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TRANSCRIPT

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"The Aegis Approach with Rear Admiral Tom Druggan"

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FEATURING

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Vice Admiral Peter H. Daly (Ret.): Good morning. I'm Pete Daly, CEO and publisher at the U.S. Naval Institute. On behalf of the Center for Strategic and International Studies and the Naval Institute, we're proud to bring you this continuation in our Maritime Security Dialogue Series. This series is made possible through the generous sponsorship of Huntington Ingalls Industries.

Today's topic is the Aegis Approach, a conversation with Rear Admiral Tom Druggan, U.S. Navy. Admiral Druggan is the program executive Aegis Ballistic Missile Defense at the Missile Defense Agency. He's joining us today to discuss the history of development of the Aegis program, its current and near-term capabilities, and next steps for continued development.

This conversation is particularly timely, given the recent headlines on hypersonic weapons. A 1989 USNA graduate, he served at sea primarily in guided missile destroyers, culminating in command of USS O'Kane DDG 77. Ashore, he served in program management billets, which included major program manager for Aegis combat systems and major program manager for in-service Aegis readiness and sustainment.

His previous assignment was as commander of the Naval Surface Warfare Center where he led over 17,000 scientists, engineers, technicians, and support personnel across the eight divisions of NSWC. Rear Admiral Druggan became program executive Aegis BMD at MDA in June of 2018.

Our moderator today is Dr. Tom Karako, senior fellow International Security Programs and director of Missile Defense Project at CSIS. Tom will start the conversation with Admiral Druggan and then we'll move into Q&A from the audience.

Over to you, Tom.

Tom Karako: Well, good morning, everyone, and welcome. Thank you, Admiral Daly, for that kind introduction to kick us off. Again, I'm Tom Karako of the International Security Program and director of the Missile Defense Project here at CSIS. Thanks to USNI and also our sponsors, HII.

Today, we're talking about the Aegis combat system, what it does for air and missile defense and what we can learn from what one might call the Aegis approach. The phrase is, of course, an allusion in part to the Obama administration's framework for missile defense, the phased adaptive approach.

A lot has changed in the past 11 years since 2010. But I think the point here is to explore some of the reasons that this combat system has proven so

durable over the years, so in demand, and why it was tapped for the missile defense mission, going back to the Bush administration and before.

So, hopefully, we can tease out some of those characteristics in our conversation today and I, of course, want to encourage the folks watching online to please submit questions and, through the magic of Baseline 10 technology, the tracks will be passed to this pane of glass with low latency and this gentleman will engage on remote as we're able to with time.

So we're happy to welcome Rear Admiral Tom Druggan, well known in the missile defense community. And, sir, over to you.

Rear Admiral Tom Druggan: First, thank you. Thank you to CSIS and the United States Naval Institute for continuing the conversation. This is actually a critical conversation to have now. So thank you, Dr. Jones, the director. Thank you, Vice Admiral Daly. It's really an honor and a personal privilege to be here today. And thank you, Tom, for moderating.

Mr. Karako: All right. Well, thanks. We're going to cover a lot today – history, threat, philosophy, programmatics. But let's really start with what is, after all, a threat-driven program, Aegis. So what was the threat that Aegis was created for and what are the threats that you are primarily focused on today?

Rear Adm. Druggan: So thanks very much. If we roll back in time, this really became a central element of the Cold War, how to preserve our carrier strike groups – the carrier itself is our power projection platform – and its escorts from large raids of anti-ship cruise missiles delivered either by Soviet Union warships or also raids of their backfire bombers.

So at the end of the day, we had to take care of a large number of anti-ship cruise missiles attacking a strike group almost simultaneously. So that was a large order, and the reality is our weapon systems from the '50s and the '60s, and even into the early '70s, we knew we were not up to that challenge, and there were a number of reports and a number of practical experiences and a number of live fire failures – it's particularly true in the 1960s – that led directly to the demand signal that we have to do better in the United States Navy to prevail at sea and win. And that was, really, the start of the Aegis effort and started as advanced surface missile system out at Nemesis, which was also now known as Naval Surface Warfare Center, Port Hueneme.

There was a commander, Wayne E. Meyer, that was in charge, working under the tutelage of an admiral, to come up with what is the right genesis and what is the right approach, given where technology was at that time, to take advantage and prevail and win at sea.

So that was the start – the Soviet Union threat, large raids of anti-ship cruise missiles targeted at our carrier strike groups. Now, as you move forward in time, the sad reality is the threat has moved on and advanced significantly from that time on, and today's fight at sea is a missile fight and it has been for a number of years.

We used to have high-diving anti-ship cruise missiles. Those were the ones launched from Soviet Union bombers. And then we started getting the lower cruise missiles and then we started getting sea-skimming cruise missiles, and then today, our challenge is supersonic sea-skimming missiles – incredibly fast difficult targets – and then we've also opened up other missile defense domains, whole domains. Ballistic missile defense was the first one and then the latest is hypersonic missile defense.

So as you stack up those three domains – cruise missile defense, followed by hypersonic missile defense – these are weapons and threats that are in the upper atmosphere, thin atmosphere, incredible speeds, incredible maneuverability – and then ballistic missiles in space. It's still – I'm amazed every day and, really, it's an honor to lead this program. Ships at sea shooting down threat missiles in space – that's an incredible capability.

Mr. Karako: Well, that's a pretty diverse threat set. You have several hats, I understand. One of your titles that sums them up, I guess, is PEO – program executive officer – for Aegis BMD. But, of course, as you just described, the threat is becoming much more sophisticated, more maneuverable, less predictable as ballistics are.

So, you know, does this suggests that – is there some hat switching, hat evolution that you can, perhaps, foresee, going forward? Is there a PEO for IAMD, given where the threat is going?

Rear Adm. Druggan: Yeah. So, the first piece of that was our name change. So just last year, Aegis BMD, within the Missile Defense Agency, became Sea-Based Weapons System, and that is to address that specific thing that threats are no longer just ballistic. Ballistic is easy and old compared to where we are today.

We have maneuvering ballistic, and then we have hypersonic, both within the Missile Defense Agency's charter and, in fact, the Missile Defense Agency is the executive agent for hypersonics – hypersonic defense, I should say.

In terms of any maturation organizationally, I have a hybrid program office. About a quarter of my civilians are actually Navy civilians. I work hand in hand with the PEO – Program Executive Office – for Integrated Warfare System under Admiral Okano, and there's a program office there called PEO – excuse me, IWS 1.0, Aegis combat system, that's led by Captain Andy Biehn.

And so I work closely with that organization. In fact, the capability I deliver today is not a separate and distinct capability. It's fully integrated into the Navy.

Mr. Karako: I wonder if you could give us an overview of where the Aegis fleet is today. How many ships we got out there, roughly speaking? You know, how would you characterize the relationship between the Aegis fleet and the rest of the fleet and kind of the relationship of the Aegis combat system and the Joint Force?

Rear Adm. Druggan: OK. So, we'll take first things first. What is the Aegis fleet? And so our lexicon will change. We talk about Aegis globally, but there are Aegis warships. There's two Aegis Ashore sites. Then we have an Aegis combat system, and then we have an Aegis Weapon System.

And so all of those put together really combine and create what we call the Aegis community, supported by and delivered by our industry partners. That's one of the great things about Aegis is we have fantastic industry partners. We've got General Dynamics that builds the ship up in Bath, Maine, Huntington Ingalls – HII – that delivers them out of Pascagoula.

Then we have Lockheed Martin, who is the combat system engineering agent for the Aegis Weapon System, and then we have Raytheon, who actually delivers most of our missiles as well as they also do the transmitter on the SPY-1 radar.

So those are very strong industry partners, and we have a rich history and heritage of working well together. And then there's some major government oversight that's provided both by Naval Surface Warfare Center in Dahlgren and Naval Surface Warfare Center Port Hueneme.

In terms of the fleet, we're at a high-water mark in terms of Aegis ships, about 90 today. Twenty-two of those are cruisers and then the rest are destroyers, and they're broken up into tranches that we call flights. So when you talk about the Aegis fleet, which part of the Aegis fleet are you talking about?

Our cruisers are super special. They're our air and missile defense commanders. Even if they don't have a BMD capability, they are often tasked with the command and control level. That's an O6 captain at sea with the strike group that is working air and missile defense, right. They are the commander, the warfare commander.

And so that's their service. That's the primary mission, really, of those precious cruisers. Then we get into the destroyers. So out of those destroyers, we have Flight I destroyers. Then we have Flight II destroyers.

Those are groups of 15, 20 each. Then we get to Flight IIA. That started with DDG 79. And we have carried that whole design, Flight IIA, all the way through DDG 124, right. So those are the Flight IIAs. And then you get to Flight III, and USS *Jack Lucas* (DDG 125) is the lead Flight III Arleigh Burke-class destroyer, and she is under construction today.

Mr. Karako: So you've listed the number of ships, the types of ships, the different classifications. But let me ask again, what is Aegis? It's more than the hardware. It's more than the hardware and the software. And it's frequently complained in the defense acquisition world that, you know, our development timelines and such are such that by the time it gets fielded it's obsolete by the threat. And, yet, Aegis has been – has proven durable for 40-some years. So what is it about Aegis? What's the philosophy? What's the secret sauce?

Rear Adm. Druggan: Yeah. So to sum it up, many people say that's the Aegis system engineering approach, and that is absolutely true. It is the glue that puts all of those different industry partners and government organizations and organizations like Johns Hopkins, Applied Physics Laboratory, assisting the government, that's the approach that keeps everything moving forward and, importantly, laser focused on the threat, which is really key.

Aegis always starts with the threat and it's an accurate assessment. Do we have capability? Do we have effective capability? Do we have a limitation or do we have a gap? And based on a system engineering approach, we go after all of those based on the priority of the day.

Mr. Karako: OK. So let's dig into some of the pieces of – and the principles that dig into that, the Aegis cornerstones. You've mentioned, of course, Admiral Meyer. There is an Aegis ship named after Admiral Meyer. First of all, what are some of the cornerstones that go into that systems engineering approach?

Rear Adm. Druggan: Yeah. Before I get to that, I'd like to talk about – (clears throat) – excuse me, DDG 108, USS *Wayne E. Meyer*, which most people don't know, but that – the weapon system that – the Aegis Weapon System that is on Wayne E. Meyer was the centennial Aegis Weapon System. It was the 100th. So it was perfect that the namesake to carry the centennial Aegis Weapon System is USS *Wayne E. Meyer*.

So I actually brought something today, which is called the combat system control Aegis Weapon System, Mark 7. This was Wayne E. Meyer's brief to advertise, advocate for, and advance the United States Navy's capability through combat system, dated January 1973, and this booklet is called the coloring book. I'm not sure where that name comes from.

But in here, he does outline the foundational system engineering principles – the cornerstones – that have remained timeless for us. So I'll just go through those real quick. These are the original words. There are a couple changes over time, but this is the beginning.

The first one was performance in the environment, and we have to understand the maritime environment is distinctly different than the terrestrial environment. Maritime environment, one, the ship's always moving, right. It has – you have to have redundancy. It has to be able to operate in high seas.

It has to be able to operate in high-clutter environments. So those are atmospherics where there's dust or particulate, which is particularly challenging for radars if you don't work on that in advance, as well as – so those are the natural kinds of effects, as well as manmade effects – jamming, electronic attack, and those kinds of things. So environmental performance was key.

Reaction time. I cannot tell you how many times I've been asked, well, why can't we just, you know, use this cost processor or that – it's so easy. It's plug and play. It's time. You cannot afford to have buffering on your weapon system.

You cannot afford to sit there and wait for something to load on your weapon system. This is the self-defense of a capital United States Navy ship charged with the self – charged with the force defense of an aircraft carrier that is the power projection arm of the United States Navy.

We cannot afford any latency within the processing and display of the system nor can we afford latency end to end within the system. And many people think that what you see is the reality at that millisecond. And we are talking milliseconds. We're not talking seconds or minutes. We're down at the millisecond level, and within that framework, any delay can be lethal.

Actually, what you see on your radar – the one thing we know is that when you see on a screen a representation of time, elevation, and azimuth of a target, it's not there because it moved since then. The air track moved. Where did it go?

Now, if it's a manned aircraft, level flight, pretty easy to predict where it went, right. But if it's an anti-ship ballistic missile coming in at incredibly high speeds from space that is – has control services and is incredibly agile and can pull significant Gs, where it's going to be is key and your whole system end to end has to account for every single error, and we call it an error budget. There's error in where the ship thinks it is.

That's just particularly true when you're doing multi-ship operations. We know where we are. I think I know where you are, right. And so there's some error there. Within my own system, I have some navigation error.

Within my radar beams, I have some error. Within my missile flight, I have some error. And then I have some pretty significant error on where is that target, not when I got my radar return because radar goes up, comes back, processing time. There's a delay. The where it actually is at this point. Most importantly, where is it going to be in the future.

And so there's, I would say, very significant magic in radar tracking and very significant magic in weapon – the weapon control system, which is trying to get our interceptor, our guided missile, into a very close proximity to the threat so then we can have a warhead detonation and destruction of the target. A lethal intercept, if you will. So that's just –

Mr. Karako: The coloring book, though, predicted a lot, right?

Rear Adm. Druggan: Yes, absolutely. In fact, everything we're doing are just more logical steps of what started here. So that was number two. We started with environmental performance. Now, down to reaction time. Firepower. If I only have eight missiles, then I can only take on a certain number of threats, and this is where understanding not only the threat capabilities in terms of the missile itself, right, but the scenario. What's the vignette? Is it just one attacker? No. And much of people's thought is, OK, what's your capability against a threat?

No. No. No. It's what's our capability against a raid of those threats or, as we've seen recently demonstrated, a mixed raid of anti-ship cruise missiles, anti-ship ballistic missiles, and hypersonic missiles, all converging on a particular area in the ocean, which, in the future in a conflict, would be a United States carrier strike group, right.

So our job between the Navy PEO IWS and myself in Aegis BMD is to make sure that we have the time and space – time and battlespace to attrite a raid and prevail, defend. That was number two, firepower. So that's why we have so many VLS cells, folks. We need the firepower. That's just the bottom line.

Things that help you have less need for even more firepower is the fact – the good news for the Navy is we're always mobile. We're always maneuvering. Most of the threats against us have to have a seeker, right, so that gives us options. We have options for deception. We have options for decoys. We have options for countermeasures, including electronic countermeasures against that threat.

But at the end of the day, we need also some certainty on the hard kill side of the house with the lethal intercept and we have to do that in a layered fashion. We're going to do it a long range, attrite the raid, continue to attrite the raid, continue to attrite the raid. So the layered defense, the defense in-depth, that's being delivered today is robust. So that was three.

The next one is – so, again, environmental performance, reaction time, firepower, and then system availability. This is where I think our acquisition training can do better. For a weapon system we need an availability, an operational availability called AVSO, of .9999. If you take an operational availability of .9, so it works 90 percent of the time. Like, oh, that's pretty good. Ninety percent of time.

Ninety percent of the time is horrible. That's three weeks without my SPY radar or my Aegis combat system in a six-month deployment. That means I can't defend myself. I can't do my mission. I can't do my duty. I can't defend the carrier. I can't defend critical infrastructure ashore. So we need the highest level of operational availability, system availability, possible, and that was identified as one of the cornerstones very early on.

And then, finally, area coverage. It'd be great to have all these weapons, but if I can't use them outside 10 miles then I cannot attrite a raid over time and battlespace nor – and I'm just putting myself at a disadvantage. I need to have long-range sensors. I need to have long-range netted sensors to help me understand what's coming, and I need to have longer-range weapons in order to actually attrite that raid over time and battlespace.

So just to review, environmental performance, both manmade – both natural and manmade. Reaction time, super important, and that leads to some level of automation. We'll talk about that later. Firepower, AVSO, operational availability of the system, and then area coverage. So that's just a quick primer on the cornerstones. Thank you for the question, by the way.

Mr. Karako: If I'm not mistaken, I think the coloring book is called the coloring book. I've seen the color version, and it had about the computer-generated graphics version that you might expect from 1973 and sort of drawn-in colors – (laughs) – as it were.

Rear Adm. Druggan: Yeah. Well, actually, it's – look it up. It's actually kind of neat to go back to 1973, and these were actually overhead projectors, transparencies, for those of you who remember that, that were leading the way. This is well before Harvard graphics and all that kind of stuff. So pretty neat.

Mr. Karako: So Admiral Meyer, father of Aegis, there's some – what are called Wayne Meyerisms. I wonder if there's a couple of them that you have particular

application that are especially relevant today as you go through your days. What are the Wayne Meyerisms you repeat most frequently?

Rear Adm. Druggan: Yeah. The best one is "build a little, test a little, learn a lot". All right. And, actually, what I've loved is in the commercial software industry, you know, agile software development is the name of the game, right. The reality is that that is the natural conclusion of "build a little, test a little, learn a lot," because an agile – you'll work on a particular function end to end and you'll actually then test that before you move on to another feature. That's about as granular as you can get in build a little, test a little, learn a lot.

Now, we weren't able to do that before so we had to build a little more, test a little more, learn a little – learn a little more in those tranches. But the reality of the day that we've worked in throughout Aegis is that we do – we've done model-based system engineering from the beginning – digital engineering, in today's vernacular.

We have turned that into code tied to the hardware. We're decoupling from the hardware now but we were coupled to the hardware in the beginning. Testing in the lab ashore. That's really important. You don't want to put ships at risk with a new software update and it doesn't work. That's not the business of Aegis.

We have to test it ashore, wring it out, and then that's the development side. And then you have to test what you actually deliver to the ship because, believe it or not, ship to ship there are a bunch of small changes in the hardware or some piece of equipment wasn't available. They had to buy a new piece. There needs to be an adaptation.

So you have to test the configuration going to the shipyard and then, obviously, you take your lead ships with the new hardware-software configuration and you go to sea and you test it there.

Mr. Karako: But you really emphasized a minute ago the raids, the structured attacks thing that was a thing in the Cold War. It's, certainly, a thing today, a complex integrated attack. And so there's also the Wayne Meyerism about beware of the single-point failure.

Rear Adm. Druggan: Absolutely. Yeah, that one's fantastic. So Aegis – a system engineering principle as well that has fallen out it's tied to availability – system availability – and that's been achieved on the system side through redundancy. Aegis has a highly redundant system. We always have failovers, whether it's navigation, cooling, power, even computing nodes and processors. There's graceful degradation built in. There's real time diagnostics from – USS Ticonderoga, the lead Aegis ship, had a system called

ORTS, real-time diagnostics that could be run. Online tests for computer folks, right.

So that's been there on the system side. He also advocated not having a single point of failure in terms of people, right. There's some redundancy in our watch stations and the combat information center onboard our cruisers and destroyers. There's some common display that's called a large-screen display or a multi-mission display where the captain and the tactical action officer and others can look at in a large overview. Throughout the system as well as the people approach there is trying to build in those safeguards so there is no single point of failure.

Also what happens there is making sure that on the software side that you have graceful degradation, because you can have a software failure, a single point of failure, just as easily as you could have a hardware single point of failure. So that piece has been engineered in as well. And a lot of this has to – his last one that – one of my other favorites was, we can't engineer in the impossible. The other way to say that is, you know, physics get a veto on your good idea.

So we're always very well aware of our understanding of physics and our level of technology to exploit our understanding of the physics. And, you know, our understanding of, particularly, hypersonics has grown and is growing again. Certainly, through the '60s and '70s, we did quite a bit of work. We did not weaponize that capability. It's been weaponized today by other nations.

And so understanding the physics of the different domains, really, really important. Really germane to talk about this where it's applicable today is lasers on ships at sea. One of the challenges that's different for lasers on ships at sea goes to you can't engineer the impossible, which is really a recognition of what's the limitation of the physics of the problem I'm trying to solve.

So lasers at sea in a maritime environment, we have something called the evaporative duct and it's – you know, and it varies day to day. It can be five feet. It can be 40 feet. But it's heavy, dense, humid air. All right.

So we know that our lasers will be environmentally sensitive based on just the existence of that evaporative duct, which is why we're spending the right amount of time on the Navy side to make sure that as we scale up we can scale to an operationally relevant power level, and there's different missions at different power levels and we're taking advantage of that today.

Mr. Karako: So talk to me a little bit about the Baselines, the Baselines and the Common Source Library. What's that all about?

Rear Adm. Druggan:

OK. So we talked about the ships themselves – cruiser destroyers, and then destroyers Flight I, Flight II, Flight IIA, now Flight III, right. That nomenclature is tied to the actual ships themselves, to those tranches of ships. Baselines used to be synonymous with Flights. They are no longer and that's just because these are capital assets that are around 30 to 40 years. They go through upgrades and modernization.

So depending on ship schedules and how the profiles work out in terms of major maintenance availabilities where you can do a major upgrade, we end up – the Baselines do not neatly or do not perfectly align to the Flights anymore. For instance, two of our most capable destroyers are USS *Arleigh Burke* (DDG 51), the lead Arleigh Burke-class destroyer, and USS *Barry* (DDG 52). Why? They went through Aegis modernization and they now have Baseline 9. I'll talk about Baselines here in a second.

But I just want to make sure that we have the scene setting. You got fixed flights over on the warship and hull side of the house. We get to Baselines it's not a perfect match and that's why sometimes people get confused.

So let me go back about a dozen years. We had about 13 Baselines in the United States Navy, and that was a product of tying the Baseline development for a new threat to a new flight of ships or a new configuration of hardware. So what that meant was that our older Baselines were not getting much better and we were putting all our new capability, all the new threat capability, into a new Baseline and a new Flight that was being built.

That's unaffordable to maintain, absolutely unaffordable, and it's unaffordable in training. It's unaffordable in maintenance. It's unaffordable in software development to meet the threat, and there was configuration chaos from a macro level. I mean, within the Aegis community everybody knew. and we weren't spending much time or effort on the older configurations and more time on the newer ones or the ones coming. But that was leading to an unsustainable model.

So what we've done – this is actually a tribute to Vice Admiral John Hill, who's the director of the Missile Defense Agency – is we need to work on convergence every way we can so that we can overcome the configurations and get better return on the Navy's investment.

So the first piece of that was something called the Common Source Library, and the Common Source Library was the first time we were really decoupling the hardware from the software. It was an approach for open architecture. The open architecture really started with Baseline 8 but it was coupled to the hardware pretty significantly. And then Baseline 9 took us to the next step.

Here's what's great about the Common – let me go back to Baselines real quick. So we had 13 Baselines. Today, we're on the cusp of getting down to Baselines 5, 7, and 9, with Baseline 10 in development. So that's from 13 to three in service. That's a great story. We're all happy about that. So out of those 90 ships, 40 of them today are BMD capable, 20 of those are Baseline 9 IAMD, and that's going to grow to about 45 Baseline 9 ships in the mid '20s. Fantastic capability.

What that means is for a dollar of investment, you can field capacity. You do software update against the threat, you get instant capacity.

Mr. Karako: Air and missile defense?

Rear Adm. Druggan: Air and missile defense, but even, you know, integration with a gun, integration with, say, you know, ODIN, which is a laser system. Maybe there's a new capability in the Evolve Sea Sparrow missile. SM-6 may come out with all of those, right. So Baselines 5, 7, and 9 out in service today.

As an example of convergence, Baseline 5.4 replaced a BMD stand-alone Baseline called 3.6, a stand-alone BMD Baseline called 4.0, and a Navy Baseline called 5.3. All converged, got combined into a single Baseline called 5.4. Baseline 7, going through modernization now. So by the end of the 2020s, those will all be Baseline 9.

So we're going to go from 5 , 7, 9 to 5, 9, 10. And, really, the magic is pretty neat is we're going to have Baseline 5 and we're going to have 9 and 10 in the Common Source Library. Believe it or not, Baseline 10 – it's about 75 percent of the code is derived from Baseline 9. They are resident together. That work is going on right now to have them resident together in one single code base.

So, again, we'll go from 5, 7, 9 to 5, 9, 10, but 9 and 10 really, really close. That gives us a lot of synergy in terms of giving capability to the fleet. The other thing the Common Source Library did was allowed us to really do the build a little, test a little, learn a lot, because now we can do – we're doing two significant capability upgrades every year for Baseline 9. That's where we've been for about the past three years.

That improves our self-defense. That improves the reliability and availability of the system. It improves our force level defense. It gives us entree to be able to take care of other combat system elements that are being added in a very measured responsible way. So super grateful to the former Aegis program managers and Vice Admiral Hill for setting that up. It is paying dividends today. It'll pay dividends in the future. Also gives us the opportunity to be agile and quick when we need to.

Now, you have to pair that with responsible – making sure that we test and move it into the in-service fleet. So that's Baselines overall, 13 down to – you bring it down – now down to 5, 7, 9 – Aegis Baselines 5, 7, and 9 and then by the 2030 we'll be Baseline 5, 9, 10.

Mr. Karako: I got a whole lot of programmatics I want to get to – (laughter) – in the time we've got left. But let me just ask before we get to that, you know, big picture – stay big picture here. What are some things that maybe Aegis can do better on the acquisition side, on the hardware-software? Just some high-level stuff before we dig in.

Rear Adm. Druggan: OK. So we're going to start really high then.

Mr. Karako: OK.

Rear Adm. Druggan: So the first thing is we have to fight at the network level. All right. We're doing that in the Navy with a capability called Naval Integrated Fire Control-Counter Air, NIFC-CA. That's where Baseline 9 – Aegis Baseline 9 ships, both cruisers and destroyers, can shoot a smart missile over the horizon at a missile threat they cannot see with their radar using third-party fire control quality.

Those words, fire control quality, are really important there because now I'm not using my own sensor. I'm using somebody else's sensors. I got more delay, more navigation air and everything. So those lightning bolts that are in NIFC-CA, every single one of them was engineered.

And so, you know your USB that you plug into your computer? The engineering documentation for that is 800 pages, just for that little common standard, right. So when you see lightning bolts connecting systems, you really – what's the level of integration there or interoperability or are we just passing high-level data where the timing doesn't matter? Weapon system, timing matters. Quality data matters. End-to-end latency matters. But that's been done in NIFC-CA and now we can shoot smart missiles over the horizon and attrite that raid over time and battlespace.

So that's the Navy working at the – you know, fighting at the network level and that's just going – that's just continuing to grow as we build out the other providers, the fire control quality data. In Aegis BMD, we're also fighting at the network level, and it's not really Aegis BMD. I'm the shooter, but it's really the Missile Defense Agency. There is one 24/7/365 global network. It's called C2BMC. It goes to every combatant commander. It goes to other – it goes everywhere for those who are involved in missile defense.

Mr. Karako: Gen C2 before it was cool – the force?

Rear Adm. Druggan: So JADC2 will be here one day. This can be a part of it. Could be foundational. So we'll see how all that works. But the C2BMC network I can actually – using that network, I can actually use third-party fire control quality data to fire a ballistic missile and intercept it in space, and we're talking about a radar that is thousands of miles away. So that's pretty robust, and we are building that capability out even further as more sensors come online and as more capability comes online.

So we're fighting at the network level. The reason that's important is, to get to the programmatic side, it's organizationally hard. It takes time. It takes engineering. Hand waving doesn't do it. PowerPoints don't do it. This is engineers sitting down from different program offices, actually, I'll say nuking it out, getting into that fine level of detail down to message protocols and message formattings that are going to be traded back, the timing that goes with it. And one of the challenges is, well, that's a legacy system. I hate that word. It's an in-service system. It's still got a lot of capability.

So you got an in-service system, and you have a new system. You're trying to get some more capability by putting the two together. It's organizationally hard. It's usually – the engineering work is not science and technology. It's – it is more about standards and interface documents. But the details matter because if you're – if you make the wrong call in terms of, you know, computer processing or systems talking to each other, you don't get the capability.

Mr. Karako: Yeah. So that engage on remote stuff is hard, as you're pointing out, like, long-term remote. Let me take you to a particular place where that is useful and that's Romania, Poland – the Aegis Ashore sites. If you'd give us a quick update on the work the sailors are doing in Romania today for Aegis Ashore and where Poland is at as well.

Rear Adm. Druggan: OK. Fantastic. Thanks for the question.

So Aegis Ashore Romania operational just celebrated their fifth year on site, and they have the highest SPY A_0 in the fleet. So just incredible ready capability. For those of you who don't know, Aegis Ashore Romania provides ballistic missile defense to Europe, specifically, the NATO nations.

It's actually under NATO control in terms of command and control. It is focused on threats out of Southwest Asia. It is specifically not focused on threats out of Russia, despite what they say sometimes. And, in fact, not the capability. It's just the geometry is incorrect for that. Fantastic group there. We're nested within a Romania base, and we have a Navy base and then

nested within the Navy base is the weapon system and their security is built in on each one of those layers.

There's an O5 commander that is in charge of the Aegis Ashore Romania weapon station, just like there's O5 commanders in charge of our Aegis destroyers at sea. So the same mission, actually, and he has to be ready to respond to the command and control from NATO in order to defend Europe. And so it's a small group there. There's typically about 33 in a rotation and that gives you three watch sections.

We do use a rotational model for Romania and Poland for the weapon station folks and they're based out of Dam Neck, Norfolk, in that area. So there's – so then we have three of those. So it's about a hundred sailors. They deploy in groups of about 30 and then they have their watch sections. And then there's a command element on top of that that stays there the whole time.

Mr. Karako: And how does that number compared to Aegis Afloat?

Rear Adm. Druggan: So Aegis Afloat, you have about 300 sailors, but we're running a multi-mission ship. We do anti-submarine warfare. We do surface warfare. We do strike. We do air surveillance. We do air defense. We do BMD. We do diplomatic missions, all of those.

Mr. Karako: But the point being that Aegis Ashore thereby means a lot less of a crew, a lot fewer human beings.

Rear Adm. Druggan: I would say it's the crew matches to the mission.

Mr. Karako: Yeah. Yeah.

Rear Adm. Druggan: They don't have to worry about taking care of engines. They don't have to take care of auxiliaries. They don't have to feed everybody in the middle of the ocean. So they don't have a lightweight gun system to worry about, torpedoes to worry about. They don't have a helicopter and a helicopter deck to worry about it. They don't have self-defense systems to worry about. So I would say that the manning is matched to the mission.

Mr. Karako: And how is Poland?

Rear Adm. Druggan: So Poland, a good news story there on Poland, bad news story in terms of we have been delayed, and my part, which is to install the Aegis Weapon System, has been delayed as we work the military construction with our contractors. We have been behind. We are behind, given the original schedule. No question about that.

The good news is we're getting the quality we want for a facility that's going to be there 50 to 75 years, and we now have the right management in place in order to move ahead and complete this. We have good momentum now. We have not wasted that time, however. When the Aegis Weapon System was shipped to Aegis Ashore Poland, the site there, it was staged in CONEX boxes and containers.

This past summer we pulled those out and put the whole weapon system together with the exception of the antennas. We energized it, and the equipment had been in the containers for a while. We found some issues. Good news is we fixed them. And then we did an upgrade, which is saving time from a future availability.

So that system is actually our most upgraded system today, ready to be installed. We've installed the spire rays – the antennas – on the deck house. We're installing the backbone of the radar behind it. We've installed some C4I systems and we're going to keep installing our pieces in parallel to the commissioning of all the industrial equipment, power, cooling, ventilation, that's going on on the construction side.

That's not normal. Normally, we wait until construction is complete, has a bow on it, and then we start our Aegis Weapon System installation and check out. Made the decision long ago that we were not going to wait. We were going to do what we could when we could based on the conditions within the deck house. That has proved to be a successful strategy and now we've got good momentum.

So by the end of '22, we'll have an operational side but then we have to go through turnover, and that'll be with Navy, then with European Command, and then with – and then with NATO. So '22 is going to be a very busy year and we'll get you some of these turnover activities.

Mr. Karako: Excellent. Now, you have spent some time alluding to the SPY and different kinds of SPYs and the evolution thereof. There's some language in the draft NDA about, hey, all these different maritime radars, SPY dash this, that, and the other thing. What's going on there? Congress wants to know. And how do we think about the diversity of advanced radars in the Aegis community?

Rear Adm. Druggan: Great question. Just as we talked about Flights within the warships and we talked about the Baselines, we'll talk about the radar. So we'll go back to the warship. The radar variant is tied to the warship in general but there's an exception that's really important that we'll talk about.

So on the cruiser side, 22 ships, we have three variants of radar and a lot of this was the beginning of the Aegis program. So we have the SPY-1A, which was maintenance intensive, and that was on the lead Tico and the lead ships

there. And then we understood those issues, and in order to make it less maintenance intensive there was a major effort and we came up with SPY-1B, and then that was improved as really power – some power improvements, the SPY-1B(V). So that's the cruiser side of the house.

When you get to the destroyer, there's only two variants of radar that are tied to the hull – one SPY-1D and then the other one is SPY-1D(V), which came in in the '90s was the SPY-1D(V), the development of it. So those are two variants. Here's the exception. The exception is, is on some of the destroyers we've changed out the signal processing behind the active radar antenna.

Mr. Karako: Which is important for certain missions.

Rear Adm. Druggan: It's important for BMD, that's for sure, and gives you multi-mission capability – multi-mission single processor, right. So that capability has gone on different destroyers as part of the Aegis modernization program. So you can't just look at the radar variant and know what the capability is. You have to look at the Baseline and the multi-mission single processor.

So the easy way to think about it is Baseline 9 destroyers, it's going to be a SPY-1D or SPY-1D(V). But in all cases, it'll have a multi-mission single processor able to do simultaneous air and missile defense with robust capability and improvements coming in the future. So that's the radars that we have today.

Coming, we have on the USS *Jack Lucas*, our lead Flight III ship, is the SPY-6 air and missile defense radar. So that radar is, you know, which is going to come out on all our forward-looking – forward-fit construction – new construction.

Why do the radars change and why do we have so many variants in the fleet? One, capital assets last 30 to 40 years. Change out a radar? Very expensive to change out a radar, particularly when you can get enhanced capability just by working on the software or working on the single processor. That's why we have so many variants.

The other piece is some of that is driven by threat. When we went from SPY-1B(V) on the cruisers to SPY-1D on the destroyer, effectively the same SPY. The biggest difference was – a cruiser has two deck houses, and when we went to the destroyer we wanted to simplify that and we went to a single deck house and we went to a single transmitter and we went to single processor – single signal processor.

So these are details that most of you guys are probably not familiar with. They're probably boring to some of them. But that's why –

Mr. Karako: There are a lot of folks listening that wants to hear about this.

Rear Adm. Druggan: That's why we are where we are with so many configurations. But you go from – let's put SPY-1A kind of to the side because it was the first and everything. If you go from SPY-1B, B(V), and D, which is well over half of the Aegis fleet, it's the same capability. Ninety percent of the same parts, right. And then we did an upgrade for clutter and that's the SPY-1D(V). All right. So there's some changes, but it's still vastly common to the rest of it. And we're still in this – we're still kind of in the analog world here on these designs. And then you get to – you cross, you go from the MILSPEC analog into the digital solid state, and that's where we are with SPY-6.

Now, what we learned as we had the National Defense Strategy under Secretary Mattis and then the follow-on Missile Defense Review is Navy and Missile Defense Agency jointly looked at requirements for the future with our newly identified peer competitors, resurgent Russia and rising China and what did we need? And that spawned not new radars but some upgrades that are under consideration. And this is wrapped up in budget considerations, tradeoffs. And if you do a major upgrade to a ship, how long is that ship going to be around? What's its service life left?

Those are all important decisions as you're trying to get the best bang for the buck and you're trying to invest for capability. But there are radar upgrades that are under consideration for SPY-1(D), which is our older Flight Is and IIs, and for our Baseline 9 ships called digital, and that that's called low noise amplifier, sensitivity upgrade. Another sensitivity upgrade is on the Baseline 9 ships and that would be something called digital low noise amplifier.

Mr. Karako: Again, as looking forward to the future, there's different advanced radars, everything from the TPYs to the LRDRs and all that kind of stuff. How do you think about – I think this is kind of the NDAA language – the differences in the advanced SPYs?

Rear Adm. Druggan: Yeah. So the biggest – so we'll cover the different bands and how they all operate. So you have a long-range discrimination radar that's actually radiating for test up in Clear, Alaska, now. Will be turned over to the Air Force next month, and so is on track. That radar is amazing technology. It's also huge. It's got two faces. Each of them is six stories high and six stories wide. This is a homeland defense radar. But that technology has gone a couple other places. It's gone to the homeland defense radar for Hawaii. It's also gone into the government of Japan's acquisition of SPY-7 for their program. There's some direct commercial sales stuff going on separately. And then you have TPY-2. TPY-2 is going through a major – is going through some upgrades as well. And then you get to, really, aircraft kind of radars, right. So we'll stay away from those for now.

You also have the space defense radar. So all of these radars are – have crossed that generational change into digital solid state, and that gives you just a(n) incredible growth path that's affordable in the future for capability really delivered by software and processor upgrades. We're actually talking circuit cards where you take out an older circuit card and you put in the new one that's got a processor with more processing cores, and then you can take advantage of it, right. Because these are – you know, if you want to call them software-defined radars, that's accurate, actually, in terms of software-defined radars and radios and things like that.

So then we get to the bands. LRDR, HDR-H, SPY-7 are all S band. And then TPY-2 is X band. On the Navy side, SPY-6 is also – it's S band. They also have a small SPQ-9B, which is X band on those ships. So as you look at the radar development, we've crossed into that digital solid state. There's some other recent advancements that are super important. When it comes to radar and what you can do with it, the more degrees of freedom in terms of a radio wave that you have, the better off you are.

Mr. Karako: What do you mean by that?

Rear Adm. Druggan: So there's attributes, right. There's pulse lengths. There's wavelengths. There's amplitude, right, PRFs, all that kind of PR, all of that, for a wavelength. There's also something called polarization, right. So polarization diversity also opens up doors to new capability, and that capability really just became available in 2015, 2016, in terms of being producible. So that's opening up new doors. It improves your ability for high-end warfighting and improves your ability for BMD discrimination and missions like that.

Mr. Karako: So let me shift gears to C2. You know, you can't play Pentagon buzzword bingo without talking about AI-ML. So, you know, Aegis, again, has had the – what is it, the manual, semi auto, auto, auto special thing for a while. It was kind of AI before it was cool. So explain to us in brief what that is and then what you kind of see for AI-ML in the modern instantiation. Where's that coming in? An audience member asks is there going to be size, weight, and power complications as you evolve to that?

Rear Adm. Druggan: Yeah. Great question and, actually, very germane right now. There's a lot of attention on AI-ML. So our history and heritage here is actually Aegis is, like, the perfect place for implementation of AI-ML. We already have something called weapons doctrine – that's what you were referring to – something called weapons doctrine, which is a rule-based doctrine and what you do is you set it up ahead of time and then the system behaves based on the parameters that you set.

So it is rules based, but it's there. Most important, culturally, our sailors, our warfighters, our captains, our tactical action officers, our air warfare coordinators, are comfortable using some level of automation, and not just some level but a level that the human can control. And, again, we can go for manual – the person is going to do everything – to semi auto where the system's just saying, hey, here's something you may want to do, to auto where the system is actually processing all the way to pushing the button, so to speak, and in some cases can push the button, and then auto special, which is very special and used only in certain situations, is where you've set the system in full auto.

So auto and auto special can have an automated response. There's a precondition that's under human control, and that's setting the system with the fire integrity switch. So you can be nonfiring or firing. That's kind of the – it's kind of on or off, if you will, in terms of being able to launch missiles. That's under control of the watch standers. And then, in addition to this level of automation, you can decide if, at the end, you want the person in the loop or you want to let the system go ahead and prosecute the engagement.

So that – we're comfortable with that level of automation and that's the weapon side. We also have doctrine for how we display things and doctrine for identification. And so those are all automated tools that we're comfortable with and use daily and proficient in. So AIML can really help us in a couple different ways. So one is under the hood, and actually in Aegis BMD we're using AI to improve our performance under the hood, improve our algorithms based on reviewing terabytes of archived ground test data.

Mr. Karako: And the Common Source Library type?

Rear Adm. Druggan: This is – it is in the Common Source Library from the BMD piece. So we improve our specifications and then in our algorithms through the use of AIML. We're either data mining or we're using AIML to work a broader set of possibilities because it can do it very quickly and come up with a more robust specification or algorithm that then we can put into the Aegis Weapon System and it's under the hood.

So we do that with discrimination today. We have some level of AI-derived specifications in our BMD discrimination algorithms. I'll talk about discrimination in a minute. That's really important. We need to talk about BMD discrimination.

Mr. Karako: We do. All right. (Laughs.)

Rear Adm. Druggan: Then there's the other piece, which there's – which is assisting the warfighting, right, the decision-making on when to engage, what to launch, that kind of activity, which is a little bit closer to our heart as uniformed

personnel where accountability is really, really important. We insist on a chain of accountability, which is why within Aegis, even though we have weapons doctrine, it is the CO that's accountable for any weapon that leaves and that's why they have different levels of control that they can implement.

And so when we get to AI, you know, we can't blame the algorithm for a mishap. It's not in our military ethos. It's not in our warrior ethos. So this is the one area where warfighters want a vote. I totally agree. The warfighters get a vote when it comes to the automation of combat and that's – so there will be plenty of good ideas. But we're going to take it through that filter of the warrior ethos and a chain of accountability to make sure that what gets implemented is acceptable to the warfighter.

All right. So that's ground to be plowed. In between you have this thing where it's the augment of human. The one thing we know from the great chess competitions and the chess masters is we had human versus human, and we had the best. And then we put machine versus human and the human crushed the machine, for a while. And then the machine was able to beat the human chess masters over time.

And then an interesting thing happened. We did human-machine teaming. So we had a human-machine team versus a human-machine team. The result was they did – they could beat everybody. They could beat a man alone, or they – man or woman – they could beat the person alone or they could beat the machine alone. The teaming, the augment of human, is pretty powerful. So that's a very fruitful way to go.

And this gets into information overload, control of information, automated recommendations. I'm looking at my screen. I might be at X miles. There might be something at 5X miles. I can't even see it. It'd be – you know, I need that – I need the machine to say hey, there's over here.

Some great examples. Outside a region – outside an airport region, if there's two aircraft flying in formation, what are they? I have two aircraft flying close together. They're not near an airport. Somebody should say, you know, that's probably not commercial aircraft. Maybe military. Why don't you put some attention on that and figure it out? Right. Fighter turning, right. Fighters are pretty agile, right. So if something's maneuvering aggressively in the air, what do we know? We know it's probably not commercial. In fact, the wings would probably rip off of the commercial aircraft.

So a lot of people are, oh, that's not important. That's critical information, where we are working under incredible uncertainty and really trying hard to make sure that we know who's hostile, who's neutral, who are the friendlies, so that we can take positive action without risk. So this is where AI can

really help out is augmenting the human, cueing the human, helping with the information overload.

We have so far to go on display. Our displays could really – we could really improve human performance by really going back to our displays and improving our displays.

So that's the tip of the iceberg. If you have the rest of the day, we'll talk about AI-ML.

Mr. Karako: (Laughs.) Well, unfortunately, we don't have the rest of the day. We've got about 12 minutes or something, I think. Ten minutes, something like that.

So let's talk about VLS tubes. You mentioned there's only so many – 96, 104, what have you. SSGNs are retiring. "Defense News" did some math and, what, 1,800 VLS tubes fewer by the end of the decade. That's a problem. Putting them ashore is helpful there.

So I want to kind of lay that foundation there. Talk to me about some of the effectors, where you are on SM-6, SM-3, where those are going, including for the hypersonic defense mission.

Rear Adm. Druggan: OK. So let's review the missile portfolio, which is our – you know, our defensive arm. If we have – if Aegis is the shield, part of that shield is those missiles, right. So let's start with self-defense. So you got the captain's 45 on the bridge wing, right, so that's the start of self-defense, if you will. But then we move out. In terms of missiles coming out of VLS tubes, we've got Evolve Sea Sparrow missile, right. So we have a Block I and we have a Block II coming, which will bring an active front end and make it more accurate.

After that, we have SM-2, right. Today, we have the SM-2. Block IIIA and B – a lot of nomenclature here. The SM-2 Block IIIC is under development. That brings an active front end to make it more accurate. We have an SM-6 with a booster. So this is an extended-range missile. The DF –

Mr. Karako: And you're going to go 21-inch on that.

Rear Adm. Druggan: The SM – on the booster but not on the actual SM-6. We'll get to the rest. The ESSM, though, is self-defense. SM-2, self-defense, some area defense. Both – so ESSM short range, SM-2 medium range, SM-6 long – extended range. And then we get to BMD missiles. All right. They go into space. All right, and we have the SM-3 Block IA and B. They're about the same in terms of range and reach. And then we have the SM-3 Block IIA. The SM-3 Block IIA is 21-inch all the way – beast of a missile – and goes out a long range. In fact, that's my missile interceptor when I'm doing engage on remote. I've expanded – with that missile, I've expanded my battlespace, my defended

area 4X because now I can use third-party targeting and this missile has the legs to do it.

So, again, ESSM, SM-2, couple variants, SM-6 and then SM-3, a couple variants. So that's the missile portfolio. I'd be incomplete, though, if we stopped there. There's a couple other missile and self-defense systems that we do – that are – as we talk about layered defense they become important – the inner layer.

So you have RAM. You have RAM Block I. That's out there. Ram Block II under development to make it more accurate, take on higher, more stressing threats. And then you have a variant of that called SEA-RAM. It's just a smaller magazine and it's using the CIWS radar. That's on the LCS platforms. And then you have CIWS, of course, and CIWS is usable against many anti-ship cruise missiles. Not all, but it's also very useful in this small boat surface – kind of counter surface environment. So super helpful there.

So if I was to go outside in, SM-3 Block IIAs, long range, SM-3 Block IAs and Bs still in space, SM-6 extended range, SM-2s medium range, ESSM short-range, RAM very short range.

Mr. Karako: All right. So we've reviewed the bidding. Let's come down to Earth on Guam. All right.

Rear Adm. Druggan: Sure.

Mr. Karako: So lots of attention going on there. Lots of possibilities. I'm not going to ask you about the report to Congress. But you have laid over the past discussion some of the characteristics of Aegis, the fact you've got hypersonic defense in your mission.

So help us think about how the Aegis combat system is useful for the protection of some particular nonmovable, nonhideable kind of defended assets. So put some pieces together. How is it that the Aegis philosophy might be useful for something like that?

Rear Adm. Druggan: No, I appreciate that.

Mr. Karako: And you've said that the banning offshore is so much less –

Rear Adm. Druggan: It is less. Absolutely.

Mr. Karako: – than the ship itself. It releases the ship from the tether, et cetera.

Rear Adm. Druggan: Well, not just the ship. The ships.

Mr. Karako: Yeah.

Rear Adm. Druggan: So one of the things that – you know, there's some – when you're on a tether, that means a ship has to be on the tether, right. And to keep one ship in one spot forward usually takes three to five, four to five to source that one station. Not unusual. We do that with carriers.

Where are the carriers? Well, they're there, right. How many do we have? How long can they be there and what's the rotation? You have to account for ships that are in maintenance, ships that are in training, ships that are in advanced training, and then finally the ship actually on deployment, right, doing the mission.

You have to have all of those if you want somebody on that mission in that spot all the time, right. And that's a multi-mission ship and that ship has other jobs that the combatant commander would really like that ship to be doing, right, instead of just doing a single mission – for instance, missile defense. And it doesn't matter where it is, right.

So then we get to Guam. So the first thing is what's the mission? Are we denying North Korea? Are we deterring China? Are we denying China, right? And so each one of those you come up with a different set of options in order to meet that mission, right. So once you kind of have an overarching mission need what we're trying to do in the strategic – from a strategic perspective, then you get to Guam.

Aegis is an acceptable alternative, one of the options, when it comes to the defense of Guam, because we do BMD and we have some hypersonic missile defense capability, and we have cruise missile defense capability. And we do it 360 degrees and we do it reliably with the right level of firepower, and we're also fighting at the network level both Navy NIFC-CA and BMD with engage on remote and launch on remote.

So that's a pretty robust air – that's a pretty robust integrated air and missile defense capability wherever you want it. Ashore, land – that's the piece. Then you get to survivability. So that's – on survivability, let's just talk specifically about Guam. Do we want an Aegis Ashore deck house where it's in a single spot with all capability in one spot or do you want to disperse that? And if you want to disperse some of it, do you want to disperse it and – disperse it or do you want it mobile in order to increase the survivability?

And so that's a rich and valid discussion to have, right. And then the other question is, OK, you got a great cruise missile defense capability but it's over water. Now, if we take – how does that work with where we would put launchers on Guam, where would those – where would those intercepts occur? Is a naval missile optimized for overwater intercepts legitimate or is there work to be done if the intercepts are over land? Versus land-based options that are already qualified over land and may have capability over water.

So that's a fair trade, particularly in the cruise missile domain, on how to do that, and it goes right hand in hand with some of the survivability questions.

So I don't have – I don't have an architecture I can give you or talk about. But it is coming. There's a good rich debate – I think that's fair – to finally come up with the solution that we need to go forward with.

One thing I have not talked about, and I'm remiss in doing this, besides BMD discrimination – I know we're running out of time – is the SM-6. Fantastic missile. Just absolutely a great missile, right. Does self-defense, does area defense, does force level defense with NIFC-CA, does prompt sea strike and does – very key – sea-based terminal. And it is our leading defensive capability for hypersonic missile defense and we would definitely need that. That's the one thing that –

Mr. Karako: For what?

Rear Adm. Druggan: For Guam. We have –

Mr. Karako: Because you got that threat, too?

Rear Adm. Druggan: We really need that hyper – that HMD.

Mr. Karako: Yeah. You put a lot on the table. We're coming up on time. I'm just going to ask you to close out with we began with the coloring book. But as I look at the coloring book, we've kind of achieved a lot of what Wayne Meyer anticipated, envisioned. What comes next? What's the vision for Aegis IAMD for 2030, 2035? What's the next page of the coloring book?

Rear Adm. Druggan: So the next page is fighting at the network level and building that out and then, based on the threat, which is getting really challenging, we are going to need that AIML to bring into it. So we're fighting – you got to fight at the network level. That's multi-ship, multi-aircraft, multi using data from everywhere. That includes space. Space is a very important part of the Aegis future. We're starting there now just by – we'll have the capability in the

next couple of years to do space domain awareness, which is just tracking stuff, because there's a lot of stuff up in orbit – Elon Musk is putting more up every month or two – and Space Command, their mission is to actually keep track of all of that.

And so we can assist there in space domain awareness. Absolutely compatible with routine operations. You know, you lose a few radar resources for a few minutes. That's it. It's not detrimental to the mission at all. So super compatible. We're in places that might be needed by Space Command. So that's an important capability.

So we got space. We got all the sensor pieces to improve that network, because the one thing we know against a peer competitor is we need resiliency. We cannot rely on a couple paths of information – data paths, data streams. We have to have multiple, and if we don't have it, we lose that additional warfighting capability of fighting at the network level and we're down to the individual ships. That's OK when it comes to Aegis, given a defined mission. But it denies you some resiliency and some agility at a strategic level and the operational level if you have that operational – that resilient operational network.

Mr. Karako: Well, unfortunately, there's a lot of people mad at me because they didn't get to ask their question – (laughter) – but I tried to weave them in. We had a ton of them come in. But you've been very generous with your time. Thanks so much. The characteristics of the Aegis Approach – we've covered a lot. But like you said, we could have taken all day.

So thanks to everybody for listening and thanks again to USNI, our partners and also AHI, the sponsor for today. So thanks, everybody, and thanks for tuning in.

Rear Adm. Druggan: Thanks, folks.