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Subcommittee on Strategic Forces

COMMITTEE ON
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UNITED STATES SENATE

TO RECEIVE TESTIMONY ON MISSILE DEFENSE POLICIES AND PROGRAMS IN REVIEW OF THE DEFENSE AUTHORIZATION REQUEST FOR FISCAL YEAR 2020 AND THE FUTURE YEARS DEFENSE PROGRAM

Wednesday, April 3, 2019

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U.S. Senate
Subcommittee on Strategic Forces
Committee on Armed Services
Washington, D.C.

The subcommittee met, pursuant to notice, at 2:29 p.m. in Room SR-222, Russell Senate Office Building, Hon. Deb Fischer, chairman of the subcommittee, presiding.

Committee Members Present: Senators Fischer [presiding], Rounds, Sullivan, Hawley, Heinrich, King, and Jones.

OPENING STATEMENT OF HON. DEB FISCHER, U.S. SENATOR FROM NEBRASKA

Senator Fischer: The hearing will come to order. The Strategic Forces Subcommittee meets today to review the Administration's budget request for missile defense programs for the next fiscal year and to discuss the associated policies with our witnesses.

Testifying before us today we have the Honorable John Rood, Under Secretary of Defense for Policy; General Terrence J. O'Shaughnessy, Commander of the U.S. Northern Command and NORAD; Lieutenant General Sam Greaves, Director of the Missile Defense Agency; and Lieutenant General James Dickinson, who commands the Army Space and Missile Defense Command, as well as the Army Forces Strategic Command and the Joint Functional Component Command for Integrated Missile Defense.

Last year we bid farewell to General O'Shaughnessy's predecessor, General Robinson, and I understand, General Greaves, that you will be following her into retirement. I want to thank you for your decades of service to this country that you have sacrificed so much for, you and your family. We wish you well. It has been a pleasure to work with you, sir.

I would like to thank the entire panel for being here today. We look forward to hearing from you.

First I would recognize our Ranking Member for any comments he would like to make.

Senator Heinrich?

STATEMENT OF HON. MARTIN HEINRICH, U.S. SENATOR FROM NEW MEXICO

Senator Heinrich: Thank you.

First I want to thank Senator Fischer for holding this hearing, and let me also thank today's witnesses for testifying. We very much appreciate the time that they took to prepare for today's hearing and for the work that they do every day for our country.

Now that we have the 2019 missile defense review, it's important that we take this opportunity to review the Fiscal Year 2020 budget request to ensure that it's consistent with the MDR and that it provides sufficient resources so that our missile defense systems perform reliably and effectively.

We also need to continue to improve our sensor and discrimination capabilities so that we have a better picture of the ever-evolving threats, including hypersonic missiles.

And we need to continue to conduct smart simulation and testing before we commit to buying new technologies.

While we continue to improve our homeland defense systems, we should not take our eyes off the ball when it comes to protecting our deployed troops and reassuring our allies and partners. The demand for our combatant commanders for Aegis ships, THAAD and Patriot batteries remains high. We need to consider how we can best allocate

these systems and effectively train the warfighters who operate them, and to provide the protection that is needed in today's demanding environment.

But what was most notable about the missile defense review is what it didn't do, since it failed to recommend any new creative solutions for addressing the expensive shock doctrine that we currently face. Simply put, the cost curve is not in our favor.

The targets are extremely cheap, and our interceptors are extremely expensive, which means we need to more aggressively pursue new technologies and emphasize left-of-launch approaches.

The missile defense review also avoided proposing any actions to defend against hypersonic missiles despite repeatedly acknowledging the threat. So I look forward to hearing about how we can, as a nation, move with a sense of urgency to best address that threat.

Again, thank you for coming today, and I look forward to this dialogue.

Senator Fischer: Thank you, Senator Heinrich.

We now turn to our witnesses for their opening statements. I would remind you that your full statements will be made part of the record.

Secretary Rood, please.

STATEMENT OF HON. JOHN C. ROOD, UNDER SECRETARY OF DEFENSE FOR POLICY

Mr. Rood: Senator Fischer, Madam Chairman, Senator Heinrich, other members of the committee, thank you for the opportunity to testify before you today on the Department's missile defense policy, posture, and budget.

The missile defense review, or MDR, articulates a comprehensive approach to address the missile threat through strength and deterrence and active missile defense systems. It is based on a recognition that the threat environment is more dangerous and calls for a concerted U.S. effort to improve the existing capabilities for both homeland and regional missile defense.

The Fiscal Year 2020 budget requests $12 billion for missile defense, which includes $9.4 billion for the Missile Defense Agency, as well as other funding for the Army and Air Force. These funds support improving the current system and moving towards innovative concepts and advanced technologies.

Now, today more than 20 states possess offensive missiles. Potential adversaries are developing sophisticated ballistic and cruise missile systems with increased speed, range, accuracy, and lethality.

Over the past decade, for example, North Korea and Iran have accelerated efforts to develop and field missiles

capable of threatening U.S. strategic interests. While North Korea has not tested a nuclear-capable missile in over a year, it possesses a range of systems, including road-mobile ICBMs, solid-propellant medium-range ballistic missiles, and submarine-launched ballistic missiles.

Iran continues to improve its missile capabilities and develop space launch vehicles which provide knowledge to develop an intercontinental-range ballistic missile. Iran already possesses the largest stockpile of regional missiles in the Middle East and is now enhancing their precision.

We see the re-emergence of long-term competition with Russia and China. Both of those countries are expanding and modernizing a wide range of offensive missile capabilities. For example, they are fielding increasingly diverse missile systems and integrating those missiles into their coercive threats and military plans.

Russia is developing the hypersonic glide vehicle, which maneuvers outside traditional trajectories and typically maneuvers in the atmosphere, and China is also developing advanced technologies, such as maneuverable reentry vehicles, as well as hypersonic glide vehicles.

As highlighted in the missile defense review, a comprehensive approach is needed to address today's complex threats. Our focus is on a layered defense, with adaptable systems to meet the changing environment.

Within the MDR framework, the key roles for missile defense include: one, protecting the U.S. homeland, our forces abroad, our allies and partners; two, diminishing the benefits of adversary coercive threats and attacks; three, assuring allies and partners we will stand by our security commitments; four, assuring our freedom of action to conduct military operations; and lastly, hedging against future unanticipated threats.

Let me now turn to the missile defense capabilities, posture, and budget that flow from our policy in the MDR to counter these threats. Regarding our first priority, to protect the U.S. homeland, the United States is protected by the ground-based missile defense system. The budget requests $1.8 billion for this system, which includes a number of improvements such as: 20 additional ground-based interceptors, bringing the total to 64; continuing development of the redesigned kill vehicle; and continuing to build a new missile field at Fort Greely, Alaska.

The budget also requests funding to field new discrimination radars in Alaska and Hawaii, and extend operations for use of the sea-based X-band radar.

The MDR also recognizes the need for improving our capability to detect and defend against increasingly stealthy cruise missile threats. This includes a phased effort to enhance our ability to warn and defend against

air-breathing threats and cue our air and missile defense systems against these threats. Funds for homeland cruise missile defense in the 2020 budget request include $301 million for the wide-area surveillance system.

To address the regional missile threat, our efforts are focused on integrated air and missile defense to defend our forces, allies, and partners against missile threats from any source. General Greaves will talk about a number of the programs where we have requested funding and the budget request for them.

In addition to improving our legacy systems, the MDR calls for pursuing a range of technologies and examining advanced concepts and breakthrough technologies. We are requesting funding for: additional space-based sensors; integrating space-based kill assessment; operating and sustaining the space tracking and surveillance system; developing defenses against hypersonic missiles, including near-term sensor and command and control upgrades; testing an SM-3 Block IIA capability against an ICBM-class target; kinetic boost phase intercept using a tactical air platform; and technology maturation initiatives, including a neutral beam technology demonstration program and continuing High-Energy Laser development and scaling, as well as a study of space-based interceptors.

The MDR stresses the importance of working with allies

and partners and encouraging them to invest in their own air and missile defense capabilities. The United States, for example, is committed to completing the deployment of European Phased Adaptive Approach. Phases 1 and 2 are complete and included: stationing ships in Rota, Spain; positioning a TPY-2 radar in Turkey; and deploying the first operational Aegis Ashore system in Romania. Deployment of Phase 3, in Poland, for an Aegis Ashore system is underway.

In the Middle East we are working with our Gulf partners. We are also working and supporting Israel's programs. And in the Indo-Pacific region, Japan is perhaps the best example, where we have developed the SM-3 Block IIA together with that country.

So in conclusion, let me just say that our missile defense investments and priorities focus on the concepts and advanced technologies to ensure the continuing effectiveness of missile defenses against capabilities of potential adversaries. By doing so, we will strengthen our ability to protect the homeland, enhance deterrence, stabilize crises, better control escalation, protect and assure our allies, and hedge against future threats.

Thank you again for the opportunity to testify.

[The prepared statement of Mr. Rood follows:]

Senator Fischer: Thank you, Mr. Secretary.

General O’Shaughnessy, please.

STATEMENT OF GENERAL TERRENCE J. O'SHAUGHNESSY, USAF, COMMANDER, UNITED STATES NORTHERN COMMAND AND NORTH AMERICAN AEROSPACE DEFENSE COMMAND

General O'Shaughnessy: Thank you, Chairman Fischer, Ranking Member Heinrich, and distinguished members of the subcommittee. I am truly honored to appear today as the Commander of the United States Northern Command and North American Aerospace Defense Command.

As a warfighter responsible for defending the homeland from attack, I am truly grateful for the steady support we receive from Under Secretary Rood, General Greaves, and General Dickinson, and I appreciate the opportunity to appear with each of these great partners today. And I also thank you, ma'am, for recognizing Sam Greaves' upcoming retirement and the great work that he's done for us.

USNORTHCOM is responsible for the ballistic missile defense of the United States, while NORAD has responsibility for cruise missile defense over the United States and Canada. In an era of rapidly evolving technology and renewed great power competition, the importance of USNORTHCOM and NORAD's mission to deter, detect, and defeat threats to the homeland cannot be overstated.

Our adversaries have engaged in deliberate, focused efforts over a number of years to exploit our perceived gaps and erode many of the advantages previously afforded by our

geography and technological superiority. As a result, it is clear that our homeland is not a sanctuary.

Revisionist powers Russia and China have given every indication that their own security strategies are based on holding the United States at risk with both conventional and nuclear weapons, and they have signaled that we must anticipate attacks against our civilian and defense infrastructure in the event of conflict.

Russia has modernized its aviation and submarine fleets and fielded long-range cruise missiles designed to evade radar detection. Russia and China continue developing and testing hypersonic glide vehicles, and both have also established a noticeably stronger foothold in the Arctic along the northern approaches to the United States and Canada, well within the striking distance of both nations.

Meanwhile, North Korea's stockpile of nuclear weapons and ICBMs remain an immediate concern.

USNORTHCOM and NORAD's mission to deter our adversaries is dependent on our ability to detect and defeat potential threats to the homeland, and I am grateful to the subcommittee for your strong support of USNORTHCOM and NORAD priorities along those lines of effort. Improving our ability to see and defeat missile threats to the homeland is among my top priorities. Congressional support for fielding AESA radars for our aerospace control and warfighters and

improving the capability and capacity of our missile defense sensors and interceptors clearly demonstrates our shared sense of urgency and resolve. In that same spirit, I ask for your continued support as we improve our defenses against new and emerging missile technologies.

We must take prudent steps now to ensure our next generation defense capabilities to include a space-based sensing layer are not late to need. That effort cannot start too soon given that our adversaries are already developing and testing advanced weapons specifically intended to avoid detection in order to hold targets in the homeland at constant risk.

With these challenges firmly in mind, I sincerely appreciate the much-needed predictability and stability that came from an on-time budget in Fiscal Year 2019. I am also grateful for the subcommittee's ongoing efforts to ensure that we avoid the devastating impacts that a return to sequestration would bring to the Department of Defense in Fiscal Year 2020.

USNORTHCOM and NORAD work every day with our partners to keep our citizens safe while confronting challenges emanating from multiple approaches and in all domains. I especially want to take this opportunity to express my gratitude to the amazing men and women in the National Guard who are great partners and critical to our ability to

perform our missions.

The threat to the homeland from both ballistic missiles and cruise missiles are significant and increasingly complex, but the airmen, soldiers, sailors, Marines, Coast Guardsmen and civilians of USNORTHCOM and NORAD are deeply committed to defending our nation, and I am honored to represent them today. We have the watch.

Thank you, and I look forward to your questions.

[The prepared statement of General O'Shaughnessy follows:]

Senator Fischer: Thank you, sir.

General Greaves, welcome.

STATEMENT OF LIEUTENANT GENERAL SAMUEL A. GREAVES, USAF, DIRECTOR, MISSILE DEFENSE AGENCY

General Greaves: Chairman Fischer, Ranking Member Heinrich, distinguished members of the subcommittee, good afternoon and thank you for this opportunity to testify on the Missile Defense Agency's budget request for Fiscal Year 2020.

Madam Chairman, thank you for those very kind comments at the beginning of the hearing. It has been my distinct pleasure and true honor to serve within our United States Air Force these past 37 years.

As for the budget request, I am pleased to report that we have nearly completed execution of the missile defense enhancements funding we received in the Fiscal Year 2018 budget amendment that provided funding to enhance the Department's missile defeat and defense capabilities.

Once again, I would like to express my appreciation to this body for its support in this process. In Fiscal Year 2020 we will continue to leverage this funding to meet our nation's critical missile defense needs.

I would also like to thank the thousands of men and women across government and industry who work tirelessly every day in support of our nation's ballistic missile defense mission. Without question, they are the source of our strength and one of the reasons the armed forces of the

United States remain unparalleled in the world.

Our budget request of $9.4 billion supports the President’s commitment to sustain, expand, and improve performance and reliability of the nation’s missile defense systems, and reflects what was broadly articulated in the 2019 missile defense review.

This funding request will continue development, rigorous testing and fielding of reliable, increasingly capable advanced defenses for the protection of the United States, our deployed forces, and our allies and partners against current and projected missile threats.

As part of our intensive engineering efforts, this past year the agency began development of a high-fidelity, all-digital, integrated ballistic missile defense system simulation capability to support both developmental and operational ballistic missile defense system assessments. This effort integrates the best high-fidelity, all-digital models from each of our ballistic missile defense system elements using an integrated framework which is progressing towards the Missile Defense Agency’s first use in calendar year 2021 on the ground-based midcourse defense program.

Program plans include the continued construction of 22 missile silos at Fort Greeley, Alaska, and the procurement of an additional 20 ground-based interceptors for homeland defense upon completion of the redesigned kill vehicle

development program. The emplacement of the new interceptors will bring the total number of operational ground-based interceptors to 64.

Initial plans were to begin fielding those ground-based interceptors with redesigned kill vehicles in 2023. However, during the redesigned kill vehicle design phase, I assessed that we were unable to meet the critical entrance criteria for the critical design review, resulting in a projected delay in the program of up to two years.

Sensors. We continue to make investments in sensors to improve homeland missile defense. The Department conducted the Sensors Analysis of Alternatives to assess the most cost-effective options for enhanced sensor capability to increase ground-based interceptor effectiveness, and highlighted the operational value of placing additional discrimination radars in the Pacific region.

With the addition of the long-range discriminating radar in Alaska, the homeland defense radar in Hawaii, and the future Pacific radar, we will have in place a diverse sensor architecture in the Pacific to provide an improved and persistent midcourse tracking discrimination capability against future threats.

The combination of high-speed maneuverability and relatively low altitude of some of the emerging advanced threats makes them challenging threats for missile defense

systems. A space sensor layer is needed since we cannot populate the earth and the oceans with terrestrial radars to meet this need. The birth to death tracking that space sensors can provide when integrated with terrestrial sensors will make it possible to maintain custody of missile threats from launch through intercept regardless of location.

On the advanced threat, we must also prepare for future security challenges. Developing advanced missile defense technologies to address emerging threats will remain a top priority. The projected missile threats include new ballistic missile systems, advanced cruise missiles, and hypersonic missile capabilities that are now being actively tested by other nations.

With this budget, we will fund software modifications to the current ballistic missile defense system and further define the architecture for future hypersonic defense demonstrations.

The agency is taking significant steps in understanding the cybersecurity posture of the ballistic missile defense system and the ability to defend against emerging cyber threats.

Madam Chairman, Ranking Member Heinrich, and members of the subcommittee, in closing, our Fiscal Year 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 defense systems and make measured investments in advanced technology to counter the adversarial threat.

Thank you once again, and I look forward to your questions.

[The prepared statement of General Greaves follows:]

Senator Fischer: Thank you, General.

General Dickinson.

STATEMENT OF LIEUTENANT GENERAL JAMES H. DICKINSON, USA, COMMANDER, UNITED STATES ARMY SPACE AND MISSILE DEFENSE COMMAND / ARMY FORCES STRATEGIC COMMAND AND JOINT FUNCTIONAL COMPONENT COMMAND FOR INTEGRATED MISSILE DEFENSE

General Dickinson: Chairman Fischer, Ranking Member Heinrich, distinguished members of the subcommittee, I'm honored to testify before you today. Thank you for supporting our service members, civilians, and their families, and your continued support to the U.S. Army, U.S. Strategic Command, and the Joint Missile Defense community.

As air and missile threats continue to evolve, your support enables the nation's air and missile defense forces to accomplish their critical worldwide missions. I will briefly summarize those missions in the context of three roles in which I serve, along with some selected achievements over the past year.

First, I serve as the Commander of the United States Army Space and Missile Defense Command, Army Forces Strategic Command, which provides trained and ready space and missile defense forces to support the warfighter and the nation. With two warfighting brigades, as well as science and technology capability development centers, we provide low-density, high-demand capabilities for today's fight and develop future space and missile defense concepts and capabilities for tomorrow.

Last week, SMDC/ARSTRAT's 100th missile defense brigade, comprised of Army National Guard soldiers from Colorado, California, and Alaska, supported the FTG-11 ground-based midcourse defense test. These flight tests allow our soldiers to demonstrate their readiness and lethality to protect the homeland in the event of an ICBM attack.

Additionally, over the past year soldiers have supported numerous regional air and missile defense tests, including the maneuver fires integrated experiment, and a successful interoperability demonstration between THAAD and Patriot.

SMDC/ARSTRAT is also developing directed energy for air and missile defense. In 2018, soldiers at the Joint Warfighting Assessment engaged in defeating targets with a 10-kilowatt laser mounted on a Stryker combat vehicle. With soldiers' input, the Army is developing tactics, techniques, procedures, and concepts of operations for soon-to-be fielded high-energy laser systems.

In my second role I serve as the Army's Air and Missile Defense Enterprise Integrator, coordinating across the Army air and missile defense community to balance priorities, inform resourcing decisions, and pursue innovative approaches that enhance our strategic flexibility. Our team recently published Army Air and Missile Defense 2028. This

document is aligned with national DOD Army strategic guidance to include the missile defense review. It synchronizes the Army's AMD capabilities, capacity, training, and our ally and partner initiatives to ensure our forces are flexible, agile, and integrated, capable of executing multi-domain operations and defending the homeland, joint and coalition forces, and critical assets.

As one of the Army's top six modernization priorities, Army air and missile defense is achieving accelerated delivery of capabilities and capacity. The Army selected and has begun production of the first of four battalions of interim mobile short-range air defense, or IM-SHORAD.

Additionally, per the Fiscal Year 2019 National Defense Authorization Act, Iron Dome was selected as the interim cruise missile defense capability for inter-fire protection capability, or IFPC, and will serve to deliver cruise missile defense protection by the end of next year.

In the past year, the Army expanded air and missile defense capacity by activating an additional air defense artillery brigade in INDOPACOM, activated a SHORAD battalion in Europe, and resourced force structure for future IM-SHORAD battalions.

Finally, I serve as the Commander of the Joint Functional Component Command for Integrated Missile Defense, or JFCC IMD, which supports USSTRATCOM by integrating and

synchronizing global missile defense operations. JFCC IMD also advocates for missile defense capabilities and provides global missile defense training.

In 2018, JFCC IMD, our team spearheaded the biennial Nimble Titan campaign, an exercise which brings together representatives from over 24 allies and partners, and four international organizations to explore solutions for collaborative missile defense. Nimble Titan builds confidence in shared missile defense and enables collaboration, interoperability, and cost-sharing with our allies and partners. The campaign serves as a linchpin by building trust and increasing integration to maximize our collective capability and capacity.

So in summary, there is no one silver bullet or single capability to counter the rapidly changing and complex operational environment. We must continue to develop more cost-effective capabilities that position us on the right side of the cost curve. We must invest in solutions to counter threats through all phases of flight, in any weather, and in a denied, degraded, or contested environment.

And finally, all that we do depends on our greatest strength, which is our people. Our remarkable service members, civilians, contractors, and their families provide global support to the Army, joint warfighter, and the

homeland every day as they deploy, develop, and operate our nation’s air and missile defense systems.

So thank you for your continued support for these dedicated professionals, and I look forward to your questions. Thank you.

[The prepared statement of General Dickinson follows:]

Senator Fischer: Thank you, General.

Secretary Rood, the deployment of space-based sensors is generally looked upon as a necessary next step for missile defense, especially as threats from maneuvering hypersonic weapons increase. Last year, funding to pursue such a network was not included in the budget. It was placed on MDA's unfunded priorities list. But Congress provided funding to begin moving forward.

Now, in this year's budget request, the project is again on the unfunded priorities list. Can you help me understand what the Department's approach is here? We have heard a lot of testimony about how important this capability is, but it doesn't seem to ever be included in the budget documents. What's going on?

Mr. Rood: Senator, as you point out, the growth in hypersonic threats that we face is one of our concerns. And so in the approach that the Department has taken for this year as compared to last year, one of the things that we've had is that Under Secretary Mike Griffin, former NASA director, who also spent a great deal of his career working in missile defense, has put forward a concept that the Department is embracing for a proliferated low earth orbit constellation of satellites. That proliferated, or P-LEO constellation, there is funding requested from the Department that the committee will review, of course, to

begin the work both to architect that proliferated LEO concept, which leverages work that DARPA has done, initially with studies of the architecture, the sensor, a space transport layer to communicate that data, and then a ground-based system as well for command and control. That work would be done by the Space Development Agency.

Senator Fischer: So it's my understanding that there is -- is it $20 million that's in the budget for the SDA to study that low orbit?

Mr. Rood: The SDA budget request is for just under $150 million for that purpose. That will include $20 million, as you point out, for the P-LEO sensor technology, but it will also include funding requested for the transport layer at $15 million, the ground warning integration for $30 million, as well as the launch and space situational awareness portion of that at $10 million, and for the staff and studies just under $45 million. That's in addition to a space-based discrimination study for the Space Development Agency, which has applications both for ballistic missile defense and other activities.

Senator Fischer: General Greaves, can you discuss the project on the Missile Defense Agency's unfunded priorities list? Would you say it's premature to move forward at this point, or is this for work that needs to be done regardless of the outcome of this study?

General Greaves: Madam Chairman, thank you for the question. It is absolutely essential that we continue to move forward, and this work would be needed to be done now or done later. It involves essentially initiating work for long lead procurement of such things as the sensors themselves, the focal plane arrays that will be needed to do the missile defense mission from low earth orbit, things such as cryogenic coolers, and things such as solar arrays, which take a long time to be developed.

So what Secretary Rood has mentioned is a proliferated architecture where Dr. Griffin's organization and the Space Development Agency will be presenting and preparing the infrastructure required to host whatever mission set is plugged into that low earth orbit architecture, such as missile defense. It could be positional navigation and timing. It could be some other mission.

But our enemy is time. This nation is extremely capable of doing just about anything it puts its mind to. The threat is moving fast and faster, and the reason I include it as my top priority in the unfunded list is that I believe that as time is the enemy, let's not waste it, and if additional funding is provided, that's where it would go.

Senator Fischer: Thank you.

General O'Shaughnessy, can you talk about why a space-based sensor network is necessary in terms of threat?

General O'Shaughnessy: Yes, ma'am. Thank you for the opportunity.

First off, obviously with our adversaries, continuing to make more complex weapons systems that we have to be able to respond to. An example is the hypersonics, where our current sensing capability just doesn't have the ability to watch it from birth, from the time it launches, all the way to the time that it would impact. The space-based sensing layer gives us the ability to see it from the time that it launches, and because of the unique fashion in which the trajectory is, where it starts out very high but then it will come down low, it will not be seen by our current sensors. The space-based sensing capability now gives us the ability to track it from birth all the way to ultimately when we defeat it.

So to me, that is of the highest urgency that we gain that capability as soon as possible, because our adversaries are actively developing these weapons as we speak.

Senator Fischer: Agree. Thank you.

Senator Heinrich?

Senator Heinrich: I'm going to stay on the same subject because I think I'm in a very similar position to the Chair on this issue. It just seems like this is the thing that we should be doing now. I'm deeply concerned that SDA doesn't even exist yet, and we can't continue to

push this off down the timeline.

So I guess I want to ask you, Under Secretary Rood, isn't this an urgent need that we ought to be focused on now?

Mr. Rood: Senator, I would agree that this is a high-priority need. The hypersonic testing that we see being conducted by countries like Russia and China is a noteworthy concern. The Space Development Agency, which reports to Under Secretary Mike Griffin, has just begun its work with a director and a small staff being named, and they have started the construction of the agency. As you know, it's part of a focus for a space force and a renewed focus that the Department would have on that broad mission area.

So I quite agree that it's an important priority. The early parts of this program are leveraging work that DARPA has done in order to ramp that up over time, and that's listed in the Department's plans coming out through the coming years.

Senator Heinrich: I have great respect for Dr. Griffin. I just think this needs to land someplace that is ready to move now, as opposed to in the future.

One of the things that I'm concerned about that's related to this is that MDA's budget includes $34 million to revive work done in the 1990s on neutral particle beam technology for a potential space-based directed energy

interceptor, and one of the things -- I mean, I think all of you know that I'm about as big a booster of directed energy technology as you're going to find in Washington, but it seems to me that it's important to have the sensors in place to discriminate these paths before we start talking about a new interceptor; and, from a budget point of view, that we might want to move up the space-based layer and consider doing something like this that is brand new down the road.

So I guess, General Greaves, what was the reason back in the '90s that that program was stopped? What's the reason for reviving it today? And are we doing this in the right order?

General Greaves: Senator Heinrich, just a short summary. It was stopped because the Cold War ended, essentially. A lot of work was done back then to prove out the basic technology. Most of the components except for two of the major actions within that system are at high technology readiness levels, within being proven in the lab.

The reason why we looked at it is akin to the comment that was made earlier about what are we doing new that's different that can reduce the cost of missile defense and move us down the cost curve. So we looked at something that was radically different that had a significant amount of work done that we can prove in a lab and the move to space if the nation decides that's what we need to deploy. But

to, again, do it in the lab, prove the technology, then move to space.

As far as the order in which things are done, I firmly believe that with the work that's been going on with the space sensor layer with the Missile Defense Agency, with the United States Air Force, with DARPA since 2015, there's a lot of work that's been done with industry already to lay the groundwork for the deployment of these sensors. The major change this year has been the movement from the medium earth orbit deployment of an architecture to a low earth orbit deployment of an architecture.

So we will continue to use the funding that we received last year. If we receive additional funding this year, it will go into the very same sensor technology and development activities. I think that we'll be ready in time to match up with the infrastructure that the Space Development Agency is producing; i.e., the communications transport layer, as well as the satellite process.

Senator Heinrich: I'm going to run short on time here. Given the votes coming up, I'm just going to yield back and we'll see where we go from here.

Senator Fischer: Senator Hawley?

Senator Hawley: Thank you, Madam Chair.

I thank the gentlemen for being here. Thank you, as always, for your exemplary service.

I want to start, actually, by going back to something that you said, Secretary Rood, about the positioning of the -- is it the TPY-2? -- in Turkey. We've heard much, in effect -- we just heard, before the full committee, we heard from the new UCOMM commander that we are strongly considering and indeed may pull back F-35s from Turkey if they move forward with their procurement.

Are we worried about the TPY-2 being placed in Turkey given their current pursuit?

Mr. Rood: Not at present, although depending on where our relationship with Turkey should go, of course, it would be one of the things that we would watch. We do still enjoy generally good relations with Turkey. There are some areas, particularly their interest in the S-400 Russian air defense system, that concern us, and that's what you were referring to, that there may be some results. But as far as Turkey hosting the deployment of that radar, we've been pleased. It's been a positive experience for us.

That's not the only facility, of course, that the United States military maintains in Turkey. We have other both Air Force and Army facilities there.

Senator Hawley: Right. Let me ask you about -- a number of you have mentioned, both in your written testimony and here, the development by both China and Russia of hypersonic weapons of intercontinental range. So say

something more -- we'll start with you, Secretary Rood -- if you could, about what we are doing to defend the continental United States and Hawaii, the homeland, from these hypersonics, and are we in a position where we're likely going to need to rely on nuclear deterrence in order to successfully defend ourselves? What are the options that are on the table?

Mr. Rood: We do plan to rely on both nuclear and conventional deterrence to deal with the hypersonic threat, in addition to other things that we use those capabilities for. However, our basic approach -- and others on the panel can add if I leave something off -- would be first we want to have the capability to detect and track those launches of hypersonics. And so that's where this proliferated low earth orbit concept with lower-cost sensors we hope can begin as early as three years from now to place into orbit would provide the means, along with a space transporter communications layer and the ability to control those things on the ground -- first to track it, to have enhanced command and control, and then some of the money that has been requested this year is to continue to work on architecture for effectors to effect the hypersonic vehicle during its flight.

Senator Hawley: Can you just say a word on nuclear deterrence, about the importance of low yield tactical

nuclear weapons to an effective modern deterrent, contemporary deterrent, and given the context now of the return of peer or near-peer competition?

Mr. Rood: Yes. What we see in both Russia and China is a substantial improvement and increases in their nuclear forces; in Russia's case, a very large growth of so-called tactical nuclear weapons. One of the things we see in Russia's doctrine, which we see them exercise as well, of escalate to deescalate, we get concerned that some of the Russian writings and their practices lead us to conclude they think they have an advantage, that if they escalate and perhaps use tactical nuclear weapons earlier, that the United States does not have a comparable capability that is survivable and responsive. And therefore we have requested money for both a low-yield modification to an existing warhead for a submarine-launched ballistic missile and a submarine-launched cruise missile. A submarine-launched cruise missile is further behind and we're just doing the AOA, or analysis of alternatives, at this stage, Senator.

Senator Hawley: Thank you very much.

Thank you, Madam Chair.

Senator Fischer: Thank you, Senator Hawley.

Senator King?

Senator King: I'm going to ask a series of dumb questions, which people have told me I'm well equipped to

do.

[Laughter.]

Senator King: The first one is give me a speed comparison between a ballistic missile and a hypersonic missile.

General Greaves: Let's see. Hypersonic missiles go Mach 5 or above, and ICBMs are at, depending on altitude, Mach 10, 12, 13, something like 22,000 miles an hour.

Senator King: So a ballistic missile is much faster, but a hypersonic missile doesn't go up and down, it goes straight; is that correct?

General Greaves: The hypersonic missile follows a profile that's boosting and then reduces altitude into a longer glide phase, and then a shorter terminal phase.

Senator King: What's the range of a hypersonic missile? Could a hypersonic missile go from North Korea to the continental United States?

General Greaves: Yes, depending on the booster that's attached to it. It could range ICBM or intermediate range nuclear missile or --

Senator King: Does a hypersonic missile create a more difficult or a different targeting scenario for our missile defense?

General Greaves: It's a different, and with the current sensor network that we have, a more difficult

problem, and that's why the space sensor layer is so significant, so that we can capture it from the time it launches to the time we intercept it, birth to death.

Senator King: And is North Korea doing any work on hypersonics, or is that just China and Russia?

General Greaves: I would need to discuss that in a classified forum. But the concern is potential, if not likely, proliferation.

Senator King: And can hypersonic missiles have nuclear warheads?

General Greaves: Yes.

Senator King: So this presents a really new challenge, and you say that the necessary step is additional sensors?

General Greaves: That is the first step, sir, to ensure we have custody --

Senator King: And did I understand from the Chair's question that those sensors, that that new sensor layer is on the unfunded priorities, not on the front burner?

General Greaves: It is on both. It is initiated in the Space Development Agency's budget to develop the architecture to support that sensor layer. But as my if not top concern, near top concern, it's my number-one priority in the Missile Defense Agency's unfunded list that was requested by the Congress.

Senator King: It seems to me that's a very, very high

priority given the speed with which hypersonics are being developed by our adversaries.

General Greaves: Sir, I would agree, and I made a comment earlier that in my mind the enemy is time, not the ability to develop effective defenses against hypersonic threats.

Senator King: General Greaves, could you describe the recent test? Is that something that you can describe here in an open setting?

General Greaves: Yes, sir. The reference is to the acronym FTG-11, flight test ground-based midcourse defense 11, which, together with the U.S. Northern Command and General Dickinson's team, we executed back on last Monday. It was the most complex, comprehensive, and operationally challenging test ever executed by the Missile Defense Agency.

Senator King: And it was a success, was it not?

General Greaves: It was. We are doing about nine months' worth of data review because we collected lots of data, but the initial look says it was a complete success.

Senator King: And define complete success. Did the bullet hit the bullet?

General Greaves: Yes, sir. The object of the test was to launch an ICBM, an intercontinental ballistic missile representative target, and we did that from the Marshall

Islands out at Kwajalein, to ensure to achieve the speeds you asked about earlier, and the profile of a realistic threat. But this test was different because we launched within a very short period of time two ground-based interceptors, operationally released by the combatant commander using their operational processes, which is very important, and the lead interceptor intercepted the ICBM representative threat.

But what's most important is that it created a debris field, and this test has been 10 years or more in the making, and the importance of that is the trailing interceptor was able to discern the debris from the next most lethal object that I can talk about in a classified forum, and also intercept that object.

What that means is enemy operations which seek to confuse our missile defense system by launching junk or debris would not be successful. That's why it was a success.

Senator King: Congratulations. That's an amazing achievement. I know thousands of people -- scientific, technological, physics. So please convey the heartfelt congratulations from this committee.

One other quick question. Do we know if the North Koreans are developing a submarine-launched missile capacity?

Mr. Rood: Yes, Senator, they are.

Senator King: So that changes this calculation again. If they're launching their missiles from North Korea, that's one thing. If they're launching them from the Bering Strait or somewhere in the North Pacific, that's a different problem.

Mr. Rood: It changes the defense equation in terms of where the origin could be and what are other anti-submarine capabilities in a potential conflict, how they would be utilized, and it also changes the geometry depending on how the North Koreans could choose to deploy that.

Senator King: And the time.

Mr. Rood: Yes, depending on where they launch from. Yes, sir.

Senator King: Thank you, Madam Chair.

Senator Fischer: We have had a vote called. We don't know for sure what the schedule is going to be for votes in the next few hours, but we'll try and do a tag team here until we're sure what's happening.

Senator Sullivan?

Senator Sullivan: Thank you, Madam Chair.

I really want to reiterate what my colleague from Maine said in a bunch of his questions. But first of all, gentlemen, congratulations. The way I've been describing this -- General Greaves, correct me if I'm wrong. I think

Senator King’s questions were actually quite good; basic, but good.

So is this a bullet? How fast is this bullet going? I’m talking about the successful test.

General Greaves: Twenty-two thousand miles an hour.

Senator Sullivan: So it’s one bullet hitting another bullet; correct?

General Greaves: Yes, sir.

Senator Sullivan: At 22,000 miles an hour in space?

General Greaves: Yes, sir.

Senator Sullivan: Okay. And then the first successful hit created a fragment --

General Greaves: Debris field.

Senator Sullivan: -- and the second missile then tracked the biggest fragment, adjusted at 22,000 miles an hour, and hit the fragment?

General Greaves: Yes, sir.

Senator Sullivan: That’s unbelievable.

General Greaves: I would say it hit the next most lethal object, because the architecture --

Senator Sullivan: Is that the next biggest object?

General Greaves: The next object that most closely resembles a threat vehicle.

Senator Sullivan: First of all, congratulations.

Second, you might remember in the last couple of NDAAs

I had rather comprehensive missile defense bills that got incorporated, very bipartisan, by the way, but we encourage you to test at least once a year, the Congress does. We want you to continue that, and, in part, here's the reason.

Had that test failed, the New York Times, certainly the LA Times -- for whatever reason, they are real big skeptics of missile defense -- it would have been front page news, how horrible and weak the system is. I don't even know if I read any news articles on this remarkable test. So if any media, if you're listening -- I don't know if we have any media here, but why don't you write an article on this? Because had it failed, had it failed, it would have been front page news. We all know that, and yet you do something that is unbelievable and you get no press.

So, thank you. We're noticing, and it's remarkable.

My colleague from Maine is always asking the questions that I want to ask, so here it is. What message does this send to our adversaries, Kim Jong-un, Putin, the Chinese, anyone else who wants to mess with us? Can they do this?

[No response.]

Senator Sullivan: Well, you don't have to answer that.

[Laughter.]

Senator Sullivan: But what message does it send?

General O'Shaughnessy?

General O'Shaughnessy: Part of our deterrence is based

on a credible capability to deny an enemy the ability to achieve their objective. So this test clearly shows that they would not be able to achieve their objective, which leads to our ability to deter so we could prevent a conflict from ever happening because they know they can't reach their objectives. As the operator of the ballistic missile defense system, this gives me great confidence because we actually use our operators, the actual folks who are doing it, to include your team from Greeley, as we launched this through the operational construct. It really gives us that high sense of confidence that we can use it to deter our adversaries.

Senator Sullivan: Secretary Rood, what do you think in terms of the message this sends, whether you're Kim Jong-un or Putin or whomever?

Mr. Rood: I think it sends a very strong message about the credibility of our capability and reinforces deterrence. Missile defenses are part of contemporary deterrence, both offenses and defenses. If you're Kim Jong-un or another adversary, you have to think about first the probability that your attack would be successful; and then secondly, even if we successfully defended against an attack, an attempt to incinerate an American city, the story wouldn't end there. We still maintain our offensive capabilities.

Senator Sullivan: I think it's a great point. My

point -- and again, you guys are the experts, and you've done a great job, remarkable. But I think it's the message of if you do want to go out in a flame of glory, Kim Jong-un or the Ayatollahs in Iran, (a) it won't work if we have this capability; (b) we will flatten your country after you try, so it's double deterrence. I think that that's important.

Let me ask one quick question here. I think you're kind of seeing what you might call in the military a foot stomper on the issue of space-based sensors. The last two NDAAs, again in a very bipartisan way, led by bills that my team and I and a lot of you wrote, but to deploy a space-based sensor, there's a strong interest in doing that here. I think you're seeing it. We would be a little bit, I think, disappointed if somehow, with the development of the new Space Development Agency, if that kind of got lost in the shuffle there.

General Greaves, I'm going to ask you a question. Of course, I'm going to ask for your professional military advice on this one. But where do you think the best place for space-based sensors to be put and deployed the most rapidly would be, in the Missile Defense Agency or in the new Space Development Agency?

General Greaves: Sir, I will say that --

Senator Sullivan: I know it kind of puts you a little bit on the spot.

General Greaves: It really doesn't because the Space Development Agency, as it was stood up, it was given special authorities that are very similar or almost exactly what the Missile Defense Agency has, except for the milestone decision authority. I think that's still within the --

Senator Sullivan: So MDA or the new Space Development Agency, most rapid deployment for space-based sensors?

General Greaves: If it's executed per the plan that was laid out, the Space Development Agency is best suited to provide the capability, and the example is the --

Senator Sullivan: Is that a big if?

General Greaves: If it's executed. My concern is the big if, because if it's done the way we did the STSS, the space tracking surveillance satellite program, where the Space and Missile System Center contracted and delivered that capability to the Missile Defense Agency, where the Missile Defense Agency held the requirements and we continue to lead operation of that capability, that can work.

If it's all co-located in one organization that has responsibility for developing space capability, that's probably the most efficient place to be. But it's got to have, it must have, the responsibility, authority, and accountability that I have in my position today. If that is not executed, if the Space Development Agency does not have milestone decision authority, which is critical for

acquisition programs, then that is not the most efficient place for it to be.

Senator Sullivan: You're seeing a lot of us want to get that deployed quickly.

General Greaves: Yes, sir.

Senator Heinrich: [presiding] Senator Jones?

Senator Jones: Thank you, Mr. Chairman.

Thank you all for being here today and for your service.

This is really just for anybody that might want to chime in here. I'm wondering if we've already made plans or plan to make any changes to our missile defense structure as a result of the President's announcement that we're going to be withdrawing from the INF. If those changes -- are they adequately covered in the budget? What changes are there, if there are going to be any, or if you've already made them or whatever? And are we covering those with the budget that's there?

Mr. Secretary?

Mr. Rood: Senator, in the budget for missile defense, there isn't a change necessary as a result of the President's decision to withdraw from the INF Treaty. Of course, that will take effect in August of this year. The change that you will see going forward is the treaty, of course, prohibited the United States from the pursuit of

intermediate range missiles, and we will begin to explore, and there's funding requested from the Congress to explore concepts and to look at what the options are that would be available to the United States for offensive missile capability.

But from the defensive perspective, to withdraw from the treaty would not affect the budget request for defenses.

Senator Jones: All right. Anybody else? Is that covered?

All right. So, General Dickinson, I've obviously got a very -- coming from Alabama and the Huntsville area, the space force is an intriguing part. We've been part of a space force in some way or another for a long, long time. And I'm wondering how will the proposed space force impact your command, and how do you believe creating a space force is going to enhance our national security?

General Dickinson: Well, thank you for that question. So, in terms of Army space, we've got some great capabilities within the Army space portfolio, if you will, that as we go along in support of the legislative proposal that is now here on the Hill that I think will fit nicely with that proposal.

Our work right now in terms of supporting the ground maneuver forces that reside within the Army, in terms of the future of that, I think we will still see our ability to do

that. But as the space force, the opportunity to be able to organize, man, and equip as an enterprise for space, as a space warfighting domain is all included within that proposal, and I think I support that.

Senator Jones: Great. Thank you.

General Greaves, let me also congratulate everyone on the success of the salvo intercept test. My only simple question of this is what are the next steps on that, and are they adequately funded in this budget?

General Greaves: The next step, sir, the number-one priority in the agency is to continue ensuring that we maintain and sustain the deployed fleet so that General O'Shaughnessy retains his high confidence in the system. That's the number-one priority.

The next step is to continue on with the reliable kill vehicle program. I mentioned earlier that it's part of a disciplined acquisition strategy. We had very strict entrance criteria into what's called a critical design review. The design did not meet it, so I assessed that and made the decision that we would not enter into it.

What we're working now is to get back to the critical design review. But the top priority is to deliver that more reliable kill vehicle along the plan that we have submitted in the budget.

Senator Jones: So the budget is okay on that? You're

satisfied that it's adequately funded in this budget?

General Greaves: Yes, sir.

Senator Jones: Great. All right.

That's all I have, Mr. Chairman.

Thank you so much for being here, gentlemen.

Senator Heinrich: In that case, I'll fill up a little time here and follow up on what Senator Jones was just chatting about.

General Greaves, the redesigned kill vehicle has a projected delay of two years, and I understand there's a process in place to review the challenges in the RKV program and to ensure that we develop and provide the warfighter with a more reliable kill vehicle. In your statement you described the test events that will involve the RKV, and I just want to confirm that given the delay time there, the two-year delay, that these tests will still occur before you procure RKVs so that you fulfill the "fly before you buy" requirement.

General Greaves: Senator, the answer is, in general, yes. As part of the disciplined acquisition approach, we have not deleted or modified any of those test requirements. The only caveat I'll state is that we may approach the SECDEF as granted in the language for a waiver of some sort if we believe that we can and are able to and are credible enough to pursue that waiver. But the scheduled delay was

planned. It encompasses the activity we need to complete a disciplined acquisition approach, which I firmly believe we should continue on.

Senator Fischer: [presiding] Thank you, Senator Heinrich.

Secretary Rood, in last year's hearing we discussed some of the unanswered policy questions related to boost phase missile defense. It was my understanding at the time that these issues were being considered by the missile defense review that the MDR did not go into any great detail other than to state that boost phase capabilities could enhance our missile defense efforts.

Can you discuss what the Department is pursuing with respect to boost phase capabilities and whether there are unanswered policy questions that really need to be resolved before any capabilities can be deployed?

Mr. Rood: Yes. First, boost phase defenses are very attractive to us because the missile is at its slowest point, and potentially the debris could even fall back on the launching state's territory. That's also the area where we don't have substantial capability of any note in our arsenal as part of a layered defense, which is another reason it's attractive to us, to get at the missile as early as it is launched.

With respect to the policy barriers, there aren't any

policy barriers at this stage. As the missile defense review notes, we are giving all the framework and guidance that the developers need in order to go pursue those capabilities.

One of the noteworthy areas that we speak to in the missile defense review is the incorporation of our tactical air fifth-generation platforms as first sensors, and later potentially carriers, for interceptors to attack offensive missiles in their boost phase. We're also looking at other potential capabilities in directed energy for that purpose. But it's mostly a capability limitation. At this stage the policy gives encouragement to pursue the boost phase defenses.

Senator Fischer: Thank you.

General Greaves, when we spoke yesterday it was an unclassified setting, and you explained the low orbit sensors. We've had a lot of talk about that. I know my colleagues went to vote, but I think it would be good for the record if you could give us an explanation of really what that all entails, what we went through yesterday. I think it would be helpful to have that in the record, what we're talking about here.

General Greaves: Thank you, Senator Fischer. Let me begin with the activity that I was involved with three years ago, three-and-a-half years ago now, when I was the

commander at the Space and Missile Systems Center. Vice Admiral Sering was in my position, and General Hyten was transitioning between Air Force Space Command and USSTRATCOM. We saw the need for a shared responsibility, shared capability between what the U.S. Air Force was providing with the space-based infrared system in geo-synchronous orbit 22,000 miles out in space, and the ability to execute such missions at lower orbit levels, such as the hypersonic defense mission.

So we, working with industry, explored architectures, which resulted in a government reference architecture, essentially, based at medium earth orbit, about 10,000 miles out, but with fewer spacecraft to do the hypersonic defense mission and look for new, low signal level propulsion capability as the threat is developing.

So that's where we started, and we were making significant progress in that area. What has changed within the last year -- and the last year has been a year of transition within the Department -- is that Dr. Griffin is now approaching space capability from a Department-wide perspective. So what has changed is that with industries' progress in actually developing the capabilities to proliferate multiple small satellites in low earth orbit, very significant potential to deploy a low earth orbit architecture that can do multiple missions, one of which is

missile defense.

So the vision from Dr. Griffin is to deploy that architecture, multi-hundred satellites, very small, together with a communications transport layer to move the information around between satellites and to the ground and to the warfighters where it needs to be, and to have mission areas plug in as required. We do not need 200 satellites to do the missile defense mission. We need a smaller number. Position navigation and timing may need a smaller number. But together we would ride on these spacecraft buses, as we call them, take advantage of a communications transport layer architecture, and execute the mission at lower cost.

The difference also between what our original government reference architecture was and what Dr. Griffin is proposing has to do with resiliency, the ability while under attack to gracefully degrade your capability and not have it shut off immediately. The way I try to explain it is if you've got six big targets up at medium earth orbit, that's a lot easier to go against and have a bigger effect than a few hundred down at a lower orbit that we have shown through analysis and study that can gracefully degrade and still maintain capability.

Senator Fischer: Thank you, sir.

Senator King?

Senator King: Thank you, Madam Chair.

Let me just follow up, and I apologize. You understand, for some odd reason, the Chairman and I aren't in charge of the schedule around here.

Senator Fischer: We should be.

Senator King: We should be, yes. It would work much more efficiently. But let me follow up.

I was asking questions about could the capability of the North Koreans in a submarine -- if a missile is launched from somewhere in the mid-Pacific between Hawaii and California, would you still have time, if it was a ballistic missile, to target and hit it as successfully as you did the one coming from Kwajalein?

General Greaves: Senator, yes. That would be an intermediate-range to short-range attack, for which our current systems -- the THAAD system is an example, and if they're in the right position to defend a certain area, or the SM-3s that are carried on Navy ships as part of the Aegis weapon system, they would be positioned, and we've demonstrated the ability to counter those threats. The latest demonstration was last year with THAAD against an IRBM.

Senator King: So that deals with the shorter range.

General Greaves: Yes.

Senator King: With the submarine launch, if that's the choice.

Secretary Rood, talk to me about directed energy. One of the problems with missile defense is that the missiles that we're shooting are quite expensive. Where are we with directed energy? How far away are we? What might the role be -- for example, could it be ship-borne into the boost phase? Give me a tutorial on where we are in directed energy.

Mr. Rood: Senator, I can begin, and then General Greaves and General Dickinson may have something to add to that as well.

But the short answer would be we are requesting funding to continue directed energy work that the Missile Defense Agency would lead. The main reason that that work for ballistic missile defense has been centered at higher altitudes, both for high-altitude UAVs or potentially space-based applications, is it's difficult to propagate lasers in the atmosphere. There's a lot of water, clouds, other things. And so by going up above the cloud layer or at a higher altitude or in space, that is a simpler --

Senator King: Then you have the problem of weight and a sufficient electric charge.

Mr. Rood: Yes, sir. This is the engineer's challenge, yes. If you optimize in one area, other parts of the trade space, you do encounter that. But it is easier to propagate the beam across that area, and the energy that is output and

beam quality on the target is the key, really energy on the target. General Greaves could teach a Ph.D. dissertation course, so perhaps I should defer to him on it.

General Greaves: Senator, the main constraints or challenges have to do with power on the target, as well as beam control to ensure you can stabilize it, as well as pointing the laser in the right direction. So those are the major challenges we're working on right now.

The scaling effort is one that has the most priority. The original lasers that flew on the airborne laser, for example, they were chemical based, so they were huge and took up lots of room. Right now we're working with three industry partners, the National Labs, looking at electric lasers; fiber-combined lasers is one of the technologies. The other technology is -- forgive me for the acronym here, but diode-pumped alkali lasers. We've seen significant progress with both of those, and we're shooting to essentially move up from about 30 or 40 kilowatts. For us in the missile defense area, 1 megawatt is high power. We need that to go against a --

Senator King: If you had 1 megawatt at the source, what's the delivered power to the target?

General Greaves: We need 1 megawatt at the target.

Senator King: So what I'm looking for is what's the differential? How much -- in the electric business I used

to be in, we talked about line losses. What's the differential between where it leaves and where it hits?

General Greaves: Sir, it depends on the altitude from which the weapon is fired. We're looking at above 55,000 to 60,000 feet to get out of the atmosphere to allow maximum power on target, energy on target. I missed the second part of your question.

Senator King: Well, in order to put a megawatt on the target, how much power do you have to have leaving the source? A megawatt-and-a-half, or two, or one and --

General Greaves: I may have misspoken. We need a megawatt capability at distance with line loss to affect the target. I'm sorry about that.

Senator King: Okay.

Mr. Rood: I know less about this than General Greaves. I think the answer, Senator, is it's highly dependent on several variables, the beam quality from its emission at 1 megawatt, and your ability to control that and change its optic over time. In other words, it's not like electricity transmission. It's a constant depending on what your sensor is telling you about how this very dynamic environment with water and air is moving, and you sense that, you change, like with a contact lens changing its prescription over time, what you are putting out. So it's a highly complex set of variables to say it depends on many of the qualities

of the system, how much line loss, essentially, you have.

Is that accurate, General?

General Greaves: Yes. What I'll say, sir, is while we were working on this successful mission within the last three weeks, we've been doing some testing out of White Sands against representative objects out there, but at much, much shorter distances, and very successful in penetrating threat representative articles --

Senator King: Can I be assured that this is a major area of research and development and effort? It seems to me this is an enormously potentially important development.

General Greaves: Sir, within the Missile Defense Agency it absolutely is, and that's why we continue to have three activities going on in that area and request funding for it.

Senator King: Thank you.

General Dickinson: And, Senator, if I could add on to that, that's a major priority within the United States Army. So we've had some success, a lot of success recently with integrating a 10-kilowatt laser into a Stryker combat vehicle where it is totally self-contained within that vehicle that will be able to maneuver with ground maneuver forces. And while 10KW may not sound like a lot, what we've done over the past few years is grow it from a 2KW to a 5KW, and our road map is to put a 50KW onto a Stryker combat

vehicle within the next four or five years and be able to provide that to the ground maneuver commander.

What we envision using that for is we've already demonstrated successfully against an unmanned aircraft system, and we've actually had soldiers actually operate the system when it was a 2KW/5KW/10KW as recently as this year, and we envision that in the future. So that's allowed us to have warfighters using the technology at a very early stage so that we can start developing our techniques and procedures that we will use in combat.

We're on a path to get a 100KW high-energy laser as part of our IFPC increment 2, our indirect fire protection capability in the Army, which will be responsible for fixed and semi-fixed defense, and we envision that. It's going to be designed for not only UAS but also counter-rocket artillery and mortar, and we've already demonstrated some success with a 50KW against artilleries out in White Sands missile range.

Senator King: I foresee a hand-held UAS anti-weapon staffed entirely by duck hunters from Arkansas.

[Laughter.]

Senator King: Thank you.

Thank you, Madam Chair.

Senator Fischer: Thank you, Senator.

Senator Sullivan?

Senator Sullivan: Thank you, Madam Chair.

You know, one of the things that all of you have been mentioning is that time is the enemy here because of the advancements of -- whether it's North Korea or some of our other adversaries or potential adversaries. As an Alaska senator, I certainly take pride in the fact that we are the cornerstone of our nation's missile defense with the Fort Greeley field and the long-range discrimination radar and the radar sites out in the Aleutian Island chain, and we're making progress on all of these, as you know, gentlemen.

One area, though, where it looks like we're not making progress -- General Greaves, can you talk about the potential two-year delay of the redesigned kill vehicle, and is that a best-case or worst-case scenario? And can you talk in public about what the problem is?

General Greaves: Senator, I'll start with the last question. We cannot discuss the details of the problem. What I'll say in general is that if this same issue had occurred when we were developing the original extra-atmospheric kill vehicle, the current fleet, a decision could have been made to move ahead and deliver the capability, whatever we had, the best capability that we can deliver.

The major difference here is that from the outset this acquisition strategy was destined or intended to deliver a

more reliable vehicle that followed a disciplined acquisition process to include robust design, robust testing, and a system which was more maintainable --

Senator Sullivan: But does that make the acquisition process slower, almost by definition?

General Greaves: No, it does not, sir, because of the unique acquisition authorities that both the Congress and the Department have provided to the Missile Defense Agency. The issue with acquisition is the inability for rapid decision-making within DOD 5000. That's the simplest way I can put it. But with the authorities in this position that I occupy to be the milestone decision authority, which has major approval authority before we make major decisions, before we get to production, as the program manager, as the head of the agency, the decision authority lies right here.

It's what I personally use to decide that if we had done something other than that, we would not be credible to the acquisition strategy that we signed up to.

Senator Sullivan: So let me -- can you answer the first part of my question? Is that a best-case or worst-case scenario? Two years is a lot of time.

General Greaves: It is.

Senator Sullivan: Especially given that time is the enemy.

General Greaves: We are testing components as we

speak, and that time may be adjusted over the next few months.

Senator Sullivan: Which way do you think it's going to be adjusted?

General Greaves: More likely shortened, but it could go the other way. When we developed the plan for up to two years, we took a best guess, almost worst case --

Senator Sullivan: Is there something we can do as a Congress to help you with shortening that time line?

General Greaves: Negative, sir. Continue to support what we're doing, ensure we --

Senator Sullivan: Is it a contractor issue? Is it a company issue?

General Greaves: It's a technical issue, sir.

Senator Sullivan: Okay. Let me ask Secretary Rood, you and I were all at the big rollout of the missile defense review at the Pentagon. I think it was important, an important symbol that not just you and the Secretary of Defense and the Vice President but the President of the United States was there. I think that also sent a message to our adversaries and our friends that this is a serious issue for the country.

In your view, what are the top three most critical elements of the 2019 missile defense review? A number of us -- and you know that you and I had a lot of discussions

about this -- were pressing you guys to get this nice piece of work out as soon as possible so it could impact the NDAA. Well, here we are. We're already starting to draft up the NDAA. What are the key elements that you think you need our help on? And again, one of the positive things that's going on with regard to missile defense right now in the last few years is that it's generally a bipartisan endeavor in the Congress, particularly in this committee.

So, top three things, and what do you need from us, and is there anything missing? Now that you've written it and put your heart and soul into it, and the President rolled it out, are there things that you think, oh, shoot, we should have gotten that in there, and let's try and get it in the NDAA?

Mr. Rood: Well, on the first question, in terms of the key elements of the missile defense review, I think for the purposes of the NDAA one of the things that you see contained in the missile defense review is the support for the legacy systems. That is to say, as those things that are existing programs. Sustainment costs more, upgrades need to be made to them, and then additional units that we've procured. So the missile defense review essentially says let's continue to support what are installed bases or those things that are currently planned and keep them robust and vital.

Senator Sullivan: So like the things in Alaska the President highlighted in his remarks.

Mr. Rood: Yes, sir. So that would be one part of it. But at the same time, then, the missile defense review speaks to developing new technologies and looking for new breakthroughs and things that will take us to the next level, if you will, of effectiveness of missile defense, things like space-based sensors, starting to look at space-based interceptors, directed energy, whether that's lasers, neutral particle beam, or other activities like that. And trying to do this in a more innovative way, leveraging DARPA's work for this proliferated low earth orbit series of sensors and the means to communicate with them.

So, one, the Congress continuing to support the planned sustainment and upgrades and additional production of the current legacy systems, if you will; support for these new technology efforts; and there's a certain art between always, when you're moving to the next generation of technology, how robustly do you fund that, because, as you know, those efforts start smaller but then grow in funding.

And then the third area, which may sound very fundamental but has had a huge impact on us, the Congress last year did terrific work in the defense area to both finish an authorization bill and an appropriations bill before the end of the fiscal year, and I've seen the impact

that that has had on our ability, the purchasing power. Essentially, that gives us more, the stability and the ability to focus on things other than continually managing change orders and change activities to keep going. So the terrific work that you did last year, if it were possible again -- and they were strong bills, the authorization and appropriations bills that showed bipartisan support for what we are doing. If you can re-create that, it's hard to understate how important and how much that has benefitted the Department overall.

Senator Sullivan: Thank you.

Thank you, Madam Chair.

Senator Fischer: Thank you, Senator Sullivan.

Gentlemen, earlier we had a discussion on the recent missile defense test, and I would like to ask you, General O'Shaughnessy, if you have anything to add about NORTHCOM's involvement in that test.

General O'Shaughnessy: Thank you, ma'am. As we discussed about the sense of confidence that that test gives us as the operators cannot be overstated. For us to actually participate in the test from the aspect of the same way that we would do it in an actual launch, so not in a test environment, not using a different system but using the very systems that we would use, with the very people that we would use to man those systems, in a manner that is

representative of a real-world event, really gives us the confidence in the system, confidence in our ability to give our senior leadership a sense of confidence that we can execute this mission. We had a discussion with Senator Sullivan about our ability to have that credible deterrence and be able to say with authority that we do have the confidence to be able to defend this nation. I'm thankful to General Greaves for giving us that opportunity.

If you actually look at the myriad of different things that were tied to this test to take full advantage of the cost of putting this together is not insignificant, but to take full advantage of that, from the operational side, from the test side, from some of the future capabilities that we tied into the test as well, I think it was masterful the way that General Greaves put that together.

Senator Fischer: Thank you. Congratulations again.

Also, sir, I understand that what you can say is limited in this unclassified environment, but can you briefly describe your level of concern about your ability to defend the homeland from cruise missile threats that we're facing?

General O'Shaughnessy: Thank you for highlighting that. We talked a lot about ballistic missiles today, and hypersonics, but the one in the middle, the cruise missile threat, is equally as potent, and we certainly have

adversaries that have invested significantly in that cruise missile threat; for example, certainly Russia and China. And as we look to defend the homeland, that is one of our significant concerns. As you mentioned, for much of this we'd have to go to a classified environment. We've had the opportunity to have some of that discussion.

But I do have concerns that we have to continue to invest in our ability to defend against the cruise missile threat as well, to be able to stay ahead of our adversaries. So as we do go forward, I was happy to see, for example, the ballistic missile defense review became the missile defense review. That's a very subtle but very important change within that, that the focus is not just on ballistic missiles but also on the cruise missiles.

So as we look to go forward, I look forward to the committee's continued support to invest in and allow us to be able to pursue advanced capabilities to defend against what our enemy is doing to hold us at risk with advanced cruise missiles that have low RCS's, very difficult to track and very difficult to defeat, and so we have to stay ahead of that threat.

Senator Fischer: Thank you, sir.

Senator Heinrich?

Senator Heinrich: I apologize for going back to ploughed ground here, but I do want to return to the space

sensor layer issue because I'm just having a hard time with the timeline. Correct me if I'm wrong, but it's my understanding that the Space Development Agency doesn't have budget authority yet, doesn't have funding yet, and will need a reprogramming request approved by Congress before they can really get off the ground.

So at this point it exists in name only, which is why I'm having a hard time understanding why we just don't move forward with this space development layer under MDA and re-sort out the relationships a year down the road once we know how SDA is working and how it's organized and that it's ready to hit the ground running.

Maybe Secretary Rood?

Mr. Rood: Well, the Space Development Agency, as you say, is just being stood up in terms of the director being named and the initial staff and the charter, and its authorities have been granted. We are at the beginning phase of the creation of that entity. The intent is, as General Greaves said, that it be modeled for rapid acquisition and centralized authority after the Missile Defense Agency's authorities but with a focus on space. So the initial requests to the Congress, as you point out, sir, relate to reprogramming; and then, of course, the funding for the next fiscal year, for Fiscal Year 2020, to fund those projects, and it's just part of a broader activity

that would affect more than the missile defense mission.

The intent is, because of our contested warfighting environment in space, that we have a more rapid acquisition, sir.

Senator Heinrich: I think I get the underlying architecture and the need for an entity that can move rapidly and nimbly. I'm more worried about losing this, what could be a real bottleneck for us on hypersonics to the right of the timeline.

Mr. Rood: Well, certainly this is one of the considerations that the Department leadership -- as the Secretary was evaluating what work to provide to the Missile Defense Agency and what the Space Development Agency was given, there was some consideration, but the belief being that with Under Secretary Griffin's oversight, and he oversees the Missile Defense Agency as well, sir, that the Space Development Agency, with a focus on a narrow set of items initially that would grow, could provide the fastest possible route to get those things into orbit.

I agree with you that it is a priority that this continue and be done with purpose.

Senator Heinrich: General Greaves, in the Fiscal Year 2018 annual report, Director of Operational Test and Evaluation, DOT&E, again recommended the MDA should develop independently accredited modeling and simulation to evaluate

GMD effectiveness. Can you explain what needs to be done, if more needs to be done in that area, and whether or not additional resources are needed to meet DOT&E's recommendation?

General Greaves: Thank you, Senator. We worked with General Behler's organization in DOT&E to develop a plan that we are executing now to eventually, not in the too-far term, deliver accredited models. So that work is going very well. I think if you ask DOT&E, they will tell you the same thing.

While additional resources, if provided, would help to speed that up, I believe that --

Senator Heinrich: You feel good about the fundamentals.

General Greaves: Absolutely. The commitment is there. We made it a centerpiece of the organization while I've been there, and it was seriously started before he departed. The Missile Defense Agency has always had models and simulations that we used, but the realization that we really can't grade our own homework, if you get right down to it, that that's not credible, that we needed an agency that's appointed and certified and recognized as being able to grade our homework, to go do that.

So the effort has been getting the two cultures, the people to work together to realize that it's for the better

good.

Senator Heinrich: Thank you.

Senator Fischer: Thank you, Senator.

Thank you, gentlemen, for your attendance today.

With that, the hearing is adjourned.

[Whereupon, at 3:57 p.m., the hearing was adjourned.]