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Upsetting the Reset : The Technical Basis of Russian Concern Over NATO Missile Defense

By YOUSAF BUTT and THEODORE POSTOL

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FOREWORD

The New START Treaty, which entered into force on February 5, 2011, while modest in terms of strategic warhead reductions, represents an important accomplishment for Russia and the United States. It re-established the data exchange on strategic weapon systems and reset the U.S.-Russia nuclear arms control relationship.

However, as Yousaf Butt and Theodore Postol underscore in this report, the renewed relationship is at risk because of Russian concerns about the future capability of the planned missile defense system to erode Russia's strategic nuclear deterrent. Their technical assessment shows how the planned system could be geographically reconfigured to engage Russian (and Chinese) warheads. The authors explain that even though the defense could be defeated by countermeasures, it may still raise concern in the mind of a cautious Russian military planner that the delicate balance of arms agreed to in New START will be upset. While the first two phases of the planned system would raise little or no concern, proceeding with the last two phases (post-2018) could set back further U.S.-Russia nuclear arms reductions. Russian officials would, at the least, want binding assurances that the then more potent system would not devalue their nuclear deterrent.

Upsetting the Reset: The Technical Basis of Russian Concern over NATO Missile Defense makes a technically sound contribution to the policy debate about the future of missile defense and the implications for further cooperation between Russia and the United States. Officials in the Obama administration and Congress should heed Dr. Butt and Prof. Postol's warning that the latter phases of the Phased Adaptive Approach could "threaten to provoke Russia's exit from New START, in addition to possibly restarting a nuclear arms race – while providing no credible defense against possible future Iranian or North Korean missiles hosting simple countermeasures. Russia and China might increase their arsenals, end future arms reductions talks with the United States, and decrease their assistance with worldwide counter-proliferation efforts. Such a result would diminish U.S. – and global – security and would be at odds with President Obama's vision of a nuclear-weapons-free world."

Charles D. Ferguson
President
Federation of American Scientists
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Yousaf Butt and Theodore Postol

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EXECUTIVE SUMMARY

This study examines the Obama administration's planned Phased Adaptive Approach (PAA) to the European missile defense system in order to assess its technical capacity for engaging Russian ICBM warheads on various flight paths to the United States. The main aim is to ascertain whether there might be some genuine technical merit in recent expressions of Russian concern regarding the capability of the planned system against its strategic nuclear forces. While the focus is on Russian ICBMs, the study also includes an analysis of the capability of this system for engaging Chinese warheads.

According to the Congressional Research Service (CRS), the planned PAA calls for more than 500 SM-3 interceptors based on 43 ships and two land sites in Europe by 2018.[1] Increasing numbers of the more capable SM-3 "Block II" interceptors are envisioned in the later phases III and IV of the PAA. The Russians have expressed concern regarding the plan, as encapsulated in their resolution of ratification to the New Strategic Arms Reduction Treaty (New START). The U.S. (and NATO) response has been to state that the system does not pose a threat to the Russian strategic forces. Indeed, NATO has invited the Russians to participate in the program.

This study does not aim to judge the actual effectiveness of the PAA against Russian strategic forces. Previous technical studies have shown how simple decoys and other countermeasures can render midcourse missile defenses largely ineffective.[2] The focus here is on what would be the main concern of cautious Russian military planners —the capability of the missile defense interceptors to simply reach, or "engage," Russian strategic warheads—rather than whether any particular engagement results in an actual interception, or "kill." Interceptors with a kinematic capability to reach Russian ICBM warheads would be sufficient to raise concerns in Russian national security circles – regardless of the possibility that Russian decoys and other countermeasures might defeat the system in actual engagements. In short, even a missile defense system that

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[1] Ronald O'Rourke, CRS Report: "Navy Aegis Ballistic Missile Defense (BMD) Program: Background and Issues for Congress," Congressional Research Service (CRS) Report, April 19, 2011. http://www.fas.org/sgp/crs/weapons/RL33745.pdf

[2] For example, A. Sessler et al., "Countermeasures: A Technical Evaluation of the Operational Effectiveness of the Planned U.S. National Missile Defense System," Union of Concerned Scientists and the Security Studies Program at the Massachusetts Institute of Technology, (April 2000). http://www.ucsusa.org/assets/documents/nwgs/cm_all.pdf

could be rendered ineffective could still elicit serious concern from cautious Russian planners.

The last two phases of the PAA – when the higher burnout velocity "Block II" SM-3 interceptors come on-line in 2018 – could raise legitimate concerns for Russian military analysts. The higher speed SM-3 Block IIA and Block IIB interceptors could be used to create an integrated continental U.S. missile defense system that could engage Russian ICBM warheads, either in combination with, or independent of, the strategic Ground-Based Midcourse (GMD) system now deployed in Alaska and California. This fact introduces the possibility that Russian ICBMs could face many hundreds, or eventually thousands, of SM-3 interceptors in addition to the already deployed 30 or so GMD interceptors. Such large numbers of interceptors, which might in reality have little capability in combat, could be expected to create fears among Russian political and military leaders that the PAA could cause some attrition of Russian warheads. As the preamble to New START explicitly recognizes the interplay between strategic offense and defense, the potential of a substantially expanded U.S. continental ballistic missile defense system could be considered an infringement on the numerical parity that forms the basis of New START, and a threat to Russia's strategic deterrence forces.

I. Introduction

In September 2009, the Obama administration discarded its predecessor's European missile defense initiative that called for powerful ground-based interceptors (GBIs) in Poland with a large radar site in the Czech Republic. The GBIs are large silo-launched rockets, weighing more than 20 tons each, derived from the Pegasus, Taurus, and Minotaur space launch boosters. Some Russian critics characterized them as threatening because they could potentially be re-engineered to be offensive nuclear-tipped missiles.[3]

The Obama administration instead proposed the new European Phased Adaptive Approach (PAA), presented as a more flexible alternative based on the roughly ten times smaller SM-3 interceptors. These smaller and lighter interceptors would be incrementally tailored to the perceived threat over the coming decade. Current versions of the interceptors are designed to engage missiles with ranges up to a few thousand kilometers. Over this decade, the United States, working with NATO, would ramp up the deployment of a mix of sea- and land-based SM-3 interceptors, including a next generation of longer range interceptors around Europe in an attempt to guard against missiles launched from Iran.

The shelving of the original plan was initially greeted with much optimism as it was seen as the first step in "resetting" bilateral relations with Russia, which had suffered under the George W. Bush administration. It allowed the discussions of New START to get off the ground and cleared the way for greater cooperation on areas of common concern, such as addressing the possible military dimension of the Iranian nuclear program.

Over the last two years – as details and analysis of the PAA plan have emerged – Russian officials have voiced increasing concern about its scope and implications for Russia's strategic deterrent forces. Specifically, they fear the possibility that the missile defense system might undermine the smaller Russian strategic nuclear forces post-New

[3] Pavel Felgenhauer, Interview CFR Report: "Russians See U.S. Missile Defense in Poland Posing Nuclear Threat," Council on Foreign Relations, (March 18, 2009). http://www.cfr.org/missile-defense/russians-see-us-missile-defense-poland-posing-nuclear-threat/p18813

START.[4] These concerns have been expressed in Articles 2, 3, and 4 of the Russian resolution of ratification of New START [5] [emphasis added]:

New START shall be implemented subject to the following conditions:

"Article 2:

> (1) Maintaining the capacity of the Russian Federation's strategic nuclear forces at a level necessary to ensure the national security of the Russian Federation, including by the development, testing, production, and ***deployment of new types and new kinds of strategic offensive arms that will have advantages for overcoming missile defense***;

Article 3:

> (2)The Government of the Russian Federation: ... (g) shall, after the day of entry into force of the New START Treaty, annually inform the chambers of the Russian Federation Federal Assembly about the progress of implementation of the New START Treaty in regard to the following issues: ... ***deployment by other states of missile defense systems, their effect on the capacity of the Russian Federation's strategic nuclear forces;***

Article 4
[...]

> (3) The Russian Federation shall exercise the right provided by Article XIV of the New START Treaty to withdraw from it in case of extraordinary events that jeopardize its supreme interests. These events may include: [...] ***deployment by the United States of America, another state, or a group of states of a missile defense system capable of significantly reducing the effectiveness of the Russian Federation's strategic nuclear forces.***"

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[4] For example, Nikolai Sokov, Center for Nonproliferation Studies report, "New Start Ratification in Russia: Apparent Smooth Sailing Obscures Submerged Drama and Revelations," Center for Nonproliferation Studies, (January 2011).
http://cns.miis.edu/stories/110125_russia_new_start_ratification.htm,

[5] Official Russian text of the resolution of Ratification of New START: http://m.rg.ru/2011/02/01/snv-dok.html and English translation available at Arms Control Wonk, January 15, 2011.
http://lewis.armscontrolwonk.com/archive/3481/russian-new-start-resolution

In addition, a draft supplementary statement to the resolution of ratification states that "[t]he State Duma believes that maintaining Russia's nuclear deterrent in an adequate state of readiness is one of the main tasks of the country's military policy, with the focus on those strategic offensive systems that are most survivable and that have the highest potential to penetrate missile defenses."[6]

The United States and NATO have stated that the PAA is not directed at Russia and poses no threat to its nuclear deterrent forces. Though NATO has invited the Russians to join the program, there has been no consensus on the degree or the form of that participation. Moscow prefers to develop a joint European missile defense network with NATO to ensure that the elements of the PAA (in a number of European countries) will not threaten Russia's national security. NATO, in contrast, proposes the creation of two entirely separate systems that would exchange information. On January 24, 2011, President Dmitry Medvedev of the Russian Federation expressed his view on this impasse: "[e]ither we agree to certain principles with NATO, or we fail to agree, and then in the future we are forced to adopt an entire series of unpleasant decisions concerning the deployment of an offensive nuclear missile group..."[7]

Recent moves by elements of the U.S. government may further incite Russian fears. For example, some U.S. senators have endorsed the placement of a missile defense radar facility in the nation of Georgia, which fought a brief war with Russia in 2008, instead of in NATO-ally Turkey.[8] And the NATO Secretary General has mentioned Ukraine as another possible site for elements of the missile defense system.[9] Moreover, Poland is once again planned as the site of land-based missile defense interceptors, though the "Aegis ashore" SM-3 interceptors will launch kill vehicles with significantly smaller infrared target acquisition ranges to much lower velocities than the Bush-era GBIs.

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[6] Translated from Russian Duma document at http://ntc.duma.gov.ru/duma_na/asozd/asozd_text.php?nm=4765-5%20%C3%C4&dt=2011. Also mentioned in a news report with a slightly different translation, "Russian Missiles Must Penetrate Any Defenses – Parliament," *Ria Novosti*, January 22, 2011 at: http://en.rian.ru/mlitary_news/20110122/162246289.html

[7] "Russia demands role in NATO missile shield: otherwise will deploy nuclear weapons," *Nuclear News,* January 2011. http://nuclear-news.net/2011/01/25/russia-demands-role-in-nato-missile-shield-otherwise-will-deploy-nuclear-weapons/

[8] "Build Radar Station in Georgia, Senators Urge" *Global Security Newswire,* February 4, 2011. http://gsn.nti.org/gsn/nw_20110204_9039.php

[9] Interfax news report, "Rasmussen plans to discuss Ukraine's participation in NATO missile defense system," February 17, 2011. http://www.interfax.com.ua/eng/main/61371/

The Deveselu Air Force Base near Caracal in Romania is also slated as another Aegis ashore site. Several radars are also part of the PAA infrastructure and potential sites include Bulgaria, Turkey, the Czech Republic, Azerbaijan and Georgia, as well as Israel for a transportable AN/TPY-2 radar (originally designed for the Terminal High Altitude Area Defense, THAAD, anti-ballistic missile system).[10]

[10] "Russia Says U.S. May Extend Missile Shield to Bulgaria, Turkey," *Bloomberg News,* May 20, 2011. http://www.bloomberg.com/news/2011-05-20/russia-says-u-s-may-extend-missile-shield-to-bulgaria-turkey.html

II. Midcourse Missile Defense – General Considerations

Both the Ground-Based Interceptors (GBIs) in Alaska and California, and the Navy's SM-3 interceptors are "midcourse" missile defense systems, where the incoming warheads are intercepted in the near vacuum of space before re-entry through the atmosphere. Both types of interceptors are equipped with "hit-to-kill" warheads designed to acquire and home on target warheads or missile bodies using infrared sensors and destroy them by direct collision.

However, because the trajectories of lightweight decoys as well as heavy warheads are the same in the vacuum of space, it is straightforward for a missile to release dozens of simple, lightweight decoys that will be indistinguishable to infrared sensors on the interceptor or to radars on the ground. Making matters yet more problematic, it would be quite easy to inflate a balloon around the warhead, or hang material from the warhead, that would make it look different from its expected appearance to these sensors. Since the decoys and warheads would all look different from the expected appearance of the warhead, there would fundamentally be no way for the defense to identify warheads from decoys.[11] In sum, the simple scientific reason why the GBIs and SM-3s will never be able to reliably function in real combat conditions is because the infrared emissions and reflected radio waves from targets can be modified by an attacker to disguise, remove, deny, or simply overwhelm (e.g., via decoys and other countermeasures) critical information needed by the defense to find attacking warheads.[12]

The 2010 BMD Review (BMDR) document states that "[t]he United States, with the support of allies and partners, seeks to create an environment in which the acquisition, deployment, and use of ballistic missiles by regional adversaries can be deterred, by eliminating their confidence in the effectiveness of such attacks, and thereby devaluing their ballistic missile arsenals."[13] This statement assumes that countries seeking ballistic

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[11] More than a decade ago Robert D. Walpole, the CIA's National Intelligence Officer for Strategic and Nuclear Programs, attested that such countermeasures are relatively straightforward to obtain and implement, even for fledgling ballistic weapons states . See: https://www.cia.gov/news-information/speeches-testimony/2000/nio_speech_020900.html. See also, http://www.ucsusa.org/assets/documents/nwgs/cm_all.pdf

[12] George N. Lewis and Theodore A. Postol, "A Flawed and Dangerous U.S. Missile Defense Plan," *Arms Control Today*, May 2010. http://www.armscontrol.org/act/2010_05/Lewis-Postol

[13] Ballistic Missile Defense Review Report, U.S. Department of Defense, (February 2010). http://www.defense.gov/bmdr/docs/BMDR%20as%20of%2026JAN10%200630_for%20web.pdf

missile capabilities would be confronted by such robust U.S. defenses that they would relinquish ballistic missiles as instruments of their national purpose. Because simple decoys can defeat the planned U.S. defenses, this assumption is false.[14]

In addition, many countries desire ballistic missile technology for prestige or because of regional considerations. The United States may not be their only concern. Whether or not a U.S. missile defense system is operational, these nations will still try to acquire ballistic missile technology. In fact, the countries of most interest to the United States – Iran and North Korea – already have well-developed ballistic missile programs. The BMDR's claim of an already-functioning missile defense shield has not diminished their ballistic missile ambitions.[15]

Moreover, space-launch and ICBM technology are virtually identical, and U.S. missile defenses are unlikely to dissuade an adversary from pursuing a space-launch capability.

So midcourse missile defense is, and will be, an empirical failure at dissuading countries of concern to the United States from pursuing ballistic missile programs – or their equivalent space launch programs.

On the contrary, instead of dissuading countries from pursuing ballistic missiles, missile defense may well lead to more missiles and more nuclear weapons in the world. The BMDR report states, "Both Russia and China have repeatedly expressed concerns that U.S. missile defenses adversely affect their own strategic capabilities and interests." And the bipartisan Strategic Posture Commission points out that, "China may already be increasing the size of its ICBM force in response to its assessment of the U.S. missile defense program."[16]

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[14] Robert D. Walpole, CIA National Intelligence Officer for Strategic and Nuclear Programs, "The Ballistic Missile Threat to the United States," Statement for the Record to the Senate Subcommittee on International Security, Proliferation, and Federal Services, February 9, 2000. https://www.cia.gov/news-information/speeches-testimony/2000/nio_speech_020900.html. See also, http://www.ucsusa.org/assets/documents/nwgs/cm_all.pdf.

[15] Yousaf Butt, "The Myth of Missile Defense as a Deterrent," *Bulletin of Atomic Scientists,* May 8, 2010. http://www.thebulletin.org/web-edition/features/the-myth-of-missile-defense-deterrent

[16] William Perry (Chair) and James R. Schlesinger (Vice-chair), "America's Strategic Posture: The Final Report of the Congressional Commission on the Strategic Posture of the United States," United States Institute of Peace Press, 2009.
http://www.usip.org/files/America%27s_Strategic_Posture_Auth_Ed.pdf

While missile defenses would likely lead to increased worldwide missile stockpiles, such defenses could be defeated by any country capable of making missiles. The U.S. intelligence community has expressed concern about the ready availability of highly effective countermeasures that even developing world countries could use to defeat the PAA and GMD systems. Robert D. Walpole, the CIA's National Intelligence Officer for Strategic and Nuclear Programs, testified more than a decade ago that countries that have the technology and expertise to build long-range missiles would have the capability to add decoys and other countermeasures to those missiles.[17] It therefore makes no sense to assume an adversary would develop technologically complex missiles and intend to use them but not add simple countermeasures to make them effective.

Exaggerating the abilities of missile defense is dangerous. It suggests that political and military leaders have capabilities and options that they, in fact, do not have. For instance, the BMDR claims, "The United States now possesses a capacity to counter the projected threats from North Korea and Iran for the foreseeable future." And that "[t]he United States is currently protected against the threat of limited ICBM attack, as a result of investments made over the past decade in a system based on ground-based midcourse defense." There have been no tests of these systems under realistic conditions to substantiate either of these claims: the current systems cannot reliably intercept a single test warhead that is launched at a known time and on a known trajectory, even when there are no countermeasures or decoy warheads involved.

None of the various missile defense systems, sea- or land-based, have ever been tested in a realistic setting:[18] for instance, a surprise attack on a trajectory unknown to the intercept team and incorporating simple countermeasures or decoy warheads.[19] The Navy's sea-based Aegis system has not been tested in rough weather or against something as mundane as a tumbling missile with an attached warhead.

When the unclassified conclusions of a Defense Science Board study of the PAA were revealed during a hearing of the Senate Appropriations Defense Subcommittee, some

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[17] Walpole, op.cit.

[18] For example, Elliot Blair Smith and Gopal Ratnam, "$35B Missile Defense Misses Bullet With Bullet," *Bloomberg News*, August 3, 2011. http://www.bloomberg.com/news/2011-08-03/missile-defense-costing-35-billion-misses-bullets-with-bullets.html

[19] For a layman's account of why countermeasures will defeat any midcourse national missile defense system see, e.g., page 38 of "The European Missile Defense Folly," *Bulletin of the Atomic Scientists*, Vol. 64, No. 2, May/June 2008, pp. 32. http://www.thebulletin.org/files/064002009.pdf

U.S. officials expressed concern about decoys and countermeasures: "The report's unclassified conclusion [is] that [the Missile Defense Agency's] plans to achieve an early-intercept capability as part of the PAA is simply not credible," Senator Richard Shelby (R-Ala.) was quoted as saying.[20] This interest in an early-intercept capability – where the interceptor attempts to engage the missile in its post-boost, pre-apogee phase before the decoys and warhead are released – indicates that, at some level, the challenging task of differentiating decoys from the warhead during midcourse is understood and appreciated within the U.S. government. Nonetheless, the Defense Science Board study concludes that the MDA's claim that the PAA can deal with countermeasures in this way is "simply not credible."

For these reasons, the planned PAA midcourse missile defense system cannot devalue the nuclear deterrent forces of any nation, especially if simple countermeasures or decoys are used on their missiles.[21] There will be a significant probability that some nuclear warheads will get through, causing destruction to the United States.[22] Thus, U.S. cities, military installations, and political leadership could be held at risk, or deterred from action, whether or not the planned midcourse missile defenses were in play.

Missile defenses that show little promise of working well can, nevertheless, alter perceptions that the strategic balance between otherwise well-matched states is stable. Political leaders and military planners have natural concerns that some unforeseen future circumstance could lead to the neutralization of some of their nuclear warheads. Missile defense could also strengthen over-cautious, misinformed, opportunistic or hawkish elements within the Russian and Chinese political and military establishments. The interplay of the unknown future and pressure from internal constituencies to react to missile defenses can lead to an increase of deployed stockpiles and military expenditures. Advocates who argue for a response to the missile defenses could play up the uncertainties about future missile defense developments by pointing to the inflated claims made in documents like the BMDR and by senior U.S.

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[20] "Gates, Mullen Defend European Missile Defense," *Aviation Week*, June 16, 2011. http://www.aviationweek.com/aw/generic/story_channel.jsp?channel=defense&id=news/asd/2011/06/16/05.xml

[21] Yousaf Butt, "What Missile Defense?" *Foreign Policy*, October 21, 2009. http://www.foreignpolicy.com/articles/2009/10/21/what_missile_defense?page=full

[22] Pavel Podvig, "The False Promise of Missile Defense," *Bulletin of the Atomic Scientists*, September 14, 2009. http://www.thebulletin.org/web-edition/columnists/pavel-podvig/the-false-promise-of-missile-defense

government officials.[23] Over time, these internal constituencies may pressure or intimidate their political leaders into actions that would have adverse consequences to U.S. security, as well as for the security of their own states. A similar dynamic also exists in the United States,[24] where defense projects of dubious effectiveness, cost-effectiveness or need are often politically championed and eventually funded.

Thus, even when missile defenses can be shown to have little, if any technical capabilities, they can still cause adversaries and competitors to react as if they might work. The U.S. response to the Cold War era Soviet missile defense system was similarly overcautious [25].

Because of the vulnerability of hit-to-kill interceptors to countermeasures, some Russian or Chinese analysts may also fear that a future U.S. administration may resuscitate interest in nuclear-tipped interceptors.[26] Nuclear tipped interceptors could also be defeated by appropriately designed countermeasures. But many of the countermeasures that would be highly effective against hit-to-kill interceptors would be rendered ineffective because the nuclear explosion could destroy entire formations of closely spaced decoys and warheads. Uncertainties about the types of countermeasures that could be needed to deal with nuclear-armed interceptors relative to hit-to-kill interceptors could cause the Russians (and the Chinese) to modernize and expand the

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[23] For example, General James Cartwright, Vice Chairman of the Joint Chiefs of Staff, in U.S. Senate testimony claimed that the missile defense system in place in the United States was 90 percent effective: "I'd be very comfortable saying 90 percent." See: "Hearing to Receive Testimony on Ballistic Missile Defense Programs in Review of the Defense Authorization Request for Fiscal Year 2010 and the Future Years Defense Program," (June 16, 2009). http://armed-services.senate.gov/Transcripts/2009/06%20June/09-44%20-%206-16-09.pdf See also, Bradley Graham, "Test of Missile Defense System Delayed Again" where claims of "greater than 80 percent" effectiveness were made by the MDA. *Washington Post,* September 14, 2004. http://www.washingtonpost.com/wp-dyn/articles/A18975-2004Sep13.html

[24] For example, Thomas L. McNaugher, "New weapons, Old politics: America's Military Procurement Muddle" (Washington, DC: Brookings Institution Press, 1989). http://books.google.com/books/about/New_weapons_old_politics.html?id=MgFPwnOxIC0C. See also, Hans K. Klein, "System Development in the Federal Government: How Technology Influences Outcomes," *Policy Studies Journal*, Vol. 28, No. 2, 2000, p. 313-328. http://www.prism.gatech.edu/~hk28/Klein_System-Dev_Policy-Studies.pdf

[25] For example, Hans M. Kristensen, Matthew G. McKinzie and Robert S. Norris, "The Protection Paradox," *Bulletin of the Atomic Scientists*, March/April 2004, p. 68-79.

[26] News report, "Nuclear-Tipped Interceptors Studied," *Washington Post*, April 11, 2002. http://www.washingtonpost.com/ac2/wp-dyn?pagename=article&node=&contentId=A28866-2002Apr10

number of delivered warheads and diversify the types of countermeasures required to defeat both nuclear and hit-to-kill systems.

Furthermore, in order to reassure their public that the government is responding decisively to threats to their security, Russian and Chinese leaders might respond in a more clear or visible way than by only building countermeasures into their missiles. For instance, they may decide to increase their stockpiles or modernize their weaponry. The Russian public's perception of the PAA capability might thus play a significant role in shaping their government's response to the defense system.

The PAA might also sow doubt in the minds of military planners regarding the effectiveness of any putative small strikes that may exist in Russian or Chinese war plans. They may be forced to reevaluate and possibly upgrade their war plans even if their technical experts are confident of defeating the planned defenses. Russian officials could also be concerned that the most potent phase of the PAA is due to be activated just as New START expires in 2021.

It is important to note that the governments in Russia and China and many other states are not monolithic but, as in the United States, have lobbies for and against increased nuclear stockpiles. Though some political leaders and military analysts exaggerate the abilities of the PAA, this may be considered part of their job, or may play to various political and bureaucratic agendas in their countries. Internal constituencies at the Pentagon, in the Congress, and elsewhere within the U.S. government play a similar powerful role in creating pressures on U.S. political leaders. As in the United States, high-level decision-makers in Russia or China would not necessarily have to believe or share the concerns of these political constituencies, or military analysts to feel pressured to react to them. The fact that U.S. officials continue to spend billions of dollars per year and promulgate a technically flawed missile defense system makes it plausible that similar dynamics could be at work in other nations.

The central conundrum of midcourse missile defense, then, is this: while it creates incentives for U.S. adversaries and competitors to increase their missile stockpiles, it does not offer the combat capability needed to defend the United States or its allies from these weapons.

III. Details of the Phased Adaptive Approach

The U.S. government's BMD Review document provides the broad outlines of the PAA plan:[27]

In Phase 1 (2011 time frame), existing missile defense systems will be deployed to defend against short- and medium-range ballistic missiles. Phase 1 will focus on the protection of portions of southern Europe by utilizing sea-based Aegis missile defense-capable ships and interceptors (the SM-3 Block IA). This first phase will also include a forward-based radar, which, by providing data earlier in the engagement, will enhance the defense of Europe and augment homeland defense capabilities already in place in Alaska and California.

In Phase 2 (2015 time frame), a more advanced interceptor (the SM-3 Block IB) and additional sensors will enhance the capabilities. Phase 2 will include land-based SM-3s in southern Europe, in addition to the sea-based locations, expanding coverage to additional NATO allies.

In Phase 3 (2018 time frame), coverage against medium- and intermediate-range threats will be improved with a second land-based SM-3 site, located in northern Europe, as well as an upgraded Standard Missile 3 (the SM-3 Block IIA, which is already under development) at sea and land-based sites. These changes will extend coverage to all NATO allies in Europe.

In Phase 4 (2020 time frame), an additional capability against a potential ICBM launched from the Middle East to the United States will be available. This phase will take advantage of yet another upgrade to the Standard Missile 3, the Block IIB.

All four phases will include upgrades to the missile defense command and control system.

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[27] Ballistic Missile Defense Review, February 2010. http://www.defense.gov/bmdr/docs/BMDR%20as%20of%2026JAN10%200630_for%20web.pdf

More than 130 Block I SM-3s have been delivered to date, and are deployed with both the U.S. and Japanese navies.[28]

According to Russian Foreign Minister Sergey Lavrov, it is not these Block I interceptors that are the issue for Russia but rather the planned Block II interceptors in Phase III and beyond (see Section VI). During this timeframe, towards the end of the decade, the BMDR states that "more capable interceptors and sensors will become available. The SM-3 Block IIA will have a higher burnout velocity and a more advanced seeker. These features will make it much more capable than the SM-3 Block IA or IB and will provide greater regional coverage. A follow-on missile, the SM-3 Block IIB, is now in the process of being defined, and it is in the initial phase of technology assessment and development. It is expected to be even more capable than the IIA, with a higher burnout velocity and a kill vehicle that has a greater divert capability. The SM-3 Block IIB will have some early-intercept capability against long-range missiles. Matched against regional medium-range and intermediate-range ballistic missiles, the SM-3 IIB will, in theory, be able to defend a greater area than the SM-3 IIA." [See Figure 1]

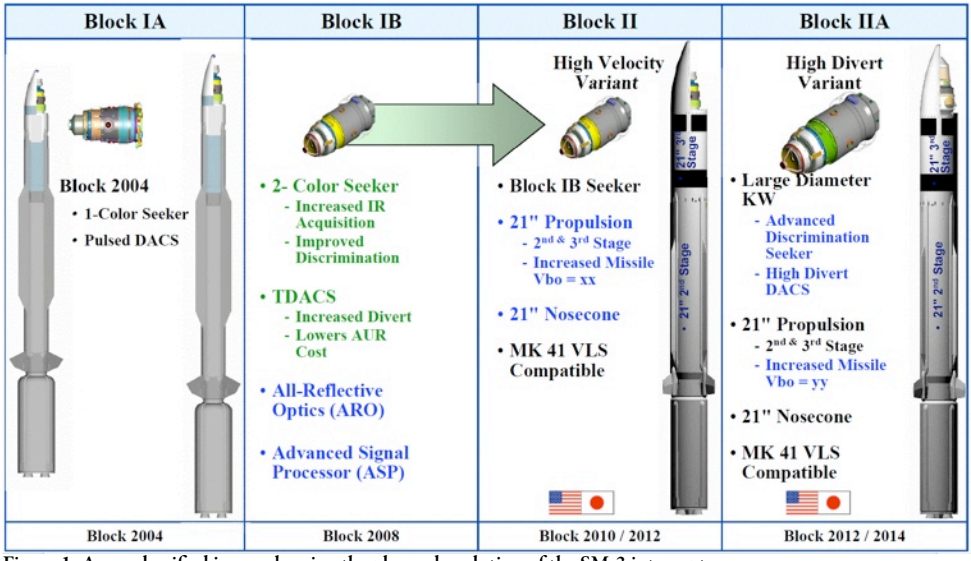

Figure 1: An unclassified image showing the planned evolution of the SM-3 interceptors.

[28] Press release issued by Raytheon on February 8, 2011, "Raytheon and Aerojet Complete System Integration Test for SM-3 Kinetic Warhead." http://www.defenseprocurementnews.com/2011/02/09/raytheon-and-aerojet-complete-system-integration-test-for-sm-3-kinetic-warhead-press-release/

As shown in the figure, the overall maximum diameter of all the interceptor versions remains unchanged at 21 inches, meaning that the Block II interceptors are designed to fit in the existing launch tubes on board the Navy's Aegis cruisers. (See the Appendix for further details including the sections of the Block I interceptors that are 13.5 inches in diameter). This means that the system would have a potent breakout capability to be upgraded to Block II interceptors with short notice, which would be a natural concern for Russian and Chinese military planners.

An "engage-on-remote" technology that includes launching on data from a remote sensor track, as well as the ability to uplink data from assets other than the Aegis radar was examined in the "FTM-15" test[29] against an Intermediate Range Ballistic Missile (IRBM) on April 15, 2011. The BMDR states that the engage-on-remote technology "allows the interceptor to engage the threat missile at greater ranges. A further long-term effort seeks to develop persistent overhead sensors to detect and track large raid sizes of ballistic missiles over their entire trajectories from space. This Precision Tracking and Space System (PTSS) is an important funding priority in the President's Budget for FY 2011 and the Future Years Defense Program."

Thus, during Phase III and beyond, the higher burnout velocity SM-3 Block II interceptors, and improved sensors and battle management systems, will enable the kill vehicle (KV) to "engage the threat missile at greater ranges," and the system will be able to "detect and track large raid sizes of ballistic missiles over their entire trajectories from space." Russian and Chinese military analysts reading such official statements are liable to be concerned by the terminology of "large raid sizes," given that the system was supposedly planned to protect against smaller Iranian raids.

Several Missile Defense Agency (MDA) documents and statements claim future capabilities that could alarm Russian and Chinese planners. For instance, a presentation from the PTSS Industry Day boasts: "Anticipate and develop technologies for BMDS to negate any missile, in any phase, at any range, in any region, at anytime."[30] Although this may be yet another case of exaggerated advertising and bluster, it cannot be ignored by foreign intelligence and military planners.

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[29] Although the test itself was classified a success, it was not realistic since no countermeasures were used and the intercept team knew the timing and trajectory of the incoming missile.

[30] Presentation by Dr. David Burns, "Hedging Against Future Uncertainty," U.S. Department of Defense, Missile Defense Agency, July 29, 2010. http://www.winmda.com/downloads/2010_Industry_Day/2_Burns.pdf

Although the final configuration of the PAA (i.e., the exact numbers and versions of the interceptors, the precise location of the radar and Aegis ashore land sites, and the placement of Aegis cruisers) has not been fully determined or announced, the latest Congressional Research Service (CRS) report on the Aegis BMD system provides some guidance.[31] The plan calls for 500 or more SM-3 interceptors based on 43 ships and two land sites in Europe by 2018. Increasing numbers of the more capable SM-3 Block II interceptors are envisioned in phases III and IV of the PAA, although their precise numbers are not yet available, at least not in the unclassified reports. Of the two "Aegis ashore" land sites, the one in Romania is planned to be activated by 2015 and the Polish site by 2018. These will initially host about 24 SM-3 interceptors each.

[31] O'Rourke, op.cit.

IV. Technical Study

Does the planned PAA missile defense system have the technical capability to reach or "engage" Russian ICBM warheads on a flight path to the United States? If so, the Russians could claim this as an infringement upon the balance of strategic arms that lies at the basis of New START.

The process of intercepting the incoming warheads can be considered as two main steps:

(1) **Kinematics**: The purely kinematic issue of whether the interceptor can reach the target cluster (consisting of the warhead and any decoys that may be present) in the time available given the sensors, interceptor speed, trajectory geometry, etc., and:
(2) **Kill Probability:** The issue of whether the interceptor can identify and actually hit the warhead, assuming that it has reached the position of the target cluster in time.

The first step in the two-stage process can be analyzed given knowledge of, or reasonable assumptions about, the basic parameters of the intercept. The second step is sensitive to precise details of both the offensive and defensive systems, in addition to the exact nature of the combat environment (e.g., engagement geometries, closing speeds, quality of tracking data used to commit the interceptors, kill vehicle acquisition, homing and divert capabilities, the presence of intended or inadvertent countermeasures, etc.). Determining the kill probabilities for the myriad circumstances that could occur during various types of engagements, even when there are no intentional countermeasures, is fundamentally not possible[32] and not something that Russian, Chinese or even U.S. planners would – or even could – base their analysis on. The critical issue of concern for Russian and Chinese analysts is whether the

[32] The extremely small number of highly scripted tests of the GMD and PAA that have been made, and are expected to be made in the future, provides no information about what level of performance can be expected in combat. For example, prior to the Gulf War of 1991, the Patriot missile defense was reported by its contractor, the Raytheon Corporation, to have been successful in 17 out of 17 similarly scripted missile defense tests. The substantial body of evidence from videos of Patriot engagements against Iraqi Al-Husayn missiles during the Gulf War of 1991 indicates that the Patriot system's performance was consistent with 0 interceptions in 44 attempts during actual combat. See, Sullivan, J. D. et al., "Technical Debate over Patriot Performance in the Gulf War," *Science and Global Security*, Volume 8. pp. 41-98, (1999). http://www.princeton.edu/sgs/publications/sgs/pdf/8_1sullivan.pdf

interceptors of the planned PAA system could engage their ICBM warheads, i.e., whether the first step of the two-stage process was achievable.[33]

Could the elements of the PAA be geographically reconfigured to increase the ability to engage Russian or Chinese warheads launched at the United States? Even the most cursory Russian or Chinese assessment of the proposed PAA would consider the potential geographical reconfiguration of a mobile ship-based system. Indeed, General James Cartwright has explicitly mentioned this possible reconfiguration – or global surge capability – as an attribute of the planned system: "part of what's in the budget is to get us a sufficient number of ships to allow us to have a global deployment of this capability on a constant basis, with a surge capacity to any one theater at a time."[34]

As shown below, Phases III and IV of the PAA – in which the higher burnout velocity Block II variants of the SM-3 interceptors come on-line – would be the main concern for Russia and China.

The SM-3 is designed to intercept ballistic missiles above the atmosphere, in the "midcourse" phase of its flight. It is equipped with a "hit-to-kill" vehicle, called a kinetic kill vehicle, which is designed to destroy a ballistic missile's warhead by colliding with it. The first-generation Block IA and IB versions of the SM-3 have a 21-inch-diameter booster stage at the bottom but are 13.5 inches in diameter along the remainder of their lengths [Figure 1]. By contrast, the second-generation Block IIA version would have a 21-inch diameter along its entire length. The increase to a uniform 21-inch diameter provides more room for rocket fuel, permitting the Block IIA version to have a burnout velocity that is 45 to 60 percent greater than that of the Block IA and IB versions.

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[33] Though previous detailed technical studies have shown how simple decoys and other countermeasures (e.g., A. Sessler et al., *Countermeasures: A Technical Evaluation of the Operational Effectiveness of the Planned U.S. National Missile Defense System*, April 2000, http://www.ucsusa.org/assets/documents/nwgs/cm_all.pdf) can render midcourse missile defenses largely ineffective in step (2), cautious Russian military planners would base their conclusions about the potential capabilities of the PAA system by assessing whether the interceptors could simply reach, or "engage,", Russian target clusters. Russian military planners would have little choice but to assume at least the possibility of a "worst-case" scenario. Thus, if interceptors can simply reach the target cluster, regardless of whether such an engagement results in an actual interception, the potential for a worst- case outcome would have to be considered as at least one of many possible outcomes.

[34] O'Rourke, op. cit.

This higher burnout speed makes it possible for the SM-3 Block II interceptors to engage targets at much greater ranges from interceptor launch sites relative to the Block I variants of the SM-3. The SM-3 Block I versions have a reported[35] burnout velocity of 3.0 to 3.5 km/sec and thus the burnout speed of the Block II interceptors could reach ~5.5 km/sec. To be conservative, the Block II burnout velocities are considered up to only 5 km/sec. Because the overall maximum diameter of both Block I and Block II interceptors is 21 inches, second-generation versions can use the same launch tubes that were built on Aegis cruisers for the first-generation versions.

(a)Limited Ability of Block I interceptors

The limited ability of the Block I interceptors against incoming Russian ICBM warheads is a consequence of their lower burnout velocity of about 3.3 km/sec. According to simulations, the Block I interceptors can reach altitudes of 600 to 700 km where they could, in some circumstances, engage a Russian warhead post-apogee. Block I interceptors do not have enough velocity to reach these altitudes at significant lateral ranges from the warhead trajectory. Thus, the Aegis cruisers with Block I interceptors would have to be fortuitously located beneath a given Russian ICBM warhead flight path in order to be kinematically capable of intercepting that warhead.

In addition, the kill vehicle associated with the Block I interceptors has a small sensor aperture, which means that the range at which it can acquire targets is relatively short. At the high closing speeds associated with hitting an ICBM warhead, interception would be challenging unless a (new) larger aperture kill vehicle is used. Such a larger aperture kill vehicle is on the drawing boards but will require the more powerful SM-3 Block IIA rocket booster as it will weigh considerably more than the current kill vehicle.

(b)Ability of Block II SM-3 interceptors against ICBMs

Due to their higher burnout velocity, the Block II interceptors can more easily reach altitudes to engage Russian or Chinese ICBM warheads on flight paths to the United States. Furthermore, they have sufficient velocity and divert potential to engage ICBMs at significant lateral ranges from the trajectory. The specific cases below show graphically how the Block II interceptors could be a legitimate concern to the Russians and Chinese if the Aegis cruisers are moved from the Mediterranean to the northwestern Atlantic and northeastern Pacific. For instance, the following figure

[35] *Ibid*

(Figure 2) appears in an unclassified MDA presentation, "Aegis Ballistic Missile Defense System – Status, Integration and Interoperability."[36]

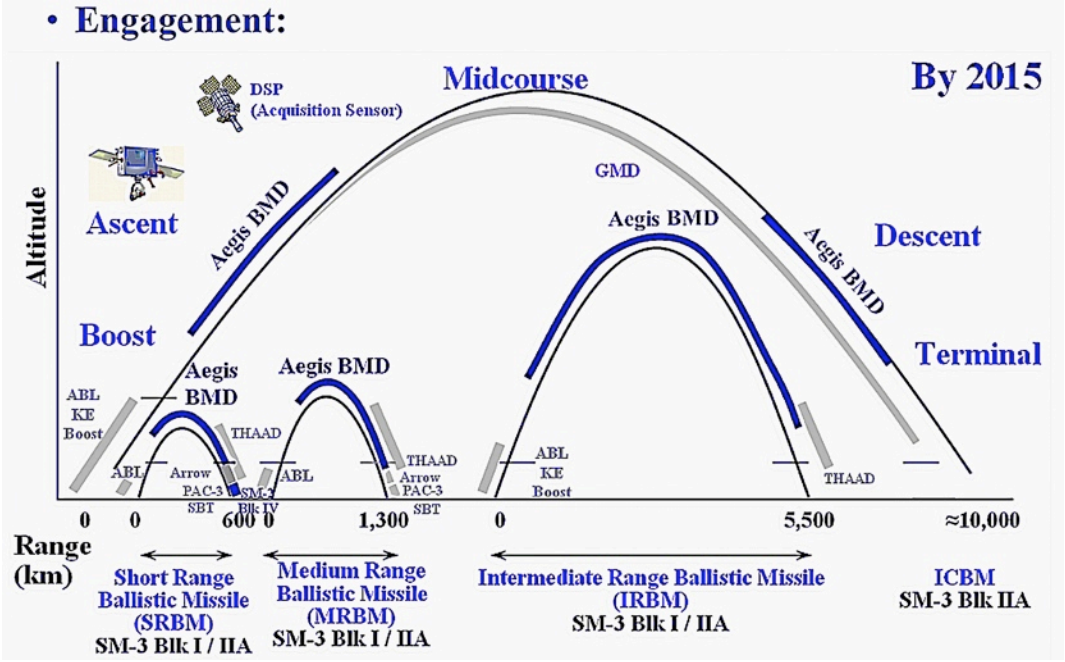

Figure 2: MDA Figure showing the post-apogee midcourse intercept ability of SM-3. The bold blue lines show the regions where Aegis BMD has a capacity for engaging ICBM warheads.

Clearly, according to the claims of the MDA, the Block II interceptors will have a post-apogee intercept capability, as depicted in the right side of the missile trajectory associated with the SM-3 Block II (descent phase of midcourse) in Figure 2 above. This means that Aegis cruisers that are placed in the northwestern Atlantic and the northeast Pacific will be able to engage Russian and Chinese ICBM warheads, even at

[36] MDA presentation, "Aegis Ballistic Missile Defense System – Status, Integration and Interoperability," National Defense Industrial Association, (May 2008). http://www.ndia.org/Resources/OnlineProceedings/Documents/8100/AegisBMDStatusIntergrationandInteroperability.pdf

considerable lateral ranges from the warhead flight path (due to the higher burnout velocity and divert capabilities of the Block II interceptors).

Furthermore, as it would take the SM-3 Block II interceptors – even assuming a burnout speed of only 4 km/sec – about 9 minutes to reach an altitude for intercepting the ICBMs, there will be plenty of time to cue the interceptor. For example, the most demanding case for the SM-3s to attempt intercepts is the one in which an ICBM is launched from the northwest corner of Russia (i.e., the Vypolzovo site with a battalion of SS-25 ballistic missiles) towards Washington, DC, New York City, or Boston. The SS-25s are solid propellant ballistic missiles, which burn for about 180 seconds (3 minutes). Such a missile could be tracked by the Fylingdales radar in the United Kingdom just as its powered flight ends. Since it would then be about 14 minutes before the intercept attempt, the interceptor would have to be launched after about 5 minutes of tracking by the Fylingsdale radar (it takes the interceptor about 9 minutes to reach the proper altitude for the intercept). These 5 minutes of tracking would be more than adequate to determine the region, or "basket", into which the interceptor must be placed for the kill vehicle's homing to have a chance to work. Other launch locations in Russia would be less challenging for SM-3 Block II interceptors due to the lower combined tracking and cueing requirements.

Of course, if the SM-3 Block II interceptors achieve a burnout velocity of ~5.5 km/sec, then they will have an even greater ability to engage Russian (and Chinese) warheads, and will require even less time to be cued. The higher burnout speed will further relax the positioning requirements on the Aegis cruisers as they will be able to engage Russian and Chinese warheads at even greater lateral ranges from the ICBM trajectory, and at higher altitudes.

Because the SM-3s (especially in Phase III and beyond) will be able to engage ICBM warheads post-apogee there may be considerable pressure to place the Aegis cruisers in the northwestern Atlantic: this will allow a second shot at any putative Iranian ICBM warheads that may have survived intercept attempts closer to Europe. Such a placement would also permit the interceptors to engage Russian warheads, inciting objections from Russia.

(c) Scenarios

Simulations of several launch scenarios were carried out in order to examine the areas that the PAA could theoretically defend against Russian and Chinese ICBMs. To be conservative, a burnout speed of 4 km/sec was assumed for the SM-3 Block II

interceptors. If the Block II interceptors are faster at burnout (as they are expected to be), then they will be able to engage warheads at greater ranges from ship launch platforms and at higher altitudes. Burnout speeds of 4.5 and 5.0 km/sec were also examined to see how much more potent the faster interceptors would be. Although the primary interest was in examining the potential of the PAA for engaging Russian ICBM warheads, Chinese ICBM trajectories were also included in the analysis. Analyses of the following trajectories was carried out:

1. A representative central Chinese ICBM field to Washington, DC, Chicago, and Los Angeles.
2. Vypolzovo ICBM field in Russia to Washington, DC, Chicago, and Los Angeles.
3. Tatischevo ICBM field in Russia to Washington, DC, Chicago, and Los Angeles.

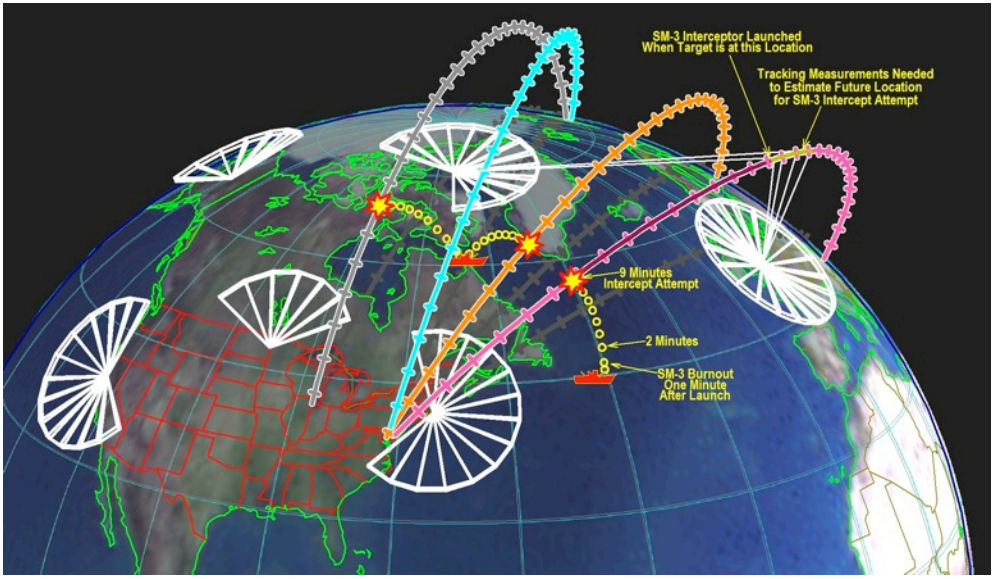

Figure 3: Northwest Atlantic-based SM3 Block II interceptors (with a conservative assumed burnout speed of 4 km/sec) engaging Russian ICBM warheads: each tick on the trajectories marks one minute.

Figure 3 above shows how an SM-3 Block II interceptor (with a conservative assumed burnout speed of just 4 km/sec) can engage Russian warheads, if launched from ships in the northwestern Atlantic. Each tick mark on the trajectories shown indicates one minute of time. It takes about one minute of powered flight for the SM-3 interceptor to achieve a burnout speed of about 4 km/s. The figure illustrates the location of the SM-3

burnout point. After this point, it takes about eight additional minutes for the SM-3 interceptor to coast to the location where the intercept will be attempted.

Figure 4 shows some representative Chinese ICBM trajectories (light blue). The analysis in this figure is for assumed 4.5 km/sec Block II interceptors, although an additional 4 km/sec simulation is included for the east coast Aegis ship off of Florida to show that slower interceptors could also reach ICBM warheads heading deep into the U.S. mainland.

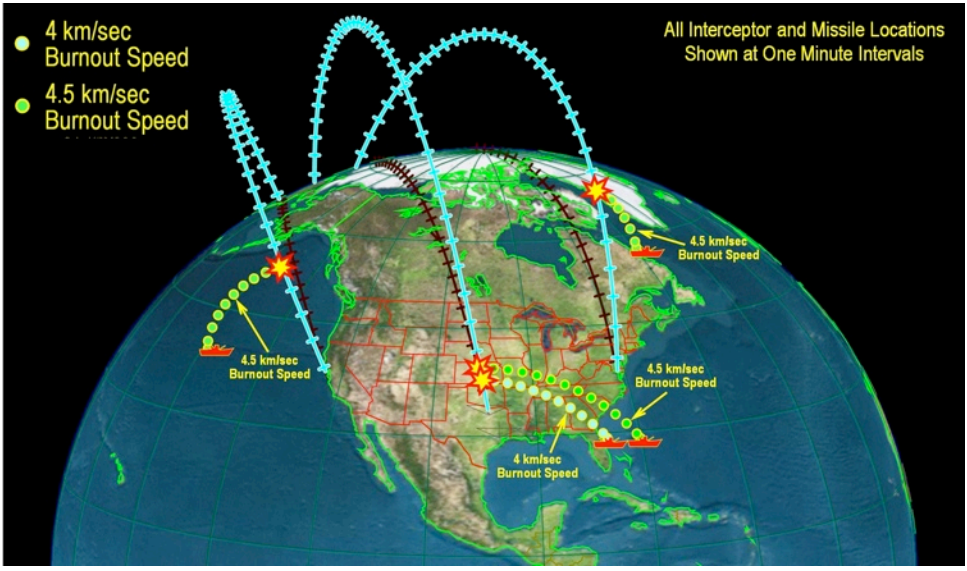

Figure 4: Atlantic- and Pacific-based SM-3 Block II interceptors (of assumed 4.5 km/sec burnout speed) engaging Chinese (light blue) ICBM warheads. Each tick on the trajectories marks one minute. An additional 4 km/sec simulation for the Aegis ship off of Florida is also included to show that slower interceptors would have a considerable reach deep into the U.S. mainland to attempt an intercept.

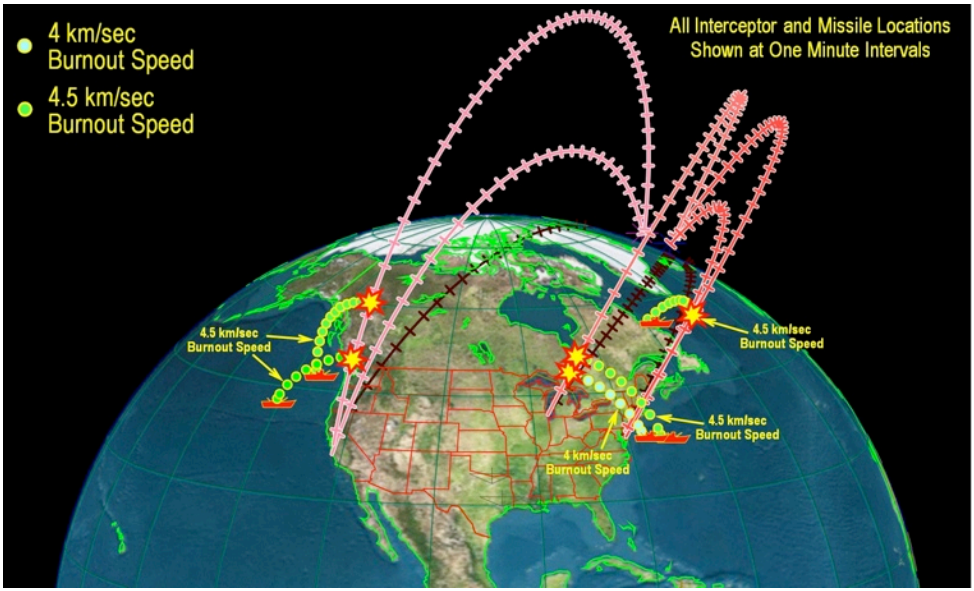

Figure 5: Atlantic- and Pacific-based SM-3 Block II interceptors (of assumed 4.5 km/sec burnout speed) engaging Russian ICBM warheads. Each tick on the trajectories marks one minute. An additional 4 km/sec simulation for the Aegis ship off of Virginia is included to show that these slower interceptors would have a considerable reach deep into the U.S. mainland to attempt an intercept. Lofted trajectories are also shown for some Russian flight paths to show that lofting does not provide an advantage against interceptors of greater than 4 km/sec burnout speed.

Figure 5 illustrates a similar analysis for Russian ICBM flight paths. Again, the analysis assumes 4.5 km/sec Block II interceptors, although an additional 4 km/sec simulation is also included for the east coast Aegis ship off of Virginia to demonstrate that slower interceptors could also engage Russian ICBM warheads heading to the Midwest.

Figure 6 illustrates the greater reach and increased standoff distances that are possible with a potential 5 km/sec interceptor, for the case of incoming Chinese warheads.

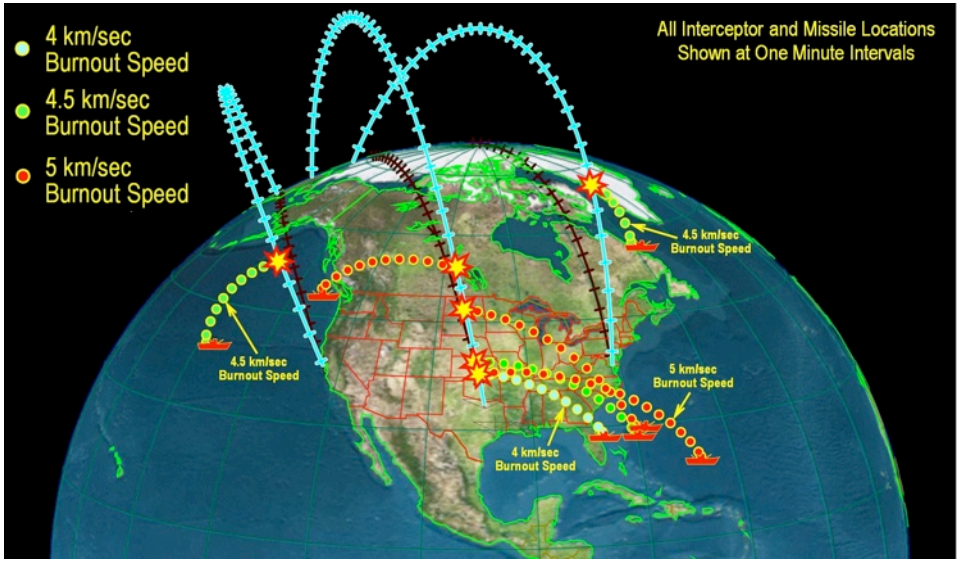

Figure 6: Same as Figure 4 but three additional interceptor engagements are shown (red dots) to illustrate the greater reach of an SM-3 Block II interceptor with an assumed 5 km/sec burnout speed.

For ballistic missile trajectories of shorter range (from the northwest of Russia to the northeast of the United States), it is possible to loft the trajectories so that they could be out of reach of SM-3 interceptors for a large part of their flight. But warheads on such lofted trajectories could still be engaged as they fall to lower altitudes towards targets. Such lofting is therefore ineffective against 4 km/sec interceptors, as long as the interceptors have the range to reach targets they are defending at sufficiently high altitudes where they can home against the warheads. The situation is even more favorable to the defense for Block II interceptors with higher burnout speeds of 4.5 to 5 km/sec as they are kinematically capable of attempting intercepts against Russian and Chinese warheads at even longer ranges and higher altitudes. Hence, lofting trajectories as a countermeasure against the postulated PAA defense holds little benefit for Russian and Chinese attackers. In Figure 7 the other trajectories shown in Figure 5 were removed to focus on a single lofted trajectory from Russia: it shows why lofting is not an effective way to circumvent engagement by SM-3 Block II interceptors.

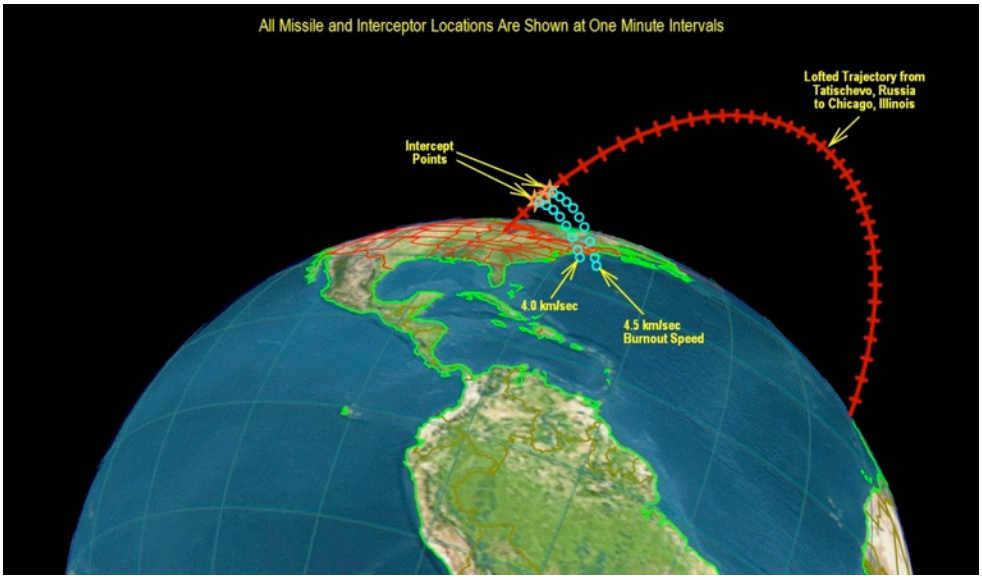

Figure 7: Northwest Atlantic-based SM-3 Block II interceptors (of assumed 4 km/sec and 4.5 km/sec) engaging lofted Russian ICBM warheads launched from Tatischevo, Russia to Chicago: each tick on the trajectories marks one minute. Lofting is an ineffective way of avoiding engagements when interceptors with a burnout speed of greater than 4 km/sec are present.

If warheads are launched on lofted trajectories in an attempt to limit the possible early intercept capabilities of the SM-3 Block II interceptors, these warheads will be easier to engage with GMD interceptors deployed in Alaska and California. Warheads on lofted trajectories take considerably longer times to reach their targets relative to warheads on minimum energy trajectories (minimum energy trajectories might take 26 to 28 minutes from launch to impact while lofted trajectories might take 40 minutes or more from launch to impact). This capability of the GMD system is illustrated in Figure 8 (a) and (b) – the two figures show different views of the same engagements.

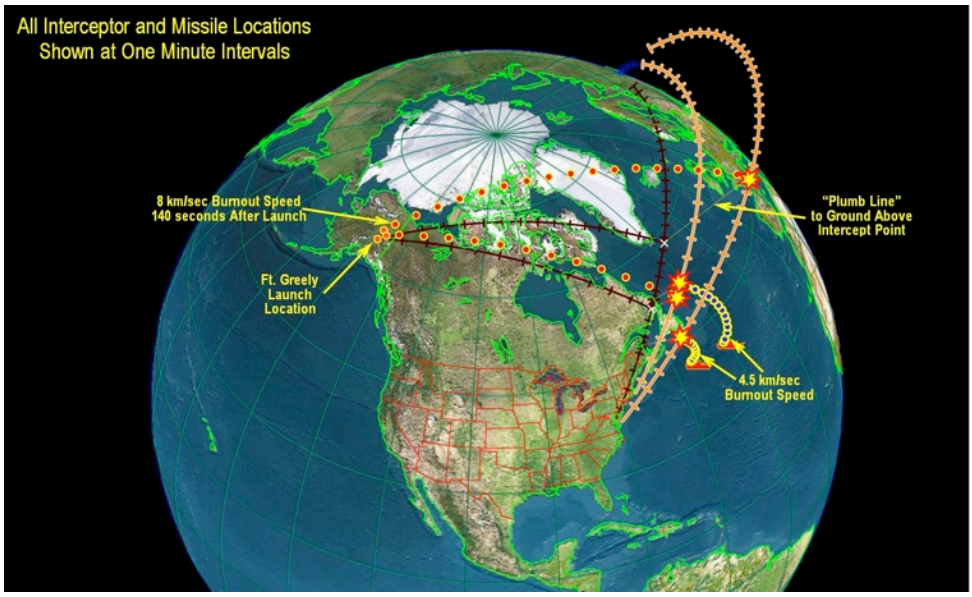

Figure 8a.

Figure 8: The two panels (a) above and (b) below show different views of the same engagements: if warheads are launched on lofted trajectories from Russia in an attempt to limit the possible early intercept capabilities of the sea-based SM-3 interceptors, then these warheads will be easier to engage with GMD interceptors deployed in Alaska and California. Notice that the GMD interceptors can engage the lofted Russian warheads much further (in projected distance along the ground) from the continental U.S. as compared to the unlofted trajectories.

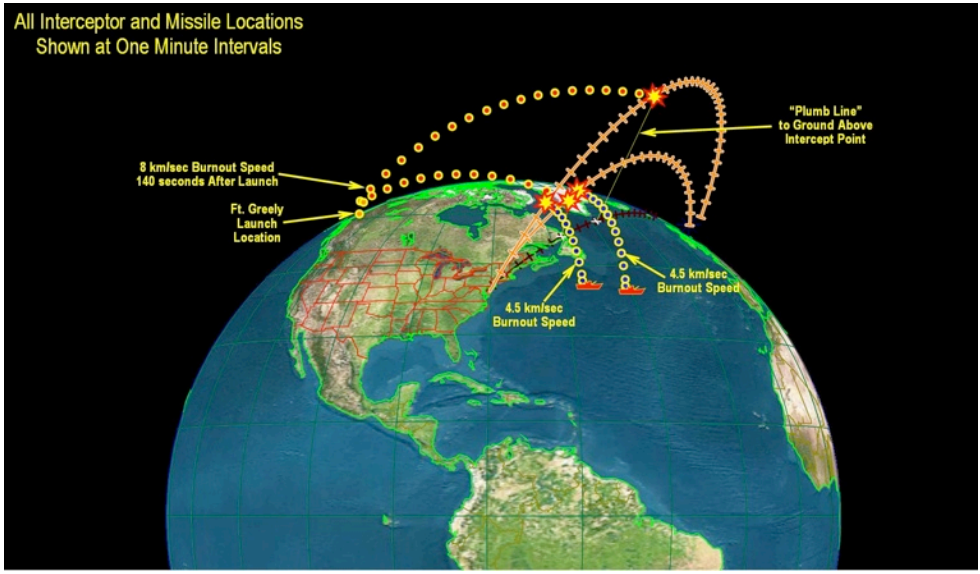

Figure 8b.

The long time-of-flight associated with lofted trajectories makes it possible for GMD interceptors on the west coast of the United States to reach and engage warheads launched towards the east coast of the United States.

V. Results

The major findings are as follows:

1. Assuming a minimum intercept altitude of approximately 250 km, SM-3 Block II interceptors with a 4.5 km/s burnout speed could engage incoming warheads at a range of about 2400 km to 2500 km. The assumption of a 250-kilometer minimum intercept altitude is quite conservative, as the actual minimum intercept altitude could be closer to 100 kilometers. The range at which engagements can occur is large enough such that interceptors launched from Aegis ships stationed off the east and west coasts of the United States could attempt a defense of any target in the continental United States.

2. A slower interceptor with a burnout speed of about 4 km/s could attempt intercepts at an altitude of about 250 km and a range of about 2100 km. The kinematic capabilities of such an interceptor would make it possible to achieve a "last-ditch" engagement of warheads bound for any locations within the continental United States. Such engagements could only be achieved if shiplaunching platforms are operated very close (less than 100 km) from land on the east and west coasts.

3. A faster interceptor, with a burnout speed of about 5 km/s could engage incoming warheads at an altitude of 250 km and a range of 3300 km. (The same interceptor would have the capability of intercepting targets at altitudes of over 800 km but at a reduced range of 2100 km to 2300 kilometers.) Such a capability would make it possible, in principle, for ships to attempt a defense of the entire continental United States while operating at many hundreds of kilometers off the coasts of the United States.

4. If warheads are launched on lofted trajectories to limit the early intercept capabilities of the SM-3 Block II interceptors, the warheads will then be easier to engage with GMD interceptors deployed in Alaska and California. Warheads on lofted trajectories take considerably longer times to reach their targets relative to warheads on minimum energy trajectories. The long flight time associated with lofted trajectories makes it possible for GMD interceptors on the west coast of the United States to reach and engage warheads launched towards the east coast of the United States.

In all cases above, the theoretical defensive capability would be degraded if the incoming ICBMs carry countermeasures or decoy warheads.

VI. Russian and Chinese Concerns with the Phased Adaptive Approach

A Russian news report sums up the Russian concerns: "[Russian foreign minister] Lavrov said Russia's agreement to discuss cooperation on missile defense in the NATO-Russia Council does not mean that Moscow agrees to the NATO projects which are being developed without Russia's participation. The minister said the **fulfillment of the third and fourth phases of the U.S. 'adaptive approach'** will enter a strategic level threatening the efficiency of Russia's nuclear containment forces."[37] [boldface added]

The analysis presented in Sections IV and V vindicate this view: whether or not the planned PAA system is *intended* against Russia, the salient point is that it will have some inherent *capability* against Russia's strategic forces, especially in Phases III and IV.

Some of the implications of this capability were discussed in general terms in Section II; below additional aspects are analyzed in light of the technical analysis presented in Sections IV and V.

While it is true that the Russians could defeat the SM-3 interceptors by using decoys and other countermeasures, it is also true that their military planners would have little choice but to entertain the possibility, however remote, of a "worst-case" scenario in which U.S. missile defense interceptors could be more effective than expected, or Russian countermeasures less effective. In other words, the potential threat to Russian nuclear deterrent forces from the U.S. missile defense system will likely be judged by the ability of the interceptors to reach and engage Russian warheads – not by whether or not every such engagement results in a kill (see Section IV).

To better understand this contrast between intentions and capabilities in strategic analysis one need look no further than the interactive process of sizing U.S. and Russian deployed strategic nuclear forces. Russian and U.S. strategic nuclear forces are not directed at each other post-Cold War and there should be little reason for Russian concern over the size of the American strategic arsenal, or vice-versa. While this may be true in principle, it is also true – as encapsulated in New START – that the United States and Russia do, as a pragmatic matter, spend an inordinate amount of time and effort carefully calibrating the size of their strategic nuclear forces to each other's. For each side, the bottom line is not intentions, but capabilities. Any system that could raise uncertainties about the strict balance in strategic nuclear forces agreed upon in a

[37] "Lavrov says missile defense projects should not 'upset parity,'" *RIA Novosti*, February 2011. http://en.rian.ru/russia/20110205/162465891.html

treaty is a natural concern to both parties, even if this violation of equilibrium does not affect deterrence. The preamble to New START explicitly recognizes this interplay between strategic offense and defense.

The concern over U.S. missile defense plans is not limited to Russia. According to cables released by WikiLeaks, Assistant Foreign Minister He Yafei implied that China could consider upgrading or increasing its nuclear stockpile in response to U.S. missile defense plans. "China is not saying missile defense is 'good or bad,' only that it will affect the strategic balance... Because missile defense undercuts China's limited deterrence capabilities, this, rather than the size of the U.S. nuclear arsenal, would 'force China to rethink its nuclear strategy,'" he stated. [38] Although this comment was made in reference to the Bush-era missile defense plan, one may assume that the sentiment also applies to the more muscular and flexible PAA of the Obama administration. A proposed Aegis BMD naval base on the South Korean island of Jeju has generated fierce opposition from local residents and has reportedly further stressed U.S.-China relations.[39]

Professor Li Bin, a Chinese arms control expert, explains that China is also concerned about "nuclear coercion." The psychological-political effect of the U.S. preserving the option of the first use of nuclear weapons means that, to Chinese eyes, the U.S. could indulge in nuclear coercion, over Taiwan and or the South China Sea.[40] Li Bin argues that China's strategic nuclear arsenal is meant to be anti-coercion. Though Chinese leaders may know they can defeat U.S. missile defenses, they may still worry that U.S. leaders will think the defenses are effective at negating Chinese forces, which may encourage Washington to be more coercive. China may, therefore, want to do something more visible than including countermeasures and decoys on its missiles – e.g., increasing the size of its nuclear arsenal – to make it clear to American leaders that they cannot negate China's deterrent, nor indulge in nuclear coercion. Indeed, the bipartisan Strategic Posture Commission has pointed out that "China may already be

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[38] Wikileak cable: "U.S.-China Security Dialogue Working Lunch: Strategic Security, Missile Defense, Space, Nonpro, Iran," June 13, 2008. http://cablesearch.org/cable/view.php?id=08BEIJING2322&hl=asat

[39] Christine Ahn, "Unwanted Missiles for a Korean Island," *New York Times*, August 6, 2011. http://www.nytimes.com/2011/08/06/opinion/06iht-edahn06.html

[40] Lora Saalman, "China and the U.S. Nuclear Posture Review," The Carnegie Papers, Carnegie Endowment for International Peace, (February 2011). http://www.carnegieendowment.org/files/china_posture_review.pdf

increasing the size of its ICBM force in response to its assessment of the U.S. missile defense program."[41]

In addition to concerns of deterrence or coercion, Russia may be preoccupied with the balance of strategic nuclear arms – referred to as "parity" – as agreed to in New START. A numerical example may be helpful in understanding these Russian objections. While the Russians could render NATO midcourse missile defenses ineffective, military analysts might assume a generous value for the defense's future effectiveness: perhaps a 20 percent chance of success per engagement. Some analysts could even assume a worst-case scenario of 100 percent. Given that there are to be ~500 interceptors,[42] a system of 20 percent effectiveness could "neutralize" 100 Russian ICBM warheads (post-2018, in Phase III and beyond). Since Russia would then be able to deliver 1450 warheads to the United States, while the United States could deliver 1550 warheads against Russia, this could be interpreted by Russia as a violation of the strict parity called for in New START.

An even more cautious approach, where the Russian military analysts would assume a 100 percent effective missile defense system, would imply 1550-500=1050 "effective" Russian weapons vs. 1550 U.S. ones, a natural cause for concern.

From the point of view of Russian analysts, and the political leaders they advise, SM-3 Block II interceptors might impose some level of attrition on Russian warheads that could be interpreted as an unacceptable infringement on the balance of arms agreed to in New START. Since this interplay between strategic offense and defense is recognized explicitly in the preamble to New START, it could be seen as legitimizing Russian concerns in a legal sense. In fact, Russian President Medvedev threatened to terminate New START over this perceived violation of parity when he said, in May 2011: "If missile defense systems are to be developed -- which would mean the disruption of strategic parity -- the treaty could be suspended or even terminated."[43]

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[41] Perry and Schlesinger, op. cit.

[42] The planned numbers of the Block II interceptors are not public yet, but by Phase III and IV many of the interceptors would likely be of the Block II variety. Russian and Chinese military analysts will likely assume a "worst-case" scenario where all the interceptors are assumed to be of the Block II design. We use this as the working assumption here.

[43] "Russia threatens nuclear build-up over U.S. missile shield," *CNN*, May 18, 2011. http://www.cnn.com/2011/WORLD/europe/05/18/russia.nuclear.missiles

China's concern over missile defense could be perceived as more serious since China is thought to possess only about 50 nuclear ballistic missiles capable of reaching the United States. The 500 SM-3 interceptors could then theoretically neutralize *all* these missiles if the missile defense system was assumed by Chinese analysts to be 10 percent (or more) effective.

Section II examined how such technical concerns and internal constituencies in Russia and China could mold political decision-making.

VII. Alternate Ballistic Missile Defense Architectures

Midcourse missile defenses are susceptible to countermeasures and decoys and therefore can be expected to be ineffective.[44] If a political decision is, nevertheless, made to move forward with future phases of the PAA, adjustments could be made to perhaps lessen Russian and Chinese concerns.

(a) Geographical Restrictions on Aegis ships

For example, restricting the placement of Aegis cruisers such that they are not in the northwest Atlantic or northeast Pacific is one way of assuring the Russians that the United States would not have the ability to use the PAA to engage Russian ICBMs post-apogee. Section V showed effective engagement ranges for various assumed burnout speeds of Block II interceptors. They ranged from ~2000-3300 km, depending on the burnout speed. This would require that the U.S. Navy keep its Aegis cruisers at least 3300 km away from both U.S. coasts during their regular patrol (and a similar distance south of a line connecting the southern coasts of Greenland and Iceland).

Since the PAA is mobile, however, the breakout time would be short. The United States could order its ballistic missile capable Aegis cruisers to operate along its Pacific and Atlantic coasts to undo any such arrangement. This rapid breakout capability would not be acceptable to the Russians and Chinese. Furthermore, the United States in announcing the PAA mentioned having a global surge capability,[45] so it is difficult to see how Russia or China – or the U.S. Navy – could accept any agreement based on geographical restrictions of the Aegis cruisers.

(b) Abandon Block II SM-3 upgrades

If NATO decides to pursue PAA, a possibility to reduce Russian and Chinese concerns is to abandon fielding the Block II variants of the SM-3 interceptors. As outlined in Sections III and IV, the higher burnout speed of the SM-3 Block II interceptors makes them more threatening compared to the Block I versions – in terms of their capability to engage Russian warheads on flight paths to the United States. Of course, both the Block I and II remain susceptible to countermeasures in practice. Abandoning the planned upgrade from Block I to Block II would go a long way towards reassuring

[44] Walpole, op.cit.

[45] O'Rourke, op.cit.

Russia and China that the PAA will not be used as a means of neutralizing their nuclear weapons and will not violate the parity written into New START.

Russian officials object most strenuously to Phases III and IV of the PAA, when the higher burnout speed SM-3 Block II weapons are due to come on-line. Russian General Staff operations head Lt. Gen. Andrei Tretiak has stated that Russian "analysis has shown that the initial phases of the U.S. system do not pose a threat to Russian strategic nuclear weapons....[t]his will change by the third and fourth phases."[46]

Abandoning the fielding of Block II interceptors will not impact the deterrence calculus between the United States and a (possible future) nuclear-armed Iran since both Block I and Block II interceptors have the same Achilles's Heel: they are equally susceptible to decoys and countermeasures. A (possible future) nuclear-armed Iran could be a threat to the Unites States whether it has no missile defenses, has just Block I interceptors, or even has Block II interceptors. Midcourse missile defense would not alter the fundamental *deterrence* equation (with respect to Iran – or Russia) but it may, in the Russian view, constitute an infringement of New START –especially the Block II interceptors due to their theoretical capability to engage Russian warheads.

Missile defense may also encourage a (possible future) nuclear-armed Iran to increase its stockpile of nuclear warheads and the number of conventionally armed ballistic missiles that could appear to carry nuclear weapons, to overwhelm U.S. missile defenses in a nuclear attack.

Lastly, there may be considerable cost savings in not further developing or testing Block II interceptors.

(c) Boost-phase Drone-based BMD system

A boost-phase drone-based BMD system would have little ability against Russian and Chinese long-range strategic missiles and may be more acceptable to them. This architecture was discussed in a recent article for the *Bulletin of the Atomic Scientists*.[47] This system would not be as expensive as the PAA and would be less susceptible to

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[46] "European Missile Shield Targets Russia, General Claims," Global Security Newswire, May 20, 2011. http://gsn.nti.org/gsn/nw_20110520_2687.php

[47] George Lewis and Theodore Postol, "How U.S. strategic antimissile defense could be made to work," *Bulletin of the Atomic Scientists*, Vol. 66 No. 6, November/December 2010, pp: 8-24. http://bos.sagepub.com/content/66/6/8.full

midcourse missile defense system countermeasures.[48] Although the capabilities of the SM-3 Block IA/B are limited, these interceptors could be used to engage shorter-range ballistic missiles, which cannot be reliably intercepted by the proposed boost-phase system. A peer-reviewed, technical, military, legal and geopolitical analysis of drone-based missile defense performed by a qualified team of objective scientists should be done to determine if this concept better supports the stated U.S. security objectives relative to the planned PAA.

48 George Lewis and Theodore Postol, "The European missile defense folly," *Bulletin of the Atomic Scientists*, Vol. 64: No. 2, May/June 2008, pp 32-39. http://www.thebulletin.org/files/064002009.pdf

VIII. Final Comments

While it would not devalue the deterrent value of (possible future) Iranian nuclear warheads on missiles incorporating simple countermeasures,[49] the planned PAA may create problems regarding the strategic balance with Russia and China. Earlier this year, Russian President Medvedev hinted of increasing the Russian stockpile in response to NATO missile defense plans,[50] and in May 2011, he threatened that, "[i]f missile defense systems are to be developed -- which would mean the disruption of strategic parity -- the treaty could be suspended or even terminated," referring to New START.[51] A further Russian concern over the planned NATO missile defense system might be the timing: New START is due to expire in 2021, just as the most potent phase of the PAA is due to be activated.

According to U.S. policy, the "ideal" missile defense system – if it could be realized – would not threaten the capabilities of Russian or Chinese strategic nuclear forces, but would be capable against Iranian and North Korean long-range missiles. The PAA does not achieve these goals: it alters the nuclear weapons' parity with Russia (at least, as viewed by Russia) while providing no credible defense from future Iranian or North Korean missiles incorporating simple countermeasures.

As noted previously, the planned PAA missile defense system will pressure national security circles within Russia and China to attempt to compensate for the perceived challenge to their nuclear strategic forces – for further details please see Sections II and VI. High-level political decision-makers would not have to embrace or share the concerns raised in internal debates to feel compelled to react to them. This conclusion is reinforced by the bipartisan Strategic Posture Commission which stated, "China may

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[49] Butt, *Foreign Policy*, op.cit.

[50] Quote from President Medvedev: "[e]ither we agree to certain principles with NATO, or we fail to agree, and then in the future we are forced to adopt an entire series of unpleasant decisions concerning the deployment of an offensive nuclear missile group..." from "Russia demands role in NATO missile shield: otherwise will deploy nuclear weapons," *Nuclear-News,* January 25, 2011. http://nuclear-news.net/2011/01/25/russia-demands-role-in-nato-missile-shield-otherwise-will-deploy-nuclear-weapons/

[51] "Russia threatens nuclear build-up over U.S. missile shield," *CNN,* May 18, 2011. http://www.cnn.com/2011/WORLD/europe/05/18/russia.nuclear.missiles/

already be increasing the size of its ICBM force in response to its assessment of the U.S. missile defense program."[52]

The central conundrum of midcourse missile defense remains that while it creates incentives for adversaries and competitors of the United States to increase or modernize their missile stockpiles, it offers no credible defense against this weaponry.

The planned Block II interceptors in the latter phases of the PAA threaten to provoke Russia's exit from New START, in addition to possibly restarting a nuclear arms race – while providing no credible defense against possible future Iranian or North Korean missiles hosting simple countermeasures. Russia and China might increase their arsenals, end future arms reductions talks with the United States, and decrease their assistance with worldwide counter-proliferation efforts. Such a result would diminish U.S. – and global – security and would be at odds with President Obama's vision of a nuclear-weapons-free world.

[52] Perry and Schlesinger, op.cit.

APPENDIX: The Evolution of SM-3 Interceptors

The CRS report, "Navy Aegis Ballistic Missile Defense (BMD) Program: Background and Issues for Congress" (April 2011), provides details on the different types of SM-3 interceptors:[53]

"The SM-3 is designed to intercept ballistic missiles above the atmosphere, in the midcourse phase of an enemy ballistic missile's flight. It is equipped with a "hit-to-kill" warhead, called a kinetic warhead, which is designed to destroy a ballistic missile's warhead by colliding with it.

MDA and Navy plans call for fielding increasingly capable versions of the SM-3 in coming years.

The version currently in use, the SM-3 Block IA, is to be followed by the SM-3 Block IB, then the SM-3 Block IIA and (for land-based use) the SM-3 Block IIB.

Compared to the Block IA version, the Block IB version has an improved (two-color) target seeker, an advanced signal processor, and an improved divert/attitude control system for adjusting its course.

In contrast to the Block IA and 1B interceptors, which have a 21-inch-diameter booster stage with a 13.5-inch diameter along the remainder of their lengths, the Block IIA interceptor would have a 21-inch diameter along its entire length. The increase to a uniform 21-inches diameter provides more room for rocket fuel, permitting the Block IIA version to have a burnout velocity (a maximum velocity, reached at the time the propulsion stack burns out) that is 45 percent to 60 percent greater than that of the Block IA and IB versions, as well as a larger-diameter kinetic warhead. The United States and Japan have cooperated in developing certain technologies for the Block IIA version, with Japan funding a significant share of the effort. The Block IIB version would include a lighter kill vehicle, flexible propulsion, and upgraded fire control software."

[53] O'Rourke, op. cit.

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