Unclassified Statement of

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Director, Missile Defense Agency

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Subcommittee on Strategic Forces

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Good morning, Chairman Fischer, Ranking Member Heinrich, distinguished Members of the subcommittee. I appreciate this opportunity to testify before you today on the Missile Defense Agency's budget request for Fiscal Year (FY) 2020.

The Missile Defense Agency (MDA) budget request of $9.431 billion for FY 2020 will continue the development, rigorous testing and fielding of reliable, increasingly capable, and state-of-the-art defenses for the United States, our deployed forces, and the forces and territories of our allies and partners against current and projected missile threats. The Agency's priorities for missile defense development and fielding will remain as follows: 1) continue to focus on increasing system reliability and sustainment to build warfighter confidence; 2) increase engagement capability and capacity; and 3) address the advanced threat. We will continue to collaborate closely with the Warfighter and support the current and future needs of the Combatant Commanders and the Services. Specifically, we will work closer with them on the development, testing, deployment, and integration of interceptors, sensors, and the command and control, battle management and communications (C2BMC) system into a multi-domain system for the Ballistic Missile Defense System (BMDS).

First, I am pleased to report that we have nearly completed execution of the emergency appropriations requested in the FY 2018 Budget Amendment that provided funding to enhance the nation's missile defense and defeat capabilities. I once again want to express my appreciation to the Congress for its support in this process.

Additionally, we have made great progress since 2002 improving missile defense performance, affordability, and reliability. The *2019 Missile Defense Review* (MDR) underscores the evolving missile threat we face and that missile defense must remain a high priority investment in our National Defense Strategy. Indeed, the missile defense mission is expanding to include non-ballistic threats. Aligned with current national security and defense strategies, the MDR strengthens our posture as we continue to make progress in the development and fielding of a BMDS to defend the homeland, our deployed forces, and our allies and partners, and it supports the critical need to pursue new concepts and technologies to address tomorrow's threat. The MDR also underscores our continued pursuit of cooperative relations with allies and partners to field interoperable and effective regional missile defenses.

The current BMDS can defeat the current ballistic missile capabilities of our adversaries, but we require additional capacity and advanced capabilities to stay ahead of the evolving threat. The projected missile threat is complex and volatile, and it includes new ballistic missile systems, advanced cruise missiles, and hypersonic missile capabilities, which are now being actively tested by other nations. It is critical we continue to develop innovative and breakthrough technologies to outpace rogue state offensive missile capabilities against the U.S. homeland.

Evolving regional offensive missile systems can threaten U.S. forces abroad, allies, and international partners, and so we also must continue to modernize U.S. regional missile defenses. We have several new technology efforts to improve discrimination capabilities and deliver space sensors to improve the ability of the system to conduct kill assessment following engagements. MDA also is continuing efforts to develop scalable, efficient, and compact high-energy lasers for potential use against threat missiles in the boost phase of flight.

In light of these realities in the current security environment, MDA understands the importance of innovating, developing, and delivering new missile defense capabilities quickly, accelerating where possible missile defense acquisition timelines while adhering to sound acquisition principles. U.S. missile defenses must be responsive to existing and new threats and leverage new approaches to the homeland and regional defensive missions by delivering capabilities faster, learning from failures to make rapid adjustments, and swiftly adapting our systems once they are fielded.

Madam Chairman, I would like to recognize the personnel at MDA as being among the most skilled and dedicated in the nation. Additionally, the nation's preeminent Federally Funded Research and Development Centers (FFRDCs) and University Affiliated Research Centers (UARCs) are integral partners providing technical depth, innovation, engineering excellence, and core competencies that are critical to providing capability and capacity to the warfighter in an expedited manner. Working together with our partners in the Services, allies, and industry, this highly capable workforce makes it possible to develop and deliver the effective and reliable defenses we need to counter the proliferating missile threat.

Missile Threat

Nearly all of our adversaries are devising various means to complicate missile defense operations. Missile defense countermeasures continue to be developed and fielded. Increasingly threat missiles are displaying maneuver capabilities such as maneuvering reentry vehicles (MaRV). Future supersonic and hypersonic powered cruise missiles may be launched from aircraft or by large rocket boosters that have traditionally been associated with ballistic missiles. Hypersonic glide vehicles are being developed as a new type of ballistic missile payload. The

combination of high speed, maneuverability, and relatively low altitude makes them challenging targets for missile defense systems.

In 2016 and 2017, North Korea conducted over 40 launches of missile systems of all ranges; this included two new intercontinental-range ballistic missiles (ICBM). As configured, the Hwasong-14 ICBM can reach North America, and the Hwasong-15 ICBM can reach the Continental United States. Pyongyang flew two Hwasong-12 Intermediate-Range Ballistic Missiles (IRBMs) over Japan in 2017, placing the territory and population of our allies at potential risk from falling missile debris. The second of these tests demonstrated a capability to reach over 3,700 kilometers, which can range beyond Guam. North Korea twice flight-tested a solid-propellant Medium-Range Ballistic Missile (MRBM), which is capable of reaching Japan. This advancement is significant because solid-propellant missiles can be prepared for launch more rapidly than liquid-propellant systems, which challenges U.S. pre-launch counter missile operations. North Korea remains capable today of conducting additional missile launches and further strategic-weapon testing.

Iran has ambitious ballistic missile and space launch development programs and continues to attempt to increase the lethality of its ballistic missile force. Iran is fielding increased numbers of theater ballistic missiles and improving its existing inventory with MaRVs, submunition payloads, and multiple seekers that enable anti-ship missions. Iran's ballistic missiles are capable of striking targets throughout the region, ranging as far as southeastern Europe. Within the Middle East, Iran has conducted missile strikes on targets in Iraq and Syria. It continues to proliferate ballistic missiles to states and non-state groups, such as the Huthi rebels in Yemen. Iran’s ongoing missile tests demonstrate its desire to increase the accuracy and effectiveness of its capabilities. Continued investments in its space launch vehicle program also

have been notable. Iran's July 2017 launch of a Simorgh space launch vehicle demonstrated technologies that are virtually identical and interchangeable with those used in ballistic missiles, in particular ICBMs.

Increasing System Reliability through Testing, Warfighter Collaboration, and Cybersecurity

MDA continues to enhance the reliability and functionality of current missile defense systems, especially the performance of the Ground-based Midcourse Defense (GMD) Ground Based Interceptors (GBIs) and Aegis BMD Weapon System/Standard Missile (SM)-3, build the confidence of Warfighters in the BMDS, and reduce the number of interceptors needed to defeat in-flight ballistic missile threats.

System Reliability

MDA executes a continuous program to improve system reliability and manage service life of BMDS components. For example, we have implemented a series of upgrades to increase the overall reliability of homeland missile defenses. Recent improvements to the GMD ground system architecture replaced a number of obsolete components and the original Command and Launch Equipment with a GMD Maintenance Manager, increased system redundancy, and enhanced cyber resiliency. The GMD program also has advanced GBI stockpile reliability. In prior years, two GBIs were removed from the fleet, inspected and tested to gain understanding of how GBIs age in the silos. Another GBI will be similarly tested this year. This testing will enable service life extension for the GBI fleet. MDA also pursues reliability improvements through our development activities. We measure availability and reliability data in the field and target improvements in the GBIs and GMD ground system development programs. A key delivery this year was the Ground System 7A.0.1 software, which eliminated cyber vulnerabilities and also

improved redundancy for the Warfighter. Key future reliability improvements include delivering interceptors with Redesigned Kill Vehicles (RKVs) and upgrading the GMD Communications Network and launch support equipment.

We also continue to improve the system and missile reliability of Aegis Ballistic Missile Defense (BMD). For example, improvements to the Aegis Weapon System with the Aegis Baseline (BL) 9.C2.0 (BMD 5.1) upgrade enhances reliability and improves cybersecurity. We conducted several successful ground and flight tests in FY 2018 of Aegis BL 9.C2.0 to demonstrate these enhancements.

We continue to improve the system reliability of the seven Terminal High Altitude Area Defense (THAAD) batteries that have been delivered to the Army's inventory, including those deployed to Guam and U.S. Forces Korea. Improvements to THAAD include software upgrades for the batteries and the Army's THAAD Institutional Training Base to improve cybersecurity and system performance against current and emerging threats. We conducted FTX-35 and numerous ground tests demonstrating improved reliability in the interoperability between and THAAD and the Patriot weapon systems.

Missile Defense Testing

MDA continues to execute a robust and aggressive test program that conducts meaningful missile defense testing. These tests demonstrate BMDS capabilities and provide confidence to Combatant Commanders in the capabilities being delivered. We remain committed to “fly before you buy” through collaboration with independent testers within the Department -- the Director, Operational Test and Evaluation (DOT&E); Deputy Assistant Secretary of Defense, Developmental Test & Evaluation; Combatant Commands; the Joint Functional Component Command for Integrated Missile Defense; Service Operational Test Agencies (OTA); and the

Joint Interoperability Test Command -- to develop the Agency's strategic test program as documented in the Integrated Master Test Plan (IMTP). The IMTP provides a flight-, ground-, and cyber-test program, to include the rigorous modeling and simulation (M&S), systems engineering and validation, and verification and analysis necessary to demonstrate and deliver proven integrated capabilities against the evolving threat. Tests comprised of multiple shooters, sensors, and command and control assets, weapon system improved functionality, and evolving targets drive the increasing complexity of our test program. We are using more threat-representative targets, longer-range targets, and simultaneous target launches in our test events. In addition, we are increasing our cybersecurity and international testing to execute a robust, cost-effective test program.

Our system ground tests are the primary source for system performance data, and they test our capability across a wide range of threats and environments that flight tests cannot replicate affordably. MDA and the BMDS OTA Team are making significant progress accrediting the ground test M&S to support developmental and operational assessments. The BMDS OTA Team, which provides an independent operational assessment of the BMDS, relies heavily on the MDA ground test program to independently assess MDA's operational capability. Ground tests allow analysts to characterize BMDS performance under varying conditions, with unconstrained red and blue force limitations, and without the safety, fiscal, and hardware availability limitations of flight-testing. Additionally, with Warfighters on console, they are able to use ground tests to refine Tactics, Techniques, and Procedures. All ground test data are used to inform DOT&E BMDS capability assessments.

In addition to 17 element-level ground tests, we conducted six developmental and operational system-level ground tests from April 2018 to present. There are four additional

system-level ground tests scheduled for FY 2019 and 10 more planned for FY 2020. Since April 2018, we also conducted or participated in more than 25 multi-event exercises and wargames, which are critical to the reliability and performance assessments of the Combatant Commands and the intensive engineering efforts across the Agency.

In FY 2018, the Agency began development of a high-fidelity, all-digital, integrated BMDS simulation to support both developmental and operational BMDS assessments. This effort integrates the best high-fidelity, all-digital models from each BMDS element using an integrating framework that manages time and the distribution of stimulus and is progressing towards MDA's first use in Calendar Year (CY) 2021.

Beginning in FY 2019, we are undertaking an across-the-board re-architecture of the M&S used in ground tests to address current limitations. With incremental deliveries scheduled over the next five years, this effort will improve every aspect of ground test M&S, including accuracy, efficiency, capacity, and credibility. By streamlining the interfaces between models, we will improve the speed with which we can integrate the BMDS and reduce the likelihood of integration errors.

Flight testing provides data for M&S and demonstrates the end-to-end performance functions of the operational system that ground testing cannot address. One of the key attributes of each flight test is combining the system under test with the Warfighters who plan to operate the system in wartime under operationally realistic conditions. We also work closely with our allies to demonstrate the integration and interoperability of BMD capabilities prior to fielding. From April 2018 to present we have executed nine flight tests. For the remainder of FY 2019, we will conduct 10 additional flight tests. Recently, on March 25, 2019, we successfully executed the first salvo test using the GMD weapon system. We will conduct 14 flight tests in FY 2020, to

include additional Terminal High Altitude Area Defense (THAAD) and Patriot integration tests in support of the USFK JEON; a Ground-based Midcourse Defense (GM) Booster Vehicle Test (BVT) flight test of the 2-/3-stage selectable GBI; and the first Aegis BMD SM-3 Block IIA test against an ICBM-class target. The Agency is also conducting detailed planning to execute the second operational test of Regional/Theater Increment 5 air and missile defense system capabilities; it will be the largest air and missile defense live-fire test in history.

Cybersecurity

MDA remains vigilant of the growing cyber threat and we continue to work aggressively to ensure the nation's missile defenses are hardened, resilient, and able to operate in a highly contested cyber threat environment. We are strengthening the cyber defensive posture of missile defense capabilities by ensuring the cybersecurity infrastructure has the latest upgrades. MDA remains focused on supporting the DoD Cybersecurity Campaign through implementation of the DoD Cybersecurity Discipline Implementation Plan -- Four Lines of Effort for: Strong Authentication, Hardening of Systems, Reducing the DoD Attack Surface, and Alignment to Cybersecurity Service Providers (CSSP) across all networks and, where applicable, BMDS weapon systems.

MDA defends its networks against the advanced persistent cyber threat through its Computer Emergency Response Team (CERT). This team provides 24/7 network monitoring and defense of over 24 thousand network devices and continues to expand its breadth of coverage. This has increased the number of recorded cyber events from 3.3 billion to 11 billion per month, leading to actionable defensive measures by three-fold in the past year alone. MDA has continuously supported DoD cyberspace efforts by providing timely MDA cyber situational awareness. To ensure MDA cyber defense posture and activities are synchronized with U.S.

Cyber Command priorities, MDA has supported as many as eight named operations at a time through active network defense measures and daily input to the Joint Force Headquarters, Department of Defense Information Cyber Tasking Order. Lastly, MDA collaborated with US Cyber Command, National Security Agency, as well as open source partners to gather and analyze more than 3.4 million threat indicators over the past year in order to characterize and identify cyber threats to MDA capabilities. MDA also has partnered with the Intelligence Community to identify threat indicators against BMDS elements and is taking action to mitigate known threats to the BMDS.

MDA has engaged with our defense industrial base (DIB) corporate partners to ensure cybersecurity is prioritized, addressed and enforced at all levels of MDA's highly complex supply chain. We continue to make strides in this arena, where our technology is largely generated and where our controlled unclassified information (CUI) resides. The government has contractual relationships with only the prime contractor and has limited knowledge and visibility with the remainder of the supply chain. Our first order of business is to have prime contractors minimize the flow down of information requiring protection. Realizing this is not an absolute solution, we have recently initiated collaborative efforts with industry on two pilot efforts to illuminate where CUI resides within the entire contract supply chain.

Not only are we focused on external threats to our enterprise, but MDA acknowledges the reality of the insider threat as one of the more pervasive threats to be addressed, and we have established and implemented an aggressive Agency Insider Threat Program. This allows us to monitor both internal and external data movement to ensure all unclassified and classified data is handled in accordance with applicable guidance and is also afforded the highest level of protection. We are continually evaluating our attack data and updating the MDA Emergency

Response Team procedures. Abnormalities or violations are quickly identified and thoroughly investigated by both MDA and DoD Insider Threat and Counter Intelligence.

This year MDA engaged in significant improvements in cyber resiliency, increasing the programs' ability to prevent, mitigate, and recover from cyber effects on mission capabilities. We extended defense coverage to the BMDS OPIR (Overhead Persistent InfraRed) Architecture (BOA) system and implemented additional C2BMC tools to create a diverse layered defense capability. MDA also upgraded cyber defense for sensors by adding monitoring tools. GMD is actively updating its monitoring tools, improving its cyber defensive capabilities, and training its cyber incident responders to address modern, sophisticated cyber threats. Extensive cyber testing involving C2BMC, sensors, and GMD was conducted in platform-level and system-of-systems integrated cyber tests pursuant to new platform and increment releases. C2BMC performed in 25 cyber related test events. MDA developed the cybersecurity test strategy, test plans, and coordination with external stakeholders such as DOT&E, National Security Agency (NSA) (Platform Resiliency & Mission Assurance division), Survivability/Lethality Analysis Directorate (a directorate of Army Research Lab), Army Threat Systems Management Office, and NSA's Cyber Protection Team, providing Red and Blue Team test experts. The increased cyber situational awareness, training, and improved cyber defense performance were demonstrated through significantly improved cyber test results. Cybersecurity requires team synergy balance capability with security requirements, Warfighters considering potential cyber effects with maintenance outages, and increased diligence of daily technicians and those responsible for cybersecurity programs. We will support the Combatant Commands in Persistent Cyber Operations testing in 2019, adding real-time daily test, fix, and cyclic test improvements to the BMDS cyber posture.

MDA is actively integrating cybersecurity and cyber resiliency requirements early into the acquisition life cycle to increase security and reduce overall cost. For example, we are upgrading C2BMC and the GMD ground systems software and hardware to enable enhanced cybersecurity protection capabilities. To better support our Combatant Commanders, in 2018 we successfully executed seven operational Adversarial Assessments and Cybersecurity Vulnerability & Penetration Assessment on BMDS systems culminating in an Adversarial Assessment during Ground Test Distributed-07b US European Command / US Central Command. This is a significant step in understanding the cybersecurity posture of the BMDS and the ability to defend against emerging cyber threats.

The MDA office of the Chief Information Officer executes several testing efforts across MDA systems on an annual basis. This cybersecurity testing includes all BMD elements, development labs, and test systems. In 2018, cyber testing included 26 cybersecurity controls validation tests, six vulnerability assessments, 46 software assurance code reviews, and 308 cybersecurity risk assessments. MDA also executes BMDS element- and system-level tests that support fielding of new capability to be included in the Operations Capacity Baseline. Per Section 1647 of the FY 2016 NDAA, MDA executes operational weapon system cyber-testing and develops risk mitigation strategies for the congressional report scheduled to be delivered first quarter FY 2020.

Our partnership with DOT&E to implement a rigorous Test and Assessment Program is focused on ensuring cybersecurity compliance, resiliency, and protection and has supported our comprehensive cybersecurity efforts since 2010. In 2018, the Agency took critical steps to improve the BMDS cybersecurity posture. We implemented a proactive approach to MDA Cybersecurity Test and Assessment to support development of assessment requirements, detailed

test designs, and executable schedules. To further harden the BMDS, we approved the MDA Standing Ground Rules to support Combatant Command Persistent Cyber Operations. Moreover, we executed seven operational Adversarial Assessments on the BMDS Weapon Systems, to include THAAD, the Army Navy/Transportable Radar Surveillance and Control Model-2 (AN/TPY-2) radar, and C2BMC, in addition to six Cybersecurity Vulnerability & Penetration Assessments. In FY 2019 and FY 2020, we will continue to plan cyber assessments on additional assets in the homeland defense architecture and an operational assessment of the EPAA Phase 3 architecture, to include Aegis Ashore-Poland. MDA is committed to implementing cybersecurity in all phases of development, integration, deployment and sustainment of the BMDS.

In FY 2018, MDA took a proactive approach to cybersecurity by modifying contracts, including system level specifications that include cyber resiliency requirements. The contract modifications address compliance, security engineering, design, development, assessments, testing, physical security and program security. The key to executing this strategy is the understanding of the linkage that cybersecurity has with system engineering and the acquisition processes. Incorporating cybersecurity into the systems engineering directorate aligns cybersecurity functions to the following other functions: software, modeling and simulation, future concepts, requirements, and system integration. This alignment ensures cybersecurity is embedded early and often in the systems engineering and development life cycles.

I am confident in our cybersecurity posture and our plans for additional cybersecurity improvements. Our innovative teams continue to refine processes and procedures in this fast-paced, ever-changing and unforgiving cyber environment. We intend to improve our cyber resiliency capabilities through increased cyber sensors, enhanced centralized visibility, and

increased cyber vigilance, all while preserving warfighter confidence in a critical national defense asset.

Left-Through-Right-of-Launch

During the past year, MDA has been working with other elements of the Department on a comprehensive effort to create a more robust missile defeat strategy.. This integration will enable the United States to identify and exploit opportunities to detect, disrupt, and destroy threat missiles. Collaboration between the Intelligence Community, Combatant Commands, State Department, the Office of the Secretary of Defense (OSD) and Joint Chiefs of Staff, and MDA has resulted in the Department developing a ballistic missile left-through-right-of-launch (LTRI) framework that will enhance sharing of data, technologies and capabilities across warfighter, policy, intelligence, and acquisition organizations. It includes discovery and development of new technologies to facilitate integration, improved data-sharing between systems, alignment of programs, and creation of a multi-year test campaign to integrate future capabilities and close gaps. The LTRI framework, governed by an Integration Senior Strategy Group (ISSG) with representatives from more than 20 organizations, provides a forum for development of comprehensive strategies to defeat any ballistic missile threat to the homeland, regardless of origin.

Increasing Engagement Capability and Capacity

This budget request maintains operational missile defense capabilities for existing operational homeland and regional defense forces and will continue to increase interceptor inventory capacity and use existing technologies to improve sensors, battle management, fire control, and kill vehicle capabilities to address evolving threats.

Homeland Defense

MDA remains committed to operating, sustaining, and expanding the nation's homeland missile defenses and requests $1.83 billion in FY 2020 for the GMD program. The Agency will continue to demonstrate improved performance through flight- and ground-testing of homeland defenses, integrate additional capabilities by development of a suite of Advanced Discrimination Radars (ADR) that maximize the engagement space of regional and homeland missile defense, to include the Long Range Discrimination Radar (LRDR), Homeland Defense Radar- Hawaii (HDR-H), and Pacific Radar. These additional ADR sensors, coupled with the Redesigned Kill Vehicle development and enhanced C2BMC will expand the GBI engagement capabilities while simultaneously improving effectiveness. We will continue improving our sensors, C2BMC, GMD ground systems hardware/software upgrades, GMD Fire Control (GFC), and kill vehicle software to improve discrimination capabilities and overall system performance. We also will continue to improve confidence in our reliability through increased testing and analysis.

Over the life of the BMDS, the intercept flight tests of the nation's homeland defenses have increased in complexity with the employment of realistic test scenarios and the use of operational weapons, sensors and fielded software. With the March 25 successful intercept of an advanced ICBM-class target with countermeasures (FTG-11), the Department executed the first test involving a salvo engagement, involving two GBIs launched from the missile field at Vandenberg Air Force Based in California. All system elements functioned as designed. The ICBM-representative target was launched from the Reagan Test Site on the Kwajalein Atoll, Marshall Islands in the Broad Ocean Area in the Pacific over 4,000 miles away. Following detection by Air Force Space Based Infrared System satellites, early tracking information was passed through C2BMC to precision discrimination sensors deployed on Wake Island (AN/TPY-

2 radar) and in the Pacific Ocean (Sea-Based X-band radar). Northern Command operators then authorized and launched the two GBIs. Once they were separated from the GBI boosters and in position, the exo-atmospheric kill vehicles successfully engaged the target complex, resulting in an intercept of the lethal warhead, with the trailing GBI observing the intercept flash and debris scene then intercepting the next most lethal object.

FTG-11 provided the data necessary to assess the performance of the GMD system, the evaluation of which will occur over the coming weeks and months. An Aegis BMD (ABMD) ship in the ABMD 5.1 (Aegis Baseline 9.C2) configuration participated in this test by tracking the ICBM target and executing a simulated SM-3 Block IIA engagement of the target as risk reduction for the planned FY 2020 SM-3 Block IIA test against an ICBM target. In that test we will determine if this advanced capability could be an additional layer of defense in support of the GMD system. During the test Spacebased Kill Assessment satellites provided data required to assess successful intercepts. We also collected real-time data from F-35 aircraft/sensors participating in the test to assess quality of track data for integration into the BMDS architecture.

Increasing GBI Capacity: MDA currently has 44 operational GBIs and, in accordance with the FY 2018 Missile Defeat and Defense Enhancement initiative, plans to expand the fielded GBI fleet to 64 in response to the rapidly advancing North Korean threat. MDA is developing the capability to provide the Warfighter the option of using all three GBI booster stages or not igniting the third stage, which would provide performance similar to a 2-stage boost vehicle. This 2-stage booster capability will provide additional homeland defense battle-space capability by enabling shorter engagement times without the expense of a separate development program. This capability is planned to be tested in a non-intercept flight test, after which it will be integrated into all boost vehicle configurations.

Redesigned Kill Vehicle: As a follow-on to the existing GBI program, MDA initiated the fielding of an additional 20 GBIs, tipped with the RKV upon completion of the development program, at Fort Greely, Alaska (FGA). The RKV will address the evolving threat, enhance kill vehicle reliability, improve in-flight communications to better utilize off-board sensor data, and heighten Combatant Commanders' situational awareness via hit/kill assessment messages. Initial plans were to field GBIs with RKVs as early as 2023 within an acquisition strategy that is disciplined, gated, and milestone-driven. Using this strategy and with inputs from key stakeholders, I assessed the RKV program did not meet the entrance criteria for the Critical Design Review, resulting in a projected delay in the program of up to two years. Re-planned RKV test efforts include Ground-Based Midcourse Defense Flight Test GM-Boost Vehicle Test-02 (GM BVT-02), a non-intercept mission in support of 2- or 3-Stage selectable boost vehicle software that will provide additional engagement battlespace to the warfighter using a GBI launched from VAFB, California in FY 2020 and Flight Test GM-Controlled Test Vehicle-03+ (GM CTV-03+), a non-intercept mission to collect RKV flight environment data in FY 2022. The first intercept flight test utilizing the RKV is planned for FY 2023, and a second intercept flight test in FY 2024.

The effort to reach 64 deployed GBIs requires MDA to develop and produce the RKV, construct a new missile field (Missile Field 4) at Fort Greely, install 20 silos, and deliver an additional 20 GBIs tipped with RKVs. In addition, MDA will initiate a plan to ensure that no less than 64 GBIs are available to the Warfighter at all times. To accomplish this, MDA will add two silos to Missile Field 1 at FGA and purchase six additional boosters.

Ground System Upgrades: MDA continues to develop and field capability upgrades and technology modernization of key ground support and fire control system components. These

include upgrades to the GMD Launch Support System, Communications Network, and the In-Flight Interceptor Communication System Data Terminals. Additional upgrades include improvements to the GFC-Warfighter interface, 2-/3-stage selectable GBI battle management, discrimination improvements, enhancements to the kill vehicle Target Object Map, and On-Demand Communications for the RKV. Ground system modernization will continue to mitigate obsolescence issues, improve cyber resilience, increase GFC capacity for emerging threat complexity and raid size, reduce life-cycle cost, increase system reliability and operational availability, and simplify the insertion of future technologies.

Defense Sensors: We are investing in radars and developing advanced electro-optical sensors to achieve a diverse sensor architecture to provide highly accurate midcourse tracking, discrimination and battle damage assessment for homeland missile defense. We request $194.3 million to sustain the COBRA DANE radar, the Upgraded Early Warning Radars (UEWR), and the AN/TPY-2 radar. The Services and Combatant Commands, with logistical support from MDA, operate a fleet of five AN/TPY-2 (Forward Based Mode) radars in Japan, Israel, Turkey, and U.S. Central Command in support of homeland and regional defense.

We request $283.5 million to continue radar development, to include advanced discrimination algorithms for the AN/TPY-2 and Sea-Based X-band (SBX) radars to counter evolving threats. The improvements will develop and field integrated capabilities to improve the BMDS ability to identify lethal and non-lethal objects. In FY 2019, MDA will complete transition to production development activities for next-generation Gallium Nitride (GaN) Transmit/Receive Integrated Multichannel Modules to support the AN/TPY-2 obsolescence and sparing strategy and set the condition for enhanced performance in the future. MDA requests $105.5 million for BMD Sensors testing activities for planning, analysis, and execution of

BMDS flight test events, including pre- and post-test efforts, such as Digital and Hardware-in-the-Loop Pre-Mission Tests and Post-Flight Reconstruction.

MDA requests $128.2 million for the SBX radar. The SBX is an advanced mobile radar that provides precision midcourse tracking and discrimination capabilities. The SBX participates in flight tests to demonstrate discrimination and debris mitigation improvements. Our budget request includes funds to continue extended operations for defense of the homeland in the U.S. Indo-Pacific Command and U.S. Northern Command areas of responsibility.

We request $136.4 million to continue development of the LRDR. The LRDR will provide persistent long-range midcourse discrimination, precision tracking and hit assessment to support the GMD capability against long-range missile threats from the Pacific theater. LRDR's improved discrimination capability in the Pacific architecture increases the defensive capacity of the homeland defense interceptor inventory by enabling conservation of GBIs. LRDR includes threat discrimination improvements to enhance BMDS effectiveness against the evolving threat. LRDR also supports other mission areas, including Space Situational Awareness. Initial fielding/deployment of the LRDR is planned for calendar year 2020. We are on-schedule for the Technical Capability Declaration in late 2021, leading to Warfighter Operational Acceptance in 2022.

The Department conducted a Sensors Analysis of Alternatives (AoA) to assess the most cost-effective options for enhanced sensor capability to increase GBI effectiveness against future complex threats. The Sensors AoA report highlighted the operational value of placing additional discrimination radars in the Pacific region. Based on the report's finding, MDA completed site surveys for the HDR-H in FY 2017. In FY 2018 we conducted source selection activities for the HDR-H and, last December, awarded this radar as the first delivery order on a fixed-price

indefinite delivery/indefinite quantity (IDIQ) contract. MDA is requesting $274.7 million in FY 2020 for the HDR-H.

The Pacific Radar will leverage a forward position to maximize BMDS discrimination areas for both homeland and regional missile defense. MDA plans to competitively award the Pacific Radar as the second delivery order on the IDIQ contract. MDA is requesting $6.7 million in FY 2020 for the Pacific Radar. Coupled with LRDR, both radars will close coverage gaps in the Pacific architecture, provide persistent long-range acquisition, midcourse discrimination, precision tracking, and hit assessment to support homeland defense against long-range missile threats.

Space provides the critical vantage point necessary to address rapidly advancing threats across multiple regions of interest and the only vantage point for global persistence to address Warfighter requirements. A space-based sensor layer consisting of two separate constellations, one for tracking and discriminating ballistic missiles and one for tracking dim ballistic targets and hypersonic missiles, would enable the United States to use interceptor inventory more efficiently and effectively to counter a broad array of threats. Integrated space and terrestrial sensors for tracking, discriminating, cueing and targeting ballistic missile threats can improve missile defense architecture performance and robustness.

We are requesting $27.6 million for the Spacebased Kill Assessment (SKA) program. Using fast frame, infrared sensors, SKA will deliver a kill assessment capability for GMD defense of the homeland as part of an integrated post-intercept assessment solution requested in the FY 2014 NDAA. As MDA's pathfinder program to host military payloads on commercial/other satellites, SKA, which received the DoD's 2018 David Packard Award for Acquisition Excellence, proved that commercial/other hosting can deploy assets on orbit quickly

and at an appreciable cost savings. To increase the Department's overall experience with commercial hosting, MDA collected and shared its SKA lessons learned with several organizations, including the Defense Advanced Research Projects Agency (DARPA) and U. S. Air Force. SKA sensors are participating in a variety of MDA flight tests and engineering missions to better understand the full capabilities of the SKA network. For example, SKA participated and performed well in FTI-03, an Aegis BMD test, and FTG-11, the GMD salvo test. In FY 2020 we will focus on steps necessary to add the SKA system to the operational BMDS.

Also, we request $35.9 million in FY 2020 for continued operation of the Space Tracking and Surveillance System (STSS) and the Missile Defense Space Center (MDSC). STSS satellites, launched in 2009, have exceeded their life expectancy and proven to be a good investment. These satellites operate in low Earth orbit and continue to collect valuable test data. The STSS program and MDSC support concept development activities for space sensor architecture studies and analyses to address advanced threats.

MDA is working with the Space Development Agency (SDA), DARPA, and the U.S. Air Force to conduct prototype concept design activities for a space-based missile tracking sensor system known as Hypersonic and Ballistic Tracking Space Sensor (HBTSS). HBTSS is one of several proposed missions within the DoD's Proliferated Low Earth Orbit (P-LEO) space architecture led by SDA. As part of an integrated multi-tier OPIR enterprise architecture, HBTSS would detect and track additional and emerging threats using persistent infrared sensors. MDA and the SDA are partnering with DARPA and Air Force Space Command (AFSPC) to ensure our nation's ability to detect and track evolving threats. MDA will coordinate and leverage DARPA's Blackjack program for advances in the areas of production-line satellite buses

and spacecraft autonomy approaches in parallel with the HBTSS risk-reduction efforts. MDA is partnering with AFSPC on integrated missile warning and missile defense requirements definition and will explore opportunities to partner with the Air Force on ground services, integration, launch, and operations. MDA is using STSS as a testbed for HBTSS, and MDA will continue to leverage the Enterprise Capabilities developed collaboratively within other Department and federal agencies. MDA will work with SDA to ensure that HBTSS is compatible with a potential P-LEO data and communications transport layer.

Command and Control, Battle Management and Communications: We request $564.2 million in FY 2020 for C2BMC. C2BMC provides persistent acquisition, tracking, cueing, discrimination, and fire-control quality data to Aegis BMD, GMD, Terminal High Altitude Area Defense (THAAD), Patriot, and coalition partners to support homeland and regional missile defense. We continue to support Warfighter command and control and battle management needs across the globe by providing the Combatant Commander with the BMD planner, situational awareness tools, and battle management capability to support global BMD situational awareness, coalition operations, weapons release authority for homeland defense, and control and tasking of the forward-based AN/TPY-2 radars, LRDR radar, and the HDR-H radar. C2BMC operators and maintainers deploy forward in some of the world's hottest threat spots and continue to provide around-the-clock support to the local commanders.

In FY 2020, we will continue development of C2BMC Spiral 8.2-5, which provides system-level discrimination data, BMDS Overhead Persistent InfraRed (OPIR) Architecture (BOA) 7.0 to provide advance threat warning capability with space sensors and threat characterization solutions and support command and control integration of the LRDR into the BMDS by 2021. These efforts support a robust homeland defense capability and integration of

HDR-H into the BMDS by 2023. Spiral 8.2-5 also will include initial integration and testing of the new Army Integrated Air and Missile Defense Battle Command System. C2BMC will continue development of Spiral 8.2-7 to meet the BMDS Increment 7 requirements, including command and control of the HDR-H radar, SKA sensor operationalization and prototyping for robust Post Intercept Assessment supporting homeland defense, expansion of C2BMC space tracking capability, and additional system-level discrimination data integration and integrated threat characterization.

In 2018, we successfully fielded C2BMC Spiral 8.2-1 and BOA 5.1 to U.S. Northern Command and U.S. Indo-Pacific Command and C2BMC Spiral 8.2-3 to U.S. European Command and U.S. Central Command along with the BOA 6.1 to Northern, Indo-Pacific, European and Central Commands. For the USFK JEON, we fielded a C2BMC Spiral 8.2-1 User Node providing improved BMD situational awareness and communications for USFK.

We continue supporting incremental improvements to the BMDS to keep pace with emerging threats worldwide by investing in the development, integration, and testing of advanced algorithms to improve track and discrimination capabilities and enhance the use of space-based sensor data from sources such as the Space Based Infra-Red System (SBIRS), using the BMDS OPIR Architecture. C2BMC will continue to update hardware/software to increase cybersecurity. The Air Force and MDA also will execute the MDR's direction to deliver a joint report to Department stakeholders within six months of the release of the MDR on how to integrate the F-35, including its sensor suite, into the BMDS for homeland and regional defense.

Regional Defenses

There are hundreds of theater-range ballistic missiles deployed worldwide. Our FY 2020 budget request continues to resource and build integrated regional missile defenses that are

interoperable with systems deployed by international partners to protect deployed forces, allies and international partners against Short-Range Ballistic Missiles (SRBMs), MRBMs, and IRBMs.

Aegis Ballistic Missile Defense

Aegis BMD continues to be a key component of the nation's regional defense for our deployed forces, allies, partners and friends, and directly supports and expands our homeland defenses with long-range surveillance and tracking capability. The FY 2020 budget request of $897.3 million supports continued advancement of the Aegis BMD system to counter growing and more complex threats, including improvements in system reliability and missile reliability as well as increases in Aegis BMD engagement capacity and lethality.

We continued to expand Aegis BMD capability and capacity through new construction deliveries and upgrades on 10 Aegis ships: Three new construction DDG-51 Flight IIA Arleigh Burke-class destroyers (DDGs) with Aegis Baseline (BL) 9.C2.0 (BMD 5.1) were commissioned into service in FY 2018 as well as six Aegis BMD 3.6 ship upgrades to Aegis BMD 4.1, two non-BMD-capable ship upgrades to Aegis BL 9.C2.0 (BMD 5.1) through the Aegis modernization program and two Aegis BL 9.C1.0 (BMD 5.0CU) ships to Aegis BL 9.C2.0 (BMD 5.1). These additions and upgrades bring, among other things, Engage-on-Remote capability, SM-3 Block IIA, cyber improvements, and enhanced reliability to the Aegis fleet.

MDA's ability to keep Aegis BL 9 ships and Aegis Ashore in relatively the same configuration and under configuration control through in-service upgrades aligns training and Tactics, Techniques, and Procedures for the U.S. Navy and ensures the highest level of BMD capability is resident and consistent across the in-service and deploying fleet. We are strongly committed to further enhancing capability of the Aegis BMD system and continue to improve the

Aegis Weapon System in alignment with Navy programs. In coordination with the U. S. Navy, we currently have 38 BMD-capable ships, which will rise to 41 by the end of FY 2019. Per direction in the MDR, the Navy and MDA will develop a plan to convert all Aegis destroyers to be fully missile defense capable within 10 years.

In 2018, we successfully conducted a number of ground and flight tests of Aegis BL 9.2.0 (with BMD 5.1 integrated), which introduces significant new capabilities in U.S. Navy Aegis destroyers in support of Department of Defense priorities to increase lethality and validate the EPAA Phase 3 architecture. Aegis BL 9.2.0 (BMD 5.1) was a joint MDA-U.S. Navy development effort. For the MDA, Aegis BL 9.2.0 (BMD 5.1) delivered Significant Object Reporting to the BMDS, BMD reliability enhancements, and Engage-on-Remote capability with the SM-3 Block IIA missile, significantly expanding Aegis BMD's defended area. In September 2018, Aegis BL 9.2.0 (BMD 5.1) achieved U.S. Navy certification and we have commenced fielding this capability on in-service Aegis destroyers (affordable software updates to current Aegis BL 9.1 DDGs), modernized Aegis DDGs, new construction DDGs, and Aegis Ashore Romania and, upon activation, Aegis Ashore-Poland.

MDA conducted an international live fire event in support of Japan's modernization efforts, Japan Flight Test Aegis Weapon System (JFTM)-5, that successfully verified the performance of the Aegis J6 (with BMD 5.0CU equivalent capability) weapon system functionality, guiding a SM-3 Block IB Threat Upgrade (TU) to a lethal intercept of a SRBM target. This test completed the certification of the J6 combat systems baseline and was an important milestone for Japan's use of the SM-3 Block IB TU missile. MDA also completed an important Sensor Integration Study with The Netherlands that will inform their future BMD

efforts, conducted Pacific Dragon 2018 with the Japanese and South Korean navies, and continued cooperation in the U.S.-European Maritime Theater Missile Defense Forum.

We also conducted Flight Test Aegis Weapon System (FTM)-45, which successfully verified the performance of the Aegis BL 9.C2.0 (BMD 5.1) weapon system and SM-3 Block IIA functionality, guiding a SM-3 Block IIA missile intercept of a MRBM target. This flight test also provided objective quality evidence to finalize a detailed Failure Review Board of missile anomalies experienced earlier in 2018 during FTM-29. Automated BMD kill assessment was also successfully evaluated after intercept.

Finally, we successfully conducted Flight Test Integrated (FTI)-03, an operational test demonstrating the Aegis Weapon System Engage-on-Remote capability to track and lethally intercept an IRBM target with an Aegis Ashore-launched SM-3 Block IIA interceptor in a European Phased Adaptive Approach Phase 3 link architecture. In this case, Aegis Ashore calculated fire control solutions using remote AN/TPY-2 radar data, and then transmitted guidance messages to the interceptor, which then accomplished a lethal intercept of the lethal object. The engagement leveraged a ground-, air-, and space-based sensor/command and control architecture linked by the BMDS C2BMC suite.

In FY 2020, we will continue our commitment to develop, test, and deliver global naval capability to the Warfighter and support defense of U.S. deployed forces and European NATO allies through delivery of EPAA Phase 3 missile defenses. The MDA requests a total of $822.8 million in procurement for Aegis BMD. As part of the overall Aegis BMD procurement request, MDA is requesting $459.8 million to procure 30 Aegis SM-3 Block IB missiles and $238.00 million to procure seven SM-3 Block IIAs, along with associated hardware and support costs. By the end of FY 2020, we plan to have 238 SM-3 Block IBs and 11 SM-3 Block IIAs in

inventory. Also part of the request, we are continuing to explore the opportunity to enter into a five-year SM-3 Block IB Multi-Year Procurement (MYP) contract for FY 2020 - FY 2024. MDA will continue to deliver both SM-3 Block IBs and SM-3 Block IIAs for deployment on land at the Aegis Ashore site in Romania and at sea on multi-mission Aegis ships with BMD capability. The procurement budget also requests $125.0 million for Aegis BMD weapon systems equipment to support program of record requirements.

In FY 2020, as part of our overall Aegis BMD request, we are requesting $198.1 million for the SM-3 Block IIA program. This includes final efforts to transition from development into production, continued integration of the SM-3 Block IIA into the BMDS, along with certification and deployment activities to deliver SM-3 Block IIA rounds to the U.S. Navy and in support of EPAA Phase 3.

We remain committed to the Aegis BMD development required to deliver the new construction DDG-51 Flight III Arleigh Burke-class destroyer with Aegis BL 10 (with BMD 6.0 integrated) and SPY-6 Air and Missile Defense Radar (AMDR). We will continue to align with the U.S. Navy to develop and deliver a comprehensive Integrated Air and Missile Defense capability against advanced threats in the Arleigh Burke-class Flight III Destroyers for a 2024 Initial Operational Capability. Aegis BMD 6.0 exploits AN/SPY-6 radar improvements to enhance Aegis combat effectiveness, to include advanced discrimination, significantly improved raid defense, and expanded engagement battlespace. This will provide advanced organic capability at longer ranges to Flight III DDGs as well as enable BMDS utilization of AN/SPY-6 data for remote engagements while also supplementing deployed assets with simultaneous multi-mission capabilities. AN/SPY-6 will enable U.S. Navy ships to have a greater standoff range from threat environments, providing greatly improved operational flexibility. Aegis BL 10

Weapon System will integrate BMD capability with the advanced AN/SPY-6 for remote engagements and increased raid capacity with simultaneous multi-mission capabilities.

We continue joint U.S. Navy and MDA development of Aegis BL 5.4 (with BMD 4.1.2 integration), which merges Aegis BL 5.3 and Aegis BMD BL 4.1 into a single computer program with multi-mission capability and updated Identification Friend or Foe processing, a significant tactical advancement for individual U.S. Navy ships. We are actively working with the U.S. Navy to certify and initiate fielding of this capability in FY 2020. MDA also continues collaboration efforts with the U.S. Navy on AN/SPY-1 radar antenna improvements that, when coupled with Aegis BL 5.4, will increase AN/SPY-1 radar detection range and sensitivity, improving discrimination, performance, and stand-off distance from threat environments.

In FY 2020, we will also incorporate new BMD threats in Aegis BMD 5.1 that are inherent in the SM-3 Block IIA Build 8 missile software. We will also improve raid performance in Aegis BMD 5.1 through Force Level Engagement and Sensor Coordination – Raid. In FY 2020, we will expand our capability and capacity through execution of 19 Aegis BMD weapon system installations: one Aegis BMD 3.6 to Aegis BMD 4.1 upgrade (enabling a follow-on upgrade to Aegis BL 5.4); three non-BMD capable ship upgrades to Aegis BL 9.C2.0 (BMD 5.1); eight Aegis BL 9.B/C2 (BMD 5.1) Software Upgrade Installs; two Aegis BL 9.C2 (BMD 5.1) Backfit Installs; five Aegis BL 5.4 (BMD 4.1) Installs.

Sea Based Terminal: A sea-based terminal capability is critical to defending high value units at sea as well as protecting air and sea ports of debarkation during mobilization. Adding an additional layer to Aegis BMD, we are using an incremental development approach integrated within the Aegis BL 9 architecture to develop and deliver a Sea Based Terminal (SBT) capability. By expanding the capability of the SM-6 missile and associated Aegis weapon

system changes, we are delivering capability to maritime forces to protect against anti-ship ballistic missiles and provide a layered defense for forces ashore.

SBT Increment 1 was fielded in 2018 after completing the final testing in 2017. SBT Increment 1 built upon an existing weapon system performance and leveraged the Navy's SM-6 Block I design to deliver an operationally effective capability. In 2019, we continue to explore opportunities to expand this capability to in-service Aegis Weapon Systems.

SBT Increment 2, which further improves our endo-atmospheric defensive capabilities, was certified in September 2018. The introduction of SM-6 Block IA with modifications, which expands capability against SRBM threats, provides larger operating areas with higher performance against threats expected in the 2020 timeframe and will undergo testing in FY 2019 and FY 2020. The flight test program supporting the SBT Increment 2 program consists of three flight tests. The first test, FTM-31, is planned for late FY 2019. FTM-31, a Development Test with Commander, Operational Test & Evaluation Force participation, consists of two independent events, both of which support the SM-6 Dual II missile Engineering Change Proposal production cut-in approval and subsequent delivery to the fleet. FTM-31 Event 1 will demonstrate an Aegis BL 9.C2 engagement of a MRBM target with an SM-6 Dual II (BMD initialized) missile. FTM-31 Event 2 will demonstrate an SM-6 Dual II engagement of an Anti-Air Warfare target. The second and third tests, FTM-32 and FTM-33, are planned for FY 2020.

SBT Increment 3 is critical to meet emerging and more complex threats. SBT Increment 3 will expand on the current capabilities of the Aegis Weapon System and leverage SM-6 engineering efforts achieved to date. This engineering effort will provide increased engagement capability against advanced threats by building on capability provided by prior SBT Increments.

SBT Increment 3 System Requirements Review was completed in December 2018 and in FY 2019 will define a preliminary design to support delivery of full capability in FY 2024.

Aegis Ashore-Poland: We continue to support the EPAA as a major U.S. contribution to NATO's BMD capability, providing coverage and protection of NATO's European territory, populations, and forces against the increasing threat of ballistic missile proliferation in the Middle East. Currently, there is an operational Aegis Ashore site located in Romania and another under construction in Poland. NATO BMD architecture also includes the U.S. contributions of a forward-based AN/TPY-2 radar in Turkey, four BMD-capable Aegis destroyers homeported in Rota, Spain, SM-3 interceptors, and a command-and-control node at Ramstein Air Base, Germany.

In FY 2020, we will continue our commitment to develop, test, and deliver global naval capability to the Warfighter and support defense of our deployed forces and European NATO allies through supporting the operational readiness of EPAA Phase 2 and efforts to deliver Phase 3 to improve defensive coverage against medium- and intermediate-range threats, which includes delivery of the Aegis Ashore site in Poland. Aegis Ashore site construction in Poland began in FY 2016. That site will be equipped with the upgraded Aegis BL 9 weapon system with BMD 5.1 and a capability to launch SM-3 Block IIAs in support of EPAA Phase 3 Technical Capability Declaration (TCD). The Aegis Weapon System upgrades are further enhanced by spiral upgrades to C2BMC and AN/TPY-2 sensors, enabling Engage-on-Remote capability and extended defensive coverage for NATO Europe.

Delays due to an unsatisfactory construction progress at the Aegis Ashore site in Poland delayed the EPAA Phase 3 TCD, and Navy Acceptance and Operational Acceptance into CY 2020. Several factors contributed to these delays including underestimation of project

complexity, slow mobilization, and challenges with trade staffing. While there is risk associated with unsatisfactory construction progress at the Aegis Ashore-Poland site, quality of accepted work is good and the Poland project continues to track to delivery of EPAA Phase 3 Technical Capability Declaration and Navy and EUCOM acceptance in CY2020. MDA and the U.S. Army Corps of Engineers (USACE) continue to use all available tools to assist efforts toward completion of the construction. In an effort to maintain post-construction schedule, the MDA,/USACE/Industry team initiated the first of three industrial work packages in support of Aegis Weapon System (AWS) Installation and Check-Out (INCO) in March 2019 on a not to interfere basis with ongoing construction. These work packages, combined with construction contractor efforts lay the groundwork to commence INCO in completed individual spaces vice waiting for the completion of all joint occupancy requirements. This approach will reduce construction delay impacts and assist with maintaining the site's TCD date. MDA, USACE, and Department of Defense leadership remain engaged with the construction contractor at high levels to ensure proper emphasis is placed on project importance and execution. Company leadership continues to express their commitment to the project. The company's performance has improved with steady progress on the ground observed. The company's actions to prioritize preparations for weapon system installation and improve trade labor placement will aid greatly to keep the overall project on track for delivery in calendar year 2020.

The site in Romania is on schedule to be upgraded this summer. This upgrade provides increased coverage capability for the defense of Europe and partially mitigates the delay at the AA Poland site.

MDA FY 2020 budget request includes $25.65 million in Defense Wide Procurement and $38.4 million in Research, Development, Test & Evaluation (RDT&E) funds to address the

multiple actions required to field Aegis Ashore in Poland and continued operations of other Aegis Ashore sites. Given the construction delays and the requirement to be on-site for at least another year, MDA's FY 2020 budget request includes funding to complete combat system adaptation, integration, installation, and testing to ensure delivery of EPAA Phase 3 capability to the Warfighter. MDA and the Navy also will execute the MDR's direction to evaluate the viability of operationalizing the Aegis Ashore Missile Defense Test Complex (AAMDTC) at the Pacific Missile Range Facility in Hawaii and develop an emergency activation plan that would enable the SECDEF to operationalize AAMDTC within 30 days of the Secretary's decision to do so.

Terminal High Altitude Area Defense

Terminal High Altitude Area Defense (THAAD) is a globally-transportable, ground-based missile defense system that is highly effective against short- , medium-, and limited intermediate-range ballistic missile threats inside and outside the atmosphere in the terminal phase of flight. THAAD provides unique, cost-effective, and rapidly deployable capability to the Combatant Commanders to deepen, extend, and complement BMDS homeland and regional defenses. THAAD has successfully intercepted threat representative ballistic missile targets in all 15 of its intercept attempts. In 2018, MDA completed fielding of the 7th THAAD Battery to the U.S. Army while continuing to provide maintenance and sustainment support and deliver interceptors to the inventories of both the United States and United Arab Emirates (UAE).

MDA requested $99.8 million of Operations and Maintenance funding to support the maintenance and upkeep of all BMDS-unique items of the fielded U.S. THAAD batteries and for all THAAD training devices. In FY 2020, MDA will provide support to seven THAAD batteries, including the two forward batteries stationed in the U.S. Indo-Pacific Command

(USINDOPACOM) area of responsibility and is prepared to support the U.S. Army in any future deployments around the world.

MDA requested $425.9 million to continue procurement of THAAD equipment, including 37 THAAD interceptors in FY 2020. By the end of FY 2020, MDA will deliver 85 additional THAAD interceptors to the U.S. Army, for a total of 351 interceptors delivered. Synchronized with the deliveries for U.S. inventory, MDA is on track to complete delivery of THAAD interceptors to the UAE in FY 2020 as planned.

On November 26, 2018, the Kingdom of Saudi Arabia (KSA) signed Letters of Offer and Acceptance (LOA) for THAAD, with a program value of $13.4 billion. MDA will deliver seven batteries, 360 interceptors, and associated support services to the KSA. The U.S. government expects to award the contract for the first phase of the KSA THAAD effort in FY 2019, which will include acquisition of long-lead items and obsolescence efforts.

MDA requested $302.8 million in FY 2020 for THAAD development efforts. We will continue development of multiple, independent THAAD software upgrades to address the evolving threat, improve the Warfighter's defense planning capabilities, and provide improved interoperability with other BMDS elements. THAAD FY 2020 development and integration efforts include activities in support of the USFK JEON. The US Army deployed THAAD in March 2017 to USINDOPACOM in support of the U.S. - Republic of Korea (ROK) Alliance. The USFK JEON requested improved integration of existing ballistic missile defense assets in theater. In FY 2020, MDA will support Army fielding of Electronic Protection / Objective Debris Mitigation enhancements and the THAAD Remoted Launcher capability, which allows the THAAD system to use flexible communication paths to the THAAD launchers to increase defended areas. In coordination with the Army's Program Executive Office for Missile & Space,

efforts will continue to complete the development and demonstration of the Patriot Launch on Remote (THAAD) capability in FY 2020. Integration of the Patriot Advanced Capability – 3 Missile Segment Enhancement (PAC–3 MSE) interceptor capability into the THAAD system will continue to be delivered in FY 2021. In coordination with Army and the Joint Staff, MDA will execute the MDR's direction to prepare a report that provides a current assessment of the required numbers of THAAD batteries to support needed worldwide THAAD deployments, including potential deployment timelines, and basing and deployment options.

Testing continues to reinforce the confidence of U.S. and FMS customers in the THAAD system's performance and interoperability with other air and ballistic missile defense systems. THAAD successfully executed Flight Test Other (FTX)-35 at White Sands Missile Range, New Mexico on April 6, 2018, using THAAD Software Build 3.0, which demonstrated interoperability between THAAD and Patriot by exchanging Link-16 messages over tactical data links while tracking a Close Range Ballistic Missile target. This effort also met the NDAA requirement for annual BMDS integration testing with Patriot. MDA requested $25.1 million for Terminal Defense Testing in FY 2020. This includes THAAD support of Army's Lower Tier Project Office demonstration of Patriot Launch on Remote (THAAD) in two events as well as demonstration of THAAD's capability to intercept an IRBM in the next operational flight test, Flight Test Operational (FTO)-03.

MDA and the Military Departments continue to coordinate with OSD on the path forward for transfer of missile defense programs as directed in the FY 2018 NDAA. A draft Report to Congress has been updated based on feedback from the Services and is in OSD staffing.

Addressing the Advanced Threat

We must make investments in advanced technology today to prepare for tomorrow's threats by improving system performance and effectiveness. This budget request will continue the development and technology risk reduction of breakthrough technologies for integration into the BMDS, including discrimination improvements, Multi-Object Kill Vehicle technology, hypersonic defense technology, and high-powered lasers that have potential use against threat missiles in the boost phase of flight. Scalable, efficient, and compact high-energy lasers could change future missile defense architectures. MDA is developing technology to improve reliability, enhance discrimination, and expand battle space in order to address gaps in the BMDS and dramatically drive down the cost of defending the homeland.

MDA requested $303.5 million for Technology Maturation Initiatives to conduct ground and airborne demonstrations of advanced sensor systems and refine directed energy technologies for missile defense. The Agency is maturing the technologies to increase power and testing sensors.

We are operating aircraft outfitted with passive sensors to better understand threat tracking and how an airborne layer could augment the existing sensor network. In 2020, we will add tracking lasers to these aircraft to increase precision and range and determine how these compact lasers could further influence sensor design. In addition, we are developing advanced sensors and testing them from ground sites to improve discrimination accuracy and validate performance against targets of opportunity. What we learn from these ground and airborne tests could influence future space-based sensor systems.

We continue to advance the state of the art for scaling electric laser powers and pursue competing technologies to reduce development risk. Distributed gain, diode pumped alkali laser, and fiber combining laser technology have the potential to meet missile defense requirements. In

2020, we will concentrate on laser maturation and power scaling development at the national laboratories and work with industry and the Services to investigate other promising laser technologies. Based on the results of these and other tests, we will work closely with the Department to determine the best way to integrate directed energy and laser sensing into the missile defense system.

We are exploring technology for a Neutral Particle Beam system to engage threat systems. The neutral particle beam offers new kill options for the BMDS and adds another layer of protection for the homeland. We are building upon technologies developed in the 1990's and have defined a logical building block approach that will culminate in an on-orbit demonstrator. We are exploring advancements in neutral particle beam component technology to improve the cost-benefit and size, weight and power for an operational system by incrementally building a demonstrator system in a lab environment and executing sound systems engineering practices early in the program. Per the MDR, MDA will study a space-based missile intercept layer capable of boost-phase defense and provide a report to the Under Secretary of Defense (USD) for Research & Engineering (R&E) and the USD for Policy (P) within six months of the release of the MDR.

MDA requests $13.6 million for the Multi-Object Kill Vehicle effort to establish the technology foundation for killing multiple lethal objects from a single interceptor. The more kill vehicles we can put on an interceptor, the greater the raid capacity of our Ground-based Midcourse Defense system. MOKV has the potential to significantly enhance homeland defense capabilities against the threat at a lower cost per engagement. MDA competitively awarded contracts to three major prime contractors in 2017 to reduce the technical risk for MOKV

product development. The MOKV Technology Risk Reduction effort will culminate with component demonstrations specific to the three industry concepts.

We request $157.5 million in FY 2020 for the Hypersonic Defense effort to execute the systems engineering process, identify and mature full kill chain technology, provide analysis and assessment of target of opportunity events, and execute near term space sensor technology and multi-domain command and control capability upgrades to address defense from hypersonic threats. This effort will execute the Defense Science Board's and the MDR's recommendations to develop and deliver a set of material solutions to address and defeat hypersonic threats informed by a set of near-term technology demonstrations. An integrated set of enhancements will provide incremental capability measured by progress and knowledge points in the following areas: establishment of systems engineering needs and requirements to identify alternative material solutions; execution of a series of sensor technology demonstrations; modification of existing BMDS sensors and the C2BMC element for hypersonic threats; and definition of weapon concepts and investments in key technologies to enable a broad set of solutions, including kinetic and non-kinetic means. Per the MDR, MDA and Northern Command will prepare a plan to accelerate efforts to enhance missile defense tracking and discrimination sensors, to include addressing advanced missile defense threats. Also, MDA will provide a plan that will leverage work taking place at DARPA and the Air Force identifying resources, retesting, and personnel requirements necessary for defense against hypersonic threats to USD (R&E) and USD (P) within six months of the release of the MDR.

MDA requests $20.7 million for the Advanced Research Program to continue capitalizing on the creativity and innovation of the nation's small business community and academia to enhance the BMDS. Advanced Research conducts innovative research and development with

small businesses, universities, and international partners to create and advance missile defense capabilities against current and future threats. We are fostering innovative research between U.S. and foreign universities of allied nations through international cooperative technology development projects.

We request $14.2 million for the Advanced Concepts & Performance Assessment effort, which centralizes advanced technology concept modeling, simulation, and performance analysis. The program delivers independent assessments of government, university, and industry technology concepts that, along with systems engineering requirements, support acquisition strategy decisions and define our technology focus areas. The request will fund independent government assessments of industry sensor, directed energy, and interceptor technology concepts and mature related tracking, discrimination, and sensor fusion algorithms. Assessment activities also include development of Hypersonic Defense, Artificial Intelligence and Machine Learning Initiatives, and left-through-right-of-launch integration key technology areas. The concept definition and assessment methodology enables us to verify contractor technology solutions and evaluate promising concepts in future missile defense systems architectures.

International Cooperation

The FY 2020 budget request includes funding for regional missile defense capabilities to protect deployed U.S. forces, reassure allies and partners, and build stronger regional security architectures. MDA is actively engaged with over 20 countries and international organizations and is expanding work with our international partners through joint analyses, cooperative research and development projects, co-production activities, deployment of BMD assets, and facilitating the acquisition of missile defense capabilities, including FMS.

MDA continues to encourage allied and partner investments in their own missile defense capabilities to create more effective regional security architectures that complement U.S. regional missile defense capabilities. The United States and Australia are conducting joint modeling and simulation activities looking at combined regional IAMD architectures. MDA is providing support to the United Kingdom as it conducts an analysis of requirements and potential radar options to fulfill a commitment to field a BMD radar to enhance the coverage and effectiveness of the NATO BMD system. We are engaged in multiple missile defense architecture analysis studies with our foreign partners to help them make missile defense acquisition decisions that also support interoperability with the United States. MDA also supports foreign military sales of the THAAD system, highlighted by the FMS case with the Kingdom of Saudi Arabia for seven THAAD batteries. We continue to execute the UAE FMS case and deliver interceptors for the UAE's two THAAD batteries, both of which have been delivered and have achieved Initial Operational Capability.

MDA is actively engaged with several nations across the globe to provide program information and cost data that may inform future decisions to procure missile defense capabilities, including Aegis BMD, THAAD, and BMD-capable sensors. We continue to discuss the 2016 regional Ballistic Missile Early Warning System architecture study results with the Gulf Cooperation Council nations. MDA also is assisting Japan in their pursuit of an FMS case for two Aegis Ashore installations.

MDA's work with the Israeli Missile Defense Organization is a testament to the strong missile defense partnership we maintain with Israel. MDA's FY 2020 request remains consistent with the funding Memorandum of Understanding that the United States and Israel signed in 2016, which would provide $500 million for this effort. This budget continues MDA's

longstanding support of U.S.-Israeli Cooperative BMD Programs, to include the co-development and co-production of the David's Sling Weapon System and Upper Tier Interceptor and improvements to the Arrow Weapon System. The Department continues to support co-production efforts for the Iron Dome program to provide critical defense against short-range rockets and artillery. In FY 2020, our budget will also support several flight tests across the Israeli portfolio. These continued joint efforts provide Israel with a three-tiered defense to defend from ballistic missiles, rockets, and cruise missiles and ensure Israel maintains its qualitative military edge against its advisories.

We continue to make progress with our Japanese counterparts on the SM-3 Block IIA, our largest co-development effort, which supports extended deterrence and establishes an important regional defense capability. We are committed to delivering the SM-3 Block IIA to meet global threat requirements and support Phase 3 of the European Phased Adaptive Approach. Our FY 2020 budget request also supports Allied participation in tests, exercises, and wargames, such as Formidable Shield- 2019 (FS-19). FS-19 is a multinational exercise that will build upon the FS-17 exercise, which included the first operational SM-3 intercept in the Atlantic.

Conclusion

Madam Chairman and Members of the Subcommittee, in closing, our FY 2020 budget funds comprehensive missile defense development efforts, including several critical capabilities required by the Warfighter. We will continue to increase the reliability as well as the capability and capacity of fielded homeland and regional missile defense systems and make measured investments in advanced technology to counter the adversary missile threat.

I also would like to broadly recognize the government/industry missile defense team and, more specifically, recognize the brave men and women who serve in our Armed Forces at home and abroad and who operate the BMDS. Our Nation is fortunate to have such a capable fighting force.

I appreciate your continued support for MDA and missile defense, and I look forward to answering the committee's questions. Thank you.