051618 Missile Defense Advocacy Alliance Capitol Hill Briefing with Rear Admiral Jon Hill, Deputy Director of the Missile Defense Agency; Dean Wilkening, Physicist at the Johns Hopkins Applied Physics Laboratory's Precision Strike/Force Projection Sector; Retired Navy Rear Admiral mark Montgomery, Policy Director at the Senate Armed Services Committee; and Riki Ellison, Founder and Chairman of MDAA, on "New Layers"

MR. RIKI ELLISON: Good morning, everybody. Thanks for joining us. I'm Riki Ellison and I'm the founder of the Missile Defense Advocacy Alliance. I've been involved with missile defense since 1979, went through six presidents, and we founded the organization in 2002 right after the ABM Treaty withdrawal. We are a non-profit and we educate on the fact that missile defense makes our world a safer place.

We're close to about 1,000 presentations that we've made over this period of time. We've visited close to 500 military bases for air and missile defense around the world. We've recognized close to 500 of our best missile defense people across the services and across the nation on a regular basis.

We're here to look through and look at a new approach, to some extent, of missile defense. What has happened over the last year, at least, is that we've got great confirmation of the credibility and reliability of the Ground Based Missile Defense System. If we didn't have that, we wouldn't be in a position today to have President Trump meet and engage with North Korea without his full confidence and reliability on this system to protect our national homeland and our allies in the nearby region.

The same extends to missile defense in Europe. The EPAA has also given us stability, good or bad, deal or no deal, with Iran. So these capabilities -- these are mostly kinetic capabilities -- have been brought forth by this (administration ?) and by President Reagan 35 years ago. Thirty-five years ago we had a cauldron that created a missile defense that we all thought back then was going to be directed energy and lasers in space, and it wasn't. It's what we have today, a kinetic energy-based capability across all our services that what we do to defend our allies and our country from missiles.

Today you're seeing, I think, the world scene make another cauldron, another cauldron that is driven by the threats of the near-peer and driven to some extent by Korea and Iran. But we're in a position now where the most money that has ever been spent on missile defense has come in. It looks like the policy of our nation is going to be more open, and we are (realizing ?) that we do in fact have that capability that has been successful against the limited threat of Iran and North Korea.

Moving forward, hypersonics is driving that A2AD in the Pacific by China, and the A2AD in Europe by Russia. It is driving us to re-look and look at different layers of capability that is going to better enhance our nation today and in the future.

We are really fortunate to have three great experts here today to talk you through it. We have the Deputy Director of MDA. We have one of our best physicists from the APL Lab at Johns Hopkins. And we have Mark Montgomery, the policy director of the SASC.

So you have the guys who are creating it and developing the acquisition for it, you have the physics behind it, and you have the authority or enabler of policy to move forward on that. So today I'd like to give each of them a chance to give you a brief presentation on their thoughts, and then have an open discussion. I think Mark is going to moderate and ask several questions from his perspective, to open up the discussion. Then I think we'll open it up to everybody here on the floor to ask questions.

I'm going to pass it off to you, John. This is the deputy director, and I want to again thank you for giving our nation that capability to be able to be stable and give the world some stability during these times that we are in today.

ADM. JON HILL: Thanks, Riki. Good morning, everybody, it's great to be here. On the way over I reminded myself of Admiral Montgomery's great record of service. I read his bio, and of course I read the bio of the physicist sitting here. I said, you know, I don't really have anything to say, so I just threw away my notes.

But seriously, it's great to be here. This is a pretty cool panel, Riki. Thanks for setting it up and giving us an opportunity to talk missile defense.

First I wanted to pass along regards from Lieutenant General Sam Greaves, the Director of MDA. If he could be here with you today, he would be, but he's doing exactly what we need the director to do. He's locked up in the Pentagon fighting for the program. But he does say hello, so you're just kind of stuck with me.

I want to talk to you about three key areas this morning. I want to go back and talk about the mission of the agency. Then I want to give you a sense of our priorities. Then I'm going to talk to you about the overall strategy for the agency moving forward. I'll touch on a few things as we go and try and weave them all together.

If I start with the mission, there's really three things. If you go read the mission statement of the agency, it was written by a genius because it kind of covers everything. First it says we are a layered defense. So when you think about the layers of missile defense, certainly there's Patriot, there's THAAD, there's Aegis, both ashore and afloat, and then the Ground Based Missile Defense, which defends the CONUS and of course defends Hawaii today against today's current threat. I'll come back to that.

It's also about defending our friends, our allies, and our deployed forces. So it kind of touches on the building of partnerships that the secretary of Defense talks about. And then it's about all phases of flight. We'll talk a little bit about boost-phase in just a bit. That's one of the hardest phases, and we'll get into why that is.

But we are a defense organization. When you talk about boost phase you often find yourself moving into the left-of-launch world pretty quickly, and the next thing you know you're in offensive operations, and we sort of step away. That's not our area. But we like to stay closely connected to the world of left-of-launch, so we'll talk about that in a little bit.

But that's basically the mission statement for us: layered defense, protecting our friends and allies and our deployed forces, and then coming through all phases of flight. We spent the first 10 years or so proving out hit-to-kill in the midcourse. That's where we spent move of our time.

That's where the Ground Based Missile Defense does its intercepts. That's where Aegis does it. Theater High Altitude Area Defense (THAAD) does that a little bit lower in the trajectory. And then we have terminal defenses that we've brought to bear over the last couple of years.

From a priorities perspective, when General Greaves got on board, he wanted to stay consistent with what Vice Admiral Searing had done, but the world had changed pretty significantly when General Greaves arrived last summer. In fact, one of his quotes that he says all the time is that the threat has voted, and the threat continues to vote. That is just absolutely true.

Summits are interesting. Changes out of the Middle East, deals and treaties and all that, is interesting. But at the end of the day, if you go look at where the threat is going, it has not stopped. It's not being put on the shelf. It is growing, it's changing, it's becoming more complex. We're well aware of that, and that is a high priority for us.

From the priorities perspective, we have three of them. We talk about reliability. We talk about building out capability and capacity. And we talk about dealing with the advanced threat.

So when you think about reliability, it's really about the war fighter. When I say reliability, it's not about the interceptor. It is about the whole detect, control and engage sequence. It is about every radar we've got and every sensor system that we have out there. We want to make sure it is at the highest reliability it can-be, and in fact you can trust what it's seeing or not seeing.

To use an example, when we had the recent scare out in Hawaii, we knew right away that the BMDS sensors, both at sea and on land and in space, didn't see anything. We knew that was a false alarm right off the bat, and reported that back to the Pacific Command, which then reported that to the State of Hawaii. So you have to have a good feel for how you're doing.

We want to have the highest reliable interceptors possible, right, that we can back up our salvo doctrine, back up our shot doctrine, and give the war fighter extreme confidence that they can deploy this system and have comps that are going to work. At

the end of the day, it's about the American public. It's about you feeling good that you can go to sleep at night knowing that the CONUS, Hawaii, Guam, our forward deployed forces and our allies, are protected. So reliability is an important piece.

Number two, capability and capacity. It's the same story. I can't emphasize enough that it's not only about the missile.

It is about those sensors. It is about those individual fire control systems that are all linked together through a command and control that gives us that capability and capacity. The department has been very supportive. The Hill has been very supportive, the Congress and the Senate, on building out capacity.

So we're buying more THAAD interceptors. We're buying more Aegis SM-3s, SM-6s, and we're buying more GBIs. With each iteration, as we procure and bring out more of these missile types to go with our new sensors, the more improvements we're putting in them. So we're not static.

We have a good radar out in Hawaii, because again, we know the threat is growing. The Ground Based Missile Defense defends the Hawaii Islands today against the rogue threat. But we know that that threat, as it gets more complex, that we're going to need to be able to look out farther with higher sensitivity and power and be able to discriminate.

When I say discriminate, we're talking about picking out the lethal object, the re-entry vehicles. We want to be able to point the missile in the right direction. So that's capability and capacity from a detect, control and engage perspective.

And then finally the advanced threat. As I mentioned, the ballistic threats aren't getting any easier, and they're certainly not staying static. We've seen a lot of interesting things, whether it's maneuvers upon launch or throwing off interesting things in space to suck down our radar energy. The ballistic threat is going to continue to advance.

And then we have something called the hypersonic threat, which you've heard talked about in the news, from the near-peer countries. We also know it's a regional threat. It's regional and strategic. So that's a tough one and it happens to be one of the number one priorities for Dr. Griffin, our boss, the undersecretary of defense for research and engineering. So the priorities are: reliability, capability and capacity, and then finally dealing with the threat as it changes.

The third thing I'd like to talk to you about is our strategy. It all starts like most strategies do, with taking a hard look at costs. We just talked a lot about sensors on every island we can find out in the Pacific. We just talked about different types of interceptors.

At the end of the day we know the cost of those interceptors is too much. Anyone can do the math on cost per kill. You know how much the adversary's missiles cost, just from a broad perspective, versus what we're putting up for those defensive interceptors.

We could have a debate all day long on whether or not that's the right equation, or if the equation is, what happens if you kill a city or you sink an aircraft carrier? So I think defense is very important. It's a different equation in my mind.

But that aside, we know that there are ways to draw down this cost. When we talk about getting on the right side of the cost curve, we get very attracted to directed energy. We're working within the department to scale directed energy, to get to the very unique battle space that the Missile Defense Agency is interested in, and that's in the boost phase.

What that means is we've got to scale up our power to the megawatt class, and we've got to scale down the weight so we can get it into a high altitude aircraft, either manned or unmanned. That's where the agency's strategy is for directed energy.

When you think about the threat and its changes, and the hypersonic threat and how it flies, we also know that we need a better set of eyes. Just looking at things when they first launch with a radar, and then dead reckoning through the rest of the flight because you know you can predict a ballistic track, now they're flying differently. They're ballistic and they're coming down, and they're gliding over our air defense and under our ballistic defenses.

So we've got to think differently about how we're going to track all the way through. We call it full track custody from launch to intercept. We know that we need to go to space.

We've had great support, again, from the department, great support from the Hill, to get to a detect, control and engage construct in space. We have very good indications and warnings, so we know when something is boosting. We're okay initially getting the search and track.

We really do need to establish and maintain a track over the long-haul. Something we call the Missile Defense Tracking System is working very closely with the combatant commanders and the services to get that kind of capability in space. To get that fine-tuned fire control at the end, to know where the lethal object is, you need to be able to discriminate in space. So again, there's support from the department, support from the Hill, to move in that direction.

So we're very excited about the requirements in space. We have kill assessment going up this year, so we do have capability to go in and look at the final intercept to know whether or not we need to shoot another one. This goes right back to taking care of the war fighter and their shot doctrine. If they know that they've had a successful intercept, they can hold back the next engagement.

In terms of improvements coming downstream, a lot of work is being done in coordination with the Army today on the new radar to support the Patriot. The work we're doing with the U.S. forces in Korea for THAAD is bringing improvements to the

THAAD program that years ago we just talked about but now we know we need it. Remoting the launchers, so that you can place the fire control battery further back; placing the launchers up forward; increasing the number of launchers that you have associated with that fire control; being able to control other missiles with the THAAD TPY-2's radar; being able to launch the Patriot MSE, the Missile Segment Enhancement missile, from that; being able to do launch on remote from Patriot so you can extend and get the full kinematic range of those missiles. That's kind of exciting.

I'm excited about it, as I was pretty much raised an Aegis guy where we had multiple missiles to choose from. The system does weapons systems logic and if I need a short-range missile it shoots a short-range missile. If I need a long-range missile you use a long-range missile.

THAAD wasn't designed to do that. It was designed to be in a very specific part of the battle space. Now we're going to open that up and give it more capability by bringing Patriot in and being able to do launch on remote with that.

Aegis, we're going to test against an intercontinental ballistic missile class, the radar, to prove out that the SM-3 Block IIA in fact has capability against that missile type. We do that -- that's kind of the new layer that Riki might be talking about here -- our ability is now, with the maneuver capability of Navy ships, to be able to move that layer and put it where we need it. So we've got GBI, and to have this additional layer of the SM-3 Block IIA will be very exciting. So we're going to do that test to prove it out. If you do the math and do the analysis, we've got that capability, and so we just need to go prove it to ourselves.

GBI, we're building those out and we'll be putting in the re-designed kill vehicle. Moving to a kill vehicle that is more producible, that is modular, and also allows us to do things that we haven't done before, is going to be pretty impressive.

So how does this all tie together? We talk about C2BMC, command and control, battle management. This is where it all ties together.

We had a long discussion this morning about the multi-domain aspects of C2BMC. In fact, we had a war fighter desire to bring in water depth. Wow, we're the ballistic Missile Defense Agency, why would we do that?

Well, because it's about ship stationing. We should be worried about that, for a strategic level planner. So we're doing lots of things in C2BMC.

Probably the most significant thing coming in over the next few years is the Ballistic Missile Systems Track. We call it BST. What that is, is the fusing of all sensor data. We're fusing together the overhead data today, and the radar data, and you start pulling it all together with the new radar in Alaska, the new radar in Hawaii, bringing in the ships, bringing in the other batteries, you have the ability to put together a track that if it's applicable for a shooter that's deployed forward, then they can use that track. So it's

pretty exciting work happening in the C2BMC area.

The last thing I'll leave you with is about what it takes to move fast. We talk all the time about speed. We tend to fall back on the unique authorities that the Missile Defense Agency has. Having been a Navy PEO, I will tell you it is different at the agency.

We follow the intent of DOD 5000, no kidding. That's the law, we're going to follow that. But the difference is our director has unique authorities vested in him. Head of contracts, he is the BMDS program manager. He has all the contracting authority that he needs. So rather than working through multiple layers in our own building and then over in the Pentagon, we go to one person at the Missile Defense Agency, so we can move very quickly.

So speed of decision is really important. It's not about working faster, right? We can all work really fast but in the end-game you may not get the kind of speed you want. But if you have fewer people in the decision cycle, like Dr. Griffin always says, it really does work. The Missile Defense Agency has those set of authorities to go do that.

But the one thing that we think is also important, we looked at our flight test record over the last few years and we started comparing when we made changes to our engineering discipline and things that we've done for rigor in the system. We have seen a causal effect when you have the discipline and the rigor in your engineering and your success in flight. We're not afraid to fail, we have them all the time. We learn from those.

But you don't just say, hey I learned something and walk away. You're going to deeply go through that data, you're going to do the analysis, you're going to figure out what changes you can make, and you're going to incorporate those into the system. Guess what? That takes time. It's okay to take time to get through it right. So speed is one thing, but rigor and discipline is another. You've got to make sure you don't lose that when you do the speed (trait ?).

That's my introductory set of comments for today. Thank you for the time.

MR. ELLISON: Thank you. I still would say that your Aegis platform is the world's best layered defensive capability.

ADM. HILL: The most powerful warship on the planet, yes Riki, I'm with you.

MR. ELLISON: Ladies and gentlemen, I'd like to introduce Dean Wilkening. Not many of you have seen his bio. His bio is not out there, so I'm going to read it, if that's okay with you, Dean, just to summarize it.

He's the senior staff scientist in the precision strike mission area, with an initial focus on hypersonic technology. Having recently joined APL, he brings a wealth of

experience on ballistic missile defense, nuclear strategy and policy, bioterrorism, and more recently improving U.S. precision strike capabilities. He has participated in Defense Science Board studies on advanced ballistic and cruise missile threats concerning military operations and multi-domain effects, and on U.S. National Academy of Science Committee on biological terrorism and ballistic missile defense. Prior to joining APL he worked at the Lawrence Livermore Laboratory, the Stanford University Center of International Security Cooperation, and the RAND Corporation. He received his Ph.D. in physics from Harvard.

But I know Dean best. I had the opportunity to introduce him to his wife at the (Stanford ?) pre-season game. We had a great tail gate when my son played his first NFL career game, and we're glad they have a great relationship. Dean, it's all yours.

MR. WILKENING: Thank you very much, Riki. Admiral Hill gave you a wonderful whirlwind tour through the whole panoply of activities in missile defense, so I'm just going to highlight a few issues along the way. Let me begin where he left off.

Our DOD acquisition process is broken and is in sad need of repair to speed up our acquisition across the board, not just in missile defense. We have a culture in this country that is risk averse and does not tolerate failures on test ranges. That, to my mind, is absolutely wrong.

If you go back to the 1950s and you look at our attempts to build intercontinental ballistic missiles and satellites, we had multiple failures. Eisenhower did not cancel those programs because we had rockets blowing up on the launch pad. He told the engineers to go back to it, figure it out, work it, and the next thing you know in 1968 we went to the moon. That's the right attitude. We've got to test. If you get a failure, you learn an awful lot about a system when it fails. So you don't cancel programs when you have a couple of flight test failures. That just violates every engineer's common sense.

So we need to test. Testing is expensive, in many cases, but we need to figure out how to test cheaply. So let me go back to the admiral's comments about missile defense in particular.

The technology that rests behind our current missile defense architecture is very good, the hit-to-kill stuff. It's good technology. The sensor architecture that he briefly talked about is also very sophisticated, very good technology, the radars, the infrared sensors.

So in my mind, this is a very advanced and sophisticated and good system. Having said that, there still is the problem that -- and before I say -- the way to do missile defense, as the admiral said, is layers. You want boost phase, midcourse, terminal, as many shot opportunities as you can. That's how you get highly effective missile defense architectures.

The piece that we do not have in place yet is the boost phase. We have a lot of

midcourse systems. The main challenge there is the decoy discrimination problem. That's a tough problem, but it is not insolvable in my mind. It may never work perfectly, but I think we can do a pretty good job with discriminating a number of different types of countermeasures, perhaps not all of them.

The terminal phase, we also have a lot of capability in that area. But the boost phase is the one where we don't really have any, and here I might take a little issue. The technologies that have been offered up are directed energy, it's lasers.

As the admiral correctly pointed out, you've got to have megawatt lasers. Typically you put them on airborne platforms because the atmosphere distorts laser propagation, it attenuates it and it distorts the waveform. You want to get very high in altitude so you have minimal distortion of that laser beam so you get as much intensity on the target as possible. That means you need a lightweight system, size, weight and power.

Getting a megawatt laser with a small enough mass footprint that you can put it on an airborne platform and put it at high altitude, is a challenge. I think MDA is working very hard on that. From my perspective, the jury is out on whether we'll be able to design an effective system.

We tried with the ABL, the Airborne Laser, on a 747, a big aircraft. That was a test, a prototype system. It was a test platform, but it was really not an operational system.

Of course, when it was offered up as an operational system people realized pretty quickly it wasn't going to be very useful. You can't hover over even North Korean airspace for very long with a 747 before you get shot down, much less over Iran, much less over China, never mind Russia. So whether we can design a laser with sufficient power, get it up to high altitude, get sufficient lethal range so that we can standoff, is going to be a challenge.

The one country where it will work first is North Korea, and that happens to be where we have one of our most serious threats, especially if they stick to liquid propellant ballistic missiles because the boost time is so long -- let's say 300 seconds, five minutes. So you have a lot more time to dwell on it with your laser, get multiple shot opportunities, etcetera. For larger countries like Iran, it gets kind of tough. If they put their missiles in the middle of Iran it's going to be hard to fly into that airspace.

And then China and Russia you can pretty much forget about. You're never going to have an airborne laser of sufficient lethal range to hover over Russian or Chinese airspace. So we don't have boost phase options against those two states.

There are some kinetic kill options, rockets, that can home on boosters. It's also very tough. The main challenge, of course, with boost phase -- as you probably know -- is that boost phase is very short: five minutes for a liquid propellant ICBMs; and about

three minutes for solid propellant ICBMs. It's about one minute for short-range Scud-type missiles, so you don't have a lot of time between when they launch it, you detect it and track it, fire your weapon, be it kinetic or laser, and dwell on the target long enough to kill it. That's the fundamental challenge, which is one reason why you have to be close.

So boost phase, it's a challenge. Midcourse is a challenge, as I mentioned, the discrimination problem, but there are a lot of interesting sensors that can be brought to bear. I should mention with respect to lasers, in my view one of the most interesting applications is lasers is as a sensor, not as a weapon. Lasers are great sensors, and we should think of harvesting them for different applications, be it air defense or ballistic missile defense, as a sensor platform, before we get to the weapon application.

Let me touch a bit on the hypersonic problem because, as the admiral said, this is the new threat. The reason why our peer competitors, Russia and China, are designing hypersonic weapons is because they under-fly most of our midcourse ballistic missile defense systems. Hypersonic weapons fly around 20 to 40 kilometers in altitude, very high up in the upper atmosphere, near space. And a lot of our ballistic missile defense systems don't reach that far down into the upper atmosphere.

THAAD operates in that domain, and obviously the terminal systems, SM-6 and PAC-3, operate in that domain. But those are more point defense systems or limited area defense systems. It's hard to defend a country like the continental United States unless you're going to sprinkle THADD systems all over the country, like dozens of them, and that assumes that THAAD actually would work. It's not clear.

It's very hard to intercept hypersonic systems. Not only do they under-fly missile defenses, they maneuver. They can maneuver quite a bit, which makes the whole fire control problem very hard to get a lock on it, fire your weapon and have it home on that maneuvering vehicle.

Having said that, I'll put a plug in for left-of-launch, a problem I'm sort of working on these days. We can present the same problem to our peer adversaries. They don't have ballistic missile defense systems, at least not very many or not a very large system. Russia has some, but China is still in the development phase.

But they have massive air defense systems, both Russia and China, and as the admiral said, hypersonic vehicles over-fly most air defense systems. So the U.S. has made it a high priority to start developing hypersonic strike weapons to basically render their air defenses ineffective. This would be a very interesting strategic competition. If they deploy hypersonic strike weapons to undermine our ballistic missile defense systems, we can return the favor and deploy hypersonic weapons to undermine their air defense systems, tactical and strategic air defenses. So this will be a very interesting competition to watch.

One reason why I think it's important, as the admiral mentioned, the cost

exchange ratio is tough for the defense. Ballistic missile defense systems tend to be more expensive than the offensive systems. Air defense systems tend to be more expensive than strike systems as well. So you can put our peer competitors at a strategic disadvantage by undermining their air defenses and forcing them, if they choose to stick with air defense, to spend enormous sums of money to try to improve their air defense to defend against our hypersonic weapons.

This competition will be one of the main ones I see evolving in the next 20 to 30 years. I think it's an argument for why, on the U.S. side -- at least this is my opinion -- we ought to think of missile defense as a limited defense and not get in the business of thinking we're going to design a robust ballistic missile defense system to defend against massive Russian or Chinese ballistic missile attacks. Because of that cost exchange ratio, we're on the wrong side of that equation.

Maybe some technology options will appear that make missile defense more cost effective, but that is going to be a big challenge. The two that are offered up often are lasers, as suggested earlier. Lasers may work in the boost phase, but the jury is out on that.

The other one is gun systems, rail guns, high velocity power guns. They may make very effective terminal defense systems, but again it's point defense. You're not going to defend the continental United States with rail guns. So we have to think hard about how much ballistic missile defense we really want as a country and the cost implications of that, unless we can change that cost exchange ratio.

Having said that, limited defenses play an extremely important strategic role, not just defending carrier battle groups and the like, but you basically take small escalation options off the table. Russia has a fairly aggressive nuclear doctrine these days where they think they're going to escalate to try to either coerce NATO, coerce the United States, into accepting a fait accompli in the Baltics or wherever. You can make those escalation options very difficult for Russia by deploying a limited ballistic missile defense, that is if they use ballistic missiles for their strike -- because they can't launch one or two. They have to launch tens to be able to get through that defensive system. So limited defenses are very useful as a strategic asset. But again, I think we need to think very hard about whether we're going to go down the path of really deploying a more robust architecture in the future.

MR. ELLISON: Thanks, Dean. Retired Rear Admiral Mark Montgomery is the Policy Director of the Senate Armed Services Committee. He also was the head of operations under Harry Harris for PACOM. He's got an equal academic background with degrees from Penn, from Oxford and from MIT.

Mark, I'm going to turn this over to you. I'd like, if you could, to touch on these new layers: the F-35 capabilities; the under-layer with SM-3 Block IIA; the extended range THAAD; space, both discrimination satellite constellations and weapons in space; and our boost phase intercept, which Admiral Hill has already talked about, both kinetic

energy intercept and (laser ?)? It's all yours, Mark.

MR. MARK MONTGOMERY: That should be about 30 minutes, and I have about 15. We're doing our markup now on exactly these issues, so I'm going to have to leave a little bit early. But I do want to take this opportunity first to thank Riki.

He says he publicly educates, but I'll also tell you I know Jon and his experiences with the guy. He privately educates as well, and that's important. I think Jon and I are some of the few Naval officers that have a persistent missile defense application, about a 10 or 12 year process. A lot of senior military leaders don't have a lot of missile defense experience, and part of the education that Riki does is kind of bringing it to them. It's not appropriate for a one or two star to go up to three or four star and say, you don't know enough about this. So it's actually (good ?) for Riki to get in there and talk to them. I think he does a lot of private education as well, and that's very useful for us.

I will say, before I get into the issues that Riki brought up, on the Hill one of the most important things we're looking forward to is the Missile Defense Review. It's coming soon. We're excited about it because we don't have any special insight. It has not been leaked or briefed to us. But what I've read in the paper tells me that it's doing the two things that we want to see most, which is concentrate on Russia and China and not just deal with the very limited ballistic missile defense threat from Iran and North Korea. as the previous one did, which is important, but it's just an aspect of the overall missile defense problem we're facing.

And then start to talk about something that Riki hinted at, which is that there's more than just the ballistic missile defense. There's layering in there and it gets all the way down to air-breathing cruise missile defense. Frankly, that's one of the most serious problems we face.

So we're looking forward to the BMD Review. We do hope it really emphasizes what our allies and partners can do as well. We think while we did a good job in the last Ballistic Missile Defense Review talking about how we're going to help our allies and partners, that's where a lot of the EPAA phases came from, a lot of our DDGs to Rota, and increased involvement in the Pacific by U.S. forces, came from.

We think that by expanding the Missile Defense Review there 'd be more than just the kind of exquisite technologies to ballistic missile defense, which only a few allies or partners could pay for. But instead, expand it out to the broader layered defense where our allies and partners can participate. It's going to be very important, and we hope that there is an aggressive U.S. national security and Department of Defense press into our allies and partners saying, here's what we believe, here's what we're going to do financially and fiscally and posture-wise, and here's what we expect you to do.

There's a lot to be done out there. I'll tell you, I recognize THAAD, Aegis, even Patriot, at some level a lot of our allies and partners just can't even get the critical mass to buy in, to get into that program. Those are all reasonably expensive systems.

But they can get into the missile defense business. They can get into cruise missile defense. Our European allies need to do this.

We just had one, a small ally, the very reliable Lithuania has announced it's going to buy the NASAM system. That's a country with a couple of billion dollar budget, and they're buying missile defense systems. So we think our European allies, our Asian allies, need to really get at this because we can't be everywhere all the time.

We can't be paying for the infrastructure defense of our forward posture. In other words, that needs to be done by the countries in which we are situating either temporarily or permanently those forces. So I'd be excited to see our European allies and our Asian allies, when we're in kind of a contested environment, begin to really get at these.

I also think industry needs to take a look at how many available systems there are. In our admittedly quick month or two month long look, there was not a proliferation of really capable cruise missile defense systems out there. There's a handful. If you think of most other weapons systems that need to be proliferated throughout a lot of military forces, there's a lot more tanks and artillery rounds and ground-to-ground attack missile systems available. There's five, six, seven competitors out there in this environment. In the air defense environment, it's a much slimmer tribe of options. I think that's something that needs to be taken a look at. So in the broadness of the defense arena, coming down that chain from missile defense to the layered defense to cruise missile defense, there's a lot of room for our allies and partners to be in there.

I would talk about the layered defense. I think it's going to be critical. Hypersonics is exposing basically a flaw. That is flying the layer in between two or three systems, and it's flying the layer in between our sensors as well. So it's really going to challenge us. I think MDA has the button right now for thinking about hypersonic defense for the U.S. Defense Department. We're really excited to hear when that AOA is going to finish and get out there, because it's one of those areas where the offense is well ahead of the defense. I think our adversaries, if they were having this meeting, which I don't think they have open meetings about defense systems -- they'd be having the exact same discussion, because our offensive systems will outpace our defensive systems in hypersonic as well. What we can't do is leave kind of a hole in our swing, as a baseball player would say, where we can't hit the curve ball that's hypersonic, while we take care of the cruise missile ballistic missile defense. So we really have to get at that, so missile defense is going to be critical there.

And then obviously the sensor solution is going to be a critical event too. As we think about the next generation of ballistic missile sensor systems, it needs to be adaptable for hypersonic, which probably will drive altitude, numbers, and range that it can look at. When your altitude is lower and your numbers are higher, you're probably going to be in a bunch of lighter, smaller satellite systems, which is going to drive a shorter range of view, range of vision, for the sensor looking at it. So these are all challenging issues for DARPA and the Missile Defense Agency and the department,

broadly. But I believe the Missile Defense Review will address this.

I wanted to ask one question before I get out, and it's going to be for Dean. That was a great discussion. I do think at the beginning you said something that I hope is no longer true, or is becoming untrue.

You lobbed a fairly accurate round at the procurement system, that under USD AT&L we had a slow, methodical, eventually successful, procurement program. The FY '16 NDAA broke it up into the undersecretary of Defense for A&S and for R&E; and almost more importantly changed a lot of the authorities and the system for driving product to the market, so to speak. Have you had a chance to look at what the impact of that could be, and whether you think that law could potentially address your concerns and get us into a better procurement environment, acquisition environment?

MR. WILKENING: I haven't had a chance to look at it. I doubt that any legislation would change it, it's a mindset that sort of permeates the way we do business, the U.S. government and DOD does business. We love exquisite -- not gold-plated -- but we love exquisite military systems, high reliability, very effective systems. It just takes 10 years and billions of dollars to make them, which in the old world that was okay.

But against some of the emerging threats, especially in China, we need to think very differently. We need to procure things much more rapidly, and perhaps back off on some of the exquisite characteristics. Like satellites, we put these wonderful satellites up, billion dollar balls that last for decades. We ought to think very differently about our satellite architecture.

Maybe you don't have to have them last decades. Maybe a couple of years is just fine, if you have the launch capacity, etcetera. So it's that kind of mindset. Maybe the legislation no doubt will have an effect, I just don't know if it can change the whole culture.

I think it would be worth studying. Jon, what does MDA think about it? You're part of that, under R&E now, or at least General Greaves is under R&E.

ADM. HILL: Yes, we directly report to Dr. Griffin under R&E, and then we go to Ms. Lord for production decisions. I think what's really great about -- all legislation aside and organizational constructs -- we picked two of the best people on the planet to sit in those jobs. Dr. Griffin, if you Googled his bio you'll be impressed.

But on top of that, he's a hands on kind of leader. He came over to the Missile Defense Agency down in Fort Belvoir, he got out of the Pentagon and he spent four hours with us going through the space sensor architecture. I mean, he's just a roll up your sleeves kind of guy.

The other thing he has done for us is say, you don't work for my staff minions, you work for me. So when I ask for something, don't take five weeks coming through

the staff labyrinth, come directly to me. That has been a refreshing change, to just go directly to the boss for what we need and updating him on things he's asked for directly in a reasonable amount of time, as opposed to letting weeks go by and things get lost in a safe someplace.

Ms. Lord has been side by side as we go through our missile defense executive boards, which is our speed version of a DAB. She has been fantastic in terms of production decisions. To your point, doctor, rather than spending a lot of time saying we've got to have this perk and we need to have all this documentation in place and make sure you've got that, she has said, let's get this capability downstream to the war fighter now. I'm ready to sign.

So both of them are incredible leaders. They have great backgrounds. They are just perfectly suited for the jobs that they're in. It has made life -- I wouldn't say easy, it's still very challenging. But when you've got people who know what they're doing, it really matters.

MR. MONTGOMERY: I'll jump in and say you're right, we haven't had a budget cycle yet with the new rules. I don't know that it can make it worse, but I will tell you what I've seen so far. It will make it better. There will be a little rivalry on service versus the fed. No law can account for all the paranoia and bitterness that can occur. But I do think once they get the rule sets, the business rules down inside DOD, I think it's definitely a situation that has completely committed to this. There is going to be change.

The best sign of that will be failure. The best sign will be a program that we start off on and get farther than we normally get before we kill it. I think your other complaint, and the one I want to ask both of you about, is the zero defect mentality in testing. I think it's driven by a zero defect mentality in project development. No one has ever gotten the legion of merit and/or promotion to SES upon delivering a failed program, or being the guy that kills his own program because he no longer thinks it's relevant.

So I think what you've been referring to -- and the test case is Kim Jong-un. At some point he decided to stop killing test directors at the end of a failed exam and allow them to have a robust testing cycle with a significant number of failures that included several successes followed by a group of failures, again something you don't usually see in a testing program after you get through the (burble ?). So they have had a definite non-zero defect mentality to their testing. I'm not sure we can adapt the North Korean system exactly, but Jon, what's your feeling now in terms of -- I won't say more aggressive, but a more robust testing cycle that allows bringing things a little faster to the run with a little bit of increased risk of failure?

ADM. HILL: For me, General Greaves was very open when we got onboard that we were not going to be afraid to fail. But in order to do that, you've got to make sure that you fully understand all your risks when you roll into a test range. So he's comfortable not having everything perfect, so long as he understands that hey, I've got a

risk in this one area. And he's willing to go do the test to hit the larger objective.

It is a different mindset. I'll tell you that within the agency we don't have a fear of failure, but it exists within the culture everywhere else. So we don't test fire (solo ?), right? We're under the guidance and over-watch of a lot of different organizations.

Whether it's fundamental requirements or the test objectives themselves, you have that whole culture that will often come in with a very risk adverse view. We don't think you should go because of these following reasons. A lot of them are (ad men ?) in my mind, and it just drives us nuts.

Getting to where Dr. Wilkening is going, the question about the cost of tests is still tough. We're limited by range capability and capacity, for example. We can't just go in and say we're going to go test next week at (Pier F ?) because they've got other things scheduled. We can't bump everybody out of the way. Sometimes we do, but we'll go work with the services to say, we really need to go do this.

But the range capacity is tough. We need some investment in these ranges. Their basic sensing capability and everything you need for range safety is really important. You've got to take care of the ranges. They sort of get lost in between fleet ownership over range with the Navy versus the folks that are using it, paying the bill to keep that range in place.

So we've got to address that. Getting test assets in place, a lot of times we bump up against the procurement rules. Oh my gosh, you can't buy before you fly. Well how are we going to fly if we can't buy anything? So you have to buy the test articles so we can get them out there. And yes, they are expensive, to your point.

MR. MONTGOMERY: One thing I'd bring up, and I do need to run after this, an interesting thought that has occurred recently is that there's two types of targets that are driving costs. When you're deciding you're going to shoot down an IRBM, there's a different cost between a generic IRBM, which can be done pretty cheaply with solid fuel boosters strapped to generic rockets, and I'm going to shoot down a Nodong look-alike where we have to capture the exact mass and weight and size as the boosters and drop times of those. That builds into risk and that's probably something that's worth us looking at, driving down the cost of targets.

Also, allowing to have multiple targets on station so that you don't lose the test ranges. Frequently we spend millions and millions, tens of millions of dollars, on not a failed test but a non-executed test because weather or something scratches us out or a target fails to launch properly. If we have multiple targets we can get at that, but to do that the cost of targets has to go down or you have to have a mix. Sometimes you test against a Nodong II and sometimes you test against a generic IRBM flight pattern.

ADM. HILL: That's exactly the way you do it. You start your tests with cheap systems that are not necessarily threat representative, and only when you've ironed out a

lot of the bugs, then you start testing against the real threats that you think you're going to face. That's the risk MDA has to start considering a little more frequently.

ADM. HILL: I grew up on the Navy side doing ballistic missile testing. We shot against something called the ARAP (ph) target, which was actually just some old boosters that were kind of strapped together just to get them up there and give them something to track. We took a lot of heat for that, it's not representative, right? But at the end of the day, that was a cheap, small-scale target.

In fact, what it took to actually track and hit that smaller sub-scale target was hard. But I'll tell you, working for a defense organization is different, because not only are you developing the system, but you do have to go develop the threat representative target when you go to operational tests of these. So we have a targets development program on top of building the defense system.

It's something I didn't give a whole lot of thought to until I got into the Missile Defense Agency and realized how complex it is. At the end of the day, it goes back to that whole culture and that big infrastructure of folks that are pushing those requirements and demanding to see the full hypersonic trajectory, when we actually don't plan to shoot until here, but we've got to go build the whole target to show that we can track the whole thing to get to the kill. So it's a really tough balance and getting inexpensive targets is challenging. I've on targets for years on the Navy side, worked on them here at MDA, and there's not an easy answer yet. As long as we're willing to accept maybe sub-scale strapped together boosters in the early phases, and then we make the investment to get to the more complex target to really test the system out.

MR. WILKENING: You can do sub-system tests too.

ADM. HILL: Absolutely.

MR. WILKENING: Less so maybe on the defensive side, but certainly on the strike side. You test all kinds of sub-systems before you put it together in a whole multi-million dollar large test.

ADM. HILL: Which is time, again.

MR. WILKENING: Lots of time. But to underscore what Admiral Hill said, we don't have enough test ranges. Our ranges are very restricted. I don't know what to do about that, except this is an example where our range safety constraints are amazingly tight.

If there's one fishing vessel that sails into our range, we shut down the whole test. To me, that's a little bit -- I don't want to sound insensitive here to the fishermen, but the chance that you're going to do any damage over this thousands of mile flight path with some debris that might fall down is epsilon, or a very small number. So I would like to see us back off some of these requirements that make it so expensive, so restrictive, we

have to cancel tests because of -- if it's a legitimate reason because of weather or something, fine. But I see all kinds of little impediments to being able to test frequently, rapidly and at less cost.

But to underscore what you said earlier, Jon, Mike Giffin, I think, is going to be a great addition to the Defense Department. I very much look forward to his tenure. He is bringing in exactly the right mentality, the engineers mentality. Go out and test. Test frequently. If it fails, that's not a problem.

If you have a whole string of failures, maybe then you need to review whether the fundamental system is right. But we have a great example in your world, THAAD. THAAD failed. The first generation of THAAD failed nine out of 12 times, a horrendous failure rate. They finally did a full review of that system. They brought in the A-team at Lockheed Martin. They re-designed things, and now THAAD has had a wonderful test record. So we were right on the brink of canceling that program around 2004 or something, and that was turned around. Fundamentally THAAD was a good system, it just didn't have perhaps the quality control. I don't know what the problems were, but we ought to test a lot. We shouldn't be scared of test failures. We shouldn't call for the cancellation of programs unless there are fundamental, solid engineering or science reasons, or maybe policy reasons why we don't want to deploy some system.

ADM. HILL: Kind of coming off that and back to the R&E versus A&S discussion, I originally was concerned -- and I'm kind of a practical guy -- I saw one box, AT&L, and all of a sudden we were going to have two. I thought, if you're going to replicate the AT&L structure into two new structures -- I'm imagining myself again as a program manager -- I thought that is the world I don't want to live in. But I think Dr. Griffin and Ms. Lord have done a nice job on figuring out how to split that up. I think what it has really done for us, by the establishment of R&E, is help us to get more focused on that advanced technology side and investing in the areas that we need, whether it's directed energy -- really our view is let's just go determine whether or not it's feasible, instead of just keep talking about it for years. It's always five years away, right? So we want to go prove the feasibility, and if it turns out it's not feasible, we're ready to walk away. So I think that focus now in that area has become really important for us and I think it's one of the benefits of that legislation.

MR. ELLISON: I think we'd like to open this. Are you guys ready?

MR. : Sure.

MR. ELLISON: We'd like to open this discussion up to your questions.

MR. : (Off mic) -- SM-3 Block IIA -- (off mic).

ADM. HILL: The SM-3 Block IIA is in fact a cooperative development with Japan. That is the program of record. Years ago we talked about a 2B program, but that has been taken off the table. It is no longer in the program. We'll be looking at

improvements to the SM-3 Block 2A downstream, but we're wrapping up development tests now so that we can then go to production. Part of that path is doing that tests against an ICBM. I hate making things easy on our adversaries, so I'm not going to tell you when we're going to do it or how we're going to do it, but we're going to do it. It has been legislated, we have a plan, it is in our test plan, and we're going to execute.

MR. : (Off mic).

ADM. HILL: There is a technology roadmap, but we're not formally into the program yet. We're going to go down that path that Dr. Griffin wants to get into that Dean has kind of mentioned. We're going to prototype a new technologies and we're going to fold those into a follow-on to the Block IIA. But at this point, we're still completing development test on the IIA. We've got to go to production and get it deployed.

MR. ELLISON: Thank you, Jon. The IIA can do ICBMs?

ADM. HILL: That test I'm referring to is an ICBM test, yes. And by the way, I think I mentioned already our analysis shows that we do have that capability. We call it residual capability. We believe it's there, but we've got to go test it to prove it to ourselves and prove it to the country.

MR. ELLISON: Can you go on extended range real quick and what the difference is with THAAD. Will THAAD have that capability or is it a different confidence that you have in SM-3?

ADM. HILL: We had a THAAD extended range program, we call it THAAD follow-on. But when we moved to accelerate a lot of those capabilities into the U.S. Forces Korea capability where we were remoting launchers, we moved a lot of things to the left. So we're restructuring the THAAD follow-on.

MR. ELLISON: But it does have some inherent capability against ICBMs? We don't know or --

ADM. HILL: It wasn't designed for that, so I would say it's not in the design space. The Block 2A was designed for the intermediate range, so it's not that far afoot to get to an ICBM. THAAD was really designed against the medium-range. So we know it can now go against an IRBM. We've proven that. That's outside of its original design space. Going to the next step to an ICBM, I think, is a bit of a stretch at this point. I can't tell you that we're ready to go do that yet.

MR. WILKENING: If I can make a comment on this issue of SM-3 Block IIB, I was on the National Academy of Science study that was in part, I think, responsible for the cancellation of that program. It was a misunderstanding of what the National Academy report said. What we said in that report is that the SM-3 Block IIB could not defend the continental United States from Iran, which was the mission it was being

advertised for.

Because of that, Congress killed the program, which we thought was an absolute mistake. The SM-3 Block IIB was a good missile. It should have been deployed.

I hope we have a follow-on to the 2A that adds more capability to it. So the mission was not the appropriate mission for that missile. Canceling the missile was a mistake on the part of our illustrious Congressional leaders here.

ADM. HILL: I wasn't around for that cancellation. When I was a Navy commander I was working on the Block IIA program, standing up the agreements with Japan at the time. Some of you in the room are smiling because you were there in that war room with me as we were working our way through that.

That was no small feat, working with Japan to develop rocket motors, but we did that. It's really great to come back now serving the agency and seeing that missile fly, doing its job, and doing it very well. That's a very, very capable missile.

I think the IIB is not only against that particular threat you were mentioning, it was also some concerns about reliance on the Japanese propulsion (stats ?). So part of that strategy was to have a U.S. shadow program. I think that's how we referred to it at the time. So it doesn't exist at this point, but there will be a follow-on to the IIA. Again, we've just got to get finished up the development tests and go to operational tests and get it deployed.

MR. : What effect do you think pulling out of the Iran deal will have on jump-starting (the GCC common missile?)? General Greaves, in his testimony this year, raised the notion that you're still working the study from a couple of years ago for a common ground and air picture. Where does that stand and what do you see as the consequences of pulling out of the Iran deal?

ADM. HILL: I don't do policy. I really can't address the impacts of pulling out of the deal and what that would have on our program. It's really not my place to speak to that.

I will tell you that we are working with countries in that theater to increase their capability for say our version of the BMC that I mentioned earlier, that overall network. I'll even call it the mesh network because that's where Dr. Griffin wants to take us. I kind of talked about it becoming more of an all domain kind of network.

Part of that all domain piece is bringing in our allies into that network. We're doing that now with Japan. We're going to work that with some of the countries in the area that you're speaking of.

MR. : It seems you first mentioned that you were still working this a couple of years ago. Is that new report, in terms of (a network ?) with the Kuwaitis and the Saudis

would be --

ADM. HILL: Yes. We come to architecture studies and we're working technical solutions now.

MR. : Can I press you on the ICBM tests. Can you give us a broad -- is it going to be two years from now -- (off mic).

ADM. HILL: No, it's coming soon.

MR. : Soon as in two or three months?

ADM. HILL: Not in two or three months, but again I'm not going to help our adversaries out by giving the date. But we do have a firm date set for that test and we're on path to get there.

By the way, just as a follow-on, it goes back to the expensive targets and all that, right? We made a conscious decision within the agency to prioritize the GMD salvo test. We want to test the GBI against a salvo of ICBM targets.

So we did not want to pull a target away to go do that IIA test and lose that opportunity to characterize the performance of two GBIs going after an ICBM. We did not want to pull that target away to go do that. We prioritize homeland defense over that capability, so that's the reason for the timeline being a little bit to the right.

MR. : And when is the salvo test scheduled?

ADM. HILL: I'm not going to tell you that either. That one is coming up very soon. That salvo test is going to be our ability to go characterize and intercept the RV, and then what the follow-on missile does against whatever is left up there.

We are looking at the opportunity of bringing a ship out. In fact, I'll even credit Riki with the idea. Why not get the ship out there early to track and view that whole intercept? If there's anything left, maybe you can take a shot. So we're looking at what that would do, almost like a run-up, almost a Track X for the Block IIA shooter.

MR. ELLISON: Jon, can I just follow up, because it is a complex world of doing the best shooter with the best sensor and the C2. When you go into a multi-domain capability with our offense/defense, left-of-launch, right-of-launch. Do you see C2BMC for the ground-based missile defense system is the best shooter, the best sensor, across multiple domains? Is that where we need to go as a nation in terms of a C2 capability, or is that too out there?

ADM. HILL: I want to say the C2BMC is probably the only battle management system that is globally deployed like that. I mean, it spans 17 different times zones. This thing is huge, and it does allow us to build that systems track fusing the data to go to the

best shooter. But as you know, it's all geography based. You can have the ship in some area that doesn't make sense and maybe it doesn't have the range with whatever missile it has onboard, so it's not going to be a player even though it's seeing the data.

MR. ELLISON: Taking it down to the lower regional level like the GCC or EUCOM or PACCOM, can we do that same thing, non-ballistic and underneath to create that air picture and do that? Or, is that something that --

ADM. HILL: That's certainly what we're doing in South Korea, for example. We enable the ability for ships that will operate in that area to be pulled into that network and if it makes sense, they'll take a shot.

MR. : (Off mic).

ADM. HILL: What sort of kinetic interceptor would we use?

MR. : (Off mic).

ADM. HILL: You can go Google, if you're not familiar with the hypersonic threat, go see what it looks like. In generic terms, it's ballistic. It's going to look ballistic and then it's going to go into a glide phase, and then it's going to come back into the atmosphere and it's going to maneuver, and sometimes come back around the other side. So that's generically what it does.

So our systems, as we have them today, will detect that ballistic phase, which is why it could be confusing to the systems when it goes into a glide, because now it's doing something different. In that glide phase most of those systems are fairly vulnerable because they're bleeding off heat, they're doing other things. So that's a great place to intercept. So we're looking heavily at the ballistic phase. If you have a boost phase capability, or if you have a left-of-launch capability, even better. That's one way to go after it.

The vulnerability within the glide phase is a good place to do it. We can do things in that high maneuver space. We've proven that with the sea-based terminal and we've talked about THAAD maybe having that capability in that regime.

But again, that's the point defense that Dean talked about. That's where you don't want to do it. But that's a great layer, you want that layer, for sure. But there's probably better places to take on that threat along that trajectory space. Does that make sense?

MR. : There's two things about hypersonics that I'm concerned with. Number one is that the intelligence analysis of hypersonic glide vehicles needs to take into account the tactics of the adversary in how they would use them. But given that they're an expensive vehicle, there are a limited number of vehicles. They're going to be aimed at prime targets. My personal analysis is that prime targets are your sensors. Therefore,

once your sensors are gone everything else is (minimal ?).

So the second part of that question is, have you changed the amount of the budget that is going to be focused in hypersonic glide vehicles from the less than 10 percent -- I think it's less than one percent of your budget last year -- to the $11.4 billion that you get this year? How much of that is going to go into hypersonic defense? Because if you don't do that, you don't have a game.

ADM. HILL: A couple of things. We know we're paying a catch-up game, so we have established a program office to focus our energy on that particular threat. We just released some broad area announcements to take a look, you know, get the best and brightest from industry, from our field activities and labs, to come in and give us thoughts on overall weapons system kill chain, as well as different kinds of weapons options. So we're working now with industry and our government labs and field activities to kind of come through that.

Admiral Montgomery mentioned the analysis of alternatives. That's wrapping up real soon. We know enough from that. That gave us enough insight to put the broad area announcements out. So we have the program office established. In fact, Dr. Griffin has established us as the executive agent for hypersonic. From a budget perspective, because of where we're at in the study phase doing the architecture analysis, working with industry, we don't' need to shift a big bunch of the budget right now this year to go after that. But as soon as we do have the architecture laid out -- and I'll stand by and wait for the Missile Defense Review as an example -- we'll hit it in the next budget cycle and I think you'll see a shift and heavy focus there. Because it is one of the major priorities of Dr. Griffin, and it's a major priority for us. It's in our top three.

MR. : (Off mic).

ADM. HILL: Yes.

MR. WILKENING: Let me just add one comment I think that makes the problem worse. They're not necessarily expensive, the weapons, and there won't necessarily be a handful. They may be deployed in the hundreds, if not thousands. They could be like --

MR. : We (could take that ?).

MR. WILKENING: I'm sorry.

MR. : In a different world we (could take that ?).

MR. WILKENING: Okay, but it just makes your problem worse. There is no question, if you're trying to defeat a defense you go after the eyes and you try to take out the sensors. But, of course, you have to get through the defense to do that. So if you're defense is going to be -- one of the key things they will be defending is their sensors, their ground-based sensors.

MR. : (Off mic) -- to improve the cooperation and integration of U.S. and Japanese missile defenses?

ADM. HILL: I'll answer the first question of IAMD and integrated air and missile defense. It's defined differently, depending on where you go. The Joint Staff, for example, defines it as kind of concurrent operations. Admiral Montgomery talked about European ships that provide air defense to a ballistic missile defense ship. That's one version of IAMB.

Then the U.S. has the first destroyer on the planet that has integrated air and missile defense, and that's the baseline 9 version of Aegis that has the ability to do both cruise missile defense and ballistic missile defense at the same time, simultaneously doing that, which is a pretty impressive capability. Japan is moving down the path to do IAMD and, in fact, they requested Aegis Ashore in Japan. They're looking at two sites and they've asked both those sites to be integrated air and missile defense.

Now, they haven't been very clear on their requirements in terms of threat and how much air defense do you want to do and what kind of air defense and the ballistic missile defense. They're very focused in on primarily ballistic missile defense, but they want an air defense capability, likely to protect the site. But I think they're probably moving a little bit beyond that.

But they haven't been real clear with their priorities, so if I were to say anything to our friends in Japan, our greatest ally in my opinion, they need to be clear as to what the requirements are. It always starts with an architecture design, right? So we're spending time with the government of Japan to really assess the architecture that's required to defend that island nation. Does that answer the question?

MR. : Yes.

ADM. HILL: Okay, great, thank you. Sir, did you have anything to add?

MR. WILKENING: No.

ADM. HILL: Okay.

MR. : (Off mic) -- my question deals with our ability to glean lessons learned from these operational tests. (Off mic) -- you discussed the culture within MDA and the willingness to -- (off mic). Here on the Hill, there's also a culture of risk aversion that once the first failure happens -- (off mic). So my question is, is enough being done to be able to try and help turn the tide -- (off mic).

ADM. HILL: I would say that it all starts with openness. We're in the middle of a number of failure review boards in the agency today for some recent flight test failures. Being open with our partners on the Hill -- and I see a few of the staffers in the room -- as

soon as we know that we have an issue and we've established a failure review board, we come right to the Hill to tell them where we're at, so they understand where we're at. If you keep it a secret and you don't tell anybody, they really don't know the significance of that.

We've had some tests that have been operator-based, in which you know that the system is fine but the problem is we still need to go back and redo the test to prove that we don't have any system issues. We've had failures that have been tied to manufacturing and production defects, which we know we can very quickly move through. Openness with the Hill is important. So we really try to practice that and we're waiting for the report card on how we're doing at some point.

I'm looking to see if the staffs are smiling yet. They're not, so obviously we still have work to do there. But I think being open with the Hill, being open within the department, and sharing what you have -- for instance, we had a failure in one of our tests with the Japanese cooperative program. That was difficult for us to immediately come over and say look, this is what we think happened. We had to go back and make sure that that was okay with Japan. They're such an incredible partner we wanted to make sure that we all had agreement there and that they were a part of that failure review process.

So I think being open about what you're finding and where you're going next is important because that gives everyone a sense of the stability of the program and you won't just go willy-nilly and cancel the program if you have an understanding. So sharing that understanding is important.

We are build a little, test a little, learn a lot kind of people. That's the world that I grew up in in the Aegis program. We follow that precept in MDA.

I think one of the problems is -- and the doctor raised it here earlier -- is about the complexity of tests. If you're moving right from prototyping or very simplistic tests to prove and meet your objectives, or you just go to this big bang thing to where you can't go in and determine what happened and come down to a root cause very quickly, you do lose confidence in the program. So the first thing we try to do is to move to a root cause right away so that we have a full understanding of what that is and whether or not we can fix that quickly to keep moving.

Or else, the program should be -- we deserve to be slowed down until we can get it right. That goes back to that whole speed equation about, it's always in the data. Data every day. You've got to be able to prove to yourself that you know where you're at.

MR. : What is our persistent over-the-horizon over-head sensor to deal with maneuvering cruise missiles and so forth? What is that program, since JLENS is no longer in existence? Can you do it from satellites?

ADM. HILL: That's a hard one. I'll just go back to the ballistic missile flight. We talked about exquisite indications and warning in order to do the boost phase mission.

That is really important, to be able to see the flash from space, to know that you've got something, and then immediately get the radars on it so you can develop the track. That's how we do it in ballistic missile defense. We get the indications of warning first so that we know we've got it, then we go to a firm radar track, and then we get to a radar that can discriminate and then we hand it over to the missile. That's how we complete that engagement.

Those sensors are there today. The problem is when you get into these exquisite threats where things change and it's no longer as predictable, so you need to keep eyes on it the whole way, which is why the agency's strategy is to get up into space so we can track that whole thing. A lot of that is being done because the hypersonic really has a lot of cruise missile kind of characteristics to it that we're used to seeing, and so seeing it from space will be very important.

MR. WILKENING: If I can just add a comment to reinforce what was said earlier, I think there's a tendency to think about the ballistic missile defense problem and forget about the air defense problem. The cruise missile threat is all about air defenses, and in some respects it's a harder problem. Ballistic missiles, you see that flash and you know they're coming. They're way up in space. You get powerful radars. You can track them pretty early on.

Cruise missiles, not so. So the elevated platform that you need is, of course, the airborne systems. The E-2 and the AWACS are the ones that you use. But short of that, it's hard to detect those things from a very long range.

MR. ELLISON: Do you think a space low-Earth orbit constellation could do that, could give you global coverage over the horizon, or is that technology too far away?

MR. WILKENING: It's a little bit difficult to talk about, but I will say one thing. With respect to the hypersonics threat that was mentioned earlier, we don't have a good tracking architecture. That, I don't think, is true.

The one thing that's easy about hypersonic threats is because they're moving so fast they're very hot, they're very bright infrared. You put any infrared sensor up there on an airborne platform, in space, whatever, chances are you're going to be able to see that from a long ways away. So the detection and tracking part of the problem is relatively straightforward for hypersonic threats.

It's intercepting the bloody thing that's hard, because it can be maneuvering, because it's fast. It doesn't take many minutes before it's on top of you. Your battle space is compressed, fewer shot opportunities, the thing can be maneuvering very aggressively, so your interceptors have to be very agile, and that's what makes the hypersonic threat a challenge.

MR. ELLISON: Can we expect our most expensive platform, the F-35, to be able to do some of this sensing? Is that part of the loop? Are we looking at that?

ADM. HILL: It needs to be a part of the loop, so one of our first engagements with Mr. Rood when he checked in as our undersecretary for policy, he kind of reminded us that if you're in a ballistic missile defense kind of gig, you're not going to be out there alone. Say we're defending South Korea, there's going to be F-35s in the area. There's going to be ships in the area. There's going to be submarines in the area. So his question to us was, are they integrated into the C2BMC? I think you can guess the answer.

But it's not a hard put to get there, right? I grew up as an air defender where we had multiple sensors on the target. Everything you've got, just put it up there. The big challenge for us was fusing all that data, which is a hard challenge, to fuse the data. So when I talk about the ballistic missile 6 system track, that's assuming you have multiple sensors.

Because really, the way we do it today is we kind of hand off from one sensor to the next. So it's not a big fusion game, it's really more about handover, which in itself is a heck of an engineering challenge. But now if you've got multiple sensors on target, whether they're space or terrestrial-based or the maneuver force of the Navy are on top of those, it becomes a fusion question. So maybe that is the offset to the loss of the JLENS program.

MR. : (Off mic).

ADM. HILL: We tend to, in the past, be very biased over what we control. Any good program manager is going to do that. The unfortunate thing is, every program manager is in a stovepipe. We're in our BMD stovepipe, so to say.

What General Greaves is really trying to tell you is that he's willing to break out of that stovepipe. We have structures in place with our unique authorities, to work very closely with the services. In fact, on a very regular periodic basis we meet with the Air Force. For instance, they're going to take over lead service of radars. They have the lead service responsibility over some of our terrestrial-based radars today, and as we put the radar in Hawaii and things like that, the Air Force are major players there.

So we have the forms in place already, and so F-35 is on the docket for us to have that conversation. We have the technical sessions happening now, what capability that sensor is, how it can be fused into the system. And it's not that hard of a put.

When I was on the Navy side, believe it or not, the surface guys talking to the aviation side, that's a couple of different tribes coming together. But we went off and we tested and worked very hard with the Joint Program Office at the time to bring down that link into an Aegis ship to show that we can close that fire control loop. And with the kind of capabilities we have out there, say with the SM-6 missile we talked about, that is quite the capability.

There's no reason why we shouldn't be doing that. So we see the same sort of lift

happening. When we're off the coast of South Korea with ships and submarines and aircraft in the air, all of that data ought to be coming in and be available to the war fighter to make decisions, whether it's just situational awareness or if they can actually do fire control with it. We ought to be moving down that path and that's what General Greaves is really getting at. When he says multi-domain, that's what he means. Bring the F-35 in. If there's a submarine off the coast that has a capability, bring that in so we can leverage that for the BMDS.

MR. : Last year, or it might have been the year before, the National Missile Defense Act wanted a change from defending against a limited threat to a robust threat. I'm wondering if you all have embraced that and see that as a mandate to defend against peer or near-peer adversary missile threats? Also, kind of a secondary question, General Hyten has said space-based missile defense is not a technical question, it's a policy question. Are you factoring in -- are there any short-term or long-term plans that incorporate potentially the use of space platforms?

ADM. HILL: A great set of questions. Yes, I went to bed one night and woke up the next morning and the word limited was removed from that mission statement that I talked about earlier. But I don't believe there was the word robust inserted in there.

I will tell you that a couple of year ago when that happened it was a bit confusing for the agency because we know that capabilities against those upper echelon tier one capabilities, we're not really geared for that. So we immediately started going in and looking at the residual capability that we might have in our systems that go against ICBMs. Probably the best way to answer that is to delay the answer until after the Missile Defense Review.

I think that's where we're going to get very clear guidance by what it means to take on -- and you heard the doctor's view on what it means to go beyond a limited capability to something else. That term robust would be a major change if that came in. I think even General Greaves has said in an open forum that if you were to do that to our mission statement, stand by to start plussing up the budget very significantly if we want to go do that. That's a big change in a national level strategy from a missile defense perspective.

To your other question about -- what was the second question, because I can read my own writing?

MR. : Are you incorporating space?

ADM. HILL: Oh yeah, space. Absolutely, we incorporate space today. I mentioned indications and warning, as the first, left-end of setting up the fire control for that. I talked about how we've got to get to the full sensor layer of support from the department and the Hill to prototype in that area. The doctor mentioned already that there are sensors today that can do that. The technology is available, we've just got to get it up and continue to work with the combatant commanders and the services to fully

populate that kind of constellation.

I mentioned the need for a discrimination layer. I mentioned the fact that we are going to finish deploying our space-based kill assessment later this year. So it is a major part of the overall battle, particularly driven by more complex threats.

MR. WILKENING: If I can comment, space is a great place for sensors. It's a lousy place for weapons. So if you're thinking of space-based lasers and all the stuff that was talked about in the mid-'80s, that's going to be hugely expensive.

With respect to the first question, the key issue is going to be what the cost exchange ratio is between offense and defense. If they can flip that equation so that defenses are cost competitive at least, if not cheaper, then you can start talking about more robust architectures. If that is not the case, you're going to have a real hard time thinking of a thick defense against a peer competitor.

I'm not actually so concerned about Russia, because they're not economically all that strong. China is just the opposite, and I think we would be putting ourselves on a very dangerous position to try and run that kind of offense-defense race with China. So look out for the cost exchange ratio and find people that can do that analysis accurately. Then you can answer that question about whether we should go from limited to more robust architectures.

MR. : Dean, just on that point, if we did lasers up in space, is a chemical-based laser a lot easier to handle than a solid state laser because of the weight to power ratio? Or, is it different --

MR. WILKENING: Yeah, I don't actually know. Both could be options up there. The problem is, first of all, the countries we're worried about are developing anti-satellite weapons now. Supposedly a space-based laser could defend itself, unless you're coming at multiple azimuths. So you have to worry about the survivability of that platform.

You have to worry about the cost of getting up -- launch costs are huge. We hope that our friend Mr. Tesla is reversing that cost exchange, that cost ratio for lift into orbit. But today, getting all that mass up in orbit and having it survive and having it be viable for a decade or so, is a very expensive proposition.

Sensors are a totally different story. We are using space for sensor architectures. It's a great place for sensors.

MR. ELLISON: We've got one last question, and then we'll close the discussion.

MR. : Last week Huntington Ingalls started construction of the first flight for -- (off mic) -- and that ship is going to bring the SPY-6 radar. Can you comment on the improvements the SPY-6 radar is going to bring to the IAMD fight and what advantages

it's going to have, if at all, against the advanced threat?

ADM. HILL: We have it set up within the BMDS architecture to come into a very specific increment. As you already know, the power and sensitivity of that radar is incredible. Married with the baseline 10 Aegis on a maneuver force ship, I think it's going to bring an incredible capability to the BMDS.

Very early on, back when I was with the Navy side of the house, we started looking at that hypersonic threat and looking at where we can incorporate early hooks into the development of that radar. So that radar is going to come out with some inherent capability to track that kind of threat. I think it's going to be a big lift not only for the Navy, but just its inherent maneuver force capability.

That kind of sensor, globally deployed, is going to be a big lift for BMDS. It's another one of those assets off the cost of say, South Korea, that is going to be a formidable asset because it's not only a sensor, it's networked and it's a shooter, and of course it's run by United States Navy sailors.

MR. ELLISON: Thank you. Thanks, Dean. Thanks, Jon. It was a great discussion, open discussion.

(Applause).