



China's Hypersonic Missile Advances and U.S. Defense Responses

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- Dr. Thomas Karako, *Senior Fellow and Director, Missile Defense Project, International Security Program, Center for Strategic and International Studies*
- Dr. Austin Long, *Nuclear Policy Advisor, Strategic Deterrence and Nuclear Policy Division, Joint Staff J5, Office of the Joint Chiefs of Staff*
- Roger Zakheim, *Washington Director, Ronald Reagan Presidential Foundation and Institute*
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TRANSCRIPT

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REBECCA HEINRICH: Welcome to Hudson Institute. My name is Rebecca Heinrichs. I am a senior fellow here. And today we are going to talk about Chinese hypersonic missile advances and how the United States ought to defend against them. The administration's National Security Strategy states, great power competition returns, and that - later on, it says - China seeks to displace the United States in the Indo-Pacific region, expand the reaches of its state-driven economic model and reorder the region in its favor. Indeed, China has been investing in its military and has done so carefully, investing in advanced technologies to enable its rise and to specifically gain the ability to deny U.S. access to airspace, cyberspace and maritime domains.

Today, we hope to dig in a bit and discuss a particular weapon set, and that's China's hypersonic weapons. You can't attend a hearing or an event on China's military threats or on what particular missile threats present to our missile defenses without hearing about hypersonic weapons. So we hope to kind of put that threat in context, talk about why these weapons are particularly challenging. And we have a very qualified, distinguished panel here to do that for us. And how I'm going - I'm going to introduce them very briefly now, and then I'm going to turn it over to each of them to give about five minutes - five to eight minutes - opening remarks to kind of come at the question a little bit differently. I will then prompt a discussion. And then I hope to leave some time for you all to - if you have some questions to - and if you could just then say your name and your affiliation, that would be wonderful. And then we'll get out of here right at noon.

Directly to my left, we have Roger Zakheim. He's the Washington director of the Ronald Reagan Presidential Foundation & Institute. And he was on the commission on the National Defense Strategy for the United States. Dr. Austin Long is a nuclear policy adviser - strategic deterrence and nuclear policy division - on the Joint Staff J5, office of the Joint Chiefs of Staff - and then Dr. Thomas Karako, a senior fellow with the International Security Program and the director of the Missile Defense Project at CSIS. So with that, I'm going to turn it over to you, Roger.

ROGER ZAKHEIM: Thanks, Rebecca. And thanks to Hudson Institute for hosting this event and for everybody - for your participation today. Great to be with Austin and Tom. For Tom, this is a reunion of sorts. Last time we were seen together like this, we were staffers on the House Armed Services Committee not quite a decade ago. He was trying to educate us on the importance of hypersonic weapons - not hypersonic, just to let you know - sonic. And we internalized that message - clearly. Yeah, so I'm going to give a little bit of a background from a kind of strategic standpoint and referring to some of the work we did on the National Defense Strategy Commission. And what I want to hit on - basically, kind of three or four areas. One is put this particular technology or technological challenge in context of the National Defense Strategy. Well, I think it's unique and uniquely important. Second, I want to hit on the budget piece because I think we're really at a moment where we're putting our money where our mouth is, and that is a part of the solution but not the solution, assuming that there's appropriation authorization for all of that. And then I also want to hit on the industrial base piece because as I look at this problem set, it's a great example of where we have an industrial base challenge, but it's not the industrial base challenge that much of the National Security Strategy and the National Defense Strategy is preoccupied with. So I'll just jump in here on those three points and then turn it over to the experts to my left in terms of really going into the operational ins and outs and the capabilities that we need.

From a National Defense Strategy standpoint, you know, we have been struggling for some time with the A2/AD challenge. And that challenge of Anti-Access Area Denial is no clearer - there's no clearer case, no clearer challenge than in the Indo-Pacific theater and the challenges that China is imposing upon the United States as a Pacific power. And hypersonic weapons goes right to the heart of that challenge because it is the capability that will keep us out from carrying

out our treaty obligations and other support we offer to our friends and allies, and really what make us a Pacific power. So whether it's our carriers, which are hypersonic weapon-based on our missile defenses and other capabilities today, essentially, we'll be pushed out and rendered kind of operationally useless, or our ability to shore up our allies because we have no response to the capability of hypersonic weapons is right at the heart of it. And then, of course, in terms of our ability to hold our adversaries' targets at bay, which is a key component of deterrence - this kind of one-on-one - yes, we can deter today. But in the era of hypersonic weapons, where we are right now, we may not be able to deter. So both in terms of defensive posture and then off - and then from an offensive standpoint, this is key.

And I want to also kind of hit on the technology here because so much has been made of all these new technologies. Think Third Offset and Bob Work. Think, you know, DIU and everything you need from the commercial sector. That's generally what people think about 21st century warfare - artificial intelligence, you know, machine learning, even the robotics. And so the immediate thinking is, all right, let's go outside the traditional aerospace and defense community for solutions to these problems; let's look to Silicon Valley. Hypersonic weapons, to me, is one that is key to 21st century warfare, perhaps the one that's most precise, most clear. Yet, the solution - the capability's going to come from the Pentagon and the traditional defense industrial base. You don't look outside of it. We need to make investment within it to get there.

And the last - the other piece on the technology front is that so much of these new technologies - which I buy into wholesale and the National Defense Strategy calls out as well as the commission called out as being important - so much of that we don't really know clearly how we're going to integrate those technologies into our military systems, you know, the next - the next kind of - what the next conflict will look like. It's actually quite clear in the world of hypersonic weapons, right? We actually do have the clear concept of how we might use these capabilities if we're able to realize them. Last point I'd make on the technology front is that so much of this we talk about from the standpoint of the competition, the day-to-day deterrents. Of course, hypersonic weapons is highly relevant to that. But also, this is one of those new technologies which is going to be critical in terms of the actual conflict. So on all aspects of how we think about the National Defense Strategy, where we're naming names now - we're calling out China, calling out Russia in terms of any capabilities that we currently don't have - I think in my mind, the hypersonic weapons is the one that's most clear. I'll make two other points, and I'll wrap up. Great, we've identified this priority. It's there in the words on the page. But of course, as all of you know in the room, those are just words on the page unless we have programmatic and funding behind it. I've seen some reporting that we will go from roughly a quarter billion dollars in FY19 funding to the hypersonic enterprise; we're going to go to \$2.5 billion. That will be a very strong statement. Of course we'll have to have all the budget monitors and the programmatic people and the people on my left make sure we're spending it wisely and actually realizing the capability. Everybody knows in town that money doesn't necessarily deliver you a capability. In fact, too much of it at the wrong time can have a negative impact. I'm not saying that here. I think it's a good sign, though, that we're putting money behind what seems to be a consensus, serious problem.

Last point on industrial base - this is also an interesting one. The industrial base is one, as I referenced, needs to be present here. And it's not only that China and Russia are developing this capability. In the case of China, many have said - including current officeholders - are ahead of us, but their industrial base is ahead of us. And this is not one where you have some sort of, the Chinese are exercising, you know, the central government, you know, command and control economy and driving, you know, investments in 5G, meaning something, like, outside the realm of traditional defense and military affairs. This is basically their defense industrial base. They've chosen to prioritize it. And they have, you know, these wind tunnels, which

they've - I guess public reporting suggests that they'll be able to test up to Mach 10, higher - but certainly way above what we're able to do today. We're simply knocking the door of Mach 5. Clear case, traditional industrial base need, we're going to need strong cooperation between the government and our defense industrial base to realize something that our commercial sector - you know, our Silicon Valleys - will never, ever deliver for us. Let me pause there. Hopefully I provoked some discussion.

HEINRICHS: Thank you. Austin?

AUSTIN LONG: Thanks. So let me say thanks to the Hudson Institute and Rebecca for the invitation to be here. And let me also say I'm appearing in a personal capacity. I'm not representing the views of the Joint Staff, the Department of Defense or anyone other than myself. But I do think a lot about the challenge posed by hypersonic weapons, as Tom rightly points out. It's a - hypersonic is an adjective, not a noun.

HEINRICHS: (Laughter).

LONG: And I principally think about it in terms of the sort of combined function, one of the functions of the U.S. nuclear command and control system, right? So this is integrated tactical warning and attack assessment. And hypersonic weapons of the kind we're talking about here pose both tactical warning challenges and attack assessment challenges. So at the risk of being a little too basic, just to make sure we know what we're talking about, I'll talk a little bit about what's unique about the category of weapons we're talking about. So heretofore, there have been two main sort of flight profiles for missiles of any long range. You have a ballistic trajectory, which goes up quite high and then comes back down at supersonic or hypersonic speed. So that speed characteristic is not new for that flight profile. You also have cruise missiles, which for a long range typically have a boost that gets them going, or they come off an airplane. And then they have, essentially, a jet engine. So they typically travel - if you're going to go long ranges, they travel relatively low-altitude and relatively slowly, subsonic, right? So what's unique about the category of weapons we're talking about today is they combine some features of both, right? So they typically have - we'll talk about hypersonic glide vehicles, a term you've probably heard. They have a boost that's much longer than a cruise missile, much more like a ballistic missile in terms of the initial boost. But then instead of traveling that high arc where they can be very easily seen by radars and things like that, they will then shift to a flight profile that's much lower altitude, not as low as cruise missiles typically but still much lower. And then they'll skim along at hypersonic speed, able to maneuver as they get near their target. It's that - that combination of characteristics that makes hypersonic weapons very challenging for integrated tactical warning and attack assessment.

So just to talk through how the U.S. does strategic - and I'm emphasizing strategic because that's the business I'm in, but a lot of this applies to the tactical fight, the A2/AD piece that Roger was talking about. The way we do it today is we have satellites in orbit that will detect that boost phase burn, right. So you'll know that there's a launch. And then once a ballistic missile starts to get above the radar horizon for different radars, many of which are deployed on the soil of U.S. allies, you'll detect it with radar. And that dual phenomenology is the term that's used for that, that you have an infrared source that's telling you there's an attack going on, and you have a radar source. It's really important to prevent false positives of attack - right? - because there are sometimes system errors, right? You might detect something that you think is an attack in the infrared satellite, but it's an infrared anomaly. And you might have a radar anomaly. But to have both simultaneously detect the same anomaly is extremely unlikely. What you lose with hypersonic glide vehicles is relatively early warning by that radar piece. You'll still detect the boost. And General Hyten was very clear on this in his testimony to the Senate Armed Services

Committee a few weeks ago. You'll detect the boost. But then, instead of the vehicle traveling very high and you see the radar, see with the radar, you won't see it with the radar until it's quite close to its target or at least close to one of your radars that's looking for it. So that's a real challenge for dual phenomenology. The Strat Comm commander will not be able to go to the president and say, yes, sir, we've confirmed with two independent sources that an attack is underway until the attack is almost complete, in all likelihood, with our current architecture. So that's the challenge for the warning piece. And as I say, that applies to the tactical fight as well, where you might see the boost. And you provide that warning, but then you won't see the tactical engagement until very late. The other piece is attack assessment.

So because ballistic weapons travel in a predictable trajectory once they get out of the - out of the boost phase, you can very - with some confidence, confirm where the weapon is going to land once you start getting a radar track on it. Because these weapons are maneuverable, not only will you not get a track on it until very late with radar, but because they can maneuver, you won't have very high confidence where it's going. I mean, it'll have a certain footprint. It can't be, well, sir, it'll either hit Oregon or Washington - right? - state, Washington, D.C. Washington state, though, is a different story. So that could cause real problems. An attack that's intended to strike, say, Hampton Roads down the road that, you know, is a tactical attack, you might believe could be coming for Washington, D.C., and going right up the road to the White House or to the Pentagon. So that attack assessment problem is potentially quite challenging as well. So the last thing I'll say is there are potentially ways to deal with this, both from a - from a warning and an attack assessment problem. But they're quite challenging, right? If you want to do dual phenomenology - right? - continue to have two completely independent sources that will confirm an attack is under way and you want to use radar, you'll need a lot more radars, right? They'll have - you'll have to proliferate radars, in all likelihood, or start relying on radars that are a little less reliable, like over-the-horizon radars. So I'll stop there. I'm happy to talk more to this in Q&A. But I just wanted to kind of set the table for what I see as some of the big challenges posed by these weapons.

HEINRICHS: Thanks. Tom.

THOMAS KARAKO: Well, thank you. And thank you, Rebeccah, for the invite. This is a great topic. Thank you for having a focused issue here. Since both Roger and Austin alluded to it, I'll kind of explain a little bit. My personal pet peeve is the use of the phrase - or - the word hypersonics as a noun. And both of them mentioned that. And why is that? Well, I'll just say very briefly, it's because I think it's - it's imprecise. It's misleading about what we need to do. And it's ungrammatical. It's - it's imprecise because it refers to a speed. It refers to a speed rather than what we're really talking about is the flight trajectory and some other more interesting endo-atmospheric characteristics. That's really what we're talking about. And furthermore, it's not just HGVs. It's also really fast cruise missiles. And so when you begin to break it apart into maneuvering ballistic missiles, H - hypersonic glide vehicles - oh, and really fast cruise missiles, you begin to recognize it is a variety of things. So that's kind of the imprecise part. The misleading part is that I think it tends to get - and I'm just sort of going on my reactions with the defense press corps here - the sense that we just need things that are really fast, when in fact the solution is much more complex than that. And the ungrammatical part is that until Merriam-Webster update and kind of absorb the barbarism that is hypersonics is a noun...

HEINRICHS: (Laughter).

KARAKO: ...It describes these things, not a specific thing. So let me kind of walk through the significance here. For the past 35 years, we've been talking about ballistic missile defense. We've kind of been chasing that threat in a big way. For the past 30 years, since 1989, we've

kind of put the Soviets and other folks on notice that we were thinking about things like space-based interceptors. And what you've seen as we have pursued this is an adaptation. The Cold War ended, and we kind of patted ourself on the back. And we said, aha, we've got air superiority. We're going to keep doing the ballistic missile defense, and that's good. But during the time that we were focused on the counterterrorism mission, Russia and China had begun to adapt. And they've begun to adapt especially with a spectrum of air and missile threats. They've kind of gone lower, especially to the atmosphere. This is why I talk about the spectrum of air and missile threats - not just one little bright, shiny object bouncing along with some really cool material science. And it's the spectrum of everything from UAVs to anti-ship cruise missiles to all these other things. That and the specter of their combination, complex and integrated attack, that is the defining character of what - of that A2/AD challenge, so much of which is missile-based, that Roger talked about. And the strategic significance of this is that it really strikes at the heart of America's place in the world, America's role in the world, especially in terms of power projection.

It's unfortunate, I think, that the discussion of especially hypersonic glide vehicles is so frequently kind of misunderstood as kind of just a substitute for nuclear ICBMs, when I think the primary purpose of this is to hold at risk our power projection - our carriers, our bases and everything else. And Russia and China don't have to use these things kinetically against us to change our behavior, right? They can change our behavior of a carrier group and these other things. And that might be good enough for them to win without fighting. OK, so what about the - the so what? And this is really what it comes down to. And Roger talked about the big muscle movements that are rightly being done right now to kind of play catch-up in terms of, on the first side, are offensive hypersonic glide or maneuvering ballistic, different kind of hypersonic delivery systems - all for the good. And that so far is getting a lot of budget love over the past year, some big billion-dollar contracts, for instance. The counter hypersonic glide threat, so far it's getting a little bit less attention. And let me just kind of connect this back to our chasing of the ballistic missile defense mission for the past 30 years. We've been putting a lot of money in that and justifiably so. In fact, we've developed an entire single major acquisition program, MDAP, called the BMDS. OK, so what happens when you want to begin thinking about non-ballistic threats? Are we going to create a defensive architecture that is kind of part of the BMDS? Is it going to be an entirely new thing and call it the CHGVDS, right? What is that going to look like? Because when it comes down to it, you're going to need - you're going to need an entirely new sensor layer.

The idea of wallpapering the Pacific Ocean with radars ain't going to happen. And even if we do, there's not enough islands, and they'll fly around them or over them. You're going to need probably some different, or at least adapted, airframes, interceptors to handle this. You may be able to take what's off the shelf. Sure - and surely they're looking at all the options here. But it may need tweaked, at the very least, to go faster. And thirdly, you're going to need a different command and control system. Maybe it's related to, connected to the C2BMC, which is currently used for ballistic missile defense, and maybe it's not. But suffice to say, for the reasons these gentlemen talked about, the sensors and the command and control are going to need a dramatically different solution than that which we've been using for BMDS. Austin talked about those big, predictable, Keplerian ballistic trajectories. That ain't this. In the beginning, there was air defense. And this is what we're having to go back to. So in the first instance, that means you need elevated sensors. An archipelago of ground-based radars ain't going to cut it. And so that's why Mike Griffin's been pounding the table and going after a space sensor layer.

I would, however, ask the question - and maybe we'll find out next Monday, when the budget drops - what kind of space sensor layer are you talking about? Because we've been chasing a space sensor layer for ballistic missile defense for 25 years, 30 years. Every administration has

had one on paper. Is this space sensor layer going to be just in LEO, looking down, focused only on looking for these things which, after all, are not only maneuverable and everything else, but a lot cooler and, therefore, harder to see than big, ballistic-type objects? Or are you going to be looking out and up? And so hopefully the space sensor laser focus will be looking at both of these missions because the integration of the counter-hypersonic glide defense system and the BMDS, putting all that together is going to be a ginormous challenge. That's also an adjective.

HEINRICHS: (Laughter).

KARAKO: All right, back to you.

HEINRICHS: We had ain't and ginormous after our grammar lessons.

KARAKO: (Laughter).

HEINRICHS: (Laughter). So that's very good. Thank you so much. I think that sets the scene very, very well. One of - my first question is, we will often hear that the Chinese have invested in this capability because they're - they're trying to get around our current missile defense system. So they've - they've looked to see what we can do. And they've responded in this way to what we were already doing, which is interesting because we don't - we haven't, until this recent missile defense - you talked explicitly about China in the missile defense context, explicitly trying to get in a regional context to provide some modicum of defense against what China is doing. What defenses did China see that we had that they were - that they had decided that they were going to try to get around, is my first question - specifically. So we kind of talked around it, but what specifically are they looking at to get around? And then - and then, Tom, I thought you said very, very well that we might - we might not even just have to have a new sensor. We might have to have a new interceptor as well, both of those things. Why? I mean, you talked about the particular - the challenges of hypersonics. But what is it that our current system simply, especially from the interceptors perspective, can't, can't get at? And any of the three of you can kind of try to get at - get at that question, if you're willing.

KARAKO: I'll take the first part. I mean, look, China doesn't want to just chase our threat. They want to outpace our threat. But I know some folks will go to the - to the Homeland, you know, trying to scare the GMD. I would - I would focus elsewhere. I would look at the regional stuff. I think it is high time. It is - you've heard me say this before. We have to not get into a national-versus-theater-defense food fight. We have to make theater missile defense great again and do it like we mean it because it's that spectrum. It's hypersonic glide, but it's a bunch of other things. So, you know, look. They've been looking at our evolving families of interceptors here to include the SM family, Patriot, et cetera. And because they're not just interested in one big out-of-the-blue attack - they're looking at holding at risk all these things - all that matters. So that would be the first part. And the second part of your question was about the - what do we have to do on the interceptor side?

Well, look; I think it's pretty straightforward. On the one hand, you're going to have to probably have greater reach. You may have to fly out. Mike Griffin's been pretty upfront about the fact - pretty explicit that he doesn't want to kill these things in the terminal phase, in which case they're doing these high-G maneuvers. He has said - and it makes perfect sense - you want to reach out and touch it earlier. But if you're going to reach out and touch it in its midcourse gliding phase and you don't know exactly the path it's coming from, you are going to have to have a longer reach to get out there, presumably from a defensive asset. You can't dock the Pacific Ocean with these things - shorter range. That's one. And second, you probably are still going to have to have some greater velocity, as well as the ability to both operate outside the atmosphere or a very thin atmosphere, as well as within it. So you need to make sure you have

enough atmosphere to push off of if you're using fins on your missile - things like that to be able to operate in different domains that it could be in.

ZAKHEIM: I just want to emphasize one point Tom made. I mean, I like that make theater missile defense great again. Did I just catch that correctly?

KARAKO: You got it.

ZAKHEIM: OK. Good. OK, MAGA. But I couldn't agree with that more. This is the, I think, the test where the U.S. military continues to be the pre-eminent military power, which, of course, a stated objective of the National Defense Strategy, and a Pacific power. And the absence of us demonstrating a response to the Chinese capability there and to shore up the security gaps not only that our fleet has, but also our allies, we're going to, you know - Freedom of Navigation operations are just not going to do it, right? That's important, but that show of force won't be showing much force in the advent of hypersonic weapons. That - from a strategic standpoint, that's what's at stake. And I think deploying it in the theater and having that theater capability is exactly the right message because that's what China's strategy, at least at this stage, is to dominate. I mean, yes, they're operating in Africa. They're seeking to do other things. But they want to be the dominant power in the Pacific. We are the dominant power in the Pacific today. And it's that challenge that we need to respond to. Sure, homeland - right? - the kind of national-level in this event's still important, but that - if you pull the thread of the National Defense Strategy where it names China - such strategy actually says China explicitly (ph) - this is a clear case where we need to respond from a military capability standpoint.

HEINRICH: And I like what Tom said, too. You know, this is tying both of those things together. It's not even that, you know, you'll hear some people say, well, China would never dare to attack the United States. That would mean, really, doom for both of us. But it really comes down to having the ability to hold at risk what we have in that region, gives them a coercive ability against the United States. It affects - it could have the effect of changing our behavior, what we feel comfortable doing and what risk we're willing to take on in that region, which is bad and bad enough.

ZAKHEIM: Quick - Frank Kendall - I was a participant at an event with him not too long - he had a great line on this. Someone was criticizing the National Defense Strategy - the strategy of the commission - one of us, critical that, oh, you're look - you know, you're just looking for the war, the conflict with China. You're saying it's inevitable. And Frank said that's not the case at all. It's saying that if we don't respond to these challenges, like we're discussing right now, then there will not be a conflict because they essentially would have outpaced us, put us in a position where they would've prevailed, right? And the question is, how do you - what steps can you take to ensure they don't prevail, whether it's unplugging us through new technologies or holding our targets and pushing our - you know, pushing ourselves further out where we're not present anymore, and they've won without ever firing a shot? That was Frank's point. I thought it was spot on.

LONG: I just wanted to highlight something else when we're talking about why different nations are looking at building these capabilities. You know, the United States is also not the only country that builds missile defenses. The Russians in particular have invested quite significantly in continuing to expand and create layers of missile defense. So they have an interceptor regime around Moscow that's pretty sophisticated. They have S-400 and S-500 missiles. So if you're thinking about why China might want to do these things, it's probably looking, in the first instance, to the United States, but not exclusively, and that's something the United States should keep in its mind as we're doing this. We're not simply doing tit-for-tat investments in

hypersonics. We face some of the same challenges looking at other countries' missile defenses as well.

HEINRICHS: Next question is about, you know, where we would put if we have to make hard choices about where we're going to invest first. And when I'm asked this question, I always kick it and say just, I want all of it, but I'm going to ask it now. And Dr. Griffin will often say, you know, you can't hit what you can't see. And so it's sensors. That's what I want. Of course the response to that is, OK, but if you can see it, you still got to hit it. So you have to have an interceptor capability. But is that where you would - if you're talking about the dual phenomenology, you wanted the warning piece, and you want to - you know, you've got to be able to see it, and you've got to be able to go to the president to make a quick decision. Is that where you would put it on sensor architecture radar? Is that...

LONG: So that's certainly, you know - coming at it from my perspective - where I would invest, is, you know, the sensor architecture's is the foundation of almost everything you want to do. And again, General Hyten and General O'Shaughnessy, I think, in their testimony a couple weeks ago alluded to this. If you want to be able to deter, you have to be able to detect and characterize attacks. If you want to be able to defend, you have to be able to do the same thing. So that's certainly, in the first instance, where I would put resources. But your point that, you know, that's merely the first step is exactly right.

HEINRICHS: And then, Tom, I think it would be useful to think about - you said you're going to have to make choices about orbits. So we hear it a lot - LEO, it's got to be in LEO because that's going to be the quickest way we can get something online. It's going to give us the capability quicker. But there's a trade-off to having your sensor, your Space Sensor Layer in LEO. Can you just give us just a little bit of understanding of why that is? What are we trading off if we have - if we go with the LEO option?

KARAKO: Look, if you put a - Mike Griffin's been hitting this point pretty hard. And for the most part, the emphasis has been on very low earth orbit, looking down soda straw - well, not quite soda straw but relatively narrow perspective - staring, looking for those not very hot objects, basically, to fly by. And furthermore, LEO is going to have a lot of them. We highly proliferate. And the idea there being, go in lots of different directions. It'd be very hard for an adversary to take out a small number, and therefore, to suppress the sensors, to punch a hole, which is something that's frequently said about, for instance, smaller numbers at higher orbits. And that's fair, but I think it's important to remember, what's the mission? What are the missions, plural? And so it's both glide vehicles but also ballistics and other things. And I think that it's going to be important for the folks doing the Space Sensor Layer to remember that it's not just this one thing that we're chasing at the moment - the glide vehicles, right? - it's this larger thing. And hopefully, there will be enough connectivity between the Missile Defense Agency, which is currently pushing this ball, and whatever other entity is finally tapped to build these things and deploy these things because there's going to need to be connectivity on this so that a particular mission doesn't get lost. But yeah, you could do the mission presumably from a higher orbit, but then you have a smaller number of satellites. Does that contribute to - you'd have a different sensor perhaps and perhaps contribute to the ability to be suppressed in different ways. So put up a small number faster but then not have quite as much resilience.

HEINRICHS: And then my last question - and then I'm going to turn it over to some of you all - is, can you give us a sense of how urgent this is? So - and especially the China threat in particular. Where are they on hypersonic weapons, and how fast - because it certainly seems like there is a sense of urgency coming from Pentagon officials. Can you just calibrate that for us a little bit and give us your...

ZAKHEIM: From the commission's standpoint, it was clear that, of the competitors - if you call them that - China was in the lead, and that was on the basis of nothing I saw that was classified, but it was both in terms of the programs they have, the planned test and their industrial capabilities and where their investments are to test these things because that's 101. And so as far as what I understand, is that they are - there isn't a close second in terms of industrial capability to test hypersonic weapons that can go, you know, above Mach five, up to 10. And so they're first with no real clear second.

HEINRICH: And I guess I do have one more question, unless...

ZAKHEIM: Anybody want to add or detract from that?

HEINRICH: OK, my last one, and then I'm going to turn it over here to you. I will often get fielded the question, too. OK, so if the United - we kind of are in this tit for tat. We develop defenses, they're trying to outpace those, and then we're going to come up, we're going to spend these resources and get something online to defend against these. The first question I get is, well, can they just adapt their hypersonic weapons to counter measures - that sort of thing? And I know Tom wants to answer that question. And then just respond to that. Respond to this idea that, because we're going back and forth, that maybe we should just, you know, stop with the back and forth and come up with some other diplomatic solution and end the cycle where it is.

KARAKO: Well, first of all, I think one aspect of this that hasn't gotten enough attention is that this is - this has all the markings of a cost to position strategy. Whether it's going to be most imposing costs on us or whether it's going to impose more costs on them, I think remains to be seen and remains to be seen especially in terms of whether our OODA loop is faster than their OODA loop or whether our OODA loop is faster than their Fiebing and re-engineering loop. And so a couple of things feed into that dynamic. And then on terms of the countermeasures part, you know - I like to point out and I think this has not got any attention - is the nice thing about them going lower is it strips out all those prospects of decoys and stuff that we've been dealing with from the discrimination standpoint for so long here. Well, look, you go lower, and you're going to do an air defense problem? OK, we're actually pretty good at air defense. The killing of it - back to the thing - the sensors is the right thing to focus on because the killing of it - I'm pretty confident we'll figure out how to get something there to a place and time, if we can figure out the C2 and the sensors.

ZAKHEIM: Can I get 10 seconds on that real quick? I mean, so I understand the balance of the conversation's focus on defense of hypersonic weapons, and it's important and complicated, and the tension between ballistic missile defense and hypersonic defense, you know, is one that we need smart people like you guys focusing on. But yes, the best - you know, the best defense is a good offense here, and we need that capability as well. And there's independent, you know, kind of arguments for why a hypersonic weapon that the U.S. would have - would do a lot to shift the balance and impose costs on the Chinese and others that we're not realizing today and may not realize alone with a defense capability.

KARAKO: If I could just jump in here. If we have to get in a situation where our acquisition of those capabilities means they're going to spend a really sizable part of their budget on air defenses - great.

ZAKHEIM: Exactly.

KARAKO: Because every bit that they spend on air defenses means that they have less money to spend on strike forces.

LONG: I'll just say, you asked about arms control, essentially, and, you know, arms control is a way to manage competition. It typically doesn't eliminate it, but it is a tool to manage it. The issue is, it's tough, right? I mean, we're having a variety of issues, which are in the news, with Russia on existing arms control and at least, to date, the Chinese have not been particularly interested in arms control. So while I think it certainly remains a valid tool, you have to have somebody on the other side of the table that wants to negotiate.

HEINRICH: Well said. We're going to go here, sir. Yes, sir, there's going to be one coming for you.

AUDIENCE MEMBER: Excellent briefing. We did the counterforce study years ago for General Jumper, and he once said, how do we keep from being the catcher's mitt? How do we go ahead and find - one, how do you go ahead and detect, identify, acquire and engage? It seems to me the short straw on the stick right now is, how do you go ahead and engage once it's - once you detect it. One of the excellent things out there right now is what Lt. Gen. Dave Deptula did at AFA, and he briefed that - it was a video - and what the Chinese are doing right now. Specifically, the feeling - surface-to-air missiles, they take out our J-STARS, our AWACS and our Hawkeye. What they're doing with their new fighters, to be able to engage our F-22s, is the same thing; they're looking at what we depend on and do that. My biggest concern about this hypersonics, basically, is, yeah, we can detect them. You know, we can acquire them. We can engage them. But really, if we can't, you know, destroy on their route, then it doesn't matter how good your capability was doing the other things.

HEINRICH: Thank you, sir.

AUDIENCE MEMBER: My two pet peeves are Taliban are and data - Taliban is and data is. And I went to a very famous editor, and he said, Peter, get over it.

(LAUGHTER)

AUDIENCE MEMBER: Language evolves. I want to ask about the countermeasures; what kinds of fields seem most productive. Presumably, we're not going to breach three 1960s treaties and mount anything in space, although I have a concern that China might breach such treaties. Are we looking toward - you can't do bullet on bullet anymore. I just don't see that as productive. So maybe a million BBs launched in front of the path of the thing, or do we have to really invest heavily in lasers? Is there any hope for the depleted uranium machine guns on our ships? What kind of technologies do you think might be most productive?

KARAKO: Actually, let me kind of answer that, and weave some of those two together because the first question, I think, was - it presupposes something about terminal guidance here. You know, it may well be that these things are not doing a whole lot of that. And so frankly - and this is the national defense strategy, and this is other folks - that part of the defense may just be to move around. And our ships can only move so fast, but more distributed operations and more deception and more moving things around is going to be one way to get at this. It's to form a passive defense. We need to make passive defense great again because then they can send in some screaming fast, hyper-this-that-and-the-other thing, but if they hit in the wrong place, then great. So that's one piece of it. And then on the other side, you know, look; these things got this plasma all round and all this other stuff. Maybe directed energy is part of it, maybe it's not. How well shotguns work in that kind of a domain, not so - to go back to your other thing - maybe it is, maybe it's not. But first, I think we've got to get the sensor thing right, and then we'll figure out a way to kill it. Because I guess I feel we're good at killing stuff in air defense, but first, we got to see it and figure out the command and control. That is - and fundamentally. Pardon?

AUDIENCE MEMBER (Unintelligible).

KARAKO: Yeah.

LONG: If you detect early enough.

KARAKO: Especially if you kill - yeah, if you kill it early as well.

HEINRICHS: And I would just make the point that there is no treaty there to prohibit the United States from having a defensive capability in outer space - to the first point of your question. Yes, sir?

AUDIENCE MEMBER: Thank you. No. 1, am I correct that Putin has already warned us not to place any of these in Europe? Is that correct? No. 1. No. 2, the president just today proposed a budget of \$4.7 trillion - trillion dollars - cutting social programs but increasing defense programs. Very interesting. Is this going to be that the wall or the shell is very well protected by the inside rot (ph)? But that's my own comment on this situation, which could be the case. But in that budget, do you think that hypersonic - the funding that you're talking about - is included in that budget already? Thank you.

ZAKHEIM: I can go with - start with last - not about the about the wall and the rot. But I'll just go to the request. And yeah, I mean, reporting - the budget dropped today. There was this huge bump in investment in hypersonic. Well...

LONG: In terms of Putin warning, the warning has been specifically about intermediate range systems, right? The United States has suspended compliance with the INF treaty because the Russians have violated the treaty serially for some time. So the warning was, don't introduce intermediate range systems. It was not specific to hypersonics.

KARAKO: Well, I'm not going to speculate because we don't have a detailed budget. The report is, of course, that the Missile Defense Agency will get \$9.4 billion. We don't know exactly what's in there or whether some of this stuff is going on in other places. I would just have a bit of pessimism here, a bit of caution, that, you know, we've been earnestly dedicated to space sensors on paper for six administrations. And so when the budget does come out in detail next week, we're going to need to have to look real closely, whether it actually - no kidding - got the muscle movement to deploy in the timeframe that Mike Griffin has been talking about, or did it get punted a little bit, right? Did it get punted to 2021? Is 2021 going to be the masterpiece for this issue, as opposed to '20? I'm going to be looking for that. And then again, I'll be looking, which SSL is it?

HEINRICHS: And then for comparison, too, Tom mentioned \$9.4 billion for the Missile Defense Agency last year. Last year's president budget request was 9.9. So we have had a dip in the Missile Defense Agency, but to underscore what Tom said, some of these interesting things that we're looking at could be found outside of the MDA budget and - because they have other missions as well, and they're just in different budget lines. But it remains to be seen. We just have top lines right now, which doesn't really paint a full picture for us to make an assessment on that.

ZAKHEIM: But look in OCO for it.

KARAKO: (Laughter) That's where it should be.

HEINRICHS: You're going to have to look in OCO for almost everything. And then interesting because the budget comes out about \$750 billion total, but the actual base budget is in the

\$500s, \$560, and then the rest of that is OCO. So we'll see how Congress handles this ball that was thrown to it. Here.

AUDIENCE MEMBER: So if this is a cost imposition strategy, and offense is the best defense on this, what would be a good mix of weapons to avoid the cost imposition strategy?

KARAKO: All right. Well, I'll take that first. First mix - first in the mix needs to be passive defense. The National Defense Strategy talked about, you know, dynamic force employment and talked about new operational concepts. Let's see where that actually begins to materialize, where we actually begin to move away from the Iron Mountains to lots of deception and distribution. That would be point one. Secondly, in terms of the other active defense side of it, in terms of the mix, I'm going to answer it by way of reference to the CNO. Your publication and others have been reporting on the Chief of Naval Operations Admiral Richardson and reports about his comments about the Navy getting out of the missile defense mission. And I would suggest that the reports of this mission are problematic. I do not believe that the Navy will get out of the missile defense mission anytime soon. So long as ballistic and non-ballistic missile threats exist, the Navy is going to need to be in the missile defense mission, if for no other reason than for fleet defense. And so your question about the mix - how is it - this is an answer to your question - those ships only have so many tubes on them. And so every time they load up, they've got to figure out, OK, how many Tomahawks, how many air defense missiles, and how many strike things do we take out to sea this time? And so that's going to be the question. They're going to get some CORs (ph) defense from moving around rapidly at sea as well. But that question, we faced by the Navy, in the first instance, I think, and then other folks on land, separately.

ZAKHEIM: Keeping on that one - in the National Defense Strategy, they've had this concept of blunt force, which is their operational language for the distributive force that Tom references. And I think we'll have to see over the next, you know, year or two to what extent operation of that plays out. But that was a new concept associated with the defense strategy to really get at the cost-imposing strategy. Second piece - you know, I think where missile defense needs to go over time or - is to be able to answer the question of, how is that not a cost-imposing strategy on us because of the cost? And huge missile defense advocate - but I do think we need to recognize that as a challenge and have some answers for it. The response for why we do it now is a good one, which is protect the homeland, protected the forward-deployed forces. That's worth whatever investment is required. Got it. But where I think we need to take it for, particularly, the competition - challenge to the Chinese is to address the cost aspect.

HEINRICHS: Of course that's where DE comes in.

ZAKHEIM: Yeah, absolutely. Absolutely.

HEINRICHS: That's how you really get at that question.

ZAKHEIM: Which has been cut and held up for years.

HEINRICHS: Cut and held up. And it might be expensive in the - right up front, but then it is one of the most cost-effective solutions over the long term to handle some of these other challenges.

LONG: Can I - so I would just say that the sensor problem that we've talked about for defense is, you know, as Tom was alluding to, is also on the offensive side if you have non-fixed targets, right? So when you talk passive defense, dispersal is a big piece of it. And that can be, you know, ship movement and deception, but it can also be getting off of main operating airbases, right? I mean, those tend to be not quite single points of failure but big points of failure. They're

very efficient to operate but maybe not survivable. So that's something else to think about, is just dispersal in general of high-value assets.

KARAKO: We've got to present the other guy with a really hard SCUD hunt in every possible way.

HEINRICHS: Great.

AUDIENCE MEMBER: Hi. I'm - so in Aviation Week, we've had two sort of simultaneous stories that don't really sort of belong together. One is that China has had an enormous difficulty mass producing a reliable supersonic military engine and, secondly, that they've gained a competitive advantage of some level on hypersonic propulsion. And how did that happen? Do we have any information about what enabled their ability to leap ahead of us in that way while still, at the same time, despite every motivation in the world to get away from Russian engines, still struggling with that technology?

ZAKHEIM: On the hypersonic - kind of their advances they've made, I think they've been consistent and disciplined in their investment over time. And one of the things I saw is - Rebecca, you'd appreciate this - is I was looking back. I was actually trying to see whatever happened with the much-reported problem by your publication's hypersonic weapons roadmap that Dr. Griffin - I guess was in the news about a year ago. And so I did what every good person who prepares for a Hudson panel does - Googled it. And - that's a verb, right? I can seize that verb? Is that appropriate?

HEINRICHS: (Laughter).

ZAKHEIM: And what I found was a 2008 hypersonic weapon roadmap mandated by the Defense Authorization Bill. And would you know it, that roadmap had us I think ready to go, certainly the industrial base requirements all done, by 2020. And I think we're going to field the capability by 2022. That was about, you know, kind of 10 years ago. What happened? We've had other priorities - leadership at the top, in my mind rightfully. But, you know, this is the fallout. We're focusing on other things and couldn't pull that through. So we've had roadmaps, and they've had investments.

KARAKO: You know, I mean, connected into 2008 report with what the Army was doing in 2006. Again, this - it's not just about one bright, shiny object. 2006, U.S. Army, you know, and the U.S. Joint Force, self-satisfied with air superiority, divested itself of SHORAD. And right now, the Army is scrambling to reconstitute SHORAD, and they're pulling stingers out of the barn to have something in the field quickly. And so this is why it's not just about the glide vehicle or some fancy new engine. It's about that, that complex and integrated attack of a spectrum of air missile threats.

ZAKHEIM: Check out that 2008 roadmap, though. It's pretty cool where, at the end, they tell you when they're going deliver them. It's all, like, '20, '21, '22 or something like that.

AUDIENCE MEMBER: And my question is if China export this missile to Iran or North Korea, what will happen? Thank you very much.

HEINRICHS: Excellent question. And I would just say, just generally, if we can just talk about - because, you know I think there's a danger - is we can talk about one country and one threat, which is important, and I wanted to specifically talk about China. But what about the proliferation challenge? Because we - you know, we don't have the luxury of just handling one problem, and then - and letting the rest of it go. And can - maybe Austin. I don't know if you're willing to...

LONG: I mean, if you build a global sensor network, as sort of Tom was alluding to, you know, that will at least work regardless of where the missile originates. If you're talking about having interceptors, then, yeah, that's when it becomes challenging, is how are you going to intercept a system unless you have - you know, even if they have much longer arms, they're not going to be sort of intercontinental or global in reach. So, you know, to my mind. I'm a little bit like a broken record. But I think the sensor architecture is going to be key to being able to handle that kind of proliferation.

KARAKO: Assuming it's the right kind of sensors.

LONG: Yes, yes, yes.

KARAKO: Then it can help all the different families. But only if it's got that...

LONG: Right.

KARAKO: ...Not merely diversity of orbits and lots and lots of numbers of them, but they're looking in different directions.

ZAKHEIM: I think a different tack. I mean, I think I agree with what you said. That presumes proliferation, right? And then what do we do. We got to make China a more responsible actor. I mean, I think the discussion before about arms control, we absolutely need to get after these capabilities. I think the Trump administration is spot on by calling out Russian violation of INF, and as a result, it's not useful for us to be a part of it. We need to make investments in these capabilities. And yet, at the same time, in parallel, we should be pursuing multilateral arms control treaties because I'm not worried about the U.S. complying. But wish we'd - pressure on the Chinese, public pressure, exposure in terms of what they're doing and how they're not bound by any treaty. And if they want to be a - you know, this regional powerhouse, then there's some responsibility comes with it.

And I think on the diplomatic front, whether or not you think the Chinese can ever be a responsible actor, ever comply, they need to be called out for it. And we need to lead with some arms control pursuit. I mean, Reagan did this in the '80s. I mean, that was his approach with the Soviets. You know, it was trust, but verify. He invested across the board at the same time, though - he didn't miss a diplomatic opportunity - by calling out the Soviets for not being subject to any arms control regime. And he was there in Geneva throughout the presidency. I mean, talk to George Shultz about that. You know, he always was talking because it advantaged us. It was an element of the cost-imposing strategy.

KARAKO: I think, unfortunately, China has zero incentives to get it to buckle itself into an arms control treaty that restricts it in any way, shape or form until we reset the table.

ZAKHEIM: I agree. We need to do it on the investments fronts and have the capability. That's part of the incentive. I think there's a diplomatic challenge as well. They don't want to be called out for this. They don't want this to be made public. And I think we ought to.

HEINRICHS: And I would just say that was actually an important theme in the Missile Defense Review, which is that closing the gap that is being exploited by our competitors, China and Russia, having a better defensive capability actually empowers diplomacy. It actually strengthens diplomacy. You put the squeeze on them to this - to a much greater degree than we are because you - at this point, they're going to act in their interest, and there is no incentive or interest in - from the perspective of the Chinese to enter into some kind of agreement that's going to restrain anything they're doing. Yes, sir.

AUDIENCE MEMBER: Thanks. I wanted to ask about warheads. What kind of warheads are you seeing or envisioning in this - is MIRVed or other types of multiple warheads or single warheads, nuclear warheads and non-nuclear warheads, or is it the full range?

LONG: Are you asking what do we see other countries deploying, or what's the U.S. looking - so, I mean, the - probably in the business I'm in, the one that's most advanced is the one the Russians have announced, which is the Avangard warhead for their SS-19. So this is a potentially MIRVed hypersonic glide vehicle that could be conventional or nuclear. So I think you see the gamut. It can be MIRVed. It could be single. It can be nuclear. It can be conventional. We see, you know, all of the above globally. I mean, the Russians are only constrained by New START, so those warheads count. But that's the only constraint, is total limits. The Chinese don't have any total limits.

HEINRICH: Not restrained by treaty at all. We've got time for one last question. Come over here - the sir in the front. We might have time for one more.

AUDIENCE MEMBER: Got a question regarding offense being a great defense. I think it's very worthwhile to invest in offense. However, can you say a few words about how their investments in offensive strike systems may put us in a different bind than what we would put them if we were to invest in our own offensive systems?

KARAKO: Could you elaborate on what kind of a bind you're alluding to?

AUDIENCE MEMBER: Basically, what is held at risk. So obviously the U.S. presence around the world is very different than, say, the Chinese or the Russian presence around the world. And this asymmetric balance is basically what strikes at the heart of these hypersonic strike systems.

KARAKO: This is kind of what we talked about. This is their home game. And, you know, yes, they may have global reach down the road, but, you know, shorter-range stuff is more accessible in the near term and we are having to project half a world away to put those carrier groups and bases over there. So it's a home game for them. It's an away game for us. And so we've got a small number of aim points, a smaller numbers as long as we keep consolidating stuff on top of each other. And so therefore, we are at a disadvantage in that sense and so why it's so important to disperse and move around and actively defend in other ways.

HEINRICH: And just so the takeaway there isn't, well, then maybe the United States should pull back from the region, that would be the exact wrong lesson in that. You know, we're there so that we actually have freedom of navigation there. It is in our interest to have that, which is why it's also I think an unuseful comparison to look at what the United States spends on defense compared to what all these countries spend on defense. It doesn't really tell us a whole lot. What tells - because the missions are different, and our interests are different, and so our - and so the investments are going to be different. So I think that's an important point. Anybody? Roger, do you have...

ZAKHEIM: I was just going to add, I mean, I think this goes back to what Tom was saying before about the theater hypersonic defense because that theoretically should allow us to maintain our presence within, you know, the first island chain in a way that their capability's pushing us out. I think there'll be operational concepts to be developed. We had a hypersonic weapon, which we could leverage to, you know, almost have this kind of - what others have described as a linebacker-type entry into a Taiwan scenario, which presently we won't - we don't have, or we're lacking. So I think both on the defensive side and the offensive sign, if we - side,

if we were able to realize these investments with the capability, it would be a bit of a paradigm shift in that theater, which we're in desperate need of.

LONG: And I would just say that if China has global ambitions, and I believe it does, that requires power projection of their own. If they want to be a Pacific power, the Pacific's a big ocean, right? So some of the dilemmas we face, they will increasingly start to face if they want to push out further from the home game.

ZAKHEIM: That's for sure.

HEINRICHS: Gentlemen, thank you so much for your time and your expertise. Will you join me in thanking them?

(APPLAUSE)