Virtual CRT Golden Launchers

[Riki Ellison]
Good afternoon, ladies and gentlemen, from probably the first fall day here in Alexandria, Virginia. It's a beautiful day here. I'm Riki Ellison, and I'm the founder and CEO of the Missile Defense Advocacy Alliance. We have a sole mission of advocating for the development, the evolution, and deployment of missile defenses, drone defenses to make our nation safer and the whole world safer for that. We've been involved with it 40 years, 40 plus years. MDA's been founded about 25 years ago.

It's been a great day so far. I have just come from the White House, where the Golden Dome is a primary position today, and the urgency for that and the excitement behind that and the movement for that is there. Momentum is pushing this thing forward, and it's exciting to see.

We're here today on our 85th roundtable virtual, and this one is on Golden Launchers. I want to just step back on how this fits into the overall Golden Dome position, because I think we have to stay focused on what the main element of Golden Dome is, and that is the C2. That is the ability to command and control, number one, of all the data that's going to come from all the sensors that can detect any launches anywhere coming towards the United States. To be able to give that data to the commanders, to be able to process that data and send that data out to effectors or so forth.

The second thing is that systems of systems have integrated everything together. They can't be confused as a C2. It's system integration with whatever is out there that we have, whatever we're going to develop next, is to be able to integrate, and that's what R&E does best. That's what we think we do very well at.

Then the third thing is what we're talking about, being able to do cheap, I wouldn't say cheap, I'm not going to say cheap, but capacity, a capacity of capability that we have to go mass. We're not in a position where we were doing North Korea and Iran with small numbers now. Now this is about mass on mass, and we have to be able to show that. I think one of the key cool things here, we've got one thing here, this golden launcher that I think, well, not think, believe that will be a part of that mass that we're talking about as we scale up with Golden Dome to have a capability that can be put on containers and be able to have multiple different types of effectors on that to be able to handle that.

That's the discussion we're going to have today. We have some great speakers today. As we know, the history of the container of the VLS is a Navy history. They are the ones that created the multi-mission VLS for their destroyers. I don't know, 40, 50 years ago, we'll go into that history, but they've used them effectively, obviously, both offense and defensive capabilities, and so good that, Tom, you've been part of that, of moving it on land to some critical sites in Europe and Romania and Poland and testing sites. It's a very effective way to do this on that.

I want to just introduce that the Army has also now, because it's such a great idea, not now, but years ago, have also their variant of being able to do that aspect with Navy inventory, with SM-6s and Tomahawks. To give you a good perspective, and I think we're going to get

heavy focus on it, but I like to start off with an Army perspective of how valuable this is and the sense of what the strategy is behind having something like this. We have an esteemed board member, Lieutenant General retired Jamie Jarrard, who was the Deputy Commander of INDOPACOM, where a lot of the Army capability in this measure is being put forward with our allies in that area of the world. I always like to say he's a special forces guy, and also very proud to say that he is a Georgia Bulldog to his heart. Jamie, you get to go. You're up.

[Lieutenant General (Ret.) Jamie Jarrard]
Thanks very much, Riki. And just to be accurate, I was not the Deputy at INDOPACOM. I was the Chief of Staff there, then the Deputy at Army Pacific my last couple of years. And I do feel like Riki and I were talking about 8th grade level here earlier, and I think I'm the only one on here that talks at an 8th grade level. Y'all are at the PhD level, JD and Tom.

I have a few thoughts here as we start off. Riki talked about the significance and importance of data and being able to move data seamlessly so that we can see, sense, understand, decide, and execute. And that's really any data, any service, any sensor, any shooter. And that, I think, is the focus of the Golden Dome initially. If we really get to the graduate level, we got to throw any nation at the beginning of that because we're going to need allies and partners to help us if we're going to defend as far forward as possible. Again, I'm not a defense missile guy, but if we try to do it all from the homeland, it's going to make it a little bit harder, I think. And so how do we do that?

And then I'll just make one comment on the IBCS system. The Army just had a successful, according to the Army test on IBCS. And I think that there is some good aspects of that system. It's hard for me to believe that a capability that took 15 to 20 years to develop is going to be relevant into the future with the Golden Dome. And I could easily be wrong.

There are people out there that could prove me wrong. But everything that, with all the technological advances, even in the last year or two, much less five years, we're still going to use the Army's all-in on IBCS, which took a long time to develop. And is that going to serve our purposes well as we look to have the best capability for the Golden Dome? And I think that it's hard for me to understand how that's going to happen. But that's kind of the command and control piece.

The second thing I'll mention is the capability itself. And we really do need new, innovative, creative thinking as we try to solve this problem. And we've talked about all of these in various previous virtual sessions, Riki. And I think, you know, we've talked about command and control in detail. We've talked about the capabilities we need. You know, from my perspective, the Army has really done a good job creating some new capabilities relatively quickly in the last three or four years. The typhon's one of them. And it's been deployed. And it's causing some consternation among some of our adversaries. And I think that's good. I think that's excellent. And they did some things out there with that and the hypersonic weapon this summer. And I think that is all good.

[Riki Ellison]
Can you describe to everybody what the Typhon is? I don't think the public understands that. Can you just go over that real quick?

[Lieutenant General (Ret.) Jamie Jarrard]
Yeah, it's the Army's stationary system to shoot the—I'm losing my—somebody help me. You said it earlier, the classification of the missile.

[Riki Ellison]
It's SM-6 or Tomahawks.

[Lieutenant General (Ret.) Jamie Jarrard]
Thank you. Yes, SM-6.

[Riki Ellison]
Both Navy missiles.

[Lieutenant General (Ret.) Jamie Jarrard]
Yep, absolutely. And so, again, they tested that and—or developed it, tested and fielded it very quickly. But there are some limitations with it. And I won't go into details with it, but there are some environmental sensitivities that have to be accounted for. It's a large system. And so, it takes a lot of effort to move it from point A to point B. And so, it's not necessarily mobile. Mobile from the standpoint of identify a threat, shoot, and then move—have a survivability move so it can remain effective into the future. And so, there are things that need to be improved on that system.

And then the other aspects of it is expensive. It's very expensive. We don't have a huge magazine depth. And I think everybody understands the significance of magazine depth. And so, again, kudos to the Army for getting the system into the field relatively quickly when we talk about how long it takes to build some of these things. But is that going to be suitable as we talk about the Golden Dome? And I'm not sure the Army's thinking those systems for the Golden Dome. But as we look to platforms, the—we've got to be able to scale very quickly. And that means we can't have tremendously expensive capabilities. They've got to be a lot less expensive than some of the capabilities, especially those that I just talked about.

We've got to have an open architecture. Whatever we field cannot be the solution for the next 15 or 20 years. We've got to be able to innovate at the speed of war, at the speed of lessons learned across the world, wherever there are conflicts. We've got to be able to factor those into our systems and upgrade them so that they remain relevant and can provide a solid defense. I think mobility is key to that. And these containerized systems would allow us the ability to move them relatively quickly. The other beautiful thing about containerized systems is that, you know, there are—I don't know how many containers there are around the world. There's a lot of them. And nobody—there will be an element of secrecy as we move those things around wherever we place them. And it's probably a lot less impactful to communities around the United States to have some containers that move in and set up at locations to be coordinated with all of the community-level leadership, the state leadership, as well as we try to position some of those forward.

The same goes for our allies and partners. You know, they would, I think, much readily have systems that are not necessarily overt military footprints, large military footprints in some of those locations. And so, I think there's a whole host of advantages for having a system like the containerized systems that we're talking about.

But the last thing I want to talk about is manning. And, you know, from—this is a significant issue for the Army. Who's going to man these things when they're on the land? The Navy and Air Force would say, hey, it's on land the Army needs to man them. I would just advocate for a very detailed discussions to take place as quickly as possible because we can't just take soldiers and say, hey, you're going to—you're doing this today. You're going to do this tomorrow. And so, if we use the National Guard and everybody thinks that the National Guard is a good solution to this, that's fine. Is it all going to be Army National Guard or is there going to be some Air Force National Guard involved? And I think it could easily be both. But we need to know that as soon as possible. So, both of those organizations, whichever organizations, whichever service is responsible can start preparing for it because there are all kinds of training implications to man new systems.

I think that there's a good model. I think the Army used a good model with the multi-domain task forces that they created a few years ago and are continuing to field where they created the unit, the organization, before we ever had a capability. And it was completely opposite of how we've done things in our past. But it ended up being a pretty good model because we were able to fill the organization, build a cohesive team, and they went through training at the same time the capability was being fielded and developed.

And so, they kind of evolved together. And as soon as the system was tested and validated and they were even part of the final validation test, it was fielded to the unit and now we have a fully operational organization. And so, I think that model would be a good one for whichever service is responsible, whether it's the Army, Air Force, or the National Guard Bureau to man these systems.

And I'll pause there, Riki, for any questions.

[Riki Ellison]
Yeah, James. I just want to get clear that the Typhon is different. It's not a container. The container, MK-70, is the one we're talking about with the Golden Launcher.

[Lieutenant General (Ret.) Jamie Jarrard]
Yes.

[Riki Ellison]
Correct. And so, the manning for that would be very minimal, I would believe, because that system is not going to be connected directly to a radar like Patriot or THAAD. And Patriot and THAAD have maybe 100, I don't know what the manning power is for that, where this one significantly would not have that and be able to be, I believe, connected to other sensors. Any sensor that's out there would be the ultimate thing. Is that correct? Am I hitting the right spot on that?

[Lieutenant General (Ret.) Jamie Jarrard]
I think you are. There are two separate systems, but I think the sensitivities or the limitations around the Typhon, I think, need to be incorporated so that we make sure that the containerized MK-70 doesn't have any of those concerns.

As far as manning goes, I think that, you know, yes, it may be smaller than Patriot batteries. But what I do know is that the Navy did not want to touch that with a 10-foot pole. They didn't want to do it in Poland. They didn't want to do it in Guam. And so, even though the numbers were small, they still didn't want to do it. And so, even small numbers are significant, especially with the scale of numbers of these that are going to be located that we're going to field. And so, manning is still an issue, regardless of the size of the crew on each one of those.

[Riki Ellison]
So, Jamie, I'm just going to keep going with you a little bit on Guam. Weren't these MRC's launchers supposed to be on Guam for their defense of Guam as an alternate to the VLS that was there? And now we withdrew all that? Can you be somewhat specific on that?

[Lieutenant General (Ret.) Jamie Jarrard]
Yeah. So, I am not—you're smart on where we are on Guam currently. But initially, the MRC's—and I'm trying to make sure I'm accurate, but I think that the MRC's—JD can correct me to 100 percent—but were the MRC's part of that initial Army solution? Yeah, yeah. So, yes, they were, even though, again, based on some of the comments, and I don't want to speak into very deep and minute details, but based on some of those environmental sensitivities, based on magazine depth, it was not an optimal solution. But that was what the Army was talking about initially.

[Riki Ellison]
And this is the last question. Just on the big broad perspective, to have containers all over the country on railroads, on ships, on trucks, and not knowing if they're empty or full or decoy or commercial, that gives you a mass-on-mass narrative to the Chinese and Russians to see this, correct? How would you best say that?

[Lieutenant General (Ret.) Jamie Jarrard]
I absolutely think it is. I mean you prevent the enemy from being able to target your key capabilities by them not knowing where they are. And if they don't know where they are, but they know what they look like, and they look like the same thing on the back of every 18-wheeler driving down an interstate road or any shipyard that has thousands of these containerized boxes in them, then that makes it a pretty significant problem for them to try to solve.

[Riki Ellison]
All right, Jamie, thank you. I appreciate your comments and intellect on that. Now we're going to go to JD. JD is going to give us a history of; I think he was part of the history of how this converted over topic. JD has been in the Navy, I think, 32 years or something like that. Captain of the Hopper, advisor to the INDOPACOM, where a lot of this action has happened in the Pacific theater. So, it would be great to hear from you, JD, on the history, a little bit more specific on the development of the MK-70, et cetera.

[JD Gainey]
JD Yeah, yeah, thanks, Riki. Fellow panelists, it's good to see you. Thanks for this opportunity. It's hard to come behind a special operator when he starts talking about clandestine operations and employment. Just a side note, one of the reasons why the Ukrainian Spiderweb operation was so successful against those strategic bombers was

because those launchers were in containers hiding in plain sight. Okay, so yeah, that's super cool.

A few things I just want to convey to this audience. We're going to talk about what actually makes up this capability, why it is a requirement and desperately needed. And the final part is, you know, how does this open up to new opportunities and new concepts of operation and concepts of employment?

So just a quick history lesson on how we got here. It started back when Aegis was being built. The very first Aegis ships, cruisers, did not have VLS. They actually had single-armed bandits that were, where the rockets, the SM-1s, were in a magazine within the skin of the ship. And we're like, hold on a second, that just doesn't make sense to us. So, what you really get out of the MK 41 vertical launch system is, it is a magazine, and it's a launcher. The two are together. So that enabled the Navy to get up and deploy anywhere and load whatever types of missile.

Well, the way that the Navy constructed the MK 41 VLS system is it allowed for different types of weapons to be utilized within it. Right now, you have 11 different countries using this capability. You have weapons from the Air Force; you have weapons now from the Army, PAC-3 MSE. You have various types of anti-air weapons. You can even shoot a torpedo out of it, right?

So you'll start hearing terms like universal launcher, which came out of the missile defense, the Golden Dome symposium that happened a few months ago. The inspiration came behind the effectiveness of the MK 41 VLS. So let's talk about what actually is the components of, in this case, the MK 70 system. It has a container, it has power, it has connectivity, and it has a weapon. Those are the four main subsystems of this capability. When you're looking at containers, you've got the outer container. That's what General Jarrard was talking about, the 40-foot con X-box can hide in plain sight. Well, that's just to keep it out of the weather and allows it to be picked up and moved around and the mobility. But you actually have the weapon inside, It's in a different container. And that's really the heart of the cell, the launching cell, which in this case is a four-pack of vertical launch capability. So, you have the outer shell, you have the shell, the container that holds the weapon, and then you have another kind of container that holds all the auxiliaries, like communications, the power, stuff like that.

So from there, let's talk about the power. Right now, it does rely on an external power source to keep it activated and moving. With all technology, that power source and the demand for the energy keeps getting smaller and then pretty soon you're going to see that space being absorbed within the container as well. The container can go deploy on its own, but just for a limited time because you are constrained by power generation.

The third part, let's talk about connectivity. There are three types of connectivity that are involved with this system. You have connectivity from the outside, home guard to tell this container, all right, turn on, it's time to go do some fun stuff. You have connectivity within the system itself from the weapons system telling the weapon, hey, you're about to go do something really, really fun. Let's get ready, download all the threats, the information, the flight patterns, the vectors. Essentially, it's the final piece to go out and here's the threat,

here's the target. Let's get up and go do it. Then the third piece that people really don't talk about this connectivity, you still have to have communications with the missile itself. You have concepts like in-flight targeting that are introduced. The connectivity piece is essentially threefold.

The final piece is the weapon. I mentioned before, you got different types of Roman candles you can put these launchers. The adaptability of using this type of capability that the individual cells that act like magazines can go a long way. That's the over concept that makes the MK 70 successful. Just the difference between the MK 41 and the MK 70, the MK 70 has four cells within this launcher. The MK 48 is comprised of multiple eight cell modules throughout the ship. That's the first part I want to talk about.

The second one is, this isn't a technology problem. This is not an engineering problem. This is a people in a policy problem. We know how to shrink down capabilities, reduce form factors, and we can put it into something usable and mobile. As we talk about this, are there technologies that can enhance it, make it sleeker, make it faster, make it smaller? Yeah, probably, but that's not the real burden here. The burden is, how can we take something that is traditionally referred to as a Navy system, Riki, you introduced this as a Navy system, and use it in a construct that is where you focus on the output and the function, which is delivering anti-air capability or anti-ballistic missile defense capability or anti-hypersonic, in some cases, anti-submarine capability. That's the second point.

The third one is, concept of operations, concept of employment. The 2028 INDOPACOM IMD Vision, the bumper sticker was, engage on remote with remote launchers, agnostic of the sensor. When we talk about engage on remote, I'm not talking about engage on a network, which people say, hey, you have to buy into my network, and once you buy into my network, which is expensive and costly and hard to do, then we can use different types of weapons and sensors. No, we're talking about engage on remote. Remote being, it doesn't matter where the data is coming from. As long as that weapons system understands and has enough cowbell of threat recognition, classification, identification, and track custody, then it can tell that weapon to go do what it's supposed to do. So, engage on remote, and this is the MK 70, is an example of a remote launcher.

The new air defense, Army air defense doctrine of divorcing subcomponents of some of their major systems like THAAD, really Patriot, into subcomponents like the M903 launcher is a separate entity from the engagement operations center, which is separate entity from this power and all these other subcomponents. The ability to start divorcing the smaller components from the overall components starts allowing flexibility on how you design the different constructs and where you want to put launchers independently. So, do I really need a Patriot minimum engagement package that requires in between 16 to 21 C-17 lifts. No, I may just want the launcher, right? I just may want the weapons in there. So, what it does is this type of concept and allows flexibility.

And so, I'll just pause right there for any questions, Riki.

[Riki Ellison]
Okay, JD. I want to just go back to the VLS, because as we've seen it, you have a radar on the ship right next to it. You know, as you've seen in Poland, Romania, radar is right there next

to it. So, in this Golden Dome construct with a C-2 system of any sensor, how does that work now? And we're able to – you said you can't plug in the network, because you can start – I think the vision is to be able to use all sorts of sensors to support that one and or mass containers. This is a different concept.

I don't know, Tom, if you're going to answer it, but JD, help me understand where we're going with this. If it doesn't have its own organic radar, how much can you do besides Aegis baseline 10 and having – this is beyond that now. This is going to be mass with all that satellite data or ground data or air data being pumped into this.

[JD Gainey]
A couple different concepts that are being blended right there, Riki. One is, regardless of the weapon, there's a weapons system that tells it what to do and where to go and what to hit, right? That weapons system already has a preset requirement of how much information from sensors, either organic local sensors or sensors outside of that picture, to be able to tell it to go do things.

We do this all the time. The Missile Defense Agency does beyond line of sight, space-based sensor detect, and it uses remote launchers from MK-41 Farms at PMRF facility in Hawaii. It is continually proved that you can take threat information from one area of the world and be able to have enough cowbell behind that weapons system telling that weapon what to go do. That's the first part of it.

The other part is there is already a surrogate on what this dispersed defense design looks like. The initial outfitting at Aegis Ashore at PMRF, the launchers are two and a half miles away from it. In fact, whenever they ran the optical fibers from the launcher to the Aegis Ashore facility, they actually had to dumb down and slow down the fiber relay because the way that it was constructed, it was, well, we weren't ready for that technology. Well, technology has blossomed from 5G networks, the amount of latency, the amount of data that you can hold in each packet. We're in a place right now where we're not really limited on distance from a weapons system telling the weapon what to do.

In fact, we're shrinking some components of the weapons system logic into smaller desktops, laptop versions, with the Virtual Aegis weapon system as an example. That shrinkage allows it to be co-located with the launcher, and now you literally can just pick it up and move it. All you have to have is enough information coming from the sensor, and that weapons system can tell that weapon what to do.

As we shrink the technology and reduce the form factor, now you're bringing in space into the conversation, having weapons system logic in space. The detection, the identification, the processing, and assignment of a weapon, it doesn't have to be terrestrial or air-based anymore. You can start moving that stuff up into space.

[Riki Ellison]
Great explanation, JD. Two things. What's your version of what the manpower is for a container? How many spots? And the second thing, can you give us a pretty good logical explanation of what happened in Guam with the VLS versus the MRC and where we ended up? Because that seems to be relevant a little bit to this discussion.

[JD Gainey]
Yeah, they're directly tied. What was not accounted for with the MRCs, with their initial inclusion, the design, was the infrastructure support for it. From the security system, the security personnel that are supposed to be to support the outer perimeter type security, the motor pool, they needed a large vehicle, a separate large vehicle motor pool because you had to have the larger trucks that was associated with the M903 launchers to be on island. So, the infrastructure to support the MRCs was unattainable. And it added more soldiers, which increased the top line even more.

So at the end of the day, it all came down to how many cells are available to knock down the I'm sure you're going to go into raids---

[Riki Ellison]
What's the difference between that and the MK70, if they can have the same problems that that the MRC has or not, I'm going back to manpower on that. So there is clear difference between MRC and MK70.

[JD Gainey]
As is, it requires about the same infrastructure. The 2B is, it really comes down to the power supply and the power generation. Once you do that, you can have a truly self-contained entity that you just put up, load up, and it just keeps checking every once in a while, is this go time or not? And so, yeah, so we're the folks of effort to make this more feasible and viable in a large area defense construct like the United States. You really have to go after a power source and power generation. Once you figure that out, you can lock it down and it's a self-contained locking mechanism. So it'll be pretty secure.

[Riki Ellison]
Okay, J.D. Thank you. We're going to move on. Mark Montgomery is in Ukraine right now flying back. So we may not have him. We may have him, but I just wanted to let everybody know that. I'm very honored to have Tom Druggan with us, a retired Bureau Admiral, head of Aegis for MDA, and was, I believe, the creator of Aegis Ashore on PRMF and the movement you have been doing with Romania. You know this system better than anybody on what it's capable of doing. So, we'd love to hear from your perspective, the pros and cons and moving, and if this is really doable for the Golden Dome and mass capability.

[Rear Admiral (Ret.) Tom Druggan]
Well, first, thanks, Riki, for having me. Point of clarity, Aegis Ashore was already architected and being built. I got to do cleanup on Aegis Ashore Poland. Important capability, though, those two sites defend all of Europe from ballistic missile attacks out of the Middle East. So a great investment under NATO command today. But there's an O5 commander at each of those stations with weapons release authority.

[Riki Ellison]
But Tom, so you're saying that you, we have SM block 2A on there, 2B, and be able to defend half the country or post one of those containers?

[Rear Admiral (Ret.) Tom Druggan]
Not a container. I'm talking about the Aegis Ashore sites there. So now we'll get to the container. Let's do some context here, right? We're kind of in phase zero of Golden Dome.

That's the planning phase. General Guetlein is the Director of Reporting, PM, is doing that. He'll get blessings and move forward. In my mind, I picture there's at least three phases, and they'll all kind of start at the same time.

The first phase is do what we can immediately, right? And that really speaks to one of the things out of the executive order that was a demand signal, not for development and deployment. It just said deployment, deployment of an underlayer, and terminal phase intercept capability. So with no development, that means use what we have now and get it out there to defend the United States of America and our critical infrastructure and our citizens, right?

So that means use the systems we have now. And there's only a few really to choose from, right? There's the Aegis BMD capability. And then there's really THAAD, are the two pieces. You can also buy more ground-based interceptors, which is under development as the next generation.

[Riki Ellison]
And Patriot, would you include Patriot?

[Rear Admiral (Ret.) Tom Druggan]
Patriot depends. So as you look at it, so Patriot can defend kind of a city, right. THAAD can defend a metro area, maybe the DC area, maybe the DC Baltimore area, right. And then Aegis, and that's because it intercepts higher. And Aegis can defend, a site can defend everything east of the Mississippi, except for the tippy top of Maine and Key West Florida, right?

So why is that? That's because we're intercepting that range in space. That's why you get such a large defended area. You need three to five to the lower 48. And maybe you want some additional overlaps or maybe a couple other sites. So those would be the traditional approach of Aegis Ashore sites and everything.

So that would kind of be phase one, right? Is to get something out there.

[Riki Ellison]
Do you include ships off on phase one?

[Rear Admiral (Ret.) Tom Druggan]
So the way to deal with ships, obviously the Navy is not in favor of having ships on BMD deployment in a homeland role, right. I think where the Navy can play a role and probably should play a role is like we did on 911. We are always being prepared to defend the homeland as necessary when called upon. And even as Abraham Lincoln said, you know, thanks to the Navy, they went wherever the soil was a little pale, right? So that can be in our job jar. The way we do it today is there's a mission called Noble Eagle where certain ships on each coast are assigned as ready ships, ready to go in case there's kind of a 911 event. There's aircraft in the air mission to go do and Navy ships are needed to fill in the gaps. The flip side of that is you could expand that mission to include Aegis BMD and those would be BMD ships ready. They're in the training cycle, but they're ready to go if called upon.

Permanent persistent rotations off the coast of the United States is not what the nation needs the Navy to do. We need to play the away games. We need to take it overseas and forward presence is really important. And we prep the battle space, understanding the pattern of life overseas, as well as reassuring friends and allies by being around. You know, virtual presence is actual absence, right? We need to be there to engage. And the way to do that is ships because it's sovereign territory and we can come and go as necessary. We've done that since the founding of the nation, right?

So, phase one is get stuff out there as quick as you can. And that's where a MK 70 might come into play, right? Because it takes, and so phase two would be permanent installations of things. Phase one is do what we can now, either with the assets we have or things that we can build pretty quick. Building a VLS, transporting it, doing all the environmental stuff, doing all the explosive standoff distances and things like that takes time.

[Riki Ellison]
That's Aegis ashore?

[Rear Admiral (Ret.) Tom Druggan]
That would be Aegis ashore. So you could do this quicker and get it out there. And so that could be phase one and phase two could come along with more permanent installations where you want them. Phase three is all the space stuff, which is going to take a while, A, to get on orbit and B, the space-based interceptor or interceptors is going to take time.

And just a little piece on that. Can one interceptor intercept both ballistic missiles in the boost phase and in mid-course and a hypersonic missile in boost phase and in mid-course? Or do we need a couple of interceptors up there, different types? We don't know that yet. Lots of trade studies to be done on that. And I think all that's kind of buried in phase three and there'll be a lot of innovation.

I think a pretty open approach to let's try what we have. We know what we have, but let's try some new things.

[Riki Ellison]
And phase one is where we're at.

[Rear Admiral (Ret.) Tom Druggan]
But phase one, MK 70, could play a role, right? Because it could be done pretty quick. It's a launcher. Here's my concern, top down. Who's watching the end-to-end performance? Because this missile, when launched, needs guidance. Where's it coming from? And where is it telling the missile to go? Remember, these missiles are not, when they come out of the launcher, they don't know where the threat is. They can't see the threat. They have this little tiny battery that's powering it throughout its flight for a few minutes, right? They don't have the computational power or the sensor, right?

That's why the Aegis weapons system was architected as a single system. Same for THAAD, same for Patriot, and then they got broken apart. Okay to break them apart as long as someone's accountable for the end-to-end performance.

[Riki Ellison]

How would you do this?

[Rear Admiral (Ret.) Tom Druggan]
Well, that's the great question here. So if we're using our missiles that we have today, like the SM-3 Block 1B or 2A, right? And we put one of those in there, or four of them, I guess, and we have that capability, when it launches, who's giving it commands?

And so you need two, three different things. You need sensor data, all right? And while there's lots of data out there, it has to be good data. It has to be actionable data, which means it has to have high fidelity on the position, the kinematics, as well as time. And this is, time's going to work against us in this kind of architecture with the MK 70.

So typically in Aegis, what happens is, because it's a ballistic missile and in space, once you have velocity burnout, you know the trajectory and you can predict it. That's why we can kind of shoot blind, right. That's the engage on remote where we're doing over the horizon, right. Or we can shoot and then the missile comes into our field of view of our own radar, at which point we see, we don't see a single warhead, right. You see all kinds of stuff, dozens of tracks. You got tank, you got warhead, you might have multiple warheads, you got chaff, you got chuff, you got decoys. So, whenever we talk about BMD targets, people think, oh, you're going to get a radar hit on a single warhead. No, it's a whole complex of stuff that's up there. And you have to track it all. And then what you have to do is discriminate. You have to find the needle in the haystack, ID the re-entry vehicle, and then that becomes the target, right? And then it's all closed-loop fire control. Spy radars tracking the re-entry vehicle that we've identified. We can launch our missile, we can guide our missile to an intercept point. And then at one point, the missile takes over to get the final hit to kill. Why? Because these are so at such a range that that's what you need if you're going to do it.

You got to have something that's going to do the weapon computations, which gives you a predicted intercept point. Now, against hypersonics, we can't shoot blind. We always have to have track custody. It's particularly when it comes into the field of view.

So you got the MK 70 here. Where are you going to put them? Well, note number one is it matters. If it's mobile, it's not operational. We're not having a truck driving down the road.

[Riki Ellison]
It’s not a James Bond movie.

[Rear Admiral (Ret.) Tom Druggan]
No, so that's out. Two, this has a booster. These missiles have boosters. Well, the booster's job is to get the missile out of the launcher. That's it. And then it falls off. So where does it fall? Riki, where does it fall? So where the launcher is matters. There's an explosive standoff distance just based on the rocket fuel alone. If they had warheads, it would be bigger. And then there's a booster drop zone, which is even bigger. And oh, by the way, and somebody's going to have to look at it and make a risk-based decision. There's a second stage that falls off and returns to the earth.

Naval warfare, not an issue. Big ocean.

[Riki Ellison]
On the coast, not an issue.

[Rear Admiral (Ret.) Tom Druggan]
It depends on which direction you're shooting, but typically we'd be shooting away from the United States. There's some polar trajectories that are problematic, but that booster is going to land somewhere on our homeland. So, there's some work to be done there or some risk decisions to be made.

So that impacts where you put these. And then the question is, who's doing the fire? Where in that system of system is the fire control computations being made that gives you a predicted intercept point? And how is that getting to the missile?

[Riki Ellison]
Is that the OV-1 architecture that they're supposed to come out first with?

[Rear Admiral (Ret.) Tom Druggan]
Well, and that's a great question. Is anybody actually doing that, right? And so we love space-based stuff because they have a great field of view.

But when you do the time from a space-based sensor tracking a target, it's got to be a very good fidelity, high quality, and very time, great time. We have the radar energy. It could be EOIR, which we need to explore, which is multiple sensors, right? But we'll stick with radar for now. The radar hits the missile, goes back to the satellite. That's time. There's time to process that. That's more time. There's time to send it somewhere, that data. Is it going to a ground station? Is it going directly to the missile? If it’s going directly to the missile then we're going to do bench compute for weapons control. It's a bigger satellite with a lot more compute. And now you're going to have to replicate that by hundreds because every satellite is going to have to have that capability. So the system-to-system view, I would say it's one system, but people will say system-to-system view: somebody needs to be accountable for that end-to-end performance.

[Riki Ellison]
That's just one shot. It's just one shot.

[Rear Admiral (Ret.) Tom Druggan]
Just one shot. And we have to remember how fast is fast. You know, a ballistic missile is moving at orbital speed: 17,000 miles per hour plus. Only takes 45 minutes to get from one point on the world all the way around to the opposite.

[Riki Ellison]
What's your solution to that?

[Rear Admiral (Ret.) Tom Druggan]
That's 50 miles a second.

[Riki Ellison]
What's your solution to the C2?

[Rear Admiral (Ret.) Tom Druggan]

I think that you're going to have to have active radar associated with the – one can support many, right? One radar can support many. But if you don't have active radar, then I don't know how you close the fire control loop.

Now, there might be a possibility – and we're talking things that have gotten through the boost phase. We didn't get them in boost phase. We didn't get them in midcourse. And now they're coming at the homeland, right? So, this is underlayer and terminal phase.

[Riki Ellison]
Well, with an SM-3 Block II, you can cover a lot of the United States, right?

[Rear Admiral (Ret.) Tom Druggan]
That's like I said, east of the Mississippi.

[Riki Ellison]
Let me ask you–

[Rear Admiral (Ret.) Tom Druggan]
But this is four, right? What's the advantage of having a bunch of these spread out versus four, five, six, seven sites on federal land with in-ground VLS, 122 cells, like a cruiser? We literally have that software today. We could do that. And then we get to the training point, your training point. I will tell you, I'm not worried about –

[Riki Ellison]
Isn't that what you did in Guam? That's that argument you made, and you lost the argument because it went to the *[indecipherable*] , right?

[Rear Admiral (Ret.) Tom Druggan]
Yes. But then what happened?

[Riki Ellison]
Nothing happened.

[Rear Admiral (Ret.) Tom Druggan]
Yeah. The VLS came back, right?

[Riki Ellison]
Yeah.

[Rear Admiral (Ret.) Tom Druggan]
So, maybe I didn't lose the argument. Okay. Right?

[Riki Ellison]
Okay. Yeah.

[Rear Admiral (Ret.) Tom Druggan]
So, let's talk about training. All right, listen. The United States Navy trains our sailors.

We also train Spanish, Norwegian. We're going to train Canadian and Australian in the future. We train Japanese and South Korean sailors to operate, maintain, and operate the Aegis weapon systems, despite an incredible language barrier.

If we can do that with the Japanese, if the Navy can do that with the Japanese and South Koreans, we can train any American to do it. They just need to be designated. I think this is absolutely the right time to have a Space National Guard or Space Reserve stood up, and these would be absolute fantastic assignments.

[Riki Ellison]
The Army National Guard could do this.

[Rear Admiral (Ret.) Tom Druggan]
Or the Army National Guard can do it, right? Yeah. Sure.

It's just so much of the command and control and the–

[Riki Ellison]
Tom, is this doable? This whole thing is doable, having this MK-70 launcher on?

[Rear Admiral (Ret.) Tom Druggan]
If you have the other – my point is, you have to have the other pieces.

[Riki Ellison]
And that's part of it.

[Rear Admiral (Ret.) Tom Druggan]
You have to have the other pieces.

[Riki Ellison]
This phase one can happen.

[Rear Admiral (Ret.) Tom Druggan]
And you have to look at – you have to look at booster drop zone. You have to look at second stage drop zone, right?

[Riki Ellison]
If somebody's attacking you, I think those risks go out the window.

[Rear Admiral (Ret.) Tom Druggan]
I would say that the second stage does. You can absolutely plan for the booster drop zone. There's no reason not to.

Yeah. There's no reason not to do that.

[Riki Ellison]
Let me go to the next–

[Rear Admiral (Ret.) Tom Druggan]
And then you can move MK-70s in the near term, which buys you time to do a larger VLS.

Or if you want to have a bunch of MK-70s, that's an architectural decision. I'm not personally invested in that.

[Riki Ellison]
One of the critiques of this is it's got very expensive weapons in there.

[Rear Admiral (Ret.) Tom Druggan]
Yes.

[Riki Ellison]
Is there a way we can get the cheaper weapons for cruise missile defense or other things in that system?

[Rear Admiral (Ret.) Tom Druggan]
So, let's break that up a little bit. Let's talk about command and control real quick. I'm hoping that they're looking – you know, everybody's assumption is Jet C2, maybe, or something like that for Golden Dome, right?

If you want it today, you want it quick. My personal recommendation: C2 BMC for ballistic missile and hypersonic defense. But keep cruise missile separate. Use the Air Force ABMS. Use that system. It's already got all the information in it from commercial – and now we add this one piece. If we take all the information that's in ABMS and inject it into the C2 BMC, we actually – that would actually be a multi-year development.

[Riki Ellison]
Would this be used as a cruise missile?

[Rear Admiral (Ret.) Tom Druggan]
Keep those two separate.

[Riki Ellison]
Would you use that – Cruise missile defense only thing?

[Rear Admiral (Ret.) Tom Druggan]
Yeah, so, your cruise missile defense, how are you going to solve that? So, first is surveillance. You're going to have to have space surveillance, but it's hard.

[Riki Ellison]
It's hard.

[Rear Admiral (Ret.) Tom Druggan]
Hard for cruise missiles to find them from space because they're not – they don't have – they're not high heat. They're below the layer.

Did you know that 60 to 70 percent of the Earth's surface is covered by clouds every day?

[Riki Ellison]
I didn't know that.

[Rear Admiral (Ret.) Tom Druggan]

Yeah. It's that persistent and that pervasive. 60 to 70 percent of the Earth's surface every day.

So, cruise missiles are hard from space, which then gets you to our radars. Well, we can't line the coast with radars, right? But we can have a few over-the-horizon radar sites where we're using HF energy and bounce it off the atmosphere.

And it's not fire control quality, but it'll tell you there's a raid coming, right? At which point you have other options. So, we can solve the cruise missile surveillance pretty quick if we use over-the-horizon radars.

Mark Montgomery's favorite high-altitude dirigibles, right? Absolutely. The look-down capability there.

And work on some space. And then the question is, well, what's your lethal effector? So, if it's cruise missiles, it's lots of these, right?

And can you defend everything? No, you can't. We should recognize that.

That's why we have to look at the critical infrastructure that we need to defend, right? And you want to have aviation pouncers, right? The Air National Guard and the Air Force needs to have a cruise missile defense responsibility.

We know that they have capability out of the Red Sea. Air Force and the Navy were shooting down.

[Riki Ellison]
But we have not used this type of launcher for cruise missile defense yet.

[Rear Admiral (Ret.) Tom Druggan]
No, not yet.

[Riki Ellison]
Even the VLSs that we've got.

[Rear Admiral (Ret.) Tom Druggan]
You know why?

[Riki Ellison]
Let's use them on the ship.

[Rear Admiral (Ret.) Tom Druggan]
You know why? If you want to shoot down a cruise missile, you're using an interceptor. It needs guidance.

And you have to have a radar. That's why this container approach is great for offense. This container does nothing, and the missiles in it do nothing on defense without the rest of the system.

You've got to have guidance. Why? Because the threat missile can maneuver.

Cruise missiles maneuver all the time. Hypersonic missiles will maneuver occasionally. Ballistic missiles, once they have velocity burnout, don't maneuver, which is why we can shoot them down pretty well.

But once they hit the atmosphere, they can do a range extension. So those are all real problems on defense. As you know, defense is hard, right?

Really hard. A lot harder than offense. And as a result, you got to have guidance.

And the guidance comes from an active sensor.

[Riki Ellison]
I want to open this up to J.D. and Jamie to ask Tom on this conversation. J.D., you got anything to add to this?

[JD Gainey]
It's not really a question, but just to reinforce one of his points. The reason why the MK 70 is as expensive as is, is because the weapon inside is exquisite, right? It has a lot of internal compute to do the final target tracking and homing in.

And that's because there has to be a compensation on the front end of the kill chain, the detect sense piece of it. So you can make those weapons, those specific missiles cheaper if you start focusing on the exquisite battle management and enhancing that weapon system piece of it on the front end. It's not going to be a one for one trade.

But for example, the SM-6 or the MSC PAC-3, you tell the PAC-3 the zip code and they'll find a seat in the stadium, right? It's very accurate when it knows where the threat is. There's some other weapons like the SM-2, it takes very specific guidance of somebody showing them where that seat is to be able to get there.

So there's opportunity to reduce the cost of this if we start shifting from exquisite weapon requirements and shifting more toward exquisite battle management output. I just wanted to put that comment out there.

[Riki Ellison]
Just on that, do you think that is, it's not phase one, I don't think it's a development.

[Rear Admiral (Ret.) Tom Druggan]
The real key in what J.D. is saying is it's about the time. Time for that exquisite C-2 to get that data to the interceptor, right? How much time?

And you can’t be late. And if you're late, you miss. Done, right?

So that's why somebody needs to be responsible for the end-to-end account, not just responsible, accountable for the end-to-end performance. Because we're missing a piece here in this conversation, which is getting data, getting acceleration commands to the interceptor so it knows where to go. It doesn't know what the point in space is, it just knows go right, go left, go up, go down.

[Riki Ellison]

And ruise missilecs are going to have more latency, correct? You can get away with some time.

[Rear Admiral (Ret.) Tom Druggan]
You can, that's right. They're not moving at orbital speeds or anything like that. JD?

[JD Gainey]
Yeah, just a comment about the cruise missiles. The cruise missiles are going to be launched from a platform. You don't have cruise missiles that can span thousands and thousands of miles without an opportunity to hit it in between.

[Rear Admiral (Ret.) Tom Druggan]
Totally agree.

[JD Gainey]
So unless we see the continental shelf and our submarines, our NORAD air defense measures in a reaction, unless that all goes away, we're going to have multiple opportunities to shoot down the archer or the platform carrying these cruise missiles. So it's hard to-

[Rear Admiral (Ret.) Tom Druggan]
If we know, right? If we know that they're there.

[JD Gainey]
So if it becomes clandestine and they're shooting raids at us from a direction that we're not looking or anticipating, like Operation Spiderweb from the Ukrainians, yeah, it's just going to be a hard problem set.

[Rear Admiral (Ret.) Tom Druggan]
But we don't have 360-degree surveillance against cruise missiles around the United States. That does not exist today.

[Riki Ellison]
So for the Golden Dome, you know, thinking about 13, 14 Patriot batteries to do that, would this be a cheaper way to do that? But we don't have a cruise missile defense interceptor in there yet as an alternative, or is that phase two?

[Rear Admiral (Ret.) Tom Druggan]
I mean, Patriot's truck-mounted. I mean, why would this be cheaper than that? Why would this be a better solution?

[Riki Ellison]
It’s not.

[Rear Admiral (Ret.) Tom Druggan]
Same with that, right? Same with that.

[Riki Ellison]
Hey, Jamie, you got anything?

[JD Gainey]
Hey, Riki. Yeah, go ahead, sorry.

[Lieutenant General (Ret.) Jamie Jarrard]
Tom, just one question, just so I'm straight. I mean, when we talk about that, and I agree, I think you make a great point with the end-to-end responsibility of who's making sure we're looking at it and tying it all together.

But when you talk about a radar for each one of those VLS systems, are we not, when we're talking about the Golden Dome system, aren't we talking about an array of sensors that sees and makes sense of the environment? And so it understands when threats are coming from, and then that data is going to move throughout the system seamlessly so it could get to that, the launcher that it needs to.

[Rear Admiral (Ret.) Tom Druggan]
That is the narrative, right? I may trust but verify. I don't think the systems engineering has been done to verify that the data can be received as necessary in a timely manner.

I could be wrong. I could absolutely be wrong. But we don't even know what systems are going to be on orbit.

We don't even know what sensors are going to be up there yet for the tracking layer, right? We don't know the quality of that tracking. And so that—we're not in the cruise vessel, we're in the BMD and the hypersonic domain.

So until we actually get real specifics on the capability, then we can't even double check. Now, what we do know is that the hypersonic and ballistic tracking surveillance system, HBTSS, which was a prototype effort under the Missile Defense Agency, right? It had two satellites on orbit.

They learned a lot. It was put up there as prototypes to really validate that we could track hypersonic targets with fire control quality data, right? Just make sure we can track the threat with fire control quality data from space, right?

And then there's a handoff of those requirements, very important. So the good news is we know what the requirements were. We now have real life data from tracking of the HBTSS prototypes to compare against those requirements.

They'll do some tweaking, I'm sure. That goes over to the Space Development Agency, where they can now do the whole tracking constellation, right? So remember, there's actually, it's not the tracking, I misspoke, the custody layer.

Remember, there's three layers in the proliferated warfighter space architecture. There's the transport layer, as in data transport layer, right? So it's moving all the data around.

Then there's a tracking layer, but the tracking layer is not necessarily fire control quality data. But then there's the custody layer. And the custody layer is absolutely supposed to be designed to do fire control quality data. Very important, that custody layer. Really built, I mean, the requirements started to get after the hypersonic threat and those missiles coming at us.

So we're down that road now. I'm sure that the final requirements have probably been done. I don't know if the handoff has been made to SDA, but the custody layer is absolutely critical. That gives us tracking, that gives us custody data, right?

Now, it's all about getting it to a weapon system that can take action on that data, right? And if you're a hypersonic, so the question is the timing. And do I have to have ground-based radars around the United States in order to service these interceptors, or can I do it from space?

I would say we actually don't know the answer to that yet, because we don't actually have, at least in the public domain, the hard requirements for the custody layer of satellites. So I think that is to come, that's homework to be done. There'll probably be several trade studies.

It gets more complicated if you have multiple vendors building satellites in the custody layer. So this is just one of those things that's going to be iterative. And at one point, we may go, we could do it from space.

Great. It might come to another point that, ah, we're going to have to have some terrestrial radars to help out. Whether this is a MK 70 or a VLS, it doesn't matter.

What does matter is the interceptors need guidance. Otherwise, we're not going to hit a maneuvering threat, period, right? It'll shoot one place and it'll be another, or the update rate's too late, things like that.

So I think we'll find those out. Those are absolutely technical areas of exploration. And it needs to be done up front. Otherwise, we're going to build a bunch of satellites that don't provide fire control quality data. And then we've lost time and we're not able to get to it.

The boost phase will be very interesting. I hope we do a lot of experimentation with small interceptors and space launchers that can shoot out a bunch of mass. Yeah. Using solid rocket motors in space is fine, but you eat up time as you separate from the launch platform before you activate the solid rocket motor.

And they're expensive and they're big. So hopefully we'll experiment with different ways to do intercepting for the boost phase and even a little bit of mid-course, right?

[Riki Ellison]
So JD, you had some comment?

[JD Gainey]
Yeah, I do. But what's important here is the ability to scale whatever this initial design is.

Riki, you briefly mentioned 13 Patriot battalions to be able to cover the homeland. Well, as a data point, if that logic carried over to Guam defense, we would only need a quarter of the size of a Patriot battalion to defend Guam. That's not the case.

There's 800 soldiers going out there just for cruise missile and a little bit of battle management piece to it. So, with this capability, coming back to the MK 70, having a system that can be separated from the larger systems, can be deployable, and can be built at scale

is the direction that—rightfully so—that the Golden Dome intercept piece needs to go after. I just wanted to put that comment out there about scalability.

[Riki Ellison]
Jamie, anything? JD, were there any questions out there that you would like to ask from the public?

[JD Gainey]
Oh, yeah. There's some fantastic questions. Let me pull them up.

[Lieutenant General (Ret.) Jamie Jarrard]
Hey, Riki, I got to run. Thank you. Thanks, Tom. Thanks, JD.

[Riki Ellison]
Okay. Thank you.

[JD Gainey]
One is: is there going to be attempted studies to be able to utilize the National Guard or the manned piece of this to be able to support the end state? And if so, what is going to be the most important part of that training system?

We kind of alluded to it, but we're talking about starting from a blank piece of paper, creating a National Guard, missile defense, unmanned defense cadre—won't be that first thing we go after.

[Rear Admiral (Ret.) Tom Druggan]
In terms of the training and how it's done and everything? Well, look, the training, both for maintenance and operations, absolutely has got to be, you know, a perfect match to what we actually field. Okay.

So, if you talk about the MK 70 new system, that's going to be a new schoolhouse.

[Riki Ellison]
But not Dahlgrim? You couldn't put this in there?

[Rear Admiral (Ret.) Tom Druggan]
You could put it in Dahlgrim. But I'm just saying, hey, it's a new teaching module, right? It's a new course, right?

So, who's going to take care of this box? Who's going to take care of that box? Is it one tech to do it all, or is it two techs or three techs with different MOSs or codes, right? NECs, things like that.

And that's actually one of the things that can work against you, which deploy, traditionally, against deploying a lot of new systems is, well, now we have to have different maintenance and training. So, that's why sometimes, particularly with this phase one, is we push out systems that already exist, reusing the schoolhouses that we want.

And this, I'm sure a VLS technician on a MK 41 VLS, Navy technician could probably very well take good care of that. I bet other people could too, right? So, I don't see any particular

barrier, it's just making sure it's stood up. That means budgeting, planning, and schoolhouse. If you don't do that, then your systems aren't going to be ready, right?

There's a whole list of maintenance actions that come with doing any system, but we'll take the MK 70. Every now and then, you're going to have to elevate it and put it in firing position, right? Just to make sure you can.

You're going to have to lubricate all the mechanical parts. You're going to have to do continuity checks on all the electronic parts. You're going to have to make sure that the weapons are still in a good-to-go position, doing bit tests and diagnostics.

Who does all that? Technicians do that. Sailors, airmen, guardsmen, they all, that's the work they do day-to-day to keep our nation safe. It's important work, and this requires something a little bit different than what we have today. Okay, fine. We just plan for it.

[Riki Ellison]
Like you said, phase one. Phase one is—we've got to go with what we got.

[Rear Admiral (Ret.) Tom Druggan]
This is not, this is straightforward.

It's just making sure that this is standing up a small schoolhouse on the MK 70. Traditionally, actually, when we do this, we rely on contractor training. They would go to the builder of the MK 70.

They would go through their training. They would get certified, and then they're online. The tougher problem here is the operations side of the house. Who's got command and control of the MK 70? Who's responsible for the lethal weapons that are in there, and who's responsible for the security of wherever this is? Right? Who's responsible for it?

[JD Gainey]
Thank you. The final one: how soon should we anticipate the advanced manufacturing, 3D printing, utilization of crematic tiles for reentry? All these advanced manufacturing techniques, how soon do we see that being incorporated and included into the Golden Dome supply chain and effector and defense design?

[Rear Admiral (Ret.) Tom Druggan]
So, I think anytime it's going to be cheaper, you'll see it quickly. Unfortunately, when it comes to additive manufacturing of metal, it's not cheaper. Incredible amount of electricity, sometimes mis-starts, right?

So, very, very – it's slow, right? So, today there's not a cost advantage or a time advantage to using additive manufacturing for large-scale metal parts. There is some work being done in the space industry on the thrust nozzles, right, the rocket engine itself, the actual output, right?

There's been some work there, and it's been successful to date, but it would be taking that and then scaling it. Reentry is unique, right? And some of this stuff may not be compatible with additive manufacturing.

Particularly in this kind of very robust, hostile environment, which is what reentry or flying in the high atmosphere at Mach 15 is, right, one of the issues with additive manufacturing is it's not internally perfect and consistent. And anytime there's a discontinuity, i.e., a little tiny crack or a little tiny – you know, it's just like diamonds, you know, they have internal flaws, right? If you have an internal flaw and you put it in a very hostile environment, it can fail.

And so, there is learning to be done with metal manufacturing of large objects for use in weapons, right? We can do a lot with polyurethane and things like that, like carbon 3D. They come out.

They're perfectly internally consistent. You can do them at scale in terms of numbers. You cannot do it at scale in terms of size.

I mean, once you get a certain size, it's too big for the technology today. But that's polyurethanes. That's not metal. Metal is harder. Laser sintering is kind of the current hammer that you use for metal in additive manufacturing. That will be improved.

There's lots of reasons for it to improve. Our submarine forces and the Navy sometimes – and this is Navy in general, right? We run into problems where we have a piece of equipment that's got a metal part in it, and the last time it was built was 1967 or 1974.

And so, we either have to recreate a production line, we have to repair it, but now we're starting to experiment with actually using additive manufacturing, advanced additive manufacturing to recreate those. So, the technology is coming, but, you know, if I'm creating a metal part for a submarine or a ship, it's not a hostile environment, like trying to reenter the atmosphere at 17,000 miles an hour or, you know, flying Mach 10, Mach 15 in the hypersonics regime. I think we have a while to go.

You said ceramics. I'm not up to speed on additive manufacturing of ceramics. And remember, when we talk about ceramics in this, we're really talking about you really need some carbon-carbon kind of additive manufacturing technology.

I don't know that that exists today.

[Riki Ellison]
Okay, J.D., I think you got any closing comments? I think we're about done. It's been a great discussion. Very telling.

[JD Gainey]
Yeah, my closing comment is :this is just an example of where the missile defense enterprise needs to go. It needs to have the ability to start breaking up these large, massive systems and take advantage of the best of the best.

And you'll start seeing new concepts being introduced as a result. And one is, and I stole this from the Australians, is when you start talking about the engagement piece of it, it's not man on the loop or man in the loop. For this scenario, we need to start talking about man initiates the loop.

Because we are going to autonomy, we are going to remote launchers, we are going to an AI-enabled kill chain to be able to close it from a software system perspective. So, that

concept of man initiates the loop, we need to start thinking through that. And what does that really look like in practice?

A warning pops up on your screen that says, do you want to do this? You hit yes, and it says, no, do you really, really want to do this? All actions after here will continue without your interference or something like that.

So, man initiates the loop is going to be a concept that we need to start thinking through to be able to enable this type of capability.

[Rear Admiral (Ret.) Tom Druggan]
Yeah, JD, I think a lot of that intellectual work is actually in our experience, right, on Aegis ships, right, where we have doctrine. And what weapons doctrine allows you to do is go to full manual with multiple fire safes through a number of steps, very discrete steps, not a continuum, not a spectrum, but very discrete steps to get to the point where you're full auto, right. And Golden Dome needs something like that, because in some cases there might be, maybe there's a rate of four or six missiles that are launched, and maybe the decision is, we're going to deal with that manually.

And then all of a sudden you see 102 get launched, and the system says, recommend auto, bam, right, in order, or maybe it's even set up ahead of time to say, oh, in case of a large raid, launch. The problem is deception and deceiving, right, so we have to work through that. Totally agree with you, but the chain of accountability matters, right.

Somebody, when things go wrong, somebody needs to be accountable for that, right.

[Riki Ellison]
Anything else, JD? Good. Thank you, Tom.

It was a phenomenal discussion. Closing remarks?

[Rear Admiral (Ret.) Tom Druggan]
No, so this can be done, focus on the end-to-end system performance, not all the piece parts. And there's a lot of system engineering work and system integration work that can be done up front to provide the boundaries for the system design. That's important, because when you have constraints on a system, it's actually very good.

It speeds things up, because everybody knows what box they need to live in. It's when things are wide open that, and without consideration of the end-to-end performance, you get systems that, at the end of the day, we spend a lot of time trying to fix them and make them work together after the fact. So, let's avoid that.

[Riki Ellison]
Do you think this is deployable in three years? The MK-70? The truck.

[Rear Admiral (Ret.) Tom Druggan]
Yeah, there's no reason, there's no reason.

[Riki Ellison]
This can go, this is going to happen. You said phase one, this is going to happen.

[Rear Admiral (Ret.) Tom Druggan]
Well, this is a quick solution. It's not my choice to make it, right, but it's quicker than buying, you know, buying MK-1 BLS. Yeah, this is real.

Missiles have been shot out of this, SM-6 has been shot out of it. You have to do some work to make sure the SM-3 Block IIA can come out of it, right, that hasn't been done. But this is launched.

What's key, though, is that this launcher can take the booster that we have today, which is the MK-72 booster, right, which is very energetic. If you've ever seen a launch of a Navy missile, it's very energetic, right, it's kind of a violent accident, right, and building a launcher that can take that rocket pulse, that booster, it's engineering required, very heavy engineering, right, because there's a lot of considerations. The back blast alone, the heat alone, all those are considerations.

All that's been done, though, in the MK-70. So, it's an option. It's a real option.

[Riki Ellison]
All right, well, thank you. Thank you for just a phenomenal discussion, and this is probably one of the first we've ever done of taking one little part of Golden Dome, and it seems so simple from the outside, you just put this in place, but you saw today how much thought, process, and all the things that have to matter to make that work, and what the positive thing is, is that this can be done. This will be done, and so it was just a great...

[Rear Admiral (Ret.) Tom Druggan]
Let's be clear, it has been done, so now it's an option. It’s a real option.

[Riki Ellison]
It's an option, but you got to put... You have to add the other pieces, right.

You got to put all the stuff that we talked about, which I don't think people understand how complex...

[Rear Admiral (Ret.) Tom Druggan]
My biggest worry, Riki, it's my biggest worry. Everybody's looking at the piece parts and not the end-to-end performance, so critical.

[Riki Ellison]
And that was well, well thought out, articulated today to understand this, to move this thing to the next phase. I think we've been pretty quiet on the Golden Dome, to expose one small little element of it was brilliant. I think today was a great discussion for this movement.

This is not the first. It's not the last. We're going to be attacking this every day throughout the next three years on pushing forth the Golden Dome.

So thank you, JD. Thanks, Jamie. I know Mark is in travel in Ukraine.

Tom, awesome coming in here to be here in person. Thank you for doing this.

[Rear Admiral (Ret.) Tom Druggan]
Happy to.

[Riki Ellison]
Ladies and gentlemen, thank you for listening. Bye-bye.