WELCOME BACK, MULTIPLE OBJECT KILL VEHICLES

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Ever since the United States began developing a missile defense system, the focus has been on pursuing a *robust* missile defense system. As not much progress has been made on boost phase interception, it becomes mandatory to study a technology that could make the midcourse system of the ballistic missile more vulnerable to enemy missile defense system. At present, with counter measures like decoys, chaffs, and multiple independently targetable re-entry vehicles (MIRVs), the mid-course phase of the ballistic missile becomes a complicated phase of interception. The Multiple Object Kill Vehicle (MOKV), a program of the United States, is believed to negate these challenges of the missile defense system in the mid-course phase.

What Are MOKVs?

The Multiple Object Kill Vehicle (MOKV) is an offshoot of its Multiple Kill Vehicle (MKV) program, established in 2004 under the Missile Defense Agency (MDA). While the MKV then was being designed to cater to Ground Based Interception (GBI), reports stated that the US could consider developing the same on space-based interceptors.[1] However, before long, there was an announcement to drop the plan of developing Space Test Bed to avoid destabilizing relations with China and Russia.[2]

[1] Jeremy Singer, "Tests ease overheat concerns with MKV technology", *Space News,* October 18, 2015, http://spacenews.com/tests-ease-overheating-concerns-mkv-technology/
[2] Peter L. Hays, "Problems, Controversies and Solutions", Space and Security (USA: ABC-CLIO, 2011), pp.75

While the United States has steadily worked on its Ground-Based Missile Defense (GMD) system for some time now, there has always been a challenge to counter threats from multiple warheads. The MKV program was a result of this concern to counter multiple threats with just one launch from a single booster, similar to the concept of offensive Multiple Re-entry Vehicles (MRVs) and the Multiple Independently Targetable Re-entry Vehicles (MIRVs). This means just like MIRVs reduce the number of missiles needed to strike a target, MOKVs would reduce the number of interceptors needed to counter offensive missiles, should the system be capable of effective discrimination. The incremental cost of an additional warhead on the MOKV would need to be less than the incremental cost of either a warhead or an effective decoy on the offensive missile (one of the Paul Nitze criteria). Also, the footprint of MIRV-ed ICBM is likely much larger than the footprint of a MIRV-ed BMD interceptor.

This MKV was designed to be integrated with the SM-3 interceptors of the Aegis sea-based missile defense system.[3] The MDA pursued two developmental concepts: one by Lockheed Martin (MKV-L) and the other by Raytheon (MKV-R). MKV-L consisted of a carrier vehicle and a number of attached kill vehicles. Key features of the carrier vehicle included kill vehicle restraints and dispense mechanisms, endgame management and command and control suites, and infrared and visible sensors. MKV-R, on the other hand, did not use a carrier vehicle; small kill vehicles were deployed directly from the interceptor rocket. Each kill vehicle could communicate with all other kill vehicles, and could act as the engagement coordinator.[4]

Due to lack of funds for the MKV program and the slow growth pace of the development of the system, the program was terminated in 2009.[5] The MDA claimed the program to be costly and time sensitive.[6] Some even advocated towards concentrating more on boost phase, ascent boost phase, and early mid-course phase interception[7] before the counter measures of the offensive ballistic missiles were to be displayed. A U.S. Senator then reasoned it out as a policy of the Bush administration and the policy of the Obama administration "to develop a missile defense against rogue nations, not against China and Russia. And the MKV, in addition to schedule and cost and technology issues, was designed against a far more capable enemy than either North Korea or Iran is going to be for the next 10 to 15 years."[8]

[3]Jeremy Singer, "Congress Eliminates MKV Money for Aegis Program", *Space News,* December 6, 2007, http://spacenews.com/congress-eliminates-mkv-money-aegis-program/

[4] Ballistic Missile Defense Systems, *Global Security,* http://www.globalsecurity.org/military/library/budget/fy2009/dot-e/bmds/2009technologyprograms.pdf

[5] Ballistic Missile Defense Review Report, Office of the Secretary of Defense, in eds., Kristen E. Boon, Aziz Huq, Douglas C. Lovelace, *Terrorism: Commentary on Security Documents* (U.K.: Oxford University Press, 2010) pp.444

[6] Ibid

[7] Jeremy Singer, "Congress Eliminates the MKV Money for Aegis Program", *Space News,* June 29, 2004, <http://spacenews.com/congress-eliminates-mkv-money-aegis-program/>

[8] Quoted in Rebeccah L. Heinrichs, "Staying Ahead of the Threat: Improvements Needed for U.S. Missile Defense", *George Marshall Policy Outlook,* February 2015,< http://marshall.org/wp-content/uploads/2015/02/Staying-Ahead-of-the-Threat-Heinrichs-FINAL-02192015.pdf>

Even critical sensors were not used any more, though they were maintained. The decision to stop the MKV program's funding and ensuing cancellation implied that the "priority of homeland missile defence has been downgraded with the result that industry reduced substantially its own investments in related research and development."[9]

Revival of the MOKV Program and Its Relevance

However, reports in 2015 confirmed that the MDA is planning to revive the MOKV program in 2016 to provide credible missile defense protection to the US homeland. A congressional mark-up to the 2016 Pentagon budget had pointed out the necessity to "fill current military requirements and capability gaps,"[10] among which the MOKVs would be an attempt. This MOKV would form a component of the Common Kill Vehicle (CKV) program. This MOKV technology would be a concept that can "destroy several objects within a threat complex by considering advanced sensor, divert and attitude control and communication concepts." MKV interceptor comprises a Carrier Vehicle (CV) and many Kill Vehicles (KVs) that are initially stored in the CV, to be released to intercept incoming targets.

Both China and Russia possess the MIRV capability for their ballistic missiles. In 2014, reports confirmed that Iran too had developed Multiple Re-entry Vehicles (MRVs) for their ballistic missiles. Cold War literature suggests that MIRVs are first strike weapons and could be strategically destabilizing. The United States realizes these threats and is working towards a robust missile defense system.

Raytheon, Lockheed Martin, and Boeing are all set to work on designs for the MOKV and to at least develop a preliminary concept. These companies are to provide a proof-of-concept prototype plan and demonstrate risk reducing measures and critical functional aspects of the kill vehicle to destroy multiple vehicles by 2016,[11]

The MDA had announced that Boeing has been awarded $9.8 million, while Lockheed Martin received $9.67 million and Raytheon $9.77 million to "assess the technical maturity of their concept, prioritise and nominate risk-reduction tasks for all critical components, and describe how the tasks will reduce risk."[12] Doug Graham, Vice President of Missile Systems and Advanced Programs at Lockheed Martin Space Systems, stated the desire of the company to "devise and explore the most effective solutions for destroying more than one warhead with a single

[9] "Adapting U.S. Missile Defense for Future Threats: Russia, China, and Modernizing the National Missile Defense (NMD) Act", Statement prepared of the Former Under Secretary of State for Arms Control and International Security, *House Committee on Armed Services,* July 23, 2014, <http://docs.house.gov/meetings/AS/AS29/20140723/102528/HHRG-113-AS29-Wstate-JosephR-20140723.pdf>

[10] "Pentagon investing millions on 'Multi-Object Kill Vehicle' anti-missile program", *The Washington Times,* August 14, 2015, <http://www.washingtontimes.com/news/2015/aug/14/pentagon-investing-millions-multi-object-kill-vehi/>

[11] Geof Fein, "Raytheon readies for December MOKV concept review", *IHS Jane's Defense Weekly,* November 23, 2015, <http://www.janes.com/article/56168/raytheon-readies-for-december-mokv-concept-review>

[12] Geof Fein, "Update: Developing MOKV will be challenging but results could reap cost savings", *IHS Jane's Missiles and Rockets,* August 17, 2015, <http://www.janes.com/article/53676/update-developing-mokv-will-be-challenging-but-results-could-reap-cost-savings>

interceptor, an important step in changing the cost curve for missile defense engagement." However, thus far, this is all only in the paper phase and the system is still at its developmental phase, which means that the cost to develop such systems could be exorbitant.

In 2016, the Missile Defense Agency (MDA) requested $72 million for this program, allowing the United States to engage a more numerous and increasingly more complex threat early in the flight trajectory.[13] There is also a plan to design solid Divert Attitude Control System (DACS) that would support the MOKV program.[14] An advantage of the solid propelled DACS is that it is non-toxic in nature, has a high density impulse, and meets safety requirements. According to Navy Vice Admiral and Director of the MDA, James Syring, "Ultimately, these MOKVs will revolutionize [US] missile defense architecture, substantially reducing the interceptor inventory required to defeat an evolving and more capable threat to the Homeland."[15]

The unreliability of the EKVs mounted atop the GBIs has prompted the Army to develop the MOKVs [16] in compliance with its 'less-than-optimal' shot doctrine by allocating more number of interceptors for a missile.[17]

The MOKV would be a critical component of the midcourse phase missile defense system and it is expected to nullify counter measures, such as low tech decoys, by distinguishing between them and missile warheads. Technically, the boost phase remains the most vulnerable phase, since it is in this phase of the ballistic missile flight trajectory that the missile cannot display any counter measure. On the other hand, in the midcourse phase, which is travelling in space, the missile is capable of displaying its counter measures, like decoys and MIRVs, and is therefore more difficult to intercept. Intercepting these could be made easier through advanced sensors and divert and attitude control systems in the MOKVs, which would allow the MOKV to home in on an individual target. [18]

The Future

[13] "Department of Defense Fiscal Year (FY) 2017 President's Budget Submission", *Missile Defense Agency,* February 2016, <http://comptroller.defense.gov/Portals/45/Documents/defbudget/FY2017/budget_justification/pdfs/03_RDT_and_E/MDA_RDTE_MasterJustificationBook_Missile_Defense_Agency_PB_2017_1.pdf>
[14] Ibid
[15] J.D. Syring, Director of Missile Defense Agency (MDA) speaks before the House Armed Services Committee Strategic Forces Subcommittee, *Missile Defense Agency,* April 4, 2016, <http://docs.house.gov/meetings/AS/AS29/20160414/104621/HHRG-114-AS29-Wstate-SyringJ-20160414.pdf>
[16] Amy Butler, "MDA Plans To Build Team For Redesigned Kill Vehicle", *Aviation Week,* February 5, 2015, http://aviationweek.com/defense/mda-plans-build-team-redesigned-kill-vehicle
[17] Ibid
[18] Ibid

Success of the MOKV is largely dependent on the success of the Redesigned Kill Vehicle (RKV), also referred to as the EKV CE-III with improved target acquisition and discrimination capabilities,[19] which is expected to lay the foundation for the MOKV technology. The RKV is expected to be a modular design that would use mature subassemblies and components for which there would be full qualification and reliability tests. This would be done to ensure improved "reliability, maintainability, producibility, and affordability when compared to the current EKV."[20]

The first flight test of the RKV is planned for 2018, and the first intercept test is planned for 2019.[21] In order to ensure that the MOKVs are able to hit the actual warheads, communication architectures and guidance technology will be developed as a game changing approach. These seekers and guidance systems are being developed in the MOKV to distinguish between a decoy and a real warhead, thus differentiating the MOKVs from GBIs. The carrier vehicle dispenses a large number of small kill vehicles. They are guided to destroy the targets designated by the seeker. With the enemy now in sight, the carrier vehicle dispenses the kill vehicles, guiding them to their designated targets.

Also, greater concentration needs to be given to the "command and control strategies in both digital and hardware- in-the-loop venues," while also concentrating on the guidance control and communication architectures.[22] Success of this development and testing would ensure that the United States can "manage the engagements of many kill vehicles on many targets from a single interceptor."[23] It is reported that development and testing will be completed by 2017. It is necessary to take into account that hardware of the MOKVs is not subjected to overheating; tests had been conducted in the early 2000s when the program was a reality to ensure no overheating or malfunctioning occurred.[24] In addition, there would also be issues pertaining to weight, miniaturisation, and control bandwidth to acquire, track, and intercept multiple targets.[25] All these factors need to be considered as well.

Strategic Implications

[19] J.D. Syring, Director of Missile Defense Agency (MDA) speaks before the Senate Appropriates Committee Subcommittee on Defense, March 18, 2015, *Missile Defense Agency*, March 18, 2015, <http://www.mda.mil/global/documents/pdf/ps_syring_031815_sacd.pdf>

[20] J.D. Syring, Director of Missile Defense Agency (MDA) speaks before the House Armed Services Committee Strategic Forces Subcommittee, *Missile Defense Agency,* March 19, 2015, <http://www.mda.mil/global/documents/pdf/ps_syring_031915_hasc.pdf>

[21] Ibid

[22] Kris Osborn, "North Korean Missiles Long Range", *Scout Warriors,* March 30, 2016, <http://www.scout.com/military/warrior/story/1621309-star-wars-missile-defense-takes-new-step>

[23] "MDA Making Plans To Revive Multi-Object Kill Vehicle Initiative", *Missile Defense Advocacy Alliance,* June 3, 2015, <http://missiledefenseadvocacy.org/missile-defense-news/mda-making-plans-to-revive-multi-object-kill-vehicle-initiative/>

[24] Jeremy Singer, "Tests Ease Overheating Concerns with MKV Technology", *Space News,* October 18, 2015, <http://spacenews.com/tests-ease-overheating-concerns-mkv-technology/>

[25] "Multiple Kill Vehicle Interceptor and method for intercepting exo and endo-atmospheric targets", <http://www.google.ch/patents/US20090001214>

Both Russia and China are also developing their own missile defense system and in the future, they too could develop such sophisticated systems to negate the U.S. nuclear deterrent capability.

According to Cold War literature, MIRVs are first strike weapons. However, a defensive weapon system that can destroy MIRVs, thereby could also make it difficult for a country like Russia to launch a preventive or pre-emptive decapitating strike on the United States.

While many could believe that the missile defense system could result in a nuclear arms race, a robust missile defense system could result in nuclear arms control. Nuclear arms control mechanisms like the Strategic Arms Reduction Treaty (START) have failed in de-MIRVing of ICBMs/Submarine-launched ballistic missiles (SLBMs) by both the parties (United States and Soviet Union/ Russia) to the Treaty. One of the reasons for the failure to achieve de-MIRVing of missiles is due to the deterrent value attached with the MIRVs. A robust missile defense system that can negate the destructive capability of the MIRVs actually negates the deterrent value of the MIRVs. Once the deterrent value of the MIRVs is nullified, states may not want to venture into this technology.

At the same time, countries like China, which have lesser nuclear capable ICBMs in its nuclear arsenal than the United States, wish to rely on MIRVs to offset its disadvantage of not having parity with the United States over its offensive ICBM capabilities. MOKVs could negate the offensive advantages that countries like China would enjoy vis-à-vis the United States despite a smaller nuclear arsenal. Such disadvantages could bring China to negotiate on nuclear arms control treaties.

While the MOKV is not the only technology that can ensure a robust missile defense system, as the United States looks to develop a layered missile defense system that could intercept a missile in every trajectory phase of the ballistic missile, the MOKV is a crucial component.