071119 Air Force Association Mitchell Institute for Aerospace Studies, National Defense Industrial Association, and Reserve Officers Association Capitol Hill Seminar with Former Missile Defense Agency Director General Henry Obering, Executive Vice President at Booze Allen Hamilton, on "Missile Defense and Directed Energy"

(For additional information on AFA/NDIA/ROA seminars contact Peter Huessy at phuessy@afa.org).

MR. PETER HUESSY: Good morning, everybody. I want to say thank you for being here at the next in our series of missile defense and nuclear deterrence seminars. Tomorrow we have Mo Brooks from the wonderful state of Alabama who will give us a review of what the House Armed Services Committee and the HAC has done with respect to missile defense across the board, and what the prospects are for conference.

On the 24th we're hearing from the vice chief of staff of the Air Force, General Wilson. On the 25th we'll hear from Mike Turner, a member of the Armed Services Committee and Intelligence Committees, about North Korea and Iran with respect to both nuclear proliferation and missile defense.

Our triad symposium in Crane, Indiana with the NavSea folks is the 22nd and 23rd of August. If you're interested in attending we'd welcome to have you. Our two keynote speakers there are General Clark, who is head of A-10, and Admiral Wolfe, who is head of SSP.

On the 8th of October here at the Capitol Hill Club we have our second symposium on the nuclear triad. The theme this year is "Maintaining and Strengthening the Consensus on Nuclear Modernization." Our keynote speaker will be Jack Weinstein, the former head of A-10, and our luncheon speaker is going to be Admiral Haney, the former head of STRAT Command.

We're honored today to have General Henry Obering III. He's a retired lieutenant general from the United States Air Force. Prior to his retirement he was, as you know, director of the Missile Defense Agency.

He is a native of Alabama and joined the Air Force in 1973, completing the reserve officers training corps program at the University of Notre Dame. He received his pilot wings in 1975 and flew operational assignments in the F-4. He was later assigned to the Space Shuttle program and participated in 15 Space Shuttle launches as a NASA Orbiter project engineer, and was responsible for integrating fire and launch operations.

He also was assigned to tours as the Air Force Inspector General in the Defense Mapping Agency and Electronics Systems Center. He is also a graduate of the Squadron Officers School and also Stanford University, where he has a Master's of Science degree in astronautical engineering. He also went to the Air Command and Staff College and the Industrial College of the Armed Forces at the National Defense University.

He is currently the vice president at Booze Allen Hamilton. He is a dear friend of ours, a great advocate and friend of missile defense. Would you now welcome our good friend, Lieutenant General Henry Obering?

(Applause).

GEN. HENRY OBERING: Good morning, everyone. Can everybody hear me okay? Peter told me to get your attention to start with, so I'll tell you a quick story.

When I was in graduate school at Stanford NASA-Ames was doing a little competition with colleges which they had put together a mission to a planet of their choice and had to brief out the collective panel, and we were part of that. There are three universities that are close to my heart. One is Notre Dame where I did my undergraduate work. I'm from Alabama, so Alabama Auburn is always part of the whole equation. It just happened that they were up giving their talks.

The Auburn guys came up and said we're all about War Eagle so we're going to go to the planet named for the god of War, Mars, and they briefed out their mission. Then the Notre Dame guys got up and said, we're going to go to Jupiter, the largest planet in the solar system, and they briefed their mission. The Alabama guys got up and they said, we're going to the sun. The panel said, wait a minute, you can't go to the sun, you'll burn up. The Alabama team responded don't worry, we'll go at night.

(Laughter).

I think the moral of the story is to make sure you understand your environment first of all as you give these talks. Thank you very much, Peter, for the invitation here.

Many of you may realize that 15 years ago last month we began deploying the first long-range interceptors into the ground at Fort Greeley, Alaska, which became a part of the first integrated layered missile defense system that this country had ever had. We were modifying Cold War-era radars in Alaska, California, Greenland and the United Kingdom. That gave us the first protection from a North Korean or emerging Iranian type of threat.

Today we have 44 of those long-range interceptors standing watch in both Alaska and California. In addition we have deployed both sea- and land-based missile defense capable radars from Japan to Guam to South Korea to Hawaii to Alaska to California, which is quite a remarkable achievement. We also have radars in Romania, Poland, the United Kingdom, Greenland and the U.S. that are keeping watch against potential Iranian threats, along with SM-3 interceptors deployed in Romania.

We deployed hundreds of sea-based SM-3 interceptors on more than 30 U.S.

Navy ships and dozens of mobile land-based THAAD interceptors. I'm very confident in our ability to handle any threat from North Korea or Iran, but as pointed out in the Missile Defense Review, we must deal with a resurgent Russia and an aggressive China today. The way I like to characterize our strategy is to say we need to be able to defend against anything and everything that a North Korea or Iran could threaten us with. And from a capability perspective, we have to be able to defend against anything a Russia or China could throw at us, and enough capacity to ensure that we maintain our strategic and our tactical deterrence.

So the deployed interceptors, radars, command and control battle management and communications systems that make up our integrated missile defense system today are based on technologies that were developed in the 1980s and 1990s. You can trace back the pedigree of the technology in our kill vehicles and our boosters to that timeframe. That means to meet the emerging threats of today and of the future, we really need a major investment in technologies that will provide us these capabilities into the future.

What am I talking about? These capabilities include space-based precision tracking and kill capabilities. Many people don't realize today what we do from space is that we do early warning.

We can detect a missile launch. We can say it's heading into, for example, New York or Chicago or whatever. But, they're not very precise and we certainly cannot engage missiles based just on those satellite tracks.

We do have two demonstration birds up, STSS, that will allow us to do precision tracking, and we actually demonstrated that in our missile defense testing, so we know we can do that. Another capability that may be surprising is peer-to-peer networks, especially combined with artificial intelligence. That has an incredible impact on what we can do in space with respect to a network, an Internet in space, with peer-to-peer based technology. When you overlay that with artificial intelligence, for example even what's in the Uber technology, that is an incredible advantage and leverage for us.

Of course, one of the most promising areas and what I'm going to talk about mainly this morning is directed energy. What do I mean by directed energy? It's specifically high energy lasers, high powered radio frequency or microwave devices, and charged or neutral particle beam weapons.

They have long been pursued for their speed of light engagement, their deep shot magazines, stealth-like performance because for the most part they're invisible and you can't hear them, precision targeting for both lethal and non-lethal applications, and really a low cost per shot when compared with traditional kinetic munitions. One would think that the use of directed energy in warfare is a relatively recent technological event. However, in the second century B.C. the Greek scientist Archimedes is believed to have used reflected sunlight to set Roman ships on fire.

In 1935 the British Air Ministry asked Robert Watson Watt of the radio research station, whether a death ray was possible. He concluded at that time that it was not feasible. But as a consequence of that suggested using radio for the detection of aircraft, which started the development of radar in Britain.

Nicola Tesla, a noted inventor, scientist and electrical engineer, developed early high frequency technologies and worked on plans for a directed energy weapon from the early 1900s. In 1937 he composed a treatise entitled, "The Art of Projecting Concentrated Non-Dispersive Energy Through the Natural Media Concerning Charged Particle Beams." In 1937 he wrote that.

In World War II the Germans conducted research in both X-ray and microwave weapons. And, of course, in the 1980s and 1990s and early 2000s, as part of this nation's -m research, both the Airborne Laser Laboratory and the Airborne Laser programs were developed but later cancelled.

So, what is the promise and potential of direct energy weapons, and why are they attractive to our war fighters? How far have we come today in the technology to develop these weapons, and what are the barriers that exist to fielding? Where should we go from here? Those are some of the questions I want to talk about today.

Since Archimedes was believed to have focused the sun to set fire to the Roman ships, directed energy weapons have been am ambition of militaries across the world. Where would these attributes fit into war fighter scenarios? Well, as I stated earlier, I believe we can defend ourselves and our forces and allies from a North Korean missile attack. But one leverage that is not discussed very much in the news is that the missile North Koreans are counting on nearly 14,000 artillery pieces and rocket launchers that are within range of the 10 million inhabitants of Seoul.

Imagine how the geopolitical calculus would change if U.S. and South Korea deployed a layered ground-based defense against this threat incorporating the use of directed energy weapons, which is certainly feasible. And while the U.S. can certainly defend against a North Korean ICBM threat using its Alaska- and California-based interceptors, having high altitude UAV armed with high energy lasers to destroy missiles in their boost or ascent phase would dramatically improve the effectiveness of the overall U.S. defenses, especially against greater numbers of threat missile raids.

Turning to a different kind of missile threat, one of our high altitude unmanned aircraft, a naval variant of the Air Force's RQ-4 Global Hawk, known as the Broad Area Maritime Surveillance Demonstrator, or BAMS-D, was shot down recently by an Iranian surface-to-air missile, according to U.S. Central Command reports. If that drone had been outfitted with a laser which could destroy their inbound missile, which is clearly technically possible, it would have survived. And, of course, if we were to deploy high energy laser weapons to space, they could be used not only for defense against ballistic and maneuvering missiles, but also for space defense and control. I'll talk more about that later.

These are just some of the directed energy applications in war fighting scenarios. But, how close are we to achieving these capabilities? Let's take a look at today's directed energy technology environment.

As I said earlier, the U.S. began its directed energy research in the 1980s with airborne laser, as well as the High Energy Laser Systems Test Facility, or HELSTF, the latter of which still operates the Department of Defense's most powerful laser today. But a lot has changed since the HELSTF became operational in 1985. We have dramatically improved our knowledge base and made significant technological advances, including along the way programs like the Advanced Tactical Laser, which is integrated on a C-130; the megawatt-class airborne laser on a 747, which by the way successfully shot down both a solid and liquid propellant missile in 2010; and the Navy most recently with their Navy Laser Weapons System, or LAWS, quick reaction capability, which was deployed aboard the USS Ponce in 2014 as a counter drone and small boat weapon.

Perhaps more importantly, our adversaries have also made significant advances. Threat are evolving that direct energy is uniquely qualified to address, including boost phase missile defense against advanced intercontinental missiles. Some also predict that the use of direct energy may play a role in the future of defense against hypersonic weapons, which I'll also talk about later.

In addition to the speed of engagement required to address some of these threats, the cost exchange ratio between inbound rockets or missiles and a laser engagement is certainly to our advantage. What was once a science project is now a necessity, and our continued military superiority, in my opinion, depends on this outcome. There are several instances where directed energy weapons are moving from one of demonstrations to operational prototypes in quantity using rapid acquisition approaches and programs of record.\

For example, the U.S. Navy has now defined a Navy laser family of systems for its ships following the successful deployment of the LAWS 30 kilowatt operational prototype. The weapon used on the Ponce was used nearly 24/7 during its three year deployment from 2014 to 2017, with many valuable insights being provided back to the development community. This family will now include both high energy lasers that will be exceeding 100 kilowatts, as well as reduced power lasers for other uses.

At our Booz Allen Hamilton directed energy summit in 2018 here in Washington, Colonel Dennis Wiley (ph), the Army G-3 Strategic Program chief for U.S. Army Europe at the time, announced that the U.S. Army had successfully demonstrated a laser weapon integrated onto a Stryker Combat Vehicle in Europe. He said that the 2nd Stryker Cavalry Regiment, supported by the 7th Army Training Command and the Fires Center of Excellence at Fort Sill, Oklahoma, conducted live fire engagements of the five kilowatt Mobile Expeditionary High Energy Laser Demonstrator at the Groffenmaier (ph) training area in Germany. That was in March of 2018.

This is just the beginning of a plan by the Army to deploy 50 kilowatt lasers on four of its Stryker vehicles over the next years for operational use. A fire support NCO with the 4th Division Artillery who participated in the testing of a two kilowatt version of the laser at Fort Sill, Oklahoma last year against unmanned drones was quoted in the Army Times as saying, it was extremely efficient. I was able to bring them down as fast as they were able to put them up.

The Air Force Secretary and Chief of Staff signed out their directed energy flight plan outlining the path ahead for the Air Force to develop and deploy both high energy lasers and high powered radio frequency weapons for its aircraft. This plan includes a program which aims to test high energy lasers on aircraft against surface-to-air and air-to-air missile threats. In addition, the Air Force has partnered with the Navy in the development of a high powered RF weapon called the High Powered Joint Electromagnetic Non-Kinetic Strike, or HIJENKS, which is capable of attacking electronics, communications and computer networks.

But by far, the most ambitious program underway in the department is being led by my former agency, the Missile Defense Agency. The recently released Missile Defense Review proposes that the MDA study the potential to develop and field space-based lasers to intercept ballistic missiles. MDA would have to develop a very high powered megawatt-class laser that would have a range of hundreds of miles with the size, weight and power input required to deploy on a space-based platform to target missiles during their boost, ascent and even midcourse phase. Is this capability feasible in the next 5 to 10 years?

After discussions that I've had with many experts across industry, across government, and especially our national labs, I get the answer is yes. The first step in this endeavor is underway with the funding for laser scaling and beam quality improvements for both combined fiber lasers as well as hybrid lasers such as the diode pump alkaloid laser, or DPALS. These lasers represent a generational change and improvement to what we had in Airborne Laser. Back in the Airborne Laser days, to produce a megawatt of power basically the only technology available to us were chemical-based oxygen iodine lasers. That flew on a heavily packed 747 in which the entire volume -- and I was on the aircraft and flew on it -- in which you could hardly move because of all the laser modules, the chemical storage tanks, the optical benches, the control equipment, all of that was required to generate a megawatt-class of power.

Today we're reaching the point where we can generate a megawatt of power in a size, weight and volume that is capable of being put on either a high altitude platform or a space-based platform. The laser diode, the fiber amplifier, the batter and power management, the thermal control and optical systems are so much more advanced than in the ABL days. Space-based lasers would have a profound impact on the U.S. ability to defend and if necessary fight in space. Of course, this is very much in line with the direction this country is now taking with the Space Force and what we're trying to do to make sure that we can operate and fight in space like any other domain: land, sea, air or cyber. Not only could these space-based lasers be used to defend against ballistic missiles in their boost, ascent and midcourse phase, but it could also be used to defend critical space-based assets against enemy anti-satellite attack.

As the Department of Defense works to develop and incorporate these technologies, much of the work should be collaborative, as in the improvement in materials, power generation, thermal control, etcetera, to continue to reduce the size, weight and power required to operate the weapons. However, the wide variety of missions, platforms and implementation environments necessitate continued service differentiated development activities. This also includes fundamental differences such as the wavelength of the lasers and the beam quality required for success.

What do I mean? For example, a Navy ship-to-air laser will have very different requirements than an Air Force air-to-air system, which will have even different requirements than a space-based missile defense system, and therefore different technological considerations. So, we can't try to lump everything into one box to try and solve that problem. We need to make sure that we maintain our service-differentiated development activities.

But, there are some common core things, like materials science and research and reductions and improvements in power generation. These discrete mission aligned efforts will maintain our pace of development in a race to get these technologies into the field.

Now let me return to what has been described as the number one threat to the U.S. by my great friend, the Undersecretary of Defense for Research and Engineering, Dr. Mike Griffin, hypersonic weapons. There are two types of hypersonic weapons, boost glide and air-launched high speed cruise missiles. Boost glide weapons are launched atop ballistic missiles and then released to glide to the target. The air-launched hypersonic cruise missile uses scramjets or rockets to power it throughout flight.

These high speed missiles fly at Mach 5, five times the speed of sound, or greater. They can not only achieve these speeds, but they can maneuver as well, including varying their trajectory, their headings and their altitudes. Therefore, our currently deployed integrated defenses against ballistic missiles will not work and will not be effective in defending against these non-ballistic threats.

There is no silver bullet defense, and I want to make sure I make that clear. There is no silver bullet against these weapons. In fact, there will have to be an architectural approach to defending against them. But directed energy weapons can certainly play a major role.

Since these weapons maneuver, we need to be able to precisely track the hypersonic missile throughout its entire flight, or birth to death. The only cost-effective way to accomplish this is to do it from space. I can't tell you how important that is, to be able to precisely track from space.

We know we can do it. We've demonstrated the technology. This type of capability helps not only our long-range interceptors in Alaska and California, but also our ship-based interceptors. Our THAAD, even our Patriots can benefit from these precise tracks.

So, it was very disheartening when I saw recently that the House has cut money for our space-based precision layer. That is absolutely ridiculous. We've got to go back and we've got to correct that.

Developing hypersonic interceptors will also be an option in our defense architecture. But, there's a rule of thumb that you typically need to be aware of when you're developing an interceptor, which is that it has to be capable of three times the speed of its target in order to have enough energy to maneuver against it in the intercept. So, hypersonic kinetic interceptors would have to be able to achieve speeds of Mach 15 or higher in order to intercept these hypersonic weapons.

Well, one of the greatest attributes of directed energy weapons is what? They operate at the speed of light. So, even if you have a hypersonic weapon that is traveling at 25 times the speed of sound, a high energy laser can engage it at roughly 35,000 times its own speed. This makes targeting and tracking much, much easier.

Space-based high energy lasers could be brought to bear especially in the boost ascent phase of boost glide hypersonic missiles, where a high energy laser could destroy the vehicle early in its trajectory. At the speeds these hypersonic missiles fly, they have vulnerabilities which could be exploited by directed energy weapons. What do I mean?

As opposed to a New York Times Magazine article that was recently published, these are not unstoppable weapons, these hypersonic weapons. You can actually turn their speed against them. When they're flying in the atmosphere as fast as they're going, they're very vulnerable in two ways.

One is aerodynamically. If you can change their angle of attack instantaneously they're going to break up. An unfortunate example of that was the Challenger. It did not blow up, it broke up.

There was a rupture from the solid rocket booster which caused an instantaneous angle of attack change with the orbiter, which broke up the orbiter. That was only at supersonic speed, it was not hypersonic. The effect is dramatically more emphasized at hypersonic speeds.

What is the other one? Thermal. It's right on the thermal edge in terms of being able to cool itself and maintain that. If you could, using a laser for example, cause a point burn in the weapon, it's going to cause a thermal destruction. So, they're not invulnerable. There are ways to do this, ways that we can go after these weapons.

Again, an unfortunate example of that is the Columbia. It had a thermal breakthrough on its wing when it came back in over Texas and broke up. So, these things are not unstoppable. We can actually defend against them.

So, if the technology is maturing and the warfighters are ready, what are the barriers to fielding these weapons. The barriers to this progress are not unlike those of every disruptive technology that came before it. They are technical, political, policy and programmatic hurdles put in the path of directed energy development.

In addition to the technical challenges that I mentioned earlier, there are issues of policy and politics, including public reticence toward misunderstood technology. As with any weapons development effort, some groups oppose investment in direct energy as a matter of ideology. In fact, in 2010 when the Airborne Laser successfully shot down both a solid and liquid boosting missiles, the director of the MDA at the time was told that he could not say anything to the media and could not discuss the success of the test. Some in the government at the time apparently believed that such weapons were too provocative.

There are also those who believe that directed energy weapons threaten the continued use of kinetic ones. But directed energy weapons should not be viewed as a replacement for kinetic weapons because each has dramatically different capabilities that I believe are, in fact, complementary. The most significant barrier to directed energy development today is funding. In the days of the Airborne Laser, I like to say we were funding rich and technology poor. Today we are technology rich and funding poor.

In overcoming these barriers we can look to the cyber domain for similarities and differences in approach and application. No threat has escalated the way that cyber did. The threats to which directed energy responds are increasing, but not at the pace and scale of cyber threats.

Investment in cyber, unfortunately, has been reactionary, but we actually can be proactive in directed energy. Both technical areas have faced similar challenges in stakeholder understanding of capabilities and effects. So, what are the next steps in making directed energy weapons a reality for the U.S. military?

First and foremost, the amount of funding for these capabilities needs to be increased to at least $3 billion a year. We were on a path recently of doubling the budget. We doubled it between ‘17 and ‘18. Unfortunately there was a slight decline and now we’re back to less than a billion dollars for that. It needs to be $3 billion or more, and that’s across the entire Department of Defense.

This is a reasonable goal considering the pace of the threats and the priority that these weapons have. This would allow a much accelerated pace for both the continued increase in laser power and beam quality, as well as the reductions needed in the size, weight and power input required. In addition, the political outlook is optimistic and the support for DE weapons has been strong and bipartisan on the Hill in the past, with Congressman Lamborn, the Republican from Colorado, and Congressman Langevin, the Democrat from Rhode Island, leading expanding the DE Caucus in the House to include appropriators joining the effort.

Leading the charge in the Senate are Senators Heinrich, Democrat from New Mexico, and Inhofe, a Republican from Oklahoma, and an increasing number of senators expressing their support. So, we do have a building bipartisan support for these weapons.

Second, we must not use our conventional weapons acquisition processes or we will not be successful. I can tell you that with a lot of emotion. We must use the same approach that we do to satisfy urgent operational needs or highly classified programs. What do I mean?

First of all, the consolidation of requirements, budget and acquisition authorities at the lowest possible level. Think about it. In the Department of Defense, where do the requirements authorities and the acquisition authorities to go to milestone to milestone, and the budget authorities all come together? For the majority of programs that comes together at the deputy secretary of Defense. That's the first place that it comes together.

What causes a lot of the turmoil in the acquisition processes is the infighting between those three processes. If you have all of that in one place, or at least one level, like I had it as the director of the Missile Defense Agency -- I had requirements waiving authority in conjunction with STRATCOM, I had acquisition and budget authority all wrapped up into one position. We have to have empowered program management and streamlined oversight.

If there's a mistake made -- for example, I'll take the NRO, the Future Imagery Architecture, the FIA, that was such a disappointment for them. When that happened, what happened to NRO decision-making? The Pentagon pulled that into itself. It escalated the decision-making up at the OSD and the DNI level.

What did that do to the NRO? It constipated every single decision-making process they had in the organization. Decisions that should be taking weeks were taking months. The reason I know that is because I led a review team for Admiral Denny Blair, the DNI at the time, to find out how should we re-charter the NRO, and re-empowering NRO management was one of our major recommendations.

Using rapid acquisition processes and early technical risk reduction through advanced prototyping is very important. I know there are a lot of contractors in the room, and I'm not being pejorative, but you guys are great, you're wonderful, you're the ones that actually make this stuff happen, but you're as optimistic as you can be. And you should be, because that's the nature of your business.

But the government has to be very clear eyed about this and we need to understand what the technical risks are going into these programs. Too often we will hand out a big contract and we have big technical problems that we have to overcome while we're paying a standing army of engineers waiting on us to overcome those technical challenges. So, early up front reductions in technical risks are really, really critical.

Finally, we must get these weapons into the hands of the war fighter as soon as they have some measure of military utility for us to learn and improve over time. I guarantee you, I guarantee you, that the uses of these weapons in the hands of the war fighter will not turn out the way that we initially predicted. An example is the LAWS laser we put on the USS Ponce.

We thought it was going to be used about eight hours a day. Booz Allen was one of the integrating contractors for that. We thought it would be used about eight hours a day and put back into its doghouse.

It almost never came back in the doghouse. They used it 24/7 around the clock. What for, primarily? ISR. It was the best sensor they had on the entire ship.

So where we are today in the directed energy community reminds me quite a bit of where this nation was in missile defense in 2001 when I was first assigned to MDA. At that time missile defense capabilities had been in a research and development mode for decades with little shot of moving into the operational arena. That all changed when the U.S. withdrew from the 1972 ABM Treaty. The flight intercept tests showed real military utility and the political leadership, both in the White House and Congress, became energized.

Think of where we would be today without that occurring. I see the same thing happening in directed energy right now. We've been in an R&D environment for decades as well, but the technology is now finally catching up with the promise. It is time to get on with it.

We are standing at the starting line of a race to incorporate directed energy in wide-spread military employment. As with any novel capability, once these operational prototypes are available war fighters will find new and expansive ways to use them, as I said. We can expect a dramatic increase over the next five to 10 years as the technology readiness levels meet battlefield necessity.

Directed energy is an inevitability. The question is not if it will be, it's if it will be for us or for our adversaries. Since World War II America has enjoyed a game-changing technological advantage over all of our adversaries. Many believe that it is the foundational reason the U.S. has been the sole or dominant superpower in that timeframe. We cannot afford to have that change.

Some decry that directed energy weapons development and deployment will start another quote-unquote, "arms race." I have to tell you, this is my own view, we in the United States had better understand that as a great power in today's world, we are always in an arms race whether we recognize it or not. We are fighting tomorrow's wards today in our labs, our system program offices and at our test sites.

Whether we can continue to prevail in the future will be directly determined by our present day investments and priorities. Investments in directed energy weapons will play a large role in our ability to maintain military superiority in the future.

I thank you for your attention and I look forward to your questions. Thank you very much.

(Applause).

MR. : If these weapons in space are supposed to be used against targets in space, and if that's the case, will it create a lot of fragments, space junk, that has to be tracked?

GEN. OBERING: Typically the effect the laser has on spacecraft would not create a lot of space junk that would have to be tracked, not nearly as much as we would have with kinetic interceptors that we would launch into space. The effect that lasers have typically would be burning holes in different parts to make their mission kill. If you're talking about a warhead or something like that, a boosting missile, that would cause a lot of debris. But that debris typically would be very low altitude in the boost ascent phase.

MR. : Just a clarification question. Thank you for your comments. You talked about the means to defend ourselves from anything from North Korea and Iran, and then with Russia and China there was a new one. I just wanted to make sure I understood that part. We can defend ourselves against their capabilities, but perhaps not their capacity?

GEN. OBERING: Right, so what did I mean? Let me give you a couple of examples. Right now they're developing hypersonic weapons. They've been very vocal about that. We have to be able to defend ourselves against those. We can't just say we're going to rely on our strategic deterrent.

Let me ask you a question. You are the president, right? You're the president. China takes out a U.S. carrier. Are you going to respond nuclear to that? Is that the only option you have?

Or, if they can take out all of our forces and capabilities on Guam conventionally with a hypersonic weapon, are you going to respond nuclear-ly? So, you've got to give the leaders more decision options and more trade space. If we could defend ourselves from those missiles to begin with, you don't put the president and the leadership in that kind of a position. That's what I mean.

In terms of capacity, we have to be able to maintain our strategic and tactical deterrent. Using that example, if we can defend ourselves from enough of the hypersonic weapons that we make sure that we maintain an offensive response capability from Guam or from the Pacific fleet or whatever, that's what I mean by enough capacity to maintain our deterrent. And you can escalate that to strategic as well. We want to make sure that we can maintain a strategic response if we are attacked by these weapons.

MS. : (Off mice) -- Chinese areas where they might be able to outstrip the U.S. and what the U.S. needs to do to get back on track to either matching the Chinese capacity or outstrip it?

GEN. OBERING: Let me ask you a question. Who developed this technology to start with, do you know? We did. The U.S. developed hypersonic technology in the 1980s and '90s. So, it's a matter of, we just took our eye off the ball. We beat our chest. We said, we won the Cold War. We sat back. Aren't we great?

In the meantime, as I said, everybody else is in a race with us and we didn't even realize they were. So, we can in fact get back to that position of technological superiority, so to speak. It's a matter of will.

We have the talent nationally. We have the resources to do this. It's a matter of directing our resources to do it and it's a matter of will to show that we want to do that.

I know that at least in the department, in the conversations that I've had with Mike Griffin and others, this is number one on their list, not only to be able to defend against hypersonic weapons, but also to develop our own. Each service right now has efforts ongoing to develop hypersonic weapons, the Army, Navy and the Air Force. They're using some common components as part of those efforts. So I'm confident we can in fact not let the Chinese steal a march on us.

MR. : What are the power requirements for a space-based laser intercepting a warhead in midcourse as opposed to the power required for intercepting a booster in boost phase?

GEN. OBERING: Well, it would all depend on the warhead material, it would depend on the range and everything else, but you're typically talking about a megawatt of power. A megawatt of power would be able to do both missions. It's a matter of range, basically.

But for the boosting it's a little easier in terms of where you may be able to target the missile, in terms of the steel part of the propellant tanks and that type of thing. The warheads are typically harder, so it would take more power. But it is still within what I know of the lethality of what we learned in our lethality testing over these several decades.

MR. : You talked about the limited funding and how it's not getting to where we want it to support the development of the capability. It seems like we've kind of been alternating between the demonstration of capability and what I call laser scaling. In this limited environment of funding, where do you think we should be putting our priorities?

GEN. OBERING: I think that the department's focus on laser power scaling and beam quality are exactly correct. I think those are the two areas that we really have to scale up to make sure that we've got that right.  Those are all very promising, between the combined fiber laser work for example at Lincoln Lab, and the DPALS work at Livermore.  That all is looking very well.

What I would suggest is that industry themselves should be also focused on the size, weight and power requirement reductions.  I think that's where you also get a big bang for the buck.  Those are kind of complementary to each other.

MR.  : Another quick clarification on funding from the House.  Did you mean the appropriations cut to the SEA account for space-based interceptors, is that right?

GEN. OBERING:  I believe so, yeah.

MR.  :  So is the concern more about the agency's mission being funded or the technology?

GEN. OBERING:  I don't know.  Peter, do you have any insight on that?

MR. HUESSY:  Both

GEN. OBERING:  Both, okay.

MR. HUESSY:  And what it would do to MDA.

GEN. OBERING: I know that there is an effort underway to re-look at MDA and what the organization structure is.  It's good to kind of refresh that every so often on a periodic basis.  We've done it over time at MDA, and I think now is the time to re-look at that as well.

But I think that for a lot of different factors, a lot of different reasons, it's pretty simple and straightforward.  Bureaucracies cannot stand for somebody to be one of.  They can't stand that.  When I was director I was asked I can't tell you how many times, when are you going to be normal?  When are you guys going to be back in 5000?  When are you guys going to be back in the JSIS (ph) process?

My answer would be, tell me one normal program you want me to emulate.  I'd never get a response to that.  So, the bureaucracy wants to bring them back into the fold, so to speak.  That's part and parcel of it.

Over time, they've been able to do that, kind of chipping away at it.  I think now is the time to go back and re-look.  Let's go back and see how agile and lean we can make MDA again in order to get back to where we were in terms of rapid acquisition and rapid capability production.

MR.  :  Can you talk a little bit about the challenges of employing directed energy in terms of deconfliction?

GEN. OBERING: That's a very good question. The question was about deploying directed energy weapons and deconfliction, because they have ranges that are much greater than kinetic weapons. What I would say to that is, first of all, yes that has to be done. Second of all, tactical decision aids that go along with these weapons as part of the war fighter decision-making process has to be a part of that. And also, artificial intelligence, I believe, and machine learning will have a major role to play in that environment. You can actually generate a lot of information from a lot of data points and provide the knowledge to the war fighters as to what they have in terms of ability to fire, lanes of fire, and that type of thing. I think it's all within the technological achievements that are possible.

MR. : You mentioned some new developments in terms of delivery systems of some of our adversaries like Russia and China. Do you know if either of those two countries are developing similar directed energy weapons systems as well?

GEN. OBERING: That area gets classified really quickly, especially from where I sat and sit. I will tell you that they are not sitting on their hands and are not addressing directed energy research and development. They, in fact, are doing directed energy research and development.

MR. : I'm a reporter for the Voice of America Korean Service. Could you be more specific on how directed energy could prevent the (batteries ?) of North Korea? Secondly, since missile North Korea shot the missile two months ago, for many experts it's a variant of Iskandr and it's very difficult for the current defenses to defend.

You actually in 2017 commented on that. The short-range ballistic missiles will (threaten ?) the allies and homeland security. Does that judgment still sustain a this moment? And, do you believe that since South Korea has only one unit of THAAD, do you believe that we need more than one, at least two?

GEN. OBERING: You've got a lot of questions there. Let me see if I can remember all of them. The first one, we've already demonstrated an ability to shoot down rockets, mortars, and artillery pieces. That has all been part of the testing of directed energy weapons and laser weapons especially. So, that capability is there and has been demonstrated. It's a matter of scaling, it's a matter of deployment, and it's a matter of basically will to be able to do that.

Your second question about whether we can still defend even against a short-range, at the time I'm still talking about ballistic threats. I'm not talking about maneuvering threats. So, anytime you have a maneuvering threat that begins to change the equation of what we can defend against or not.

Your last one was about --

MR. : If we need more --

GEN. OBERING: Whether we need more THAAD, right? As a former director of MDA I will always be in favor of more THAADS. I'm not in isolated company, I think every CoCom would like more THAADS because it is a tremendously capable weapon that we have. For those of you who aren't familiar with it, it actually operates inside the atmosphere as well as outside the atmosphere. It's the only interceptor we have that does that. That's a big technical challenge to be able to do that because of the different environments, but it has proven itself and its track record over and over again. And let me tell you one other thing, this is a great lesson for this town. How many successes do you think we had in the first five launches of THAAD?

MR. : Zero.

GEN. OBERING: Zero, none. There were people saying bail it, cut it, we're done. We kept saying look, we can do this. We have the ability. This is hard stuff and we'll work through it.

Once we made the transition, basically went back and revamped the program, how many failures have they had? None. So, it's a matter of patience sometimes in this town that we don't exhibit very well.

Unfortunately, our adversaries do that very well. They fight through failure. They test through failure.

North Korea is a perfect example. How many failures they had on the TP-2, the Taepodong II, etcetera, and they kept going until they were able to get a success. We've got to learn some lessons from that. We've got to be a little more patient when it comes to these weapons developments.

MR. : I guess my question is, the former Iraqi defense minister actually said in the past that if there's only one single THAAD it's very difficult to cover the whole region. So, do you need --

GEN. OBERING: Yeah, that's right, that's right.

MR. : Do you see a lot in the way of particle bloom, overcoming that issue? The other one would be, recently China has been discussing, we can overcome U.S. DE chemically and with coatings and things like that. Do you see a lot of credence in that statement?

GEN. OBERING: The first question again was about --

MR. : Particle bloom, making sure that the effect actually happens.

GEN. OBERING: I'm not a technical expert in that, but I will tell you that what I have seen of what has been demonstrated, both at Lincoln and Livermore and other places, the beam quality improvements have been dramatic, and much, much, much greater than we saw in the Airborne Laser, for example. So, I'm encouraged about that.

Can you defeat directed energy weapons? Yes, you can. Is it easier to do that? No, it is not.

People have the wrong impression sometimes. You know what a flashlight looks like, a flashlight beam. You know what a laser pointer looks like. So in their mind, they think about a laser pointer when we talk about laser weapons. You can't think like that. Think like a blow torch at hundreds of miles. That's more like the energy you're depositing in some of these services. We had a very exhaustive lethality testing program as part of Airborne Laser program back in the day. We tested literally hundreds of coating and different material and that type of thing. It's not as easy as people think it is.

MR. HUESSY: I'm going to ask you a question on -- not technical -- but the paradigm of arms control and how that impacts our ability to deploy missile defenses; not just sensors, not just interceptors, but particularly space-based interceptors. For a moment, tell us what you think the strategic implications are if we don't deploy a robust sensor suite in space and interceptors.

GEN. OBERING: Okay. Let me talk about arms control in general versus missile defense, and I'll get into more specifically what you asked there. In 1972 how many countries had ballistic missiles or ballistic missile technology around the world? Does anybody have a guess? The reason that's important is that's when we signed the Anti-Ballistic Missile Treaty with, at that time, the Soviet Union. Seven, seven countries. The vast majority of them were friendly to the United States: Britain, France, etcetera.

Let's fast forward, in 2002 when we withdrew from the Anti-Ballistic Missile Treaty, which was an arms control agreement, how many countries had ballistic missiles or ballistic missile technology? More than 30. So don't tell me arms control agreements in and of themselves work. They don't. They do not. They have to be enforceable. They have to be verifiable. They have to be a part of an overall option. I'm not saying they're not things that we shouldn't pursue, but you cannot rely on those solely. You cannot do that. I think it's a fool's folly to do that.

Now, as it relates to arms control in space, there is a misconception out there that we cannot put weapons in space. Have you heard that, that it's against the 1967 Outer Space Treaty? Not true.

The 1967 Outer Space Treaty prevents what? Nuclear weapons, weapons of mass destruction in space. We're not proposing that. In fact, even a space-based kinetic interceptor would not be able to make it back through the atmosphere. It wouldn't. So, it poses no threat to the ground.

We're talking about being able to defend our assets in space, okay? And so, when arms control folks start talking like that, you've got to say time out. What is the reality?

Now, as I said, do I believe we can on arms control to prevent putting weapons in space? No. In fact, when an ICBM transits to the United States now from enemy territory, where is it going through? Space, right? So, the weaponization of space has already occurred.

And oh, by the way, the U.S. military, our allies' militaries rely heavily on space. I mean, a lot of our weapons rely on space-based capabilities. Our communications rely on space-based capabilities.

When you swipe your credit card at a gas station, guess what? Most likely that's going through a satellite back to a control center to allow you to purchase the gas. People don't realize how dependent we are.

Our financial transactions, Wall Street, is heavily dependent. International commerce and financial movements are based on space-based capabilities. So, we have to be able to protect that. Would I feel safe that I had an arms control treaty that is protecting me for that? No, no.

MS. : I'm working on the prevention of an arms race in outer space. One of the interesting things is it's really important for Russian and Chinese collaboration in terms of -- (off mic) -- trying to define that AOR a little bit better.

GEN. OBERING: I would never say that we don't try to do that. That we don't try to limit and that we don't try to work out agreements, I would never say that. But too many times they are not enforceable, they're not verifiable, and if you don't have that you don't have anything.

Before my job at the Missile Defense Agency I was the U.S. rep on four NATO boards. In my Missile Defense Agency job I must have briefed the NATO Council and the NATO-Russia Council 20 times or more. In fact, the secretary-general used to kid me that I should have an apartment in Brussels.

But one thing I learned in all of that interaction and discussions is soft power, smart power, diplomacy are wonderful tools. But if you don't have hard power as a foundation, it is nothing, it is negligible, you're kidding yourself.

And that includes our allies in terms of even paying attention to what you want or what you're trying to do. So, I am a big fan of at least trying, but I would be very, very, very reticent to just rely on that only. We've got to be able to have both. So, it's part and parcel.

MR. : How is the U.S. thinking about expanding these types of capabilities? We talk a lot about burden-sharing with NATO allies, especially, but how far does that extend to DE and hypersonic and all that sort of thing?

GEN. OBERING: Let me give you just a couple of examples. I mentioned that my company sponsors a directed energy summit every year. By the way, if you haven't been it's a really great conference. We've had it five times now. We do it again in March of next year, in 2020 at the Reagan Building here in town.

Last year we had the UK there, so they brought a full contingent. They briefed their programs on our collaboration. I just saw on the news this morning where they're announcing our directed energy developments and their deployments to their war fighters in the UK.

So again, to me it reminds me a lot of missile defense. When I first started briefing NATO it was, we don't want to talk about missile defense. We don't want to talk about the threat from Iran.

By the time I left in 2008 almost every country around the table was supportive of what we were doing in terms of missile defense. So, a lot of it is just understanding over time what the threats are, what the capabilities are. As I said, one of the barriers is just education and making sure that people understand what exactly you're talking about.

But it's not a panacea, so don't go away from the talk thinking that. There's a lot of issues with directed energy we still have to work through. There are things that -- you know, it will not solve world hunger. But it certainly should be a tool, a very viable took that we should put in our toolbox for our decision makers, especially in the emerging threats that we see today of swarms of drones, and swarms of boats, by the way.

One thing I didn't even talk about was high powered microwave weapons and what they can do to boat motors. You've seen on the news, in fact they just had an example where there are reports Iranian gunboats tried to seize a British tanker. Well guess what, if you had a high powered microwave device on that tanker, guess what you could do? Stop those boats where they are, before they ever even get within a significant range.

Think about that. That's the kind of thing -- and we've actually demonstrated that capability. We, the United States, have demonstrated that capability. We have downed multiple drones with a single HPM device, falling out of the sky. We've stopped vehicles.

Think about vehicles approaching a checkpoint and the poor guy there, or gal, with a weapon is not sure if that's a family escaping an ISIS zone or whether it's a group of terrorists going to blow them up. Just stop the vehicle and sort it out, how many high speed chases end up in tragedies? Flip a switch on the dashboard of the police car and stop the vehicle in front of you. So, there are a lot of applications to this technology we haven't even thought through yet.

MR MARK MARTIN: Mark Martin from the National War College. Could you talk a little bit more about high powered microwaves and the applications for space and aerospace defense. Obviously lasers are great but you need good weather. On the ground if you get a cloudy day you might have some issues. Can high powered microwaves against incoming missiles?

GEN. OBERING: Again, I'm not a technical expert but I'll say this. The biggest problem with high powered microwave weapons is range. You would have to have -- right now I don't see a way that you're going to have the ranges you need for HPMs from space. That's the issue.

Lasers have the range, and like you say, they're very, very effective. In fact, lasers are effective in the environment as well, in the atmosphere. They can be degraded, but a lot of that depends on the frequency of the laser and the wavelength. But, high powered microwaves just don't have the range for that. They have ranges, like I talked in other scenarios, but not from a space-based capability.

MR. HUESSY: General, thank you.

GEN. OBERING: Thank you very much, I appreciate it.

(Applause).