Raining down: Assessing the emergent ASBM threat

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The anti-ship ballistic missile (ASBM) has been portrayed as a game-changing weapon that threatens the dominance of the carrier strike group (CSG). *Andrew Erickson* examines emerging ASBM capabilities, assesses their potential operational effectiveness, and considers the technological and tactical means to counter them

China's development and deployment in small numbers of two dedicated operational anti-ship ballistic missile (ASBM) types - the DF-21D (CSS-5) and DF-26 - has attracted much attention in recent years. While some limitations in China's reconnaissance/strike complex, along with evolving US and allied countermeasures, continue to render their operational effectiveness uncertain, they are clearly purpose-designed ASBMs of some potential capability.

Ships from the USS Theodore Roosevelt Carrier Strike Group underway in the Atlantic Ocean in 2014. Chinese developments in ASBMs appear focused on creating a credible anti-carrier strike capability. (US Navy)

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China is not the first nation to invest in ASBM development. In the early 1970s, the Soviet Union attempted to develop the world's first ASBM, the R-27K (SS-NX-13), to be launched from a modified Project 629 'Golf'-class submarine.

Despite the extensive Soviet constellation of Radar Ocean Reconnaissance Satellites (RORSATs) and Electronic intelligence Ocean Reconnaissance Satellites (EORSATs), however, this nuclear-armed system suffered severe target location problems, had a 370 m circular error probability (CEP), and never became operational. In rare Western coverage of the subject, the noted analyst Norman Polmar said Moscow cancelled the weapon system because of its implications for the Strategic Arms Limitation Talks (SALT), but this was likely making virtue of necessity.

While this example reflects the difficulties in developing an operational ASBM, it also indicates industrial-age limitations concerning vacuum tube and early transistor technology. China has mastered ballistic missile technology and enjoys better satellite capabilities in today's information age than the Soviet Union had then.

China's extensive ASBM-related literature does not devote significant attention to Soviet efforts or suggest it played a role in inspiring later Chinese developments - an unusual instance in which Chinese analysts do not regard Russia as a model for weapons development. Rather, it was US development and deployment of the Pershing II theatre ballistic missile fitted with manoeuvring re-entry vehicles (MaRVs) that helped inspire - and quite possibly furnished vital technology for - Chinese ASBM development.

Deployed in 1983, the Pershing II was the first ballistic missile to be equipped with terminal guidance technology, including adjustable control fins for terminal manoeuvre on its re-entry vehicle (RV), thereby improving CEP to about 37 m. Beginning as early as 1976, Chinese experts studied the Pershing II extensively, and appear to have emulated - and perhaps directly incorporated - some of its key technologies. Dozens of Chinese articles covered the Pershing II, gradually shifting from basic overviews and translations of foreign media reports to detailed programme analyses and, finally, technical research by identified experts from Chinese government academies, with apparent application to China's own programmes.

Some Chinese sources state explicitly that the Pershing II programme inspired Chinese research and development relevant to an ASBM - and even served as a prototype of sorts, with the DF-15/CSS-6 based directly on the Pershing II. While some DF-15 versions lack RVs with control fins, at least one has an RV virtually identical to the Pershing II's.

A2/AD capability

Since at least the mid-1990s, Beijing has pursued ASBMs as part of a panoply of anti-access/area denial (A2/AD) capabilities. It 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-, sea-, undersea-, and air-based platforms in co-ordinated sequence.

The intention of this A2/AD capability is to achieve control across the 'Near Seas' (the Yellow, East China, and South China seas) and their immediate approaches and to exert peacetime deterrence (both to uphold and further China's unresolved territorial and maritime claims in the Near Seas).

The ways Chinese strategists have envisioned involve exploiting China's strategic depth as a hybrid land/sea power operating along interior lines and long-prioritised strategic rocket forces as part of 'using the land to control the sea'. The means involve developing and deploying symmetric capabilities, along the lines espoused by President 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 during the Balkans conflict - a bombing that shocked and awed China's leadership - to initiate and reinforce existing megaprojects to build what were termed 'assassin's mace weapons', including the ASBM.

China Youth Daily occasionally publishes in-depth articles not available elsewhere that detail otherwise-obscure aspects of Chinese development of major weapons systems. An article published in its online portal in 2006 and subsequently removed revealed that, in the late 1990s, Dr Xin Wanqing at China Aerospace Science and Technology Corporation (CASC) had "completed proof-of-concept work on anti-aircraft carrier ballistic missiles".

Starting in 1996, the article stated, Xin "proposed and demonstrated the missile weapon system's multidisciplinary optimisation 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 optimisation and of the demonstration and verification laboratory". Xin subsequently played a major role in ASBM development, the article related, winning many high-level awards in the process.

On 3 September 2015, a Chinese military parade showcased nearly a dozen ballistic missiles, including the DF-21D ASBM. (Press Association Images)

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Beijing's 3 September 2015 military parade showcased nearly a dozen ballistic missiles, including two Chinese ASBMs: the DF-21D and DF-26. All are apparently operational in what, since 1 January 2016, is termed the PLA Rocket Force (PLARF), now an independent military service thanks to President Xi Jinping's ongoing reforms to restructure the PLA to prevail in 'informatised local wars'.

Official commentary at the event dubbed the DF-21D a "road-mobile anti-ship ballistic missile, the assassin's mace for maritime asymmetric warfare". The Pentagon's 2015 PLA report states that, "China has fielded DF-21D [ASBMs] specifically designed to hold adversary aircraft carriers at risk once they approach within 900 n miles of the Chinese coastline .... The CSS-5 Mod 5 [DF-21D] anti-ship ballistic missile ... with a range of 1,500 km and manoeuvrable warhead, gives the PLA the capability to attack ships in the western Pacific Ocean."

China's long-range DF-26 intermediate-range ballistic missile (IRBM) was anticipated publicly by the Pentagon in 2010 and forecast, although without a specified name, in a *Global Times* article on 18 February 2011. The missile "can perform medium- to long-range precision attack on both land and large- to medium-sized maritime targets", the September 2015 military parade commentary stated, dubbing it "a new weapon for strategic deterrence". Respective variants are "capable of nuclear and conventional strike", the latter including both land attack and "targeting large- and medium-sized targets on water". It is credited with a 3,000-4,000 km (1,800-2,500 mile) range, sufficient to strike the US territory of Guam and surrounding sea areas.

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. The article represents the most authoritative, comprehensive public analysis to date of the DF-26. The authors 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". During the first half of February 2016, *China Daily* reports, the DF-21D was involved in a 10-vehicle simulated launch drill in southern China. While this tested the crew's ability to prepare and launch a missile, it says nothing of specific capabilities.

The DF-26 IRBM, produced by the China Aerospace Science and Technology Corporation (CASC), is credited with a 3,000-4,000 km range, sufficient to strike the US territory of Guam and surrounding sea areas. (Unknown authorship)

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The researchers claim, 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 is part of a larger dynamic, they assert, 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 commentary, in which external sources are sometimes cited to suggest information that might be difficult to state directly, the researchers 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, as noted in US media sources, there is no public reporting of China having conducted an integrated overwater test of either ASBM against an unco-operative target. Internet rumours claim a co-operative 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 16 November 2006, are one or more tests in the Gobi desert conducted 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.

Such efforts, China's overall missile capabilities and programme trajectories, public statements by government officials, and reports in the United States and Taiwan - together with the appearance of the DF-21D and DF-26 in the 2015 military parade - make it clear the missiles themselves work. The parade appearance suggests China considers the missiles to be minimally operational and capable of achieving a measure of deterrence. China might even be pursuing testing and other capability demonstrations in a fashion designed to alert and deter other military forces, while thus far refraining from publicising such activities for fear of failure or of fuelling foreign publics' support for military efforts to counter China's.

Notably, however, the ability of China's reconnaissance/strike complex to provide accurate targeting for its ASBMs remains unclear. China has command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) capabilities relevant to the task and is extending and integrating that architecture, but would benefit from making further progress. Moreover, such operations' command-and-control (C2) cannot be verified conclusively through open sources. Finally, it seems unlikely that China has enough C4ISR coverage to target the DF-26 ASBM variant towards the maximum extent of its range. It could, in theory, be employed at shorter ranges through some combination of lofted trajectory and blow-out ports to vent combustion, but Chinese sources do not address this possibility.

Reconnaissance/strike complex

Central to maximising Chinese ability to employ these ASBMs are its emerging C4ISR capabilities. They can enable cueing, reconnaissance, communications, and data relay needed for maritime monitoring and targeting, as well as for co-ordination of Chinese platforms, systems, and personnel thus engaged. Particularly important will be effective utilisation of both ISR and the collection and processing of information concerning potential military targets. Successful achievement of high-quality, real-time satellite imagery and target-locating data and fusion as well as reliable indigenous satellite PNT are important enablers.

China's development of an anti-ship ballistic missile (ASBM) capability has attracted much attention in recent years. Pictured in the foreground is the DF-21D. (US Office of Naval Intelligence)

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While doubtless an area of continuous challenge and improvement, the DF-21D's C4ISR infrastructure should be sufficient to support basic CSG-targeting capabilities. 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 land-based radars and satellites - possibly augmented temporarily with the deployment of unmanned aerial vehicles (UAVs) and microsatellites.

ASBMs require the provision of accurate 'third-party' or over-the-horizon (OTH) targeting support that integrates disparate information from multiple sources. In practice, this is a difficult challenge to achieve: 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 consuming. Applying rules of engagement and avoiding collateral damage represent additional hurdles. Challenges grow with time, distance, and speed.

Space-based surveillance is therefore considered important. China has recently launched diverse satellites at impressive rates yet still confronts multiple challenges: a difficult physics problem, a complex surveillance architecture whose components are controlled by different organisations, and uncertain real-time data fusion capabilities complicated by a highly 'stovepiped' military organisation.

Imaging satellites, based of necessity 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. 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 variants as well as radar, especially synthetic aperture radar (SAR). Maritime-relevant variants include the Fengyun, China-Brazil Earth Resources (CBERS), Ziyuan, the Disaster Monitoring Constellation (DMC) satellite Beijing-1, Haiyang, Huanjing, Yaogan, and Gaofen satellites. Fengyun weather satellites provide visible, infrared (IR), and microwave imaging. The CBERS near-real-time EO satellites, with 2.7 m resolution, are used for military observation. By offering reliable location signals, PNT satellites in China's growing Beidou/Compass constellation facilitate C2 as well as the monitoring of friendly forces and targeting of opposing forces.

Within this list, three satellite series 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 more than 30 currently operational advanced, paired, SAR, and EO remote sensing satellites "may provide multi-wavelength, overlapping, continuous medium-resolution, global imagery of military targets".

In total, China has launched 39 Yaogans to date, with Yaogan-29 launched in late November 2015. 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 Chinese 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 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 [ASBMs]."

This is similar to the first and second generations of the US 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.

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 followed by more capable variant(s).

Among the Yaogans, in addition to the aforementioned four operational triplets possibly containing SAR satellites, the most useful for ASBM targeting are the additional eight SAR satellites orbited to date (of which only Yaogan-1 is clearly no longer operational). SAR satellites discharge energy, unencumbered by weather or time of day, to measure potential targets' speed and range changes. Only such active sensors can offer the most targetable information. EO and IR counterparts face far more limitations.

Even as Yaogans continue to be orbited, the next-generation Gaofen-1, -2, -4, -8, and -9 satellites have already been launched. *IHS Jane's* projects that -3, -5, and -6 will follow in 2016 and -7 in 2018. According to *IHS Jane's* and Chinese sources, Gaofen-1's resolution is 2 m panchromatic, 8 m multispectral, and 16 m wide-angle multispectral. Gaofen-2's resolution is 0.8 m panchromatic, and 3.2 m multispectral. Gaofen-4 has a high-resolution CMOS camera. Gaofen-8 has a lower orbit to increase resolution. Gaofen-9 may be supplementing/replacing Gaofen-1, while Gaofen-6 is projected to share similar performance parameters. Gaofen-3 is projected to have SAR 1 m resolution, Gaofen-5 a visible light-near infrared hyperspectral camera, and Gaofen-7 sub-metre stereo mapping.

At the time of writing, China has launched 25 Beidou/Compass PNT satellites (the latest on 1 February 2015). Nineteen are currently functional in orbit. First operational with 10 satellites in 2011, Beidou achieved regional coverage in 2012. China appears on track to achieve its goal of a 35-satellite constellation with global coverage by 2020.

To target mobile maritime platforms, China must master a tremendously complex, difficult process: correlating and fusing real-time sensor inputs and then disseminating 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 transmission of targeting data to the shooter will impose time delays.

Software and data management requirements will be complex. C2 almost certainly will pose a particular challenge. The PLA must co-ordinate among the many service elements that 'own' various ISR sensor and ground station architecture and within the chain of command that would authorise their prioritisation and use, in addition to the release authority for the weapons systems that would employ their inputs.

Nevertheless, China has made tremendous progress and is 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 match.

At this time, China has also established a high-frequency radar installation on Cuarteron Reef, one of the Spratly features that it has radically augmented and is now fortifying in the South China Sea. Assuming an effective range of 150-200 n miles (278-370 km), and deployment of other such radars on the other Spratly and Paracels features it occupies as well as on land to the north, this would enable the detection and reporting of a CSG across the vast majority of the South China Sea.

Iran's enigmatic 'ASBM'

China has two functional ASBM missile types, but is still developing and proving the reconnaissance/strike complex to target them effectively under realistic, challenging conditions. Iran has similar A2/AD aspirations vis-à-vis the Gulf, but lags far behind China in capability. The factors that represent ongoing challenges for Beijing to address would appear to pose extreme limitations for Tehran. Iran's only mitigating factor is that it seeks to target ships in a far more confined geographic space than China.

A 2014 picture of what is understood to be Iran's Khalij-e Fars anti-ship ballistic missile, in front of the Fateh-110 short-range ballistic missile from which it was derived. The EO-guided ASBM has fins and canards to enable manoeuvre and could theoretically achieve sufficient in-flight correction to strike a moving maritime target. (Iranian Defence Ministry)

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Iran's Khalij Fars ('Persian Gulf') ASBM is based on the Fateh-110 series short-range ballistic missile (SRBM). EO-guided, and with fins and canards to enable manoeuvre, it could theoretically achieve sufficient in-flight correction to strike a moving maritime target.

"The distinctive feature of the missile lies in its supersonic speed and trajectory," the official Fars News Agency asserts. "While other missiles mostly traverse at subsonic speeds and in cruise style, the [Khalij Fars] moves vertically after launch, traverses at supersonic speeds, finds the target through a smart programme, locks on the target, and hits it. The range of the solid-fuel missile is 300 km and it can be fired from triple launchers. The missile could successfully hit a mobile target a 10th [the size] of an aircraft carrier in its early tests."

Despite the state media's claims, the Khalij Fars remains unproven. Its limited seeker window and limited energy in ballistic free-fall impose exacting requirements regarding the ability to predict where a target ship is headed - requirements Iran would likely have difficulty meeting under most realistic conditions.

The missile appears to have been tested twice, with the last shot in 2011. Despite official claims to the contrary, both tests appeared to be conducted against stationary target vessels (a barge or small ship). Moreover, Tehran has a track record of exaggerating missile and other military capabilities in its state media, including through relatively primitive, easily debunked means (for example, altering images to augment simultaneous missile firings). Finally, Iran does not appear to have sufficient reconnaissance/strike infrastructure to attack under realistic conditions a moving target, let alone an unco-operative target.

Potential countermeasures

Any ASBM's effectiveness in combat is part of a dynamic multivariate equation that 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, land-based mobile launchers - which could make defence against it difficult and/or highly escalatory. If technology development unfolded so that a Chinese ASBM could overcome the best US efforts at active and passive countermeasures, China could change the game unilaterally.

In marked contrast to some commentators' blanket dismissals of Chinese ASBM efforts, the US military has clearly been taking China's ASBM potential seriously for over a decade. Since at least the first public US government mention of Chinese ASBM development in a 2004 Office of Naval Intelligence report, US military leaders and other spokespeople have underscored this and other A2/AD challenges, while expressing confidence that US and allied countermeasures were keeping pace with them.

Continued effort is required, however. It would be hubris to assume that Chinese ASBMs suffer many of the shortcomings of Soviet industrial-age attempts, yet are nevertheless susceptible to interception by US ballistic missile defence (BMD) systems. The US military, for instance, routinely conducts precision strikes that would have been considered impossible in the 1970s. The question is not whether the Chinese are trying to do something the Soviets could not do three decades ago, but whether the current programme can solve the technical problems that led the Soviet programme to falter.

So far, China appears successful. In fact, both ballistic missiles and BMD systems have progressed. China is leading the world in ballistic missile development, while the United States leads the world in BMD. Counter-targeting efforts (radar and communications emissions control, use of decoys and deception emitters, unpredictable operational patterns, and so forth) can make it challenging - perhaps prohibitively - to target a moving ship at sea, especially at long range. However, it is hard to maximise a CSG's operational effectiveness while minimising its signature.

Active defences are also problematic. Cost-exchange ratios of ballistic missiles versus BMD tend to greatly benefit the shooter. The number of interceptors required to defeat multiple ASBMs, the availability of ships in the Western Pacific, the costs of interceptor missiles or their successors, and the geographic and competing mission demands planned for BMD-capable ships complicate active defences. An extended competition in this realm will be very expensive, with the financial and tactical advantage seeming to lie with Beijing.

Based on official statements, the United States and its allies are 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'. Here, US Navy efforts during the Cold War to confuse the Soviet Ocean Surveillance System may be instructive. Applying a similar approach could exploit ongoing Chinese limitations in operational 'jointness' and data fusion, as well as China's lack of experience with real-time decision-making and delegation of authority concerning sophisticated long-range precision strike.

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ASBMS: RE-BALANCING STRATEGIC COMPETITION?Views of the operational status and potential impact of the DF-21D 'carrier killer' missile vary from the alarmist to the dismissive: from a 'game changer' imminently imperilling the future of US CSGs to an overstated and easily countered system years away from operational reality. The truth likely lies somewhere in between: an increasingly viable but still vulnerable system that warrants attention by other powers now and into the future.

However, stand-alone assessments of the anti-ship ballistic missile (ASBM) challenge are narrow. Even an immature but operational DF-21D should be seen in the context of China's ambitious missile programme and emerging A2/AD challenge in the Western Pacific region. The combined effect of the growing quantities of inexpensive, longer-range, and more accurate Chinese cruise missiles fired from land, air, and sea and ballistic missiles, including ASBMs, will impose costs, complicate potential responses, and could overwhelm regional missile defence systems that prominently rely on limited magazines of expensive kill vehicles.

The result would be to erode the competitive balance - or, more accurately, stabilising imbalance - in the missile/missile defence competition, one of several domain area contests on which regional stability and security in part depends.

In this competitive context, a holistic approach to missile defence is required, one that augments current capabilities with novel technologies, expansive operational concepts, and innovative competitive strategies.

The technology of next-generation missile defence is advancing. Jamming, spoofing, and cyber attacks on China's launch and targeting C4ISR infrastructure are gaining momentum as approaches for pre-emptive 'left-of-launch' or early stage 'just right-of-launch' interventions. Directed energy weapons, rail guns, and exo-atmospheric kill vehicles are also being developed and refined to support various missions across the launch and kill chain.

However, technology alone will not fully address the A2/AD challenge in the East Asian region or drive fundamental shifts in the missile/missile defence competition. Even non-kinetic pre-emptive 'left-of-launch' activities incur risks and require sound protocols and decisive intelligence and C2 - a big ask in the sometimes unstable Asia-Pacific regional context, in which deliberation and response times are highly compressed.

New concepts of deterrence and dissuasion could reduce the likelihood of launch, an objective that also could be reinforced by the development of both offensive capabilities and effective competitive strategies that impose new costs on China while not incurring excessive costs for the United States and its allies. For example, the introduction of anti-ship Tomahawk cruise missiles could force the PLAN to consider reducing its focus on offensive capabilities in favour of more defensive weapons.

A note of caution: just as the introduction of the DF-21D will not signal a decisive end to the missile/missile defence competition in the region, and neither will a suite of linked and novel technologies, strategies, and operational concepts. New measures will produce countermeasures and, most importantly, new competitive dynamics, the origin and pace of which will be difficult to predict.

The DF-21D's most pronounced impact, then, may be as a catalyst for strategists and decision makers to broaden their thinking about the future of the missile/missile defence relationship and assess from a holistic perspective how the shifting strategic balance could drive this critical competition along previously unexplored trajectories.

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COMMENT

Whatever its ongoing limitations, China is the only nation to date to possess a dedicated, basically functional ASBM. This emerging capability is founded on a multi-layered reconnaissance/strike complex within which the DF-21D and DF-26 missile systems themselves operate.
Given the challenges inherent in developing, fielding, and targeting an ASBM, such weapons are likely to long remain the preserve of the greatest military powers with the most sophisticated national innovation systems. For less-capable nations, shore-based anti-ship cruise missiles (ASCMs) are likely to remain a more reliable, cost-effective way to threaten moving ships. While Iran's ASBM claims remain dubious, it is exploiting its limited but focused military-industrial complex, access to Chinese weapons, and the Strait of Hormuz's narrow geography to deploy shore- and ship-based ASCMs capable of significantly threatening ships in the Gulf.
Today witnesses an era in which long-range precision strike weapons are ascendant, increasing A2/AD options for coastal states of reasonable technological capacity. At the apex of the military-industrial food chain, the top missile powers - China, Russia, and the United States - have the capacity to develop and field technologically demanding but operationally promising ASBMs. With Washington and Moscow constrained by their signing of the Intermediate-Range Nuclear Forces Treaty in 1987, which prohibits their development and deployment of land-based missiles of 500-5,500 km range, Beijing has pressed forward and made significant progress. Whatever specific uncertainties remain, navies are rightly taking these emerging dynamics into account.

A Block IV Tactical Tomahawk sea-launched cruise missile. The US Navy is considering broadening Tomahawk's capability to give it an anti-ship role once again. Introducing such a capability could force the PLAN to consider reducing its focus on offensive capabilities in favour of more defensive weapons. (Raytheon Missile Systems)

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