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Assessments

BACKGROUNDER

November 9, 2004

THE CRUISE MISSILE CHALLENGE OVERVIEW

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INTRODUCTION

The growth of foreign ballistic missile arsenals has received considerable attention in recent years. Less noticed has been the spread of increasingly capable cruise missiles. The 2003 Iraq War showed that while the United States has made strides in protecting its forces against ballistic missiles, it has yet to address the threat posed by cruise missiles. While US and Kuwaiti Patriot theater ballistic missile defense (TBMD) batteries intercepted and destroyed all nine of the ballistic missiles the Iraqi military launched at military targets, they failed to detect or intercept any of the five HY-2 Seersucker cruise missiles launched against Kuwait. One came close to hitting Camp Commando, the US Marine Corps headquarters in Kuwait, on the first day of the war. Another landed just outside a shopping mall in Kuwait City. The missiles also contributed to fratricide that caused the loss of two coalition aircraft and the death of three crewmembers.[1]

This paper provides an overview of the cruise missile challenge. It argues that while cruise missiles are hardly new, technological developments are making them increasingly lethal. Cruise missiles have a number of characteristics that make them desirable as weapons; the dominance of US air forces and the demonstrated effectiveness of US ballistic missile defenses may further increase their attractiveness. As a result, the United States and its allies are likely to face a growing cruise missile challenge in coming years.

A BRIEF HISTORY OF THE CRUISE MISSILE

The cruise missile has played a prominent role in recent US military operations. Throughout the 1990s, the Tomahawk cruise missile appeared to be the embodiment of US military power. The United States used more than 2,000 sea-launched BGM-109 Tomahawk Land Attack Missiles (TLAM) and air-launched AGM-86D Conventional Air-Launched Cruise Missiles (CALCM)

[1] Dennis M. Gormley, "Missile Defense Myopia: Lessons from the Iraq War," Survival 45, No. 4 (Winter 2003-04), pp. 61, 63, 66.

in Iraq, the former Yugoslavia, Afghanistan, and Sudan.[2] During Operation Iraqi Freedom's major combat operations alone, the United States launched 802 TLAM and 153 CALCMs.[3] Similarly, cruise missiles have played a prominent role in recent naval operations, including the Falklands War, the Iran-Iraq War, and US strikes against the Libyan and Iranian navies.

Cruise missiles first appeared on the battlefield in World War II. Between June 1944 and March 1945, Germany launched approximately 10,000 V-1 cruise missiles against Britain (primarily London) and more than 6,000 against Belgium (primarily Antwerp). Early Cold War missile development focused on the cruise missile as well. The United States, for example, deployed the Matador, Mace, and Snark ground-launched cruise missiles and developed the longer-range Navaho. The Navy fielded the surface- and sub-launched Regulus.[4] The Soviets tested, but did not deploy, an intercontinental cruise missile as well.[5] Such early weapons suffered from poor navigational accuracy and vulnerability to air defenses. As a result, they were soon eclipsed by ballistic missiles, which were faster and less vulnerable. The exception was at sea, where cruise missiles continued to dominate.

Between the 1950s and the 1980s, improvements in engine, materials, fuel, and guidance technology transformed the cruise missile, making it a more effective weapon.[6] The result was cruise missiles such as the Tomahawk, first deployed in 1984, and its Soviet counterpart, the SS-N-21 Granat, deployed in 1987.

Current trends are further increasing the effectiveness of cruise missiles. Indeed, the same technologies that undergird the emerging revolution in military affairs (RMA) have made cruise missiles highly effective weapons. Until the late 1980s, accurate land-attack missiles required the use of sophisticated guidance and navigation technologies—such as high accuracy inertial navigation systems (INS), Terrain Contour Matching (TERCOM), and Digital Scene Matching Correlation (DSMAC)—that were expensive and regulated by strict export controls. Now, however, precision navigation systems, such as those that use signals from the GPS satellite constellation, allow cruise missiles to land within feet of their intended targets. According to one estimate, the commercial availability of accurate satellite navigation data has allowed those seeking cruise missiles to shave 15 years off their development.[7] Highly efficient and compact turbojet and turbofan engines and fuels allow designers to field missiles capable of greater range and payload.

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[2] On the use of TLAM and CALCMs, see Lt Col Rex R. Kiziah, *Assessment of the Emerging Biocruise Threat*, The Counterproliferation Papers, Future Warfare Series No. 6 (Maxwell AFB, AL: Air University Press, August 2000), p. 2.
[3] Lt Gen T. Michael Moseley, Operation Iraqi Freedom: By the Numbers (USCENTAF Assessment and Analysis Division, April 30, 2003), p. 11.
[4] Kenneth P. Werrell, The Evolution of the Cruise Missile (Maxwell AFB, AL: Air University Press, 1996), ch. 4.
[5] Steven J. Zaloga, The Kremlin's Nuclear Sword: The Rise and Fall of Russia's Strategic Nuclear Forces, 1945-2000 (Washington, DC: Smithsonian Institution Press, 2002), p. 43.
[6] Werrell, The Evolution of the Cruise Missile, p. 135.
[7] Kiziah, Assessment of the Emerging Biocruise Threat, p. 29.

The commercial availability of radar-absorbent materials (RAM) allows them to reduce radically the signatures of cruise missiles. Finally, high-resolution imagery and geospatial information systems (GIS) allow operators to develop highly accurate three-dimensional maps for targeting and mission planning.[8]

Cruise missiles have a number of desirable characteristics, including their small size, which makes them easy to hide and more mobile than ballistic missiles. Cruise missiles can also be developed at a substantially lower cost—and greater accuracy—than comparable ballistic missiles.[9] They are also better at avoiding air defenses; while ballistic missiles follow a predictable trajectory, some cruise missiles can fly close to the terrain and maneuver to avoid air defenses. They have inherently low visual, infrared, and radar signatures and can be made stealthier. Finally, they are much better suited to delivering chemical and biological weapons than ballistic missiles.[10]

A DIVERSE THREAT

Cruise missiles can be divided into two broad categories: anti-ship cruise missiles (ASCMs) and land-attack cruise missiles (LACMs). Even here, however, the distinction is less than perfect. Russia is currently marketing the 3M-54 (SS-N-27) Klub family of missiles, which includes the supersonic 3M-54E and subsonic 3M-54E1 ASCMs as well as the 3M-14E LACM.

More than 70 countries worldwide have over 75,000 ASCMs in their inventories. The largest classes of exported ASCMs are the US Harpoon, which entered service in 1981, the French Exocet, which entered service in 1977, and the Russian SS-N-2 Styx and its Chinese cousin the HY-1 Silkworm, which entered service in 1959.[11] However, a growing number of navies are acquiring the SS-N-22 Sunburn and the Klub, low-flying supersonic missiles that are very difficult for current shipboard defenses to destroy.

Only about 12 industrialized nations currently produce LACMs. However, they are expected to proliferate greatly by the end of the decade.[12] As then Director of Central Intelligence, George J. Tenet, testified in March 2004, "Many countries remain interested in developing or acquiring land-attack cruise missiles, which are almost always significantly more accurate than ballistic missiles and complicate missile defense systems."[13] A growing number

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[8] Ibid., pp. 29-30.
[9] Ibid., p. 34.
[10] A cruise missile's steady horizontal flight path allows it to release chemical or biological agent at right angles to the wind direction and upwind of target area, greatly increasing the efficiency of agent dispersal. Disseminating either chemical or biological agent from a rapidly descending ballistic missile is both less efficient and more technologically challenging.
[11] Dennis M. Gormley, "UAVs and Cruise Missiles as Possible Terrorist Weapons," in James Clay Moltz, ed., New Challenges in Missile Proliferation, Missile Defense, and Space Security, Occasional Paper No. 12 (Monterey, CA: Monterey Institute Center for Nonproliferation Studies, 2003), pp. 3, 6.
[12] Ibid., p. 3.
[13] Testimony of Director of Central Intelligence George J. Tenet before the Senate Armed Services Committee on "The Worldwide Threat 2004: Challenges in a Changing

of countries are acquiring advanced weapons such as the British Storm Shadow and French SCALP EG, stealthy air-launched cruise missiles that use terrain following and GPS to fly at very low altitude and strike very accurately. Moreover, such weapons are spreading: Italy and Greece have purchased the SCALP EG, and Britain and France have sold a variety of the missile, the Black Shaheen, to the United Arab Emirates.

ASCMs can be converted into LACMs as well. The Styx/Silkworm family, the third most proliferated model of ASCM, appears to be best suited to conversion.14 As noted above, the Iraqis used components from C601 and C611 ASCMs and modified the propulsion system of 10 HY-2s to extend their range to 150 km or beyond. In late 2001, they initiated another program to modify the missiles' flight computers, engines and propellants to convert it into a 1,000 km LACM.15 In addition, North Korea, Iran, and Pakistan all have LACM programs based on the Silkworm.

To show just how easy it would be for "almost any person or small group of persons with the necessary knowledge and skills" to build a cheap cruise missile, an engineer in New Zealand, Bruce Simpson, began building one in his garage with materials purchased over the Internet for under $5,000, documenting his project on his website.[16] He was able to build and test a pulsejet engine for the missile before being put out of business by local authorities.

The growth of unmanned aerial vehicle (UAV) and unmanned combat air vehicle (UCAV) programs further blurs the line separating cruise missiles from other weapons. According to one recent survey, at least 40 countries have produced over 600 different types of UAVs, nearly 80% of which have ranges of over 300 km.[17] In general, UAVs are unarmed, reusable systems, while cruise missiles are always armed and are not reusable. However, UAVs can be modified to carry weapons or become crude cruise missiles. The United States, for example, has modified some of its RQ-1 Predator UAVs to carry two Hellfire air-to-surface missiles. In addition, Israel produces the Harpy, which is designed to detect, attack and destroy surface-to-air missile radars. A number of countries are developing more sophisticated UCAVs.

Global Context," (as prepared for delivery) at http://www.cia.gov/cia/public_affairs/speeches/2004/tenet_testimony_03092004.html (accessed October 15, 2004).

14 Unlike smaller (and more modern) weapons such as the Harpoon and Exocet, the Silkworm has the internal room needed to increase the size of fuel tanks and add navigation systems.

15 Comprehensive Report of the Special Advisor to the DCI on Iraq's WMD, Volume 2 (Washington, DC: GPO, September 30, 2004), pp. 37, 39.

16 "A DIY Cruise Missile," at http://www.interestingprojects.com/cruisemissile/ (accessed October 14, 2004). See also Bruce Simpson, "The Low Cost Cruise Missile: A Looming Threat?" at http://aardvark.co.nz/pjet/cruise.shtml (accessed October 14, 2004).

17 Dennis M. Gormley, "New Developments in Unmanned Air Vehicles and Land-Attack Cruise Missiles," in SIPRI Yearbook 2003: Armaments, Disarmament and International Security (Oxford: Oxford University Press, 2003), p. 410.

IMPLICATIONS FOR US STRATEGY

Cruise missiles are likely to be increasingly attractive to US adversaries. The success of the US air forces has made competing head-to-head with the United States in the air a singularly unattractive prospect. Moreover, the demonstrated effectiveness of US theater ballistic missile defense units may divert some competitors away from investment in ballistic missiles. As the Chief of Staff of the 32nd Army Air and Missile Defense Command commented regarding Iraq's cruise missile force, "this was a glimpse of future threats. It's a poor man's air force. A thinking enemy will use uncommon means such as cruise missiles and unmanned aerial vehicles on multiple fronts."[18]

The Defense Department has stipulated the need for forces that can, among other things, protect "critical bases of operations, including the US homeland, forces abroad, allies, and friends, and defeating weapons of mass destruction and their means of delivery."[19] Cruise missiles already pose a threat to US bases. One recent analysis determined that less than a dozen cruise missiles equipped with submunition warheads could severely damage or destroy almost an entire fighter wing parked in the open.[20] ASCMs similarly threaten US ships, particularly in chokepoints and littoral waters.

Another potential threat would be the use of cruise missiles by terrorist groups. According to a recent unclassified National Intelligence Estimate on missile proliferation, "A commercial surface vessel, covertly equipped to launch cruise missiles, would be a plausible alternative for a forward-based launch platform. This method would provide a large and potentially inconspicuous platform to launch a cruise missile while providing at least some cover for launch deniability."[21] Even the relatively large Seersucker can be hidden and launched from a standard 12-meter shipping container complete with a small internal erector for launching.[22]

SUMMARY

A number of considerations make cruise missiles attractive to both states and, potentially, non-state actors. Moreover, the spread of precision navigation and

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[18] Quoted in Dennis M. Gormley, "Missile Defense Myopia: Lessons from the Iraq War," Survival 45, No. 4 (Winter 2003-04), p. 62.

[19] Donald H. Rumsfeld, Transformation Planning Guidance (Washington, DC: Department of Defense, June 2003), p. 10; and Quadrennial Defense Review Report (Washington, DC: Department of Defense, 30 September 2001), p. 30.

[20] One GPS-equipped ballistic missile armed with conventional submunitions could do the same damage. See John Stillion and David T. Orletsky, Airbase Vulnerability to Conventional Cruise-Missile and Ballistic-Missile Attacks (Santa Monica: RAND, 1999), p. 13.

[21] National Intelligence Council, Foreign Missile Developments and the Ballistic Missile Threat to the United States Through 2015 (Washington, DC: Central Intelligence Agency, 1999), p. 12.

[22] Gormley, "Missile Defense Myopia," p. 75.

signature reduction technologies holds the potential to make them much more lethal weapons. However, any strategy to deal with the cruise missile challenge must be based on an analysis of both current trends and potential future discontinuities.

The Department of Defense is pursuing a number of initiatives to improve the ability of US forces to deal with the cruise missile threat.[23] What is needed in order to evaluate the merits of such programs is a comprehensive assessment of the spread of cruise missile technology, one that explores the status of and trends in cruise missile proliferation as well as their potential military significance. Such an assessment is a vital first step toward meeting the challenge.

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CSBA is an independent public policy research institute established to promote innovative thinking about defense planning and investment strategies for the 21st Century. It is headed by Dr. Andrew Krepinevich and funded by foundation, government, corporate, and individual grants and contributions.

[23] See, for example, Ravi R. Hichkad and Christopher Bolcom, "Cruise Missile Defense," CRS Report for Congress RS21921 (August 25, 2004).