Proliferation Papers

Cruise Missiles and NATO Missile Defense

Under the Radar?

In collaboration with the Atomic Energy Commission (CEA)

Dennis M. Gormley

Spring 2012

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Thérèse Delpech (1948 – 2012)

Thérèse Delpech passed away on January 18, 2012. As Director of Strategic Affairs of the French Atomic Energy Commission (CEA), Thérèse was instrumental in promoting and supporting several research programs on proliferation in France and abroad. But for her and her continuous support along the years, the *Proliferation Papers* would not exist. Ifri's Security Studies team is as sad as we are indebted to her, and would like to dedicate the 2012 issues of the *Proliferation Papers* to her memory.

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Though it has long been a concern for security experts, proliferation has truly become an important political issue with the last decade, marked simultaneously by the nuclearization of South Asia, the weakening of international regimes and the discovery of frauds and traffics, the number and gravity of which have surprised observers and analysts alike (Iraq in 1991, Libya until 2004, North Korean and Iranian programs or the A. Q. Khan networks today).

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About the Author

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Besides writing three books, Gormley has contributed extensively to edited books and newspapers, while his journal articles have appeared in *Survival*, the *Washington Quarterly*, *Arms Control Today*, the *Bulletin of the Atomic Scientists*, *Nonproliferation Review*, *Orbis*, and many others. The author thanks Etienne de Durand and Corentin Brustlein at Ifri, as well as the anonymous reviewers, for their helpful suggestions and comments on earlier drafts of this paper. Finally, the author would like to acknowledge his gratitude to the late Thérèse Delpech for her incisive insights and support of this and past work related to this paper's topic.

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Introduction

"There is a tendency in our planning to confuse the unfamiliar with the improbable. The contingency we have not considered seriously looks strange; what looks strange is thought improbable; what is improbable need not be considered seriously."[1]

Meeting in Lisbon, Portugal, in November 2010, North Atlantic Treaty Organization (NATO) leaders adopted a new Strategic Concept that commits the alliance to provide protection of Alliance territory and populations against ballistic missiles. This new initiative complements and extends NATO's existing plan to protect deployed forces against tactical ballistic missile threats.[2] To implement the guidelines of the new Strategic Concept, which emphasized NATO's need "to be effective in a changing world, against new threats," the heads of state and government called for a full review of NATO's defense and deterrence posture to be ready for the spring 2012 NATO summit in the United States.[3]

Surely, we can expect NATO's posture review to emphasize the importance of defending against the increasing threat of long-range ballistic missiles, which indeed has become evident in the case of Iran's ballistic missile developments. Yet, ballistic missiles are not the only form of missile contingency in which rogue states might threaten NATO's population centers. Although U.S. missile defenses performed admirably against Iraq's ballistic missile threat in 2003, Iraq's use of cruise missiles demonstrated the woefully inadequate state of America's cruise missile defenses. In the aftermath of the 2003 war's formal fighting, land-attack cruise missiles have begun to spread widely in the Middle East, South Asia, and Northeast Asia.[4] More often than not, acquiring states stipulate that the appeal of these low-flying missiles is that they are difficult to defend against. Indeed, the combination of ballistic and cruise missiles in threatening arsenals could severely complicate missile defenses that are expected to defend against both types of missiles. This is true for both land-based *Patriots* and

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[1] Thomas Schelling, Foreword to Roberta Wohlstetter, *Pearl Harbor: Warning and Decision*, Stanford, Stanford University Press, 1962, p. 7.

[2] This program is known as the Active Layered Theater Ballistic Missile Defense (ALTBMD) program. See http://www.tmd.nato.int/ for details.

[3] See "Strategic Concept for the Defence and Security of The Members of the North Atlantic Treaty Organization", availaible at: http://www.nato.int/strategic-concept/index.html.

[4] Dennis M. Gormley, *Missile Contagion: Cruise Missile Proliferation and the Threat to International Security*, Westport, Praeger Security International, 2008. The Naval Institute Press published a paperback reprint edition in 2010.

sea-based *Standard Missile* (SM)-variants, as well as various European and Russian air defense systems, all of which purport to defend against low-flying cruise missiles but truly cannot do so effectively without improvements in a supporting overhead sensing network. Unless missile defenses function more effectively to address ballistic, cruise, and UAV threats alike – a concept formally called "integrated air and missile defense" – NATO planners will fall prey to "confusing the unfamiliar with the improbable" by neglecting a combination of missile threats that is hardly as improbable as it once was.

The purpose of this paper is to demonstrate that the threat of cruise missile proliferation is as equally challenging to NATO as the threat of ballistic missiles.[5] Inattention to defending against cruise missiles will leave NATO effectively with a half of a territorial missile defense system. The paper first explores the slow emergence of the cruise missile and UAV threat over the last two decades, and how governments, particularly the United States, reacted to these developments. To be sure, ballistic and cruise missile defense investments have been decidedly uneven, especially in the United States. Obviously, the simple reason for this disparity is that ballistic missile proliferation clearly matured more quickly as a threat than have land-attack cruise missiles. What's more, there are important political, organizational, and bureaucratic reasons why the United States has focused so heavily on ballistic missile defense to the neglect of defending against cruise missiles. The paper next briefly recapitulates the chief reasons behind the sudden appearance, beginning in 2004, of several new land-attack cruise missile programs,[6] and then examines in greater detail the extent to which more recent cruise missile developments, together with demonstrably dramatic global interest in armed and unarmed drones or UAVs, have worsened the existing threat and show promise of only continuing to do so. The paper then turns its attention to whether or not any of these emerging threats could plausibly endanger NATO population centers and forces. Finally, the paper closes with an examination of a range of options that could be implemented to address NATO's myopic view of missile defense.

[5] By no means are single-use cruise missiles the only non-ballistic missile threat facing NATO. The global spread of both unarmed and armed UAVs only further complicates the missile defense challenge. On the negative impact UAVs may have on military operations, see Major Darin L. Gaub, "The Children of Aphrodite: The Proliferation and Threat of Unmanned Aerial Vehicles in the Twenty-First Century", Fort Leavenworth, School of Advanced Military Studies, U.S. Army Command and General Staff College, 2011.

[6] These were documented more fully in Gormley, *Missile Contagion, op. cit*.

The Cruise Missile Threat's Reluctant Emergence

Measured by the sheer number of cruise missile defense studies – totaling ten – conducted by the Pentagon's Defense Science Board (DSB), the Government Accountability Office, and other non-governmental organizations from 1990 to 2008, coupled with the scant progress made to develop and deploy truly integrated cruise missile defenses, one might safely conclude that perceptions about this threat's emergence greatly exceeded realities.[7] With the exception of the most recent ones, common to virtually all of these studies was an admission that while the cruise missile threat had yet to emerge, it was nonetheless destined to do so, and most likely in a surprising manner. By contrast with the ease of detecting the telltale infrared launch signature of a ballistic missile, land-attack cruise missiles offered virtually no possibility of launch detection during testing[8] while their comparatively small size and the ease of intermingling their development with manned aircraft programs rendered precise threat assessment problematical. That the proverbial dog seemed disinclined to bark furnished convenient cover for service officials to remain fixed on service-unique solutions rather than bowing to a truly integrated, joint-service approach to cruise missile defense.[9]

The best that might have been expected during the 1990s was for the administration and Congress to agree upon a hedging strategy against the cruise missile threat's sudden emergence. Indeed, the Congress did manage to fashion a "Cruise Missile Defense Initiative" in the *National*

[7] These include the *Air Defense Initiative* (Defense Advanced Research Projects Agency, 1990); *Deployable Air Defense* (MIT/Pentagon, 1993); *Cruise Missile Defense Study* (Defense Science Board, 1995); *Land-Attack Cruise Missile Defense* (Defense Science Board,1996); *National Cruise Missile Defense Study* (Department of Defense, 1998); *Cruise Missile Defense: Progress Made but Significant Challenges Remain* (General Accounting Office, 1999); *National Cruise Missile Defense* (Department of Defense, 2011); *Summer Study* (Defense Science Board, 2004); *The Cruise Missile Challenge* (Marshall Institute, 2007); *Evaluating the Novel Threats to the Homeland*, RAND 2008.

[8] Launched from an aircraft, a cruise missile does not need a small booster rocket, as do ground- or ship-launched cruise missiles. In any case, the infrared signature of any cruise missile launch will provide signatures too faint for confident launch detection by space-based or even most airborne sensors, particularly when there is cloud cover or rain.

[9] For insight into this longstanding problem, see *Cruise Missile Defense: Progress Made but Significant Challenges Remain*, Washington, US General Accounting Office, March 1999.

Defense Authorization Act of Fiscal Year 1996, whose authorizing language was not matched by an appropriations bill with the level of funding needed to hedge against the threat's sudden emergence.[10] A new organization, called the Joint Theater Air and Missile Defense Organization, was launched within the Joint Staff, but by the end of the decade the new organization was seen by the services as a threat to their own prerogatives or a waste of Joint Staff resources altogether.[11] Most importantly, this new organization possessed not the least bit of clout to direct the individual military services to cast aside their modest service-centric approaches to cruise missile defense into an integrated, joint-service approach.

Preoccupation with the Ballistic Missile Threat and Defense

The seeming disinterest in cruise missile defense during the 1990s was by no means the case with respect to ballistic missile defense. Despite the end of the Cold War and Ronald Reagan's Strategic Defense Initiative (SDI) with the election of Bill Clinton, soon into the newly elected administration Republicans sought to resurrect ballistic missile defense to center stage. The Clinton administration had refocused the program away from SDI's national protection and global ambitions toward theater defense cast in a more regional approach. Yet, by the 1994 mid-term elections, Republicans offered the American public a renewed commitment to national missile defense with their "Contract with America", which consisted of several political promises. After capturing control of both the House and Senate in the mid-term elections, the Republicans saw the chance to resurrect national missile defense by challenging the intelligence community's *National Intelligence Estimate* (NIE) of 1995 on the ballistic missile threat to the United States. Simply put, they argued that the NIE was politicized to fit the wishes of the Clinton administration's refocusing away from national missile. This set the stage for two bipartisan panels, one to examine the NIE itself, and when that failed to satisfy, yet another to conduct an entirely independent assessment of the threat.

Led by Robert Gates, former CIA director and future Secretary of Defense, and delivered in December 1996, the first panel concluded that, based on the intelligence evidence they reviewed, if there was any serious shortcoming in the report it was that a more powerful case should have been made for its conclusions. They also found no evidence of politicization. Remarkably, the panel also found that the intelligence community had not devoted nearly enough attention to the cruise missile threat emanating from an offshore vessel.[12]

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[10] A suitable hedging strategy might have involved funding research and development work forward to the engineering and manufacturing development stage, the last point before a full procurement decision could be taken.

[11] Daniel G. Dupont, "Joint Theater Organization May Be Terminated", *Inside Missile Defense*, Vol. 6, No. 17, August 23, 2000, pp. 3-4.

[12] "Independent Panel Review of 'Emerging Missile Threats to North America During the Next 15 Years'", 1996, available at: http://www.fas.org/irp/threat/missile/oca961908.htm.

The second bipartisan panel, chaired by Donald Rumsfeld, then a former and later to become future Secretary of Defense, delivered the kind of report that would fundamentally affect future prospects for global ballistic missile defenses as well as the U.S. abrogation of the 1972 Anti-Ballistic Missile Treaty.[13] Whether or not the Rumsfeld report would have achieved such a galvanizing effect without the fortuitous event that followed its release in July 1998 is doubtful; nonetheless, the report's conclusions, however debatable, furnished diehard supporters of missile defenses the ammunition they needed.

Central to the Rumsfeld Commission's finding was the declaration that North Korea and Iran, based on possessing a *Scud*-based missile infrastructure, could develop a viable intercontinental ballistic missile within about five years of deciding to do so, and moreover, could do so with "little or no warning before operational deployment."[14] While the report's dire findings sparked an intense debate immediately after its release, no matter the unanimous findings of its bipartisan commission membership, North Korea provided just what the report's findings required to solidify its ominous portents: on August 31, six weeks after the report's release, Pyongyang launched for the first time a three-stage *Taepo Dong*-1 missile. Intending to place a very small satellite in space, the test failed to accomplish its goal, yet it handed missile defense's supporters precisely the dramatic event they needed to vindicate the commission's findings.

By March of the following year, by a vote of 97 to 3, the U.S. Senate passed a Republican-initiated bill, the *National Missile Defense Act*, which declared that the policy of the United States is "to deploy as soon as is technologically possible an effective National Missile Defense system capable of defending the territory of the United States against limited *ballistic* missile attack" (emphasis added). The House bill passed the following day by 317 to 105. Although President Clinton judged that the technology had yet to mature enough to support moving forward with deployment before leaving office in 2001, the stage was set for the Bush administration to move aggressively forward by abandoning the ABM treaty in December 2001 and a year later by announcing a firm deployment date just before the presidential election of 2004 – all without benefit of demonstrating the system's true effectiveness.[15] Although the missile defense debate – albeit focused exclusively on the ballistic missile threat – would not disappear entirely, the sum effect of these developments was to

[13] For an insightful essay that argues along these lines, see Greg Thielmann, "The National Missile Defense Act of 1999", *Arms Control Today*, Vol. 39, No. 6, July/August 2009, availaible at: http://www.armscontrol.org/act/2009_07-08/lookingback.

[14] Executive Summary of the Report of the Commission to Assess the Ballistic Missile Threat to the United States, July 15, 1998, availaible at: http://www.fas.org/irp/threat/bm-threat.htm.

[15] America's engagement in the fight against global terror after September 11, 2001 provided convenient cover for the President's ABM Treaty withdrawal. But the true implications of 9/11's import for missile defense was and remains highly debatable. For my own view, see Dennis M. Gormley, "Enriching Expectations: 11 September's Lessons for Missile Defence", *Survival*, Vol. 44, No. 2, Summer 2002, pp. 19-35.

foster the notion of strong congressional support for ballistic missile defense, even among strong doubters about the systems overall utility. The consensus on ballistic missile defense remains as robust today.[16]

A Belated Attempt to Deal with Cruise Missiles

With congressional support for ballistic missile defense having become more theological than practical, it is not surprising that hedging against the inevitable emergence of the cruise missile threat merited virtually no attention whatsoever.[17] Still, a year after the September 11 terrorist attacks, a front-page story in the *Washington Post* reported that Secretary of Defense Rumsfeld had sent a classified memo to the White House warning about the spread of cruise missiles and the need for a government-wide effort to defend against them.[18] Rumsfeld's warning grew out of threat anticipation rather than any specific threat warning from the intelligence community; simply put, Rumsfeld believed that the threat was imminent because all of the underlying technologies needed for land-attack cruise missiles were commercially available. And not only were states expected to acquire cruise missiles; non-state actors like al Qaeda were seen to have the capacity to develop crude but effective "poor man's" cruise missiles, capable of delivering biological or chemical weapons.

The *Washington Post* story also included a brief synopsis of shortcomings in dealing with cruise missile defense, including lack of a single-integrated air picture, air fratricide difficulties, and little linkage between airborne radar platforms and ground-based interceptors like *Patriot*. Perhaps the most salient observation made in the *Washington Post's* account came from the head of the U.S. Army's Space and Missile Defense Command, Lt. Gen. Joseph Cosumano, quoting him about his complaint "about the absence of a single Pentagon agency to coordinate

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[16] The Obama administration may have jettisoned the Bush plan for a third interceptor site in Europe, involving ground-based interceptors in Poland, and cut missile defense funding by roughly $1B, yet it has by no means abandoned strong support for ballistic missile defenses by focusing instead on the more proven SM-3 interceptor. While a broad consensus still exists between Democrats and Republicans, the most avid supporters of missile defense would be willing to deploy space-based interceptors without concern for either Russia's or China's reactions. For one illustration of such a staunch position, see the Heritage Foundation's film, "33 Minutes: Protecting American in the New Missile Age", available at: http://33-minutes.com/33-minutes/.

[17] The notion of missile defense as more theological than practical is attributed to former Sen. Sam Nunn, according to Philip Coyle, who directed missile defense test and evaluation at the Pentagon during the Clinton administration. See Ben Preston, "Missile Defense Success Questioned", *Santa Barbara Independent,* December 21, 2008, available at: http://www.independent.com/news/2008/dec/21/missile-defense-success-questioned/.

[18] Bradley Graham, "Rumsfeld: Cruise Missile Threat Rises", *Washington Post*, August 18, 2002, p. A1. This wasn't the first time Rumsfeld had voiced concern about cruise missiles. Although his 1998 commission was limited to investigate the ballistic missile threat to the United States, the report acknowledged concern about the cruise missile threat. I was invited to brief the commission on the subject. For details on the reaction to my presentation, see Gormley, *Missile Contagion*, *op. cit.*, pp. 91-96.

development of cruise missile defenses the way the Missile Defense Agency (MDA) oversees work on anti-ballistic missile systems." In essence, Cosumano's call would strip each military service of their independent authority, under Title 10 of the U.S. Code, to train, man, and equip their forces, including cruise missile defenses. MDA possessed this kind of budgetary control over each service's ballistic missile defense programs, and it was made even stronger when, in January 2002, Rumsfeld wrested control over the establishment of a program's operational requirements from the services and elevated it to the MDA. The underlying logic for these difficult decisions hinged on the fundamentally integrated nature of the ballistic missile defense mission – the very same logic that underlies cruise missile defense.

Few U.S. Secretaries of Defense are willing to challenge such fundamental service prerogatives. In Rumsfeld's case, in spite of the urgency he saw regarding the poor state of cruise missile defense, he left service prerogatives in place. Seven months later, Iraq surprised U.S. forces in Iraq by employing converted anti-ship cruise missiles and land-attack systems, causing three air-fratricide incidents and loss of three lives.

The Cruise Missile Threat Suddenly Emerges

As many had foresaw in the early 1990s, the accelerated emergence of several new land-attack cruise missile programs within a year after the formal end to major combat operations in Iraq surprised most analysts. Between 2004 and the end of 2007, an extraordinary number of new programs were either tested for the first time or nations announced their intention to pursue new cruise missile programs.

In the Middle East, Israel was once the sole country possessing land-attack cruise missile, but Iran is now pursuing both land-attack and anti-ship cruise missiles, including the conversion of Chinese HY-2 anti-ship missiles into land-attack system and the introduction of the new 350km-range cruise missile called *Raad*, thought by some to perform both anti-ship and land-attack missions.[19] Iran also surreptitiously acquired via arms dealers in Ukraine 12 Russian Kh-55 nuclear-capable, long-range (2500-3000km) cruise missiles in 2001. Curiously, China, a country which has provided Iran with anti-ship cruise missiles, some of which reportedly have been converted into land-attack missiles, also participated in this "acquisition" a year later when it too received six Kh-55s. Such a small number of units suggests their acquisition was primarily for examination and possible reverse engineering. Iran also provided Hezbollah with UAVs and more sophisticated anti-ship cruise missiles. Both were employed in the 2006 war in Lebanon, with the latter causing severe damage to an Israeli vessel, while killing four sailors.

In South Asia, India and Pakistan both are deploying new land-attack cruise missiles for delivery of nuclear and conventional payloads. India, with Russian collaboration, is developing the 290km-range *BrahMos* supersonic cruise missile. It comes with both anti-ship and land-attack versions, and India has plans to fire *BrahMos* from army ground launchers, from navy ships and submarines, and air force aircraft. India also announced that at least two other land-attack cruise missiles were being developed, including the *Nirbhay*, a subsonic missile with a range of 1,000km and another shorter-range system co-developed with Israel. The biggest surprise occurred in August 2005 when Pakistan successfully launched its first land-attack cruise missile, called *Babur*, purportedly a nuclear-capable ground-launched missile with a range of 700km. Two years later, it tested a second land-attack cruise missile, the air-launched *Raad*, with a range of 350km. Pakistan claims that these are indigenously

[19] For more details related to the following brief summaries, see *Ibid.,* pp. 47-82.

produced, but it appears evident that at least China has helped in a substantial way.

In Northeast Asia, China has recently unveiled two new land-attack cruise missiles. In 2004 it first tested the ground-launched DH-10 with a range of more than 1,500km, followed later by the air-launched YJ-63 with a range of 500km. The DH-10 not only joins the growing number of Chinese conventionally armed ballistic missiles facing Taiwan, but it also possesses sufficient range to strike critically important U.S. airfields in the region. Taiwan, for its part, first tested its HF-2E land-attack cruise missile in 2005 and seeks to extend its range from its current 600km to at least 1,000km, to reach targets such as Shanghai, and potentially 2,000km, so that even Beijing is within range. As many as 500 HF-2E cruise missiles were originally sought for deployment on mobile launchers. Not to be outdone, South Korea announced after North Korea's nuclear test in 2006 that it had four new land-attack cruise missiles under development with ranges between 500 and 1,500km. The South Korean press took immediate note that all of North Korea, as well as Tokyo and Beijing, would be within range of these new cruise missiles. Even Japan, a nation whose constitution renounces war and offensive forces, is toying with the prospect of acquiring land-attack cruise missiles after first considering and then dropping the idea of developing a ballistic missile earmarked for "preemptive" strikes against adversary ballistic missiles.

Why the Sudden Explosion in Cruise Missile Proliferation?

What explains the rapid emergence of several new land-attack cruise missile programs in 2004 and thereafter? In many respects, analysts in the early 1990s foresaw the barriers to land-attack cruise missiles succumbing to the quantum leap in widely available technologies underlying their development. The commercial marketplace had begun to alter the nonproliferation environment facing security planners. Dramatically increased and miniaturized computing power, the widespread availability of cheap guidance, navigation, high-resolution satellite imaging and digital mapping technologies combined to suggest to analysts the rapid and inevitable spread to land-attack cruise missiles beyond U.S. and Russian possession. As one respected analyst noted in a 1992 monograph, "It now appears inevitable that Third World countries will begin to acquire land-attack cruise missiles during the 1990s."[20]

Several factors likely explain why new land-attack cruise missile programs began to appear in surprising numbers around 2004 and thereafter. Surely, America's use of cruise missiles in seven different contingencies during the 1990s, including most prominently the 1991 Gulf

[20] W. Seth Carus, *Cruise Missile Proliferation in the 1990s*, Westport, Praeger, 1992, p. 3. My own view then was roughly similar, though expressed with a bit more caution, seeing the threat "probably emerging by the end of the decade", with one important caveat: it would be critically dependent on the availability of available system engineering/integration skills. See K. Scott McMahon and Dennis M. Gormley, *Controlling the Spread of Land-Attack Cruise Missiles*, Marina del Rey, American Institute for Strategic Cooperation, 1995, p. 26.

War, figured into the commencement of several new cruise missile developments during that decade, which only appeared after 2004. Still, other factors seemed to have nudged cruise missile growth toward an evident tipping point by the middle of the current decade. One surely lies squarely with the challenge of developing a land-attack cruise missile, independent of the floodgates opening widely with respect to all of the necessary component technology.

The Importance of Specialized Knowledge

Iraq, for example, sought in 2002 to transform their Chinese HY-2 *Silkworm* anti-ship cruise missiles into land-attack systems that could achieve a range of 1,000km.[21] Insight into this challenge came from a government-sponsored study I directed in 1997 that essentially examined the transformation of such an anti-ship cruise missiles into a land-attack system. This work was presented to the Rumsfeld Commission in 1998, where Commission chairman disagreed with our chief finding that a country like Iraq or Iran would require, depending on the extent and type of foreign assistance, 6 to 10 years to fully develop and integrate these missiles into their force structure. Rumsfeld argued that such a task could be accomplished in no more than one year. Fortunately, the Iraqi Survey Group's interviews with Iraqi engineers engaged in their conversion program suggest quite a longer anticipated development cycle. They reported that they had worked six months on the program without much accomplished, save for a computer simulation to test the prospects of integrating their chosen engine into the HY-2. Importantly, they hadn't started from scratch; engineers had devoted years of work on extending the range of the HY-2 from 100 to 150km, which they claimed directly contributed to their transformation quest. Before starting, their own estimate to complete the project was three to five years, but it should be kept in mind that on even simpler UAV projects, they had achieved only modest progress over as much as seven years of development work. In short, the three-to-five year estimate, no less Rumsfeld's one-year guess, seems excessively optimistic.

The kinds of specialized knowledge that Iraq surely could have used appear essential in helping to explain the recent spike in cruise missile proliferation. For example, Chinese fingerprints are all over Pakistan's *Babur* cruise missile, while Russian engineering is known to have enabled China to produce a workable propulsion system for its new land-attack cruise missiles. Russian technical assistance, formalized in a joint production agreement, has aided India in the production of its first cruise missile, the *BrahMos*. And Israeli assistance is manifest in New Delhi's subsonic cruise missile programs as well. Iran's three new cruise missile programs are believed to depend on foreign-trained engineers working with Iranian engineers in a "Cruise Center," a research division of Iran's defense ministry. And despite periodic U.S. efforts to forestall Taiwan's cruise missile ambitions, Taiwan obtained critical U.S. cruise missile technology and has attempted, without known success, to obtain more advanced

[21] *Comprehensive Report of the Special Advisor to the DCI on Iraq's WMD,* Vol. II Washington, Central Intelligence Agency, September 30, 2004, pp. 37-46.

engine technology to achieve its range ambitions for the HF-2E cruise missile. These brief examples illustrate that while the flow of technology components is necessary, it is not sufficient to enable the spread of land-attack cruise missiles without the critical support of highly skilled engineering practitioners. This may well represent the good news related to the spreading contagion of interest in cruise missiles. To the extent that states can effectively stanch the spread of these "black art" skills, there is hope that the most advanced kinds of cruise missile development can be controlled, or slowed down significantly. Sadly, that has not happened yet.

Ballistic Missile Defenses Finally Show Promise

Most prominent is the notable improvement seen in U.S. ballistic missile defenses and its consequent effect of bolstering the narrative appeal of cruise missiles. Prior to the 2003 Gulf War, U.S. missile defense systems had yet to prove effective in war. In the 1991 war with Iraq, *Patriot* PAC-2 interceptors were at first thought to have performed nearly perfectly. But that notion was proven to be apocryphal in the war's aftermath. The U.S. Government Accountability Office concluded that at best only 9 percent of Iraq's ballistic missiles were successfully engaged.[22] Nevertheless, the loss of 28 U.S. Army soldiers to an Iraqi ballistic missile, which struck a U.S. military barracks at Dhahran, Saudi Arabia, on February 25, 1991, the last day of that war, had a profound effect on the U.S. Army's willingness to embrace the *Patriot* missile defense program.[23] As the U.S. Army's official history of the 2003 Gulf War air and missile operation solemnly observes, "In the twelve years since Operation Desert Storm, we have remembered the loss of our soldiers from the last launch on the last day of the way against Dhahran, Saudi Arabia. We vow not to let this happen again…"[24] This commitment manifested itself in more than $3 billion the U.S. Army

[22] Andrea Stone, "Friend or Foe to Allied Troops", *USA Today,* April 4, 2003, http://www.usatoday.com/news/world/iraq/2003-04-14-patriot-missile_x.htm. It's fair to note that the PAC-2s rushed into combat in 1991 were designed not to destroy the incoming missile's warhead, but rather to knock incoming missiles off course to protect the launch units from being destroyed.

[23] During President Reagan's second term, the *Patriot* program came close to cancellation, as the threat *du jour* then was Soviet intercontinental missiles, not short-range Scuds. This left the U.S. Army with three experimental launchers in its inventory when Iraq invaded Kuwait in July 1990. However, Saddam Hussein gave the U.S. and its coalition partners six months of time not only to build up forces in the region but also for U.S. Army's contractors to produce enough missile batteries for deployment in Israel and Saudi Arabia before the January 1991 start of the war. See K. Scott McMahon, *Pursuit of the Shield: The US Quest for Limited Ballistic Missile Defense*, Lanham, University Press of America, 1997, pp. 55-92 and pp. 297-306. For the first hearing before the U.S. Congress to call attention to this shortcoming, see U.S. Congress, Senate Committee on Armed Services, *Soviet Military Developments and NATO Antitactical Ballistic Missile Defenses: Hearings Before the Committee on Armed Services*, 99th Congress, 2nd session, January 30, 1986.

[24] "Operation Iraqi Freedom Theater Air and Missile Defense History", Ft. Bliss, 32nd Army Air and Missile Defense Command, September 2003.

invested in improving *Patriot* missile defenses in the twelve years that separated the first and second Gulf Wars.[25]

The second Gulf War at once legitimized U.S. investments in upgrading *Patriot* missile defenses while also demonstrating the system's continuing shortcomings. As far as intercepting Iraq's ballistic missiles is concerned, the *Patriot*'s scorecard was outstanding: Of the 19 short-range ballistic missiles Iraq launched at coalition targets in Kuwait and Iraq, only nine threatened potential targets (the others landed in deserted areas) and all were successfully engaged and destroyed. Still, U.S. missile defenses were not without flaws. U.S. warning systems, including *Patriot*'s ground-based radar and the U.S. Air Force's *Airborne Warning and Control System* (AWACS) failed altogether to detect or intercept any of the five primitive Iraqi cruise missiles launched against coalition targets. One cruise missile came perilously close to a Marine command post on the first day of the war, while the others landed innocently or produced minor damage to civilian targets. More ominous for the future, however, was the fact that Iraq's use of both ballistic and cruise missiles forced U.S. commanders to alter *Patriot* batteries' restricted rules of engagement, thereby forcing them to cope with both ballistic and cruise missile threats. Until then, those rules had directed the batteries to focus only on high-angle ballistic missile threats. This change, among other reasons, led to a series of friendly-fire incidents, including the loss of two aircraft, a U.S. F-16 destroying a threatening *Patriot* radar, and worse, the deaths of three crew members of the two destroyed aircraft.[26] None of this should have come as any surprise; several of the aforementioned Pentagon Defense Science Board studies dealing with cruise missile defense noted the serious combat identification and friendly fire challenges needing rectification. In fact, in a report issued prior to the 2003 war in Iraq, the U.S. Senate Armed Services Committee stated that the Pentagon's "longstanding" combat identification and friendly-force tracking weaknesses were not being rectified "in the most expeditious manner."[27]

A New Narrative Forms Around the Value of Cruise Missiles

The lessons learned in the 2003 Gulf War took effect in the war's aftermath. Because the five crude Iraqi cruise missiles that evaded detection or destruction caused only limited fratricide damage, they were but a footnote to an otherwise swift destruction of conventional resistance. But to specialists within the U.S. government and elsewhere, the chief lesson

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[25] See Espionageinformation.com, Patriot Missile System, available at: http://www.faqs.org/espionage/Pa-Po/Patriot-Missile-System.html.

[26] See Gormley, *Missile Contagion, op. cit.*, pp. 108-117, for an analysis of U.S. missile defense performance during the 2003 Gulf War.

[27] David Ruppe, "United States: Army Describes Patriot Friendly Fire Difficulties", *Global Security Newswire,* July 29, 2003, available at: http://www.govexec.com/dailyfed/0703/072903gsn1.htm. Yet another example of the U.S. Army's weakness in detecting and engaging low-flying threats occurred in the 2003 war when two Iraqi ultralight aircraft, feared capable of carrying biological or chemical agents, managed to fly directly over a large U.S. Army encampment south of Baghdad before the final assault on that city. See Sean D. Naylor, "Iraqi Ultralights Spotted Over U.S. Troops", *Army Times,* March 29, 2003.

became that ballistic missile defenses alone cannot address the threat of low-flying cruise missiles. However much cruise missiles were seen to possess certain advantages over ballistic missiles (cost, ease of logistical support, multiple launch options, potential precision), and no matter how much American *Tomahawks* may have burnished their appeal in multiple contingencies, the symbolic and psychological power of ballistic missiles trumped cruise missiles' superior efficiency and effectiveness – that is, until ballistic missiles were not seriously threatened by effective missile defenses.[28]

Just after the formal combat of the 2003 Iraq war ended, senior U.S. military officials voiced their concern about the implications of Iraq's minimal cruise missile attacks. "This was a glimpse of future threats. It is a poor man's air force," the chief of staff of the 32nd U.S. Army Air and Missile Defense Command told the *New York Times. "*A thinking enemy will use uncommon means such as cruise missiles and unmanned aerial vehicles on multiple fronts."[29]

During the 1990s, when some of the cruise missile development programs noted before were launched, the cruise missile narrative rarely if ever fixed on the appeal of surviving missile defenses. But in the 2003 war's aftermath, a new cruise missile narrative began to stick with virtually every new cruise missile program. President Pervez Musharraf could have chosen to hide Pakistan's inaugural launch of the *Babur* cruise missile in August 2005. Instead, shortly after the test's success, Musharraf appeared on national television declaring, "The biggest value of this system is [that] it is not detectable. It cannot be intercepted."[30] Perhaps an Indian audience was on Musharraf's mind; six months earlier, a Pentagon team of technical specialists had visited New Delhi to brief their Indian counterparts on the *Patriot* PAC-2 missile defense system. Musharraf managed to set a narrative hook that has been reinforced with every test of *Babur*, and was taken up not only by Pakistan's media outlets but also by a Pakistani researcher at the Islamabad Policy Research Institute, Kuwaiti News Agency, and Agence France-Presse. After *Babur*'s third test, in July 2007, the press reported, "The *Babur*, which has near stealth capabilities, is a low

[28] Roughly 2,500 American cruise missiles have been used in nine different contingencies from 1991 through 2003. See Gormley, *Missile Contagion, op. cit.*, figure 1, "History of Cruise and Ballistic Missile Use", p. 48. Admittedly, the effectiveness features noted here may reflect an American-centric view. However, one cannot help but think that a state that struggles mightily with supporting highly vulnerable liquid-fueled ballistic missiles might wish to take advantage of some or all of these cruise-missile advantages.

[29] Michael R. Gordon, "A Poor Man's Air Force", *New York Times*, June 19, 2003, p. A1.

[30] "President Musharraf Compares Babur Missile with India's BrahMos", Islamabad PTV World (in English), August 11, 2005 (Foreign Broadcast Information Services [FBIS] transcribed text).

flying, terrain hugging missile with high maneuverability … and radar avoidance features."[31]

The Indians, for their part, had from the outset of the *BrahMos* program, featured the missile's low radar signature and supersonic velocity in their publicity. But after *Babur*'s surprise appearance in 2005 the Indian narrative immediately began to focus more heavily on the system's ability to penetrate missile defenses. Indeed, immediately following the 2003 Gulf War, Indian defense experts, seemingly having absorbed the lessons from *Patriot*'s poor performance against Iraq's slow-flying cruise missile threat, began singing the praises of subsonic cruise missiles like *Tomahawk* because of their greater range (than *BrahMos*) and capacity to survive despite their comparatively slow speed. India's subsequent turn towards subsonic cruise missiles with substantially more range than *BrahMos* (to wit, *Nirbhay*) logically followed.

In the Middle East, where Iran's cruise missile ambitions are evident if not terribly overt, the narrative appeal took hold roughly a year after the end of major operations in Iraq in 2003. Independent journalists cast Iran's interest in cruise missiles as "meant to defeat U.S.-origin missile defense systems," adding that the United States had offered to sell PAC-3 missile defenses to Gulf Cooperation Council states, while Kuwait and Saudi Arabia had already expressed interest in the system.[32] News of Iran's illegal procurement of Russian Kh-55 strategic-range cruise missiles prompted a multimedia broadcast network in Jerusalem to observe in March of 2005 that the problems that U.S. missile defenses faced against cruise missiles during the 2003 war in Iraq demonstrated just how difficult these missiles were to defend against not just for Israel but eventually for Europe as well.[33]

In Northeast Asia, the narrative changes in China's newfound fascination with cruise missiles are subtler than elsewhere; they focus less on rhetoric and more on system employment of ballistic and cruise missiles together to complicate an enemy's missile defenses. They emphasize the importance of saturation attacks and note especially that cruise missiles possess nearly an order of magnitude cost advantage compared with the price of defending against them. These narrative changes have occurred for the most part in the specialist literature rather than in news accounts, thereby avoiding the already palpable tension in the region.[34] Taiwan has

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[31] "Pakistan warns of strong responses to nukes grab", *Agence France-Presse*, December 10, 2007, available at: http://afp.google.com/article/ALeqM5hv2rhDfRqzkPApjAMZCEngSDy_Ww.

[32] "Iran's Seeks Cruise Missile to Support Shihab", *Middle East Newsline*, June 10, 2004.

[33] Iddo Genuth, "Ukraine's Sale of Cruise Missiles with a Nuclear Potential to Iran Also Pose a Deadly Threat to Europe", IsraCast, March 21, 2005, available at: http://www.IsraCast.com.

[34] One notable exception is Minnie Chan, "Old Jets Converted into Cruise Missiles Could Hit U.S. Ships", *South China Morning Post*, May 12, 2007, which reported that the *PLA Military Digest* indicated that the PLA was converting more than 1,000

proven much more provocative. Three months after the conclusion of the 2003 Iraq War's invasion phase, Taiwan's military observers began writing about how China's new cruise missiles threatened to bypass Taiwan's costly purchase of American missile defenses. By 2005, as China began deploying new cruise missiles, the press continued with its focus on the high cost of missile defenses and the comparatively low cost of producing its own offensive missile force, notably its newly tested HF-2E land-attack cruise missiles.

On the surface, South Korea seemed to have little reason to focus on the difficulty of defending against its new land-attack cruise missiles; North Korea neither possessed missile defenses nor were its air defenses of any notable capacity. Still, perhaps with other Northeast Asian states in mind, Seoul's defense ministry spokesmen began to fixate on the assured penetration afforded by its new cruise missiles. Japan found reasons not only to consider its own cruise missiles; Tokyo also became so animated over the prospect that Iran might share the fruits of its Kh-55 acquisition with North Korea, it issued a demarche to Tehran to refrain from doing so. More tellingly, in June 2005, an unnamed Japanese government official said, "if [North Korea] succeeds in gaining cruise missile technology, we cannot respond with a [missile defense] system based on ground-to-air missiles or the next-generation sea-based [missile defense] system to be installed on *Aegis* vessels…"[35] By January 2008, *Yomiuri Shimbun* reported that the Japanese defense ministry now recognized that its current missile defense initiatives would not suffice to defend against land-attack cruise missiles and that Japan planned to commence its own cruise missile defense program to deal with these new threats. China's growing cruise missile arsenal was particularly noted.

The Price of Weak Nonproliferation Norms

Norms governing the spread of missiles do not have nearly the robustness or legal standing of those pertaining to the proliferation of nuclear, biological, or chemical weapons. But this is not for wont of trying. In 1999, MTCR member states started work to strengthen the normative underpinnings of missile proliferation, which eventually led, in November 2002, to the adoption of the Hague Code of Conduct against Ballistic Missile Proliferation. The year before the MTCR membership began formulating what became the Hague Code was arguably the nadir of any consensus about the danger of cruise missile proliferation. To its credit, the regime focused not only on fleshing out the Hague Code; they also began to work seriously on reducing confusion in MTCR language on determining the true range of cruise missiles.[36] Equally important were consideration

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retired Jian-5 fighters into cruise missiles, which, if true, certainly underscore's China's emphasis on saturation attacks.

[35] "Cruise Missile Technology May Have Leaked to DPRK From Iran; All Parts of Japan Fall Within Range", *Sankei Shimbun* (internet version, in Japanese), June 26, 2005 (FBIS translated).

[36] The then existing rules on range were written primarily with ballistic missiles in mind (assuming a maximum range trajectory). Longer range cruise missiles can take advantage of flying at higher altitudes, which produce greater fuel efficiency) than the low flight profiles they generally assume when they must operate as low

and adoption of seemingly prosaic but critical changes to the MTCR's technology annex, which were particularly relevant to cruise missile development.[37] Several of these improvements were approved at the 2002 plenary meeting in Warsaw, which occurred a month after launching the Hague Code of Conduct against Ballistic Missile Proliferation. As the code's name denotes, and in spite of the MTCR's companion attempt to elevate the MTCR's effectiveness with respect to cruise missiles to a level roughly equivalent to ballistic missiles, cruise missiles were not included in the code's normative treatment. Ordinarily parsimonious in its public declarations about its deliberations, the MTCR membership did not provide its reasoning for the decision.

By comparison with ballistic missiles, such unequal treatment of cruise missiles also manifests itself in subtler and sometimes pernicious ways. However much some may worry about cruise missiles' starkly better efficiency than ballistic missiles in delivering biological agents—safely, by a factor of ten—the appeal of modern land-attack cruise missiles, especially as seen by the weapons' U.S. practitioners, lies in their presumed discrimination due to their precision delivery of conventional, not nuclear, payloads. The MTCR and its offspring, the Hague Code of Conduct, were designed to deal with mass-destruction delivery systems. To that end, the Hague Code's first stab at norm building for missiles dealt primarily with behavior rather than possession. The Code contains various behavioral measures, most notably, exercising maximum possible restraint with respect to development, testing, and deployment of ballistic missiles. Given that ballistic missiles are broadly viewed as the preferred means of delivery for nuclear weapons, exercising maximum constraint seems a desirable phenomenon, especially in light of reductions in U.S. and Russian ballistic missile arsenals due to various arms control agreements.[38] Certainly, the United States has practiced restraint in regard to nuclear-armed cruise missiles, but such restraint is hardly evident with respect to conventionally armed cruise missiles.[39] When one compares ballistic and cruise missile use from the end of World War II to the 2003 Iraq War, one finds that cruise missiles recently surpassed ballistic missiles. Because actual or prospective enemies of the United States accounted for the overwhelming share of ballistic missile use, while the United States accounted for most of the cruise missiles employed, it is understandable why the United States views ballistic missiles as the predominant threat.[40] Yet, by the beginning of

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as possible to avoid enemy air defenses. The new rules adopted in 2002 state that UAV system range will be determined by calculating the most fuel-efficient flight profile.

[37] For details see Gormley, *Missile Contagion*, *op. cit.*, pp. 133-135 and 150-155.

[38] The most pronounced exception is China's deployment of more than 1,400 conventionally armed ballistic missiles facing Taiwan. The U.S. wish to arm some Trident missiles with conventional penetrators provoked a firestorm of protest in the U.S. Congress, which led to its demise.

[39] In 2007 the U.S. Air Force announced that it will retire its entire inventory of AGM-129 nuclear-armed cruise missiles, while in February 2010 news from Japan indicated that the U.S. government had advised the Japanese government that it would retire its sea-based nuclear-armed *Tomahawk* cruise missiles.

[40] My estimate is: 2,380 ballistic missiles versus 2,645 cruise missiles. See Gormley, *Missile Contagion*, *op.cit.*, especially figure 1, p. 48.

the twenty-first century, land-attack cruise missiles had not spread widely beyond the United States and Russia. That is no longer the case. And virtually every new state that has joined the cruise missile club since 2003 has married its cruise missile developments to a growing fascination with preemptive strike doctrines.[41] Whether cruise missiles are intended for nuclear or conventional use, these developments are most unwelcome.

[41] Cruise missiles in the hands of Iran and North Korea are or could be clear threats, but there are other developments worthy of close watch. The United States strove for years to prevent a missile arms race between the two Koreas. However, South Korea's four new cruise missile programs had their origin in the weak normative basis upon which Washington attempted to constrain Seoul's missile ambitions prior to its entry into the MTCR in 2001. The end result was a seemingly freer hand for Seoul to pursue cruise missiles by comparison with its ballistic missile plans. These developments are interacting ominously with the missile ambitions of China, Taiwan, and Japan. Similar interactions are occurring in the Middle East and South Asia. See Gormley, *Missile Contagion*, *op. cit.*, pp. 123-145.

New Developments in the Cruise Missile Threat

Since the publication of my book *Missile Contagion,* in 2008, the spread of cruise missiles continues unabated around the globe. This section primarily discusses these new developments in the three principal regions of potential hostilities: Northeast Asia, South Asia, and the Middle East. Russia's developments are also worthy of mention to the extent they could plausibly affect NATO missile defense plans. The Middle East is notable for two reasons. First, the region's proximity to NATO means that Middle East states could conceivably threaten NATO population centers and military forces. Second, the Middle East is a region of the world where missile use stands out: nearly 91 percent of the more than 5,000 cruise and ballistic missiles fired in combat since the end of World War II have occurred in the Middle East.[42] Nonetheless, all three regions are worthy of inspection if only because several key states depend on collaborative assistance of other states or outright acquisition of complete land-attack cruise missiles.

Northeast Asia

China, Taiwan, South Korea, and Japan have all continued to contribute or react to the contagious outbreak of interest in land-attack cruise missiles in Northeast Asia. China is clearly the most active country in the region to incorporate land-attack cruise missiles into its nascent but rapidly improving long-range conventional strike capacity. Especially given China's reticence to display its military technology publically, perhaps the most notable development since 2008 was making the ground-launched DH-10 land-attack cruise missile one of the centerpieces of China 60th National Day military parade on October 1, 2009. First tested in 2004, the DH-10 was featured in the National Day event as one of China's "precision striking capabilities."[43] The latest unclassified U.S. Department of Defense report to Congress reports that between 40 to 55 ground launchers and 200 to 500

[42] Data extracted from Figure 1 in Gormley, *Missile Contagion*, *op. cit.*, p. 48, covers wars fought between the Yom Kippur War of 1973 to Operation Iraqi Freedom in 2003.

[43] Martin Andrew, "China's Conventional Cruise and Ballistic Missile Force Modernization and Deployment", *China Brief Volume*, Vol. 10, No. 1, January 7, 2010, available at: http://www.jamestown.org/uploads/media/cb_010_01.pdf.

missiles with estimated ranges of greater than 1,500km have already been field deployed.[44]

While several U.S. analysts of China's emerging long-range strike systems, including both ballistic and cruise missiles, foresee near-term threats to U.S. force projection into the region, some Chinese analysts are less sanguine about the challenges of turning land-attack cruise missiles into highly effective strike systems.[45] In contrast to their independent use as delivery systems for nuclear or biological weapons, land-attack cruise missiles employed as precision conventional weapons are dependent on a variety of complex military requirements. First is the challenge of carefully orchestrating a multifaceted air and missile campaign over many days of execution. Effectiveness depends on both human and technical factors – extremely well trained military personnel who have practiced these routines in diverse ways over many years and a command and control architecture needed to direct with agility combined-arms operations. Chinese planners are establishing a Firepower Coordination Center within the Joint Theater Command, which would manage the application of aircraft and missile firepower. Separate coordination cells would deal with missile strikes, aircraft strikes, and special operations, and ground and naval forces.[46] Critical to achieving the delicate timing between waves of missile strikes designed to leverage the effectiveness of subsequent aircraft attacks is developing the skill to coordinate and de-conflict large salvoes of missiles and waves of aircraft operating in multiple sectors. Besides implementing the aforementioned command and control mechanisms, Chinese analysts have also underscored the essential need to develop improved intelligence collection and analysis as well as battle damage assessment capabilities.[47]

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[44] *Annual Report to Congress: Military and Security Developments Involving the Peoples Republic of China*, Washington, Office of the Secretary of Defense, 2011, p. 78.

[45] For one cited example, see Michael S. Chase, "Chinese Land Attack Cruise Missile Developments and their Implications for the United States", *China Brief Volume*, Vol. 8, No. 24, December 19, 2008, available at: http://www.jamestown.org/programs/chinabrief/single/?tx_ttnews[tt_news]=34299&tx_ttnews[backPid]=168&no_cache=1. For an example of the presumptive advances in China's military capabilities that could manifest themselves quickly, see Mark A. Stokes, *China's Evolving Conventional Strategic Strike Capability*, Washington, Project 2049, September 14, 2009.

[46] For more on these developments, see Mark A. Stokes, "The Chinese Joint Aerospace Campaign: Strategy, Doctrine, and Force Modernization", in James Mulvenon and David M. Finkelstein (eds.), *China's Revolution in Doctrinal Affairs: Emerging Trends in the Operational Art of the Chinese People's Liberation Army*, Alexandria, Center for Naval Analyses Corporation, 2005.

[47] Zhang Zhaozhong, "Desert Fox' in Perspective", Jiefangjun Bao, January 12, 1999, p. 14, as cited in Chase, "Chinese Land Attack Cruise Missile Developments and their Implications for the United States", *op. cit.* Intelligence support to battle damage assessment (BDA) is an area that the U.S. military struggled mightily during the 1991 war with Iraq. Two decades later, the experience of operating in multiple contingencies coupled with significant improvements in near-real time intelligence collection has improved U.S. BDA capabilities, but it still remains a stiff challenge.

A second critical factor is less obvious but nonetheless essential to successful use of cruise missiles as precision conventional delivery systems. It entails optimizing missile use to improve their effectiveness over time. Conventional wisdom has it that the revolution in information technology easily enables the precision delivery of conventional payloads over great distances in the form of land-attack cruise missiles aided by advances in global positioning technologies. To be sure, the advent of global positioning technology has eased the process somewhat for states wishing to make effective use of cruise missiles. But the process of becoming truly proficient requires more than simple access to technology. What is unique about today's *Tomahawk* cruise missile is the extent to which its performance has depended on years of feedback from system diagnostics collected ever since the first *Tomahawk* was introduced in the 1970s. Virtually each and every *Tomahawk*, in peace and war, is analyzed to determine precisely what accounted for the missile's performance, no matter whether the missile crashed after taking off or hit precisely where it was programmed to hit. To learn from such successes and errors requires that missile developers have not only the kind of sophisticated diagnostic equipment that provides hints about system performance but also highly skilled systems engineers who possess specialized know-how accumulated over years of interaction with other skilled missile developers. *Tomahawks*' ubiquitous appearance in multiple contingencies since the first Gulf War in 1991 has facilitated the creation of an enormously valuable storehouse of knowledge that lends itself to steady improvement in missile performance.[48]

Such tacit knowledge is accumulated best through practice, not just by testing during peacetime. Repeated testing is no substitute for real combat to prove one can achieve the results that parametric analysis might suggest. Not since 1971 has China fought a war. And only since the late 1990s has the People's Liberation Army (PLA) begun large-scale exercises and more recently commenced work on the stiff challenge of joint operations among the different military branches. Whether the quality of such exercises is sufficient to show clear progress in the challenges enumerated above appears doubtful at best. China military scholars John Lewis and Xue Litai quote a PLA military officer speaking candidly about such large-scale exercises: "The exercise is part of the PLA's annual training, but its political significance is greater than its military significance."[49] That so many western analysts lean towards characterizing China's military capacities in exaggerated fashion should perhaps not be so surprising. As retired U.S. Navy Captain Wayne Hughes argues in his profoundly influential book *Fleet Tactics: Theory and Practice,* "The art of

[48] Three hundred and seventeen land-attack cruise missiles were used in the 1991 Gulf War, which lasted roughly 5 weeks. Eight years later, 420 were used in 4 days during Operation Desert Fox. And 12 years after the first Gulf War, 1,370 cruise missiles were employed in the second Gulf War. The highly reliable Harpoon anti-ship cruise missile achieved only 50 percent reliability after 50 peacetime tests. On Harpoon, see U.S. House of Representatives Appropriations Committee, "Department of Defense Appropriations for 1987", 99th Congress, 2nd Session, Part 3, p. 714, cited at http://www.fas.org/spp/aircraft/part03.htm#N_38_.

[49] John Wilson Lewis and Xue Litai, *Imagined Enemies: China Prepares for Uncertain War,* Stanford, Stanford University Press, 2006, p. 261.

concentrating offensive and defensive power being complicated, it is easy to exaggerate the potential of the enemy to master it."[50]

China's shortcomings in aiding the accurate targeting of both its cruise and ballistic missile systems may be ameliorated over time as the PLA acquires more sophisticated and ubiquitous intelligence platforms, including both overhead imaging and global positioning systems. Most notable is China's intense interest in unmanned air systems. In November of last year, at the eighth Zhuhai Air Show, China displayed 25 types of UAVs, although it was by no means clear how far along many of these models were. Still, according to the U.S.-China Economic and Security Review Commission, the Chinese military "has deployed several types of unmanned aerial vehicles for both reconnaissance and combat." China is also keenly interested in selling its multiplying UAVs, as evidenced by Beijing's willingness to permit the PLA's combat drones to be shown at the 2011 Paris Air Show, which included a UAV, called *Wing-Loong*, that had the appearance of being a *Predator* clone.[51] Perhaps more relevant to supporting the prosecution of long-range ballistic and cruise missile strikes on moving targets, such as aircraft carriers, are reports from China of a new UAV with joined wing and tail – aids to increasing range and payload – undergoing radar-cross-section testing at a military facility.[52] Surely the direction and pace of China's cruise missile and UAV developments merit close watching.

Can we expect China to play a role in furnishing its cruise missile and UAV expertise and component technology to various states as it has already done with ballistic missiles? Absent Beijing's full membership in MTCR and consistent adherence to the regime's guidelines and technology controls, China has already become an important enabling source for satisfying Pakistan's and Iran's cruise missile developmental needs. In the first case, Pakistan's two new land-attack cruise missiles (*Babur* and *Raad*) surprised most observers. Pakistan simply does not possess the necessary aeronautical, mechanical, and computer-engineering skills needed to produce modern cruise missiles. Reflecting a general consensus of Indian analysts, one Indian observer wrote a detailed story that Beijing and Islamabad struck a deal in August 2004 to furnish Pakistan with one regiment of *Babur* cruise missiles, consisting of 18 road-mobile transporters each carrying four canister-mounted cruise missiles. China Precision Machinery Import and Export Corporation was to act as the prime contractor, responsible for supplying all components to Pakistan's National Development Complex for license assembly locally.[53] While there is reason to treat this story with diffidence, China surely had reason to reward

[50] Wayne P. Hughes, Jr., *Fleet Tactics: Theory and Practice*, Annapolis, Naval Institute Press, 1986, pp. 191-192.
[51] William Wan and Peter Finn, "Global race on to match U.S. drone capabilities", *Washington Post,* July 4, 2011, p. A1.
[52] Blog posting by David A. Fulghum and Bill Sweetman, *Aviation Week & Space Technology*, July 1, 2011, available at: http://www.aviationweek.com/aw/generic/story_channel.jsp?channel=defense&id=news/asd/2011/07/01/02.xml.
[53] Prasum K. Sengupta, "Babur's Flight", *New Delhi Force* (Internet Version, in English), September 9, 2005. See Gormley, *Missile Contagion*, *op. cit.*, p. 61, for reasons to doubt the veracity of Sengupta's story.

Pakistan with ample support for providing Chinese specialists with two unexploded U.S. *Tomahawks* of the six that errantly crashed on Pakistani territory in 1998 (they were launched at al-Qaeda targets in Afghanistan after that group's two embassy attacks in Africa).[54]

Iran does not possess the level of specialized skills and technology that either Russia or China could provide, but it can and does employ its vast energy reserves as a magnet to draw upon both countries, notably China. Beijing has become Iran's largest trading partner. As sanctions inhibit Western investment in Iran, China has filled the gap by buying up vacated space left behind as many firms depart Iran.[55] According to U.S. Congressional documentation, China, or its entities, have been implicated in selling Iran at least six cruise missiles, including the C-601, HY-2 and HY-4. China has used the C-601 and HY-2 as test beds for longer-range land-attack cruise missiles, a task Iraq undertook on its own (without success) immediately before the 2003 U.S. invasion. The HY-4 is the only anti-ship cruise missile in the HY-series equipped with a turbojet engine, which may explain why Iran was able to achieve a range of 350km for its *Raad*. According to the NATO Parliamentary Assembly, China has provided substantial assistance to Iran's cruise missile programs, one of which involved upgrading around 300 HY-2 anti-ship missiles into land-attack ones by fitting them out with turbojet engines and improved navigation systems.[56] Most recently, military reports from the Persian Gulf region have Iran harassing the ground-based air defenses of the U.S. Army and regional allies by means of employing swarms of UAVs, of reportedly "Chinese design or origin."[57] The Iranian UAVs exploited the limited coverage of these radars by flying low or around them, and on one occasion they were misclassified due to their slow speed or small radar cross section. Such tactics have the character of China's emphasis on taking advantage of the huge cost deferential between "tidal waves" of cheap cruise missiles or UAVs and expensive air defense interceptors.[58]

China remains a critical wildcard with respect to enabling the spread of land-attack cruise missiles and UAVs. Beijing's current "adherent" status, consisting of a pledge to stand by the MTCR's general guidelines, is problematic especially in regard to cruise missiles. After China became an

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[54] On details of the *Tomahawk* recovery, see Mark Williams, "The Missiles of August – Part II", *Technology Review*, August 29, 2006 and Robert Hewson and Andrew Koch, "Pakistan Tests Cruise Missile", *Jane's Defence Weekly*, August 17, 2005, p. 4.

[55] Sonia Luthra and Allen Wagner, "Iran's Sanctions: Is India between a Rock and Hard Place?", An Interview with Harsh V. Pant, The National Bureau of Asian Research, March 3, 2012, available at: http://www.nbr.org/research/activity.aspx?id=217.

[56] Lothar Ibrugger, "Report of the NATO Parliamentary Assembly, Subcommittee on the Proliferation of Military Technology, Missile Defences and Weapons in Space", November 2004, No. 22, available at: http://natopa.ibicenter.net/default.asp?SHORTCUT=497.

[57] Loren B. Thompson, "Iranian Unmanned Aircraft Signal New Threat", Lexington Institute, February 17, 2012, available at: http://www.lexingtoninstitute.org/iranian-unmanned-aircraft-signal-new-threat?a=1&c=1171.

[58] Gormley, *Missile Contagion, op. cit.*, pp. 76-77.

MTCR adherent in 1992, two years later it took the unusual step of formulating its own version of what adherence meant – namely, "not to export ground-to-ground missiles featuring the primary parameters of the MTCR."[59] This formulation left air-to-ground cruise missiles out altogether, a shortcoming that remained unrepaired even when Washington waived sanctions against Chinese entities for adding missile-related exports to Pakistan and Iran in 2000. By this point, China undertook not to export nuclear-capable ballistic missiles and related technologies and to publish an MTCR-like export control list. Although Washington praised Beijing's reference to nuclear-capable ballistic missiles, early in the Bush administration's first term officials averred that they needed "to do additional work to clarify China's willingness to implement fully the terms of the November 2000 agreement."[60] In 2002, China finally delivered on its promise to create an MTCR-like export control list. While the list emulates the MTCR's Category I provisions dealing with complete missiles and subsystems, it comes up short in the Category II technology annex, notably bearing on cruise missiles and UAVs.[61] This leaves China with ample wiggle room to support the proliferation of such non-ballistic missiles. As industry pressure in the United States increases to liberalize extant export controls on UAVs, a Chinese industry official has boldly acknowledged that while "the United States doesn't export many attack drones … we're taking advantage of that hole in the market."[62]

As for Taiwan's missile ambitions, over the past four years, Taiwan has judiciously toned down, but by no means reduced, its longstanding interest in deploying both land-attack cruise and ballistic missiles. Taipei sees such offensive systems as satisfying its perceived need for an affordable deterrent against China's growing military advantages – especially its inventory of roughly 1,600 ballistic and cruise missiles facing Taiwan. No doubt the transition from Chen Shui-bian's pro-independence Democratic People's Party to a new government led by Ma Ying-jeon and his Kuomintang party in legislative and presidential elections in early 2008 accounted for Taiwan's more judicious approach to satisfying its missile deployment ambitions. On the other hand, Washington's wishes with respect to Taiwan's missile ambitions have vacillated between strong pressure against their acquisition and deployment and indirect but important actions that have implicitly and explicitly supported Taiwan's offensive missile objectives.

However clumsily so, Washington has intermittently pressured Taiwan to forgo long-range ballistic missiles. Beginning in 1981, Taiwanese sources claim that Washington forced Taiwan to give up its nascent

[59] Ministry of Foreign Affairs of the People's Republic of China, "China's Non-Proliferation Policy and Measures", December 3, 2003, available at: http://www.fmprc.gov.cn/eng/wjb/zzjg/jks/cjjk/2622/t54978.htm.

[60] Quote in Alex Wagner, "Washington to Sanction China, Pakistan for Missile Co-operation", *Arms Control Today*, Vol. 31, No. 7, September 2001.

[61] For a breakdown of precisely where, see Gormley, *Missile Contagion, op. cit.*, p. 62.

[62] William Wan and Peter Finn, "Global race on to match U.S. drone capabilities", *Washington Post,* July 4, 2011. The Chinese official quoted is Zhang Qiaoliang, a representative of Chengdu Aircraft Design and Research Institute.

development program, called *Tien Ma* – intended to become a 1,000km range ballistic missile. On the other hand, Taiwan was given a free hand to develop the HF-2 anti-ship cruise missile or *Tien Kung-2* air defense interceptor programs, both of which could be – and appear to have been – transformed respectively into offensive, long-range cruise and ballistic missiles. By 2003, rumors swirled in the Taiwanese press about a medium-range missile underway at the Taiwanese military's Chung-Shan Institute of Science and Technology (CSIST) that could reach Shanghai. With the first test of the HF-2E land-attack cruise missile in early 2005, it became clear that CSIST had been working diligently not only on converting the HF-2 anti-ship missile into the HF-2E land-attack system while the *Tien Kung-2* was on course to become the *Tien Kung-2B* short-range ballistic missile system.[63]

By 2006, after Taiwanese military analysts had linked their land-attack cruise missiles to a "preventive self-defense" strike option to sow confusion in China's strike plans, Washington's concern grew sufficiently focused to send a general officer to Taipei in August to learn more about these unwanted developments. After Taiwan revealed in April 2007 its new "Tactical Shore-Based Missile for Fire Suppression" during the simulated portion of its Han Glory annual exercise, which consisted of 100 land-attack cruise and ballistic missiles fired against Chinese airfields, a senior American official representing U.S. interests in Taiwan chided Taiwan for focusing on offensive weapons as well as for budget delays in procuring American PAC-3 missile defenses.[64] All of these developments prompted the Bush administration to grow concerned, according to a Congressional Research Service report to the U.S. Congress, "about a misperception of U.S. assistance for or approval of" the Taiwanese HF-2E land-attack cruise missile program.[65]

Washington had good reason to be concerned. If there is any consistency, it is that while U.S. State Department and National Security Council officials have tended toward dissuading Taiwan from pursuing its HF-2E cruise missile program, U.S. Defense Department officials have implicitly, if inadvertently, encouraged Taiwan's cruise missile ambitions. A central element in this tension is Washington's wish to see Taiwan purchase missile defenses to cope with China's missile buildup. Although Taiwan finally did acquire some U.S. PAC-2s in the mid-1990s, Taiwan broadly recognizes the decided cost advantages of offensive missiles over defensive interceptors yet it sees more advantage in more affordable offensive missiles than in high-cost defensive interceptors. In the latter regard, U.S. defense officials have encouraged such a belief more than once. The Pentagon's 2004 annual report to Congress saw deterrent strength emanating from Taiwan's threat to conduct missile attacks against Chinese urban centers or other high-value targets like the Three Gorges Dam. And after Taiwan's 2007 test of its HF-2E cruise missile, a U.S. defense official was quoted as seeing virtue in Taiwan's pursuit of land-

[63] *Ibid.*, pp. 42-43 and 77-78.
[64] *Ibidem.*, pp. 11 and 77-78.
[65] Shirley Kan, *Taiwan: Major U.S. Arms Sales Since 1990*, Washington, Congressional Research Service, January 2008.

attack cruise missiles, with the ultimate goal being to achieve deterrence against China. And perhaps the most palpable evidence of U.S. endorsement of Taiwan's early cruise missile ambitions was its provision of critical mission planning technology to support CSIST's cruise missile efforts.[66]

In the aftermath of 2007 Han Glory exercise and growing concern over irritating China, it seems evident that any expectation of continuing U.S. technology support had dried up completely. What seemed highest on Taiwan's list of technology needs was a suitable turbofan or turbojet engine to extend the range of the HF-2E from 600 to 1,000km. Reports in late 2007 indicated that CSIST was seeking non-U.S. sources of components to achieve their range goal.[67] By July of 2008, the press reported that the new parliament had restored 2007 cuts in HF-2E production funding to produce 245 missiles over an 8-year period. Shanghai and Hong Kong were mentioned as intended targets, and Russia as a possible alternative source for U.S.-denied component technology.[68] But within three months, under apparent U.S. pressure to desist from countervalue targeting rhetoric, the new Ma government hinted that it might cancel an 800km-range variant of its HF-2E cruise missile and only deploy the 600km range system with tactical military targets in mind.[69] By late 2010, reports solidified that Taiwan was preparing to start mass production of the HF-2E, despite U.S. pressure to kill the program. Taiwanese analysts insisted that the country had no choice in light of China's continued missile buildup, including hundreds of new cruise missiles, facing Taiwan. As one Taiwanese analyst saw it, the HF-2E could "be a tactical deterrent and strategic bargaining chip in possible military confidence-building measures" with China. Moreover, this analyst argued that Taiwan's new cruise missiles could "indirectly give the U.S. some flexibility in diplomatic terms" should war become unavoidable.[70] Seemingly to appease its vacillating U.S. benefactors, Taiwan chose not to parade their new land-attack cruise missile in their National Day ceremonies for the 100th anniversary of the Republic of China in 2011.

Washington's concerns, however unevenly expressed, about Taiwan unnecessarily provoking China by means of acquiring both ballistic

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[66] The provision of mission planning technology reportedly occurred between 2001 and 2003 with the convenient stipulation that it could only be applied to a missile with no more than a 300km range. Gormley, *Missile Contagion, op. cit.*, pp. 79, 105, and 142.

[67] Hsu Shao-hsuan, "Hsiung Feng II-E Missiles Have Been Deployed: Sources", *Taipei Times*, October 18, 2007, available at: http://www.taipeitimes.com/News/front/archives/2007/10/18/2003383640.

[68] "Taiwan parliament restores budget for cruise missile production," posted on July 3, 2008, DPA News Category: Asia, at Earthtimes.org.

[69] "Taiwan Said Not Deploying Longer-Range Missiles Capable of Hitting Shanghai", *Hong Kong AFP* in English, September 1, 2008. It is doubtful, however, that the debate over range and targets is over with. A Taiwanese legislator called for retaining the longer-range HF-2E despite warming relations with China. See "Lawmaker Says Taiwan Needs Long-Range Cruise Missiles Despite Warming", *The China Post Online* in English, September 1, 2008.

[70] Wendell Minnick, "Taiwan Readies Mass Production of Cruise Missiles", *Defense News*, December 9, 2010.

and cruise missiles applied equally as well to South Korea's missile ambitions. Fearing, on the one hand, that Seoul's missiles might be employed by Pyongyang as a pretext for expanding its own missile programs, and on the other hand, that China and Japan would find South Korea's missile ambitions destabilizing as well, Washington caped South Korea's ballistic missile program (consisting of a converted U.S. *Nike Hercules* air defense interceptor into the NHK-1 ballistic missile) at not to exceed 180km, just shy of Pyongyang. Executed in 1979, this agreement took the form of a memorandum of understanding between the United States and South Korea, which remained in place for over two decades. But in the context of North Korea's nuclear ambitions and supporting missile developments, Seoul sought in the mid-1990s to abandon the 1979 restriction and replace it with a 300km cap for ballistic missiles. By that time, too, South Korea had begun research on, and sought external sources of assistance for, land-attack cruise missiles.

In the waning days of the Clinton administration, Washington and Seoul struck an unwritten "self-declared" adoption laying out the conditions for South Korea's entry into the MTCR. The agreement reportedly included the go-ahead for South Korea's deployment of a 300km-range ballistic missile (already tested in 1999), authority to build for "research purposes" a 500km-range ballistic missile, and most controversially, conditions under which Seoul could develop a 500km-range cruise missile as long as its payload remained less than 500kg.[71] The rationale for such a formulation seems dubious on the surface: presumably that a cruise missile with a range of 500km and a payload less than 500kg could avoid being declared a Category I missile subject to the MTCR's most restrictive transfer provision. The MTCR's Category I guidelines direct member states to assess whether or not recipient states could modify missiles via range/payload trade-offs so as to develop missiles that meet the 300km/500kg Category I threshold. While this tradeoff provision applies to both ballistic and cruise missiles, it is arguably more relevant to cruise missiles in light of the ease of customizing such highly modular systems. Thus, the 2001 self-declared adoption not only gave Seoul substantial room to expand its cruise missile plans, but left the door open for broadening its ballistic missile ambitions, too.

In the aftermath of North Korea's decision to break its self-imposed moratorium on missile testing in July 2006, when it tested seven ballistic missiles, South Korea decided to leak the existence of four South Korean land-attack cruise missile programs that not only included two 500km-range missiles but also two others with ranges of 1,000 and 1,500km.[72] While U.S. defense officials most likely were apprised in advance of South

[71] Gormley, *Missile Contagion, op. cit.*, pp. 44-45.

[72] It is difficult to imagine that a cruise missile with 1,500km range could not be readily modified to carry a 500kg payload to more than 300km range. For details on these missiles, see Gormley, *Missile Contagion, op. cit.*, Appendix A and pp. 44-45, 80-81, and 144. Any adverse impact on cruise missile nonproliferation would likely be seen as more than counterbalanced by the strategic military advantages of South Korea's potent new conventional strike capabilities aimed at deterring North Korea.

Korea's cruise missile programs, the announcement surely must have surprised other states in the region, no less North Korea, the presumed primary reason for their development.[73] Sadly, however, after virtually each new revelation in the South Korea press about its new long-range cruise missiles, three narrative notions figured into the press account: the first, that according to an unidentified defense official, Seoul's new longer-range cruise missiles were capable not only on reaching all targets in the north but also ones in Japan, China, and Russia;[74] second, that low-flying cruise missiles avoided radar detection and thus could foil missile defenses;[75] and third, that Seoul's new cruise missiles do not violate the MTCR because the regime only applies to ballistic, not cruise missiles.[76] Ironically, if the U.S. objective in fashioning the 2001 self-declared adoption as a condition for South Korea's membership in the MTCR was to avoid precipitating an Asian arms race in ballistic missiles, the unintended consequence was to fuel one in land-attack cruise missiles instead.

Preemption has maintained its privileged place in South Korea's new defense doctrine that was disclosed on the heels of leaking the existence of its new land-attack cruise programs in 2006. Called the "nuclear defense" plan, the doctrine aims to deter North Korea's nuclear threat via "surgical strike," or preemptive use of highly accurate cruise missiles against missile launchers, command bunkers, and other related targets. Not just cruise missiles figure into South Korean plans; Seoul is slated to acquire from the United States 1,400 U.S. *Joint Direct Attack Munitions* (JDAM) and roughly 270 *Joint Air-to-Surface Standoff Missiles* (JASSM), the latest U.S. Air Force stealthy land-attack cruise missile.[77]

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[73] Within two days of North Korea's missile tests in July 2006, the South Korean defense minister announced that South Korea had "tested cruise missiles probably more than ten times over the last three years", and that the United States was aware of these developments. See Daniel A. Pinkston, "South Korean Response to North Korean July Missile Exercise Includes Unveiling of New Cruise Missile", *WMD Insights*, October 2006, available at: http://cns.miis.edu/pubs/other/wmdi061004_pinkston.htm. That said, General Walter Sharp, commander of U.S. forces in South Korea, remarked in September 2009 that South Korea had no immediate need for such long-range cruise missiles. See "ROK Deploys Long-Range Cruise Missiles", *Hong Kong AFP* in English, October 15, 2009.

[74] While Japan and China were included in this narrative beginning in 2006, only in early 2010 was Russia, too, mentioned within range of the South Korea's new missiles. See Agence France-Presse, July 17, 2010, which continued into press accounts in 2011.

[75] See, for example, Jung Sung-ki, "S. Korea Deploying 1,000-Kilometer Cruise Missiles", *The Korean Times*, August 17, 2009. This message appears more relevant to China and Japan than it does to North Korea, whose air defenses are minimal and missile defenses non-existent.

[76] *Ibid*. To give the anonymous South Korean officials the benefit of the doubt, reporters probably are confused between the 2001 self-declared adoption agreement between the U.S. and South Korea and the provisions of the MTCR. Yet, the consistency of this narrative does a disservice to the MTCR and South Korea's membership in that important regime.

[77] Jung Sung-ki, "US Nuclear Umbrella: Double-Edged Sword for S. Korea", *The Korean Times*, June 24, 2009. U.S.-provided air-to-ground cruise missiles, like JASSMs, would complement South Korea's 500km ship-to-ground cruise missiles and 1,000 to 1,500km range ground-launched cruise missiles. South Korea also

South Korea's military modernization plans, embodied in their Defense Reform 2020 plans, also call for securing independent surveillance and reconnaissance assets, including unmanned combat air vehicles for both strike and surveillance missions, satellite reconnaissance, and drones to provide the intelligence that is so critical to make precision-strike conventional attacks successful.[78] Yet, precise conventional strike against particularly hard targets requires larger payloads, at least larger than South Korea's 500kg cap for both ballistic and cruise missiles. To that end, South Korea and the United States have reportedly begun negotiations to revise the 2001 Self-Declared Adoption agreement on ballistic missile range from 300km to Seoul's desired 1,000km or more, and possibly also alter the payload cap to permit more effective attacks against hardened targets.[79]

Japan, for its part, has embraced missile defenses capable, most demonstrably, with defending against ballistic missiles. Yet, cruise missile defense is also on Tokyo's mind. Animated by the prospect that Iran might share Kh-55 technology with its close missile collaborator North Korea, Japan worries that its substantial investment in ballistic missile defenses may become fruitless were North Korea to achieve developing or acquiring land-attack cruise missiles. An unnamed Japanese government official told *Sankei Shimbun* in 2005, "if [North Korea] succeeds in gaining cruise missile technology, we cannot respond with a [missile defense] system based on ground-to-air missiles or the next-generation sea-based [missile defense] system to be installed on *Aegis* vessels …"[80] Clearly, the Japanese had begun to appreciate the unique challenges of defending against low-flying cruise missiles with existing ground-based radars. New elevated detection platforms as well as new sensors for interceptors would be needed. Within two and a half years later, in January 2008, *Yomiuri Shimbun* reported that Japan's Defense Ministry now recognized that its current ballistic missile defense initiatives involving the *Aegis*-based SM-3 and PAC-3 protecting major cities would not suffice to defend against land-attack cruise missiles and that Japan planned to commence its own cruise missile defense program to cope with the anticipated rise in regional cruise missile threats. China's growing cruise missile arsenal was particularly noted.[81] Since that time the cruise missile threat in the region has continued

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has future plans to build its own 3,000-ton submarines armed with land-attack cruise missiles. For details on South Korean cruise missile deployment and production plans, see "Seoul Deploys Home-Grown Cruise Missiles", *Chosun Ilbo*, July 19, 2010, available at: http://english.chosun.com/site/data/html_dir/2010/07/19/2010071900309.html. By no means has South Korea neglected anti-ship cruise missiles, including new supersonic ones designed to attack aircraft carriers. See "Supersonic Cruise Missile in Development", *Chosun Ilbo*, August 17, 2011, available at: http://english.chosun.com/site/data/html_dir/2011/08/17/2011081700566.html.

[78] See, for example, Jung Sung-ki, "South to Boost Surgical Strike Capability Against North", *The Korean Times Online* in English, June 26, 2009.

[79] On range extension talks, see "S. Korea, U.S. in talks to extend Seoul's missile capability", *Yonhap*, January 19, 2011. Information on South Korea's need for larger conventional payloads comes from personal communication with a South Korean government official, October 2009.

[80] See Gormley, *Missile Contagion*, *op. cit.*, pp. 121-22.

[81] *Ibid*.

to grow while Japan has been reticent about disclosing precisely what, if anything, it has done to deal with the threat.

Japan is slightly more willing to discuss openly its offensive counterforce requirements. Responding to North Korea's second nuclear test on May 25, 2009, on the day after the government held a meeting of defense policy specialists to discuss whether or not Japan should possess the capability to attack enemy missile bases. It was reported that many of the 30 or so attendees argued that Japan should posses such an offensive capability.[82] That cruise missiles and bombers were notably mentioned was no surprise, as Japan, at least since 2003, began evaluating the possibility of acquiring U.S. *Tomahawks* for such a purpose.[83] Japanese officials appreciate that *Tomahawks* alone will not meet this counterforce requirement; improved surveillance systems will be needed for precise target identification and characterization. Of course, Japan would also need the cooperation of the United States to achieve these particular attack objectives.

South Asia

Cruise missile ambitions on the part of both India and Pakistan remain center stage as India in particular seeks conventional military advantages, however slight, without provoking nuclear escalation. To that end, both countries view land-attack cruise missiles as survivable nuclear delivery means, while the Indian military exploits its growing arsenal of land, sea, and air cruise missiles as precision conventional fire support systems and a key component of its nascent Cold Start preemptive doctrine.

The reconstituted Soviet-era *BrahMos* multi-role (anti-ship or land-attack) cruise missile is by far the most mature Indian cruise missile program.[84] The product of a truncated Soviet-era anti-ship cruise missile, the 3M-55, which fell prey to the Soviet Union's collapse, *BrahMos* reappeared in the late 1990s when India and Russia formed a joint venture (Russia handles propulsion, India guidance, fire control, and on-board electronics). The missile has a range of 300km and 200 to 300kg warhead options (conventional and nuclear) while traveling at supersonic speeds of between mach 2.5-2.8. *BrahMos* was first tested in 2001 and has undergone over 20 successful tests and been inducted into the Indian army and navy; the air-delivered *BrahMos* awaits a successful 2012 test of a modified, lighter version that requires integration with the Russian Sukhoi Su-30MKI fighter, slated for Indian air force. India's naval version is currently a vertical-launched system, but an underwater version is planned for eventual deployment on Indian submarines, while the missile is also planned for deployment on India's three new stealth warships being built in Russia. The *BrahMos* joint venture also plans to develop a *BrahMos-2*

[82] *The Daily Yomiuri Online* in English, May 28, 2009.
[83] Gormley, *Missile Contagion*, *op. cit.*, p. 81.
[84] See Gormley, *Missile Contagion*, pp. 69-72, for details on BrahMos' evolutionary development.

hypersonic (mach 5-8) cruise missile, but its range will remain 300km due to Russia's MTCR obligations.[85]

BrahMos Aerospace anticipates producing 1,000 missiles to meet India's service requirements and another 1,000 for future export after India's needs are fulfilled. The joint venture has claimed that they can capture 20 percent of the global market for cruise missiles. Various stories have appeared that suggest that the joint venture is overwhelmed with orders for future deliveries of *BrahMos* worth between $10B to $13B, though these claims are contradicted by other reports of a total expected market, foreign and Indian, of $10B.[86]

Uncertainty surrounding India's acquisition of a *Kilo*-class diesel-powered submarine equipped with Russian *Club* 3M-14 land-attack cruise missiles, with a range of 300km, was clarified in late 2008 when delivery finally took place after an extended refit at a St. Petersburg shipyard. India had previously refused to take delivery until the cruise missile's poor performances in test firings at sea were corrected. The Indian navy now has five *Kilo*-class submarines outfitted with the 3M-14E land-attack cruise missile.[87]

India's remaining land-attack cruise missile ambitions are far more opaque than the longstanding *BrahMos* program. In part, this is because of India's substantial dependence on continuing external assistance. For example, the 1,000km-range *Nirbhay* subsonic cruise missile, first disclosed in 2007, was supposed to be set as a technology demonstrator by 2009. Yet, by late 2010, *Nirbhay*'s status remained uncertain; only a hint that the missile would make its public debut at the February 2011 AeroIndia trade show indicated that the program remained under continuing development. An apparent competitor became apparent in 2010. Called simply the "*Long-Range Cruise Missile*" (LRCM), it shared *Nirbhay*'s range of 1,000km but not its subsonic speed. Instead, the LRCM is meant to achieve speeds of mach 3.2 by means of a liquid-fueled ramjet engine, a

[85] "Brahmos Eyes 20% of Global Market Share", *New Delhi Political and Defence Weekly* in English, Vol. 10, No. 36, June 14 to June 20, 2011 and "BrahMos-Fitted Stealth Ship in 2012", Chandigarh, *The Tribune Online* in English, July 20, 2011.

[86] Brazil, South Africa, and Chile are frequently mentioned as interested states. "Brahmos Cruise Missile Contracts Worth $10 Bln – JV Chief", *Moscow Interfax-AVN* in English, June 15, 2011 and "Russia-India Cruise Missile Garners 13bn Dollars' Worth of Orders", *Moscow Interfax-AVN Online* in Russian, September 2, 2010. Such orders seem dubious in light of the lengthy period foreign countries must wait for *BrahMos* deliveries. In late 2010, Russia and India agreed to stabilize *BrahMos'* price out to 2017 in order to service internal Indian requirements, which have priority over foreign deliveries. See Moscow ITAR-TASS in English, December 15, 2010.

[87] Rajat Pandit, "India to Acquire New Undersea Cruise Missiles", New Delhi, *The Times of India Online* in English, August 4, 2008.

purported indigenous design. The nature of any outside assistance remains at best speculative.[88]

If India's LCRM seems mysterious, the highly classified Indian navy program dubbed K-series (alternate names include B-05, *Sararika*, PJ-08, K-15, *Shourya*) surely merits Winston Churchill's "enigma wrapped in a mystery" characterization. The latest manifestation of this 750km-range solid-fuel missile has it as a combined hypersonic ballistic/cruise missile, launched from a submarine or from a ground-launcher, with several boosters that take it outside the atmosphere, the missile re-enters at mach 7 while undergoing a series of terminal maneuvers to cope with missile defenses. It has supposedly undergone 8 successful tests and started a small serial production while a bureaucratic debate rages over how soon it should replace existing *Prithvi* liquid-fuelled ballistic missile units.[89] Fact or fiction, or somewhere in between, the K-series missiles reflect India's desire to be seen as possessing an advanced defense industry.[90]

India's many land-attack cruise missile programs are critically important were India to employ its new Cold Start preemptive doctrine. In a Wikileaks document consisting of a U.S. embassy New Delhi appraisal of the Indian army's 2004 Cold Start Doctrine, the doctrine was seen as "a mixture of myth and reality," principally due to "substantial and serious resource constraints" facing India.[91] Executed within 72 hours from a standing start, Cold Start consists of *blitzkrieg*-like shallow penetrations of Pakistani territory by newly configured integrated battle groups supported by long-range fire support from the Indian air force and navy. Such a lightning strike would present Pakistan with a *fait accompli* from which India would have a putative negotiating advantage. While the embassy appraisal

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[88] According to an *Aviation Week & Space Technology* account, the Indian LRCM resembles the French ASMP-A supersonic cruise missile, and like the latter system, which delivers a nuclear warhead, the India system is designed to do so as well. Curiously, in September 2006, India sought to establish technology assistance with France's MBDA, the developer of the ASMP-A, but the deal fell through. By 2010, a framework agreement for technology cooperation was in place with MBDA, although it remains uncertain whether or not the agreement covers support to India's LRCM program. On LRCM and the Franco-Indian cooperation, see "Indian Cruise Missile Developments Proliferate", *Aviation Week & Space Technology*, September 13, 2010, p. 33. The Indo-French relationship, however, does appear slated to include co-production of short-range surface-to-air missiles, however. See "India, France to Co-Produce SA Missiles", *New Delhi Political and Defense Weekly* in English, Vol. 2, No. 10, December 14-December 20, 2010.

[89] Sandeep Unnithan, "The Secret 'K' missile family", *India Today*, November 20, 2010, available at: http://indiatoday.intoday.in/site/story/the-secret-k-missile-family/2/120488.html.

[90] On India's dependence on foreign assistance, see Gormley, *Missile Contagion, op.cit.*, pp. 101-102. For an appraisal of how India intends to pursue improved defense modernization, see Barath Gopalaswamy and Guy Ben-Ari, "India's Defense Production Policy: Challenges and Opportunities", *India in Transition*, Philadelphia, University of Pennsylvania Center for the Advanced Study of India, August 1, 2011.

[91] "COLD START – A DAO PERSPECTIVE", REF: IIR 6 0101 10, Wikileaks, available at: http://www.guardian.co.uk/world/us-embassy-cables-documents/248971.

reflected on logistical difficulties and slow reinforcement limitations facing India, it did not consider the critical importance of long-range conventional fire support to Cold Start's effective implementation (putting aside the huge risks of nuclear escalation). As one India military specialist observed, "The entire success of 'Cold Start' war doctrine would overwhelmingly rest on the application of long range devastating fire power and this would have to include SRBMs [*short-range ballistic missiles*] and cruise missiles."[92] Seven years after Cold Start's introduction, India has only recently begun to outfit its army units with *BrahMos* regiments and navy ships with vertical launchers for *BrahMos*. And Indian longer-range subsonic, supersonic, and hypersonic cruise missiles remain more conceptual than actual, meaning that they are years away from successful deployment. Pakistan, for its part, reacted to Cold Start's ambitious pretensions by testing the so-called *Nasr* battlefield range – 60km – ballistic missile in April 2011, in effect implying that should India ever truly develop a Cold Start capability, Pakistan's retort would be a nuclear one.[93] Given the escalation risks involved in implementing Cold Start doctrine, Should these intemperate developments continue unchecked, South Asian stability would clearly not be well-served.

Middle East

As Israel has increasingly sought to improve its ballistic missile defenses through acquisition of American *Patriot* missile defenses and its own, with U.S. financial and technical support, *Arrow* missile defense deployments, it has hastened Iran's efforts to seek longer-range land-attack cruise missiles to complicate, or work around, such defenses. Like China, who has supplied Iran with several anti-ship cruise missiles, Iran is believed to have used the Chinese HY-2 (or possibly also the HY-4) anti-ship cruise missile as test bed for developing longer-range land-attack systems. Several hundreds of these are reported to already exist in Iran's missile inventory with at least a range of 300km and a payload of 500kg.[94] Other new developments like the 350km-range *Raad* cruise missile, which bears a Chinese HY-2 lineage, may come in both anti-ship and land-attack versions. And new Iranian anti-ship missiles, such as the *Nur* and the recently revealed *Ghader*, seem like derivatives of the Chinese C-802. Because such designs are smaller in volume to the HY-series of missiles, they are not best suited as candidates for ranges probably greater than 300km.

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[92] Subhash Kapila, "India's New 'Cold Start' War Doctrine Strategically Reviewed", South Asia Analysis Group, Paper No. 991, April 5, 2004, available at: http:///www.southasiaanalysis.org/papers10/paper991.html. Another dimension constraining Cold Start's implementation is India's longstanding interservice rivalries and the problematic extent to which the Indian air force and navy would be truly willing to support an army-conceived doctrine. See Walter C. Ladwig, III, "A Cold Start for Hot Wars? The Indian Army's New Limited War Doctrine", *International Security*, Vol. 32, No. 3, Winter 2007/08, pp. 158-190.

[93] For a useful debate on whether or not Pakistan could develop a small fission warhead for such a small-diameter missile, see Jeffrey A. Lewis, "Pakistan's Nuclear Artillery?", *ArmsControlWonk.com*, December 12, 2011, available at: http://lewis.armscontrolwonk.com/archive/4866/pakistans-nuclear-artillery.

[94] Gormley, *Missile Contagion, op.cit.*, pp. 62-63 and 67-68.

Iran appears headed toward seeking a cruise missile with sufficient range to attack Israel and possibly targets in Europe. A new Iranian cruise missile, with possibly South African origins, is the *Karrar* aerial drone, that Iranian officials claim has a 1,000km range but only a 230kg payload.[95] According to Flightglobal, the *Karrar* is a modified version of the South African *Skua* target drone, which Iran may have acquired from one of three export customers of the *Skua*, according to the South Africa manufacturer, Denel. Israel seems most concerned about Iran's ambitions to exploit the 12 Kh-55 long-range cruise missiles purloined from Ukraine's inventory in 2001. Addressing Israel's first multinational ballistic missile defense conference in May 2010, Yair Shamir, head of Israel Aerospace Industries, claimed that Iran was extending the Kh-55's range and also adapting it for air launch from one of their aircraft (the SU-24 probably being the best candidate). The range of such a cruise missile would enable Iran to launch missiles against Israel or parts of Europe without leaving its own airspace. Although this assessment appears overstated, it does express an important concern evident in Shamir's comment that "The pace of [cruise] missile development [in Iran] is much faster than that of the solutions."[96] Put more explicitly, Israel's capacity to develop effective cruise missile defenses may prove more problematic and costly than Iran's struggle to develop such a strike capacity.

What constraints face Iran in exploiting the 12 Kh-55 cruise missiles in its possession? If these samples were acquired for so-called "reverse engineering," it is important to keep in mind several critical factors that shape the outcome of such a tedious and time-consuming endeavor.[97] The process entails working backwards from the sample in hand to reconstitute design information in enough exacting detail and to precise engineering tolerances so that reproduction of each and every part of the sample can be accomplished. For Iranian engineers to accomplish this demanding task without external assistance is doubtful. Soviet and Chinese reverse engineering of German and Soviet missiles depended in part on having access to the original designers who could assist them with learning about the processes and specialized equipment needed to build production prototypes of the sample missiles.[98] Once appropriately detailed engineering blueprints are available and the exploiting engineering staff has accumulated enough knowhow to support prototype development, Iran

[95] "Iran Bomber Drone Reveals New Sophistication", *Flight Daily News*, August 24, 2010, available at: http://www.flightglobal.com/articles/2010/08/24/346473/iran-bomber-drone-reveals-new-sophistication.html. Of course, such a payload is more than adequate to suffice for delivering a biological payload, which is more effectively delivered via a cruise than ballistic missile.

[96] "Iran builds nuclear-capable cruise missile able to strike Israel from afar", *DEBKAfile*, May 5, 2010, available at: http://warsclerotic.wordpress.com/2010/05/11/iran-builds-nuclear-capable-cruise-missile-able-to-strike-israel-from-afar/.

[97] Gormley, *Missile Contagion, op. cit.*, pp. 67-68. As head of foreign intelligence at the U.S. Army Harry Diamond Laboratories in Washington, D.C., the author experienced first hand the challenges of exploiting Soviet-era military equipment for reverse-engineering purposes.

[98] For an excellent evaluation of the limits and constraints of reverse engineering, see Mark Fitzpatrick (ed.), *Iran's Ballistic Missile Capabilities: A Net Assessment*, London, IISS, 2010, p. 69.

would need to establish a production capability, including special production tools, testing equipment, and raw materials, much of which is subject to tight export controls. Even if Iran could manage to get this far, the stiffest challenge remaining would entail reverse engineering the small turbofan engine needed to produce the 2,500-3,000km range of the Kh-55. Here outside assistance from China, Russia, or Ukraine would likely be essential and what might emanate from such an effort might not look like the original sample but more like a reinvented Iranian version with hints of external assistance embedded within the "new" missile.[99]

Another option would be for Iran to deploy a few of the Kh-55s missiles as part of their overall missile inventory. The Iranian deal to acquire the 12 cruise missiles from Ukraine's inventory reportedly included a Kh-55-associated ground-targeting system along with service support, including visits by Ukrainian technical specialists. While this may give some slight credence to a report from a former head of the Iran resistance movement that some of the missiles were transferred to Iran's Revolutionary Guard missile units and are now deployed, such a claim would mean that Iran had solved the problem of developing a small rocket booster to launch the missile from the ground or the more demanding challenge of adapting the missile for launch from Iran's Su-24MK *Fencer*. In either case, such a course would likely necessitate expending perhaps half of the 12 missiles for testing purposes.

Israel certainly assumes that Iran will inevitably and successfully exploit the fruits of its Kh-55 acquisition. Besides Yair Shamir's warning previously noted, Uzi Rubin, former head of Israel's Missile Defense Organization, assumes that Iran will ultimately succeed in producing a strategic cruise missile based on the Kh-55 exploitation, but likely only after gaining the assistance of the other recipient of Kh-55s – China – and perhaps the cooperation of its ballistic missile partner, North Korea.[100] To the extent that China remains simply an adherent – albeit one with convenient omissions – of the MTCR and not a full and abiding member of that regime, Beijing will likely continue its selective support to preferential clients such as Iran. Indeed, China's desire to become an MTCR member has not occurred due to its inconsistent implementation record vis-à-vis MTCR standards.[101] China has continued its missile-related activities with Iran in spite of repeated U.S. sanctions. After the Bush administration imposed sanctions on Chinese entities on 20 occasions, the Obama administration has done so six times for missile and other weapon proliferation activity.[102] In any event, hints that Iran has succeeded in exploiting the Kh-55 are reflected in two recent reports, one in late August 2011 stating that Iran planned to unveil a new cruise missile shortly with a longer range than the current *Shabab-3* ballistic missile – meaning a range

[99] *Ibid.*, pp. 34-35 and 69.
[100] Uzi Rubin, "The Global Range of Iran's Ballistic Missile Program", *Jerusalem Issue Brief*, Vol. 5, No. 26, June 20, 2005, p. 28.
[101] Gormley, *Missile Contagion*, pp. 159-160.
[102] "China uncommitted, aiding nuke proliferation: US report", *Firstpost.com*, June 16, 2011, available at: http://www.firstpost.com/world/china-uncommitted-aiding-nuke-proliferation-us-report-26448.html.

of over 2,000km;[103] the other, a May 2010 report from an Israeli think tank director who works closely with the Israeli air force who claimed that Iran had already displayed a cruise missile that looked very similar to the U.S. *Tomahawk*.[104] Although the reliability of any new Iranian strategic cruise missile may be questionable, Israel has reason for concern given its exclusive emphasis on ballistic missile defense.

Russia

Russian cruise missile developments bear watching for several reasons. Russian military experts state that their own military facilities, including hardened missile silos, are vulnerable to U.S. land-attack cruise missiles armed with conventional warheads.[105] This assumption is not just based on a simple damage estimate but also on the assumption that cruise missiles can readily penetrate current Russian missile defenses, including the S-300 and S-400 systems with purported capabilities against cruise missiles. A further example of this appreciation is the Russian response, in 2007, to then-U.S. plans to deploy elements of a missile defense system in Poland and the Czech Republic. It included testing two new missiles: one, the R-24 intercontinental-range ballistic missile, the other, the R-500 land-attack cruise missile (deployable on the *Iskander* transporter-erector-launcher), both of which were expected to penetrate planned U.S. missile defenses. After the 2007 test of both missiles, Moscow's *Izvestiya* proclaimed that in regard to the R-500 cruise missile, "neither the National Defense system (it has not been designed for this principle) nor even the most modern *Patriot* surface-to-air missile systems are capable of noticing, still less intercepting such a target."[106]

Undoubtedly the most provocative cruise missile development on Russia's part is the marketing, commencing in early 2010, of the *Club-K Container Missile System*, colloquially know as a "cruise missile in a box," or more recently, "*Pandora's Box*." The system consists of four land-attack or anti-ship cruise missiles in a standard 12m shipping container, together with an associated compartment for two launch personnel and all necessary communications and targeting systems. The container is configured to be carried on a truck, merchant ship, or on a flatbed railcar, in an entirely covert manner. *Club-K* first appeared in an animated film depicting a small country employing the system against a much larger and

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[103] "Report: North Korea sent nuclear software to Iran", Harretz.com, August 24, 2011, available at: http://www.haaretz.com/news/middle-east/report-north-korea-sent-nuclear-software-to-iran-1.380409.

[104] "Israeli aerospace official: Iran cruise missile poses 'extremely serious' threat", WorldTribune.com, May 6, 2010, available at: http://www.worldtribune.com/worldtribune/WTARC/2010/me_iran0382_05_06.asp.

[105] See, for example, Eugene Miasnikov, "Advanced Conventional Capabilities and Their Impact on Arms Control", Remarks at the International Workshop "Russian Interests and Western Priorities: The Future of Arms Control in Europe", Friedrich Ebert Stiftung, Berlin, Germany, May 12-13, 2011, available at: http://www.armscontrol.ru/pubs/en/em051211.html.

[106] On these tests and the press reaction, see Gormley, *Missile Contagion, op.cit.*, pp. 60 and 122.

well-equipped military force.[107] At its first appearance at an international defense exhibit in Malaysia in 2010, the Russian exhibiters marketed the system at any country threatened by the United States. Iran and Venezuela have reported to have shown interest in the *Club-K* system.[108]

The *Club-K* features the Novator Design Bureau's *Club* family of cruise missiles, including the land-attack 3M-14, with a stated range of 300km and a payload of 450kg, as well as the anti-ship 3M-54 with a similar range and payload. Other cruise missiles may be added to the offering in the future.

Not surprisingly, the initial U.S. reaction to the appearance of *Club-K* system's marketing campaign prompted a posting of news accounts on the system by the Department of Homeland Security's "National Terror Alert" news feed.[109] The initial summary of accounts focused expressly on reported Iran's and Venezuela's interest in the system, as well as the dire consequences should such a system fall into the hands of a terrorist group. Apparently feeling under the gun because of the resounding criticism of such a marketing package, the Russian marketing company, Concern Morinformsystem-Agat, downplayed the negative reaction as hysterical propaganda, while observing that small countries have the right to protect their sovereignty by threatening larger countries with "unacceptable damage."[110] Not too long after the firestorm, the Russian marketing organization removed it from use and essentially, if only temporarily, erased the *Club-K*'s web presence. It reappeared recently when the *Club-K* system was displayed at the Russian MAKS 2011 in August 2011.[111] Earlier in the year, the *Club-K* was also on display at a naval defense exhibit in St. Petersburg, all of which suggests that any initial timidity about the *Club-K*'s provocative employment and deployment configuration had evaporated.

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[107] "Club-K Container Missile System", available at: http://www.youtube.com/watch?v=9xupOQSvnas .

[108] Thomas Harding, "A cruise missile in a shipping box on sale to rogue bidders", *Telegraph*, April 25, 2010, available at: http://www.telegraph.co.uk/news/worldnews/europe/russia/7632543/A-cruise-missile-in-a-shipping-box-on-sale-to-rogue-bidders.html.

[109] "Russian Company Markets Hidden Cruise Missile System", *National Terror Alert*, April 25, 2010, available at: http://www.nationalterroralert.com/2010/04/29/russian-company-markets-hidden-cruise-missile-system/.

[110] Ron Synovitz, "Russian Firm Denies 'Cluk-K' Missiles Could Be Used by Terrorists", *Radio Free Europe/Radio Liberty*, April 29, 2010, available at: http://www.rferl.org/content/Russian_Firm_Denies_Club_K_Missiles_Could_Be_Used_By_Terrorists/2027728.html.

[111] For photographs of the Club-K exhibit, see http://worldwide-defence.blogspot.com/2011/09/club-k-container-missile-system.html. According to an attendee, the 12m container includes everything needed to employ the system with precision, including a power generator to erect the container for launch, an auxiliary power unit, command and control, targeting, navigation. One container command and control system can command several nearby containers' missiles, if desired. The system is ready for delivery immediately and export discussions are claimed to already be underway.

Plausible Threats and Affordable Responses

In light of China's recent and continuing build-up of advanced and conventionally armed land-attack cruise missiles, surely U.S. planners deserve to be concerned about current and future anti-access strategies in the Northeast Asian context. Anyone concerned about stability in South Asia also should be concerned about the continuing buildup of both cruise and ballistic missiles, as well as the respective nuclear arsenals, especially in light of India's seeming dependence on a risky preemptive strike doctrine (Cold Start) and Pakistan's all-too-frequent dependence on fostering terrorist attacks on India soil. And Israel certainly has reason to worry about Iran's land-attack cruise missile ambitions as a means of working around Tel Aviv's substantial investment in ballistic missile defense.

This paper by no means represents the first attempt to demonstrate concern about the plausibility of the cruise missile threat in a European context.[112] The question here is similar to the one Israel faces in regard to the evolution of Iranian cruise missile threats: NATO has committed the Atlantic Alliance to defend both its forces and population against missile threats, but the focus is only on the ballistic missile threat. On September 17, 2009, President Obama launched the European Phased Adaptive Approach (PAA) designed to deal with the threat of Iran's short- and medium-range ballistic missiles in a first phase (2011); expand the defended area with improved interceptors and radars as Iran's ballistic missile threat matures (2015); deploy even more effective interceptors to counter intermediate-range ballistic missiles (2018); and, finally, develop and deploy the most advanced interceptor to defend U.S. and NATO territory against the predicted availability of an Iranian intercontinental ballistic missile (2020). As noted earlier, the logic behind the Obama administration's decision to launch the PAA stemmed from intelligence assessments indicating that Iran's near-term threat of shorter-range ballistic missiles that can threaten Europe has developed more rapidly than Iran's progress toward achieving an ICBM that could threaten the United States. Threat assessment is no less important in regard to Iran's cruise missile

[112] It is fair to say, however, that European authors seem more concerned about the future viability of Western force projection strategies than direct cruise missile threats to European population centers. See, for example, Corentin Brustlein, *Toward the End of Force Projection? I. The Anti-Access Threat*, *Focus stratégique*, No. 20*bis*, Paris, French Institute of International Relations, July 2011; Bruno Gruselle, *Cruise Missiles & Anti-Access Strategies*, Paris, Foundation for Strategic Research, June 2006; and Marc Oprach, "Cruise Missile Threat", *Journal der Politisch-Militarischen Gesellschaft,* Vol. 62, March 2010, pp. 10-14.

ambitions, especially because Iran appreciates that cruise missiles can actually enhance the effectiveness of its ballistic missile arsenal in penetrating missile defenses. This is reason enough to examine the plausibility of Iran's cruise missile threat to NATO.

How Plausible is the Iranian Cruise Missile Threat to Europe?

Threat assessment is a mixture of evaluating both a potential adversary's capability and intentions with respect to fulfilling its apparent ambition to penetrate missile defenses. For example, at first glance, Iran's various shorter-range (~300 to 500km) cruise missile programs, as well as its reported interest in the Russian *Club-K* container system, seem less indicative of an intention to threaten NATO territory than does Tehran's acquisition of 12 Russian Kh-55 strategic range cruise missiles.[113] Although Iran might perceive some advantage from threatening other nations via long-distance missile strikes from its own territory, doing so with a ballistic missile is certain to be detected and attributed to Iran. This is less so the case with a cruise missile, which produces not nearly the infrared signature of a large ballistic missile. That said, the attribution advantages that a cruise missile possesses apply just as well were the missile launched from an area closer to NATO territory. In this latter regard, among one of the chief virtues of several that cruise missiles posses is their multiple launch possibilities from a variety of platforms. As Albert Wohlstetter wrote long before cruise missiles became a threat to U.S. or NATO interests:

> They might be launched from concealed land locations at modest distances from their targets; or brought within range and launched from freighters, diesel or nuclear-propelled submarines or other boats so numerous and so varied that they would be hard to distinguish and track. Such "two-stage" delivery of cruise missiles could present a threat here at home as well as threat to our forces or allied forces or civilians abroad. Moreover, they might be part of a serious but isolated terrorist threat, or they might be one important component of a widespread military attack.[114]

Consistent with Wohlstetter's warning, Iran seems bent on bringing its capacity to conduct such two-stage attacks within reach of NATO territory. In February 2011, Iran sent two naval ships into the Mediterranean Sea for the first time in 30 years. Responding to an Israeli criticism of Iran's interest in expanding its regional reach, Iranian Admiral Habibollah Sayyari, who commands the Iranian Navy, told reporters that the purpose of

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[113] Providing a deliverable nuclear warhead for any reverse-engineered Kh-55 would place stiff demands on Iranian nuclear designers. The Kh-55 has a diameter of roughly 51cm and a payload weight of 400-450kg. Aided perhaps by Chinese specialists, Iran could eventually succeed in such an endeavor, which in many respects would be easier than doing the same for their ballistic missile program. The latter would have to be designed to successfully undergo the heat, extreme G-loading, and shock of atmospheric re-entry, a problem aerodynamic cruise missiles avoid. Cruise missiles also would be substantially more effective means of biological weapons delivery than a ballistic missile.

[114] Albert Wohlstetter, Foreword to K. Scott McMahon and Dennis M. Gormley, *Controlling the Spread of Land-Attack Cruise Missiles*, Marina del Rey, American Institute for Strategic Cooperation, 1995, p. 7.

operating in the Mediterranean once again was to reinforce Iran's defense capabilities.[115] More recently, on July 18, 2011, Admiral Sayyari disclosed plans to send a naval squadron into the Atlantic Ocean, noting more expansively: "Being present in the Mediterranean Sea, Suez Canal, southern Indian Ocean, and open waters is still on the Navy's agenda."[116] He went on to observe that the Iranian naval squadrons and submarines that would operate in such waters would be equipped with appropriate missiles, noting specially the *Nur* anti-ship cruise missile capable of carrying out "long-range missions."

Iran's quest to expand its naval presence is not just the wish of its traditional naval service, the Islamic Republic of Iran Navy (IRIN); equally supportive is the post-1979 Islamic Revolutionary Guard Corps Navy (IRGCN). Moreover, Supreme Leader Ayatollah Ali Khamenei has strongly endorsed Iran's naval expansion into areas outside of the Persian Gulf.[117] Worrisome from the standpoint of potential covert use of merchant vessels for military purposes is the close linkage between the IRIN, IRGCN, and the Islamic Republic of Iran Shipping Lines (IRISL), which controls Iran's fleet of merchant ships. Iran has purposely made the relationship between these entities opaque to enhance their success in skirting U.N. sanctions.[118] Among the strategies Iran has devised is obscuring the true ownership of its merchant vessels by using shell companies from Europe to Asia.[119] Iran's navy, too, has begun to mimic – albeit less demonstrably – China's efforts to protect access to oil, gas, and technology by financing the construction of deep-water ports in Asia.[120] Overall, while Iran's intentions to expand its naval presence both eastward and westward may appear less militarily significant than symbolically consistent with the Shah of Iran's ambitions to reconstitute Persia's grandeur, it would be shortsighted not to look closer at what these nascent ambitions might provide in terms of threatening NATO territory over time with missile attacks.

Were rumors that Iran was about to announce that it had developed a land-attack cruise missile with a range that exceeded the *Shabab-3* ballistic missile (~2,300km) to materialize prove true, that would place Iran

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[115] "Iran Says Navy Ships in Mediterranean Not Aggression", February 28, 2011, *Voice of America*, available at: http://www.voanews.com/english/news/middle-east/Iran-Says-Navy-Ships-in-Mediterranean-Not-Aggression-117066318.html.

[116] "Iran Navy to Send Squadron to Atlantic Ocean", *Tehran Fars News Agency*, July 18, 2011.

[117] "Iranian Navy's presence in open seas uplift's nations: Leader", MEHRNEWS.com, July 24, 2011, available at: http://www.mehrnews.com/en/newsdetail.aspx?NewsID=1366527.

[118] "Iran in 'alarming' breaches of UN sanctions, envoys", *Dawn.com*, June 24, 2011, available at: http://www.dawn.com/2011/06/24/iran-in-alarming-breaches-of-un-sanctions-envoys.html.

[119] Jo Becker, "Web of Shell Companies Veils Trade by Iran's Ships", *New York Times*, June 7, 2010, http://www.nytimes.com/2010/06/08/world/middleeast/08sanctions.html?pagewanted=all.

[120] Reportedly, such construction projects have commenced in Sri Lanka, Bangladesh, and Myanmar. See Jamsheed K. Choksy, "Why Iran's Blue-Water Naval Ambition Matters", *The American Interest*, August 5, 2011, available at: http://www.the-american-interest.com/article.cfm?piece=1025.

on a course to threaten NATO countries in southeast Europe (Turkey, Greece, Bulgaria, Romania). As previously noted, such a development would hinge critically on outside technical assistance, most notably, the provision of support in the propulsion area. A more likely avenue of approach for Iran would appear to be a two-stage solution to threatening NATO territory from the Mediterranean or possibly even the Atlantic. A cruise missile with a range of 700km, launched from outside territorial waters, could strike most of the population and industry of Europe. Indeed, even a 300km-range cruise missile, like the *Club* 3M-14 being marketed by Russia, if covertly launched from a merchant ship outside territorial waters, would still be able to target NATO countries in immediate proximity to those waters. The critical variable here is Russia's willingness to sell such a missile to Iran, which is perhaps problematic at best until U.N. sanctions against Iran are no longer in place.[121] Finally, Iran may wish to use the reportedly converted HY-2/HY-4 land-attack cruise missiles it possesses for launching off of naval vessels or merchant ships.

Should sanctions be removed against Iran, prospects that Russia would provide Iran with either the complete *Club-K* container system (one of which comes with 4 *Club* missiles) or the *Club* 3M-14 cruise missile, which Iran would have to adapt for launching from a 12m standard shipping container, are quite possible. The MTCR, however, has some nominal bearing on that eventuality.

Russia is now a full-fledged member of the MTCR and thus subject the regime's export provisions. Surely, other MTCR member states could exert enormous diplomatic pressure to dissuade Russia from such a sale. Still, in the end, the MTCR is a voluntary accord in which member states must make their own decisions.

There are several past precedents that could work in Russia's favor in regard to a *Club* missile sale to Iran. Key member states, including the United States, France, and the United Kingdom (U.K.), have on occasion exercised the "rare exception" principal to the otherwise voluntary commitment not to transfer (sell) Category I cruise missiles – those with a

[121] Flynt Leverett, a former National Security Council official, believes that sanctions are "substantively weak," particular those dealing with financial services. While the U.S. and its allies will abide by them, Leverett argues that the net effect will be "to reallocate business opportunities in Iran from Western states to China and other non-Western powers." Cited in Colum Lynch and Glenn Kessler, "U.N. imposes another round of sanctions on Iran," *Washington Post,* June 20, 2010, available at: http://www.washingtonpost.com/wp-dyn/content/article/2010/06/09/AR2010060902876.html. U.N sanctions against Iran include U.N. resolutions 1837, 1747, 1803, and 1929, the last of which froze the assets of the Iranian Revolutionary Guard and Islamic Republic of Iran Shipping Lines, which controls that country's merchant shipping fleet. However, Iran has employed a range of tactics, including changing a vessel's registered name or owner, creating shell companies, sailing under flags of convenience, and even disguising these vessels. See Mehrafarin Bahrami, "Tehran's Merchant Fleet Sails Close to Wind", *PBS Frontline*, March 18, 2011, available at: http://www.pbs.org/wgbh/pages/frontline/tehranbureau/2011/03/tehrans-merchant-fleet-sails-close-to-wind.html.

capability to carry a 500kg payload or more to at least 300km – subject to the regime's "strong presumption to deny" such transfers. The United States sold *Tomahawk* cruise missile to the U.K. in the late 1990s, while France and the U.K. sold the *Storm Shadow* (renamed *Black Shaheen*) to the United Arab Emirates in the late 1990s and have recently signed a $1.8 billion deal with Saudi Arabia for future deliveries of the *Storm Shadow*.[122] *Storm Shadows* have also been sold to Greece and Italy.

Last but not least is the prospect that the United States will make a rare exception soon in regard to selling the *Global Hawk* surveillance UAV to South Korea and perhaps other Asian states.[123] Although the South Korean deal for four *Global Hawk* UAVs may fall apart due to cost escalation (a nearly doubling of the original estimate of $400 million), the fact that the U.S. government has signaled its willingness to exercise this "rare exception" to the MTCR's Category I guidelines would set an unfortunate precedent for Russia's and China's future behavior regarding cruise missile sales. Indeed, because of strong and persistent industry pressure to open up the large UAV market to foreign sales, the United States took a leadership role in 2006 in attempting, unsuccessfully in the end, to change the MTCR's currently simple criteria for determining Category I cruise missile or UAV. Although details of MTCR deliberations are private, it seems that this attempt to alter UAV rules aimed at loosening controls on large UAVs while tightening them on supersonic cruise missiles that fall just under the current Category I range and payload thresholds.[124] On the surface, such a change would at once enhance prospects for U.S. sales of large UAVs while reducing Russian sales of its various supersonic cruise missiles that fall short of the Category I threshold. These developments might just suggest to Moscow that the MTCR's provisions governing cruise missile and UAV sales may not have the same degree of steadfastness that ballistic missile controls garner, leaving them enough wiggle room to make their own exceptions to the regime's voluntary provisions.

In fact, however provocative the *Club-K* container system may be, the missile itself is not a Category I system – though it would be subject to Category II rules. An MTCR member state can, at its own discretion, export a Category II missile but it must first do so in accord with the regime's guidelines, which note that "particular restraint will … be exercised" in regard to any items or missiles that are judged to be intended for use as WMD delivery means no matter what the range and payload are assessed to be, and "there will be a strong presumption to deny such transfers",

[122] Andrew Chuter, "Saudi Arabia Buys MBDA Storm Shadow Cruise Missile for Tornado Strike Aircraft", *Asian Defense*, February 20, 2010, available at: http://theasiandefence.blogspot.com/2010/02/saudi-arabia-buys-mbda-storm-shadow.html.

[123] Carlo Munoz, "South Korea Turns Up Heat on Global Hawk Deal", *AolDefense.com*, September 26, 2011, available at: http://defense.aol.com/2011/09/26/south-korea-turns-up-heat-on-global-hawk-deal/.

[124] Author interview in November 2006 with a non-U.S. official familiar with these deliberations.

which is the same guideline applied to Category I missiles.[125] Of course, the *Club* cruise missile, given its warhead weight of 400kg, is certainly *capable* of being used as a WMD delivery system. However, Russia could still determine that such a transfer to Iran was not *intended* for use as a WMD delivery system, and based on this finding, obtain end-use assurances from Iran that the missile would not be used for such WMD purposes, or transferred to another state or party.[126] Russia has already sold the *Club* 3M-14 to India and probably China, both of whom are declared nuclear states.[127] While Iran seems bent on producing at least an enabling infrastructure to produce a nuclear weapon, the U.S. intelligence community has stepped back lately on its assessment of Iran's actual possession of either biological or chemical weapons. Instead, the latest public estimate merely states that Iran has the capability to produce them, "if it made a decision to do so."[128] However much other key member states might pressure Russia to desist from such a transfer, not only that country's perceived national interests but also Moscow's longstanding concerns about the evolution of America's future missile defenses and global strike systems would likely shape the ultimate decision. For the immediate future, however, Russia appears steadfast in its commitment to adhere to existing U.N. sanctions prohibiting major arms transfers to Iran.

There is, however, another alternative path available that Iran appears already to have taken: an noted previously, Iran has reportedly extended the range of the HY-2 anti-ship missile by outfitting it with a turbojet engine to permit it to fly land-attack missions to at least a range of 300km carrying a 500kg payload.[129] That distance alone is enough to reach cities in eastern Turkey, Dogubayazit, for example, if launched from northeastern Iran, near Tabriz. A straighter path to such a capability, and one Iran may well have already exploited, too, is to have acquired Chinese HY-4 missiles, which unlike the HY-2's liquid rocket propulsion system, are propelled by a turbojet engine, the WP-11.[130] That would eliminate the need

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[125] The MTCR's guidelines and technical annex are available at http://www.mtcr.info/english/index.html.

[126] China's provision of C-802 cruise missiles ended up being transferred by Iran to Hezbollah, one of which struck and damaged an Israeli naval vessel during the 2006 war, killing four sailors. Interestingly, the ship's missile defense system seems to have been deliberately turned off at that time because Israeli aircraft were operating in the area.

[127] Douglas Barrie, "Russian Cruise Missile Heads for India and Potentially China", *Aviation Week* on-line, n.d., available at: http://www.aviationweek.com/aw/jsp_includes/articlePrint.jsp?headLine=Russian%20Cruise%20Missile%20Heads%20for%20India%20and%20Potentially%20China&storyID=news/08295p03.xml.

[128] See the NTI website, "Iran Profile", March 2011, available at: http://www.nti.org/e_research/profiles/iran/index.html.

[129] Although the turbojet engine Iran has employed in such a missile is not known, Tehran has diligently pursued achieving an indigenous capability to produce its own version of the Microturbo engine, a French design. See James Bamford, *Body of Secrets: Anatomy of the Ultra-Secret National Security Agency*, New-York, Anchor Books, 2002, passim.

[130] The WP-11 engine is a reverse-engineered Chinese version of the U.S. Teledyne-Ryan J69-T41A that powered the Vietnam-era *Firebee* reconnaissance drone.

to replace the liquid-fuel engine, though that is a relatively simple task. The virtue of working with the Chinese HY-series of cruise missiles compared to more modern anti-ship missiles, is their sheer size and simplicity of design, which make them easier to modify. Structural modifications, to add fuel to extend the missile's range, would require producing bulkheads or partitions between compartments and riveting simply shaped aluminum plates to increase the missile's length. In the case of the HY-2, replacing the liquid-fueled engine, bulky autopilot and avionics with a small turbojet engine and GPS/inertial navigation not only greatly improves the missile's accuracy but also frees up additional space for extra fuel to achieve significantly greater range.[131] Iraq's covert effort to transform the Chinese HY-2 missile system into a land-attack system in 2002, called Project *Jinin*, was based on the assumption that in a three- to five-year timeframe, they could achieve a range extension to 1,000km. Anticipating the return of U.N. inspectors in late 2002, Iraq terminated the program after only six months of work. Nevertheless, while their timeframe for the project's completion was overly optimistic, the objective range was not beyond their means.[132] At the very least, it appears quite plausible that Iran could possess such a cruise missile delivery capability certainly no later than it could effectively develop a WMD-armed ICBM capable of striking the U.S. homeland.

Regarding this assessment of plausible Iranian threats to NATO, there is much to keep in mind from the conclusions reached by the non-governmental "Gates Panel," formed at the behest of the U.S. Congress in 1996 to review the underlying assumptions and conclusions of National Intelligence Estimate 95-19, "Emerging Missile Threats to North America During the Next 15 Years."[133] As was noted earlier, while the panel stated that "the Estimate did not give nearly enough attention to the potential for land-attack cruise missiles launched from within several hundred miles of U.S. territory." The panel pointed out that the estimate acknowledged the technical feasibility of such a threat, but didn't believe sufficient motive existed because there were "better ways to deliver a weapon of mass destruction." To the contrary, however, panel members believed that there were several possible reasons and scenarios to support the plausibility of such a threat. Like Albert Wohlstetter's prescient warning about two-stage cruise missile threats made a year earlier, the Gates panel's nearly 16-year-old warning is no less pregnant with meaning today as NATO considers its options for territorial missile defenses.

Affordable Responses to the Threat

Conventional wisdom has it that many of today's air defense systems are capable of not only defending against manned aircraft threats but also low-flying cruise missiles and UAVs. Virtually every manufacturer of these systems advertises that they can deal cruise missile threats. Indeed, the most advanced of these air defense systems, like America's *Patriot*, the

[131] The most difficult task would be acquiring a suitable turbojet engine, such as the HY-4's WP-11, which China would likely be willing to sell Iran.
[132] For my own assessment of the Jinin project, see Gormley, *Missile Contagion, op. cit.*, pp. 63 and 92-96.
[133] For the panel's unclassified report, see "Independent Panel Review of 'Emerging Missile Threats to North America During the Next 15 Years'", *op. cit.*.

Franco-Italian SAMP/T, and Russia's S-300 and S-400, have added the capability to defeat shorter-range ballistic missiles as well. The advertisements are true, but only in a limited sense. Operating on their own, depending as most do on their ground-based radars, without appropriate linkages to airborne radars, these systems come up decidedly short as useful means of defending against earth-hugging cruise missiles and slow-flying UAVs.

Two factors explain why. Most of today's cruise missiles have sleek aerodynamic designs (and increasingly will add stealth features over time). Second, unlike German V-1 cruise missiles that flew at about 3,000m altitude, today's cruise missiles are designed to fly essentially earth-hugging flight profiles, especially as they approach their intended targets, using terrain features to avoid detection. Both airborne but particularly ground-based radars are greatly taxed by these twin realities. Reduced radar observability means that the defense has less time to react. Low flight complicates airborne surveillance due to ground clutter (radar returns from objects on the ground other than the target), which can result in very high noise rates and insufficient signals from the real target to enable its presence to be detected and destroyed in time. For ground-based radars, the earth's curvature limits the distance at which low-flying targets can be detected to just tens of kilometers.[134] As for slow-flying UAVs, today's expensive air defense systems were designed to detect high-performance aircraft and sophisticated cruise missiles, both of which fly at high speeds. Sophisticated low-down radars eliminate slow-moving targets on or near the ground, to prevent their data processing and display systems from being overtaxed. Thus, large numbers of propeller-drive UAVs flying at under 80 knots would be ignored as potential targets. Although ground-based air defense radars might detect such slow-flying threats, the limited radar horizon of these radars, in conjunction with large numbers of UAVs, means that air defense batteries would be quickly overwhelmed and their inventories rapidly depleted.

These shortcomings place a premium on linking ground-based air defenses to elevated sensors, preferably operating as high as possible to broaden the radar detection range to hundreds of kilometers. In fact, without such elevated sensors, any notion of NATO missile defense ambitions growing from point defense of troops and selected high-value targets to one of territorial defense of populations is absurd. Besides such elevated sensors, There are a multitude of other weaknesses, including poor combat identification (discerning friendly from hostile threats), the absence of interconnectivity among a disparate array of military service sensors and shooters, no less between U.S. and its various NATO partners

[134] Russia's 36D6 *Tim Shield* radar can be used to augment the S-300 system to furnish earlier target detection than the system's *Flap Lid* radar. However, when the "missile-sized target" comes in at 60m above the ground, the detection range is 20km away. Modern cruise missiles can use even lower flight profiles to shorten detection further. See http://en.wikipedia.org/wiki/S-300_(missile). Many ground-based radars supporting modern air defenses reduce ground clutter by tilting the search beam back about 3 degrees. This effectively creates a dead space that earth-hugging cruise missiles can exploit.

whose air defense systems might contribute in future. Most notable is providing a common air picture with greatly improved capacity to fuse radar data into what is termed a "single integrated air picture," or SIAP. Without SIAP, any hope of achieving a truly integrated air and missile defense system is inconceivable.[135]

To accomplish anything meaningful, affordability is paramount. American preoccupation with two wars, global terrorism, a severe recession, and the debt crisis surely explains why recently cancelled defense programs bearing on improving cruise missile defense are unlikely to be resurrected in the foreseeable future. The *Medium Extended Air Defense System* (MEADS), a co-developed U.S., German, and Italian air defense system designed principally to replace *Patriot*, arguably would possess improved cruise and UAV defense capabilities, but the program is unlikely now to be procured either by the United States or Germany. Indeed, in order to depart the program, the U.S. Army will have to spend roughly $800m over the next two years on a "proof of concept" its leadership doubts will even work.[136]

Also falling prey to budget stringencies in early 2011 was the U.S. Army's *Surface-Launched Advanced Medium-Range Air-to-Air* missile, called SLAMRAAM. Using the proven technology of the U.S. Air Force *Advanced Medium-Range Air-to-Air* (AMRAAM), the army's version was slated for launch from a five-tube *Hummer* ground vehicle. The Army's primary interest lay in the system's capacity to protect Army maneuver units from cruise missile attacks, but with two wars having taken a toll on the army – not to mention the stiff $650,000 price tag for each interceptor – SLAMRAAM simply fell beneath the budget line.[137]

Much more consequential was the Pentagon decision, in the 2008 defense budget, to cancel the U.S. Air Force's next-generation wide-area surveillance and battle management aircraft, called the *Multi-Sensor Command and Control Aircraft* (MC2A), or E-10A program. This program was originally intended to incorporate the functions of both the airborne and ground surveillance missions of the AWACS (*Airborne Warning and Control System*) aircraft and Joint STARS aircraft, respectively. But for technical

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[135] For a particularly trenchant appraisal of these shortcomings, see Captain Kevin Eyer, U.S. Navy (ret), "Out of Many, One", *Proceedings Magazine*, Vol. 138, No. 1 January 2012, available at: http://www.usni.org/magazines/proceedings/2012-01/out-many-one.

[136] Kate Brannen, "U.S. To Spend $800M as It Leaves MEADS Program", *Defense News*, March 2, 2011, available at: http://www.defensenews.com/story.php?i=5849845.

[137] This price tag, however, compares favorably to a *Patriot* PAC-3 interceptor's cost of $3M per interceptor. However, SLAMRAAM units would have only protected small point targets due to its radar's 75km range and the fact that SLAMRAAM has less range capability because of must be launched from the ground rather than from an aircraft. The U.S. Marines cancelled their version of SLAMRAAM, called CLAWS, in 2006. The Norwegian version, called NASAMS, is used around Washington, D.C., complementing U.S. Army *Avenger* air defense units.

and cost reasons, the Pentagon decided that it would be better off keeping airborne and ground-tracking missions on separate platforms.[138]

The most relevant feature of the E-10A aircraft was its revolutionary radar called MP-RTIP for *Multi-Platform Radar Technology Insertion Program*, a wide-scan *Active Electronically Scanned Array* (AESA) radar, which effectively can track very small targets, like cruise missiles, while remaining stealthy itself.[139] The larger the AESA radar's size is – the E-10A's was supposed to be 4 by 21 feet – the more effective the radar becomes in detecting and tracking small airborne targets like cruise missiles. Plans to install a smaller, and thus less effective, 2 by 21 foot AESA radar derived from the M-RTIP program slated for JSTARS were also cancelled the year before the E-10A cancellation, leaving the *Global Hawk* Block 4 unmanned vehicle the only MP-RTIP derivative radar left. But due to it's small 1 by 4-foot AESA radar, the *Global Hawk* will focus on missions other than cruise missile defense.[140] Such a performance limitation would also apply to NATO's *Global Hawk* system selected to meet its requirement for a new Alliance Ground Surveillance system.

The major consequence of not having either the largest MP-RTIP radar in the cancelled E-10A or its medium-sized version in JSTARS is that the U.S. Air Force must rely solely on its shrinking but expensive fleet of F-22s and F-35s, each of which is equipped with an AESA radar, albeit one not able to provide the broad area detection and tracking capacities of E-10A or JSTARS. What's more, also lost for the foreseeable future is a U.S. Air Force capacity to employ large airborne platforms like JSTARS to provide fire control for what would effectively become "air directed surface-to-air missiles," or ADSAMs, including *Patriot* PAC-3, SM-3, and conceivably even allied ground-based surface-to-air missiles (SAMs) like the Franco-Italian SAMP/T air defense system. Horizon limitations of its supporting ground-based radar hamper a *Patriot* interceptor to an effective range of perhaps 25km, despite the fact that the interceptor could fly to an effective range of between 100 to 150km. Directing a ground-based SAMs – known as the ADSAM – from a high-flying airborne platform would greatly expand an individual unit's effective coverage, reducing the need to bunch SAM firing batteries around point targets to provide 360-degree protection against cruise missiles. Importantly, also, such a hypothetical airborne platform could also furnish precision cues to fighters' air-to-air missiles to increase their effective ranges.

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[138] Advances in electronics convinced designers that a single platform could accommodate both the ground and air surveillance missions, but problems inevitably cropped up when the radar was expected to do concurrent missions. For details and a timeline of developments, see "Jumped-up JSTARS: New Technology for Ground Surveillance Planes?", *Defense Industry Daily*, March 15, 2011, available at: http://www.defenseindustrydaily.com/Jumped-up-JSTARS-MP-RTIP-Technology-for-Ground-Surveillance-Planes-05156/.

[139] Simply put, an AESA radar consists of numerous small solid-state transit-and-receive modules. The radar aims its intense beam of radio energy and spreads its broadcasts in such a way as to make them stealthy. Moreover, the array elements can dwell longer on critical parts of the target to positively identify the smallest of targets, notably even stealthy cruise missiles.

[140] Interview with a knowledgeable defense industry official, September 2011.

A couple of relevant, if modest, programs have managed to survive the otherwise dismal diminution of potential U.S. and NATO defense against cruise missiles. The U.S. Navy has upgraded its airborne platform, the *Hawkeye* E-2D, with a powerful AESA radar possessing 360-degree coverage of such difficult-to-detect targets as cruise missiles.[141] Yet, the E-2D's capacity to support the land-battle or broad-area territorial defense is limited by its primary commitment: to help protect U.S. carrier battle groups at sea.[142] However much budget inevitable future budget stringency might further limit using *Hawkeye* E-2Ds over land, this overhead asset represents a valuable commodity in an otherwise limited basket of cruise missile defense options.

Finally, the U.S. Army's component piece of cruise missile defense, called the *Joint Land-Attack Cruise Missile Defense Elevated Netted Sensor System* (JLENS), was originally seen as a lesser-performing complement to the U.S. Air Force E-10. JLENS consists of tethered aerostats, one of which provides surveillance while a second one furnishes tracking illumination to ground-based interceptors. Aerostats are blimp-like balloons using lighter-than-air gas for buoyancy. Once deployed in 2012, JLENS will be able to link up with ground-based *Patriot* batteries and sea-base *Aegis* cruisers outfitted with the new SM-6 missile optimized for dealing with anti-ship cruise missiles and other airborne targets.[143] The more mobile, faster-reacting, weather-insensitive, fixed-wing E-10A or E-8 JSTARS were originally thought – had they survived or been upgraded with MP-RTIP, respectively – more suitable for regional contingencies in which friendly forces must be projected into a hostile combat zone. Deployed at less than half the altitude of its airborne counterparts, JLENS is also more vulnerable to high winds and large caliber ammunition. Its relatively low operating altitude of 4500m also means that JLENS is less capable than higher-flying airborne systems of detecting low-flying cruise missiles that can exploit mountainous terrain features to mask early detection.

Certainly many of the airborne platforms and interceptors just discussed could contribute to defending NATO territory. Yet, all of the weaknesses in defending against cruise missiles in a force projection campaign are magnified by the sheer size and prospective cost of the territorial defense challenge. The North American Aerospace Defense Command routinely detects and tracks ballistic missile launches using spaceborne assets. Doing the same for cruise missile launches would make the homeland defense challenge more straightforward, but space-based sensors capable of reliably detecting and tracking low-flying cruise

[141] The E-2D is the navy's counterpart to the E-3 AWACS. However, whereas the prop-driven E-2D has been upgraded with an AESA radar, which provides robust capacity to provide fire-control-quality tracking information to interceptors, the E-3 AWACS has only improved its surveillance capability to direct aircraft toward incoming cruise missile threats. Thus, the E-2D seems capable of providing tracking information to ground-based interceptors in accord with the ADSAM concept noted earlier above.

[142] Two *Hawkeye* squadrons of E-2Cs were commandeered to provide almost two-thirds of the overland coverage in northern Iraq in support of the 2003 invasion.

[143] The SM-6 will use a larger version of the AMRAAM active seeker used on the AIM-120C air-to-air missile.

missiles are unlikely to become available for another three decades.[144] Without broad area coverage by spaceborne assets, airborne sensors like JLENS or *High Altitude Airships* (un-tethered lighter-than-air vehicles) would have to be deployed with appropriate surveillance and tracking radars linked to ground-based interceptors and aircraft armed with air-to-air missiles.[145]

Optimism about whether or not existing capabilities would suffice to accomplish the task of constructing broad area protection for the U.S. homeland differs widely among specialists. The Pentagon seems less than bullish based on a 2006 disclosure that at least nine major "capability gaps" then existed in providing defense of the homeland, and they were unlikely to be solved until 2015.[146] A much more optimistic expectation was furnished a year after the Pentagon's assessment in a Capitol Hill briefing to congressional staff and media sponsored by the Marshall Center. A Lockheed Martin executive argued that a preferential defense system, protecting the area from Boston to Washington against cruise missiles, could be rapidly deployed for several billion dollars. It would lean heavily on the *High Altitude Airship* and *Patriot* PAC-3 interceptors, although he also presented an alternative concept dependent on four tethered aerostats like the ones that are used along the border with Mexico.[147] The Missile Defense Agency cut the airship program back sharply in 2007 and terminated it altogether in 2008, but the program was resuscitated under the U.S. Army's management.[148] In the end, perhaps even the optimists, who only discuss limited preferential defense against cruise missiles, would agree that spending upwards of $50 to 60 billion for a comprehensive defense of the homeland is unaffordable for the foreseeable future.[149] The same holds true for a territorial defense of NATO member states.

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[144] This estimate is a conservative one based on periodic interviews with industry experts.

[145] Lockheed Martin Corporation has an existing High Altitude Airship program. See http://www.lockheedmartin.com/products/HighAltitudeAirship/.

[146] Among the gaps were inadequate wide-area surveillance, little tracking and high-quality fire-control capability, and low combat identification leading to high friendly-fire incidents. See John Liang, "DoD Finds Cruise Missile Defense Gaps", *Military.com*, August 17, 2006, available at: http://www.military.com/features/0,15240,110199,00.html.

[147] "The Cruise Missile Challenge", Jeff Kueter and David Kier, A Presentation before the American Foreign Policy Council, July 9, 2007, available at: http://www.marshall.org/pdf/materials/557.pdf.

[148] Concern persists within the scientific community over maintaining operational capability of such air ships at stratospheric altitudes due to unpredictable high winds. Still, Lockheed Martin is investigating such airship concepts as a communications relay for the U.S. Army's Space and Missile Defense Command. JLENS also has proven susceptible to the vagaries of severe weather. See "Army JLENS Destroyed in Major Blimp Collision; Program Held Up", *Defensenewsstand.com*, http://defensenewsstand.com/NewsStand-General/The-INSIDER-Free-Article/army-jlens-destroyed-in-major-blimp-collision-program-held-up/menu-id-720.html.

[149] This rough estimate is based on the conclusions reportedly reached by the Pentagon's 1998 National Cruise Missile Defense Study, with adjustments made for inflation. Author interview with industry participant in the study, December 1998.

Concluding Thoughts

Far more feasible and affordable for NATO's approach to its territorial defense ambitions is to acknowledge the need to focus more systematically on the growing cruise missile threat. This should come in the form of a NATO threat assessment of current and emerging cruise missile threats confronting NATO member states. Despite the fact that the Lisbon summit's new Strategic Concept emphasized NATO's need "to be effective in a changing world, against new threats", one suspects that ballistic missile threats will overwhelmingly dominate any substantive threat assessment that the deterrence and defense posture review has undertaken prior to making its report at the Spring 2012 NATO summit in Chicago. Nonetheless, NATO formally should take up the charge to produce a formal cruise missile threat assessment as a key input to deciding what steps should be taken to foster a more evenhanded approach to NATO territorial missile defense. Continuing to focus singularly on ballistic missile threats while publicly ignoring the cruise missile defense challenge will only accelerate the already palpable spread of cruise missiles and UAVs.

What does seem imperative – and affordable – in the near-term is a significant bolstering of programs aimed at providing early strategic warning of potential threats emanating from suspect container ships and Iranian naval squadrons operating in both the Mediterranean and Atlantic. This would largely fall on NATO member navies but should also include improved intra-state and inter-state collaboration and coordination of coastguard or equivalent agencies to help improve monitoring and inspections of suspect vessels. Closer collaboration among the intelligence organizations of NATO member states is also imperative. Among other benefits, this could improve collection and analysis of insurance and commercial shipping records to detect fabrication practices that Iran shipping agencies and companies acting on their behalf routinely employ to evade international sanctions, or potentially, to use a shipping vessel as a missile-launch platform.

Improved strategic warning is not only imperative to conduct more effective inspections of suspect vessels; it is the essential link to an alert force of fighter aircraft equipped with AESA radars to respond to strategic warnings. Here much work needs to be accomplished in advance to work out rules of engagement to preclude fratricide, or more likely, taking no action due to detection uncertainty. This would be far less a problem to dwell on seriously were the threat emanating from one ballistic missile and several aircraft threat vehicles instead of one cruise missile. This is the case because of the absence of a truly wide-area detection and tracking capability that would come from an appropriately equipped airborne

platform, a *High Altitude Airship*, or a tethered sensor. Aircraft sensors would have comparatively little time to detect, track, and fire upon the incoming cruise missile, which only underscores the importance of strategic warning and quick reaction to it.

NATO's quest to pursue territorial missile defense will no doubt occur in fits and starts – the inevitable by-product of defense budget reductions and important tradeoffs in defense planning, all of which will complicate rather than ease the path along the way. This has certainly been the case for NATO's Active Layered Theater Missile Defense program. Indeed, the Obama administration's much more ambitious PAA is already showing signs of not being able to meet its stiff objectives. The Phase 2 SM-3 IB missile has been plagued with development problems, which has prompted Senate appropriators to raise concerns about the overlapping development of three new interceptors. They have therefore recommended that the Phase 3 variant SM-3 IIA be eliminated in order to shift funds to the other two variants.[150] If nothing else is certain about NATO territorial missile defense, it is that further spending cuts – in all NATO states – will complicate the program's future. But to proceed as if ballistic missiles were the sole missile threat facing NATO, without due attention to affordably addressing the cruise missile challenge, would indeed be penny wise and pound foolish.

[150] Frank Oliveri, "Senate Appropriators: Missile Defense Component Should Be Eliminated", *CQ Today*, October 3, 2011.

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