved some of its most capable submarines and ballistic missile defense (BMD)-capable *Aegis* cruisers and destroyers to the Pacific. In what is likely one of the first of many difficult decisions regarding how to prioritize significant but not unlimited resources, it has halted procurement of *Zumwalt* (DDG-1000)-class destroyers in favor of resumed procurement of *Arleigh Burke* (DDG-51)-class *Aegis* destroyers. In a further sign of prioritization, U.S. Chief of Naval Operations Admiral Jonathan Greenert has published a definitive public statement on what the U.S. Navy is doing to support the Asia-Pacific Rebalance: "To support our increased presence in the Asia-Pacific, we will grow the fraction of ships and aircraft based on the U.S. West Coast and in the Pacific from today's 55 percent to 60 percent by 2020" through modest increases in overall hull numbers and redeployment and more efficient use of assets. Continuing to upgrade undersea platforms and weapons systems to maintain U.S. advantages therein enjoys particular emphasis.[261]

---

[260] Jennifer Grogan, "Submarines Rate High in Obama Budget," *New London Day*, February 2, 2010 <http://www.theday.com/article/20100202/NWS09/302029913>; Bill Gertz, "Threat in Asia is Anti-Ship Missiles: China, Rogue Nations Watched," *Washington Times*, March 23, 2010 <http://www.washingtontimes.com/news/2010/mar/23/threat-in-asia-is-anti-ship-missiles>.

[261] "The Navy's dominance in the undersea domain provides the United States a significant advantage over potential adversaries. Our undersea capabilities enable strike and anti-surface warfare in otherwise denied areas and exploit the relative lack of capability of our potential adversaries at anti-submarine warfare. We will sustain our undersea advantage in part through continued improvements in our own anti-submarine warfare capability, such as replacing the 1960s-era P-3 Orion maritime patrol aircraft with the longer range and greatly improved sensors of the P-8A Poseidon...We will also field improved platforms and systems that exploit the undersea domain for power projection and surveillance. In the coming years, newer, multi-mission Virginia-class submarines with dramatically improved sensors and combat systems will continue to replace aging Los Angeles-class submarines. With their conversion from Cold War-era ballistic missile submarines, our four Ohio-class guided missile submarines (SSGN) are now our most significant power projection platforms. During Operation Unified Protector, USS Florida launched over 100 Tomahawk missiles at Libyan air defenses to help establish a 'no-fly' zone. When she and her counterparts retire in the mid 2020s, the Virginia-class submarine 'payload module' will replace their striking capacity with the ability to carry up to 40 precision-strike cruise missiles, unmanned vehicles, or a mix of other payloads...Improved sensors and new unmanned systems allow us to augment the reach and persistence of manned submarines, and are essential to our continued domination of the undersea environment. These unmanned vehicles will enhance the persistence of undersea sensing, and expand its reach into confined and shallow waters that are currently inaccessible to other systems. This will enable detection of threats, for example, to undersea infrastructure." Admiral Jonathan W. Greenert, "Sea Change: The Navy Pivots to Asia," *Foreign Policy*, November 14, 2012
<http://www.foreignpolicy.com/articles/2012/11/14/sea_change>.

Nevertheless, the U.S. debt burden and ongoing gridlock concerning budget negotiations is already prompting concern that projected numbers may not add up. Analysis of the U.S. Navy's 2013 Shipbuilding Plan by the Congressional Budget Office concludes that it "will cost more than the Navy estimates" and "would not meet the service's goals for inventories of destroyers, attack submarines, and ballistic missile submarines." Of particular concern, "attack submarines would fall below the goal of about 48 between 2022 to 2034."[262] Even as CBO warns that SSBN numbers may not meet Navy goals, it predicts that starting in the 2020s, SSBNs will begin to consume the lion's share of spending on submarines.[263]

How best to develop and implement ASBM countermeasures thus remains a topic of vigorous discussion in U.S. Navy circles.[264] While taking steps to prevent China's ASBM from changing the rules of the game in the western Pacific, the United States is working to reduce the possibility of conflict in the first place by improving strategic communications with China. But nothing can be taken for granted.

---

[262] "An Analysis of the Navy's Fiscal Year 2013 Shipbuilding Plan," Congressional Budget Office, July 25, 2012, <http://www.cbo.gov/publication/43468>. "Under the 2013 plan, the Navy would purchase 46 attack submarines through 2042, which would not be enough to keep that force up to the stated goal of 48 throughout the next 30 years. The number of attack submarines would decline from 48 in 2021 to a low of 43 from 2028 to 2030 and then increase to about 48 or more after 2035. The reason for the decline is that, in 2014, the Navy expects to begin retiring Los Angeles class attack submarines (SSN-688s)—which were generally built at rates of 3 or 4 per year during the 1970s and 1980s—as they reach the end of their service life. It would then replace them with Virginia class attack submarines (SSN-774s) and their successors, mostly at rates of 1 or 2 per year." *An Analysis of the Navy's Fiscal Year 2013 Shipbuilding Plan* (Washington, DC: Congressional Budget Office, July 2012), pp. 3–4 <http://www.cbo.gov/sites/default/files/cbofiles/attachments/07-25-12-NavyShipbuilding_0.pdf>.

[263] "Figure 6: CBO's Estimates of Annual Shipbuilding Costs Under the Navy's 2013 Plan" in *An Analysis of the Navy's Fiscal Year 2013 Shipbuilding Plan*, p. 13.

[264] See, for example, Hendrix, "At What Cost a Carrier?"; Marshall Hoyler, "China's 'Antiaccess' Ballistic Missiles and U.S. Active Defense," *Naval War College Review* 63, No. 4 (Autumn 2010), pp. 84–104; Jean Hobgood, Kimberly Madison, Geoffrey Pawlowski, Steven Nedd, Michael Roberts and Paige Rumberg, "System Architecture for Anti-Ship Ballistic Missile Defense (ASBMD)," Department of Systems Engineering, Naval Postgraduate School (December 2009); Sam J. Tangredi, "No Game Changer for China," *U.S. Naval Institute Proceedings* 136, No. 2 (February 2010), pp. 24–29 <http://www.usni.org/magazines/proceedings/2010-02/no-game-changer-china>.

Concluding Thoughts

The United States has many options to meet the challenge of a Chinese ASBM, and it must be prepared to exercise them. Responding to the unprecedented strategic challenge presented by an ASBM capability, however, will require the U.S. military and civilian leadership to face hard truths. The most perilous approach would be to insist that the U.S. maintained its ability to keep the peace, when in fact the military capabilities that underpinned that ability were decreasing, at least in a relative sense. Such a discrepancy between rhetoric and reality would erode the United States' regional credibility and fuel Chinese overconfidence. The prospect of documenting that discrepancy publicly might motivate China to conduct an ASBM demonstration; a successful test could create the impression that U.S. power-projection capabilities—and the regional influence that depends on them—had been diminished dramatically. Striking a surface vessel or mockup with an ASBM in peacetime, if not addressed properly, could undermine Washington's regional reputation by making it appear that ways of war had undergone radical change, to the detriment of U.S. capabilities. In the event of crisis or outright conflict, the consequences could be catastrophic, particularly if the PLA overestimated its ability to regulate escalation.

To prevent these negative outcomes, the United States must redouble its efforts to promote peace and cooperation, while ensuring that its own capabilities remain strong and credible to all relevant audiences. Land-based air power will not solve the problem, because China's Second Artillery already holds all useful regional air bases at risk with surface-to-surface missiles simpler and more reliable than an ASBM. Defensive measures to increase the stealth of the CSG, such as decoys, obscurants and electronic countermeasures, may buy some time, but would the Washington bet a CSG on them? [265] More importantly, it would be difficult to demonstrate plausible defensive measures without compromising their effectiveness; China and the region may perceive an erosion of U.S. strength and credibility, even if the CSG can in fact defend itself against the ASBM. Ultimately, it may prove necessary to shift some U.S. high-end combat power from massive, vulnerable platforms that present very lucrative targets, to platforms which are more

---

[265] Thomas J. Culora, "The Strategic Implications of Obscurants: History and the Future," *Naval War College Review* 63, No. 3 (Summer 2010), pp. 73–84; Jonathan F. Solomon, "Defending the Fleet From China's Anti-Ship Ballistic Missile: Naval Deception's Roles in Sea-Based Missile Defense," *M.A. Thesis* (Washington, DC: Georgetown University, April 15, 2011) <http://gradworks.umi.com/1491548.pdf>.

concealable, survivable, dispersed, or even disposable (in the case of unmanned systems).[266] Investment in submarines, stealthier ships, long-range aircraft and advanced aerial vehicles may present options for maintaining credibility even in an environment where the CSG is perceived as vulnerable. This would require a fundamental cultural shift away from a navy centered on employing manned aircraft with limited range off large aircraft carriers for the majority of combat operations.

Amid ongoing uncertainty, this much is clear: with the DF-21D ASBM, China appears to be intent on fielding a system that directly threatens U.S. carriers. If not countered properly, this could weaken the U.S. military alliances and reassurances that have helped maintain peace in the Western Pacific for nearly seven decades in part by preventing costly and dangerous arms races. The game and its governing rules are changing, whether Washington likes it or not. Only through serious investment in counter-targeting efforts and other countermeasures can Washington prevent Beijing from changing the game uncontested. The U.S. is already taking important steps to prevent a Chinese ASBM from changing the rules of the game in the Western Pacific, but continued effort and vigilance of the highest order will be essential.

These challenges, which confront an already time- and resource-pressed Obama Administration, demand close scrutiny from scholars, analysts, and policy makers alike. Managing the proper response to this potential "game changer" will critically influence the U.S. role in the Pacific in the years to come.

---

[266] For an indication that such a process is already underway, see the following exchange at a recent Senate Armed Services Committee hearing: "Senator McCain: 'Admiral Roughead, are you concerned about the reports… about the Chinese… acquiring… missiles that can… attack an aircraft carrier as far away as 1,200 miles..?' Admiral Roughead: 'Yes, sir...I...see advances in ballistic missiles, as you have pointed out, and it was that development as well as [other factors] that was the basis for my decision to recommend that we truncate the DDG–1000 and invest more in our ability to conduct integrated air and missile defense Blue Water Antisubmarine Air Warfare." "Hearing to Receive Testimony on the Department of the Navy in Review of the Defense Authorization Request for Fiscal Year 2010 and the Future Years Defense Program," U.S. Senate Armed Services Committee, Washington, DC, June 4, 2009 <http://armed-services.senate.gov/Transcripts/2009/06%20June/09-40%20-%206-4-09.pdf>.

VIII. APPENDIX A: KNOWLEDGE GAPS AND KEY QUESTIONS

Despite these broad insights, available doctrinal sources leave many critical questions unanswered concerning how the PLA might envision the basing location, number, employment, and strategic effects of its growing arsenal of ASBMs. Appendix A consolidates a number of lingering questions about the ASBM as well as the ins-and-outs of using such a complex weapon within the Chinese organizational context.

Base of Operations:

- Where are ASBMs already deployed in small numbers, and where will further ones be deployed?
- What would be the expected range from the target?
- What restrictions do logistical considerations impose on their deployment?

Nature of Arsenal:

- What is the relative size of the ASBM inventory today, and what will it be in the future?
- Given a certain size, what would be the implications for operational possibilities and willingness to expend ASBMs in conflict?
- What would be the necessary size to "saturate" (have a proven ability to overwhelm defensive systems) against naval and ground targets?
- At what point would Chinese planners be satisfied that they have "saturation" capability that is able to overwhelm a given target's defenses?
- Are DF-21Ds envisioned to be used in combination with, or preceded by, other missiles; e.g. with cheaper and more numerous DF-21Cs used to fire "warning shots" in front of a CSG?
- Are the launchers reloadable and, if so, would it be feasible for launchers to "shoot and scoot" within a reasonable timeframe to deliver multiple salvos?

- What other ASBM variants might China develop and deploy? What would be their ranges and relative capabilities? How might extended-range variants extend coverage? What, if any, advantages might shorter-range variants offer?

Concept of Operations:

- How would ASBM capabilities be realized in practice?
- What would an ASBM firing doctrine look like, and what would be the objective?
- Target destruction or mission kill (the equivalent of 'slashing the tires' on carrier aircraft)?
- Would it rely on a first strike?
- Would the PLA plan to fire one ASBM, several, or a large salvo?
- If a salvo, then some combination of saturation (many shots in the same space, to overload missile defense), precision (firing many shots in a pattern to compensate for locating error on the target and get the CSG in the seeker window of at least one of the missiles), or both?
- What type of warhead would be used: unitary, EMP or submunitions?
- How might salvo attacks, or multi-axis attack coordination, be envisioned?
- Do Chinese planners think that the Second Artillery could handle the mission by itself, or would it be part of a high-low, time-on-target attack with both ASBMs and cruise missiles, e.g. launched by PLAN and PLAAF platforms?

Concept of Deterrence:

- Deterrence would seem to be a clear purpose of any ASBM development, but what does one have to show to deter?

- PLA doctrinal publications mention firing "warning shots" in front of carriers—how does the Second Artillery think the United States would respond?
- How would U.S. forces know it was a warning shot and not just a miss?
- What if U.S. forces did know and called China's bluff?
- Finally, from a technical perspective, how to actually fire a warning shot and miss by an intentional margin (vice having the seeker home in on the actual target)? Would this actually involve other missiles, e.g. the DF-21C?

Broader Impact:

- What are the anticipated outcomes of ASBM deployment and use?
- How would China expect deployment of the DF-21D to influence the U.S. approach to U.S.-China and cross-Strait relations?
- Has China considered the implications for regional security more broadly?
- How do China's leaders believe the U.S. would respond to an attack on one or more CSGs?
- Have Chinese strategists considered the possibility that they are creating a capability so problematic for the U.S. that it might seek to destroy or disable ISR supporting assets preemptively?

Firing Sequence:

- How do Chinese experts envision the "kill chain"—the sequence of events that must occur for a missile to successfully engage and destroy or disable its target—beyond the five steps that they commonly list: detection, tracking, target defense penetration, hitting a moving target and causing sufficient damage?

Targeting:

- What is the nature of the ASBM's seeker and sensor architecture?
- Does China have multiple sensors that it is currently capable of applying to ASBM detection and targeting?
- Even in the absence of relevant space-based ISR, might there not be some other way to cue the missile accurately enough that the possible parameters of where the carrier could move in the missile's brief flight time were within the "window" of its seeker?
- Targeting via civilian assets (i.e. fishing boats, other non-military "observers")
- As for the seeker, how would it work?
- How would it accomplish target discrimination?
- Is this a challenging issue?
- Does it hinge on the large size of a carrier?
- Could smaller ships also be targeted effectively?

Countermeasures:

- What do Chinese experts fear could go wrong and perhaps render an ASBM unusable?
- How does China view U.S. anti-satellite capabilities?
- Do anti-satellite missiles pose a threat to ASBM targeting capabilities?
- What are alternative methods to shutting down or limiting Chinese access to GPS, GLONASS, future Galileo, or present and future *Beidou* navigation systems?
- How affective are *Aegis* and Terminal High Altitude Area Defense (THAAD) systems against ASBMs?

ASBM Evasion and Maneuvering Capabilities:

- Chinese specialists have conducted considerable research on irregular ("wavy") ASBM/ballistic missile trajectories as well as on PENAIDS (decoys, heat shielding, etc.). What is the status and trajectory of such approaches with regard to development and implementation?

Organizational Issues: Orchestrating a defense that includes ASBMs also raises important organizational issues that have yet to be discussed in open Chinese sources and available doctrinal publications.

- Second Artillery vs. PLAN: How will they resolve overlapping strategic capabilities and competition for resources?
- How are Second Artillery and PLAN capabilities viewed by China's leadership?
- How are sensors prioritized and coordinated according to service needs?
- Which organization(s) control which sensors (e.g. OTH radar), and how they are used?
- Is there a risk of seams between services (e.g. Second Artillery, Navy, etc.)?
- What about problems with bureaucratic "stovepipes," particularly during general wartime crisis management?
- How to overlap areas of uncertainty from different sensors, and thereby accomplish data fusion from multiple sensors?
- How to accomplish bureaucratic data fusion—a task beyond even the most competent engineers?
- Which authorities would need to be in the decision-making loop, and what are the time-to-launch implications?
- How would joint operations be coordinated among the Second Artillery, the PLAN and other services—

particularly given the PLA's previous limited ability in joint operations?
- What role would the PLAN play in operations that clearly affect its geographic area of responsibility?
- Will the PLAN ultimately deploy submarine-launched ASBMs, as some Western sources anticipate?

Cost-Effectiveness: An important issue that has been addressed by Chinese analysts is the question of ASBMs' cost effectiveness relative to that of other platforms and capabilities.

- Given China's rather conservative decision to begin to acquire traditional large expensive platforms, such as aircraft carriers, how are asymmetric capabilities like the ASBM evaluated?
- ASBM-relevant research has been ongoing seriously since at least 1996—to what degree does this indicate that China intends to fully embrace ASBMs as a key part of its defense strategy?
- The ASBM and launcher are estimated by one Chinese source at $5–10.5 million per copy.[267] Based on the high-end estimate, "China could build 1,227 DF-21Ds for every carrier the United States builds going forward."[268] What are the advantages of investing in an ASBM and its launcher relative to a more traditional and expensive platform (e.g. submarines, aircraft, or surface ships like the Type 022 *Houbei* missile catamaran, etc.) and cheaper cruise missiles?
- How are the various advantages and disadvantages of acquiring high risk, short-range vulnerable platforms such as missile catamarans viewed relative to long-range mobile launchers with higher survivability?

---

[267] For cost estimate, see Qiu and Long, op. cit. "China's Anti-Ship Ballistic Missile Program: Checkmate for Taiwan?," *The Taiwan Link*, June 17, 2009 <http://thetaiwanlink.blogspot.com/2009/06/chinas-anti-ship-ballistic-missile_17.html>.

[268] Hendrix, "At What Cost a Carrier?" p. 8.

IX. APPENDIX B: POST-1996 ASBM PUBLICATION BOOM

Around 1996, Dr. Xin Wanqing, one of China's leading missile researchers at the China Aerospace Science and Technology Corporation, began feasibility studies and concept demonstration work for a Chinese ASBM. That year witnessed a sudden proliferation of relevant technical papers that did not typically cite Chinese sources dating before that year, suggesting 1995–1996 was a critical time period in the ASBM program. Below is a sampling of the studies that formed this publications boom.

* * * * *

Lian Baohua, Cui Pingyuan and Cui Hutao [Harbin Institute of Technology], "Gaosu zairu feixingqi de bianjiegou kongzhi jiqi liu ziyoudu fangzhen [Simulation Study on Variable Structure Control for High Speed Reentry Vehicle]," *Hangtian Kongzhi* [Aerospace Control], No. 4 (2002), pp. 39–45.

Chen Haidong, Yu Menglun and Dong Liqiang [Beijing Institute of Astronautical Systems Engineering], "Juyou zhongduan jiaodu yueshu de jidong zairu feixingqi de zui youzhi daolü [An Optimal Guidance Law of Maneuvering Reentry Vehicles with Terminal Angular Constraint]," *Hangtian Kongzhi* [Aerospace Control], No. 1 (2002), pp. 6–11.

Chen Haidong and Yu Menglun [Beijing Institute of Astronautical System Engineering], "Jidong zairu feixingqi de fuhe zhidao fang'an yanjiu [Study of a Compound Guidance Scheme for Maneuvering Reentry Vehicles]," *Yuhang Xuebao* [Journal of Astronautics] 22, No. 5 (September 2001), pp. 72–76.

Chen Haidong, Li Junhui and Yu Menglun [Beijing Institute of Astronautical Systems Engineering], "Zairu feixingqi gaokong zui youzhi daolü [An Optimal High-altitude Guidance Law for Reentry Vehicles]," *Zhanshu Daodan Jishu* [Tactical Missile Technology], No. 1 (2001).

Chen Haidong, Yu Menglun, Xin Wanqing and Li Junhui [Beijing Institute of Astronautical Systems Engineering]; Zeng Qingxiang [Beijing Institute of Special Mechanical and Electronic Devices], "Zairu feixingqi gongji mansu mubiao de zhidao fang'an yanjiu [Study for the Guidance Scheme of Reentry Vehicles Attacking Slowly Moving Targets]," *Daodan yu Hangtian Yunzai Jishu* [Missiles and Space Vehicles], No. 6 (2000), pp. 5–9.

Lin Hai [Beijing Institute of Technology], "Tuxiang zhidao daodan de xianqi daoyin yu sousuo guilü yanjiu [The Searching Guidance and Searching Program of an Image-Guided Missile]," *Yuhang Xuebao* [Journal of Astronautics] 20, No. 4 (October 2009), pp. 83–88.

Gao Jianping and Chen Zongji [Beijing University of Aeronautics and Astronautics] "Feixianxing bianjigou jieou kongzhi ji dui zairu feixingqi de yingyong [Nonlinear Variable Structure Decoupling Control and Application in Reentry Vehicle]," *Feixing Lixue* [Flight Dynamics] 16, No. 3 (September 1998), pp. 87–92.

Fu Wei [53rd Research Institute, Ministry of Electronics Industry], "Jiguang–tuxiang fuhe zhidao jishu gaishu [A General Exposition on Laser-Optical Composite Guidance Technology]," *Guangdian Duikang yu Wuyuan Ganrao* [Electro-Optics & Passive Countermeasures], No. 2 (1998).

Li Yushan and Yao Yu [Harbin Engineering University], "Zairu feixingqi de dajidong guiji shixian [The Realization of a Large Maneuver Trajectory for a Reentry Vehicle]," *Ha'erbin Gongye Daxue Xuebao* [Journal of Harbin Institute of Technology] 29, No. 5 (October 1997), pp. 90–92.

Ding Chibiao and Mao Shiyi [Beijing University of Aeronautics and Astronautics], "Zhudong xundi mozhidao de jiehuo xingneng fenxi [Acquisition Performance of Terminal Guidance for Active Radar Homing Missiles]," *Hangkong Xuebao* [Acta Aeronautica et Astronautica Sinica] 18, No. 4 (July 1997), pp. 473–76.

Zhao Hanyuan, Chen Kejun, Guo Zhenyun and Cheng Guocai [National University of Defense Technology], "Zairu jidong feixing shuxue fangzhen yanjiu [Simulation and Analysis of a Maneuverable Reentry Vehicle]," *Yuhang Xuebao* [Journal of Astronautics], No. 1 (January 1997), pp. 96–99.

Li Jiping and Que Zhihong [Northwestern Polytechnic University], "Fuhe zhidao jiaoban wuchafenxi de shedong xiangliangfa [Perturbation Vector Method for Computing Pointing-Angle Errors at Handoff of Combined Guidance System]," *Xibei Gongye Daxue Xuebao* [Journal of Northwestern Polytechnic University] 14, No. 4 (November 1996), pp. 527–30.

Deng Zichen [Northwest Polytechnic University], "Feixingqi zairu jidong zhidao de yizhong xinfangfa [A New Method for Reentry Maneuver Guidance of Flight Vehicles]," *Feixing Lixue* [Flight Dynamics] 14, No. 2 (June 1996), pp. 87–91.

X. APPENDIX C: CHINESE ANALYSIS OF THE PERSHING II

A plethora of writing tracking the development, successes and failures of the *Pershing II* missile system shows the close attention paid to the system by Chinese weapons engineers. Interestingly, the articles first appeared in 1976 and continued through 1994, several years after the last *Pershing II* missile had been destroyed. The following articles provide a glimpse of China's long-term interest in the *Pershing II* program.

* * * * *

Huang Pinqiu [Beijing Institute of Special Mechanical and Electronic Devices], "Panxing II daodan he dantou de chubu fenxi [Primary Analysis of the Pershing II Missile and Reentry Vehicle]," *Daodan yu Hangtian Yunzai Jishu* [Missiles and Space Vehicles], No. 1 (1994).

Liu Yong [Beijing Systems Engineering Research Institute], "Cong Panxing II yu Zhanfu de bijiao kan yuancheng xunhangdaodan de zuozhan xiaoneng [Examining the Efficacy of Long-Range Cruise Missiles in Battle from the Perspective of the Pershing II and the Tomahawk]," *Feihang Daodan* [Winged Missiles Journal], No. 3 (1993).

Kang Jiaren, "Panxing II qingque mozhidao jishu fenxi [An Analysis of the Pershing II's Precision Terminal Guidance Technology]," *Daodan yu Hangtian Yunzai Jishu* [Missiles and Space Vehicles], No. 12 (1991).

Liu Xianglin, "Leida quyu xiangguan pipei jishu jiqi zai Panxing II zhanshu didi daodan mozhidao shang de yingyong [Radar Area Correlation Matching Technology and its Use in the Pershing II Tactical Ground-to-Ground Missile's Terminal Guidance and Control]," *Feihang Daodan* [Winged Missiles Journal], No. 5 (1989).

Li Yulan, "Panxing II daodan zitai kongzhi xitong [The Pershing II Missile's Attitude Control System]," *Hangtian Kongzhi* [Aerospace Control], No. 4 (1988).

Wang Yanwen, "Panxing II daodan de danzai jishuanji [The Warhead Computer in the Pershing II Missile]," *Hangtian Kongzhi* [Aerospace Control], No. 4 (1988).

Liu Jianying and Fei Yuzhou, "Panxing II daodan shigu diaocha [Pershing II Missile Accident Investigation]," *Guti Huojian Jishu* [Journal of Solid Rocket Technology], No. 4 (1988).

Zheng Jinde, "Panxing II daodan fangzhen yanjiu [Pershing II Missile Simulation Research]," *Hangtian Kongzhi* [Aerospace Control], No. 2 (1988).

Wang Dushi [Ministry of Spaceflight, First Department], "Panxing II Daodan zhidao fangan de xuanze jiqi qishi [The Selection of the Pershing II Missile's Guidance and Control Plan and its Inspiration]," *Zhanshu Daodan Jishu* [Tactical Missile Technology], No. 3 (1987).

Zhang Jing, "Panxing-2 daodan [The Pershing II Missile]," *Daodan yu Hangtian Yunzai Jishu* [Missiles and Space Vehicles], No. 2 (1987).

Pei Mingyuan, "Panxing II daodan wuqi xitong [Pershing II Missile Weapons System]," *Daodan yu Hangtian Yunzai Jishu* [Missiles and Space Vehicles], No. 4 (1986).

Huang Wei, "Panxing II daodan chenggong de jinxing le sanci shiyan [The Pershing II Missile Successfully Carries out Three Tests]," *Guti Huojian Jishu* [Journal of Solid Rocket Technology], No. 1 (1986).

Li Weiqing, "'Panxing' II wuqi xitong [The "Pershing" II Weapons System]," *Zhongguo Hangtian* [Aerospace China], No. 8 (1985).

He Xiaosi, "'Panxing' II daodan shigu diaocha baogao ["Pershing" II Missile Accident Report]," *Zhongguo Hangtian* [Aerospace China], No. 7 (1985).

Guang Jian and Lan Tian, "Meiguo zai xide de Panxing II daodan zanting bushu, jinxing xiugai [The U.S. Suspends Deployment of Pershing II Missiles in West Germany, Carries out Modifications]," *Guti Huojian Jishu* [Journal of Solid Rocket Technology], No. 3 (1985).

Gao Ling, "Panxing II di yi ji tuijin jizhe huo shijian [Pershing II Level One Propellant Fire Incident]," *Guti Huojian Jishu* [Journal of Solid Rocket Technology], No. 2 (1985).

Wang Xizhen, "Lujun jiuzhi de Panxing 2 hao feixing shiyan shibai [Flight Test of the Army-Manufactured Pershing II Fails]," *Hangtian Kongzhi* [Aerospace Control], No. 1 (1985).

Wu Huiyong, "Panxing II Daodan 'lengdong' shiyan [The Pershing II Missile's "Freezing" (Temperature) Trial]," *Daodan yu Hangtian Yunzai Jishu* [Missiles and Space Vehicles], No. 11 (1984).

Xie Wu,"'Panxing 2' jidongshi diddi dandaodaodan [The "Pershing II" Mobile Ground-to-Ground Missile]," *Zhongguo Hangtian* [Aerospace China], No. 10 (1984).

Su Yuyu, "Meiguo de yunhang daodan he Panxing II xing daodan—Beiyue dui Sulian daodan weixie de dafu [U.S. Cruise Missiles and Pershing II Missiles—NATO's Answer to the Threat of Soviet Missiles]," *Xiandai Fangyu Jishu* [Modern Defense Technology], No. 1 (1984).

Cheng Minsheng, "'Panxing' II daodan di 13 ci shishe jin bufen chenggong [The "Pershing" II Missile's Thirteenth Test Firing is Only Partially Successful]," *Zhongguo Hangtian* [Aerospace China], No. 9 (1983).

Zhang Xiaqi, "Panxing II daodan de xin dongxiang [The Pershing II Missile's New Trend]," *Zhongguo Hangtian* [Aerospace China], No. 5 (1983).

Wu Heqin, "Panxing II daodan shishe chenggong [Pershing II Test Firing Succeeds]," *Zhongguo Hangtian* [Aerospace China] No. 4 (1983).

Gu Xiao, "'Panxing II daodan di san ci fashe [The "Pershing" II Missile's Third Launch]," *Zhongguo Hangtian* [Aerospace China] No. 3 (1983).

Zhang Dexiong, "Panxing-2 daodan di san ci shifei bufen chenggong [The Pershing II Missile's Third Test Flight is Partially Successful]," *Guti Huojian Jishu* [Journal of Solid Rocket Technology], No. 1 (1983).

Song Zhiyong, "Panxing-2 daodan di yi ci shifei shibai [The Pershing II Missile's First Test Flight Fails]," *Guti Huojian Jishu* [Journal of Solid Rocket Technology], No. 1 (1983).

Cheng Minsheng, "Panxing II daodan feixing shiyan jihua yi xiugai [Pershing II Missile Flight Test Plan Has Already Been Revised]," *Zhongguo Hangtian* [Aerospace China], No. 10 (1982).

Xie Zuowei, "Panxing daodan de feixing shiyan [The Pershing Missile's Flight Test]," *Zhongguo Hangtian* [Aerospace China], No. 7 (1982).

Guo Yi, "Panxing II he dimian fashe de xunhang daodan tuichi bushu [Deployment of Pershing II and Ground-Launched Cruise Missiles Deferred]," *Xitong Gongcheng Yu Dianzi Jishu* [Systems Engineering and Electronics], No. 8 (1981).

Liao Zhaopei, "Panxing II daodan keyi dadao 10mi yinei de pingzhong jingdu [The Pershing II Can Hits Target with a Precision of within 10 Meters]," *Feihang Daodan* [Winged Missiles Journal], No. 9 (1980).

Jun Ya, "Panxing II daodan dingyu April, 1982 jinxing shouci fashe [Pershing II Missile Scheduled for First Launch in April 1982]," *Xitong Gongcheng Yu Dianzi Jishu* [Systems Engineering and Electronics], No. 4 (1980).

Wei Fang, "Panxing II daodan [Pershing II Missile]," *Zhongguo Hangtian* [Aerospace China], No. 2 (1980).

Xie Zuowei, "Beiyue zhunbei bushu Panxing II daodan he dishe xunhang daodan [NATO Prepares to Deploy Pershing II Missiles and Ground-Launched Cruise Missiles]," *Zhongguo Hangtian* [Aerospace China], No. 1 (1980).

Liao Zhaopei, "Mei 'Panxing II' de leida quyu xiangguan zhidao xitong de feixing shiyan" [Flight Test of the U.S. 'Pershing II's Radar Area Correlation Control and Guidance System]," *Feihang Daodan* [Winged Missiles Journal], No. 1 (1979).

"Wei 'Panxing' hao daodan shiyan de zhidao zhuangzhi [The Control and Guidance Installation for the "Pershing" Missile Test]," *Feihang Daodan* [Winged Missiles Journal], No. 2 (1976).

ABOUT THE AUTHOR

Andrew S. Erickson

Dr. Andrew S. Erickson is an Associate Professor in the Strategic Research Department at the U.S. Naval War College and a core founding member of the department's China Maritime Studies Institute (CMSI). He is an Associate in Research at Harvard University's John King Fairbank Center for Chinese Studies (2008-). Erickson also serves as an expert contributor to the *Wall Street Journal*'s China Real Time Report. In 2012, he was awarded the inaugural Ellis Joffe Prize for PLA Studies for his contributions to U.S. understanding of Chinese security issues. Erickson received his Ph.D. and M.A. in international relations and comparative politics from Princeton University and graduated magna cum laude from Amherst College with a B.A. in history and political science. Erickson is coeditor of, and a contributor to, the Naval Institute Press book series, "Studies in Chinese Maritime Development," comprising *Chinese Aerospace Power* (2011), *China, the U.S., and 21st Century Sea Power* (2010), *China Goes to Sea* (2009), *China's Energy Strategy* (2008) and *China's Future Nuclear Submarine Force* (2007). Prior to entering academia, he also worked at the U.S. Embassy in Beijing, the U.S. Consulate in Hong Kong, the U.S. Senate, and the White House. Proficient in Mandarin Chinese and Japanese, he has traveled extensively in Asia and has lived in China, Japan, and Korea. He runs two research websites, <www.andrewerickson.com> and <www.chinasignpost.com>. The views expressed in this paper are solely those of the author and in no way represent the policies or estimates of the U.S. Navy or any other organization of the U.S. government.

ACKNOWLEDGMENTS

The author would like to thank the following people for their incisive comments and suggestions on the various components of the paper and its preceding works: Dennis Blasko, Michael Chase, Tai Ming Cheung, Peter Dombrowski, Ian Easton, David Finkelstein, Richard Fisher Jr., Joseph Gavin Jr., Lyle Goldstein, Kristen Gunness, Scott Harold, Craig Koerner, Carnes Lord, William Murray, Jonathan Pollack, Kevin Pollpeter, Robert Rubel, Mark Stokes, Christopher Weuve, David Yang, Christopher Yeaw and Toshi Yoshihara. The author also would like to thank an anonymous expert for useful wording and source inputs. He is indebted to Peter Mattis and Peter Wood for their invaluable editorial assistance.

This comprehensive, updated report draws on and synthesizes several of the author's previously-published and co-published articles, including the following:

- (with Gabriel Collins) "China Deploys World's First Long-Range, Land-Based 'Carrier Killer': DF-21D Anti-Ship Ballistic Missile (ASBM) Reaches 'Initial Operational Capability' (IOC)," *China SignPost*, No. 14, December 26, 2010;
- "Eyes in the Sky," *U.S. Naval Institute Proceedings* 136, No. 4 (April 2010), pp. 36–41;
- "Take China's ASBM Potential Seriously," *U.S. Naval Institute Proceedings* 136, No. 2 (February 2010), p. 8;
- (with David Yang) "Using the Land to Control the Sea? Chinese Analysts Consider the Anti-Ship Ballistic Missile," *Naval War College Review* 62, No. 4 (Autumn 2009), pp. 53–86;
- "Chinese ASBM Development: Knowns and Unknowns," *Jamestown Foundation China Brief* 9, Issue 13 (June 24, 2009), <http://www.jamestown.org/single/?no_cache=1&tx_ttnews%5Btt_news%5D=35171>;
- (with David Yang) "On the Verge of a Game-Changer: A Chinese Antiship Ballistic Missile Could Alter the Rules in the Pacific and Place U.S. Navy Carrier Strike Groups in Jeopardy," U.S. Naval Institute *Proceedings* 135, No. 3 (May 2009), pp. 26–32.


The JAMESTOWN
FOUNDATION