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A Preliminary Examination of the Proposal to Add Sea-Based Intermediate-Range Ballistic Missiles (IRBMs) to the U.S. Navy Future Fleet

Sam J. Tangredi

sam.tangredi@usnwc.edu

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The Institute for Future Warfare Studies (IFWS) was established in 2017 to serve as a focal point for research and analysis on future warfare trends and challenges, the future operating environment, warfare innovation, and future strategy and force structures.

The current IFWS research program focuses on the options, assumptions, costs and risks of near-term decisions that will affect the Navy and the Nation in the years to 2050 and beyond.

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Summary

This paper describes the findings of an individual assessment of a proposal originating in the *Navy Future Fleet Platform Architecture Study* drafted by the MITRE Corporation (a federally-funded research and development center) in 2016 to satisfy a requirement of the Fiscal Year 2016 National Defense Authorization Act that three independently-produced studies of alternative Navy fleet platform architectures in the 2030s be conducted and submitted to Congress.

One of the MITRE future fleet architecture proposals is that the U.S. Navy should pursue the development of a conventional-warhead sea-based intermediate-range ballistic missile (termed Pershing 3 by MITRE), to be launched from large surface combatants or submarines. This conventional sea-based IRBM would provide a long-range offensive capability in response to the threat of ground-launched anti-ship IRBMs already developed by potential adversaries. [Note: For this paper, *Pershing II* refers to the past U.S. Army land-based IRBM; Pershing 3 refers to the MITRE-proposed sea-based IRBM; *Pershing III* to a follow-on U.S. Army land-based IRBM proposed in the 1980s that was never developed.]

In submitting the three studies to Congress, through the Secretary of the Navy and the Secretary of Defense, the Chief of Naval Operations noted that "some recommendations show promise but will need further analysis and exploration." Although no individual proposal was actually singled out for further analysis, this Institute for Future Warfare Studies (IFWS)/Strategic and Operational Research Department (SORD) assessment is intended to fulfill the CNO's intent as concerns the MITRE Pershing 3 recommendation.

Findings of the IFWS/SORD assessment:

The findings of this assessment are based exclusively on open-source (unclassified) publications.

- Given the objectives of the Chinese Communist Party (CCP) in the People's Republic of China (PRC) there exists a possibility of a conflict in the seas adjacent to the Chinese mainland. There are similar possibilities of near-seas conflict with other potential opponents of the United States and the current international system.

- Mobile land-based anti-ship ballistic missiles operated by the People's Liberation Army (PLA) of the Chinese Communist Party (CCP) in the People's Republic of China (PRC) hold U.S. forces at risk when operating in the South China Sea, East China Sea, or Yellow Sea. Other potential military opponents have or are developing similar capabilities

- The U.S. Navy, and U.S. joint forces overall, currently do not possess conventionally-armed kinetic weapons capable of out-ranging the PLA mobile land-based anti-ship missiles nor conducting timely counter-attacks against them with ordinance capable of decisive effects. (This excludes intercontinental ballistic missiles with nuclear warheads, considered an unlikely option.) Such attacks could be conducted by bombers or attack aircraft, but current weapons ranges would require them to penetrate potentially dense air defense networks.

- The anti-ship ballistic missiles are perceived to have created a near-seas area in which U.S. warships cannot operate effectively under combat conditions. Whether or not this perception is accurate, it has already undermined regional deterrence. (It should be noted that PLA land-attack IRBMs and anti-ship IRBMs share similar characteristics.)

- Potential future weapons and/or operational concepts capable of countering anti-ship ballistic missiles remain underdeveloped (electro-magnetic rail gun) or have politico-military liabilities (continental U.S.-based prompt global strike concept).

- The use of manned or unmanned aircraft to deliver counter-strikes remains an option, but the unrefueled range of manned tactical aircraft is a limiting factor. Unmanned aircraft can increase that range, but with corresponding reductions in payload. Manned or unmanned refueling aircraft certainly can be utilized to extend strike range, but they themselves may be vulnerable.

- A conventionally-armed (non-nuclear) sea-based intermediate-range ballistic missile (IRBM) capability for surface warships and submarines holds the potential to out-range the PLA land-based missiles and provide an effective counter-battery strike capability, thereby enhancing regional deterrence. The primary purpose would be strikes against land targets, but such a weapon could be directed against opposing fleet concentration areas. (This statement assumes the existence of sensors and battle management systems necessary for effective targeting.)

- There are no arms control treaties or international laws that restrict the construction and deployment of sea-based IRBMs (whether conventionally or nuclear armed). It is possible that development of sea-based IRBMs may facilitate the creation of a future regional arms control regime in similar fashion to those governing nuclear-capable land-based IRBMs and ground-launched cruise missiles in Europe.

- A conventionally-armed sea-based IRBM based on the design of the former land-based *Pershing II* missile may be a cost-effective solution in comparison with other technologies. IRBMs represent mature technologies that do not require an extensive research and development cycle. *However*, engineering a land-based *Pershing II*-type missile to operate at sea would involve technical risk, and many aspects of the effort would require extensive technical studies.

- Without extensive technical studies it is impossible to estimate the development and per unit costs of sea-based IRBMS. However, the MITRE report provides a per unit cost estimate of $15 million. Per unit cost for *Pershing II* converted to 2017 dollars was $19 million.

- It is conceivable that deploying sea-based IRBMs in deck-mounted box launchers might allow their integration in existing U.S. Navy (USN) and U.S. Naval Service (USNS) ships, precluding the need to design specialized platforms.

- Integration of sea-based IRBM fire control into current naval tactical networks to enable effective use against real-time targets is difficult (as with other over-the-horizon weapons systems), but certainly not an insurmountable engineering challenge. There are various methods of systems integration; similarly there are alternative methods of targeting and control.

- There are, however, serious administrative difficulties with capitalizing on mature sea-based IRBM technologies. The primary one is that the current Department of Defense (DoD) programming and acquisition system may be incapable of bringing a significant weapons system into operational status in less than a decade.

- Other concerns include available funding (most obviously), support by defense industry, and political and diplomatic issues.

- A preliminary assessment of potential costs, risks, and benefits indicates that the possibility of developing a sea-based conventionally-armed IRBM and integrating it into the future fleet architecture should be thoroughly and rigorously examined by the U.S. Navy.

Recommendations:

In order for the U.S. Navy to further examine this proposal, the following actions are recommended:

- OPNAV N3/5 should conduct a study of the effects of including sea-based IRBMs in the future fleet in terms of strategic requirements.

- OPNAV N8 should conduct campaign analysis and modeling related to the integration of sea-based IRBMs into the future fleet architecture.

- OPNAV N9 should initiate discussions concerning the appropriate sponsor of a sea-based IRBM program and how such a program would develop across weapons and platform-sponsor boundaries.

- Commander, Naval Surface Force (COMNAVSURFOR) should initiate a series of experiments in employing ground mobile missile systems—beginning with relatively small and short-range missiles—on USN and USNS ships. An appropriate starting experiment would be to determine whether artillery missiles such as the High-Mobility Artillery Rocket System (HIMARS) can be employed operationally while transported on the deck of an amphibious warship under varying sea conditions.

- The U.S. Marine Corps, in conjunction with Naval Air Systems Command (NAVAIR), should conduct studies concerning the possibility of equipping HIMARS-type systems with anti-ship missiles.

- Commander, Naval Submarine Force (COMNAVSUBFOR) and/or other appropriate undersea warfare commands should examine the feasibility of converting *Ohio*-class submarines to conventional IRBM launch platforms, similar to their conversion to cruise missile SSGNs.

- Commander, Naval Air Systems Command should begin preliminary technical feasibility studies on the adaptation of *Pershing II*-type systems for sea launch.

- Commander, Naval Sea Systems Command (NAVSEA) should begin preliminary technical feasibility studies and analysis of alternatives for sea-basing IRBMs on existing vessels and future designs.

- The Chinese Maritime Studies Institute, U.S. Naval War College, should monitor open-source Chinese literature for reactions to this proposal and PLA/CCP commentary concerning sea-based IRBMs.

- The Office of Naval Intelligence should monitor classified sources concerning this subject.

- U.S. Navy Fleet Forces Command (FFC) and its subordinate doctrine and tactical development commands should initiate discussion with appropriate U.S. Army commands and agencies concerning previous experience with *Pershing II* IRBMS.

- The U.S. Navy should encourage defense industries to conduct their own studies concerning this subject.

- The U.S. Navy should encourage interested public policy institutes (think tanks) and academic institutions to conduct their own studies concerning this subject.

Supplementary narrative:

An attached appendix contains the article “Fight Fire with Fire” from the U.S. Naval Institute *Proceedings* 143/8/1374 (August 2017), pp. 42-47. It appears courtesy of the U.S. Naval Institute, which holds the copyright. The article provides a narrative summarizing the logic of this assessment.

MITRE Proposal

From MITRE, *Navy Future Fleet Platform Architecture Study*, 2016:

p. 23. "**Long-Range Sea Strike.** The surface force requires a long-range strike capability to dissuade, disrupt and delay an adversary at 1,000 to 2,000 nautical miles. The SM-6 does not have the necessary range. The TLAM has greater range, but it is too slow. Consequently, the surface force needs a new missile. The U.S. Army had a long-range strike capability with the Pershing 2 missiles. These missiles were decommissioned as part of the Intermediate-range Nuclear Forces (INF) Treaty signed in 1988. However, the INF only covers ground launched systems. The U.S. Navy should pursue a Pershing 3 variant, to be launched from a large surface combatant, to provide a long-range offensive capability. More details on this topic are provided in the classified annex."

p. 56. "**Weapons Procurement**. To improve the effectiveness of the naval force, the study made the following recommendations with implications for weapons procurement:

- **Pursue a Pershing 3 variant, to be launched from a large surface combatant, to provide a long-range offensive capability**. Recommended eleven MG(X) ships with some flexibility in configuration. If each has 24 VLS cells for this weapon, then 264 missiles are required to fill all of the launchers."

Note 7 on p. 56 provides an assumed cost for a Pershing missile variant at $15 million/unit.

In the 1980s, Martin Marietta used "Pershing III" as the name for a proposed small intercontinental ballistic missile (ICBM) consisting of a Pershing II with two additional booster stages. The program was never developed.

Statement of the Problem

- Anti-access/area denial (A2/AD) systems appear to be forcing U.S. Naval surface forces away from the littoral regions. Emblematic of that is the (perceived) threat posed by the PLA DF-21D/DF-26 anti-ship ballistic missiles. Both missile fall under the category of Intermediate-Range Ballistic Missiles (IRBMs) as defined by the INF Treaty, which covers missiles with a range of 1000-5500 kilometers (622-3418 land miles). *Note: The A2/AD term will be used in this assessment because it is a well-recognized acronym with DoD. However, as identified by the CNO, there are problematic implications for the term.*

- Operations research conducted at the Naval Postgraduate School indicates that naval warfare favors the side that can "attack effectively first" (particularly in the missile age), but the range of A2/AD weapons exceeds that of U.S. Naval aviation, forcing U.S. Naval air and surface forces to operate on the defensive as they comes within strike range. SSN/SSGNs can operate within the opponents A2/AD envelope, but the number of the platforms are limited and will necessarily be expected to carry out other missions.

- Naval strike weapons that can attack from outside A2/AD range, such as sea-launched cruise missiles (*Tomahawk*) are precise, but *not* timely, and appear to have limited capabilities against mobile and buried/hardened targets. This includes *Tomahawk*s carried on SSN/SSGNs. *Tomahawk* speed-to-target is roughly Mach 0.7. In contrast, IRBMs (such as DF-21/26) can achieve post-boost phase speeds of Mach 20 (actual speed-over-ground is somewhat lower).

- The relatively slow speed of *Tomahawk* has been perceived as a weakness in that weapon's use during the war on terrorism (particularly operations in Afghanistan). Although *Tomahawk* has been used against fixed targets, such a terrorist training camp infrastructure, its speed has limited its use against real-time mobile targets such as terrorist personnel. This has prompted support for a prompt global strike (PGS) system of conventionally-armed inter-continental ballistic missiles (ICBMs) to be fired from the continental U.S. against terrorist targets. Such a system, however, would have serious implications for nuclear arms control and might be considered limited by current treaties (START).

- The U.S. Navy currently does not possess a weapon that can conduct prompt strike against mobile or hardened targets from outside the A2/AD range of potential opponents. Such strikes would rely on carrier aviation or joint assets.

- Current carrier strike aircraft (F/A-18E/F) have an approximate combat radius of 390 nautical miles (NM)/722 kilometers (km) without aerial tanking. F-35C rated combat radius is 600 NM/1112 km without aerial tanking. Combat radius varies based on weapons load. Current per unit acquisition cost of F-35C is estimated at $116 million. [Note: Life-cycle costs for manned aircraft far exceeds that of missiles.] PLA DF-21D range is estimated at 780 NM/1450 km. *Extending the range of strike aircraft in the future is possible; older carrier strike aircraft had rated unrefueled combat radii in excess of 1000 NM.*

Characteristics of the Former *Pershing II* IRBM

- *Pershing II* (a follow-on to *Pershing IA*) was two-stage solid fuel missile designed as a tactical nuclear weapons delivery system. Although tested with dummy warheads, it was not designed for conventional ordnance.

- *Pershing II* development commenced in 1973 and production models were built by 1981. The system was deployed to Europe and declared operational there in 1983. By 1986, three missile battalions with 108 missiles were stationed in West Germany. The missiles were removed following the ratification of the Intermediate-Range Nuclear Forces (INF) Treaty on 27 May 1988, and by 1991 the missiles and their rocket motors were destroyed with the exception of seven airframes now on display at the Smithsonian and other museums.

- *Pershing II* range was 1100 miles/1770 kilometers throwing a warhead with a physical weight of 880 pounds/400 kg. Over 234 missiles were built, the majority not actually deployed. The missile was land mobile using a truck/tractor-pulled erector-launcher with crane and electric generator. With a self-orienting guidance system, the missile could be launched from any reasonably flat ground. In actual practice, sites were pre-surveyed.

- The maneuverable reentry vehicle (RV) and warhead achieved terminal guidance to the target by active radar. The RV was unitary (not multiple RVs). After it reentered the atmosphere it would conduct a pull-up maneuver.

- At 34.8 feet long and with a diameter of 40 inches, *Pershing II* would not fit in a standard vertical launch system (VLS) cell. Mk 41 VLS cells are rated at a maximum missile weight of 9020 pounds. Missile weight for *Pershing II* was 16,451 pounds.

- *Pershing II* was also designed to carry a "hard target kill" earth-penetrating nuclear warhead, but that weapon was never built.

Arguments for Sea-based IRBM as a Proposed Solution

- IRBMs possessed sufficient range (1000-5500 km) to conduct offensive strike from the outer edge or, potentially beyond an opponent's A2/AD envelope.

- The former *Pershing II* ground-launched IRBM (built with 1970s technology) had a range of 1770 kilometers, which would outrage the open source (unclassified) estimates of DF-21D (1450 kilometers). *Pershing II* was a solid-fuel missile, allowing range to be decreased or increased based on booster staging.

- When combined with accurate, real-time intelligence, IRBMs possess the speed and warhead throw-weight to strike mobile and buried targets, such as PLA DF-21D/DF-26 transporter-erector launchers and associated C4ISR nodes.

- IRBMs would have a lower attrition rate than aircraft when facing robust anti-access/integrated anti-air defense systems (IADS). In a comparison with aircraft, cost-versus-attrition calculations favor IRBMs.

- Sea-based IRBMs are not restricted by the INF Treaty; this is an interpretation held by every Presidential Administration from President Reagan to President Obama.

- IRBM technologies are mature and do not require the further development of an "emerging" technology. Since they are mature technologies, they require less research and development (R&D) and generally less costly overall than "exotic" systems.

- With experience in utilizing box and canister missile launchers on ships not originally designed to carry them, the U.S. Navy is capable of engineering launch canisters or (as necessary) unique ways to integrate Sea-based IRBMs in existing ships. (It is conceivable that launchers could take the form of a commercial container boxes which reach up to 53 feet in length.)

- There are no existing or planned programs that will have a similar effect in countering PLA ground-based anti-ship missiles and enhancing deterrence.

- Deterrence is based on perception. The DF-21D is popularly referred to as the "carrier killer." The existence of a U.S. "carrier killer-killer" (in the form of Sea-based IRBM) that can disrupt the PLA's warfighting calculus would enhance regional deterrence.

- Deploying sea-based IRBMs on amphibious warships and combat logistics force (CLF) ships would support the emerging concepts of "distributed lethality" and "distributed maritime operations."

- Use of conventionally-armed sea-based IRBMs in a regional conflict is not likely to precipitate a strategic nuclear response.

Arguments <u>against</u> Sea-based IRBM as a Proposed Solution:

- A sea-based IRBM is not a current "program of record" (POR) and therefore would be subject to a ponderous requirement development, programming, budgeting and acquisition cycle that appears incapable of fielding even a derivative weapon system in less than a decade. (Of course, this is largely a condemnation of the DoD Planning, Programming, Budgeting and Execution (PPBE) system rather than the sea-based IRBM concept per se.)

- There have been no recent technical studies (at least no public studies) conducted concerning the engineering requirements of putting IRBMs to sea, which means it is difficult to determine the technical risks of such a program. Despite the apparent feasibility, the risks of program failure may be high, particularly if initial cost estimate are understated and engineering difficulties mount.

- By the time sea-based IRBMs are fielded, other technologies under ongoing DoD research and development might already be mature.

- By the time sea-based IRBMs are fielded the PLA will have developed conventional intercontinental-range anti-ship ballistic missiles that can place the fleet as risk beyond the "second island chain" thereby rendering a response to DF-21/26 moot.

- Ballistic missiles constitute "legacy systems" that will be superseded by energy, information, and cyber weapons.

- At a length of 34.8 feet and with a diameter of 40 inches, a *Pershing II* would not fit in the standard Mk 41 Vertical Launch System (VLS) launcher cell, with VLS dimensions (for a missile canister) of 23 feet in length and 28 inches in width (or in the Mk57 VLS cells on DDG-1000, which are but slightly larger). Mk 41 VLS cells are also rated at maximum missile weight of 9020 lbs. In contrast, the *Pershing II* weighed 16,451 lbs. Obviously, either a new, larger VLS must be developed, or another launch system designed if *Pershing*-type missiles were to be installed on surface ships.

- If a new, larger VLS launchers or box or canisters cannot be back-fitted in existing platforms, sea-based IRBMs will inevitably require naval platforms of different size and configuration than currently exist or are being contemplated by the U.S. Navy. This would involve platform procurement costs.

- The counter-DF-21/anti-ship ballistic missile mission should be assigned to non-naval assets.

- In meeting the PLA/PLA Navy challenge, the U.S. Navy's primary mission will be sea control. As a power projection (land strike) weapon, a Pershing 3-type sea-based IRBM will take the Navy's focus away from the sea control mission.

- Sea-based IRBMs could generate an arms race by provoking the PRC to expand their current weapons inventory.

- The existence of sea-based IRBM capabilities would entice the U.S. DoD to plan for land strikes during any confrontation with the PRC in near-seas areas. This creates a possibility of unintended escalation.

Costs and Risks of the Proposal

- The costs involved with the proposal include:
  - Feasibility studies
  - Concept of operations and analysis of alternatives (AOA) studies
  - Preparation of acquisition program and solicitation
  - Missile costs
  - Launcher costs
  - Installation (assuming existing platform)
  - Design of new platform (if necessary)
  - New platform program
  - Testing, evaluation, training
  - Life cycle costs

Feasibility Studies

The potential cost of feasibility studies varies in accordance with task assignment. Although a 'higher' cost can be estimated for federal government labor than contract labor, the reality is that federal work force labor is a sunk cost; government employees assigned to feasibility studies of sea-launched IRBMs are already employed. Federal reports, however, are required to identify the cost of their production. For example, the cost of the OPNAV Report to Congress "Alternative Future Fleet Platform Study" of October 2016 is identified as $202,080 ($80 expenses, $220,000 in DoD labor).

Concept of operations (CONOPS) and analysis of alternatives (AOA) studies

CONOPS and AOA studies are often contracted outside of DoD are a cost in the $150,000 range. It is also possible that they can be conducted within DoD.

Preparation of solicitation and structuring of potential acquisition program

- The cost to government of preparing a solicitation and structuring and potential acquisition program certainly varies by specificity and complexity. Solicitations can vary from dozens of pages to hundreds. However, much of the personnel costs of preparation are sunk or can be primarily considered opportunity costs.

- "Subpart 15-2—Solicitation and Receipt of Proposals and Information" of the *Federal Acquisition Regulations* (https://www.acquisition.gov/far/html/subpart%2015_2.html) lists multiple steps by which a solicitation might be developed from requests for information (ROI) to site visits. Overall cost would reflect the range of activities conducted, but if the entire range is conducted the cost could be in the millions.

- On industry's side, the general rule of thumb for the cost of developing a response to a request for proposal (RFP) is 1%-2% of program value.

Missile Costs

- MITRE assesses the cost of an individual "Pershing 3" IRBM at $15 million/unit. Such costs are dependent on the total buy of missiles, which MITRE recommends at 264 missiles. It is unclear whether the $15 million figure is calculated from a total buy of 264, but that would be a logical assumption.

- Other sources indicate that the cost of an individual *Pershing II* in the 1980s was $19 million/unit (adjusted to 2017 dollars). A total of 274 missiles were procured, however, this figure may include *Pershing I* missiles that were upgraded/converted. Total program cost was estimated at $4.3 billion.

- It is unclear whether the proposed Pershing 3 would be more or less costly than *Pershing II.* Factors would include the relative costs of new technology (digital versus analog). Obviously, detailed analyses are required to determine anticipated costs.

- Whether tooling from *Pershing II* still remains or can be rapidly reconstituted is unknown. Although the overall manufacturer was Martin Marietta, now Lockheed Martin, numerous parts manufacturers are no longer in business. If tooling is existent, the cost of creating a Pershing 3 would presumably be less than a new design.

- The highest cost of any missile is the guidance system. In recent years, defense industry has had considerable success in re-purposing missile radars and guidance systems from existing systems to newer airframes pursuing different missions. For example, AIM-120 AMRAAM has been adapted from an air-to-air missile to be the core of surface-to-air weapons as well as the RIM-172 Standard Missile 6. It is possible that a Pershing 3 could adopt existing guidance systems, thereby reducing the costs of a new design.

Launcher Costs

- As noted, existing VLS cells could not house and fire a Pershing 3-type missile. It is difficult to calculate the cost of an extended VLS launcher suitable for Pershing 3.

- In 1996, Lockheed Martin, then sole-source developer and manufacturer of the MK 41 VLS, offered to sell a shipset of 1996 512-VLS cells (64 8-cell launchers) for $138 million. If such an offer were made in 2017 dollars, it would be approximately $216 million.

- Since VLS launchers are integral to ship design, the stand-alone cost of a particular VLS launcher (8 cells) is difficult to specify. However, one estimate suggests that a single launcher/8 cells would cost $2.75 million (in contrast to $3.3 million which would be the individual cell cost for the 512 cell buy). Because of addition costs in service, spare parts and logistics, Foreign Military Sales (FMS) pricing is generally higher than domestic costs; Defense Security Cooperation Agency (DSCA) figures derived from foreign missile and VLS launcher sales suggest that one VLS launcher alone could be procured by a partner nation for $8 million.

- In 2014, the U.S. was reported to have contracted for an upgrade of existing VLS launchers for $182 million depending on options exercised. This was a cost-plus contract. It did not included extending the length of the cells, which would be a more expensive prospect.

- It would be logical to assume that a VLS launcher of extended length and width would be greater than the $2.5 million estimate, though likely below $8 million.

- Box or canister launchers attached externally to the ship would logically be less costly than installation of a VLS launcher. Since the armored box launchers designed for *Tomahawk* installation on the USS *Iowa*-class reactivated battleships were more similar to the *Pershing II* launcher-erectors than is VLS, they could be a model for sea-based ICBM installation.

- Installation on former SSBNs may be the most cost-effective possibility, potentially requiring only the adaptation of existing systems.

Installation (assuming existing platforms)

- Contemplating the installation of box launchers would require stability studies. The armored box launchers of the *Iowa*-class contained four *Tomahawk* missiles, which combined would have a weight of 13,200 lbs., approximately 3000 lbs. less than a single *Pershing II*. The greater length of the *Pershing II* would also be a significant design factor.

- Space exists on amphibious warships—particularly the *San Antonio*-class (LPD-17)—for such launchers. The LPD-17 class was originally designed for the inclusion of VLS.

- According to recent unclassified briefings, It is possible that a future sea-based IRBM could be substantially shorter than *Pershing II* reducing launcher size. Missile size, however, reflects a trade-off between size, range (due to fuel capacity) and payload.

- Installation on former SSBNs would logically entail fewer engineering challenges.

Design of New Platform (if necessary)

- The size of a Pershing 3-type missile would appear to necessitate a larger hull if the vessel were to carry sea-based IRBMs in significant numbers.

- A new platform for the deployment of sea-based IRBMs would likely be similar to an "arsenal ship" concept. MITRE recommended the development of "magazine ships" (MG(X)), very similar in concept to previous arsenal ship characteristics. The term "magazine ship" is obviously an effort to disassociate the proposal from aborted arsenal ship development in the 1990s.

- The 1990s arsenal ship program provides a difficult cost-comparison because it was structured for industry, rather than the Navy, to determine the characteristics of the platform. However, $16 million in then-year dollars was allocated to each competitor for preliminary design work. That would be $24 million in 2017 dollars.

- The MITRE report (and subsequent presentations to OPNAV) suggest the use of a combat logistics force (CLF) or commercial hull as the launch platform. Although this would necessitate the expenses of building a specialized platform, use of an existing hull design would narrow design costs to the integration of launchers.

New Platform Program

- If a CLF-type design were to be selected, the *Kaiser*-class T-AO, *Puller*-class Expeditionary Support Base, or newer *John Lewis*-class (T-AO 205) are potential platforms.

- Most CLF construction have a rough order of magnitude (ROM) cost of $500 million or less. Inclusion of IRBM launch cells would increase that cost, but as per the previous discussion concerning VLS, depending on the number of launch cells or launchers installed. A modest number would not necessarily mean a substantial increase.

Testing, Evaluation, Training

- Obviously these are costs that are natural to all programs and thereby need to be considered in any decision to proceed.

Life Cycle Costs

- A natural consideration for any and all programs.

- Missile life-cycle costs have been categorized by one manufacturer as being 11% of total costs for Research, Development, Testing, and Evaluation (RDT&E), 77% for production/acquisition, and 12% for operations and support (O&S). Extrapolating from previous acquisition estimates of $19 million per missile and $2.5 million per launcher, RDT&E costs might be in the range of $2.3 million and O&S $2.5 million per *Pershing*-type IRBM.

- Of interest in the case of *Pershing II* were the demilitarization costs that occurred within eight years of initial deployment following ratification of the INF treaty. One can make the case that *Pershing II*, with its truncated life-cycle, was a very cost-inefficient way of achieving an arms control agreement. On the other hand, the agreement was consider to greatly enhance the security of NATO-Europe, thereby reducing the need for the costs of additional military systems. If sea-based IRBMs—appearing as an effective counter to land-based anti-access systems—were to produce an elimination of land and sea-based IRBMs in the Asia-Pacific region, the costs of a truncated program would seem worth the expense.

The following table lists the above rough cost estimates/extrapolations for a sea-based IRBM by category.

Cost Activity	**Cost Estimate (per missile)**	**Risk Factors**
Feasibility studies	$200,000 (?)	In Navy/DoD control
CONOPS/AOA studies	$150,000 (?)	In Navy/DoD control
Solicitation	Possible $million range	In Navy/DoD/Federal government control
Missile cost	$19 million (based on *Pershing II*)	In industry control under Navy/DoD direction
Launchers costs	>$2.5 million	In industry control under Navy/DoD direction
Installation on existing platform	>$2.5 million (?)	Platform dependent; in industry control under Navy/DoD direction
Design of new platform	$24 million	In Navy/DoD control; industry participation
New platform program	Variable; $500 million range if CLF-type design	Platform dependent; in industry control under Navy/DoD direction
Testing, Evaluation, Training	$2.3 million based on extrapolation of life cycle costs; training costs would include portion of O&S	In Navy/DoD control; industry participation
Life Cycle O&S	$2.5 million (includes launcher)	In Navy/DoD control; industry participation

Alternatives

- ***Tomahawk*.** Primary land-attack cruise missile of U.S. Navy. Current per unit cost reported at $1.8 million (Block IV). Its operational range varies based on "Block" variant, but extends to 1350 NM/1550 miles/2500 km. Depending on range, 550mph speed may not be sufficient for successfully engaging mobile targets. However, "short-distance" launch from submarine could impede an opponent's IRBM use. It has been reported on-the-web that that a supersonic (Mach 3) version incorporating a ramjet engine is under investigation. Such a substantial increase in speed would make it a more capable weapon and potentially able to strike more non-static targets. However, the Mach 3 version may not be compatible with current VLS launchers.

- **RIM-172 SM-6.** Although SM-6 has not be designed for use against land targets, its ability in an anti-ship attack has been demonstrated. It is one of the world's fastest anti-ship missiles at a speed of 3.5 Mach. Its official range as a surface-to-air weapon is 100 NM/185 km; however, numerous sources have speculated that it can reach beyond 200 NM/270 km. As the MITRE study maintains: "the SM-6 does not have the necessary range." However, SM-6 has been tested against a "complex, medium range ballistic missile target." If capable of neutralizing an enemy's IRBM, one could argue that a sea-based IRBM is not a requirement. However, SM-6 is not designed for long-range attack against IRBM launch vehicles or positions.

- **Rail gun.** Pace of research and development and "marinization" does not support near-term deployment. There has been range of estimates concerning its IOC, some of which have passed.

- **AGM-84H/K SLAM-ER.** An air launched cruise missile based on ship- and submarine-launched *Harpoon*, SLAM-ER has been identified by the U.S. Navy as having the best circular error probable of all missiles in its inventory and is capable of being fired by most Navy and Air Force tactical aircraft. Its operating range is reported at 170 mi/270km with a speed of 0.698 Mach, comparable to *Tomahawk*. With a flight time of under 20 minutes at maximum range it could provide counter-battery fire if its parent aircraft can penetrate anti-access air defenses.

- **JASSM-ER/AGM-158C LRASM.** A subsonic air-launched cruise missile compatible with most Navy and Air Force tactical aircraft, JASSM-ER has a range of 500 nm/580 mi/930 km. LRASM is an anti-ship version with seeker upgrades. It increases aircraft stand-off range beyond SLAM-ER.

- **Prompt Global Strike concept.** Prompt global strike is concept championed by the U.S. Air Force by which conventionally-armed intercontinental ballistic missiles (ICBMs) would be launched from the continental United States against difficult and time sensitive targets. The speed of the warhead could be potentially increased by the use of hypersonic projectiles. The primary concern generated by the concept is that it would greatly enhance the risk of nuclear escalation; if targeted against another nuclear power, it would be difficult to discern whether or a nuclear attack was underway. Nations with a nuclear launch-on-warning doctrine might commence a responding salvo upon initial detection of what was intended as a conventional strike—perhaps even if targeted on adjoining territory.

- **Longer-range aviation.** During the Cold War, naval tactical aircraft were capable of combat radii in excess of 1000 NM without refueling. Ranges for later-generation aircraft were gradually reduced as more sophisticated electronic systems were integrated. However, another factor in range reduction was the post-Cold War assumption that longer ranges were not necessary for the wars the United States would be likely to face (against relatively limited regional opponents), such as Serbia, Libya, Afghanistan, Iraq and Syria. Range was sacrificed in order to fund stealth characteristics and overall increases in combat capabilities, particular under a cost-restrained or resource competitive construct. It was also assumed that air refueling assets would be relatively immune to threats. However, these assumptions do not appear valid against robust anti-access/integrated anti-air defense systems (IADS), particularly those operated by regional powers. Yet, there appears few engineering limits to expanding the unrefueled range of new naval aircraft, perhaps in excess of opposing IRBMs, thereby allowing aircraft carriers to operate attack aircraft at greater stand-off distances. An alternative to greater unrefueled range is to procure refueling assets (such as the unmanned air refueling vehicles being investigated for deployment on aircraft carriers) in sufficient numbers so that a significant loss rate can be tolerated.

- **Persistent surveillance/attack systems.** The use of small unmanned vehicles to loiter in attack range of potential targets has been proven effective for quick strikes against opponents with limited capabilities. However, their use in that role against sophisticated air defense and robust anti-access systems may not match this effectiveness.

- **Non-kinetic means of defense and/or offense.** As both a long-term and priority concept of the U.S. Navy, electromagnetic maneuver warfare consists of non-kinetic means of disrupting, deceiving or damaging enemy sensors and surveillance and targeting system. Combined with physical deception techniques, it is conceivable that such non-kinetic means could neutralize the capabilities of offensive anti-access weaponry including land-based IRBMs. However, a myriad of factors influence the success or failure of non-kinetic means of defense or offense, particularly against incoming weapons of high speed.

- **Emerging (new) operating concepts.** It is arguable that emerging operational concepts may make the need for a sea-based IRBM moot. However, evidence does not currently support that statement.

    - **Distributed lethality (DL).** The concept of distributed lethality was initiated by Commander, Naval Surface Force (COMNAVSURFOR) as a means of prioritizing an overall upgrade to offensive sea control weapons, and examining a further distribution of sea control weapons throughout the surface force—potentially to amphibious warships and CLF ships as well. While not necessary designed to improve strikes against land targets, the concept could be applied to the power projection mission as well. In the case of an exclusively sea control focus, it can be argued that a significant distribution of offensive capability throughout the fleet would tax an opponent's targeting capacity, thereby making a limited land-based anti-ship IRBM force a less effective threat.

    - **Distributed maritime operations (DMO).** U.S. Fleet Forces Command is developing and evaluating the concept of distributed maritime operations (DMO) as a means of expanding DL into operations other than sea control and power projection. DMO is also intended to tie together the corresponding concepts of electro-magnetic maneuver warfare (EMW) and distributed agile logistics. Again, distributed operations could reduce the effectiveness of a limited land-based anti-ship IRBM force.

    - **Electromagnetic Maneuver Warfare (EMW).** Effective dominance of the electromagnetic spectrum could greatly complicate an enemy's targeting capabilities thereby reducing the effectiveness of a limited land-based anti-ship IRBM force. EMW and the development of a sea-based IRBM capability would seem complementary; however, it is possible that both would compete for the same limited resources. Current efforts to increase EMW capabilities cannot be considered a *new concept* per se, since it was also a Cold War priority.

- **Joint Multi-Doman Battle/Multi-Doman Operations.** According to U.S. Army publications, "multi-domain battle, a joint combined arms concept for the 21st century includes capabilities of the physical domains and places greater emphasis on space, cyberspace as well as other contested areas such as the electromagnetic spectrum, the information environment and the cognitive dimension of warfare." It is very difficult to determine the uniqueness of this concept from preceding doctrine. Previous Joint documents referred to a similar concept as "cross-domain synergy."

The following table lists the above alternatives with their potential liabilities. The assumed common advantage is that the alternatives are existing programs/concepts.

Alternative	**Liability**
Tomahawk	MITRE: "too slow"
SM-6	200 NM (?) range; not designed for land attack
Rail gun	In development with engineering challenges
SLAM-ER	170 mi range
JASSM-ER/LRASM	500 NM range
Prompt global strike	Possible nuclear escalation
Longer-range aviation	Costs; IADS
Persistent surveillance/attack (UAVs)	IADS
Non-kinetic defense/offense	Hard to determine combat effectiveness
New operating concepts	Just concepts

Aggregated Risks

- **Engineering.** Although the underlying technologies are mature, technical risks still exist in modifying a land-based system for naval applications. *However*, the Navy's previous experience in bringing ballistic missiles to sea in submarines—the original ICBMs would be classified as IRBMs today—should mitigate the overall engineering risk

- **Program risk.** All acquisition programs face the risk of underestimating costs (or using the most favorable assumptions) and exceeding allocated resources. Additionally, a sea-based IRBM (and associated platforms) program would likely be seen as a threat for resources by the managers and supporting participants of existing programs, who may take steps that could compromise the proposed programs success. However, these risks are more inherent to the acquisition process itself than to the specific proposal.

- **Political.** The past association of IRBMs with nuclear weapons may cause the proposal to collect politically-influential critics within the arms control community. Additionally, defense industrial companies supplying existing programs may see the proposed program as a threat to their interests and apply political pressure for its curtailment.

- **Strategic**. Creation of a sea-based IRBM that could potentially be converted to nuclear weapons-capable delivery system could be problematic for reducing the potential for nuclear escalation. *However*, PLA officials have stated their intention to maintain mixed nuclear and conventional land-based IRBM/ASBM batteries, so that particular potential for escalation *already exists*.

- **Budget.** In a resource-constrained environment, allocation of resources to any program involves a prioritization. Priorities within DoD can change during the life of a program, with a number of them cancelled to reduce budget shortfalls. This happens in particular to programs without powerful champions within the decision-making organization.

- **Opportunity costs.** It is possible that resource allocation toward what is, in fact, a mature technology may take focus and resources away from further development of promising emerging technological capabilities.

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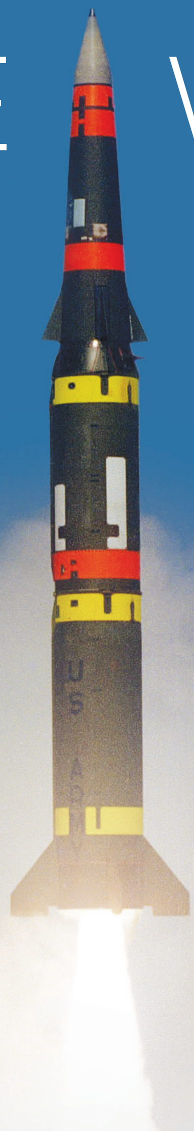
APPENDIX

"Fight Fire with Fire" from the U.S. Naval Institute *Proceedings* 143/8/1374 (August 2017), pp. 42-47. It appears courtesy of the U.S. Naval Institute, which holds the copyright. The article provides a narrative summarizing the logic of this assessment.

FIGHT FIRE WITH FIRE

BY CAPTAIN SAM J. TANGREDI
U.S. NAVY (RETIRED)



DEPARTMENT OF DEFENSE / PERSHING II MISSILE LAUNCH

Facing growing networks of antiaccess warfare systems, the U.S. Navy can regain an early offensive capability by taking conventionally armed intermediate-range ballistic missiles to sea.

Attack effectively first. That is how retired Navy Captain Wayne Hughes, long-term sage of naval tactics, describes the fundamental principle that offensive action remains the key to victory in naval warfare.[1] But in the face of growing networks of antiaccess warfare systems that appear to require navies to remain on the defensive until they can achieve the range to commence an attack, how can that principle be applied?

As noted by Chief of Naval Operations Admiral John Richardson, public discussions of antiaccess/area denial (A2/AD) invariably focus on defensive operations, with an assumption that a potential opponent's sea denial ambition is a fait accompli.[2] Contemplation of offensive maneuver is relegated to "step two." He also is right in noting that early offensive actions *can* be carried out from inside current A2/AD threat envelopes, especially by nuclear attack submarines (SSNs and SSGNs).

Yet, currently, our SSNs and SSGNs are armed with subsonic, low-altitude Tomahawk land-attack cruise missiles that—while effective against many fixed targets—do not necessarily have the speed to be effective against such mobile targets as the transporter-erectors of the Chinese Dong Feng (DF) 21D antiship ballistic missile, often referred to as the "carrier killer." Neither do the Tomahawks necessarily have the power to destroy hardened or buried facilities. If carrier aviation must stay beyond the DF-21's range, how could the U.S. Navy take the offensive actions that would be fundamental to victory if a conflict were to occur in the East or South China seas? And if the Navy lacks such offensive power, how can it be assured it could deter such a conflict?

A potential option to enhance deterrence and bring an early offensive capability against A2/AD strategies is to "fight fire with fire" and take conventionally armed intermediate-range ballistic missiles (IRBMs) to sea.[3] Although there have been a small number of recent articles discussing the development of a land-based Pershing III IRBM for operation by the U.S. Army coast artillery, taking IRBMs to sea is an option that has not been publicly examined (at least since the 1960s).[4] It is, however, a future fleet architecture option discussed in the MITRE Corporation's report to Congress of July 2016.[5] There would be many difficulties, cost, and risks, but as national security professionals, we owe it to the American people to discuss and debate this option.

What follows is a preliminary analysis of the advantages and disadvantages of the IRBM option, not with a spirit of advocacy, but to lay out what appears to have been previously unthinkable.

NOT AN ARMS CONTROL ISSUE

Before beginning the discussion, we must dispatch the common perception that IRBMs are banned under the 1988 Intermediate-Range Nuclear Forces (INF) Treaty, which prompted both the United States and the Soviet Union to destroy their entire stocks of land IRBMs, as well as ground-launched cruise missiles. Pushing aside the fact that China and other nations are not parties to the treaty, and that Russia appears ready to break from its constraints, the INF Treaty *does not* include sea-based IRBMs. This has been a consistent interpretation of the U.S. Department of State in every administration from President Ronald Reagan to President Barack Obama. The implications for arms control and objections to the idea of IRBMs at sea can provoke a fierce debate, but for now, it must be recognized that sea-based IRBMs and shorter-range ballistic missiles are not constrained by any treaty or informal agreement.

Another issue that needs to be resolved up front is what constitutes an IRBM. A range of 1,000-5,500 kilometers is covered by the INF Treaty. Other sources separate "medium-range" (1,000-3,000 kilometers) from intermediate-range (3,000-5,500 kilometers) ballistic missiles. This distinction often is used within the Department of Defense (DOD); however, it is not a distinction codified in international law. Other nations do not categorize their arsenals in terms of medium range. The DF-21 frequently is described by U.S. analysts as a "medium-range missile," but it would fall under INF Treaty limits. Moreover, the DF-26 missile, follow-on to the DF-21 with additional booster staging, has an estimated range of 3,000-4,000 kilometers. Referred to as the "Guam killer" or "Guam express," the DF-26 is thought also to have an antiship ballistic missile variant. Given these facts, it is logical to apply the IRBM term to the INF 1,000-5,500 kilometer range and include the DF-21/26 in that category.

THE CHINESE IRBM THREAT

Under many scenarios, the DF-21D could be a severe threat to the operations of U.S. and allied navies in the western Pacific. Also known by the designation CSS-5 Mod 6, it is estimated to carry a 600-kilogram/1,330-pound warhead with maneuverable reentry and terminal guidance capability targeted from either radar or information provided by the Yaogan-series maritime reconnaissance satellites.[6] Combined with an expanding Chinese maritime reconnaissance-strike network of satellites, over-the-horizon radars, and maritime intelligence assets, the DF-21D is a significant and symbolic component of the People's Liberation Army's (PLA's) antiaccess strategy.[7]

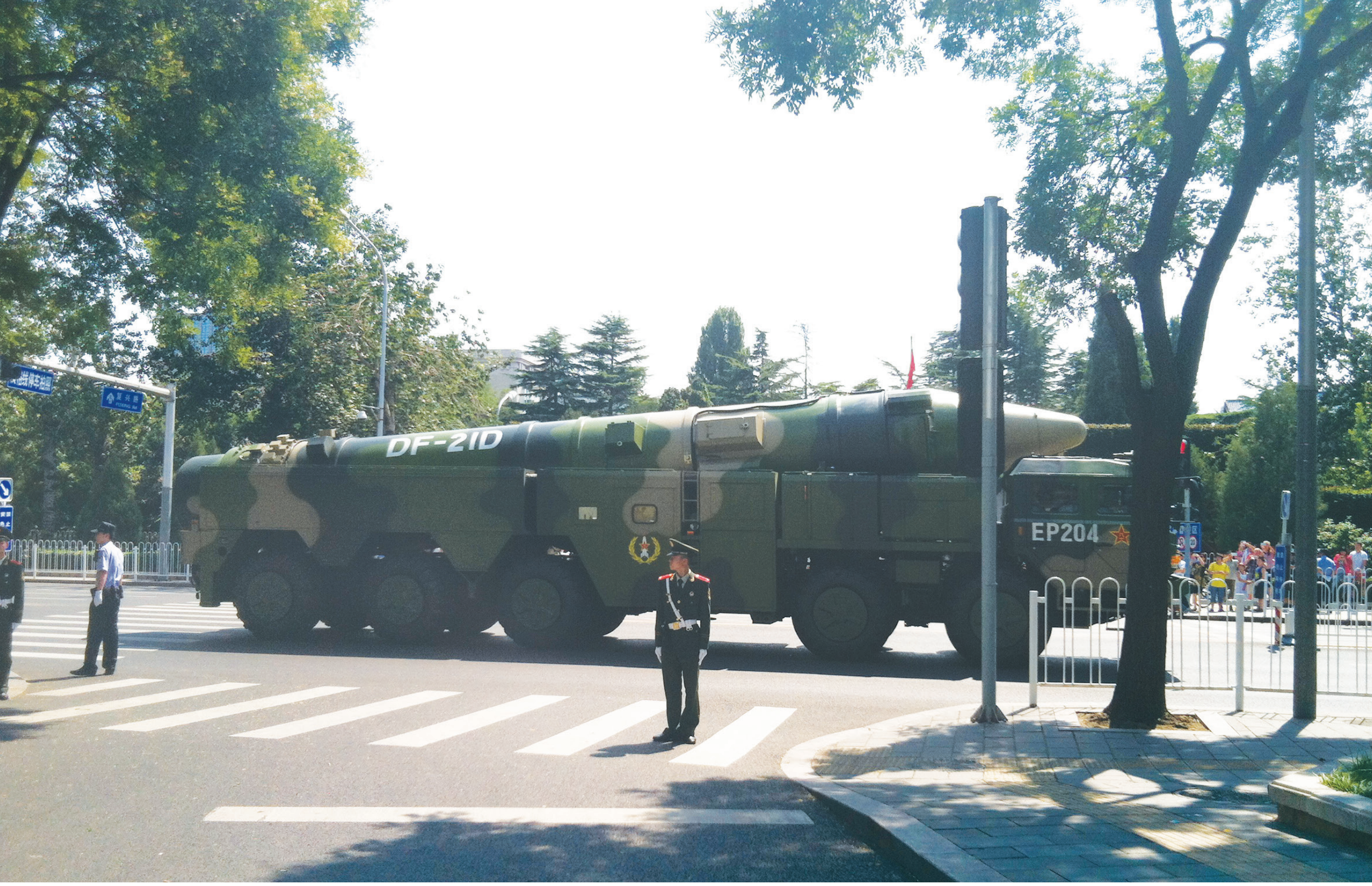
What makes it significant is its 1,450-kilometer/780-nautical-mile range, capable of reaching beyond the Taiwan Strait and "first island chain," which is considered the potential area of Chinese naval dominance.

What makes it symbolic is the perception that it is a weapon through which the PLA can "use the land to control the sea," particularly against the U.S. fleet.[8] This would ensure the United States could not intervene in a Taiwan crisis as it did in 1995-1996, when U.S. carrier strike groups operated as a deterrent in the Taiwan Strait with apparent impunity. With the DF-21, the PLA theoretically could threaten the U.S. fleet in the western Pacific *without* a sortie of the People's Liberation Army Navy (PLAN). Another perceived advantage in land-based antiship strike is that the United States presumably would be more reluctant to attack targets on mainland China than PLAN units operating at sea.

Whether or not the DF-21 would be effective in combat, its impact on naval strategy debates in the United States has been profound and continuing. Critics of new U.S. aircraft carrier construction cite cost comparisons between a large arsenal of DF-21Ds and a single aircraft carrier.[9] Numerous studies suggest the U.S. Navy cannot operate within the first island chain, which stretches from Japan to Malaysia. Adding to the debate is the development of the follow-on land-attack/antiship DF-26.

Up to now, discussions of how to best counter the DF-21 and other antiship ballistic missiles have focused on *defensive* systems, such as the U.S. Navy Standard Missile (SM) 3 with its antiballistic missile capabilities, and on electromagnetic maneuver warfare (EMW) systems. The U.S. Navy also is developing the "distributed networked operations" concept. If these systems are combined with the inherent mobility of warships, defense against the DF-21 is possible, albeit difficult, particularly if reports that the PLA is working on a *multiple* independent reentry vehicle (MIRV) payload are accurate.[10] A MIRVed payload could cover a wider area, making a hit more likely, although striking a moving target in a clutter of deceptive EMW signals and physical decoys is much harder than many commentators suppose.

Even as we work on developing other defensive operational solutions, there are potential advantages to taking a countering action on the strategic level. Introducing our *own* IRBMs at sea to target the land elements of the reconnaissance-strike networks would allow us to put



Tomahawks are not necessarily effective against mobile targets such as the transporter-erectors of the Chinese DF-21D antiship ballistic missile shown here. If carriers must stay beyond the DF-21's range, how could the U.S. Navy take the offensive actions fundamental to victory if a conflict were to occur in the East or South China seas?

DF-21 launchers and hardened network nodes at risk in ways we currently cannot. In conjunction with the defensive systems in service and under development, this could allow for an early phase *offensive* capability to break A2/AD strategies. If the offensive is truly the key to victory, then greater offensive capabilities should be a source of more credible deterrence.

STRATEGIC AND OPERATIONAL ADVANTAGES

A conventional sea-based IRBM capability appears to offer at least five strategic and operational advantages.

• Sea-based IRBMs would deliver a prompt counter-targeting capability that Tomahawks cannot provide. Although calculations vary based on booster size, a ballistic missile warhead can achieve speeds of 24,000 kph/15,000 mph (20 Mach) by booster burn-out. The approach speed of a Tomahawk cruise missile is roughly 890 kph/550 mph (0.7 Mach). One of the reported lessons learned in the war on terrorism is that the Tomahawk cannot be used at the extent of its range against real-time terrorist targets because such targets can move during the missile's flight. Obviously, conventional IRBMs could arrive on target much quicker. Having sea-based IRBMs could prove a strategic advantage over the proposed use of conventionally armed intercontinental ballistic missiles (ICBMs) under the Prompt Global Strike concept because a launch of ICBMs from the continental United States could more easily be perceived as a nuclear attack and be a greater source of nuclear deterrence instability.

• Sea-based IRBMs would allow the U.S. Navy to place PLA (and other) A2/AD assets at risk at a greater distance than today, changing the war-planning calculus. The U.S. fleet could target the PLAN and C4ISR nodes without having to enter the first island chain and therefore *not* face the level of hazard that we currently expect. Potentially, sea-based IRBMs could out-range the DF-21/26, thereby neutralizing that aspect of a PLA antiaccess strategy without being subject to it.

• Although there is considerable cost involved in a new-start IRBM acquisition program, the technology is mature, and there would be much less research-and-development cost and engineering risk than would be encountered in the development of more exotic weapons. Sources have suggested the DF-21 resembles a reverse-engineered U.S. Pershing II missile, the type destroyed under the INF. The Pershing II, with a range of 1,770 kilometers, is a proven system whose 1970s technology could be updated without having to explore previously unexploited technologies. Whether the tooling exists to rapidly reconstruct the Pershing is unknown, but from a technological risk calculation, it might be that such a system could have initial operational capability (IOC) at sea prior to the at sea IOC of, for example, the rail gun. With previous experience installing box and canister launchers, it is conceivable the Navy could put an IRBM capability to sea on big-deck surface warships with a minimum of structural changes. The word, however, is *conceivable*; there is no public record of weight and stability calculations for IRBMs on modern surface ships beyond tests of shipping Pershing missiles by sea conducted by the U.S. Army in the 1960s.[11] Conventionally armed IRBMs also could be fired from SSGNs. In fact, the original Polaris submarine-launched ballistic missile (SLBM) would be considered an IRBM today. Deploying SSGNs with IRBMs would raise arms control issues. Nevertheless, an updated Pershing could rely on proven technologies.

• U.S. Navy IRBMs would provide a nonescalatory/unconstrained-by-treaty *analogous response* to the DF-21/26 that would enhance strategic stability in the Asia-Pacific region and make the Chinese Communist Party (CCP) *less* likely to believe it could act aggressively without fear of a U.S. response. Since deterrence is about perceptions, symbolism matters. As long as it is perceived that the DF-21 can be a "carrier killer"—the symbol of a growing A2/AD network that ensures the United States cannot operate in the western Pacific—the deterrent effect of the U.S. Navy (and assurance to regional allies) is reduced. No matter the operational difficulties involved in countertargeting, regional perceptions that the United States has a carrier killer-killer that can reach beyond PLA A2/AD range would enhance regional deterrence. One could argue that the United States might not be willing to trade Omaha for Taiwan in an ICBM exchange, but it is harder to argue that the United States would be unwilling to hazard warships in a potential conventional IRBM battle.

• It is possible that deployment of U.S. sea-based IRBMs might lead to an Asia-Pacific IRBM arms control treaty in a similar way that deployment of ground-based IRBMs (and ground-launched cruise missiles) in Europe led to the INF Treaty. The United States began the search for an INF Treaty with the Soviet Union years before actual missile deployment. The Soviets refused. However, once it was clear that NATO was committed to the deployment and that the Soviet-sponsored antinuclear protest movement would not derail the decision, negotiations began and were completed in relatively short order. Would the CCP be willing to conclude such an agreement that would include the DF-21 missile family? Unknown. But it would be unlikely to even contemplate such an agreement without facing an *actual deployment* of sea-based IRBMs, rather than the mere suggestion.

It is conceivable that the *initiation* of an IRBM acquisition program itself could bring the CCP to the arms control negotiations table. Former Secretary of State Henry Kissinger once maintained that the idea of the sea-launched cruise missile (SLCM)—even before developed—brought the Soviet Union to START.[12]

COSTS, RISKS, AND DISADVANTAGES

Obviously, there are costs, risks, and disadvantages that must be weighed prior to embarking on any effort to bring modern IRBMs to sea. Depending on emerging trends and events, such cost and risks may outweigh the strategic and operational advantages. However, that can

An updated Pershing II missile would rely on proven technologies, reducing engineering risk and research and development costs, but re-creating a Pershing-type IRBM that could be deployed at sea could be as costly as any new-start acquisition program.

NATIONAL ARCHIVES

U.S. NAVY (LEAH GARTON)

A Pershing II-size missile would not fit in the cells of the Navy's current vertical launch system (VLS)—here, on the USS *Hopper* (DDG-70) firing an SM-3. A larger VLS or a new system would have to be developed to take IRBMs to sea in surface ships.

be determined only through more detailed analysis and open, public debate. At an initial over-the-horizon view, there are at least five significant disadvantages:

• The first and most obvious is cost. To re-create a Pershing-type IRBM that can be deployed at sea will require resources on the level of other new-start acquisition programs. To determine an estimated "should cost" is beyond the scope of this article, but one source suggests a cost of $18 million per Pershing II in 2011 U.S. dollars, based on an original cost for the total 1980s program of $4.3 billion for 234 missiles.[13] This would translate to $19 million per missile in 2017. The per missile cost actually would be determined by the total buy, but a new acquisition program costing $4 billion would be difficult to propose in today's constrained budget environment. Barring a substantial budget increase, other programs would have to be cut or reduced. Under the circumstance, naval IRBMs might not seem to be a priority.

• Along with the cost of the missile is the cost of launchers. At 34.8 feet long and with a diameter of 40 inches, a Pershing II would not fit in the standard vertical launch system (VLS) cell. VLS cells also are rated at a maximum missile weight of 9,020 pounds; the Pershing II weighed 16,451 pounds. Either a new, larger VLS would have to be developed or another launch system designed if a Pershing-type missile were to be installed on surface ships.

This is not an insurmountable problem, as the U.S. Navy has experience using box launchers fitted to existing ships. The weight involved likely would make it prohibitive for destroyer-sized vessels, but it could be supported by amphibious warfare ships—providing a capability that would result in some *serious* distributed lethality. Another option would be to tie down transportable erector-launchers on the decks of amphibs or aircraft carriers, and possibly smaller vessels, similar to those used for the former land-based Pershing IIs. This possibility follows a suggestion by Marine Corps Commandant General Robert Neller that the high-mobility artillery rocket system (HIMARS), a road-mobile system transported by amphibious warfare ships, be equipped with antiship missiles.[14] While such a capability primarily would be used ashore, there appears little to preclude its use from the decks of amphibs. Targeting would be provided by other sea-based, airborne, or space-based assets. But, again, this would require resources.

Another option is to design new-type vessels specifically for sea-based IRBM systems, but that, of course, would increase costs *substantially*.

• There have been no technical studies (at least no public studies) of the engineering requirements of putting IRBMs to sea, which means it is difficult to determine the technical risks of such a program. Despite the apparent feasibility, the risk of program failure may be high, particularly if initial cost estimates are understated and engineering difficulties mount. It is not that engineering challenges could not be surmounted; rather, the issue is that—despite the potential for the use of mature technologies—the total risks are unknown.

• Like for all new capabilities, concepts of operations would need to be developed, and testing, experimentation, and training would need to be funded.

• We have no clear idea how the CCP would react to U.S. development of a sea-based IRBM capability. Public rhetorical invective would be extreme, but what sort or political or military action the Chinese might seriously contemplate is unknown.

WHAT SHOULD BE DONE NOW?

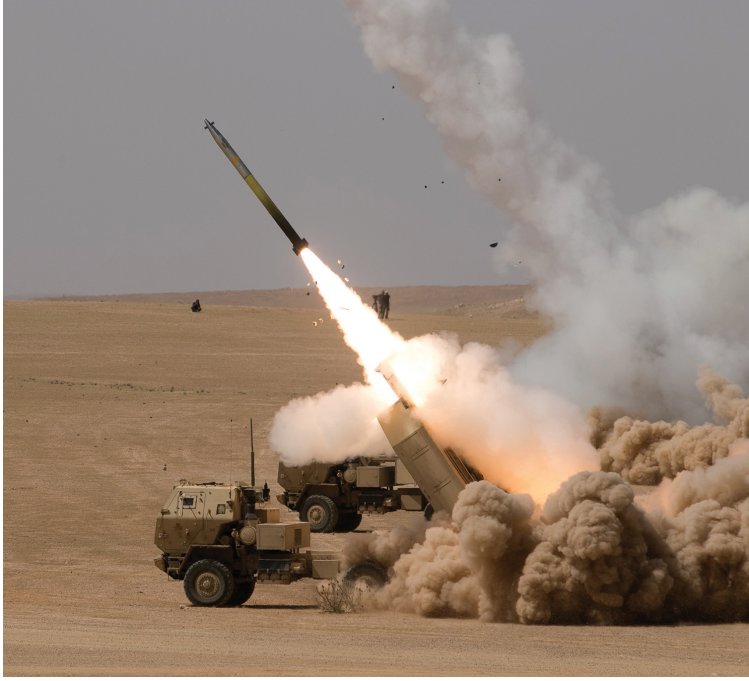
Given the advantages and disadvantages, what should the U.S. Navy do in the near term? Quite simply, now is the time for detailed study and experimentation.

First, the Navy should embark on multiple studies of the strategic, operational, and technical aspects of using sea-based IRBMs to counter antiaccess strategies and A2/AD systems. These should be both internal and commissioned studies, with emphasis on engineering requirements and technical risks. The focus should be on how to obtain such capabilities using existing technology and at relatively low cost.

Second, the Navy should experiment with the operation of existing land-based missiles on surface ships. There is no reason to wait for optimal launch systems. Most can be tied down and tested using the amphibious force.

Third, in conjunction with the eventual replacement of the *Ohio* class, the Navy should examine the possibility of converting *Ohio* submarines into SSGNs that can fire conventionally armed IRBMs. This looks feasible from a technical point of view, but there are strategic and arms control implications that must be examined.

It may be that, after a detailed examination, the Navy and the nation determine sea-based IRBMs are the wrong option. However, the time and effort it takes to examine the possibility will be worth it as it could lead us to identify a better option. In any event, we need to look at what might seem unconventional solutions if we are to regain the *offensive* capabilities to defeat antiaccess strategies and A2/AD systems. We cannot look at A2/AD as primarily a defensive challenge and expect to achieve victory. And we cannot allow an enemy to attack effectively first.


U.S. ARMY (STEVEN QUEEN)

Another option for at-sea launch of an IRBM would be to tie down transportable erector-launchers on the decks of amphibious warfare ships or aircraft carriers—similar to Marine Corps Commandant General Robert Neller's suggestion that HIMARS, a road-mobile artillery rocket system transported by amphibs, be equipped with antiship missiles.

1. CAPT Wayne P. Hughes Jr., USN (Ret.), *Fleet Tactics and Coastal Combat*, 2nd ed. (Annapolis, MD: Naval Institute Press, 2000), 40.

2. ADM John Richardson, USN, "Deconstructing A2/AD," *The National Interest* (online), 3 October 2016.

3. The IRBM category includes ballistic missiles with ranges between 1,000 kilometers/622 land miles and 5,500 kilometers/3,418 land miles, which includes the DF-21.

4. LCOL Stephen L. Melton, USA (Ret.), "Resurrecting the Coast Artillery," *Fires* (May-June 2014), 61-63; Even Braden Montgomery, "How Should America Respond to China's Deadly Missile Arsenal?" *The National Interest* (online), 19 September 2014.

5. Although the MITRE study was not released publicly, it is available from a link at Senator John McCain's official website at www.mccain.senate.gov/public/index.cfm/2017/2/statement-by-sasc-chairman-john-mccain-on-u-s-navy-fleet-architecture-studies.

6. Characteristics of the Dong Feng missiles are compiled from numerous open (unclassified) sources and should be understood as approximate.

7. "Maritime reconnaissance-strike complex" is a recent term used by the Center for Strategic and Budgetary Assessments to describe the Chinese and Russian antiaccess networks.

8. 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, no. 4 (Autumn 2009), 53-86.

9. CAPT Henry J. Hendrix, USN, "At What Cost a Carrier?" Center for a New American Security, March 2013.

10. Harry Kanzianis, "China's Anti-Access Missile," *The Diplomat*, 18 November 2011.

11. John H. Grier, *Pershing Transportation Study, Vessel Stowage*, vol. 4 (Fort Eustis, VA: U.S. Army Transportation Engineering Agency, July 1966).

12. Norman Friedman, *U.S. Naval Weapons* (Annapolis, MD: Naval Institute Press, 1985), 225; U.S. Department of State, *Foreign Relations of the United States, 1969-1976, vol. 33, SALT II, 1972-1980* (Washington, DC: Government Printing Office, 2013), 482.

13. Matthew Hallex, "China's Deadly Missile Arsenal is Growing: What Should America Do about It?" *The National Interest* (online), 5 October 2014.

14. Hope Hodge Seck, "Top Marine Wants to Fire Anti-Ship Missiles From HIMARS Launcher," Kit Up! Military.Com, 14 December 2016, http://kitup.military.com/top-marine-wants-fire-anti-ship-missiles-himars.html.

■ **DR. TANGREDI** is a professor of national, naval, and maritime strategy and a director of the Institute for Future Warfare Studies at the Center for Naval Warfare Studies, U.S. Naval War College. He is the author of *Anti-Access Warfare: Countering A2/AD Strategies* (Naval Institute Press, 2013) and two earlier books on the future security environment.