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# Missile Defense: State of Play and Future Evolution

## Summary, Analysis, and Future Research Questions

by Ari Kattan[1]

### Introduction

On 8 and 9 December 2014, the University of Maryland, College Park,[2] the Geneva Centre for Security Policy, and the Research Division of the NATO Defense College hosted an expert workshop entitled "Missile Defense: State of Play and Future Evolution" in Geneva, Switzerland. The workshop attracted experts from the United States, Europe, and Russia from a wide variety of backgrounds, including current and former government officials, former military officials, and senior experts from academia and the NGO community. The conference sought to enable a reasoned and informed debate about an issue that often contains more theater than substance and is often driven by ideology rather than facts and logic. This report summarizes the discussion and analyzes the main takeaways and lessons learned from the workshop.

### Missile Defense: State of Play

Over the last 20 years, there has been an acceptance of the concept of ballistic missile defense (BMD), mainly within the United States but in many other countries as well, due to the correlation between developments in technology and an evolution of the threat environment.

Current US missile defense capabilities consist of homeland defense, the European Phased Adaptive Approach (EPAA), and mobile ground-based and sea-based BMD assets deployed as part of regional defense architectures around the world. The Ground-Based Midcourse Defense (GMD) system, designed to protect the US homeland, consists of 30 ground-based interceptors (GBIs) deployed in Alaska and California (due to increase to 44 by 2017), and is scheduled to receive a new kill vehicle (KV) by 2020. The EPAA is on schedule, with Aegis Ashore slated for deployment in Romania in 2015 and in Poland in 2018. The United States is also working on building regional missile defense architectures in East Asia and the Persian Gulf.

According to one participant, Russia's actions in Crimea and Ukraine have made future cooperation between Russia and the US/NATO much more difficult and will likely render common ground on missile defense unachievable, a conclusion agreed to by almost all of the workshop attendees.

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Cooperation on missile defense with Russia was part of the initial consensus within NATO on the EPAA, but the Ukraine crisis has all but made cooperation with Russia on missile defense impossible. For some NATO countries, their commitment to the EPAA was partially contingent on Russian buy-in. As the EPAA progresses, the increased tensions it causes with Russia could cause cracks within the Alliance (one participant even referred to the EPAA as a "fragile" project). This is in spite of the fact that the EPAA does not currently pose a threat to Russia's strategic deterrent. However, an increased capability of the type that would be needed to handle larger raid sizes from Iran would have capability against shorter-range Russian ballistic missiles. Such missiles are prohibited under the Intermediate-Range Nuclear Forces (INF) Treaty, but one participant wondered if Russia's strong opposition to the EPAA was rooted in its desire to deploy intermediate-range nuclear forces in the future (perhaps as part of its plan for de-escalatory nuclear strikes against NATO Europe).

The stated rationale for the EPAA is the missile threat from Iran, but as the threat from Russia grows, it appears that the political component is becoming the project's main driver. One participant questioned the rationale for the EPAA if an agreement is reached with Iran over its nuclear program, and asked what effect such an agreement would have on the EPAA and other missile defense efforts. Another participant responded that an agreement with Iran would likely only include limits on its nuclear program, not on its ballistic missile program. Because Iran's ballistic missiles can carry conventional and non-nuclear unconventional warheads, there is still a strong rationale for the EPAA even if a nuclear deal with Iran is concluded. And while the EPAA's main raison d'être was Iran's missile threat, the EPAA also serves as a hedge against other potential future threats.

The current state of BMD assets, and the state of the systems likely to be fielded over the next decade, are what one participant called "limited" or "thin" missile defenses, which means that they can be easily overwhelmed by a major power's large and sophisticated strategic arsenal.

In addition to the deterrence and assurance value of missile defense, the technical capability of current systems takes 'cheap shots' off the table for an adversary, which has implications on how a conflict is likely to escalate. In a contemporary conflict between a country armed with limited but effective missile defenses facing an adversary with ballistic missiles, the adversary cannot escalate the conflict in a controlled way because a single ballistic missile is likely to be successfully intercepted. In order to get one or two warheads through a thin defense, a much larger portion of the adversary's arsenal will need to be expended. This has two results: first, it forces the adversary to use a large number of its missiles, which it may hesitate to do; and second, the firing of such a large number of missiles is unlikely to look like controlled escalation, perhaps deterring escalation in the first place. However, because it removes the lower rungs of the escalation ladder, it could be destabilizing, forcing an adversary to choose between capitulation or a large first strike. In addition to the political consequences (both positive and negative) of contemporary missile defense, this is the main strategic stability issue in missile defense today.

Another participant noted the effect of Iron Dome on the current missile defense debate. Some commentators have used Iron Dome's success at the sub-theater level to justify the expansion of missile defense at the theater and national levels, though for many reasons the comparison between Iron Dome and other missile defense systems is weak and unsubstantiated. That said, Iron Dome did show that missile defense can play a role in influencing domestic populations: it made Israeli society — and even Israeli individuals — feel safer against incoming rockets than they would have felt without Iron Dome. This led to an interesting discussion about how missile defense can — and should — be used if and when deterrence fails and it is called upon to perform in combat. Will the expectation be that missile defense will provide hermetic coverage, thus leading to political consequences when inevitable leakage occurs? Given limited missile defense resources, should governments prioritize the protection of the civilian population or the protection of military bases and critical infrastructure during a war? We will likely see these questions played out in Israel over the next decade.

Iron Dome also sparked a discussion about preferential defense (analyzing the trajectory of incoming warheads and only engaging those deemed to be threatening), which some participants called an incredible

leap forward in doctrine and capability that could have implications for theater and national missile defense, not just sub-theater rocket and mortar defense. However, preferential defense faces serious problems when operating against nuclear warheads. One participant said that with nuclear weapons, a nation cannot tolerate failure, while another participant said that even a 30% success rate would have deterrent value in certain circumstances, even against nuclear-armed missiles. Given that a 100% success rate is not currently realistic, it is important to better understand whether limited missile defenses with success rates beneath 100% have deterrent value, and if so, how and in what circumstances. There was significant disagreement on this issue among the experts, and because of its significance, it warrants greater discussion.

Besides Russia and American adversaries such as Iran and North Korea, missile defense appears to be having an effect on China as well. There is concern within China that the 44 GBIs slated for deployment in Alaska and California, along with increasing regional deployments and improved command, control, and communications, could undermine China's strategic deterrent and provide the United States with a first strike capability. This issue was not the main focus of this session's discussion, but its importance requires greater attention, perhaps in a future workshop.

In the past, missile defense was a capability that only the most advanced and powerful countries pursued. Now, however, it is being pursued by second-tier military powers, which in some cases could have destabilizing results. One participant noted that while missile defense was a positive development for the NATO Alliance, the proliferation of missile defenses in South Asia could be dangerous. In light of this dynamic, where advanced countries have BMD capability but the developing world does not, this participant asked if a second non-proliferation treaty should be considered, this time limiting the development and deployment of missile defenses instead of nuclear weapons.

**The Technological Dimension: Present and Future**

Over the past 15 years, hit-to-kill technology has matured a great deal and is now the primary technology used in US missile defense systems. PAC-3, THAAD, and Aegis all use hit-to-kill interceptors and have all had multiple successful tests. GMD, however, has not been very successful on the test range. This is due to the fact that the KV on the GBIs is a prototype — it was not designed as a production KV with the same quality control as the other systems' KVs. GMD's performance will likely improve when the new KV is deployed in 2020.

While hit-to-kill KVs are an important leap forward, it is actually the sensors that are the key to successful BMD. Over the past 15 years, X-band radar technology has come of age: the AN/TPY-2 and the Sea-based X-band radar are both performing well. The other main type of sensor used for BMD is optical sensors. The US's optical sensor deployments have all been canceled, leaving the United States without any optical sensor capability in its architecture.

The two major challenges facing future missile defense efforts are midcourse countermeasures and the high cost-exchange ratio between offense and defense.

All broad area defense systems intercept their targets in the exoatmosphere, which makes them susceptible to decoys. The ability to defeat countermeasures depends heavily on the BMD architecture's sensor capability. One participant summarized the countermeasure problem in this way: There is no defense for which a countermeasure cannot be designed; similarly, there is no countermeasure for which a defense cannot be designed. Much of the future work on defeating countermeasures will center on optical sensors and integrating them into a defense architecture with radars, intelligence, and other information that provides a clear picture of the threat environment.

Currently, it is more expensive to intercept an incoming warhead than it is to launch it, making the cost-exchange ratio prohibitively expensive for defense against large raids from countries with sophisticated arsenals. But providing a limited defense (or a total defense against a country with a small arsenal like North

Korea) is not prohibitively expensive. At roughly $9 billion annually, the United States is currently able to afford the expenditure necessary to continue investing in missile defense.

Much of the debate about the technical efficacy of missile defense is focused on the complexity of the testing regimes for the various BMD systems. One participant observed that there is no agreed criterion for what qualifies as a "realistic" test. Another participant noted that, while an actual test conducted with multiple incoming warheads has never taken place for financial reasons, the testing regime is able to simulate this by jamming the sensors while it is trying to engage a single incoming warhead. BMD systems have also been able to discriminate between warheads and debris even in simpler tests, which is an important capability.

One participant asked if the EPAA will still be effective after the cancellation of Phase IV. There was a consensus that the cancellation of Phase IV would have no effect on the defense of Europe, as Phase IV was mainly about providing a limited defense of the US homeland, and was unlikely to work effectively for technical reasons. To enable a shoot-look-shoot capability against Iranian missile strikes on the US homeland, an East Coast site would be necessary. The United States already has a shoot-look-shoot capability vis-à-vis North Korea with the interceptor sites in Alaska and California.

There was some disagreement among the workshop attendees about the potential future threat the EPAA might pose to Russia's strategic deterrent. One American participant noted that the discussions with Russia over the EPAA were frustrating due to Russia's insistence that missile defense upsets strategic stability without engaging with any of the details about how the limits on the EPAA would preserve Russia's deterrent. Russia's concern is that the EPAA might evolve into a threat, but another participant noted that the cost of upgrading the EPAA to the point that it might threaten Russia would be prohibitively expensive.

The discussion then turned to the cost of deploying missile defense. One participant brought up the Israeli argument used to justify the cost of Iron Dome, saying that the cost of the protected infrastructure must be factored into any cost-exchange ratio. Other participants disagreed with this method of determining the cost-effectiveness of missile defense, mainly because in the nuclear context, an adversary can always build one additional offensive weapon at a more favorable cost, meaning the protected assets would still be at risk. Still others noted that in a non-nuclear context, like with Iron Dome, a certain amount of leakage can be tolerated, making the cost of defense worthwhile in certain circumstances.

**Implications of Missile Defense for Regional Stability and Extended Deterrence**

Currently, the United States is focusing on deploying proven missile defense platforms for theater ballistic missile defense, with less emphasis on homeland defense. The amount of theater missile defense hardware produced by the United States over the last decade has been substantial: The US Army has close to 10,000 PAC interceptors; THAAD batteries are being deployed and even sold to other nations; and by the end of 2014 the Navy had 30 Aegis-equipped ships.

According to one participant, in order for these theater missile defense assets to be used as instruments of extended deterrence, the US homeland must be secure. If the US homeland is at risk, US theater missile defense assets will have less credibility as extended deterrence instruments. Thus, in order for theater missile defense to have extended deterrence properties, the United States must focus on homeland defense as well. In addition to highlighting the importance of homeland defense to extended deterrence, this participant also stated that for missile defense to be useful as an instrument of extended deterrence, the assurance must be explicit — ambiguity about the role of missile defense in extended deterrence will weaken its credibility in the eyes of allies. Lastly, this participant said that allies must be integrated into any jointly-run missile defense system, giving them a stake in its success.

The US missile defense relationship with Japan most accurately reflects these requirements. GMD is currently most effective against North Korea, reducing North Korea's ability to hold the US homeland at risk and thus

enhancing the credibility of US theater missile defense as an instrument of extended deterrence with Japan. Japan is also integrated into the regional BMD architecture from the R&D level up to and including the operational level. Not only is Japan jointly developing the SM-3 2A interceptor with the United States, they also deploy four of their own Aegis-equipped ships and regularly conduct testing and training with the United States. According to one participant, this is a successful model for what missile defense as an instrument of extended deterrence might look like.

Transitioning to the relationship between missile defense and nuclear deterrence, another participant said that missile defense can complement, but not replace, nuclear deterrence. Missile defense is deterrence by denial — it does not have any offensive capability apart from preserving the means of retaliation. Because of this, it will never be able to fully replace offensive capabilities.

When the NATO Alliance agreed to the EPAA, it did not believe it would have an effect on stability within the Euro-Atlantic region. It believed it would discourage the development and use of ballistic missiles by Iran, or defeat a missile attack if deterrence failed. In this respect, one participant stated that the assumptions about the EPAA were, and are, correct. However, within the Euro-Atlantic region, it has caused serious tension with Russia — an effect that NATO tried to mitigate by offering cooperation with Russia on the project, but to no avail.

There was significant disagreement among the workshop participants on missile defense's effect on an adversary's commitment to building ballistic missiles. While this is one of the stated goals of the EPAA, many participants believed it could actually cause an adversary like Iran to expand the size of its arsenal to deal with attrition from missile defenses. One participant wondered if a comparison could be made to what has happened with air defenses over the last few decades. Large, resourceful states have been able to invest in capabilities to overcome US air defenses, but smaller and weaker states were forced to abandon tactical air capabilities for lack of money and technological capability. It is conceivable that the United States could dissuade Iran from building additional missiles or using its stockpile short of war if a sufficient quantity of missile defenses were deployed.

There was consensus among the workshop participants that the EPAA was viewed as a successful extended deterrence instrument, but it was not clear to what degree. Different NATO members emphasize different aspects of the EPAA when citing its extended deterrence properties. For many, it is the presence of American assets and personnel on their territory that is the most reassuring, not the actual missile defense capability. Missile defenses are also useful for extended deterrence because they are less threatening than offensive systems and can be surged in a crisis. One participant noted that the constant changes in US policy towards regional missile defense in Europe undermined its credibility, and urged the United States to stick to a long-term strategy instead of changing the strategy with every new administration.

One participant said that, given Russia's new aggressive posture towards the West, missile defense can no longer replace nuclear weapons stationed in Europe because NATO members are increasingly worried about Russia, yet unwilling to increase their defense budgets. In the past, when Iran was NATO's priority, reduced nuclear capabilities and increased missile defense was an appropriate posture; now, because both Russia and Iran are NATO priorities, NATO must focus on both.

According to one participant with knowledge of the Asia-Pacific region, current US BMD capabilities do not pose a threat to China's strategic deterrent. The Chinese have sufficient countermeasures to overcome US defenses at the strategic level. A more interesting question that should be explored further is the impact of theater missile defenses against China's conventionally-armed ballistic missiles.

**Implications for Nuclear Disarmament and Non-Proliferation**

There is fundamental disagreement about whether missile defense enables or inhibits nuclear disarmament. Both viewpoints were raised during the discussion, but a consensus was not formed about which viewpoint

was correct.

Russia has said it will not discuss offensive nuclear reductions further until the missile defense impasse is resolved. Furthermore, because Russia views the EPAA in a threatening manner, they may wish to deploy additional systems currently banned by the INF Treaty to destroy missile defense sites located in Europe. This demonstrates that missile defense may not only hinder further progress on disarmament: it may actually serve to reverse it, at least in the case of Russia.

In order to resolve the impasse over the EPAA, Russia has made a number of demands, including limits on the number and velocity of interceptors and even joint control of the system. The United States has shown a willingness to accommodate Russian concerns, but under no circumstances is the United States prepared to offer Russia joint control of the system, nor is it willing to share certain sensitive technologies with Russia. Thus, the bargaining range between the two countries is severely limited.

According to one participant, missile defense presents a catch-22 obstacle: missile defense will likely have a role in the future of nonproliferation and disarmament, but it is making it more difficult to achieve that future. The best way to get around this catch-22 issue is to have a grand bargain, where disarmament, missile defense, and other strategic issues are dealt with comprehensively. As the world gets closer to global zero, there will be increased pressure to link further reductions to limitations on defensive capabilities, but if global zero is achieved, there will be pressure to create a foolproof missile defense system.

Another participant, representing a more pessimistic viewpoint about missile defense, stated that the drawbacks of missile defense outweigh the benefits when it comes to non-proliferation and disarmament. It is clear that the current capabilities of the EPAA do not pose a threat to Russia's strategic deterrent, but Russia is concerned about future developments that one day may undermine their offensive forces; the open-ended nature of the EPAA — and missile defense in general — is a major Russian concern and a substantial barrier to further reductions.

Another participant pointed out that missile defense may have little effect on Russia's willingness to move towards disarmament because it sees nuclear weapons as necessary to compensate for its weaker conventional forces, and for reasons of prestige. This sentiment was shared by many of the workshop attendees.

Missile defense could also prevent any future multilateral nuclear disarmament agenda from taking place, given the numerical disparity between US and Chinese strategic forces. Because of this, the question of global limits on missile defense was raised again.

**Issues for the Future**

Russia's actions in Ukraine and its violation of multiple treaties and understandings related to European security mean that plans to ground missile defense in a stronger legal framework may not materialize, and the significance of any legal understanding surrounding missile defense would be weakened. According to one participant, Russia can no longer be treated as a partner, which changes the entire strategic landscape in which missile defense in Europe is taking place. Even though the EPAA is not designed with Russia in mind, either at the political or technical levels, it still has consequences for deterrence and assurance for the NATO Alliance, particularly its Eastern European members. Eastern Europe views the EPAA positively, mostly because it ties the United States to Europe in a permanent way and includes the stationing of American assets and personnel in Romania and Poland.

One participant floated the idea of giving the EPAA capability against short- and medium-range ballistic missiles from any azimuth, including from Russian territory, as a response to Russia's aggression in Ukraine. In order to do this, additional sensor capability would need to be added. Another participant said that this idea went against the agreed-upon wording that NATO has used to describe the EPAA since the Lisbon Summit, and

it would shatter the delicate consensus the Alliance has achieved on the EPAA, if the United States proposed it. There was agreement that this debate is likely to surface in the future, but most participants believed it would be unnecessarily provocative towards Russia.

Israel is building a multi-tier missile defense system, but the only part of this system to be tested in combat is its Iron Dome rocket and mortar defense system. So far, Iron Dome has had a very limited deterrent impact on Israel's conflicts with its non-state enemies in Gaza, probably for three main reasons. First, Iron Dome is not strategic or even theater defense — it is sub-theater rocket and mortar defense, which has completely different properties and effects from ballistic missile defense. Second, the conflict between Israel and its neighbors has been ongoing since the founding of the state, and periodic rounds of violence are tolerated. Because of this, the use of force is not seen by the Israelis as a failure of deterrence. In fact, the use of force is often seen as a necessary part of maintaining deterrence. Third, the Israelis do not view missile defense as necessitating a change in their deterrence posture — it is simply another tool to be used by the military and decision-makers to protect the Israeli public and achieve victory. Therefore, Israel introducing a rocket (not ballistic missile) defense system into a long-standing conflict without changing the overwhelmingly offensive nature of its defense posture did not produce much deterrent value. Furthermore, Hamas and others do not necessarily need to kill Israelis or damage property to claim that its rocket attacks are successful; they simply must disrupt normal Israeli life. It is for these reasons that Israel's experience with Iron Dome is unique, meaning that the West and others must be careful when attempting to draw conclusions about strategic or theater ballistic missile defense from the Israeli experience.

That being said, the Israeli experience does posit a number of interesting questions about missile defense that may be applicable to the United States and its allies. Against conventional missile raids, will missile defenses prioritize protecting the civilian population or military sites? If a conventional missile attack occurs but most of the warheads are intercepted, should the retaliatory response be as severe as if the warheads had pierced the defenses? Will deterrence suffer if missile defenses fail to intercept a large enough number of conventional warheads during a war?

With regard to the Persian Gulf, the United States is attempting to use missile defense as a mechanism to spur greater integration and cooperation among the six-member Gulf Cooperation Council (GCC). Because of the Gulf's narrow maritime environment and the small size of most of the GCC members, a missile defense system is unlikely to be effective without integration. However, for political reasons, the GCC has not been willing or able to commit to the level of cooperation necessary for effective missile defense, making the US plan of using missile defense as a springboard for wider cooperation a flawed and unrealistic one. According to one participant, if a missile defense system deployed in the Gulf is to be expected to perform in combat against an Iranian missile raid, the United States will need to take a much greater role in operating the region-wide system.

There were a number of different views expressed about conventional prompt global strike and hypersonic glide vehicles, but the most prominent view expressed was that the effect of these systems on missile defense and strategic stability was exaggerated. First, these capabilities have been discussed for decades, but have never been seriously developed, let alone deployed. Second, hypersonic glide vehicles might be more difficult to intercept with missile defenses, but not impossible. Missile defenses would be able to adapt to accommodate the new threat.

**Questions for Further Exploration**

This workshop raised a number of interesting questions that were either beyond the scope of the main discussion topics or were not covered in detail due to time restraints.

One idea that was raised repeatedly was the prospect of a global missile defense "non-proliferation treaty."

Because many of the political issues surrounding missile defense center around the fact that it is an open-ended project, would limits on missile defense be a good idea? If so, is a non-proliferation treaty achievable, and if so, what should it look like?

The impact of BMD on China's strategic calculus and its willingness to participate in multilateral arms control or disarmament was briefly raised but not discussed in detail. Because of the growing importance of the Asia-Pacific region to global security and American security interests, a greater discussion about the effects of missile defense on China's defense posture is warranted.

There was wide consensus that missile defense increased the credibility of extended deterrence, but it appears that the increase in credibility stems not from the capabilities of missile defense, but from the stationing of American equipment and forces on allied territory. There was also a consensus that BMD could complement, but not replace, nuclear deterrence. But it remains unclear exactly how BMD might be used as a signaling mechanism or a tool of coercion during a crisis, or how it might realistically be used during a nuclear exchange. There is a strong need for greater contingency planning and theoretical work in this area.

There is also a need for greater research on the effect of missile defense on an adversary's willingness to continue developing and deploying ballistic missiles and their likelihood to use them. Workshop participants were unable to agree whether, for example, the EPAA would dissuade Iran from building more ballistic missiles capable of hitting Europe, or if it would simply encourage them to build more.

The cost-benefit debate affected nearly every topic of conversation during the conference; however, there is no agreed method for calculating the cost-exchange ratio of missile defense, either in comparison with conventional warheads or with WMD. Having an established method for calculating the cost-exchange ratio for various regional scenarios would be useful for deciding how much money will need to be spent on missile defense to achieve stated policy and operational outcomes.

Lastly, with regard to the role of missile defense on arms control, disarmament, and non-proliferation, the idea of a grand bargain was mentioned. What might a grand bargain on disarmament and missile defense look like? What technologies will need to be developed and deployed in order to make this achievable?

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Further discussion is needed to address some of the theoretical, technical, and political questions involved in ballistic missile defense. Major advancements in computing power and the capabilities of sensors, along with changes in the global security environment, will continue to spur interest in missile defense among first-tier, and potentially second-tier, nations. It was clear from the workshop's discussions that many questions about the future of missile defense and its impact on arms control, nonproliferation, extended deterrence, and crisis stability remain unexplored, let alone unanswered, by governments and the wider policy community.

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