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Five Types of International Cooperation for Missile Defense

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THE ISSUE

- International missile defense cooperation has become increasingly important in order to contend with the proliferation of more advanced air and missile threats.
- Cooperation includes the sale of missile defense elements to allies and partners, cooperative development, hosting agreements, information sharing, and combined training.
- Numerous cooperative relationships in missile defense are strong but could be further improved by developing lower-cost systems, streamlining the sales process, incentivizing co-development, complicating air and missile defense exercises, and considering ways to integrate offensive and defensive weapons.

The research, development, testing, and fielding of missile defense systems has never been an exclusively U.S. undertaking, but the value of international cooperation has become more important than ever. Cooperation between the United States and its allies and partners serves to leverage partner contributions, increase opportunities for international collaboration, distribute financial burdens, deepen interoperability among systems and operators, and better defend U.S. deployed forces.[1] International missile defense efforts also reflect the United States' broader valuation of security cooperation, a pillar of U.S. foreign policy.[2] As Missile Defense Agency director Jon Hill has said, "Missile defense is a global matter and will continue to be a global matter."[3]

The best known and most frequently discussed type of cooperation is the sale of U.S.-made missile defenses to other countries. What is less appreciated, however, is how missile defense partnerships extend far beyond just sales to include cooperative development and testing, hosting, information sharing, and combined exercises. Together, these activities contribute to creating more capable, interoperable, and cheaper missile defense architectures, which are better prepared to defend partners, allies, and the United States itself.

As missile threats proliferate and become more complex, these various forms of cooperation become more important. Iran and North Korea continue their robust missile testing regimes, not only improving the accuracy and range of their missiles but also demonstrating more sophisticated trajectories and countermeasures. China has invested heavily in missile technologies to bolster its local anti-access and area denial (A2/AD) strategies. Russia has fielded new intermediate-range missiles in Europe and is rapidly developing hypersonic weapons technology. Numerous countries are directly integrating missile strike with other aspects of military power, and

even non-state actors have developed more sophisticated rocket and missile arsenals.[4] Missile defenses are one tool in the face of these developing threats; cooperative efforts permit allies and partners to do so more cheaply and more effectively, all while contributing to other shared deterrence and defense goals.

I. SALES

The best-known form of missile defense cooperation is the sale of defenses from one country to another. In the United States, sales fall into two general categories: Foreign Military Sales (FMS), which require more strict government oversight, and Direct Commercial Sales (DCS), which do not. These sales contribute to an industry that employs millions of U.S. citizens.[5] Weapons sales signal commitment to allies, strengthen allied defenses, and reduce the U.S. security burden. Further, foreign sales of U.S. missile defenses increase the total numbers produced, which decreases individual unit costs; when allies and partners buy more rounds, overall production costs go down, which can lower the domestic cost of purchase for the U.S. military and thus for the U.S. taxpayer. Furthermore, the proliferation of U.S. missile defenses also increases the number of systems deployed globally that can be tied together as part of a larger, more effective defensive architecture.

A Patriot missile battery is seen near Prince Sultan air base at al-Kharj, Saudi Arabia, on February 20, 2020.

Photo: Andrew Caballero-Reynolds/Pool/AFP/Getty Images

In the Middle East, Saudi Arabia was the earliest customer of U.S. air and missile defenses, having first purchased the Patriot system in the 1990s. These purchases followed Iraqi Scud missile attacks targeting the country during the 1991 Gulf War. Since then, the Kingdom has made large investments in its missile defense capabilities to counter Iranian missile threats and the proliferation of its rockets among regional proxies and partners. Since 2015, when Saudi Arabia launched its intervention in the Yemen civil war, Saudi-operated Patriot defenses have reportedly intercepted hundreds of short-range missiles launched by Yemen's Houthi rebels.[6] In that time, Saudi Arabia has purchased several hundred PAC-3 interceptors, related equipment, and support services.[7] In 2018, Saudi Arabia also signed a $15 billion contract to purchase 44 THAAD (Terminal High Altitude Area Defense) launchers, 360 interceptors, seven AN/TPY-2 radars, and 16 fire control units.[8] This investment in THAAD has provided funds to invest in a more capable, follow-on interceptor.[9]

Other Middle East countries have likewise been avid users of U.S. missile defense. These include the United Arab Emirates (UAE), Oman, Kuwait, Qatar, and soon Bahrain. Just as Saudi Arabia's investments have supported U.S. missile defense developments, the UAE's Patriot purchase in 2008 provided additional funds for Patriot modernization efforts and helped the U.S. Army buy 100 more PAC-3 missiles.[10] The UAE was also the first foreign purchaser of THAAD, buying the system in 2011 and deploying it in 2016.[11]

Among the states of the Indo-Pacific, Japan has made the most significant investments in U.S. missile defense systems, especially through its purchase of Aegis-equipped ships. Japan has equipped four *Kongō*-class destroyers, two *Atago*-class destroyers, and one *Maya*-class destroyer (with an additional destroyer in development) with the Aegis Combat System, with the goal of deploying a total of eight BMD-capable ships by 2021. Japan had planned to field two Aegis Ashore sites by 2023, but Tokyo recently cancelled these plans. Japan may, however, still move forward with additional Aegis deployments in alternative configurations.[12] Until the recent cancelation, Japan's Ministry of Defense was

working with the U.S. Navy to equip its Aegis Ashore sites with the Solid State Radar—a variant of the Long-Range Discrimination Radar that uses semiconductors made in Japan to improve its tracking range.[13] Other users of U.S. missile defense in the region include Australia, South Korea, and Taiwan. Additionally, India and Indonesia are in the process of procuring the National Advanced Surface to Air Missile System (NASAMS), which is jointly produced by the United States and Norway.

One recent European customer of U.S. missile defense is Poland. In March 2018, Poland finalized a $4.75 billion deal to procure Patriot missile defenses.[14] The deal marks the largest military sale in Polish history and fulfills the requirements of Poland's Wisla medium-range air defense program.[15] The acquisition includes two Patriot Configuration 3+ batteries comprising four fire units total, the still-in-development Integrated Air and Missile Defense Battle Command System (IBCS), and a number of PAC-3 MSE interceptors.[16] In a developing "Phase II" deal, Poland is considering buying six more Patriot batteries, a 360-degree radar, and the SkyCeptor interceptor, which is based on Israel's David's Sling interceptor and is designed as a cheaper alternative missile to equip the Patriot system.[17] Other European users of U.S. missile defenses include Finland, Germany, Greece, the Netherlands, Norway, and Spain. Additionally, Hungary, Lithuania, Romania, and Sweden are in the process of procuring U.S. defense systems, while Switzerland is currently exploring the possibility of acquiring Patriots.[18]

II. COOPERATIVE RESEARCH AND DEVELOPMENT

Another important category of missile defense cooperation is a suite of activities formally called International Armaments Cooperation (IAC). Although commonly referenced as co-development, these activities include numerous aspects of research, development, production, testing, and even sustainment. Co-development between nations may include any or all of these functions; the diversity of activities reflects the diversity of partnerships. For instance, some international allies or partners may not have the resources to purchase or build their own systems, but they can still contribute in significant ways to basic science and technology, testing, or other aspects of missile defense development and acquisition.

These programs contribute to U.S. national security objectives in several ways. First, co-development helps the United States and its partners develop missile defenses while sharing costs. Minimizing costs will be especially important over the next several years, as U.S. defense budgets are likely to tighten. Although the U.S. Congress has provided generous funding to the Missile Defense Agency (MDA) in recent years, the Future Years Defense Program (FYDP) shows that decreases will come soon.[19]

Second, co-development facilitates technology-sharing and more specialized R&D among participants. U.S. allies like Israel, Japan, and Norway have become leaders in missile defense-related technologies, and they will likely continue to improve in this field over the coming years. Co-developing and sharing new technologies with these countries thus ensures that the United States and its partners remain at the cutting edge as adversary missile capabilities also improve. These partnerships also allow parties to specialize in specific missile defense components. For example, the United States might develop an interceptor's rocket booster while a partner focuses research on the seeker. This specialization leads to greater productivity and technological exploration.

The United States has worked closely with allies in the Middle East, Asia, and Europe to co-develop several missile defense systems. The most well-known partnership is that between the United States and Israel. The two countries have worked together on Israel's Iron Dome, David's Sling, and Arrow Weapons System, culminating in a layered defense architecture protecting Israel from short, medium, and long-range missiles. Iron Dome is one of the most successful missile defense systems in the world. Since its inception in 2011, Iron Dome has intercepted over 1,500 rockets—primarily launched from Gaza via Hamas—with a reported success rate of 85–90 percent.[20] While Israel developed Iron Dome indigenously, the United States has contributed substantial financial assistance to the system's procurement. Iron Dome also represents an instance of missile defense sales going the other way. In August 2019, the U.S. Army finalized a deal to purchase two Iron Dome systems as a means of interim defense against indirect fires.[21] A U.S. version of Iron Dome's Tamir interceptor, known as the SkyHunter, is also under development.

David's Sling is a medium-range missile defense system designed to counter tactical ballistic missiles, cruise missiles, long-range rockets, and aircraft.[22] The system is jointly produced by U.S. and Israeli defense companies. This cooperative effort also benefits the United States: David's Sling's Stunner missile has led to a U.S.-manufactured version called SkyCeptor, a lower-cost interceptor compatible with Patriot launchers. Some U.S.

allies have expressed interest in the SkyCeptor as a lower-cost supplement their interceptor magazines. As previously mentioned, Poland is considering the SkyCeptor to satisfy its Narew short-range and air defense requirements.[23]

The Israel Missile Defense Organization (IMDO) and the U.S. Missile Defense Agency (MDA) complete a successful test fight of the Arrow-3 interceptor on July 28, 2019.

Photo: U.S. Missile Defense Agency

The Arrow Weapons System provides Israel protection from long-range missile attack. The United States and Israel have co-developed the Arrow family since 1986.[24] The Israeli Missile Defense Organization (IMDO) and the U.S. Missile Defense Agency have conducted joint Arrow-3 tests in central Israel and Alaska to mitigate geographical limitations on testing.[25]

U.S.-Japan cooperation assumed significant importance after North Korean missile launches in 1998. The principal object of co-development in this relationship has been the SM-3 IIA interceptor. The United States has provided expertise in system and technological integration while Japan oversees the interceptor's second and third rocket stages, steering control, and missile nosecone.[26] The SM-3 IIA will be introduced in the Pacific but will also have a global role, including at the Aegis Ashore sites in Europe which defend the North Atlantic Treaty Organization (NATO).[27] The SM-3 IIA may even come to play a role in defending the U.S. homeland as part of a layered defense strategy against long-range missile threats. As directed by Congress, the Missile Defense Agency successfully tested the SM-3 IIA against an ICBM-class target in November 2020.[28]

The United States and Norway have jointly developed the National Advanced Surface-to-Air Missile System (NASAMS) since the 1990s. This medium-range air defense system can identify and engage aircraft, helicopters, cruise missiles, and unmanned aerial vehicles. Although it was built primarily to deter Russian air threats, NASAMS has proven popular beyond that mission set. Norway, Finland, Oman, Spain, the Netherlands, Chile, and the United States have already deployed the system. Several other countries are acquiring NASAMS, including Australia, Hungary, India, Indonesia, Lithuania, and Qatar.

As with numerous other international arrangements, cooperation on missile defense can face significant challenges. In the past, joint programs with Israel, for example, were criticized as essentially subsidizing the Israeli industry, with little direct benefit to the United States.[29] Multinational projects also face new challenges, like technology transfer concerns and complicated management structures. These and other problems impaired the joint U.S.-German-Italian project known as Medium Extended Air Defense System (MEADS), from which the United States eventually withdrew.[30]

III. HOSTING

The United States deploys an array of its own missile defense systems in allied and partner countries. In these arrangements, the United States manages and operates a missile defense system on the host nation's territory. These hosting programs are important for three reasons.

First, hosting alleviates pressure from allies who cannot purchase or deploy missile defenses due to budgetary or political constraints. Second, deploying these systems abroad strengthens the defense of the U.S. homeland, bases, and overseas territories. For example, U.S. radars deployed abroad are typically closer to adversary missile launch points and can thereby provide high-quality track data at an earlier stage of flight. These deployed radars can also collect intelligence on an adversary missile's capabilities during missile test flights. Third, U.S. missile

The Aegis Ashore site in Deveselu, Romania.

Photo: U.S. Missile Defense Agency

defense hosting arrangements can assure allies of U.S. security commitments. In addition to strengthening political ties, this may discourage allies from deploying offensive weapons that could lead to regional arms races or other escalatory action.

In July 2016, Washington and Seoul concluded an agreement that South Korea would host a THAAD battery in its southern region to protect troop deployment and cities in the south, which was deployed in 2017.[31] THAAD uses the AN/TPY-2 radar, which has a tracking range of at least 1,000 km. The TPY-2's placement in South Korea has sparked Chinese and Russian concerns that the United States could refocus the radar against them and possiblly even use it to support offensive munitions.[32] Japan also hosts two AN/TPY-2 radars, delivered in September 2006 and December 2014, to support both Japanese and U.S. homeland defenses.[33]

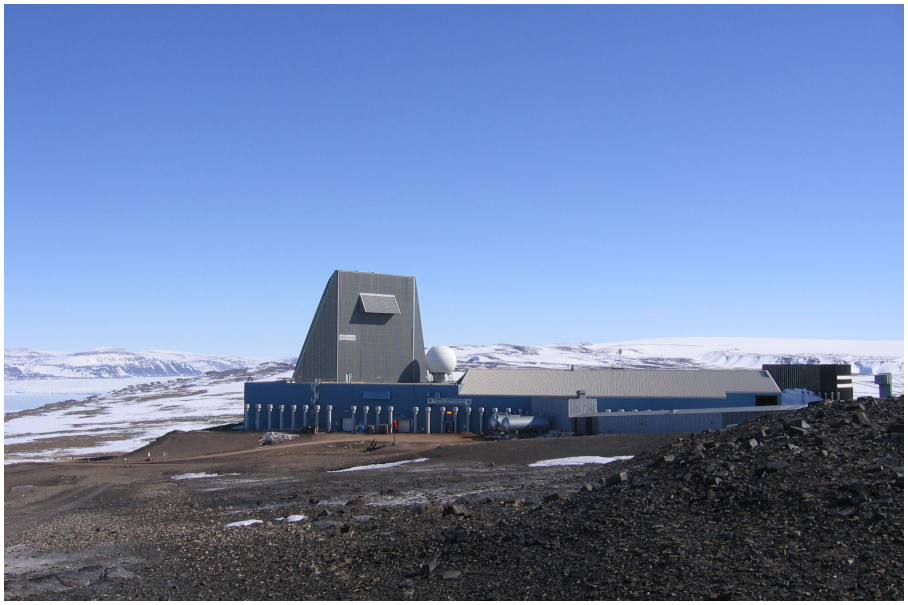
Spain is an integral part of the United States' European Phased Adaptive Approach (EPAA) missile defense architecture. The United States primarily conceived of the EPAA as a way to protect Europe from Iranian missiles.[34] As part of EPAA Phase I, the U.S. Navy forward deploys four Arleigh Burke-class Aegis destroyers to the Naval Base in Rota, Spain.[35]

Turkey has recently been in the news for purchasing multiple units of the Russian S-400 air defense system.[36] Despite this, Turkey has previously worked closely with its NATO allies to support a regional missile defense network. As part of EPAA Phase I, the United States deployed an AN/TPY-2 radar to eastern Turkey to track potential Iranian missile attacks targeting Europe. Germany, Italy, Spain, and the Netherlands have also deployed missile defenses to Turkey in response to growing air and missile threats from Syria.[37]

The United States is developing two Aegis Ashore sites in Europe: one in Deveselu, Romania and one in Redzikowo, Poland. These represent EPAA Phases II and III, respectively. The United States declared the Aegis Ashore site in Romania operational in May 2016. The site is equipped with SM-3 Block IB interceptors.[38] The site in Poland is still in development due to construction delays.[39] The United States plans to equip both sites with the SM-3 Block IIA interceptor, currently in production.

Along with Japan and Turkey, Israel has also hosted a U.S. AN/TPY-2 radar since September 2008.[40]

The United States deploys two Upgraded Early Warning Radars (UEWR) abroad, principally stationed to defend the United States from ICBM-class threats: one at Thule Air Base



Thule Upgraded Early Warning Radar (UEWR) at Thule Air Base, Greenland.

Photo: U.S. Missile Defense Agency

in Greenland and another at the Fylingdales in the United Kingdom. These radars operate at the Ultra High Frequency Band to follow intercontinental missiles and satellites in low-earth orbit, classifying potential targets and passing tracking data to other sensors and interceptors, including the U.S. Ground-based Midcourse Defense system.[41] The Fylingdales UEWR became operational in 2007; the Thule radar was brought online in 2009.

The United States also deploys two Space-Based Infrared Radar System relay ground stations in Australia and the United Kingdom. Like the UEWR hosted abroad, these stations directly support the U.S. homeland defense mission and early missile warning.[42]

IV. INFORMATION SHARING

The United States and its allies also work together by sharing information on missile threats, both before and after launch. Pre-launch information sharing is crucial to understanding adversary missile capabilities and intentions, ensuring all partners have the most accurate and up-to-date information, and developing response plans to potential attack. This intelligence includes data on the development, testing, procurement, and deployment of adversary missiles. Post-launch information sharing relates to "battlefield" intelligence—including the locations of missiles, launchers, and personnel, and passing missile launch, cueing, and tracking data. There are several challenges to pre- and post-launch information sharing, including the threat of adversary espionage and electronic warfare, political grievances, a lack of effective datalinks, strict declassification procedures, and other bureaucratic obstacles.[43]

NATO provides one avenue for information sharing. Member nations may share intelligence on missile threats with all of NATO or only with specific members, as deemed necessary based on classification levels and interests. NATO has also established an organic intelligence apparatus to work alongside those of its member nations.[44] Sharing information between NATO members supports internal analysis to clarify missile threat perceptions, allowing for wider consideration and planning within the alliance. NATO information sharing also extends to the battlefield: NATO allies share real-time intelligence on adversary missile threats and combine BMD assets to provide a joint missile defense architecture. NATO only began studying potential missile defense plans in 2001.[45] Since 2005, NATO has developed and maintained the Active Layered Theater Ballistic Missile Defense (ALTBMD) program to integrate theater interceptors and sensors for regional threats. Its architecture today comprises significant assets, including the AN/TPY-2 radar in eastern Turkey and coordinating command centers like the BMD Operation Center at Ramstein Air Base in Germany.

Another important example of information sharing is in the Asia-Pacific. In 2014, South Korea, Japan, and the United States established the 2014 Trilateral Information Sharing Agreement (TISA) to share information about North Korea's nuclear and missile threats.[46] Japan and South Korea also established their own bilateral agreement, the 2016 General Security of Military Information Agreement (GSOMIA). These intelligence-sharing agreements help ensure close and effective monitoring of North Korea's missile program. Despite rocky relations between South Korea and Japan that have endangered such programs, they remain intact today.

U.S. President Barack Obama takes part in a trilateral meeting with Japan's Prime Minister Shinzo Abe and South Korea's President Park Geun-Hye on the sidelines of the 2016 Nuclear Security Summit in Washington, DC.

Photo: Mandel Ngan/AFP/Getty Images

Missile defense cooperation in the form of information and sensor sharing has long been an aim of the Gulf Cooperation Council (GCC) members, but due to regional disputes that goal has remained rather elusive. One locus of cooperation for the region is the United Arab Emirates'

International Air and Missile Defense Centre at Al Bateen Air Base in Abu Dhabi, where there is support for training and interoperability exercises.[47]

V. EXERCISES AND TRAINING

Multinational air and missile defense exercises allow U.S. and allied militaries to test plans, weapons, operators, and operations in a joint environment. These exercises improve the interoperability of both weapons and personnel, assuring readiness in the event of an attack. Exercises also allow for rehearsals of different battle scenarios and assist in developing appropriate responses to those scenarios. BMD drills, in particular, demonstrate to adversaries that the United States and its allies can and will counter missile threats.

A Patriot missile launches to intercept a target during Rapid Arrow 2015.

Photo: U.S. Army

Formidable Shield is a NATO naval exercise that takes place biennially. As NATO explains, the exercise seeks to "improve Allied interoperability in a live-fire IAMD environment, using NATO command and control reporting structures."[48] Nine NATO allies participated in the most recent 2019 exercise; in one event, a U.S. Aegis destroyer fired an SM-3 interceptor to intercept a dummy ballistic missile.[49]

Since 2015, members of the Maritime Theater Missile Defense Forum (MTMD-F) have conducted "At Sea Demonstrations," naval exercises that focus on tracking and engaging air and ballistic missile threats. Past tests have involved SM-3, SM-2, Evolved Sea Sparrow Missiles (ESSM), and the Aster-30. In the inaugural At Sea Demonstration in 2015, Dutch and Spanish ships provided tracking data to a U.S. ship for an SM-3 intercept test, which marked the first such launch in Europe.[50] MTMD-F was established in 1999 and today includes 11 member nations.

Rapid Arrow is another NATO missile defense exercise. The 2011 iteration featured the first live-fire test using NATO's BMD system.[51] A U.S. Aegis destroyer detected and tracked the target missile and passed that information to a German Patriot missile battery, which was stationed at the NATO Missile Firing Installation in Crete. The Patriot interceptor successfully launched and engaged the target missile.[52] Past Rapid Arrow exercise participants have included the United States, Germany, Greece, Turkey, and the Netherlands.

Tobruq Legacy is a multinational ground-based air defense exercise, part of the U.S.-led Saber Guardian. The past few exercises have featured air and missile defense systems such as Patriot, Polish Osa, NASAMS, Hawk, and Kub.[53] These exercises have grown in sophistication since earlier iterations; the 2014 version, for example, only consisted of a few countries "shooting shoulder-fired systems at helium balloons."[54] Past participants include the United States, the Czech Republic, Lithuania, Poland, Estonia, Germany, Hungary, Latvia, the Netherlands, Slovakia, Slovenia, the United Kingdom, and Romania.[55]

The Rim of the Pacific (RIMPAC) is the world's largest maritime exercise. It is hosted biennially by the U.S. Navy's Indo-Pacific Command. Past air defense exercises—though limited—have featured the U.S. Navy's Rolling Airframe Missile (RAM) and the U.S. Army's Avenger and MANPAD systems.[56] In the most recent August 2020 iteration, participants included the United States, Australia, Brunei, Canada, France, Japan, South Korea, New Zealand, the Philippines, and Singapore.[57]

Pacific Dragon is a biennial trilateral exercise focused on testing the combined air and missile defenses of the U.S., Japanese, and South Korean navies. As the U.S. Navy reports, the exercise "focuses on improving tactical and technical coordination among its participants, including the detection, tracking, and reporting of ballistic targets."[58] The exercise's first iteration took place in 2016 and saw the launch of a ballistic test missile

tracked by U.S., Japanese, and South Korean ships, which shared trajectory data with each other throughout the missile's flight.

Juniper Cobra is a bilateral U.S.-Israeli air and missile defense exercise. The United States and Israel have conducted the exercise every two years since 2001. The tenth and most recent iteration took place in March 2020.[59] Past exercises have featured the live and simulated use of Iron Dome, David's Sling, Arrow-2, Patriot, Aegis, and THAAD defense systems. U.S. military and civilian personnel across service branches participate in the exercise, along with the Israeli Defense Force.

The United States and partner nations also participate in multinational IAMD wargames and computer-assisted simulations. One such exercise is Nimble Titan, a biennial air and missile defense wargame led by U.S. Strategic Command. First established in the early 2000s, the wargame is set in a notional 10-year future scenario to explore, develop, and refine multinational IAMD strategy in an unclassified environment. Eighteen nations and four international organizations participated in the most recent Nimble Titan 20.[60] Joint Project Optic Windmill (JPOW) is another simulated air and missile defense exercise, focused on the tactical and operational level. The NATO exercise was first developed in 1996 by the United States, the Netherlands, and Germany.[61]

THE FUTURE OF MISSILE DEFENSE COOPERATION

The benefits of international missile defense cooperation are many. These programs—including sales, co-development and testing, hosting, information sharing, and training—contribute to a more effective, interoperable, and cheaper missile defense architecture. They also strengthen political and military ties, limit the proliferation of offensive weapons, and help deter adversaries. Cooperation today has grown increasingly important, but there are several ways to improve it.

To keep international cooperation strong, U.S. policymakers should consider the following recommendations:

- **Develop lower-cost solutions.** Missile defenses can be costly. Larger interceptors like the SM-3 Block IB have recently cost around $11.8 million each; even smaller point defenses like the PAC-3 MSE interceptor cost about $4.6 million.[62] As missile threats proliferate, the United States and its partners will need to deploy an increasing number of missile defenses without breaking the bank. Furthermore, today's operators may not be able to hold out for the directed energy or hypervelocity artillery. Policymakers should continue to focus on lowering the unit cost of kinetic missile defenses, even if that requires trading some effectiveness. Russian air defenses like the S-400 cost less than their U.S. counterparts and are multimission. Lower-cost passive defense solutions, including concealment, camouflage, deception, mobility, and dispersal, will play an important role in cost mitigation.
- **Simplify the sales process.** The Trump administration has sought to expand and streamline the U.S. arms sales process.[63] Nevertheless, the overall process of procuring U.S. weaponry remains long, complicated, and cumbersome. Various studies have proposed ways to improve this process; enacting these recommendations would help fuel international missile defense efforts.[64]
- **Expand opportunities for co-development.** U.S. policymakers should consider new ways to incentivize collaboration among domestic and foreign defense firms. These collaborations can create air defenses designed to satisfy multinational security concerns. Of course, U.S. allies and partners may invest in their own air and missile defenses for political or economic reasons. As partner programs move forward, the United States should work with these countries to ensure their defense systems are interoperable with U.S. platforms.
- **Expand information-sharing networks.** The United States has formed various information-sharing networks for itself and allied militaries and intelligence agencies. Policymakers should consider ways to strengthen these networks. One approach would be to dedicate more personnel to relevant, regional missions or multinational intelligence centers.[65] Policymakers may also consider expanding established networks to the degree that is safe.[66] When necessary, U.S. policymakers may alternatively choose to establish new, inclusive networks for information sharing at appropriate levels of classification. In either case, modern information sharing will require sustained commitment and involvement from the senior political and military leadership. For longer-term intelligence products, the United States and its partners can increase engagement with academia and think tanks. Public research institutes have developed significant open-source analysis capabilities

as commercial satellite imagery and other publicly available information sources continue to improve. These products also have the benefit of bypassing classification issues and more easily integrating international perspectives.[67]

- **Expand and complexify air defense exercises.** The U.S. military conducts numerous air and missile defense exercises with partners worldwide. However, the focus should now shift from exercise quantity to quality. This means a greater number of training events should confront complex strikes involving the full spectrum of air and missile threats. Forces should perform ballistic missile defense tests while also engaging low-flying UAV and cruise missile threats. Exercises also need to occur under operationally realistic conditions, to include adversary jamming. The defenses employed should also be diversified so that U.S. systems are speaking with and operating alongside their European and Asian counterparts. Training should cross service lines and Combatant Commands. The United States and its partners should also establish guidelines to measure the complexity of air and missile defense exercises. Publishing these standards may also incentivize militaries to further incorporate more stresses in their training to demonstrate their high degree of preparedness.
- **Develop and train new concepts of operation.** Defense analysts have long considered new concepts of operations for air and missile defense against an increasingly broad spectrum of threats. Technical goals here may include developing multi-mission munitions and mixed-load launchers. These may help operationalize offense-defense integration, which could provide increased battlefield capability while lowering the cost of weapons systems through increased procurement, simpler logistics, and reducing required manpower.[68] Strategically coordinated investments, whether on a bilateral or regional basis, may also play a part. One country may focus on sensors while another invests in interceptors, but together they may allow both to contribute more effectively to a joint missile defense architecture according to their own ability.[69]

These policy recommendations are not new. They have been noted in numerous past studies and reports, with various political and financial obstacles continually stalling their enactment. Given the increased sophistication of modern air and missile threatshowever, improved international cooperation will be necessary to further strengthen both U.S. and allied missile defense defense efforts. ■

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