Chinese Anti-Ship Ballistic Missile Development and Counter-intervention Efforts

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China has two functional anti-ship ballistic missile (ASBM) types with maneuverable re-entry vehicle technology, and is developing and proving the reconnaissance-strike complex to target those missiles effectively under realistic, challenging conditions. This has rightly triggered growing concern, as part of a larger pattern: In what it considers the "Near Seas" (the Yellow, East China, and the South China seas),

- Beijing enjoys powerful synergies and advantages regarding the disputed sovereignty claims it pursues there,
- increasingly in defiance of regional stability and international laws and norms,
- and supported by precision-targeted systems designed to make American intervention risky and challenge American sea control.

China has developed and deployed small numbers of one dedicated operational ASBM, the DF-21D (CSS-5) medium-range ballistic missile (MRBM).[2] It has also developed a second ASBM, the DF-26 intermediate-range ballistic missile (IRBM).[3] While remaining limitations in China's reconnaissance-strike complex, along with evolving American and allied countermeasures, continue to render their operational effectiveness uncertain, they are clearly purpose-designed ASBMs of major potential capability.

Today, I will (1) highlight China's ASBM development thus far, (2) survey the related space-based architecture that China is building to provide a reconnaissance-strike complex necessary to target the missiles with maximum effectiveness, and (3) offer policy recommendations.

Here are my key points:

- With its ambitious ASBM development, China is challenging U.S. Asia-Pacific interests and military influence in new ways.
- This is part of a much larger Chinese counter-intervention effort that is advancing significantly regardless of precise ASBM capabilities or limitations.
- While China's missiles pose potential challenges to U.S. forces, ensuring that they can be targeted effectively is expensive and creates growing space-based electromagnetic spectrum vulnerabilities that can be exploited.

Here are my key recommendations. U.S. policymakers should:

- enhance efforts at developing corresponding tailored countermeasures, particularly concerning electronic warfare.
- attempt to ensure that China does not develop Scarborough Shoal into a key targeting node in the South China Sea.
- and enhance U.S. Navy (USN) ship numbers to avoid presenting China with an over-concentrated target set.

Background and Developments to Date

Since at least the mid-1990s, Beijing has pursued ASBMs as part of a panoply of counter-intervention capabilities.[4] The PLA seeks to hold adversaries' vessels at risk via devastating multi-axis strikes involving precision-guided ballistic and cruise missiles launched from a variety of land-, surface-, submarine-, and air-based platforms in coordinated attacks.

The intention of this counter-intervention capability is to achieve control across the Near Seas and their immediate approaches; and to exert peacetime deterrence (to both uphold and further China's unresolved territorial and maritime claims in these same waters). The *ways* Chinese strategists have envisioned involve exploiting China's strategic depth as a hybrid land-sea power operating along interior lines and using the strategic rocket forces to enable China's preferred approach of "using the land to control the sea." The *means* involve developing and deploying asymmetric capabilities along the lines espoused by paramount leader Jiang Zemin in 1999: "That which the enemy fears most, that is what we must develop." Jiang used the occasion of the accidental bombing of China's embassy in Belgrade that year—which shocked and outraged China's leadership—to initiate and reinforce existing megaprojects to build what were termed 'assassin's mace weapons,' including the ASBM.[5]

Beijing's 3 September 2015 military parade showcased nearly a dozen ballistic missile variants, including two Chinese ASBMs, the DF-21D and DF-26.[6] All are operational in some form in what, since 31 December 2015, is termed the PLA Rocket Force (PLARF); now an independent military service thanks to current paramount leader Xi Jinping's ongoing reforms to restructure the PLA to prevail in "informatized local wars."[7] Official commentary at the event dubbed the DF-21D a "road-mobile anti-ship ballistic missile, the assassin's mace for maritime asymmetric warfare."[8] The Pentagon's 2016 PLA report states that "China continues to field an ASBM based on a variant of the CSS-5 (DF-21) MRBM that it began deploying in 2010. The CSS-5 Mod 5 has a range of 1,500 km and is armed with a MaRV [Maneuverable Re-entry Vehicle] [which] gives the PLA the capability to attack ships, including aircraft carriers, in the western Pacific Ocean."[9] During the first half of February 2016, *China Daily* reports, the DF-21D was involved in a ten-vehicle simulated launch drill in southern China.[10] While this tested the crew's ability to prepare and launch a missile, however, it says nothing of specific capabilities.

Anticipated publicly by the Pentagon in 2010,[11] China's DF-26, has a reported range of 3,000-4,000 km, sufficient to strike Guam and surrounding sea areas.[12] It was similarly forecast, although with name unspecified, in a *Global Times* article on 18 February 2011.[13] As the September 2015 military parade commentary stated, in dubbing the missile "a new weapon for strategic deterrence," it "can perform medium- to long-range precision attack on both land and large- to medium-sized maritime targets." Variants of this missile are "capable of nuclear and conventional strike," the latter including both land attack and being "capable of targeting large- and medium-sized targets on water."

In November 2015, *China Youth Daily* published an article by two researchers at the PLA's leading academic research organ, the PLA Academy of Military Science.[14] It represents the most authoritative, comprehensive Chinese public analysis to date on the DF-26. They state that the DF-26 "does not rely on a site for mobile launching. It can move fast, and it has no strict demands for where it is launched."

The researchers claim, perhaps hyperbolically, "Against time-sensitive targets such as surface ships in particular, it [the DF-26] can attack at the last minute as soon as information on a ship's movement is acquired, meaning the ship cannot get away." This suggests that its seeker can view a large portion of the ocean, and that in the PLA's eyes, the targeted ship cannot steam or maneuver outside of the missile's ability to detect and effectively attack its intended target.

This is part of a larger dynamic, they believe, in which "using speed to get the upper hand is one of the fundamental mechanisms by which to secure victory in modern integrated joint operations. The DF-26 has numerous 'fast' features such as fast switch between nuclear and conventional, fast road movement, fast launch preparation, and fast displacement and withdrawal. Those features suit that mechanism for victory. And because of that, the DF-26 has greater deterrence and real-war power." In a pattern typical of Chinese writings, in which external sources are sometimes cited to suggest information that might be difficult to state directly, the researchers also mention that some analysts "have pointed out that the range of the DF-26 is twice that of the DF-21D, and the scope of its attack can extend to the Second Island Chain."

To date, there is still no public reporting of China having conducted an integrated overwater test of either of its ASBMs against an uncooperative target. Internet rumors claim a cooperative test was conducted against the space event support ship *Yuan Wang* 4, but there is insufficient evidence to substantiate this. Better documented, in Google Earth imagery beginning on 6 September 2006, are one or more tests in the Gobi desert against a concrete slab apparently representing a carrier's hangar deck—tests conducted perhaps with the assistance of the Beidou/Compass positioning, navigation, and timing (PNT) satellite system.[15] Such efforts, China's overall missile capabilities and program trajectories, and public statements by government officials and reports in the United States and Taiwan—together with the appearance of the DF-21D and -26 in the 2015 military parade—make it clear that the missiles themselves work. The parade appearance suggests China considers the missiles to be minimally operational and capable of achieving a measure of deterrence. It is even possible that China is pursuing testing and other capability demonstrations in a fashion designed to alert and deter other military forces, while thus far refraining from publicizing such activities for fear of failure or of fueling foreign publics' support for military efforts to counter China's own.

Notably, however, the ability of China's reconnaissance-strike complex to provide accurate targeting for its ASBMs remains unclear. Based on physics and deductive logic, onboard ASBM sensors likely center on radar[16] with some resemblance to that of the retired American *Pershing II* MRBM, albeit with appropriate technological advances and modified to distinguish moving (vice fixed) targets from the sea surface (which changes rapidly, unlike the ground surface, with significant implications for clutter generated and the challenges in mitigating it).

Chinese experts have clearly studied the *Pershing II* exhaustively, including its terminal guidance system.[17] They may well have accessed and incorporated and/or emulated many of its specific technologies in their ASBM development efforts, including the missile's shape and its unusually large maneuver fins.[18] Beyond that, open sources reveal few reliable details about Chinese ASBM sensors, MARVs, and related parameters and capabilities. Available Chinese technical writings are typically historical or theoretical in nature. Many contain basic research that demonstrates understanding of mathematical algorithms used to calculate maneuver. Some appear to integrate *Pershing II*-related diagrams directly.[19] Few document specific Chinese developments or more complex calculations pertaining to a realistic operational environment. A classic "bath tub" pattern over time—involving a dip in the availability of such sources and a transformation of their contents—suggests that this lack of information stems not from Chinese limitations *per se* but rather an effort to conceal sensitive details. In sum, this appears to be a case in which open sources paint a useful picture overall, but do not reveal all the specifics.[20]

Growing Reconnaissance-Strike Complex

China has command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) capabilities relevant to the task of targeting ships at sea, and is extending and integrating that architecture, but would benefit from further progress. Unfortunately, such operations' command-and-control cannot be verified conclusively through open sources. Finally, the difficulty of targeting China's ASBMs increases significantly with distance from China's shore. It seems particularly unlikely that China currently has C4ISR coverage sufficient to target the DF-26 ASBM variant towards the maximum extent of its range. Chinese ASBMs could, in theory, be employed at shorter-than-maximum ranges through some combination of lofted trajectory and blow-out ports to vent combustion, but available Chinese sources do not address this possibility.

Beyond fielding the C4ISR hardware and integrating its use and exploitation in a technical sense, however, this ASBM system of systems involves integrating a geographically- and bureaucratically-disparate set of C4ISR resources across the PLA's services and departments. The ASBM's reconnaissance-strike complex likely includes a combination of satellites and land-based radars—possibly augmented temporarily and imperfectly with deployment of microsatellites and even unmanned aerial vehicles (UAVs).[21]

ASBMs require the provision of accurate "third-party" or over-the-horizon (OTH) targeting support that integrates disparate information from multiple sources. OTH-B sky wave (backscatter) radars, which refract high-frequency (HF) radio waves off the ionosphere, are useful for cueing, although they cannot support a more refined targeting solution. China has reportedly been working on OTH-B since 1986.[22] Today, it has at least one OTH-B radar in active use and another under construction.[23] If it does not already have an OTH-B radar covering the South China Sea, it is likely to have one eventually.[24] In coming years, China will almost certainly desire and achieve a set of OTH-B radars covering its entire maritime periphery. OTH radars can benefit when stable, warm air layers—particularly in the troposphere and ionosphere—produce atmospheric ducts that enable radio signals to follow Earth's curvature for extended distances.[25] These conditions are sometimes present off China's coast. Nevertheless, successful targeting is a difficult challenge to achieve in practice: detecting and identifying a target may be relatively straightforward, but tracking it and passing information to shooting platform(s) in real time or near-real time is difficult and time-pressed. Applying rules of engagement and avoiding collateral damage represent additional hurdles. Challenges grow with time, distance, and speed. Space-based surveillance is therefore essential to the employment of an ASBM. China has launched diverse satellites at impressive rates lately, but still confronts multiple challenges:

- designing and emplacing functional satellites in desired orbits represents numerous, expensive difficulties;
- a complex surveillance architecture whose components are controlled by different organizations may be unwieldy;
- and real-time data fusion is complicated by a highly 'stovepiped' military organization.[26]

To target mobile maritime platforms, China must master a complex process: correlating and fusing real-time sensor inputs, and then disseminating accurate situation reports and targeting packages to commanders and shooters. Even when it achieves complete coverage of relevant maritime zones, data transmission (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. The PLA must coordinate among the many service elements that 'own' various ISR sensor and ground station architecture and within the chain of command that would authorize their prioritization and use, in addition to the release authority for the weapons systems that would employ their inputs.

China's establishment of the PLA Strategic Support Force (SSF) on 31 December 2015 appears in part to be an attempt to address these challenges by better integrating space, cyber, and electronic warfare capabilities.[27] Extensive launch plans and concerted efforts at integration suggest that in coming years, China is likely to achieve a robust remote sensing architecture for finding aircraft carriers and other large surface vessels.

By offering reliable location signals, PNT satellites in China's growing *Beidou*/*Compass* constellation help implement targeting by helping to ensure that a missile reaches a desired location. If the intended latitude-longitude location is correct in practice, then the missile should see the target and strike it. Such satellite navigation offers a linchpin that the USSR could never achieve through its more limited focus on inertial navigation. Additionally, the constellation's text message communications function supports reconnaissance and reporting. China has launched nearly thirty *Beidou*/*Compass* PNT satellites (the latest on 12 June 2016). Twenty are currently functional in orbit. First operational as *Beidou I* in 2000, the system went operational with 10 satellites as *Beidou II* in 2011, and achieved regional coverage in 2012. China appears on track to achieve its goal of a 35-satellite constellation with global coverage by 2020.[28]

Imaging satellites, based of necessity in low-earth orbit, take snapshots of pre-designated areas at periodic and predictable times. Examining satellites' numbers, orbits, inclinations, and periods therefore offers a general sense of coverage. China's reconnaissance-capable satellites include electro-optical (EO), multi- and hyperspectral; as well as radar satellites, especially synthetic aperture radar (SAR) variants. SAR satellites can provide targeting information, while other satellites can facilitate target identification. Maritime-relevant variants include the *Fengyun*, China-Brazil Earth Resources (CBERS), *Ziyuan*, *Haiyang*, *Huanjing*, *Yaogan*, *Gaofen*, and *Jilin* satellites.

Three of the abovementioned satellite series—*Yaogan*, *Gaofen*, and *Jilin*—are particularly relevant to maritime monitoring and targeting. "Operating from near-polar, Sun-Synchronous Orbits (SSO)," according to IHS *Jane's*, China's *Yaogan* series of well over 30 currently-operational advanced, paired, SAR and EO remote sensing satellites "may provide multi-wavelength, overlapping, continuous medium-resolution, global imagery of military targets."[29]

In total, China has launched 40 *Yaogans* to date, with *Yaogan*-30 launched on 15 May 2016; the vast majority of these satellites remain in orbit and functional. The *Yaogan*-9-, -16, -17, -20, and -25-A, B, and C tri-satellite constellations may constitute the largest share of a China's space-based ship tracking and targeting ISR network. Flying in triangular formation in similar orbits at identical inclination, according to IHS *Jane's*, each contains an EO surveillance satellite, a SAR satellite, and possibly a signals- or electronic-intelligence (ELINT) 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 [ASBMs]."[30] This is similar to the first and second generations of the USN's White Cloud Naval Ocean Surveillance System (NOSS), which reportedly detected surface vessels by sensing their electronic emissions and locating them using time delay of arrival (TDOA). Such a TDOA approach would allow a bearing fix through a division of labor in which an ELINT satellite would provide a precise pointing vector, a SAR satellite would process the location, and an EO satellite would confirm the identity of the target.[31]

The *Yaogan*-9 system has likely largely been superseded, as *Yaogan*-9B has apparently fragmented into two pieces. This would follow a pattern in which China's first satellite of a given type often has short mission life and/or other limitations, but is succeeded by more capable variant(s). In addition to the aforementioned four operational sets of *Yaogan* triplets possibly containing SAR satellites, the most useful for ASBM targeting are the additional eight *Yaogan* SAR satellites orbited to date (of which only *Yaogan*-1 is clearly no longer operational). SAR satellites measure potential targets' speed and range changes independent of weather. Only such active sensors as SAR can offer the most targetable information; EO and IR counterparts face far more limitations.[32]

Additionally, the next-generation *Gaofen* remote sensing satellites are being launched as part of the China High-definition Earth Observation System (CHEOS) state megaproject to provide continuous near-real-time weather-independent global surveillance. To date, this includes the *Gaofen*-1, -2, -3, -4, -8, and -9 satellites.[33] *Gaofen*-5 and -6 are scheduled for orbit later this year. The first will carry a visible light-near infrared hyperspectral camera, the second a panchromatic camera and two multispectral cameras: resolution and wide-angle. *Gaofen*-7's launch is anticipated in 2018-19. It will carry a hyperspectral, stereographic cartography camera.[34]

Finally, in October 2015, China launched the first four satellites in its *Jilin* remote sensing series. They included a high-definition multi-spectral imaging satellite, two video imaging satellites, and a satellite for "imaging technique testing."[35] By 2019, China plans to have sixteen *Jilin* satellites orbiting in a global network "capable of a three to four hours update in the data provided." By 2020, this is slated to grow to sixty satellites with 30 minutes' update, which is potentially more than adequate for ASBM targeting. Finally, by 2030, the goal is for China to have "138 satellites in orbit, forming an all-day, all-weather, full spectrum acquisition segment data and a capability of observing any global arbitrary point with a 10 minutes revisit capability, providing the world's highest spatial resolution and time resolution space information products."[36]

China has thus made tremendous progress already, and is doubtlessly working hard to improve further in all these areas. Xi has launched sweeping reforms to make the PLA more joint and better structured to wage modern wars. As part of these ongoing efforts, China is constantly extending and improving its reconnaissance-strike complex. It is launching satellites at a pace that only the United States and Russia can hope to match.[37] This is rapidly increasing China's space-based reconnaissance architecture.

For much of its ASBM operations, for the foreseeable future China must rely heavily on space-based capabilities that are expensive and difficult to implement with maximum effectiveness. With regard to the South China Sea, however, China is developing targeting solutions that are much cheaper, simpler, easier to use. It is doing so by turning its outposts there into a ring of stations for land-based and airborne radars.

China reportedly began developing high-frequency (HF) ground wave (surface wave) OTH sensors in 1967, with the first designed to have a detection range of 250 km.[38] In the South China Sea, it has already established HF surface wave radar installations on the majority of the Spratly features that it occupies, which it has radically augmented and is now fortifying.[39] Assuming a typical effective range of 278-370 km (150-200 nautical miles), and deployment of other such radars on the other Spratly and Paracels features it occupies, as well as on land to the north; as well as airborne radars on maritime patrol aircraft operating from features' runways, this should be sufficient to ensure "eyes on" all areas of the South China Sea. It would enable China to detect and report a carrier strike group across the vast majority of the South China Sea. This constant surveillance should support accurate fire control for both ASBMs and cruise missiles. This enhanced maritime domain awareness would offer China both a relatively cost-effective way to fill remaining coverage gaps and a major targeting advantage that is difficult to negate without major escalation.[40]

Conclusion and Policy Recommendations

China has deployed one ASBM variant and developed another, thus far, and is enhancing its reconnaissance-strike to target the missiles with maximum effectiveness. The capabilities of Chinese ASBMs depend on many factors, but they certainly represent a potential challenge to U.S. forces that could become grave if not addressed properly. Assessing China's ASBM combat effectiveness cannot be resolved with open sources, and may well not fully be certain to any observer in the absence of its actual use in combat. Any attempt at net assessment must consider capabilities against countermeasures.

If developed and deployed successfully, a Chinese ASBM system-of-systems would be the world's first system capable of targeting a moving carrier group with long-range ballistic missiles fired from land-based mobile launchers. Terminal defenses against such missiles will be difficult and expensive, and attempts to destroy the missiles before launch highly escalatory. If technology development unfolds in such a way that a Chinese ASBM could overcome the best American efforts at active and passive countermeasures, China would have unilaterally and fundamentally altered the Western Pacific security dynamic.

For over a decade, the U.S. military has clearly been taking China's ASBM potential seriously. Since at least the first public U.S. government mention of Chinese ASBM development in a 2004 Office of Naval Intelligence (ONI) report,[41] U.S. military leaders and other spokespeople have underscored this and other counter-intervention challenges, while expressing confidence that U.S. and allied countermeasures were keeping pace with them. This is an ongoing competition between offense and defense, however. It is currently not clear which side has a temporary or permanent advantage. Progress might be difficult in some respects: not impossible, but not cheap. Countermeasures may be quite expensive; but so too may be China's burgeoning space-based reconnaissance architecture and the ground-based infrastructure to operate it, dwarfing the cost of ASBM missiles themselves.

While China's ASBMs and other missiles pose potential challenges to U.S. forces, ensuring that they can be targeted effectively is expensive and creates growing vulnerabilities that can be exploited. Washington and its regional allies are rightly placing emphasis on targeting cost-effectively some of the greatest Chinese vulnerabilities, particularly by developing capabilities to sever—or at least disrupt—the many links in the ASBM 'kill chain.'[42] In particular, as explained in the previous section, Chinese ASBM operations almost certainly necessitate the extensive, expensive employment of space-based sensors to provide the timely targeting information required, to allow missile-based sensors to complete a successful attack.

This renders China vulnerable to electronic warfare (EW) countermeasures such as jamming; satellite-ground data links cannot be shielded in the way that Chinese forces such as the PLARF protect homeland-based communications with fiber optic cable networks.[43] Most fundamentally, EW can exploit an ASBM's reliance on speed. Speed is the ASBM's greatest strength: it may arrive on target before uncertainty builds concerning its latest location. But speed is also the ASBM's greatest weakness: if confused, the ASBM may run out of room to maneuver before it figures out what it is actually seeing. By digitally capturing and retransmitting RF signals, Digital Radio Frequency Memory (DRFM) jammers could greatly facilitate such confusion.[44] More broadly, EW countermeasures can exploit ongoing Chinese limitations in operational "jointness" and data fusion, as well as the lack of experience with real-time decision-making and delegation of authority concerning sophisticated long-range precision strike. They may do so in a cost-effective manner, and even limit escalation by employing temporary "soft kills" as opposed to permanent, physically destructive "hard kills."

EW thus has considerable potential, and U.S. planners should reenergize efforts in developing tailored countermeasures in this area. Here, USN efforts during the Cold War to confuse the Soviet Ocean Surveillance System may be instructive.[45] But the stakes are high: China is already adopting efforts to overcome the jamming capabilities that U.S. forces developed for Russian ELINT Ocean Reconnaissance Satellite (EORSATS), including via the abovementioned TDOA process. Notably, it is launching a ratio of EO to other surveillance satellites that suggest it is attempting to use the EO satellites to verify electromagnetic emissions that might be spoofed.

With its ambitious ASBM development, China is challenging American Asia-Pacific interests and military influence in new ways. This is part of a much larger Chinese counter-intervention effort that is advancing significantly regardless of precise ASBM capabilities or limitations. Beyond ASBM-specific countermeasures, U.S. policymakers must understand and address two larger, interrelated issues:

- First, the far broader counter-intervention challenge that China's military-maritime forces pose to the regional interests and security of the United States and its East Asian allies and partners.
- Second, the risk of U.S. capabilities and influence eroding if China is able to exploit a USN target set of capabilities concentrated in too few ships.

U.S. policy-makers should attempt to ensure that China does not develop Scarborough Shoal into a key targeting node in the South China Sea. As part of developing the capability to implement an Air Defense Identification Zone (ADIZ), for instance, developments such as ongoing fortification of Chinese-held features and China's possible dredging and buildup of Scarborough Shoal merit particularly concerted observation and opposition. Recent concerns by Philippine Defense Secretary Delfin Lorenzana that China will likely dredge Scarborough Reef and establish an outpost could signal Chinese intentions and capabilities regarding development of both an ADIZ and a more potent reconnaissance-strike complex.[46]

In coordination with the PLARF and China's other sea forces and services, the People's Liberation Army Navy (PLAN) is increasingly capable of contesting American sea control within widening range rings surrounding the Near Seas. At the high-end, the world's largest conventional ballistic missile force, including ASBMs; as well as road-mobile nuclear ICBMs and other advanced systems; offer a land-based "anti-navy" deterrence backstop. The Naval War College China Maritime Studies Institute (CMSI)'s latest conference volume, *Chinese Naval Shipbuilding*, has probed this challenge deeply.[47] Its key findings include the following:

China's shipbuilding industry has already produced a fleet of several hundred (currently in the low-300s; 303 per the Pentagon's 2016 report)[48] increasingly-advanced warships capable of "flooding the zone" along the contested East Asian littoral. When several hundred ships each from China's Coast Guard and its most advanced Maritime Militia units are factored in, Beijing's numerical preponderance for the "home game" scenarios it prioritizes becomes formidable indeed.

Central to this Chinese counter-intervention challenge is the PLAN's overmatching of the USN in missile loadouts. This disparity is likely to worsen as China deploys greater quantities of missiles with greater ranges than those systems potentially employed by the USN against them. In addition to two types of operational land-based ASBMs, by 2020, China is expected to have:

- quantitative parity or better in surface-to-air missiles (SAMs) and anti-ship cruise missiles (ASCMs),
- parity in missile launch cells,
- and quantitative inferiority only in multi-mission land-attack cruise missiles (LACMs).

As with the platforms on which they are based, these Chinese weapons are concentrated in the Near Seas, while their American counterparts are dispersed globally. Worse still, the next-generation long-range ASCMs on which U.S. naval superiority hinges are still "paper missiles" not yet fielded on USN surface combatants. Moreover, these new ASCMs—the Long-Range Antiship Missile (LRASM) and vertical launch system-compatible Naval Strike Missile variant—may not be effectively targetable under contested counter-intervention conditions.

Moreover, by 2020, the PLAN will be unambiguously the world's second largest blue water navy. ONI projects a fleet of 313-342 hulls.[49] If current trends continue, by 2030 China may assemble a combat fleet that in terms of overall order of battle (hardware only) is quantitatively, and perhaps even qualitatively, in the same league as the USN. Even the perception that China was on track to achieving such parity would gravely harm America's standing and influence across the Asia-Pacific and around the world.

In addition to targeting the "kill chain" of Chinese ASBMs, U.S. policy-makers must close the abovementioned missile deployment and capability gap. They should also ensure that the U.S. has enough well-equipped Navy vessels available for use in key operational areas, particularly throughout maritime East Asia. Deploying sufficient numbers would maximize peacetime presence and influence. It would deter a worst-case contingency by demonstrating capacity for overwhelming kinetic operations therein ("Peace Through Strength") via dispersed, distributed lethality. Enhancing USN fleet numbers can help avoid presenting China with an over-concentrated target set of "too many eggs in too few baskets." Lacking sufficient ASBM countermeasures and numbers of ships and missiles, by contrast, would imperil regional stability and security—and with them, vital American interests.

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[1] This testimony elaborates on and updates Andrew S. Erickson, "Raining Down: Assessing the Emergent ASBM Threat," *Jane's Navy International*, 16 March 2016, www.janes.com.

[2] *Military and Security Developments Involving the People's Republic of China 2016*, Annual Report to Congress [Hereafter: "DoD (2016)"] (Arlington, VA: Office of the Secretary of Defense, 13 May 2016), http://www.defense.gov/Portals/1/Documents/pubs/2016%20China%20Military%20Power%20Report.pdf, 25, 61, 67; U.S.-China Economic and Security Review Commission, Chapter 2, Section 3, "China's Offensive Missile Forces," 2015 Annual Report to Congress, November 2015, 352-353, 372-373; National Defense Report Editing Committee, 2011 ROC National Defense Report, Ministry of National Defense, (August 2011), http://2011mndreport.mnd.gov.tw/en/minister.html, 71.

[3] The Pentagon's latest China report mentions another variant of the DF-26 but makes no mention of deployment status. DoD (2016), 35, 70, 77.

[4] Timothy Heath and Andrew S. Erickson, "Is China Pursuing Counter-Intervention?" *The Washington Quarterly* 38.3 (fall 2015): 143-56, https://twq.elliott.gwu.edu/sites/twq.elliott.gwu.edu/files/downloads/TWQ_Fall2015_Heath-Erickson.pdf.

[5] Andrew S. Erickson, *Chinese Anti-Ship Ballistic Missile Development: Drivers, Trajectories, and Strategic Implications* (Washington, DC: Jamestown Foundation, 2013), http://www.andrewerickson.com/2013/05/chinese-anti-ship-ballistic-missile-development-drivers-trajectories-and-strategic-implications/.
[6] Andrew S. Erickson, "Showtime: China Reveals Two 'Carrier-Killer' Missiles," *The National Interest*, 3 September 2015, http://nationalinterest.org/feature/showtime-china-reveals-two-carrier-killer-missiles-13769.
[7] Michael S. Chase and Arthur Chan, "China's Evolving Strategic Deterrence Concepts and Capabilities," *The Washington Quarterly* 39.1 (Spring 2016): 117–136, https://twq.elliott.gwu.edu/sites/twq.elliott.gwu.edu/files/downloads/TWQ_Spring2016_Chase-Chan.pdf.
[8] This and all subsequent parade-related commentary is derived from Andrew S. Erickson, "Showtime: China Reveals Two 'Carrier-Killer' Missiles."
[9] *Military and Security Developments Involving the People's Republic of China 2016*, Annual Report to Congress (Arlington, VA: Office of the Secretary of Defense, 13 May 2016), 25, 67, http://www.defense.gov/Portals/1/Documents/pubs/2016%20China%20Military%20Power%20Report.pdf.
[10] Zhao Lei, "Anti-Ship Rocket 'Included in Drills'," *China Daily*, 16 February 2016, http://www.chinadaily.com.cn/china/2016-02/16/content_23496831.htm.
[11] The report stated: "China's ballistic missile force is acquiring conventional…intermediate-range ballistic missiles that extend the distance at which it can threaten other countries with conventional precision or near-precision strikes." *Military and Security Developments Involving the People's Republic of China 2010*, Annual Report to Congress (Arlington, VA: Office of the Secretary of Defense, 2010), 33, https://www.defense.gov/Portals/1/Documents/pubs/2010_CMPR_Final.pdf.
[12] The Pentagon suggests that the DF-26 will be able to reach Guam, which implies a range of at least 3,000 km, the rough distance from China's coast to Guam. Perhaps a range of 3,200-3,300 km would be sufficient to accommodate principal inland firing locations. DoD (2016), 67. Jane's reports a range of 3,000-4,000 km. "DF-26," *Jane's Strategic Weapon Systems*, 16 February 2016.
[13] Song Shengxia, Zhang Han, and Huang Jingjing, "New Missile 'Ready by 2015': Global Times," *People's Daily Online*, 18 February 2011, http://english.peopledaily.com.cn/90001/90776/90786/7292006.html.
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[15] "PLA 'Sinks' US Carrier in DF-21D Missile Test in Gobi," *Want China Times*, 23 January 2013, http://www.wantchinatimes.com/news-subclass-cnt.aspx?id= 20130123000112&cid=1101.
[16] An ASBM's reentry speed and need to lock on target at substantial distance likely precludes effective use of millimeter wave radar. Infrared is subject to reentry friction and is easily jammed. Discussion with technical expert, 15 January 2017.
[17] See, for example, Xie Yu and Pan Liang, College of Mechatronic Engineering and Automation, National University of Defense Technology, Changsha; Yuan Tianbao, Second Artillery Force Equipment Academy, "Trajectory Planning for Reentry Maneuverable Ballistic Missiles," International Conference on Manufacturing Science and Engineering (ICMSE 2015), 8-15; Shi-Xue Tsai, "Introduction to the Scene Matching Guidance Technologies," *Promotion of Chinese Aviation Between Centuries: Proceedings of Conference for 30th Anniversary of CSAA's Establishment*, No. 10 (1994) 3.1 (1996), 227-37.
[18] Andrew S. Erickson and David D. Yang, "Using the Land to Control the Sea? Chinese Analysts Consider the Anti-Ship Ballistic Missile," *Naval War College Review* 62.4 (Autumn 2009): 53-86, esp. 59, https://www.usnwc.edu/getattachment/f5cd3bb5-a1d1-497d-ab70-257b9502d13e/Using-the-Land-to-Control-the-Sea--Chinese-Analyst.aspx.
[19] Consider, for instance, the striking resemblance among the diagrams in the following four sources: "Figure 2-5. Typical [Pershing II] Missile Trajectory," *Pershing II Weapon System, Technical/Operators Manual*, (Washington, DC: Headquarters, Department of the Army: 1 June 1986), 2-8; "图 1 带有末制导的导弹飞行弹道示意图" [Fig. 1 Schematic Diagram of Guided-Missile Ballistic Trajectory With Terminal Guidance], 谭守林、张大巧, 第二炮兵工程学院 [Tan Shoulin and Zhang Daqiao, Second Artillery Engineering College] and 刁国修, 中国人民 解放军 96311部队 [Diao Guoxiu, PLA Unit 96311, Huaihua], "弹道导弹打击航空母舰 末制导有效区的确定与评估" [Determination and Evaluation of Effective Range for Terminal-Guidance Ballistic Missile(s) Attacking Aircraft Carrier(s)], 指挥控制与仿真 [Command Control and Simulation] 28, no. 4 (August 2006), 7, republished as "Figure 4. Schematic Diagram of Missile Flight Trajectory with Terminal Guidance," *Military Power of the People's*

Republic of China 2009, Annual Report to Congress Arlington, VA: Office of the Secretary of Defense, 2009), 21, https://www.defense.gov/Portals/1/Documents/pubs/China_Military_Power_Report_2009.pdf.

[20] Unless otherwise specified, data in this paragraph are derived from Andrew S. Erickson, *Chinese Anti-Ship Ballistic Missile Development*, esp. 40-46, 73-82.

[21] UAVs would likely be too easily detected to be reliable in this role. To obtain the information they need, they must transmit with active radar. Discussion with technical expert, 15 January 2017.

[22] Lt. Bin-Yi Liu, Republic of China Navy, "HF Over-The-Horizon Radar System Performance Analysis," Master's Thesis, Naval Postgraduate School, September 2007, 21.

[23] Henry Kenhmann, "Exclusif: La Chine Construit Son 2ème Radar Trans-Horizon Pour Surveiller Le Japon Et La Corée" [Exclusive: China Builds Its Second Trans-Horizon Radar to Monitor Japan and Korea], Eastern Pendulum, 18 January 2017, http://www.eastpendulum.com/exclusif-la-chine-construit-2eme-radar-trans-horizon-surveiller-japon-coree.

[24] A Chinese OTH-B radar facing the South China Sea would have to be set back some distance to mitigate the effects of coastal mountains blocking its line of sight. Author's discussion with Sean O'Conner, Principal Imagery Analyst, Aerospace, Defense & Security, IHS Jane's, 9 February 2017.

[25] Australia's Jindalee system, for instance, has a range of at least 3,000 km. "Jindalee Operational Radar Network (JORN)," *Jane's C4ISR & Mission Systems: Land*, 21 September 2016. As with other OTH-B systems, Jindalee's detection range reportedly improves with conditions in the ionosphere that correspond to daytime and periods without elevated solar activity. Bradley Perrett, "Long View: The Jindalee Over-the-Horizon Radars Are Substantially Improved," *Aviation Week & Space Technology*, 22 September 2014, 43-45. During World War II, HF radio "bounces," and corresponding range, varied considerably with environmental conditions.

[26] Kevin Pollpeter et al., *China Dream, Space Dream: China's Progress in Space Technologies and Implications of the United States* (Washington, DC: U.S.-China Security and Economic Review Commission, 2 March 2015), http://www.uscc.gov/Research/china-dream-space-dream-chinas- progress-space-technologies-and-implications-united-states.

[27] Michael S. Chase and Jeffrey Engstrom, "China's Military Reforms: An Optimistic Take," *Joint Force Quarterly* 83.4 (October 2016): 49-52, http://ndupress.ndu.edu/JFQ/Joint-Force-Quarterly-83/Article/969661/chinas-military-reforms-an-optimistic-take/.

[28] "Beidou/Compass Series," *Jane's Space Systems and Industry*, 5 July 2016, www.janes.com.

[29] "Yaogan Series," *Jane's Space Systems and Industry*, 3 June 2016, www.janes.com.

[30] Ibid.

[31] "NOSS (White Cloud)," *Jane's Space Systems and Industry*, 26 March 2016. EO satellites are dependent on daylight. If could afford to launch a sufficient number of missiles, however, it might be able to "clarify with ordnance" by shooting at all targets of interest.

[32] Satellite updates obtained from "Live Real Time Satellite Tracking and Predictions," https://www.n2yo.com.

[33] Rui C. Barbosa, "Long March 4C Apparently Fails During Gaofen-10 Launch," *NASA SpaceFlight*, 1 September 2016, https://www.nasaspaceflight.com/2016/09/long-march-4c-apparently-fails-during-gaofen-10-launch/.

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[35] "China Launches Four More Satellites," *Jane's Defense Weekly*, 9 October 2015, www.janes.com.

[36] Rui C. Barbosa, "China Launches Jilin-1 Mission via Long March 2D," *NASA SpaceFlight*, 7 October 2015, https://www.nasaspaceflight.com/2015/10/china-launches-jilin-1-mission-long-march-2d/. See also Chen Na, "Jilin-1: China's First Commercial Remote Sensing Satellites Aim to Fill the Void," Chinese Academy of Sciences, 13 May 2016, http://english.cas.cn/newsroom/news/201605/t20160513_163009.shtml.

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