HEARING ON "PART OF YOUR WORLD: U.S.-CHINA COMPETITION UNDER THE SEA"

HEARING BEFORE THE U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION

9:15 a.m.

Monday, March 2, 2026

Dirksen Senate Office Building, Room 430, and Webex

U.S.-China Economic and Security Review Commission
444 North Capitol Street NW, Suite 602
Washington, D.C. 20001

U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION

HON. RANDALL SCHRIVER, CHAIR

MICHAEL KUIKEN, VICE CHAIR

COMMISSIONERS:

Hal Brands

Taylor Budowich

Joshua Hodges

Leland Miller

Reva Price

Livia Shmavonian

Chris Slevin

Hon. Jonathan N. Stivers

CONTENTS

CONTENTS (continued)

HEARING ON "PART OF YOUR WORLD: U.S.-CHINA COMPETITION UNDER THE SEA"

Monday, March 2, 2026

U.S.-CHINA ECONOMIC AND SECURITY REVIEW COMMISSION

Washington, D.C.

The Commission met in Dirksen Senate Office Building, Room 430, and Webex at 9:15 a.m., Chair Randall Schriver and Vice Chair Michael Kuiken (Hearing Co-Chairs) presiding.

OPENING STATEMENT OF CHAIR RANDALL SCHRIVER,
HEARING CO-CHAIR

CHAIR SCHRIVER: Good morning and welcome to the second hearing of the USCC 2026 Annual Report cycle. At the outset, I want to welcome relatively new Commissioner Budowich, first hearing as a Commissioner, so thank you.

Let me also thank our witnesses. We appreciate all our witnesses and their statements and the preparation that went into your testimony, but particularly want to say thanks to the first panel here, folks still serving on active duty and have day jobs supporting our forces and our fleet that are in harm's way, as part of Operation Epic Fury. So thank you, in particular, for taking time out to support our work here.

I also want to thank the Senate HELP Committee for allowing us the use their hearing room and the Senate Recording Studio for their assistance in livestreaming this event. All the written testimonies and the transcript of this hearing will be posted on our website, USCC.gov.

Since our founding, the United States has always been a maritime nation. From the earliest days, our security and prosperity have depended on the free use of the seas, and at least since the end of the Second World War, the United States has had global responsibilities to underwrite the safety and security of the maritime commons. American sea power has ensured that the oceans remain peaceful and open to all.

And that maritime order is not a nice-to-have. It is not an abstraction. More than 80 percent of global trade moves by sea. Fiberoptic cables laid on the seabed carry vast amounts of international data traffic and trillions of dollars in financial transactions daily.

Today, that order is being tested. The People's Republic of China is working to reshape the Indo-Pacific in ways that advantage the PRC, and oftentimes at the expense of others, including our allies and partners. It has systematically adopted and pursued an increasingly expansive and belligerent view of its maritime interests. Inside the first island chain, we

have seen China develop artificial features and militarize them. We have seen them seek to operationalize their expansive claims, and they have sought to restrict the lawful activities of other states.

This competition is not confined to the surface of the ocean. Rather, China is investing heavily in capabilities designed to operate in, and potentially control, the undersea domain, an environment that has long provided the United States with a decisive strategic advantage. China is advancing a growing fleet of increasingly capable submarines, unmanned underwater vehicles, seabed sensors, and sophisticated oceanographic mapping programs. Many of these systems have clear dual-use applications, blurring the line between civilian research and military preparation.

The United States retains significant advantages in the undersea domain, but its advantages erode if they are not maintained. As strategic competition with the People's Republic of China intensifies, we must ensure that this domain remains a source of strength and deterrence, not vulnerability.

I look forward to the testimony of our witnesses and to a substantive discussion of how we safeguard America's interests in this increasingly contested domain.

I will now turn the floor over to my colleague and co-chair for this hearing, Vice Chair Michael Kuiken.

[The prepared statement of Chair Schriver follows:]

OPENING STATEMENT OF VICE CHAIR MICHAEL KUIKEN,
HEARING CO-CHAIR

VICE CHAIR KUIKEN: Thank you, Chair Schriver, and I want to thank all of our witnesses for sharing their expertise with us today.

There is a book by Russell Shorto called "The Island at the Center of the World." It tells the story of how, four centuries ago, Dutch settlers arrived at a wilderness island called Manhattan and built New Amsterdam, a free-trading colony that would become New York City and, eventually, one of the most powerful places on earth. Manhattan was the island at the center of the world.

Today, there is a different island at the center of the world, and it is Taiwan.

Consider what is powering this hearing -- the lights shining in our faces, the microphones in front of us, the cameras recording this testimony, all of them run on foundational semiconductors that almost certainly come from Taiwan. The iPhone in your pocket, the infrastructure behind whatever conversation you had with Claude or ChatGPT this

morning, those run on advanced semiconductors that almost certainly come from Taiwan too. Foundational or advanced, these chips are the lifeblood of virtually everything around us.

President Xi has directed the People's Liberation Army to be capable of taking Taiwan by 2027. Look at the calendar. That is 9 months away. We do not know whether capability will become intent, but we do know where the first signals will appear. Space, cyber, and the undersea domain are almost certainly the first places we will see indications and warnings as to whether Beijing intends to move.

So today's hearing is, in an important sense, about Taiwan, and about the undersea domain that surrounds it, connects it to the world, and defends it from adversaries.

But this hearing is about more than military competition beneath the waves. The undersea domain matters in three critical ways, and our panels today will address each of them.

First, it is a military domain, and for more than 80 years, the United States has held an enduring

advantage here. Our stealthy, nuclear-powered submarines provide a key pillar of deterrence. China understands this and is investing deliberately to narrow the gap.

At the strategic level, Beijing has elevated the deep-sea domain to stand alongside space and cyberspace as a national security priority. This is not rhetorical positioning. It is reflected in concrete capability development. President Xi has directed the PLA submarine force to become an elite service, signaling Beijing's intent to strengthen its sea-based deterrent. Over the past 5 years, China has accelerated production of nuclear-powered submarines, launching 10 in the last 5 years compared to just 3 in the 5 years before that.

China's efforts extend beyond traditional submarines. Drawing lessons from the war in Ukraine, Beijing is exploring how unmanned underwater systems could offset U.S. advantages, particularly inside the First Island Chain. Last September, the PLA unveiled two new extra-large uncrewed underwater vehicles, adding to its asymmetric capabilities. Chinese

researchers are also copying DARPA's UUV designs to develop a long-range armed reconnaissance capability.

Second, it is an economic and communications domain, and this is the part most Americans never think about. Right now, roughly 600 fiberoptic cables, each the width of a garden hose, sit on the ocean floor. They carry 99 percent of intercontinental data. More than $10 trillion in financial transactions cross these cables every single day. That data is the feedstock of the global economy. It is what enables payments for household goods, financial transactions between New York and Tokyo, and the vast flows of information that power everything from artificial intelligence to international commerce.

Anything that severs or compromises these cables is not merely a communications disruption. It is a direct threat to the circulatory system of the global economy. And China has both the means and the opportunity. Beijing has developed cable-cutting tools capable of operating at extreme depths and maintains a fleet of vessels operating near critical

undersea infrastructure in the South China Sea and the Taiwan Strait.

Undersea cables have connected continents for nearly 170 years, since the first transatlantic telegraph cable in 1858. The technology has evolved, but the vulnerability has only grown as our dependence on what flows through them has become near total.

Third, it is a strategic resources domain. China is racing to dominate seabed mining, securing more exploration contracts than any other country and striking deals across the Pacific to tap offshore critical minerals. The resources beneath the ocean floor are vast and largely untapped. Seabed mining as an arena of competition is both old and new, but the economic opportunity below the ocean floor will undoubtedly become a focal point of economic statecraft in the coming years and decades.

Together, these three dimensions -- military, economic, and strategic resources -- represent a coordinated effort by China to challenge what has long been a decisive American advantage. Beijing is working simultaneously to close the military gap,

compromise the communications infrastructure, and dominate the resources. Maintaining American advantage across all three will require sustained attention, investment, and strategic clarity.

To help us understand these challenges, we have assembled three panels of witnesses today. Our first panel will offer perspectives on the growing threat to U.S. undersea military superiority. Our second panel will examine China's strategy and growing undersea capabilities. And our third panel will address undersea infrastructure and strategic resources.

With that, I will turn the floor over to our first panel, and Randy is giving me the things I need to say before that. Thank you, Mr. Chairman.

[The prepared statement of Vice Chair Kuiken follows:]

PANEL INTRODUCTIONS BY VICE CHAIR KUIKEN

VICE CHAIR KUIKEN: Today we welcome Vice Admiral Richard Seif, Commander of U.S. Naval Submarine Forces, and Rear Admiral Mike Brookes, Commander of the Office of Naval Intelligence. As I just said, they will offer their perspectives on the growing threat of U.S. undersea superiority and explain how the Department is preparing for China's efforts to challenge U.S. presence.

And with that I will turn it over. Thank you.

STATEMENT OF VICE ADMIRAL RICHARD SEIF,
COMMANDER, NAVAL SUBMARINE FORCES

ADMIRAL SEIF: Chairman Schriver, Vice Chairman Kuiken, and honorable members of the United States-China Economic and Security Review Commission, thank you for the opportunity to discuss an issue central to United States national security in the Indo-Pacific, the undersea domain and the military advantages long provided the United States and our allies.

For decades, the United States undersea forces have been a quiet, often unseen foundation of deterrence and wartime leverage, a force able to operate where other forces cannot, to persist where others cannot remain, to create doubt through stealth, speed, agility, and fire power, and to deliver decisive effects without warning.

On any given day, our Navy has nuclear ballistic missile submarines, guided missile submarines, and fast-attack submarines at sea around the world, today over 20 submarines, all unlocated, all deterring aggression and creating uncertainty for any adversary. Most importantly, those submarines are manned by

highly trained, battle-ready sailors, and I am certain that those men and women, those sailors, are always ready, and they are a true advantage.

The undersea edge provides stability and has helped preserve a free and open regional order in the Indo-Pacific by complicating any adversary's plans for coercion or aggression. Going forward, that advantage will be tested. China is investing heavily in capabilities intended to reduce U.S. stream of action in the Western Pacific through a larger and more modern and capable submarine force, stronger antisubmarine warfare capability and capacity, and expanded sensing and targeting networks in key maritime approaches.

The undersea domain delivers four strategic benefits for the United States.

Deterrence. Undersea forces are the most survivable leg of the nation's nuclear arsenal. This is the capability that most contributes to deterring strategic attack. Similarly, conventionally armed submarines provide credible undersea combat power and lethality, raising uncertainty for an aggressor,

making conflict less attractive and escalation riskier.

Stealth and survivability. Across the spectrum of competition and conflict, submarines can gather intelligence, monitor adversary activity, and hold targets at risk while remaining difficult to detect, target, or defeat. Our speed and agility provide strategic benefit as a force multiplier, as adversaries know that we could literally be anywhere, any time.

As a World War II commander, Admiral Charles Lockwood famously said, to put a finer point on it, "It is always the factor of the unknown that instills fear in the enemy and leads the way to victory."

Power projection. Submarines provide prompt, precision-strike options with little warning and impose costs without requiring large, visible force packages.

Sea denial and sea control. Undersea forces can threaten an adversary's surface ships, logistics, and maritime commerce, often at times and places of our choosing. And our endurance allows us to create that

factor of unknown to carry out these missions for months at a time and anywhere in the world.

China's strategic aim is increasingly clear, to make U.S. intervention and regional conflict slower, costlier, and riskier, and to expand China's control of contested waters, particularly within and beyond the First Island Chain. To support that objective, China is pursuing a multi-pronged undersea strategy.

First, submarine modernization. China is fielding newer nuclear and conventional submarines, likely with improved sensors and weapons, and by many public accounts, steadily improving quieting and operational proficiency.

Anti-submarine warfare improvement. China is expanding its fleet of ASW aircraft, surface combatants, helicopters, and undersea sensing intended to detect, localize, and track submarines operating near China's maritime approaches.

Seabed and network sensing in key areas. Public reporting and Chinese industrial statements have described efforts to deploy seabed sensors and connected networks in part of the South and East China

Sea, often referred to in commentary as an Underwater Great Wall. The strategic implication is not perfect undersea transparency but rather could be a narrowing of the stealth margin in specific chokepoints and operating areas.

In the area of unmanned and autonomous systems, China is also investing in unmanned underwater vehicles for reconnaissance, mapping, and potentially mine warfare and counter-mine warfare, capabilities that could scale and persist at lower cost than manned platforms.

The core requirement for the United States is straightforward and it is enduring. Today we must continue to deliver a battle-ready force. We must leverage our undersea advantage and deter aggression by maintaining ready, responsive, and credible undersea forces and capabilities. We must continue to deliver battle-ready sailors by giving them the tools, training, and resources they need to be successful. We must deliver the battle force of both today and tomorrow, we must grow capacity, and we must develop and integrate new platforms, technology, and

capabilities to maintain our advantage and preserve undersea freedom of action in the future.

As Submarine Force Commander, I am laser-focused on the following lines of effort:

First, posture the fleet to deter and win by sustaining and growing submarine capacity and readiness. This includes accelerating both new submarine production and in-service submarine maintenance throughput, strengthening the industrial base, protecting operational availability, and investing in basing and infrastructure.

Second, we must maintain an operational posture that preserves initiative, operating forward, complicating China's planning, and demonstrating the ability to hold key targets at risk while managing escalation and protecting sources and methods.

We must continue investment in our asymmetric capabilities, expand distributed undersea sensing and counter-sensing, invest in resilient networks, fixed, mobile, and unmanned, that improve command and control, queuing and targeting, while complicating an adversary's ability to localize U.S. undersea forces.

We must field robotic and autonomous systems at scale, build and employ a family of unmanned systems for ISR, payload delivery, and mine and counter-mine missions, paired with robust command and control and autonomy that works in these contested environments.

And we must leverage our allies and partners, deepen allied and partner nation and interchangeability in the undersea domain, increase data-sharing, combined training, interoperable systems, and coordinated posture with allies and partners, especially those positioned along critical maritime approaches.

In closing, the undersea domain remains a decisive U.S. advantage, but our margin is being tested and it cannot be taken for granted. If we invest with urgency, build capacity, and integrate with our allies and partners, the United States can maintain credible deterrence and ensure the Indo-Pacific remains free and open.

Thank you. Admiral Brookes and I look forward to your questions.

[The prepared statement of Admiral Seif follows:]

VICE CHAIR KUIKEN: Go ahead, Admiral Brookes. Sorry.

STATEMENT OF REAR ADMIRAL MIKE BROOKES,
COMMANDER, OFFICE OF NAVAL INTELLIGENCE

ADMIRAL BROOKES: Chairman Schriver, Vice Chairman Kuiken, and distinguished members of the Commission, thank you for inviting me to testify here today to discuss the national security implications of the People's Liberation Army Navy, or PLAN, and their efforts to dominate the undersea domain.

China views undersea warfare as an element of its naval strategy, essential to both defending its coast and projecting power across the Indo-Pacific. This capability is essential to Beijing's approach for countering the United States in the maritime domain.

However, China perceives its undersea capabilities as vulnerable to the United States. This concern is driving investment in quieter submarines, enhanced operational security, seabed sensor networks, and unmanned vehicles. Further, the plan has embarked on an effort to build network capabilities in space, above the sea, on the sea, and under the sea, with all working in concert to create a comprehensive system designed to control key maritime areas and force an

adversary to withdraw before they can threaten Chinese interests.

China currently operates one of the world's largest submarine fleets, with 60 submarines. There are 6 nuclear-powered attack submarines that form the offensive backbone, a growing number of nuclear-powered guided missile variants for precision strikes, 6 ballistic missile submarines, ensuring nuclear deterrence, and more than 50 diesel-electric submarines, many with air-independent propulsion, extending their underwater endurance.

More striking than fleet size is China's domestic submarine production capacity. Through massive infrastructure investments at several of its primary shipyards, China has more than doubled its submarine construction capability, setting up for sustained submarine growth through the 2030s and beyond.

Furthermore, the submarine fleet is undergoing a fundamental transformation. China is shifting from diesel-electric to all nuclear-powered submarine construction, a strategic departure from historical patterns. This includes developing smaller nuclear

submarines, roughly the size of conventional submarines, potentially filling regional patrol missions more economically than full-sized nuclear attack submarines.

China's newest operational attack submarines also represent a progression forward in capability. With the ability to launch anti-ship and land attack cruise missiles, these platforms enhance China's long-range strike capability.

China's ballistic missile submarines, equipped with long-range strategic nuclear missiles, can now target portions of the United States from protected waters near China. Additionally, next-generation platforms, expected by the late 2030s, will incorporate substantial advances in design and weapons.

By 2027, the Chinese submarine force will likely include 70 submarines, and by 2035, continued expansion could yield approximately 80 submarines, with approximately half of those nuclear powered. Projections for the early 2040s include 20 modern attack submarines designed for operations well beyond

the Second Island Chain, and 10 ballistic nuclear subs that can threaten our homeland from bastions inside China's near seas.

Additionally, China has invested in unmanned underwater vehicles for over two decades, fusing military and civilian technologies. Underwater gliders collect oceanographic data, improving sonar performance, and China has revealed extra-large, unmanned vehicle concepts capable of reconnaissance, mine placement, and one-way attacks.

Beijing envisions autonomous vehicles for long-range mine and ISR missions, intelligence surveillance, and reconnaissance, with unmanned systems operating independently or in swarms alongside manned platforms, emphasizing modular payloads, sensors, mines, torpedoes, missiles, and even deployable smaller vehicles.

Central to China's strategy is what they call the "Underwater Great Wall," a seabed sensor architecture monitoring submarine activity through fixed and floating platforms. These systems gather hydrographic and intelligence data to enhance China's understanding

of the undersea domain.

China has also made deep-sea mineral mining a national strategic priority. Chairman Xi Jinping has championed this effort, driving major investment in mining technology, targeting minerals essential for advanced batteries, electronics, and defense applications, areas where China already dominates terrestrial supply chains. In fact, China holds more exploration contracts from the International Seabed Authority than any other nation, 5 of the 22 mining permits.

We are concerned that China's deep-sea mining operations could serve dual-use purposes. The data they are collecting from mapping the ocean floor directly supports submarine warfare capabilities, that is, they are learning the sea floor's topography which helps with submarine navigation and concealment. They are gathering information about acoustic characteristics, which allows them to optimize their sonar systems. And they are identifying locations for anchoring systems, places where they could potentially deploy sensors or weapons platforms in the future.

By 2040, China's undersea forces may credibly challenge U.S. undersea dominance, complicating crisis response and allied defense. China's deep-sea capabilities could threaten undersea cables and sensor networks critical for communications and military operations. Its push for deep-sea minerals could extend control of critical supply chains from land to sea.

In closing, China is pursuing a unified approach, linking strategy, naval modernization, seabed infrastructure, and resource extraction. We cannot assume U.S. undersea advantages will ensure without sustained investment, innovation, and strategic focus.

Again, thank you for allowing me the opportunity to speak with you today and allowing me to share my thoughts and concerns on a topic that I think is vital to our nation and to our national security. I am happy to answer questions you might have.

[The prepared statement of Admiral Brookes follows:]

PANEL I QUESTION AND ANSWER

VICE CHAIR KUIKEN: Thank you, Admiral Brookes. Chair Schriver informed me that I am apparently chairing this portion of the hearing, but I am going to defer to the Chair to ask the first round of questions.

CHAIR SCHRIVER: Thank you, Mr. Vice Chair, and thank you again for your statements. Excellent way to kick off.

Admiral Seif, a couple of questions for you. One, I really appreciate the recommendations you offered, very substantial six recommendations. Some of these would involve more money expenditures. So if you had to prioritize in a resource-constrained environment, where would you put investment? Or maybe these are in rank order. I don't think I heard you say that. But is there anything you want to sort of emphasize as something you think is particularly important and would be a resource priority?

ADMIRAL SEIF: Mr. Chairman, thank you very much for the question. This gets to the heart of why this

is such an important topic with the meeting here today.

The first thing I want to do is talk about the value we place in recent supports such as the National Sea-Based Deterrence Fund and the recent fiscal year 2026 NDAA expansion of continuous production for critical components for both Columbia- and Virginia-class submarines. Those efforts are absolutely foundational to our success, and they allow the Navy and our industrial partners to award timely contracts promoting the stability and predictability essential for growth in our submarine construction capacity.

I think the need to sustain and grow submarine capacity and readiness. We talk about combat surge-ready submarines. There are really two ways to get at that. One is through improving the construction rate and the production of new submarines. But I would say more importantly is getting existing submarines through maintenance and back out at sea, back in a combat surge-ready status. So those two go hand-in-hand, again, both new construction and in-service submarines. And to do that we need to strengthen the

industrial base, but it is also basing and infrastructure.

And as far as investing in asymmetric capabilities, Mr. Chairman, I would say if I had one dollar to spend I would spend it on wide-area search and sensing. And that can be fixed systems, that can be deployable systems, that can be manned and unmanned or hybrid systems. There are efforts to recapitalize existing capability, but if you look just from an Indo-Pacific perspective, if you look at the vastness of the theater and the expanding capabilities, really capacity numbers of adversary submarines, the need for wide-area search that we can use for domain awareness is absolutely critical.

I would also go back to fielding robotic and autonomous systems at scale. We are working on a family of systems, everything from what we call extra-large unmanned undersea vehicles, things like big payload trucks for things like mine warfare, other payloads, as well as large-diameter torpedo tube launch and recovery, just a whole family of systems. So the more we can invest and move out at scale it

will be critically important in the future.

And finally, I did not mention it in my opening remarks, but the investment and the focus on SSN(X), which is our next-generation nuclear attack submarine, will be critically important. The Virginia-class submarine is highly capable. It is by far the most capable nuclear attack submarine that has ever existed in the world. But that initial design is actually 30 years old. And as we continue to develop Block V, Block VI, Block VII, and Block VIII Virginias, at some point we will need a different form factor with just fundamental differences. So I would ask for the support of the SSN(X) program, sir. Thank you for the question.

CHAIR SCHRIVER: Thank you. I might have more questions and come back in a second round, but I want to make sure I get to Admiral Brookes. When you and I trained at Navy Intelligence School together we were studying Soviet Russian systems, and my recollection is the PLAN was a bit of an afterthought at the time. And things have changed very dramatically, and it is a very dynamic environment, as you noted, all the

investments that the PRC is making.

Where would you see are the critical gaps in terms of our understanding of red here, and what might be required to close those gaps? Is it resources? Is it reapportioning resources from the global challenges we are trying to address? Is there something that is really glaring to you that we need to know more about, that there is a capability gap on our part, to be able to understand it better?

ADMIRAL BROOKES: Thank you for the question, Mr. Chairman. I concur with Vice Admiral Seif's comments with regard to the sort of asymmetric advantage that the U.S. submarine force represents, both the platforms and the sailors, ready and resilient, and then the foundry that supports them. Part of that foundry is the naval intelligence enterprise.

When Vice Admiral Seif talks about investing in wide-area surveillance and collection, collection capabilities against an adversary I fully support, strongly support. But I urge folks not to forget about the processing, exploitation, and dissemination with regard to what we collect.

We spend a lot of time tracking the Chinese development in all these areas, whether it is quieter submarines or the system of systems that they are using to try to make the ocean appear transparent. Ultimately, we need to invest in the folks that are actually going to exploit that, subject matter experts, but also tools to be able to do it more efficiently and effective, so artificial intelligence algorithms, for example.

Thank you for the question.

VICE CHAIR KUIKEN: Thank you, Commissioner Schriver. I will put both questions to both of you. If you want to answer, go ahead. In your testimony you both talked about this idea of coordination between research vessels, civilian vessels, and military vessels. I totally understand the threat. Can you just talk to us about how we can think about countering that threat and those activities?

ADMIRAL SEIF: Vice Chairman Kuiken, just so I understand the question, are you talking about the integration of military maritime forces with maritime Coast Guard activities?

VICE CHAIR KUIKEN: Yeah, 100 percent. So what we see the Chinese doing on a routine basis is they deploy sort of civilian vessels, research vessels, military vessels, and in theory, and sort of the we have thought about this historically, is they operate in sort of separate and parallel lines of effort. But what we are starting to see, or what we really have seen China do over the last decade or so is that these are actually truly integrated efforts. This is sort of one force, one fight.

So as we think about recommendations to Congress on countering this activity, in the undersea domain, especially, how should we think about that?

ADMIRAL SEIF: Okay. Yeah, thanks for the question. I do, first of all, firmly agree with your point where there is a blending of maritime, militia, Coast Guard activity, even things like civilian trawlers potentially being integrated for broader activity.

I think from an undersea perspective, we are aware of that. We track that activity closely. And as far as like a risk imposed, I do think that we, as

a stealth force, we put tremendous value on our ability to avoid detection and to be, as we say in our community, always on scene but rarely seen. So I do think that there could be a complication there, where you are not quite sure, the ambiguity of sort of different actors and activity.

As far as concerns or how to manage, right now I would say that is a manageable concern. To Admiral Brookes' point about this Underwater Great Wall, I think that is just another area where we have to continue to learn more about what the goals are and what the potential risks are. So thanks for the question.

ADMIRAL BROOKES: Mr. Vice Chairman, I fully concur with the military-civilian fusion. The Chinese have oceanographic research fleet of approximately 60 vessels. At least 80 or so have been identified as having direct ties to the PLAN. PLAN regularly exploits the information that they derive and has dual use and certainly military capabilities.

So I think awareness is the first step, awareness that that is a problem, and then looking at specific

technologies that potentially would support oceanographic research in a civilian capacity but understanding the potential dual-use military relationship there and restricting those. Additionally, restricting access for ostensibly civilian researchers whose results of their research will fuel the PLAN. Thank you, sir.

VICE CHAIR KUIKEN: Thank you. There is a lot of coverage these days about the lessons learned from Ukraine, particularly with respect to drones. How should we think about lessons learned from Ukraine and the Black Sea and apply that to sort of potential lessons for the Taiwan conflict and beyond? Again, to both of you. Vice Admiral Seif, if you want to go first, go ahead.

ADMIRAL BROOKES: Sir, we spend a lot of time thinking about what the future looks like. And if we talk about uncrewed vehicles -- airborne or undersea or on the surface -- I would say that future is here. And what we expect the future to look like is actually more of the same sort of greater scope and scale with regard to what we are being asked to do in the

uncrewed world.

But I think what we see next is pairing that with artificial intelligence and quantum computing technology to make it more effective and more efficient and to make them more ubiquitous. I think that's what the future looks like.

VICE CHAIR KUIKEN: Thank you. Admiral Seif, in your testimony you talked about forward operational presence being one of your six recommendations. Can you just zoom out -- or not zoom out, I guess zoom in because we want to talk about the undersea domain here -- how we should think about that in the undersea context?

ADMIRAL SEIF: Yeah, thanks for the question. I think, just fundamentally, we place tremendous value on the interchangeability and integration of our most capable allies and partners, whether that is Australia, Japan, South Korea, and our treaty allies as well as our broader partners.

I think when we use the term "interchangeable" versus "interoperable," just to put a finer point on that, interoperable might mean that we can communicate

together, we can share tactics, we can work together under a combined maritime component commander. Interchangeable means that if a U.S. aircraft is supposed to fly and cover a mission but they can't for some reason, an allied aircraft can just plug and play right in there. That could be a submarine. That could be a surface ship. So that's really the goal and that's the end state.

I also think that the value, if you just differentiate what the United States and our allies bring compared to China, and you look at the value and contribution of our allies and partners, who are committed, capable, and interchangeable, I really do think that is a tremendous advantage that the United States has over China, where they really have no answer for our ability to fully integrate with our most capable allies. Thank you.

VICE CHAIR KUIKEN: Thank you, Admiral. Welcome, Taylor, to the Commission, and I will turn it over to you for your first round of questions.

COMMISSIONER BUDOWICH: Thank you, and thank you both for being here. I am going to follow up on a

question from the Vice Chair. There is obviously a lot of interplay between China's commercial activity and its military activity. Is there anything in this domain that is purely commercial, or how are you looking at this and how does this play into the military ambitions wholly? Is there anything that can be overlooked or ignored as just a purely commercial endeavor, or is this completely overlapping?

ADMIRAL BROOKES: Thank you for the question, Commissioner. I think China understands the value proposition of the U.S. submarine force and its asymmetric advantage in the undersea realm. China understands it is behind and is looking for every advantage to erode that lead that we have.

So I think a short answer to your question would be no, there is nothing in the undersea realm that is simply solely commercial, certainly not from the Chinese perspective. When we mention the oceanographic research vessels, essentially civilian research missions, potentially, but China has identified the seabed as the next area for military competition. So those oceanographic research vessels

are looking for ways to protect their own infrastructure undersea but also looking for ways to attack other adversaries' infrastructure. Similarly with regard to deep-sea mining for minerals, applications for obviously commercial use but military, as well.

So I think, from our perspective, there is not a single area there, and from the Chinese perspective, that is limited to solely commercial capability.

ADMIRAL SEIF: Commissioner, if I could just add to that too. First of all, I alerted on your term "ignore." There is nothing we are ignoring about any Chinese activity, whether it is ostensibly civilian or military or this kind of gray sort of blended area. Another example would be in the Arctic. China has declared themselves a near-Arctic nation, and what that means and what level of activity.

I highlight that just because this is a global issue, and I know we're going to talk about INDOPACOM. I would say that we are laser-focused on all Chinese activity in the Indo-Pacific, but we also are looking more broadly at this accumulation of Chinese activity,

whether it is commercial or military worldwide. Thank you.

COMMISSIONER BUDOWICH: And then one more question for you, Admiral Seif. We have talked a lot about innovation in this space, but we have also talked about America's dominance, historically. That would suggest that we have platforms and technology that are dated. What percentage of our platforms that we rely on in technology is dated and being maintained? How are we maintaining it? And what is the deterioration in the immediate future?

ADMIRAL SEIF: This is a really good question, and the way I will approach it is just looking at our evolved force structure. Today we have 48 attack submarines. That is an even mix of newer Virginia-class submarines as well as Seawolf-class submarines and Los Angeles-class submarines. It is a very fair point that some of those submarines are, as we say, American classics. They are over 30 years old, and in some cases even older.

What we do have, though, is a very robust refresh technical insertion, as we call it, to take the latest

technology and very, very quickly and rapidly, not quite like a Tesla, but very quickly and rapidly upgrade the technology and upgrade the capabilities, as we bring on, like Admiral Brookes mentioned, quantum computing. We start to look at artificial intelligence, machine learning. I can tell you today we have over a dozen submarines that have really state-of-the-art algorithms. We call them like a copilot for AI/ML. Anywhere you have a lot of data and not a lot of analysts to look at the date, it screams for AI/ML, as an example.

So I guess what I would just say is that the credible deterrence that comes with our undersea forces is underpinned by this ability to quickly update. So going forward, whether it is quantum, whether it is artificial intelligence, machine learning, or other new capability, or even unmanned systems as we integrate those payloads, we will be fully ready to do that. Thank you.

COMMISSIONER BUDOWICH: Perfect. Thank you.

VICE CHAIR KUIKEN: Thank you, Commissioner. Budowich. Commissioner Hodges.

COMMISSIONER HODGES: Good morning. Thank you for your time, both. As we are examining these undersea threats in the Indo-Pacific, beyond submarine capabilities can you speak about the importance of maintaining forward deployment access? You spoke earlier about China increasing its capabilities. And as we see that sort of across the board, how important are strategic sites such as Diego Garcia and the Chagos Islands?

ADMIRAL SEIF: Thanks for the question. I will take this one first, Admiral Brookes. Our mission is to dominate the undersea and to deter aggression through our readiness for decisive victory in combat, and it really is our core business. When we start to look at the forward basing, or what we call forward-deployed naval forces, the obvious value is being already in position, already ready to do not just the sustainment but the sustained operations and operating tempo that is required.

For example, we have five nuclear attack submarines homeported in Guam. We have a very robust forward-deployed naval force capability in Yokosuka

that does not include submarines but includes support of submarines. And then looking forward to the AUKUS, what is called Phase 1 of Pillar 1, by the end of 2027 we will have the first U.S.-flagged submarine operating out of Western Australia, out of Garden Island there.

So what I would say is that forward presence creates doubt for adversaries, where we can very, very quickly be on scene. We can very, very quickly sustain. Again, we are literally only limited by the amount of food that our submarines can carry. So think about 100, 120, 140 days of operations with freeze-dried food, even back that up, because as a force commander I cannot have a boat be on Day 90 of an underway and then have to surge them for combat operations. We have to have a backup plan.

So bottom line is the forward-deployed presence means we are always there, and our ability to sustain operations, it really adds value. Thank you.

COMMISSIONER HODGES: I appreciate that. Thank you. The vulnerability of undersea cables is increasingly important. The internet literally runs

on undersea cables. While I agree with you completely detection is important, there is a little bit of ambiguity, sort of, over how do you protect, how do you repair, getting to sort of the Commissioner's earlier question. Can you walk us through a little bit what the military's current role is, given the limitations and the CCP shadow activity? Either of you.

ADMIRAL BROOKES: So for undersea cables, one of the value propositions for the Office of Naval Intelligence is to provide indications and warning on adversary threats to key undersea infrastructure, and that is something we do. Additionally, with regard to commercial cable cuts, we are often asked to ascribe attribution to how that potentially occurred.

I will tell you, from my sense, cables are valuable and they are vulnerable, but networks themselves potentially can be resilient. We talked a little bit about the valuable piece. Ninety-nine percent of all traffic goes undersea, $12 trillion in commerce on a daily basis, so definitely valuable. They are vulnerable.

Most folks do not understand that cables are cut about 200 times a year, so approximately every 36 hours. Most folks do not understand that happens, though, because service providers are paid to provide that service, and so they have built redundancy into their networks, providing resiliency.

So any part of any plan to protect the cables needs to include investing in a degree of redundancy and then the capability to quickly repair as well as lay new cables.

COMMISSIONER HODGES: Perfect. Thank you. Last question. Admiral Brookes you spoke about sort of the incorporation of attacks and threats. Can you speak briefly about how you see the PLA leveraging and implementing AI into some of these upcoming sort of activities that have the capabilities they have, and is the United States keeping pace with the implementation?

ADMIRAL BROOKES: So the People's Liberation Army Navy is interested in doing much of the same things we are. As we are looking for opportunities to stay ahead, they are looking for opportunities to catch up.

Hence, the whole-scale investment in a family of unmanned undersea systems. And I think they view artificial intelligence and quantum computing the same way as we do, as a shortcut to keeping up or catching up.

COMMISSIONER HODGES: Thank you.

VICE CHAIR KUIKEN: Thank you, Commissioner Hodges. Commissioner Miller.

COMMISSIONER MILLER: Thank you. Admiral Seif, your testimony talks about how undersea competition is often localized. Where would you say the Chinese localization advantage begins to ebb? Is it somewhere off China's coast? Is it the First Island Chain? Is it the Second Island Chain? How should we think about this?

ADMIRAL SEIF: Commissioner, thank you for that question. Again, our core mission is to dominate the undersea and to deter that aggression through our presence and our readiness. I think, intuitively, if you look at, we would say, fighting a home game for the Chinese, or their ability to mass capability and to have very sustained presence in areas inside the

First Island Chain, we have to acknowledge that.

At the same time, sir, I would tell you that we will not cede any operating areas, any battle space to any potential adversary. But as we go ahead, the way I would say it is that the Chinese are on an all-domain access denial plan. They are looking to deny us access in cyber, in space, and then in the undersea. And I think that is really why we are here today, is because the area where we know we have a solid advantage is in the undersea.

At the same time I would say, just fundamentally, the farther away from coastlines, coastal offense -- the Chairman mentioned buildup of islands, that sort of thing -- the farther you get away from that umbrella of kind of near tactical activity is where I would say, any advantage the Chinese might have today would certainly ebb. And I will turn it over to Admiral Brookes to talk next things.

ADMIRAL BROOKES: Sir, if I could add to that, where the Chinese are now is not where they want to be. The Chinese are building a global fleet, to project power globally. And so when we see the

development of new advanced nuclear submarines with advanced quieting of weapon systems, conducting extended out-of-area deployments, that is the shape of things to come.

So I concur with Vice Admiral Seif with regard to the closer they are inside the First Island Chain, potentially out to the Second Island Chain, they are more capable, but they are not satisfied with that. So they are continuing to pursue a global fleet, and along with that global fleet would be infrastructure, so bases or port facilities in which they can pull in to support that global fleet.

So I wouldn't spend too much time focused on where they are. I would look to where they are going to be. Thank you, sir.

COMMISSIONER MILLER: Another question for either or both of you. What is the UUV threat to our submarines? Typically when we hear about UUVs we think of it in terms of affecting landing barges in the Taiwan Strait or sensing underwater in sort of narrow channels or creating a wall so that one force cannot get to where they want to be. But what is the

future point, or how far are we away from the UUVs, either because of advances in technology or their just flat-out proliferation, where they become a true threat to our advanced submarines?

ADMIRAL BROOKES: Sir, I will start with the answer to that question. Again, we talk about asymmetric advantage the U.S. submarine force presents, Chinese seeking to erode that advantage. They are building what we refer to as a system of systems. We have both mentioned the Underwater Great Wall.

The concept of UUVs are multifaceted. I am an intel officer. I am mostly interested in collection. So these UUVs are a part of a system, a system of collection, to turn the ocean transparent, so they can detect U.S. submarines. But also UUVs have operational missions or role, whether it is delivering mines or torpedoes, or one-way attack.

So in addition to making the ocean transparent, they want to be able to detect, track, and if necessary, engage adversary platforms. Thank you for the question, sir.

ADMIRAL SEIF: First of all, I concur with everything Administration Brookes just hit on. What I would say, near term, any threat or any concern we would have about unmanned vehicles would be in the sensing domain, where wave gliders, things that might be able to, you know, fielding things at scale, deployable systems might present a concern of fleeting detections of U.S. forces.

Going forward, I think it is about payloads, things like mine warfare, ability to covertly deliver effects, and we talked about some of the seabed activity. Near term, though, I don't want to downplay, but I think the concern now is manageable, but as Admiral Brookes said, I think it is a growth area and one that we will have to continue to stay ahead of. Thank you.

COMMISSIONER MILLER: Thank you.

VICE CHAIR KUIKEN: Thank you, Commissioner Miller. Commissioner Price.

COMMISSIONER PRICE: Thank you, and thank you both for being here today. We really appreciate your testimony.

Rear Admiral Brookes, in your written testimony you talk a bit about China's bilateral relationships specifically related to seabed mining. Can you talk a little bit more about that and what those relationships are and what you are watching most carefully?

ADMIRAL BROOKES: Commissioner, are you referring to the military-civilian fusion in their approach to seabed?

COMMISSIONER PRICE: Yeah. It is in the section under "Deep-Sea Mining, Dual-Use Concerns." Yeah.

ADMIRAL BROOKES: Yes, ma'am. As I noted, China is pursuing military-civilian fusion both with technologies in the UUV family of unmanned underwater systems, but also with regard to taking advantage of any type of oceanographic research that is conducted in the undersea domain. That includes understanding sensing in the water column, whether it is currents or temperatures or salinity, to improve sensors, and then understanding seabed topography, to be able to drive military applications from that. Being able to identify critical undersea infrastructure associated

with adversaries that they would subsequently potentially be able to detect. So that partnership between the military and the civilian is engrained into essentially everything that they do.

COMMISSIONER PRICE: You particularly talked about the Cook Islands, Kiribati, just in terms of the security of the area. Can you expand on that?

ADMIRAL BROOKES: Yes, ma'am. That gets a little bit to, China is interested in doing deep-sea mineral exploration outside its EEZ, and is working with other countries, other partners, to help them to be able to exploit mining in their EEZ. And essentially it is an extension of the Belt and Road Initiative that they have used, where they use economic leverage to then subsequently gain political or military advantage.

So ultimately, once they get the country hooked on their economic infrastructure advantages that they provide, they use that as leverage for political gains, war, to allow military access. So that is a concern.

COMMISSIONER PRICE: Thank you. And Vice Admiral Seif, you talk about the need to really rely on our

allies and partners. You have mentioned it in response to several questions already. It is something, obviously, we have put a lot of time and energy into. Are there areas where we need to expand?

ADMIRAL SEIF: Yes, ma'am. Thanks for the question again. Just to reiterate, we place tremendous value on allies and partners and proven partners in maintaining a free and open Indo-Pacific.

I think I will just hit on AUKUS. To me that is a great example of burden sharing and what I think right looks like. Where if we look at the emerging technology, AUKUS Pillar 1 is nuclear-powered submarine technology, but AUKUS Pillar 2 is really everything else that can add value to our ability to fight together, for both Australia and the U.K.

This, to me, is a great model of going forward what we need to be focused on. We need to break down barriers about information sharing, about technology exchange. We have to really streamline any hindrance or any sort of slowdowns that we have there. Because our allies and partners are very committed, they are very eager to fight with us, but we cannot leave them

behind.

We cannot, as Admiral Brookes was talking about quantum, artificial intelligence, emerging technology, unmanned systems is another one, we cannot let ourselves get too outpaced or out of step with our allies. We have to maintain that ability to be interchangeable. And again, in the Australia example, we are fully integrated. We use the same heavyweight torpedo. We use the same fire control system. We use the same unmanned systems. We have about 200 Australian submariners either on our submarines today or in our training pipeline. We have another 200 Australian workers embedded at Pearl Harbor Naval Shipyard.

So again, we are fully integrated with this goal of being interchangeable. I would just offer that, to me, as a good model going forward. Thank you for the question.

COMMISSIONER PRICE: Thank you. That is all.

VICE CHAIR KUIKEN: Thank you, Commissioner Price. Commissioner Shmavonian.

COMMISSIONER SHMAVONIAN: Thank you. I am

grateful for both of you being here today.

I am going to switch to workforce, which we haven't really talked about, but really undergirds readiness at every element. Having a skilled workforce is critical both with respect to our military but also those that support our military in terms of manufacturing. And by some estimates we have a deficit of about 100,000 skilled folks that can make our ships and make our submarines over the next 10 years, and I would be interested in your views both with respect to ensuring that we do continue to have that workforce pipeline that is able to support readiness, both with respect to maintenance but also with respect to manufacturing.

ADMIRAL SEIF: Commissioner, I think that is a fantastic question. I think it really gets to the heart of just root problems we need to really get after.

As I think you know, we have recently stood up a Direct Reporting Program Manager, a Director for Submarines, and really, we really value, obviously, readiness and deterrence. But that comes from ships

delivered on time and ships maintained on time. And again, accountability matters, having one accountable individual, and also having accountability in our contracting process, with whether it is a prime contractor, defense contractor, or private shipyard.

And again, we absolutely need a larger and more stable skilled workforce, not just at the yards but across our supplier base. I would say the top two reasons or the top two concerns we have about submarine maintenance throughput, one is supplies, one is having the right parts that we need, when we need them, to get the job done and get the next step in the construction done or the maintenance done. The other one is not just having the workforce but retaining the workforce. The ability to get these highly skilled individuals, and then, at the same time, incentivize or retain them is also important. And again, higher supplier liability for casting, components, all the things that go with that.

And I think for this group I would also say predictable funding that allows industry to invest. I think if I was going to do forensics on sort of how we

got here and go back to decades ago, I think there were mixed signals and fits and starts signals to civilian industry about this sort of thing, which in some ways drove, I think, bad behavior. They were not incentivized to continue to grow the workforce.

I think also I would say, personally having been to our private shipyards, having been to our public shipyards, again I would say -- when I say battle-ready sailors it is also this battle-ready workforce. I will tell you that it is incredibly impressive what those men and women are doing. And I know we are looking ahead to, back to the question earlier about new technology, there could be advanced manufacturing solutions where maybe I don't need a 20-year skilled welder because I have developed some advanced manufacturing process. All that is underway, and all that is also going well. For example, we have delivered close to 100 advanced manufactured parts for submarines last year, and we are on pace to really move that out to scale.

But at the same time I think you have hit on a key point and a key question, but I would just say

that the workers we have are incredibly professional and incredibly skilled. We just need to keep them, and we need to continue to grow the workforce. Thank you.

COMMISSIONER SHMAVONIAN: Thank you. And if you have any additional recommendations that you would like to send over to staff on that piece, please let me know.

We have talked a bit about AI and quantum computing. I am interested in how you view quantum sensing and quantum communication and the risks and also opportunities associated with both of those technologies. For either of you.

ADMIRAL SEIF: This is really all about warfighting advantages, and again, sustaining that advantage, what we are here talking about today, and really new technologies such as quantum computing, quantum sensing, AI and ML, robotic autonomous systems, they really are meant to expand it.

When we think about quantum we think about encryption, sensing as you said, modeling and simulation. And then artificial intelligence, machine

learning for data management and decision-making. And really, in some cases, with a lot of data you want to make the haystack smaller. In other cases you want to automate features to allow operators to focus on what is most important.

And again, as I mentioned to the previous Commissioner's question, our architecture and our processing and computing capability on our submarines is really something we can leverage in the future. We are building in the capacity to very quickly integrate and upgrade as these systems come online. Thank you.

COMMISSIONER SHMAVONIAN: Would you say that we match or exceed China's capabilities in those spaces?

ADMIRAL BROOKES: I think that it is a race, and we are not sure where we are in the race, other than the fact that they are putting a tremendous amount of investment toward it. And then if we are unable to match or unwilling to match, then we put ourselves at a disadvantage.

COMMISSIONER SHMAVONIAN: Thank you.

VICE CHAIR KUIKEN: Thank you, Commissioner. Commissioner Slevin.

COMMISSIONER SLEVIN: Good morning. Thank you both for your excellent testimonies. I wanted to ask if you could comment at all on China-Russia coordination or collaboration and in what domains, and if there are any indicators that would signal more meaningful collaboration that what you currently see.

ADMIRAL BROOKES: Thank you for that question, Commissioner. I think historically we viewed China as having a dislike of one another, and I think that is historical in nature. At the fall of the Soviet Union, Russia did sell platforms to the Chinese, specifically kilo submarines and some anti-ship cruise missile capabilities, that significantly helped them jumpstart their submarine construction program and give them advancements in quieting, with regard to propulsion, and sensors.

Of late, we have seen a lot with regard to the relationship between China and sort of the no limits on that relationship. But I don't know that that has actually delivered anything concrete from the Russians to the Chinese in that regard. I think we would attribute more of the Chinese testing and innovating

and then continuing to iterate on their innovations for their advancements to date.

ADMIRAL SEIF: Mr. Commissioner, I would agree with Admiral Brookes' comments. I would also offer that we pay very close attention to all activity in the Indo-Pacific theater. And we have historically observed what I would call basic level interoperability type exercises or operations between those two potential adversary countries. We have not seen anything, I would say, beyond that. But when you hear relationship without limits, we are obviously alert for any indications of that, but now I would say Admiral Brookes characterized it very well. Thank you.

COMMISSIONER SLEVIN: Thank you both for those answers. Admiral Seif, you have commented on allied coordination and the importance of such, and AUKUS as an example. I am wondering if there are one or two areas of improvement or gaps that you would highlight for the Commission as to what could be improved.

ADMIRAL SEIF: Yeah, Commissioner, thanks for the question. I would say, as a positive, just

fundamentally, our allies in the Indo-Pacific theater are incredibly professional and incredibly capable, and they are very eager to do more and to fully integrate with U.S. forces in the Seventh Fleet, and more broadly, in INDOPACOM.

If there are areas we could continue to evolve and improve I would say back to this interchangeability discussion. If you look at just the vastness of the theater, growing key allies' ability just to cover either geographic areas for us or to cover specific mission sets. We talked just recently about the unmanned vehicles, surveys, could be mine warfare, could be strike warfare, could be anti-submarine warfare.

And when I say anti-submarine warfare, this is a team sport, team effort. It is cross-domain. Tracking a target submarine is space to sea floor and everything in between. And when you can plug in allies and partners into that cross-domain mix -- it could be a surface ship, it could be an allied submarine, it could be an allied aircraft with allied or U.S. sonobuoys -- and being able to just do

handoffs and do that little interchangeability, that is what we are keenly focused on. And I think those are all efforts that are underway, and again, I think our allies are eager to maintain that interchangeability and eager to break down any barriers for technology exchanges, allow them to just plug and play like we are talking about. Thank you.

COMMISSIONER SLEVIN: Thank you, Commissioner.

VICE CHAIR KUIKEN: Thank you, Commissioner Slevin. Commissioner Stivers.

COMMISSIONER STIVERS: Thank you both for being here today, and thank you for your service to our country.

Vice Admiral Seif, you said in your testimony that any perceived erosion of U.S. undersea freedom of action may alter China's risk calculus and embolden them to pursue their strategic objectives. Rear Admiral Brookes, you stated in your testimony, by 2040, the PLA Navy's undersea forces may credibly challenge U.S. regional maritime dominance, complicating crisis response, power projection, and allied defense.

You and others we will hear from today really paint a grim picture of what will happen in terms of the balance between U.S. and China in terms of competition in the undersea domain if there isn't significant policy change. And you both put very strong recommendations on what the U.S. government should be doing in terms of ramping up its activities and strengthening its capabilities.

Two of our long-term strengths, which you both alluded to in your testimonies are allies and partners in the region, in the Indo-Pacific region, and the U.S. private sector. And I was wondering if you could talk more about that relationship. And I would like to get your view on what should the U.S. private sector be doing to strengthen the capability of our allies and partners in the region. I mean, obviously, Japan, Taiwan, South Korea, but also countries that may have less capability, such as the Philippines and Vietnam, in regards to the South China Sea.

ADMIRAL SEIF: Commissioner, thanks for the question. Again, our job is to deter aggression. I know both Admiral Brookes and I talked about how our

advantage in the undersea will be tested in the future. But again, our job throughout today and in the future is to deter aggression and preserve peace through credible combat power at sea. And that is across the entire spectrum of competition, all the way into conflict. So today as we are talking, and what I would call the competition phase, all the way to, if required, if deterrence fails and we have to then either restore deterrence or shift to kinetic operations.

As far as what I think the private industry might be able to do more, I think it gets back to the previous question about the supply industrial base and just the broader submarine industrial base. I think that there are so many layers to that and so many places where we need more robust supply base. We need more robust innovation.

And at the same time, what we owe industry is breaking down these barriers that allow collaboration and allow, for example, under AUKUS Pillar 2, to be able to share technology, share information, be able to work on marquis projects. Again, I think this is

what an example of right looks like, but being able to break those barriers down, to be able to give those real capable allies what they need to be successful. Thank you.

ADMIRAL BROOKES: Commissioner, thank you for the question. From my perspective, we talk about the submarine force as an asymmetric advantage. I represent the foundry that supports that asymmetric advantage. And so when I look at growing PLAN and its capabilities, I look at the naval intelligence enterprise seeking to collect data and turn that into intelligence to support advances for the submarine force, whether that comes from commercial providers and in support of allies.

The pace and scope of how the PLAN is growing means a lot of data to be collected, which, in turn, becomes processing exploitation and dissemination from me or PED. We talked a little bit about the submarine workforce. I have civilians who are subject matter experts who are aging out and retiring. An investment there is appropriate and helpful. We have [unclear] riders that support riding submarines and are a

specialist for protection of the boat and understanding what is going on in the acoustic environment.

But ultimately there will be more data collected than I can ever throw humans at, so I need help with artificial intelligence. I need help with algorithms, to more smartly make sense of that data and turn data into intelligence that subsequently supports improvements for the submarine force, improvements in their sensors, and the like.

COMMISSIONER STIVERS: Okay. Thank you.

VICE CHAIR KUIKEN: All right. We are done with the first round. Commissioner Schriver, do you have a question?

CHAIR SCHRIVER: Yeah, thanks. Another question for Admiral Brookes. When people talk about a potential Taiwan contingency, or really any contingency in the region, people can see what China is fielding, what kit they have, and what they have invested in. But there is this, to use the Rumsfeldian lexicon, there is this known unknown. They have not seen combat since 1979. How do they do

in the fog of war? How do they do in these complex operation? And you see that mostly addressing an amphibious invasion and how complex and difficult that might be, and what are they going to do if problems are thrown at them.

But in the public domain there is not a lot of discussion about the undersea capabilities in this regard. So as they are fielding all this new kit -- submarines, unmanned systems, et cetera -- do you have a sense of how well they are doing in terms of the actual operations and integrating that and how they train and exercise, and maybe throw in the massive purges going on within the PLA, which has not left the PLAN untouched. In fact, some of the major purges have affected that area.

This is kind of our real secret sauce in the U.S. military, U.S. Navy, is how well we train and how well we exercise and how well we prepare -- train like you are going to fight. Do you have a sense of how well the PLAN is doing in that area?

ADMIRAL BROOKES: Thank you for the question, Chairman. When we look at the value proposition of

the U.S. submarine force, it is the advanced platforms. It is, of course, the foundry and the naval intelligence enterprise that supports them. But ultimately the key aspect of it is the professionalism, the training, the experience of the ready and resilient sailors and officers that man the submarine force.

So you mentioned some of the purges that are occurring across the Chinese military, and we see that occurring in the PLAN, as well, up to 80 percent of flag officers and general officers being removed from their positions, up to 80 percent.

So we look at that as, at face value anticipating it has to have some sort of impact on their overall readiness. And yet we see them operate every day, and continue to operate with proficiency and professionalism. But we assess that it is going to be problematic for them. Can they do that in a wartime environment? So we continue to observe and collect on that. It is of significant interest.

I would say overall, with regard to the professionalization of the submarine force, the

Chinese submarine force, again, that becomes a key advantage for us with regard to how they train their leaderships, sort of a dual C2 structure with regard to a party hierarchy associated in command and control on the boat itself. And then they are making strides with regard to training for their enlisted sailors, making it less rote and more dynamic. But I think they have a way to go.

So again, a significant advantage for us.

ADMIRAL SEIF: Mr. Chairman, if I could just add to that quickly, I think as Admiral Brookes said, our number one advantage is highly trained, battle-ready sailors. That is something I feel very strongly about. When I take senior leaders on submarines often, I think they expect to be impressed with the heavy-weight torpedoes and the combat system. They are always most impressed with the sailors that they meet. I really do think that is our strength.

I also would just offer that we place tremendous value on the initiative and the judgment of our on-scene commanders, our submarine commanding officers that are able to operate with autonomy, execute

mission command, but at the same time be ready to integrate with the Joint Force. I do think this is something where we have an advantage.

And I would also offer that I think it is clear that today we do have a clear advantage in platforms, sensors, weapon systems. We are more lethal. We are more survivable. As we like to say, we are the apex predator, and I would say today we do have overmatch against any Chinese undersea threat. And other than that I agree fully with Admiral Brookes' comments. Thank you.

VICE CHAIR KUIKEN: That was certainly my experience when I went on a submarine the first time. Sailors were the thing I left most impressed with.

Admiral Brookes, in your response to questions you said 200 cables are cut a year. Can just give us your sort of assessment of what global capacity is to repair cables as they are cut, and then also does it take a day? Does it take a month? Do I just go to Walmart and get a box and I go clip it on? How does this work?

ADMIRAL BROOKES: Mr. Vice Chairman, thank you

for that question. I think I would be giving you a WAG. I would like to take that as a question for the record. If you would like my WAG, cable laying capability is globally, I think speaking for the U.S., it is in limited capacity. And a lot of the large commercial companies, like Google, are using the cable laying ships. So I think speaking for the U.S. it is a fairly limited capacity. But if I could, sir, I would like to take that as a question for the record.

VICE CHAIR KUIKEN: That is fine. I had never thought of this until you just said Google. In the context of the Air Force we have a civilian air fleet that we can call upon. Is there a similar authority or capacity or capability that exists for the Navy in the event of cable cuts in a conflict situation?

ADMIRAL SEIF: In a crisis we do have an existing framework, where our repair priorities would be coordinated through an interagency process. But I think it is a fair point that we, today, do have limited repair capabilities. I am talking mainly for military applications, but I think the same would apply for -- again, this process would cover that.

Then going forward, what we really support is building resilient and reliable capability that could be government owned, it could be contracted, it could be hybrid, based on cost and readiness. I agree with Admiral Brookes, that we will take the broader question for the record.

VICE CHAIR KUIKEN: I appreciate it. Admiral Brookes, you talked about one of my favorite topics, which is data. Can you just give us a sense of sort of the data readiness of the Navy, I guess just maybe for your purposes, the Office of Naval Intelligence, when it comes to our ability to sort of plug the ethernet cord into ONI's data and just sort of deploy against it?

ADMIRAL BROOKES: I would describe us as somewhat lurching toward the future, lumbering. We talk a lot about, "We'll just do AI," but most people do not understand that AI is a process, and AI requires actually manpower to actually make the algorithm smarter, and to feed information, feed data into the tool to make it smarter. So that is somewhat problematic.

Particularly when you are coming out of a period or an era where information was not necessarily tagged or placed in consistently accessible places to then be able to feed to a machine. So part of the problem with AI is actually getting that data to be accessible, tagging it in a matter, creating it in a manner that subsequent generations of analysts can rapidly consume it and use it for future analysis.

So we have recognized that as a problem. We are working toward addressing that problem. But it is, right now, a little bit slow going.

VICE CHAIR KUIKEN: Very helpful. Thank you. And then one of the things that is a big topic these days is the idea of the sort of conversation around autonomous systems, fully autonomous systems. In the undersea domain, how do we think about full autonomy? Do we think about undersea unmanned systems that drive themselves? Do we think about submarines, you know, boomers without people on them anymore? How should we envision that domain?

ADMIRAL SEIF: This is a great fundamental question. I think big picture, what we are thinking

about is what can unmanned and autonomous, which is a different topic so I am glad you highlighted that, what value can they add? What missions could we offload to unmanned systems? Where could they provide access that a traditional submarine might not be able to get access to? What payloads could they deliver that would add value? What could they do to expand the reach and the sensing of the manned platform? And all those things work together.

I do think, fundamentally, in the undersea, we are not getting GPS fixes. We do not have continuous communications. We are relying on algorithms and on things that allow us to achieve, for example, bottom lock versus operating at the air-water interface, and those sorts of things.

As we go forward, it is all about confidence. We are not going to deploy fully autonomous systems certainly at scale until we are fully confident that those vehicles are going to do what we think they are going to do and that those payloads are going to perform as trained. We do have work to do there. There is some very near-term activity that we are

working on that I am very optimistic on. We have something we call the 2045 Vision. I know that sounds way far out there, but to get to an end state and this roadmap that we are working.

So I think it is a very key point. This is different than coordinates-based targeting in a desert with a continuous GPS. I think it is a very fair point. Thank you.

VICE CHAIR KUIKEN: Thank you both of you for your testimony today and answering all of our questions, and I believe with that we will wrap up this first round. Oh, excuse me. Mr. Hodges, you snuck up on me.

COMMISSIONER HODGES: Sorry about that. One last question. Admiral Brookes, you mentioned in your testimony that by 2040, the PLA Navy's undersea forces may credibly challenge U.S. regional dominance. If trends continue, by 2040, is the U.S. positioned to maintain our advantage? And I guess another way to frame this is, how vital are the recommendations that Administration Seif put forward? Is it fair to say the clock is working against us or for us?

ADMIRAL BROOKES: Thank you for the question, Commissioner, and after I answer I think I would like to turn it over to Admiral Seif. So is the clock working for us or against us? I think that is for us to decide. I think this is for us to win or lose. We have the advantage. Do we have the determination to maintain that advantage? And that advantage looks like investing in advanced platforms like submarines, manned submarines. It looks like investing in collection capabilities, at uncrewed underwater systems, as well as data collection, whether it is fixed or mobile sensors. And the workforce, the workforce to build these platforms, the workforce to exploit the information that we are collecting. Again, it is ours to win or lose.

ADMIRAL SEIF: So I fully agree with Admiral Brookes' comments. I think, again, highlighting our key advantages today are 100 percent our battle-ready sailors, our, what I call generational advantage in things like undersea quieting and technology. And then this other part about allies and partners. So continuing to leverage our very capable allies and

partners that, again, the Chinese really have no comparison or no answer for our ability to integrate with those.

What I think this comes down to is not just identifying a new technology, but I think history would tell us that he who can most quickly integrate that new technology in a meaningful way is what is really going to carry the day, and that is what I think we are really here to talk about. We mentioned, just hit on a few of these emerging technologies. We even talked about advanced manufacturing is probably another one. But our ability not just to be aware of those and to dabble in them and to have some activity versus real, what I would say, RPM versus torque, and really be able to move out in a certain direction is really what is going to make the difference. I am fully committed to that, and I think the work that this panel is doing is just fantastic, and will get us where we need to be. Thank you.

COMMISSIONER HODGES: Thank you both.

VICE CHAIR KUIKEN: Thank you, Commissioner Hodges. Vice Admiral Seif, thanks for being here.

Real Admiral Brookes, thanks for being here. And we will take a 7-minute break, to 10:45, so we can switch out the tables. Thank you.

[Recess.]

PANEL II

INTRODUCTION BY CHAIR SCHRIVER

CHAIR SCHRIVER: Good morning. Let's come back to order please. And we will begin our second panel. To build on our first panel, our next witnesses will look at China's strategic ambitions in the undersea domain and explore the capabilities that China is employing, both today and tomorrow, to achieve these strategic ends.

We will start with Admiral Mike Studeman, who retired from the Navy in 2023. Over Admiral Studeman's 35-year Navy career is served in a variety of senior intelligence roles, including preceding Admiral Brookes as the Commander of the Office of Navy Intelligence, and the Director of National Maritime Intelligence Integration Office. Prior to that he served as Director of Intelligence at both USINDOPACOM and the U.S. Southern Command, and as the Commander of

the Joint Intelligence Operations Center for U.S. Cyber Command. Admiral Studeman will focus on China's undersea strategy and some of the capabilities they are employing to support that strategy.

We will next hear from Dr. Michael Horowitz, who will join us virtually. He is the Director of Perry World House and a Richard Perry Professor at the University of Pennsylvania. Over the course of his career, Dr. Horowitz has served in multiple roles at the Pentagon, including as Deputy Assistant Secretary of Defense for Force Development and Emerging Capabilities. He will be speaking with us about different military concepts and how China is thinking about leveraging emerging technologies in the undersea domain.

Thank you all very much for your testimony, and we look forward to your remarks. And, Admiral Studeman, we will begin with you.

STATEMENT OF MICHAEL STUDEMAN,

REAR ADMIRAL, U.S. NAVY (RET.)

ADMIRAL STUDEMAN: Great. Good morning, Chairman Shriver, Vice Chairman Kuuiken, and distinguished members of the Commission. Thank you for the opportunity to appear before you to discuss undersea issues.

I would like to build on the excellent testimonies of Admirals Seif and Brookes, and first offer a strategic perspective regarding China's approach to maritime matters, of which the undersea is an important subset.

I must first acknowledge how deeply China has invested in its quest to rule the waves, particularly in places that matter to Beijing, all part of its grand strategy. This ambition comes from the very top. Xi Jinping has proven himself China's first great maritime statesman, and has arguably been the strongest proponent of maritime power of any world leader. Xi has helped complete China's swing from its longstanding continental focus to become the world's foremost maritime power. Xi understands that great

powers have largely been dominant sea powers. Xi regularly exhorts his people to enlarge China's access to maritime strong points around the world, secure China's perceived offshore rights, and protect China's nautical gateways. Massive state-directed investments have been made over decades to strengthen China's ability to expand its strategic space, extend and protect its lifelines to global goods and markets, exploit the "blue economy" to meet China's growing resource needs, dominate major tracts of the First Island Chain, and ready the country for high-intensity combat.

Indeed, China's efforts to expand its presence over, on, and under the ocean, from the polar regions to the distance seas, continue at a breakneck pace. China now boasts the world's largest Navy, Coast Guard, maritime militia, deep-sea diving force, fishing fleet, and marine scientific research fleet, and also enjoys the most expansive ownership and operational control regime of global ports of any nation. While America remains a great *naval* power, China will remain the world's preeminent *maritime*

power for many years to come.

The main takeaway I hope to share up front is that from China's perspective, preponderant maritime strength conveys technological, economic, commercial, military, and political advantage. To them, the undersea environment is not simply a dimension of military operations related to a few territorial disputes, as important as they may be. Beijing sees the undersea domain as a priceless frontier that is integral to China's overarching ambition to win the ultimate geopolitical contestation of the 21st century. By strengthening its hand in undersea exploration, resource extraction, and global partnerships on shared areas of scientific and economic interests, China intends to enlarge its comprehensive national power, expand its global throw-weight, and over the long run, outcompete the U.S. as the world's strongest techno-economic superpower.

I would like to shift and discuss perhaps another under-appreciated aspect of China's maritime trajectory and point out that we have mounting undersea challenges across multiple fronts. The

previous witnesses already described the vast array of systems in the Chinese inventory that will form elements of China's Undersea Great Wall and Blue Water Information Network, to deliver on Xi's mandate that he issued in 2014, to create a, quote, "impregnable wall for border and ocean defense," unquote. The PLA is investing in every type of capability to improve its undersea, anti-area, anti-access denial capabilities. The PLA intends to net a wide family of systems together, then use AI and so-called algorithmic warfare to find, fix, and finish U.S. and allied forces, or at least delay, distract, or dilute our operations.

While we must evolve smartly to deal with these rising challenges, we must also remain sensitive to Chinese cleverness and risk-taking elsewhere, not just inside and along the First Island Chain but further afield, out to the far seas and even inside U.S. and allied waters. China's core doctrine of multi-domain precision warfare involves systems-of-systems destruction of key enemy assets wherever they may be. The Chinese have debated the merits of executing

unrestricted warfare incorporating the use of dirty tricks and black operations.

As such, we need to be prepared for the Chinese to engage in a combination of symmetric and asymmetric activities that might include the following, some of which could be executed today, others within the next decade.

One, Chinese cruise missile-equipped subs gradually expanding their operational arcs into U.S. home waters, not just up to Guam or to the Hawaiian Islands, but to the U.S. West Coast and along our northern tier in the Arctic, possibly timed coincidentally with Russian sub patrols.

Two, severing or manipulation of U.S. seabed cables, sound surveillance systems, or energy lifelines.

Three, COSCO ships or other ghost fleet merchant ships dropping leave-behind seafloor sensors or munitions along critical sea lines of communication.

Four, Chinese sleeper cells in the United States that could use commercial waterborne drones for sensing or sabotage near or inside U.S. bases or

ports.

Five, development of a Chinese version of a Russian Poseidon torpedo with transoceanic capability that could threaten our coasts.

And finally, six, capabilities in other domains such as future ballistic missiles that could deliver torpedoes or other maritime effectors quickly at long range toward U.S. operating areas.

These threats are within China's means and willingness to employ under various conditions, and the Chinese continue to demonstrate that they intend to bring the fight to wherever we operate, including inside our borders if necessary.

Let me end by saying that as far as China has come, and as rapidly as they continue to modernize their capabilities, the undersea domain is a gargantuan layer of the planet, infinitely dynamic and complex, and a difficult and dangerous place to do business. The Chinese have not yet matched our technical expertise or militarily relevant knowledge of the undersea, nor have they accumulated the hard-won experiential knowhow of American operators.

Therefore, the U.S. and allied assets continue to enjoy sufficient capability to project power where they need in the near term.

But China's rapidly expanding capabilities in multiple domains have markedly increased the challenges associated with maneuver, attaining battlespace awareness, achieving sea denial or sea control, and defending our homeland.

My hope is that we continue to make the right decisions to keep our military edge so that we can deter or prevail in combat, but I remain deeply troubled that American might still lose the peace to another country that has developed a more enlightened and truly strategic approach to understanding the value of maritime power, in its broadest sense, in making and keeping any nation great.

In the interest of time I will not read aloud my 10 recommendations, but they are available in my written testimony. Thank you for the chance to contribute to this important discussion, and I look forward to your questions.

[The prepared statement of Admiral Studeman

follows:]

CHAIR SCHRIVER: Thank you. Dr. Horowitz.

STATEMENT OF MICHAEL HOROWITZ, DIRECTOR OF PERRY WORLD HOUSE, UNIVERSITY OF PENNSYLVANIA

DR. HOROWITZ: Good morning, everybody, and apologies that I could not be there in person. Hello, Chairman Schriver, Vice Chairman Kuiken, and other distinguished members of the Commission. Thank you for having me today.

The People's Republic of China is part-way through arguably the most consequential expansion of undersea military power in the post-Cold War era, and it has one real purpose, and that is to undermine American undersea superiority. There has been a lot of discussion about China's advances in nuclear-powered and nuclear-armed submarines, but over time I am extremely concerned about the way that Chinese advances in two categories, the first, uncrewed underwater vessels, or UUVs, and the second, their Transparent Ocean initiative, or expansions in sensing, could reshape the naval balance of power in the Indo-Pacific.

The previous panel's reference to 2040 as a potential important moment in this context seems apt

to me, given what we are seeing out of China in this context. Their investment in the undersea domain flows directly from four security imperatives that include, but are not limited to, the territorial disputes that we are all familiar with, including Taiwan and the South China Sea.

China is focused on the maritime domain, in particular, because they are aware that this is the area of greatest comparative advantage for the United States Navy in present, and the uncertainty that the stealth of the United States Navy generates is a substantial deterrent to Chinese activity in the Indo-Pacific.

China is pursuing a number of different maritime initiatives designed to increase its power over time, and I want to devote the remainder of my remarks to two of them. The first, uncrewed underwater vessels, and the second, expansions in sensing, and in particular, the way China seeks to use advances in quantum technology and quantum sensing to make the First Island Chain arena more transparent.

Let's start with UUVs. China's systematic

investment in autonomous undersea vehicles began in earnest now more than 15 years ago. As early as 2021, more than 48 universities and 45 enterprises across China were participating in UUV programs, and China is simultaneously developing and moving towards the fielding of UUVs that include the smaller sizes pursued by the United States Navy, but also much larger platforms that arguably unmatched by any other country, even in ambition, with perhaps the exception of Russia's Poseidon system.

In September 2025, at the PLA parade, the Chinese Navy showed two different designs for an extra-extra-large UUV, that there is no American comparison to. Both designs of it appear to be about 40 meters, with a diameter of 2 to 3 meters, and public reporting suggests a potential range over 15,000 kilometers. This would be the kind of UUV with the capability to not just do some of the mine-laying missions and other sub-seabed missions that the United States has talked about with regards to its UUV capabilities, but also the ability to launch torpedoes or other strike weapons in a way that could potentially be a game-

changer from the perspective of naval power.

It is not simply that extra-extra-large UUV that China is pursuing. China has a range of other programs, including two programs, the AJX-002, and the HSU-100 that are around the size of a slightly smaller of the largest American UUV program at the present, the Orca. But at least one of them appears to have an attribute that the Orca does not, which is the ability to launch torpedoes.

This shows the way that China is not simply developing UUVs for their own sake, but pursuing them and pursuing mission sets for them that are more ambitious, frankly, than what the United States Navy has been doing at present. And given that UUVs are cheaper and faster to produce than traditional nuclear-powered submarines or even larger diesel-electric submarines, it means that they will have the ability to iterate on these systems over time and over the next 10 to 15 years.

So just as when we look at arenas like anti-ship ballistic missiles and anti-ship cruise missiles, that China has iterated with generations of systems quickly

over time, we should expect the same thing in the UUV arena.

Shifting to sensing, China's UUV program is part of a package of undersea developments that is sometimes described as China's Transparent Ocean strategy. It consists of multiple layers, from sub-seabed all the way to space, with the goal being to gain greater sensing capacity in the Indo-Pacific to be able to detect movements of American submarines over time. They seek to use this to develop a seamless kill web that could do exactly what the United States military wants to do undersea -- take advantages of emerging capabilities and use them to improve their striking power. So China's anti-submarine warfare programs would be accelerated by successful deployment of the sensing packages laid out in the Transparent Ocean initiative.

They seek to turbocharge this with advances in quantum sensing. Just as in artificial intelligence, China is competing with the U.S. for leadership in quantum technologies. While there are questions about whether China's model of research in quantum will

succeed, and it is unclear whether there is a Chinese counterpart in the quantum arena that is to something like Deep Seek in the artificial intelligence arena, after cryptography, sensing is one of the obvious areas where there could be quantum payoffs. And China is attempting to use drone-mounted quantum sensors that would enable them to detect small movements in relatively shallow waters, making areas like the Taiwan Strait and the South China Sea obvious areas of applicability for a quantum sensing network. This is an area that China is investing a lot in, and we should expect more in the future.

I would wrap up my opening remarks by saying and re-emphasizing that China is not just attempting to challenge American undersea superiority today, but is planning for tomorrow. They are pursuing advances in emerging capabilities designed to give them the ability to detect and defeat American submarines and other undersea assets in the First Island Chain but beyond that, as well. This is a vital national interest that the United States needs to pay more attention to.

Thank you very much, and I look forward to your questions.

[The prepared statement of Dr. Horowitz follows:]

PANEL II QUESTION AND ANSWER

CHAIR SCHRIVER: Thank you, Dr. Horowitz. For my Commissioner colleagues, we are going to go in reverse alphabetical order this time, after the Chair and Vice Chair, so we will kick to you after our questions.

Let me start with Admiral Studeman. Thanks again for your testimony. And we have been the beneficiary of your input and your visits, and you have helped us get smarter beyond just this testimony.

So I want to ask you a question about the trajectory we are on the ability to create a net assessment in which we would have a high degree of confidence that we understand the deltas and, in particular, the trajectory where it would leave us. But that, as you have pointed out, is reliant on having a very good understanding of where we are at and understanding its trajectory.

So similar to what I asked Admiral Brookes, where do you see the gaps, and closing those gaps of knowledge and intelligence, is that a matter of dedicating more resources? Is that reapportioning intelligence resources more to the China challenge?

What is your take on all that?

ADMIRAL STUDEMAN: U.S. intelligence has been surprised by the Chinese in too many warfare areas, over too many years. We see things that are fielded faster than we thought, technological breakthroughs in key areas. This is a result of China, with a very extreme, secretive culture, successfully thwarting some of our best efforts to understand what is going on.

We do not know enough about what is happening in China's R&D base so that we can go upstream to see the early and faint traces of something that is developing that may be fielded later on. So we need to do a much better job of covering down across multiple sectors in China. It is a huge, labyrinthine kind of complex -- industrial, military, financial complex. It is hard to know. But that should not deter us from putting the right resources there to truly understanding it.

You need the lead time to be able to develop counters or mitigations once you have a sense of what is developing in a certain adversary ecosystem, and frankly, we do not have enough insight there to be

able to deliver that to the acquisition community or operators to make sure that we are ready for anything that may come down the pipeline.

Net assessment is critical. I think we have too little net assessment going on. The intelligence community has sort of stiff-armed doing that. The operator and procurement and acquisition community typically has the best models and will incorporate the red to then kind of fuse the red and the blue and others. And I think we need to have more net assessment in more places.

To get net assessment to be done with the highest quality output you need the highest quality input, which means that you need to be able to understand exactly what all of these technologies are that the Chinese are putting in the water, or on the surface, or in the air, in space. And we, frankly, do not have enough intel there to make sure that we have 100 percent munitions on those things. So we have to work even harder to be able to get the foreign material acquisition and then exportation, and then those circles are running fast. But you need intelligence

from every source.

I believe we do not maximize the use of open sources the way that we should. So we need to harness publicly available information, commercially available information to a better degree.

But ultimately, we need high-fidelity red to go into those net assessment models so you get a precise outcome, and you can do your sensitivity analysis, and they can really figure out where you are. Anybody that might speculate what the undersea domain may look like in a few years I think is skating on very thin ice. We do not know enough. We have to set ourselves up to know more, and to constantly understand that dynamic to see who is accelerating in other areas and who may be being passed or maintaining a sufficient advantage.

CHAIR SCHRIVER: Thank you. Dr. Horowitz, of the two areas you chose to focus on, you focused on the Transparent Ocean initiative that China has undertaken. And again, I will channel Admiral Studeman from a previous conversation that we had. It is not a binary, you are opaque and then you are

transparent. It is opaque to translucent to something close to more transparent, and so on and so forth.

So in terms of where they are now and where they could be in, say, 5 years, are there greater risks in terms of their sensing, detecting sensing, tracking that fall short of a completely transparent ocean?

DR. HOROWITZ: That is a great question. I think they are improving right now, but are not there yet. They are placing sensors, but are facing some of the challenges that we all would expect, and that Admiral Studeman is also well familiar with, which is some of the difficulties in communication undersea. And that particularly when it comes to placing sensors and networking them together, there is a difference between sensors that get information and then the ability to communicate that information and make it actionable, if you wanted to do something about it.

And it is that connection between sensing and action that I think is proving the most challenging for us and, frankly, for them. That is why, in a couple of other contexts related to artificial intelligence I have been skeptical about the prospects

for a truly Transparent Ocean developing.

I do think that the smaller the spaces that we are trying to move our submarines in, and within the First Island Chain you can get into some pretty tight spaces, the higher the probability they have of making progress within the next few years, particularly given their willingness to flood the zone, in some ways, with sensing, and then figure out how to use it, and figure out how to use it later. But as Admiral Studeman said, there is a great deal of uncertainty in this context.

CHAIR SCHRIVER: Thank you. Maybe if there is more time I will come back to you, Admiral Studeman, to add on to that. Vice Chair Kuiken.

VICE CHAIR KUIKEN: Thank you, Commissioner Schriver. It is always good to have a panel with two Mikes.

The recommendations you have, Admiral Studeman, says to supercharge the maritime industrial base and workforce. That is your first recommendation. This is something that I heard about the entire time I was on Capitol Hill. And we always thought about it in

the context of the submarine industrial base and the submarine workforce. In the context of unmanned systems, should we think about it as the same industrial base or a different industrial base, or that there is some sort of Venn diagram? I just would welcome your thoughts on that, because I think it is a possible distinction as we think about this problem.

ADMIRAL STUDEMAN: Yeah. I would prefer to be the answer E, all of the above. So I do think for some of the shipyards, where traditional shipbuilders are working on major platforms, there can be things that are incorporated there to take their best practices and using the existing industrial base.

But we are definitely going to need more rapid manufacturing facilities focused on underwater capabilities. And it is not just UUVs. It is the kinds of things that will build out underwater infrastructure on the seabed, with seabed stations that may be connected, charging stations, for example, and other types of capabilities, from sensing to mining to the use of firepower. All of those things need to be part of what we build as a nation, if we

truly want to take advantage of the oceans in our economy and in our security front.

VICE CHAIR KUIKEN: That is really helpful. I appreciate your --

DR. HOROWITZ: Can I jump in on one piece there?

VICE CHAIR KUIKEN: Oh, sure, Mike. I was going to come to you with a question, but if you want to jump in, go for it.

DR. HOROWITZ: Just to say I think that you are absolutely right what you are implying, which is there is a substantial difference between what the industrial base might look like for UUVs or for USVs, and that is especially true for things more at the smaller kind of frigate size, kind of the max size that you could build in yacht yards. Because one of the challenges is even if we improve the workforce in the main sub industrial base, the orders and sort of size of the yards means that you are already backed up for a really long time.

I think there is massive opportunity by thinking beyond that into things like DARPA's NOMARS program, or just to give an example of one company, a company

like Saronic is doing, since you could produce those in yacht yards rather than the traditional shipyards.

VICE CHAIR KUIKEN: Thanks, Mike. Admiral Studeman, you had this commentary about net assessment. I will tell you, one of the things that I had the hardest time doing when I was in my previous position was getting the intelligence community and the Department of Defense to sort of give you the net assessment. I know there has been a lot of work done on sort of CAP-SAP integration in a variety of areas in this space, but it is something we are terrible at, so I appreciate you sort of shining a light on that issue.

Mike Horowitz, quantum sensing. Last year, this Commission did a trip where we talked to the sort of quantum information science community. One of the areas that we learned a lot about was quantum sensing. As we sort of pulled the string on it last year there were sort of two big observations that I think Commissioner Miller and I had, who were the leads on this trip, and it was that, one, this technology is pretty far away, and two, that the industrial base for

the quantum sensing community mostly exists in the academic community, although there are a lot of folks that do sort of aspirational work in this area. Is that an assessment that you would share, or would you try to recalibrate our minds?

And then the second thing I would say is that one of the things we have been thinking about on the Commission is this idea of convergence. So AI's convergence with quantum sensing, the broader quantum community. Are there opportunities to accelerate the quantum sensing field of science, or is it still too far away? So I will open it up to you, Mike Horowitz.

DR. HOROWITZ: Those are great points. I agree with both of those points. I think that if there is a quantum sensing revolution, unless there is some kind of technical breakthrough that I am unaware of, that probably already happened. We are talking, at a minimum, a sort of 10- to 15-year timeline for that to really pay off. And, in part, that is because you are absolutely right about the second area, which is the quantum field, in some ways, is dominated by universities. Compare that to AI, for example, where

now, of course, it is companies that dominate the AI field, and there were trends, sort of 5 or 10 years ago, where you increasingly had elite faculty that worked on artificial intelligence, not just consulting with the companies but leaving the university world full-time to go to work for varieties of frontier labs.

We have not seen that kind of thing happen in quantum yet, in part because there is not the same amount of money in it, and it is not yet the case that there is research you can do in the commercial space that you cannot do in academia.

I think greater resources toward quantum sensing would seem to be essential. There needs to be some public-private synergy here, I think, to make that happen, because it does seem as though the timelines here are a little bit longer.

VICE CHAIR KUIKEN: Thank you. Admiral Studeman, do you have anything to add on that one?

ADMIRAL STUDEMAN: Well, I think the one area I would focus on is the fact that we have a soft underbelly for Chinese collection on our technical

advancements and our research labs in academic institutions. So if you want to protect the technology then you are going to have to think about security in a different way. You are going to have to think about who is actually in your environment, who you are interacting with, what kind of exchanges you go to.

So too often it is just science for science's sake when we are dealing with techno-economics, superpower competition, which means you need to protect the kind of technology work that you are doing, all the way back to basic research. So who wins this, it may be that we win in terms of the innovative idea, but it is stolen very quickly and scaled by the Chinese. This is the way they have done their approach in so many different ways.

So guarding our tech development at the earliest stages through to full maturity to me is very important to make about all of this, regardless of the technology type.

CHAIR SCHRIVER: Commissioner Stivers.

COMMISSIONER STIVERS: Thank you. Throughout

this hearing we are hearing that the gap between the U.S. and China on undersea capabilities are growing a lot smaller. Admiral Studeman, you wrote that China is moving at a breakneck pace. I believe the year 2040 has been mentioned a couple of times already today.

China has an enormous structural advantage because it is focused on Taiwan, South China Sea, First Island Chain, whereas, in contrast, the U.S. is working globally with Latin America, the Middle East. Given that dynamic it becomes very difficult for the U.S. to reverse the trend between the U.S. and China in terms of underseas, even with robust implementation.

So I keep going back to our allies and partners, and I wanted to ask you both, I guess first, overall, can they be a counterweight to China, and can you assess their capabilities and what do they need to do in terms of technology, in terms of unmanned underwater vehicles? What do they need to do to be that counterweight to deter the Chinese military from taking more aggressive actions in the region?

ADMIRAL STUDEMAN: Commissioner, I think that is exactly the line of thinking we need to have. We need to do everything in our power to maintain coalitions of willing partners across multiple levels. In this area, of course, we have made advances already. We have talked to European nations in underwater capabilities, where many of them in Europe actually developed some very interesting technology, but also in the Western Pacific with Japan and Taiwan and Australia. You have the whole AUKUS deal. I do think there is some potential with India, as well, to operate in a way that strengthens our undersea cooperation.

So I think these things are not sitting at the starting gates, that they are underway. The question is how fast they go, how much support we give them, how robust our experimentation may be. But doing this at scale across multiple interested stakeholder nations is, I think, exactly the right formula to be able to achieve the level of capacity and capability that we will need.

COMMISSIONER STIVERS: Thank you. Dr. Horowitz?

DR. HOROWITZ: I agree with all of that, and I would add, and maybe use Australia as an example here, not in the AUKUS context. I agree completely that Australia's acquisition of nuclear-powered conventional armed submarines would be a great step forward towards increasing the capacity of allies and partners to assist in the deterrence mission in the Indo-Pacific.

But what Australia has done with its Ghost Shark submarine, in particular, should be a real role model and a wakeup call for the United States, in that Australia is moving much faster than the United States to pursue ambitious UUV formats that could include launched effects and are already receiving early units of this.

So it illustrates that there is the ability to generate some of this capacity. UUVs, in particular, are an area where allies and partners might be able to generate more capacity quickly to assist with the deterrence mission. I mean, it is still early days when it comes to the effectiveness of Ghost Shark, and there is a lot of work to do from here to there. But

I think that really illustrate, in particular, relative to our Navy's UUV ambitions, what the range of the possible looks like. So I agree completely, the ability of allies and partners to help out in this space.

COMMISSIONER STIVERS: Are there policy actions the United States can take to, say, surge UUVs or other capabilities to countries like the Philippines?

DR. HOROWITZ: The United States does not have UUV inventory that it could send to the Philippines. A thing that the United States could pursue, for example, would be working maybe through a vehicle like AUKUS or bilaterally to try to, say, scale production of something like Ghost Shark, maybe bring in a country like Japan into the mix, and using that to try to increase capabilities with varieties of allies and partners in the Indo-Pacific, including the Philippines. That is something that would be plausible and based on technology that is now proven.

ADMIRAL STUDEMAN: And I would add that if it is in the government inventory and it has to go through FMS, too many years, too long, et cetera. So really I

think direct commercial sales right now is a good route for many of these nations to take, where you can really deliver quicker, get things in the water, experiment with them, and maybe lap the government by years, potentially. So we want to have both routes, but DCS is probably the best one in the short term.

COMMISSIONER STIVERS: Thank you.

CHAIR SCHRIVER: Commissioner Slevin.

COMMISSIONER SLEVIN: Thank you, Mr. Chairman. Admiral Studeman, you described China's willingness to employ a number of tactics, both maybe current and being prepared for foreseen tactics to harvest technology. We have this U.S. underwater innovation ecosystem, and you described it, I think, in response to Commissioner Kuiken's last question about guarding tech development.

I guess my question is, how would you prioritize where we are most exposed in that ecosystem, and then, two, if you can kind of draw that to some of your recommendations, policy recommendations, as to what Congress or the Administration should prioritize.

ADMIRAL STUDEMAN: I think we are most exposed

with the level of awareness of the American people as to the nature of what we are talking about, in general, with regard to the strategic competition and what it means for America's future and whether or not we should be hardening ourselves, because it will require more hard choices for our research labs, our academic institutions, think tanks, government folks, non-government personnel.

We just have not had a conversation with the country. We are not told that this is sort of the top priority of the 21st century to deal with this level of a nation state challenge. And it is really not just one nation state. It is multiple red nations that aim to see the U.S. decline.

So I wish we would get to this conversation as a nation, and I wish we would actually have a comprehensive campaign by which we would harden ourselves and our allies and partners to be able to understand what is at stake. So I think that is probably the most important aspect of this, to say that technologically speaking, they inhabit our system and we do not inhabit theirs. And they are very good

at theft as well as legitimate purchases and acquisition of knowledge, and this ultimately creates the capability, I think, that you want to talk about. So if you can't do that first part, you are not going to be able to actually protect yourself in the end game, of things that are actually manifest, that there are actual capabilities that the Chinese can use against us.

I do think we have enough lead time to consider what it means for us in terms of homeland defense and not just about something that is way over there. The American homeland, by the way, starts in the U.S. territory of Guam. That is where America's day begins. So we have to think of that as the homeland, Mid-Pac. We have commitments that we make to some Pacific islands. They are the Compact States. So we need to think in those terms of what does it take to actually protect those places. And long lead times may allow us to afford to do different things.

I have recommended that not only do we look at modernizing our SOSA systems, our sound surveillance systems. Those are fixed systems, but you need to

have the whole mobile network that may be established along the right places and in the right vital areas for the homeland. And we need to do things like baselining our port areas so that we understand the acoustic environment. Because you are going to find an adversary thing somewhere in there, and you want to be able to identify it and then react to it properly and not be confused as to what that is before it is too late. And we have nuclear facilities and other things that are accessible by water. So we need to make sure that we are protected. Those are the kinds of things I worry about.

COMMISSIONER SLEVIN: Dr. Horowitz, any reaction to that or anything that you would add, particularly the point about our institutions needing to harden themselves a bit, as Admiral Studeman described?

DR. HOROWITZ: Absolutely. I think that China has demonstrated for decades its willingness and ability to exploit the openness of our society to gain access to all sorts of knowledge relevant for military capabilities and to sustain them economically. Our openness is a strength. This is our great strength.

This is why America is the greatest engine of innovation the world has ever seen. But we face constraints in that regard, especially, I think, in the basic research kind of arena, where it is hard to -- you know, Admiral Studeman was pointing to some of the security challenges we can sometimes face -- it is hard to close things off or even advocate for closing things off, in some cases, because the impact might be to undermine the ability of some of our great institutions to pursue many of the innovations that they have been pursuing.

So there is a balance here, and it has been really challenging for the United States to, I think, recognize some of these security threats and act against them. But there is clearly more we need to do in that arena.

COMMISSIONER SLEVIN: Great. Okay. Thank you. Thank you both.

CHAIR SCHRIVER: Commissioner Shmavonian, just like it is spelled.

COMMISSIONER SHMAVONIAN: It is just like it is spelled. Thank you.

Admiral Studeman, I really appreciate one of the recommendations that you provided regarding raising awareness around China leveraging its merchant ship fleet, its fishing vessels, some of its other what we would describe as civilian capabilities, and the risks that are potentially associated with that. Could you unpack what those risks might look like in practical terms for us to better understand?

ADMIRAL STUDEMAN: Well, you have already seen a taste of sort of Chinese black operations, probably in concert with Russia, with some of the merchant ships dragging their anchors through the Baltic and destroying cables and energy lines there. So I would expect that the Russian tactics and techniques on this are probably being shared with the Chinese as they deepen their relationship.

Many people are obsessed on the so-called gray zone. You need to be equally conscious of the black zone. In other words, there is ambiguous behavior and then there are things that are designed not to leave any fingerprints or did the event even happen, right. And that is where the Chinese think a lot about what

their options and capabilities should be. If you think about a COSCO ship that comes through, look, we know that there are sort of party committees that they have probably intel collection capability on some or many of those, that they are traversing our port system all over the place.

So when we think about the contingency, we would need to think about how we would forestall access by those kinds of vessels. Look, you can put anything in a container. You can drop anything over the side or you can create all sorts of cavities inside merchant ships to do things that on the surface do not look like they are doing anything, but underwater there is some significant action taking place. So whether it is divers, whether it is mines, whether it is sensors, whether it is torpedoes or what have you, we need to be thinking unconventionally about these things, and without a geographic constraint, because our adversary thinks along these lines.

COMMISSIONER SHMAVONIAN: Thank you. Dr. Horowitz, anything you would like to add to that?

DR. HOROWITZ: I agree with that completely. I

think that the sub-seabed threat, in particular, from China has not gotten as much play as the sub-seabed threat from Russia. But Ben Schmitt, who is another researcher at the University of Pennsylvania, has done some extensive work on the sub-seabed topic that I would certain recommend to any of the Commissioners. And I think that this challenge is enormous and illustrates exactly that gray-black distinction that Admiral Studeman suggested.

COMMISSIONER SHMAVONIAN: Thank you. Admiral Studeman, I really appreciate you raising maritime strength versus naval strength and the risks associated with, frankly, the United States allowing our maritime strength to atrophy over the last several decades, and that obviously takes time to build back. Are there specific areas that you would recommend of particular focus in the maritime space as we continue to build out our naval power, as well?

ADMIRAL STUDEMAN: Yeah, I do think if you take a look at the Chinese commercial fleet, 12,000-plus vessels, and we have a few hundred U.S.-flagged. You are not going to catch up probably ever. But I do

think we need to expand our Merchant Marine cadre and the number of U.S.-built or cooperatively-built ships that we can have guaranteed access to, to provide a variety of different functions that relate to our economy over time, regardless of sort of the contingency.

So I think we do need to strengthen those endemic capabilities that should be part of a great nation. And I do think that the President, executive orders have been issued about how to rebuild the maritime industry. Those things should be campaigned on, intensified, followed through with thoroughly, because everything that was outlined in that initial executive order needs to be part of our future. And I hope we robustly pursue it under this administration, and regardless of whatever administration may follow, to continue to keep the knots up in producing what is described, because I do think that that was a very accurate assessment and diagnosis of where we are, and we have too many infirmities, and where we need to be.

COMMISSIONER SHMAVONIAN: Thank you.

CHAIR SCHRIVER: Commissioner Price.

COMMISSIONER PRICE: Thank you, and thank you to both of our witnesses for being here today.

I want to further pull on this string of what I keep thinking of as perhaps we have a lack of imagination on where we should be concerned. Admiral Studeman, you have one particular paragraph where you talked about how China is also masterminding the ability to legitimately buy and illicitly steal technology. I am trying to get my head around what you have alluded to and the need to harden our institutions. Do you have examples that you can share or a particular example where this stands out?

ADMIRAL STUDEMAN: When I was wearing a uniform I was once asked about something similar, and I talked with the Naval Criminal Investigative Service to find out exactly how many cases of what kinds of naval technology the Chinese have licitly or illicitly been after. And it turns out that I had to go into the second page and I was not done with the amount of aggressive Chinese collection, by any means possible, to go after naval technology. That is just one warfare area, right. That is just spread across all

of our different sectors, whether it is air, space, all the way through land warfare, cyber, electromagnetic, et cetera.

Look, this is a massive, sort of millions and millions of grains of sand collection, by hook or by crook, that targets almost every pertinent technology that exists, if it is relevant for building one's economy, developing one's own technological power, or if it is building military power outright.

So this is the way of the Chinese. If you are looking at specific technologies, it is better to ask what technology has not been pursued, because you may get a few items.

COMMISSIONER PRICE: And is it from relationships with research institutions, from manufacturers, from the corporate world, or all of the above?

ADMIRAL STUDEMAN: All of the above.

COMMISSIONER PRICE: So this failure of sort of use imagination on our part, while trying to balance it with our open society, how do you walk that line?

ADMIRAL STUDEMAN: Yeah. I do think that, first of all, our counterintelligence capability is too

small. I think that we probably pulled off some counterintelligence folks to do other missions, too, that should have been kept on this particular target. So whether you are talking about China, Russia, North Korea, Iran, others, I mean, there is a variety of different counterintelligence capacity shortfalls that we have had.

But look, counterintelligence typically goes after foreign intelligence entities, and the Chinese approach is not to just use essentially trained spies to do espionage. That is a small fraction of actually what they do. So we need to actually enlist the commercial industries to understand what vigilance actually looks like when the approach is to use any association, any connection, whether it is from the outside, whether it is a company that is just trying to buy in stakes, a Chinese company that may buy stakes in a U.S. company, just to get the IP, the intellectual property. Or you don't know that there is a Chinese entity somewhere the system down multiple levels of the supply chain, so we need supply chain transparency, which takes a lot of collection and

analysis, because it is ever moving, depending on where we are.

So securitizing our economy can't be just a government function. It will require us to make the case to American companies, no matter their size, and to help incentivize what they do to protect themselves. So this is a security issue, not just a counterintelligence issue, but that is the way to start maybe putting a lens on this to understand exactly that civ-mil fusion on the Chinese side means it doesn't matter how they get it, it ends up being fused back on the Chinese side for capabilities that then they scale much faster than we can.

COMMISSIONER PRICE: Particularly related to ports, are we paying enough attention? This Commission has talked about it a lot over the last few years. Would you comment on that?

ADMIRAL STUDEMAN: Yeah. I commented on baselining some nontraditional things, like what is the acoustic environment and how do you sample that over time to make sure you have a good baseline so you can detect anomalies. How do you make sure that we

can actually do three-dimensional support of vital areas.

The Coast Guard and Homeland Security, FBI, and others have been very attuned to buying Chinese cranes, let's say, or other capabilities that have an ability to phone home, and I think we have some initiatives underway to make sure that we are not dependent on Chinese technology that they use in commercial ports. But many states still have that tech there, and it will take them years to back out of commitments they made for cheap Chinese port technology.

So there are multiple ways this shows up. I do believe we have some visibility on those, and I hope we are pursuing, in a campaigned way, a way to derisk.

COMMISSIONER PRICE: Thank you.

CHAIR SCHRIVER: Commissioner Miller.

COMMISSIONER MILLER: Thank you, Chairman Schriver. One topic that we spend very little time talking about so far has been torpedoes. I understand that the Chinese are working on a new heavyweight torpedo. There have been advances in supercavitation

for years. A question for both of you. How much time do you spend worrying about Chinese torpedo advances?

ADMIRAL STUDEMAN: Well, it was my life for many years, so it hasn't slipped from my mind. And I mention that with regard to the transoceanic torpedo. Look, lightweight torpedoes, in numbers, and placed in the right areas, can be devastating, as well. So you don't disregard any of that.

But we do need to be mindful, and this goes back to the China-Russia connection, whether or not the Russians would make the Chinese privy to everything that they have learned about their Status-6 or Poseidon torpedo, which is a nuclear-powered, nuclear-armed torpedo that can go across entire oceans, at depth, say at about 3,000 feet, at high speed, 100-plus miles an hour. What is the challenge of detecting it and dealing with something of that nature? Whether it is conventional or nuclear, that is not just a STRATCOM question. This is a question we need to take a look at, and we need to have a fine-tuned understanding of exactly, therefore, the Russians may be sharing with the Chinese in this kind

of strategic weaponry. So we do have to look at the entire family, but I do worry about some more than others.

DR. HOROWITZ: The Chinese, it is not just the torpedo technology in this context. Something like the YJ-19, which is a hypersonic designed to be launched from Chinese torpedo tubes, I think is another example of a kind of technology they are working on in this context. And they are also looking at, in the same way the United States is looking at this in some context, edge compute, and what they can do with edge compute in some of their new, heavyweight torpedoes, to make them smarter and more accurate, especially at longer ranges.

And I would just double-tap what Admiral Studeman said about the Poseidon, which is, I mean, an incredibly dangerous piece of military technology at the end of the day. At least I am not familiar with any evidence China has said they would replicate it in the short term, but it certainly seems plausible that they might think about that over time, particularly to, again, put more pressure on the U.S. and the

undersea.

ADMIRAL STUDEMAN: And if I could just follow up, there is a little bit of hint, based on papers that have been written, about the Chinese talking about this. So that's the source of my concern.

COMMISSIONER MILLER: We have spent some time reviewing the personnel pipeline for Chinese submariners, including the process for recruiting to the PLAN Submarine Academy. The numbers I have seen have been, I think, shockingly low in terms of their recruitment numbers. But how would you say that the Chinese recruitment pipeline for submariners compares to the U.S. side, both quantitatively and qualitatively?

ADMIRAL STUDEMAN: I think the average U.S. submariner, given what they need to pass in terms of tests, they are probably the smartest folks that we allow in any community right there. I don't think the average Chinese submariner would ever compare to the average American submariner. The Chinese have a lower base, I guess, from which to work, and that is a testament to some of our academic institutions and the

quality of people that we produce.

But the Chinese have identified this as a problem, and they are searching for ways to improve everything about their training and their operations, including the talent pool that comes in. I think we will maintain an edge there for a long time to come.

DR. HOROWITZ: Yeah. I would add that I think people here are certainly our comparative advantage, and this gets back to something that I think -- I can't remember who said at the end of the first session of this hearing, which is, why don't we call it the uncertainty about China's ability to operate some of these capabilities. Nearly all the things that we have been talking about in the context of China's Navy involve technologies.

With people as our comparative advantage, that gives us an operational edge that it is difficult to quantify at times. And in some ways that is why if they fix their submarine pipeline and can get more talented people in, that might chip away, in some ways, undersea superiority even more than specific technologies over time. Because I think Admiral

Studeman is absolutely right that we have an edge in this space.

COMMISSIONER MILLER: Thank you.

CHAIR SCHRIVER: Commissioner Hodges.

COMMISSIONER HODGES: Admiral Studeman, thank you. Building off of Commissioner Shmavonian's question earlier, I just want to say thank you for highlighting the administration's efforts to prioritize the U.S. shipbuilding industry, the U.S. merchant fleet to reverse years of stagnation.

Your testimony outlined China is investing to win geopolitical contestation, to increase its leverage of, I think you mentioned, economic, military, technology, commercial, and political advantage. You talked earlier, in response to another question, about sort of the scope and the risk. Based off of your expertise, is the CCP willing to exercise or deploy that leverage if they achieve that dominance?

ADMIRAL STUDEMAN: You betcha. I mean, why not? I mean, you have already seen it exerted. And the theory goes that the more powerful China is, the more confident it is, then the more likely they will use

more of its instruments of national power across the full breadth and depth of their capabilities. So, look, you have seen it with their pressure tactics in the South China Sea and around Taiwan, the Senkakus, on the Indian border. You see the presence in the Arctic. You see a lot of different things with regard to their long-range deployments of surface assets, and subsequent risks by the way, into the far reaches of the Pacific, and the Indians are worried about them going in the Indian Ocean, as well.

But I do think that you are exactly right, and I wanted to elevate this conversation early on to say if you are only looking at this in terms of like a military pattern, like it all funnels into where they are and what they are doing, you are missing the point. The point is this is about a strategic competition and comprehensive national power, how you build, generate, and then employ that power. And the Chinese are hooking themselves into the world through the Belt and Road in order to get access to the resources and the markets to then build that capability, the actual ready, deployable power, that

we have a hard time building today.

Because I have made a point in other sessions about how converting your latent power into ready power is the main thing. And the United States has taken too much risk, and we have been too brittle in what it takes to actually convert our natural advantages into real tools of power. The Chinese have never forgotten that. They have built a lot of them, and you can bet your bottom dollar that they are going to use them as they see fit in the future. With a strong sense, too, that it is not all about hard power or sharp power. They are very savvy and very good at the combination of soft, sharp, and hard, which means smart power.

COMMISSIONER HODGES: Thank you. I completely agree. This is important because there is a pervasive view sometimes that, you know, what is the harm if China actually maintains this or gains this advantage. So thank you for those comments.

I also wanted to touch on, you mentioned earlier that CI efforts are too small, recognizing we are going to focus on the Indo-Pacific. Your testimony

also covers leveraging activities inside the United States. In your opinion, is CI reform something that is necessary?

ADMIRAL STUDEMAN: I do believe it is. Most people don't understand what it is to begin with, and then like I said, I think we need to have a new concept of what counterintelligence is. And maybe we use different words to describe the function of protecting yourself against foreign predation, but we need to get on it, because their predatory practices have already shifted the balance of power in their direction.

So for crying out loud, let's protect our economy if economic warfare is just a way of life of today. Political warfare, economic warfare, cyber warfare, information warfare, it is happening today. Therefore, we need suitable instruments that exist within government and suitable public-private activities to be able to protect the parts of the American economy.

COMMISSIONER HODGES: Thank you very much.

CHAIR SCHRIVER: Commissioner Budowich.

COMMISSIONER BUDOWICH: Thank you. Admiral, you said something earlier. You said we are constantly surprised, and you identified the U.S. is failing at open source collection. Can you talk a little bit more about that and where we are failing specifically?

ADMIRAL STUDEMAN: We have made strides -- I do not want to knock those who are working very hard within the intelligence community in the government -- with attempts to be able to harness all that. With deals that have been made with commercial companies, with the onboarding of artificial intelligence, there has been an alacrity that we have seen, particularly lately.

So we are on the move in this regard. You have a Chief Digital Affairs Office, for example, inside the Pentagon, that works on trying to mainstream these capabilities and speed up and accelerate our access to them. But, you know, we, for years, frankly, didn't value the open sources the way that we should have. The amount of knowledge in the world that is created every given day is going to be tremendous, but most of that is actually accessible in the open source

environment.

So my view is that classified sources are very important, but they will need to enrich the open sources, after we do the tradecraft thing of validating and getting confidence levels on all those, versus the other way around, which has been the culture of the intelligence community for too long, which is that the open sources might, maybe, enrich my classified deck of understanding.

So I think we need a culture shift. I think it is underway. It is probably not happening fast enough for my taste, but I do think that a lot of enlightened people are trying to get after it.

COMMISSIONER BUDOWICH: Dr. Horowitz --

DR. HOROWITZ: This is one place -- oh, sorry.

COMMISSIONER BUDOWICH: No. Please go ahead.

DR. HOROWITZ: I was just going to say, this is one place, in particular, where I feel like the incorporation of artificial intelligence could make a big deal in helping aggregate the open source intelligence out there and fuse it with information in the classified space in a way that sort of brings

together the thing that folks like Admiral Studeman have been talking about.

COMMISSIONER BUDOWICH: Thank you for that. Dr. Horowitz, we talk a lot about bottlenecks in production here in the United States, and it is often rather sobering. Can you speak to what bottlenecks you see within China's production and future in this area?

DR. HOROWITZ: I think one of the challenges here is that the bottlenecks for China are fundamentally different because their design and fielding process for ships is fundamentally different than ours. And this is true for a broader set of military capabilities as a whole.

China is willing to field capabilities that are essentially good enough. They are willing to field the 80 percent solution. That is not something the United States has been willing to do in the past. This isn't the place to sort of go through the litany of issues surround U.S. shipbuilding, in particular, or submarine production. But one of the many issues there is the emphasis on quality. Now that is a good

thing when what you are talking about, given the imperative advantage that the U.S. has in things like Virginia-class submarines or SSBNs, but because China is willing to essentially go to market with good-enough technology, they do not face bottlenecks in the same kind of way, and they are willing to iterate faster generationally, because they have really embraced the notion of mass in the future of military power in a different way than the United States. And we first saw this in the context of missile production, but we are now seeing it in the context ship production and submarine production, as well.

COMMISSIONER BUDOWICH: I was hoping to elicit a more optimistic or encouraging feedback, but I appreciate your response. That is all I have.

DR. HOROWITZ: I mean, if you want something more optimistic, I will tell you --

COMMISSIONER BUDOWICH: You don't have to give it to me. It is okay.

DR. HOROWITZ: I will give you a slightly more optimistic thing, which is I think that it has been very challenging for them, no matter how much

technology they have stolen from us, to Admiral Studeman's point, to catch in the highest leverage, highest quality undersea technologies. They are seeking to compensate in other areas, and it is an open question in some ways, whether that, for them, is necessarily going to pay off. I am very worried about that. But I do think that if what you are talking about is who has the high end when it comes to things like quieting technology and when it comes to the sort of like most elite part of the workforce, I think that is something that remains a comparative advantage for the United States.

CHAIR SCHRIVER: Thank you. We might do a quick second round if others have questions.

Admiral Studeman, we have talked mostly about the Indo-Pacific region, the Western Pacific part of that and First Island Chain. Can you give us a sense now of the ops tempo and the presence in the Indian Ocean and areas outside this Western Pacific area, including the Eastern Pacific and how we are seeing any Chinese presence near Hawaii or maybe even West Coast, or is that an ambition of theirs.

ADMIRAL STUDEMAN: So one of the things you look at, if you really want to understand what precedes Chinese military operations is where their research fleets are operating, where they may lay buoys, where they may be interested in scientific collaboration in Area X, Y, or Z. And it turns out the Chinese are in many different areas. The Indian Ocean has been littered with Chinese collectors, essentially, over decades, that suggest to you that there may be some economic exploration in there, but we know that these will precede additional Chinese deployments into that particular region, which, of course, makes New Delhi very nervous, and ought to make others nervous, as well.

I would suggest that you probably take a classified briefing on exactly where the Chinese have been operating. Suffice it to say, you probably will be surprised where they have operated, but it is worth kind of covering that, I think, sub rosa.

CHAIR SCHRIVER: Thank you. Commissioner Kuiken, Vice Chair.

VICE CHAIR KUIKEN: Thank you, Commissioner

Schriver. Thanks for all the great testimony, both of you. Let me just roll through a few questions. As I was listening to both of your answers on the industrial base I take this sort of mildly dark view that the U.S. industrial base will get there eventually, but it is probably not going to happen fast enough, and it won't deliver capability fast enough. So I sort of go to the allies and partners space and always think about what countries really do we have, that we are close with, that we can rely on to help us scale while we build out the capacity of industry. So India, Japan, Korea, maybe the Scandinavians and the Nordics come to mind. Is that a bad way to think about it, or is that the right way to think about it, or something else?

ADMIRAL STUDEMAN: No, I think it is the right way to think about it. You know, I think we need to have more tubes and more firepower, and I say this because that is the way the Chinese think, right. Ultimately, as they do the correlation of military forces, it is one of many political and international factors that they might consider as they contemplate

whether or not to move against Taiwan or anything else.

So they rate us. They scientifically rate all of our platforms and what they can do, and platforms with bigger fire power, frankly, scare them more. And when we take a look at what happens in the late '80s, we ended up decommissioning our SSGNs. Those are 154 tubes. That is 600-plus tubes. And the Chinese know we are decommissioning our SSGNs, so that matters.

So what is there to replace that? Now you have the Virginia-class. It make take 12 VLS tubes on current blocks into 40 later on in Block V. It still doesn't compensate for the absence of the tubes of our SSGNs. So you are going to need to think more creatively about the major and the middle and the smaller size, and that is where I do think we have to work more closely with the allies.

Look, we are out of balance as a military. We are invested in the high end but overinvested in the high end, and we need to keep the high end. But we need to have the middle and the low end to come in like a pyramid, so we have more of those capabilities,

a larger family of those to cover down and give combatant commanders and the President more options.

So I do think that could be a multicolored, multi-flagged thing that we do as we try to build out the base of the pyramid.

VICE CHAIR KUIKEN: That is helpful. You talked about CI reform, counterintelligence reform. I leaned into this one quite a bit when I was still working here in the Senate, and I will tell you, it is a community that does not want to be reformed. So it is something that I think is worthwhile thinking about, but I think it is a very, very hard issue to get at. There are a whole bunch of competitive services across the executive branch, and it is tough.

But I do want to talk to you about foreign military exploitation. You have a recommendation in here about doing more in this space. I think it is, one, something I like you to just talk about for a second, because I don't think it is something that people fully understand. There is huge opportunity in terms of stealing -- or not stealing -- acquiring their platforms and then, obviously, trying to get

whatever you can in terms of intellectual property out of it for counter measures and sort of other opportunities.

But as we think about the intellectual property theft that has been conducted against us, are there ways that we should think about this in a new and different way for ourselves, as well?

ADMIRAL STUDEMAN: I would like to give us some credit here. We are very smart, creative, savvy, clever collectors, and I think that will continue. We have some of the world's best professionals that are in this field. And, frankly, sometimes we have got to use friends, access through friends, to be able to get something that would be important for us to know.

It used to be that you could say, hey, I want to get access to, let's say a friend has a Kilo submarine, let me exploit the Kilo submarine. Increasingly, in today's world of foreign material acquisition and then exploitation, it is the subcomponents, and it is the elements of something that matter. It is the cyber capability. It is the software that is inside the wiring, the hardware. So

that is where it gets really complex for us. It is really difficult because, you know, like climbing Mount Everest. Of all the things that you want to have, you want to prioritize the most important.

But increasingly, they are critical elements of a target system, not simply how fast does it go, what is its endurance, et cetera. So it is getting more and more complicated as technology becomes more sophisticated, and we need, I think, to create more support for that area. Because if you can't get that right, you don't know exactly how that red system operates. Therefore, you may underrate it and it could lead to loss of American lives later on.

We need to create counters and mitigators. We need to understand systems thoroughly to accurately characterize the danger that exists for us. And it is not just about the individual things, of course. It is about all the networks that connect these things together. So what is the algorithmic solution for them as they develop a way to interconnect all these capabilities.

VICE CHAIR KUIKEN: Thank you. Hopefully my

magnanimous Chair will let me ask another question, just before we wrap up. You talked about open source, and one of the things that was always striking to me when left my last position was how much was actually available in the open source space. Thing 1. Thing 2, this is an issue that we have been trying to get at since after 9/11. I have no sort of new ideas or sort of novel approaches here. You know, everybody says, "Oh, we should fuse the things that are on the high side at the low side." I mean, go tell a CIA analyst that, and it won't ever happen but they would love to do it. Do you have any new ideas in this space that have not been tried? I would really sort of welcome your views there.

And then I will do this so Commissioner Schriver does not get mad at me. Mr. Horowitz, you have done a lot of work historically on autonomous systems. You didn't really talk about it here, but, I mean, this feels like one of these things that is just not ready for prime time. At least that is what we heard from Admiral Seif. How should we think about this, because we are seeing it in Ukraine every day, that this is

the future. So how do we get there and how do you think about it today?

ADMIRAL STUDEMAN: So I will start with that first question, and I appreciate it because I do think that if government intends to do it all, government will fail. We have so many restrictions that have grown over the decades on what we can do with information, that we don't know how to actually shed these rules. We have minimized ourselves in the spaces that have prevented us from doing things at speed and with deep insight.

And so I think we are going to need to depend more on commercial companies that, guess what, have a great deal of skill in acquiring massive amounts of information and deriving knowledge and insight. So the beauty of the future, in my view, is not to try to make government do anything. You can improve beyond where they are, for sure, and some things are happening.

But the real music, to me, the real symphonic effects you are going to get, the better knowledge you are going to acquire faster for the protective or the

option effects that you need come with trusting other companies to be in partnership with the U.S. government to provide what only they can provide. Because they may be better at actually anonymizing metadata, so they now have to worry about getting a U.S. name or any U.S. information involved in it. They have figured it out, right, in many places.

So I think that is where we need to be more serious about what does our partnership look like, with which companies, that can actually do this already today.

VICE CHAIR KUIKEN: Thanks.

DR. HOROWITZ: That is a great question. I would add that in the context of what I think we need for the future of the Navy, which is a high-low mix between our high-end, more exquisite capabilities and more what I have called precise mass, there is a real opportunity here, frankly in combination with allies and partners, to get back to your earlier question, in using yacht yards as the basis to sort of build and field more of those low-end capabilities -- think collaborative combat aircraft for the surface Navy,

which gives you more shooters, as well -- in combination with increasing autonomous systems. And communication is an issue undersea. That is, in some ways, the issue with having something like an autonomous weapon system undersea.

But you could imagine more simple variants that are pre in place, sort of slightly fancier than what you would imagine a naval mine as, that you could pre-position and then activate in the context of a crisis situation or at the outside of a conflict.

So I think there are a lot of potential opportunities for autonomy in the undersea, precisely because it is this arena where communication is more difficult. So have effectively operated autonomous systems would be incredibly useful.

VICE CHAIR KUIKEN: That was great. Thanks, Mike.

CHAIR SCHRIVER: Thank you, Admiral Studeman and Dr. Horowitz. I really appreciate your testimony.

We are running a bit behind, so let's do a 5-minute transition, and thank you for the third panel, and your patience, and we will get underway in about 5

minutes. Thanks again.

[Recess.]

PANEL III INTRODUCTION BY VICE CHAIR KUIKEN

VICE CHAIR KUIKEN: I call us back to order. Good afternoon now. We are probably way behind. I apologize.

Shifting from the military environment, our next panel will focus on undersea infrastructure and strategic resources. More specifically, we will hear experts speak about China's approach to subsea cables and seabed mining.

Our first witness is Jason Hsu, a Senior Fellow at the Hudson Institute. Our second witness is Dr. Seaver Wang, who currently serves as the Director of Climate and Energy at the Breakthrough Institute. And finally we will hear from David Calhoun, who is the Director of Baron. I am going to ask the staff to put the longer statement in the record, so in the interest of time I will turn it over to the three of you for opening statements. And I should pick the order. Why don't we go to Dr. Hsu first. It is probably what we agreed on, isn't it, Dr. Hsu?

STATEMENT OF JASON HSU, SENIOR FELLOW,
HUDSON INSTITUTE

MR. HSU: Chair Schriver, Vice Chair Kuiken, distinguished members of the Commission, it is an honor to appear before you to today on what I believe is one of the most urgent security challenges facing Taiwan and the broader Indo-Pacific region, China's deliberate campaign against undersea cable infrastructure.

As a former legislator in Taiwan and now a Senior Fellow at the Hudson Institute, my work has focused on technology, defense, and gray zone coercion. What we are witnessing under the sea is not an isolated maritime incident. It is a systematic pressure, calibrated, deniable, and escalating.

Let me be clear. Subsea cable security is not a future risk. It is a present and accelerating danger. Subsea fiberoptic cable carries roughly 97 percent of global intercontinental data traffic. Despite an imagine of the wireless world, nearly all the financial transactions, semiconductor coordination, military communication, and cloud infrastructure

depend on the subsea cables.

Taiwan connects to the world through just 24 undersea cables. These cables sustain Taiwan's semiconductor manufacturing, financial markets, civilian communication, government and military command systems. A prolonged disruption would not only inconvenience 23 million people, one estimate places the economic cost at $55 million per day, before accounting for critical damage on global semiconductor supply chains.

The Taiwan Strait is not just a geopolitical fault line. It is a data artery of global economy. In February 2023, two cables connecting Taiwan's Matsu Islands were cut within 6 days, first by a Chinese fishing vessel, then by a cargo ship dragging anchor. Fourteen thousand residents endured over 50 days of degraded connectivity.

Between January and February 2025 alone, Taiwan recorded four additional cable disruption incidents, one of which involved a Tanzanian-flagged vessel controlled by a Hong Kong company, crewed by a Chinese national, that disabled its tracking system before

dragging its anchor across the key trans-Pacific link. The vessel, Hongtai 58, responsible for severing a Taiwan-Penghu cable, had previously operated under two other names across three maritime registries. This is not coincidence. This is a shadow maritime network designed for deniable gray zone operations.

Even more concerning is the growing coordination between China and Russia. In November 2024, the Chinese vessel, Yi Peng 3 dragged its anchor for over 100 miles in the Baltic Sea, severing two European cables. European investigators identified Russian crew presence and intelligence coordination between Russia and China.

The lesson is clear. Subsea infrastructure attacks are becoming normalized forms of hybrid warfare. The threat must not be assessed in isolation. It is part of the increasingly integrated challenges to U.S.'s and allies' resilience.

In PLA doctrine, cutting undersea cable is among the earliest of pre-invasion actions. By targeting as few as three cable clusters near the Bashi Channel, China could theoretically reduce Taiwan's

international bandwidth by up to 95 percent. Combined with cyber operations and satellite jamming, this would create a multidomain informational denial strategy, from space to the seabed. In peacetime, average cable repair time exceeds 40 days. Taiwan has no indigenous cable repair ships. In wartime, repairs would be nearly impossible. Satellites are necessary but not sufficient.

My recommendations. Congress can act on several fronts.

Number one, pass the Taiwan Undersea Cable Resilience Initiative Act.

Number two, modernize the international legal framework governing cable protection. The current convention dates back to 1894.

Number three, expand enforcement tools and sanctions targeting IUU vessels and proxy actors used in cable sabotage.

On the Taiwan side, Taiwan should build indigenous cable repair capacity, ideally with Japan. Taiwan's Coast Guard should expand its vessel watchlist patrols near the critical cable corridors.

Taiwan must diversify landing stations beyond current metropolitan concentration points, reducing the geographic chokepoints that make the entire system vulnerable to precision strikes.

In conclusion, the United States has a narrowing window to strengthen deterrence before crisis dictates the response. China will continue gray zone operations as long as the costs remain low and ambiguity remains exploitable. Undersea cables are not just infrastructure. They are the barbed wire of the 21st century digital information order. They mark the threshold between stability and isolation. In a Taiwan contingency, cable disruption will not be the beginning of war, but it will be the signal that escalation has begun.

Before I close I want to speak directly, as a former legislator from Taiwan. Taiwan's legislature must pass the urgent defense budget. Taiwan's national security cannot be a partisan issue. Taiwan's political parties, both ruling and opposition, must stand in unity when facing national security threats. Only by strengthening our own

resilience, demonstrating resolve, and backing commitments with action can we ask the world to stand with us.

Thank you for the opportunity to testify. I welcome your questions.

[The prepared statement of Mr. Hsu follows:]

VICE CHAIR KUIKEN: Keep going.

STATEMENT OF SEAVER WANG, DIRECTOR OF CLIMATE AND ENERGY, THE BREAKTHROUGH INSTITUTE

DR. WANG: Commissioners Schriver and Kuiken, Commissioners, and members of the Commission staff, thank you for inviting me to testify on U.S.-China competition in seafloor minerals.

It is important for Congress to understand the significance of U.S. leadership in the nascent seafloor mineral sector in light of its weighty implications for the development of naval weapons and platforms, for the purpose of greater supply chain security across multiple critical minerals, and for the protection of U.S. national interests in the high seas.

Exploration and recovery techniques and technologies for seafloor minerals significantly overlap with the race to develop new underwater naval systems. This dual-use potential means that efforts to pursue seafloor minerals in the long term can considerably enhance the warfighting capabilities of participating nations.

Mineral exploration on the abyssal seafloor

inherently involves the launch, operation, recovery, and coordination of advanced underwater and seafloor vehicles designed for high reliability at ocean depths as deep as 4 to 6 kilometers. Such efforts will likely deliver improved performance of underwater and seabed platforms designed to contest strategic waters that are often shallower, like maritime chokepoints, the vicinity of important naval anchorages, and regions like the Western Pacific and Arctic Oceans.

Technology areas of particular interest include underwater vehicle power systems and autonomous behavior, mine warfare, and moored seabed sensors, but encompass an impressive range of domains.

Simultaneous, seafloor minerals offer the United States an opportunity to improve the country's supply chain security for four critical minerals at once: nickel, cobalt, manganese, and copper. Polymetallic nodules are the seabed mineral resource type closest to viable commercial-scale recovery and contain rich grades of these four minerals. One production vessel recovering 3 million dry tons of seafloor nodules annually would, in theory, be sufficient to confer

full U.S. manganese supply independence, with two vessels delivering full cobalt supply independence.

Preliminary deep-sea rare earth mud collection tests conducted by Japan in January highlight interest in seafloor mineral recovery to benefit other critical mineral supply chains. However, most companies targeting nodules do not current intend to extract rare earths as part of their initial processing operations.

In any case, several difficult obstacles stand in the way of the U.S. being able to make meaningful use of seafloor minerals. First, companies in this sector have yet to demonstrate nodule collector systems at full commercial scale for an extended period. Field trials have been limited to collecting a few thousand nodules over the span of just several days of test operation. At the same time, onshore metallurgical processing flow sheets for recovered nodules remain incompletely demonstrated. Unreliable nodule collection systems prone to outages could, in theory, compromise the economics of seafloor minerals as could delayed developed of suitable processing pathways.

Second, the United States also lacks suitable processing facilities and faces challenges to developing economically viable metallurgical plants. The U.S. operates no nickel smelters, no cobalt processing, no manganese smelters, and just two copper smelters, with no existing facility available and suitable for conversion to handle nodules as a feed stock. The Chinese steel and nonferrous metals sectors, by contrast, possess ample technical expertise and processing capacity in addition to vast downstream capacity to process seafloor minerals into battery cathode active materials, specialty steels, and stainless steels.

Third, regulatory and political pathways that would allow the U.S. to exploit and access seafloor minerals pose continued uncertainties. The United States is not a party to the U.N. Convention on the Lawe of the Sea, or UNCLOS, and last year asserted the right to unilaterally issue licenses and permits to U.S. citizens to explore and exploit polymetallic nodules in high sea waters beyond national jurisdiction. This firmly sets the U.S. apart from

procedures to pursue seafloor minerals in international waters through the International Seabed Authority, or ISA, established by UNCLOS.

Yet, at the same time, U.S. federal seafloor mineral licensing and permitting pathways have no precedent for actual use and require substantial revision and modernization to make them fit for purpose. Meanwhile, seafloor mineral deposits within U.S. sovereign waters remain relatively less characterized and require further assessment for commercial potentially. Additionally, opposition to seafloor mineral activities by many environmental and civil society groups remains prevalent and organized.

Overall, collector system and processing considerations, in my view, make it difficult to imagine polymetallic nodules contributing meaningfully to U.S. mineral supply on time scales of much less than 5 years, even with a fast-paced crash program. Yet this is not particularly different from long lead times facing broader miner smelter projects in the United States, making seafloor minerals worth contemplating as part of overall U.S. critical mineral

strategy, which much necessarily plan over the next 5 to 10 years.

The seafloor minerals sector may also emerge as a new dimension in which the U.S. and China compete to exert geopolitical influence and exert de facto control over ocean regions and sea lines of communication. China has already explored or secured bilateral cooperative agreements with small island nations like Kiribati and the Cook Islands to partner on seafloor minerals exploration, strengthening Beijing's diplomatic ties across the Pacific. Meanwhile, China's international seafloor mineral claims through the ISA, and potential mineral recovery operations in the future, establish avenues for persistent Chinese naval and civil maritime presence in high sea regions of the Central Pacific.

Such considerations highlight seafloor minerals as a potentially disruptive domain with multiple vectors of strategic significance. Yet the United States government will need to proceed calculatingly to advance a varied set of military, critical minerals, and geopolitical interests. The U.S. should

particularly prioritize mineral resource development in U.S. sovereign waters and partnerships to develop resources in the Exclusive Economic Zones of partner countries. Such partnerships could emphasize technical cooperation, collaborative scientific surveys, coordinated regulatory development, downstream supply chain agreements, and resource area environmental protection.

Meanwhile, federal policies should mobilize domestic scientific resources to accelerate federal regulatory development, intensify mineral resource mapping, study mineral processing approaches, and improve technologies and practices for minimizing environmental impacts. Congress should consult the U.S. Navy to explore ways to leverage the dual-use potential of relevant underwater vehicle and technology capabilities. Finally, Congress should pass legislation to correct key weaknesses of the Deep Seabed Hard Mineral Resources Act and to clarity the status of international seafloor minerals arriving in the U.S. and partner countries for policy program eligibility and trade purposes.

I look forward to further discussion and to addressing your questions. Thank you.

[The prepared statement of Dr. Wang follows:]

VICE CHAIR KUIKEN: Thank you very much. Mr. Calhoun.

STATEMENT OF DAVID CALHOUN, DIRECTOR, BARON

MR. CALHOUN: Chair Schriver, Vice Chair Kuiken, distinguished Commissioners and staff, thank you for the invitation to testify. I am honored to support this important hearing.

Two years ago, I worked with my colleagues at Baron to publish "Deep-Sea Minerals: The Next Arena of U.S.-China Competition." In sum, seafloor minerals have the potential to transform mineral supply chains, naval warfare, and the global balance of power.

Today the United States lacks mineral security, while its primary adversary, China, has established itself as the world leader. If China can secure a leading position in seafloor minerals, it will make America even more vulnerable to coercion. This industry will reshape the geopolitical landscape. There will be winners and losers.

Three factors will contribute to commercial extraction of seafloor minerals within a decade. First, the potential gap between mineral supply and demand in the next 20 years. This is due to the growing adoption of mineral-intensive energy sources

and increased electricity needs for artificial intelligence.

Second, global dependence on a relatively small group of critical mineral source. Both America and China want to reduce their import reliance and increase their mineral security.

Third, the quantity and quality of seafloor mineral deposits. According to one estimate, the Clarion-Clipperton Zone has more manganese, tellurium, nickel, cobalt, and yttrium and terrestrial reserves combined.

Collectively, seafloor minerals constitute one of the greatest untapped resource deposits on Earth. In the words of one Chinese think tank scholar, "the advent of deep-sea mining is inevitable."

Our report found that seafloor minerals would revolutionize the importance of maritime borders. This is evident in China's efforts to secure contracts at the International Seabed Authority and win what Chinese are calling a blue land rush.

China's Exclusive Economic Zone is only the 33rd largest in the world, but China disagrees. The well-

documented hypocrisy of its formal ratification of the U.N. Convention on the Law of the Sea, while disregarding the 2016 Permanent Court of Arbitration ruling is factoring into its interest in seafloor minerals. Beyond expanding its maritime borders, China sees ISA contracts as a long-term strategy to add to its blue territory.

As a result, China's prioritization of seabed mineral technology is unparalleled. Over one month before President Trump signed the executive order securing America's offshore critical minerals and resources, China's Government Work Report labeled deep-sea technology a strategic emerging industry. In the intervening weeks, China's provincial and municipal governments promulgated plans to develop the "blue economies." Advisory firms published forecasts for the sector, and companies involved in undersea technology fielded questions about their plans to enhance their undersea capabilities.

Chinese SOEs are playing a large role. Beijing Pioneer, one of China's ISA contractors, reportedly is now a subsidiary of China Merchants Group. A

subsidiary of China Minmetals, Changsha Research Institute of Mining and Metallurgy, CRIMM, is another prominent example. CRIMM is a former government research institute that secured China's first seabed mining-related patent in 1996, and has played an integral role in almost half of China's major seabed mining tests. Other major SOEs have also published reports praising the potential of the undersea technology sector.

China is actively attempting to address its remaining weaknesses. An experienced deep-sea researcher claimed, in 2024, that China suffers from an overreliance on foreign imports and described the prevailing mindset as, quote, "buying is better than making." Also in 2024, a prominent Chinese engineer described a 5- to 10-year technological gap between China and the West.

From the outset, China's seabed mineral R&D has relied on Western partners. Between 1996 and 2000, Cybernetix, a French company with a specialization in undersea robotics, worked with CRIMM to create China's second collector vehicle. A more recent example is

Global Fortune 500 member, CRRC Group subsidiary, Times Electric's 2015 acquisition of Soil Machine Dynamics. Challenges remain in localizing production, transporting minerals from the seabed to the surface, and conducting integrated operations.

Despite these issues, China believes it can leapfrog its rivals. An internal Baron estimate shows China has well over 1,000 seabed mining-related patents, compared to fewer than 50 for U.S. entities. Perhaps as a result of these efforts, one Chinese industry leader claimed, in an August 2025 interview, that China's remotely operated vehicles are already at the same level as its Western rivals. China is catching up.

Three policy recommendations. First, monitor China's progress. We are flying blind. The most recent U.S. Geological Survey country report for China is for 2023. Increasing the rate of these reports will provide vital insights for U.S. business leaders and policymakers. In addition, including a section in the annual "Mineral Commodity Summaries" on seabed minerals would help decision-makers stay abreast of

China's progress and get back on the front flip.

Second, identify abundant deposits. In the past months, U.S. research vessels have helped strengthen ties with the Cook Islands. These voyages provide a model for future U.S. efforts to bolster its network of alliances in the Pacific and will support responsible extraction operations in the future. Updated resource estimates from these voyages will also encourage the flow of U.S. capital to promising projects.

Third, build American leadership. The involvement of state-backed institutions insulate China's entrants from the regulatory and financial risks facing U.S. entrants. The Trump administration and Congress are focusing on America's more abundant mineral processing and shipbuilding industries, but more can be done to incentivize American investment. Advancing and scaling U.S. seaport mapping, extraction, environmental monitoring, shipping, and processing will not happen overnight. The highest-value investment would be a government-backed, first-of-its-kind nodule processing facility in the United

States. Such a facility would help shift the center of gravity of critical mineral supply chains away from China and back toward America.

We are at risk of ceding yet another strategic industry to China. In 20 years, the United States could see itself crowded out of the EEZs of allies and partners, international waters, and forced to watch China extract minerals in the EEZs of Vietnam, the Philippines, and around the world. China has a vital path to become a technological and processing hub of the seabed mineral sector, expanding its OPEC-like control of critical mineral supply chains in the process. This will erode American deterrence and help establish China as the regional hegemon.

Thank you again for the opportunity to testify. I look forward to your questions.

[The prepared statement of Mr. Calhoun follows:]

PANEL III QUESTION AND ANSWER

VICE CHAIR KUIKEN: Thank you, Mr. Calhoun. We are going to go in alphabetical order, so that means that Commissioner Budowich is first.

COMMISSIONER BUDOWICH: Mr. Hsu, you spoke about the need for regulations and laws to create a deterrence against the cutting of cables. What is a realistic deterrence that is obviously not military, that would stop this from happening?

MR. HSU: Thank you, Commissioner. I think one of the strongest deterrence would be allies working together in the region to share the early-stage warning, particularly when China creates false signal when they try to enter into the gray zone activities.

One of the most prevalent Chinese gray zone warfare capabilities is to shock the regional actors by creating synchronized accidents with militia boats and dragging their anchors in different areas. And this has created confusion amongst our allies, because allies, such as Japan and the Philippines, are also facing the same ambiguity and confusion as the States.

So it is very important to develop a coordinated

response as integration to deal with the real-time threats. And also, as we look at the current situation, right now this is a real-time map of Taiwan's 15, 16 cables. Now, if you look at this, 8 are currently broken, and we do not have information whether they are deliberately cut by China or they are broken because of outdated infrastructure or the weather situation.

But these are all created under the gray zone sphere, because it also takes more than 50 days to repair. So it is becoming a very challenging state as we look at already difficult situation to repair in the region.

COMMISSIONER BUDOWICH: And this is part of the problem, right, where if a fishing boat could accidentally or intentionally pull an anchor and cut a cable, trying to define a deterrence to stop that seems pretty difficult.

MR. HSU: Yeah. I would advocate that one of the probably most effective ways is joint patrol by the Coast Guards in Japan and Taiwan, especially concerning the water nearing both countries'

territory. Especially some of those cables that are broken or damaged in the areas that overlap in the two countries' territories. And Taiwan needs to broaden its vessel patrol to those corridors, and so does Japan, as well, so that when sort of accident happens there could be a joint response.

COMMISSIONER BUDOWICH: Thank you. Mr. Calhoun, when we talk about minerals offshore, what kind of exploration has been done, needs to be done? How far are we away from being able to scale some of these critical mineral deposits?

MR. CALHOUN: Yeah, for sure. The USGS has done many surveys over the past decades. There was a peak of U.S. leadership in exploration in the 1960s and 1970s. In fact, when I mentioned patents for U.S. firms, most of those happened in the 20th century, so very few have recently.

And per Seaver's comments, and I also would want to hear his thoughts on this question, too, all that matters is finding the right kind of deposit. So it could be off the coast of Alaska. It could be off the coast of Wake Island. It could be off the Marianas.

Not enough work has been done by USGS and others to have enough resources devoted to it in recent years to find potential viable deposits, and that is what the administration, I think, is trying to do with Bowen right now, to invite more exploration of these American continental waters. All it takes is finding the right deposit, but per Seaver's comments, there are a lot of technological issues that need to be addressed to make these deposits commercially viable if they are the right quantities.

COMMISSIONER BUDOWICH: Mr. Wang, how much time would it take? Can we do it in a couple of years, to try to identify, or is this a decades-long process?

DR. WANG: I think a distinction would need to be made between which resource deposits we are talking about. Based on the President's executive order, which focuses on mineral resources in international waters, particularly the Clarion-Clipperton Zone, those resources have been extensively mapped, so contractors already know where the most dense nodule fields are, and have already considered how they would strategize their plan of operations to commercially

recover those nodules. So those resources are closer to commercial scale development.

However, resources in the U.S.'s EEZ waters, my understanding is that current BOEM and NOAA mapping efforts have done basic mapping for half of those waters, and detailed resource characterizations have not yet been done. And that would be a necessary requirement in order for commercial operations in those regions to go forward, because you need a certain requisite density, particularly for nodules, in order for recovery to be economically viable.

COMMISSIONER BUDOWICH: So just for my understanding, how long does that take? If you wanted to start a survey, is this a year, or is it longer?

DR. WANG: If you were to do an intensive crash program it could potentially be done in a year.

COMMISSIONER BUDOWICH: Thank you.

VICE CHAIR KUIKEN: Thank you very much. Commissioner Hodges.

COMMISSIONER HODGES: Thanks. Several of you have spoken this morning about sort of the Chinese deploying undersea capabilities, whether that is

deploying cables, repair capabilities, seabed mineral extraction. Building off the question that was just asked by Commissioner Budowich, what is stopping the U.S. and allies from building an American Shenzhen, to really sort of tackle this and continue to seize the day?

MR. HSU: Thank you, Commissioner, for your question. I think one of the most challenging situations is under seabed mapping. Right now China controls the world's seabed mapping authority, and it is very clear that especially the law that I mentioned, that convention dates back to 1884, that was mapping that was done with telegraph wire but today it is fiberoptic cable. So there needs to be a reinitiation of convention to resuming the re-examining the current state of the seabed mapping.

And also the incidents that I describe just now around the Taiwan island, the issue that we face is those seabed mapping are now either controlled by China or China, Korea, and Japan. So when China is involved in it, it makes the other two parties also hard to react, as well. And secondly is to harden the

physical facilities around those areas, especially for the redundancy and also the data storage buildup, as well.

I mentioned that four cables that have been cut have not been repaired by the Taiwan authorities, and those are the same cables that share data by Google, Amazon, Tesla, and Apple. So those are also deliberately targeted under U.S. technology assets, as well.

COMMISSIONER HODGES: Mr. Wang?

DR. WANG: Commissioner Hodges, may I clarify the question? What is required to build an American Shenzhen?

COMMISSIONER HODGES: Yes. I guess the question I am kind of thinking through here is as the United States, sort of the policymakers are looking at this question there is a huge amount of tailwinds building off of the executive orders that have been put forward. There is obviously, per your testimony, a lot of opportunity here. What is stopping us from actually taking advantage of that opportunity?

DR. WANG: Yeah, I think it is important not to

underestimate the obstacles that are standing in the way of the U.S. actually making commercial use of seafloor minerals. One set of obstacles I outlined is regulatory uncertainty. In addition to developing the licensing and permitting system to enable companies to potentially collect these minerals, there is a lot of uncertainty around the environmental standards that they will be held to, and those performance-based standards need to be adequately developed.

I would also point out a lot of market uncertainty. There has been a lot of price volatility in nickel and cobalt markets, in particular, in recent years, and that does create some potential economic headwinds regarding the precise margin of profitability of seafloor mineral collection, particularly given the operational considerations I have mentioned.

And then, finally, there is a key set of obstacles around capability gaps. So first off, demonstrating that collector systems can work reliably, and second off, processing is a major gap, as both David and I have emphasized.

MR. CALHOUN: Yeah, building on those comments, as I mentioned in my testimony, it is regulatory and financial barriers right now, and the risks facing U.S. investment are significant without any clear prospect of getting a return on that investment. So right now the efforts at BOEM to increase opportunities for exploration in American territorial waters is a promising step. Right now you don't just have a Shenzhen in China. You have a Sanya. You have a Guangzhou. You have a Shandong. You have all kinds of different areas of the country that are mobilizing behind this effort.

So I just think it is really important for us to take into consideration, per Admiral Studeman's comments, about us being distracted. I do think we are distracted right now from how much of an effort China is putting into being able to commercialize these operations. And given it might be 10 years, that is still is relatively short for mining operations. We need to be very aware of the threat.

COMMISSIONER HODGES: Thank you.

VICE CHAIR KUIKEN: I think I am calling on

myself now. All right. Admiral Brookes talked to us about beyond China's EEZs and their activities in the critical mineral space, and he referred to as almost like BRI-like activity that they were conducting in a lot of these spaces.

Other than sort of shining a light on it, sort of identifying the debt diplomacy cycle that the Chinese get these countries into it, how should we think about this problem in a new and novel way? And the reason I ask this question is I feel like the shining a light on it strategy, I mean, has some effect, but countering it is more important, and how do we think about that? Is this an unleashing private capital situation? Is this unleashing the State Department's assistance authorities? Is it both? Is it something different? Whoever wants to take a spin at answering it.

DR. WANG: I have a few thoughts on that question. I think one important thing, from the seabed minerals consideration, is that BRI-like initiatives in collaboration with international partners, between China and international partners,

are China's potentially fastest route to being able to access seafloor minerals, because the International Seabed Authority has been in regulatory deadlock and because China is still assessing the quality of their seafloor mineral resources in their relatively limited Exclusive Economic Zone. Other countries' EEZs are their most promising route to being able to collect seafloor minerals commercially in the near term.

So here I would agree that the State Department's role, I would say the State Department's role is very important here. To take the Cook Islands as an example, I think the government of the Cook Islands is explicitly trying to balance the United States and China in soliciting technical support, scientific surveying, as it moves towards regulatory development and potentially eventually commercial recovery of the minerals in their EEZ.

So I think other island nations in the Central Pacific would be interested in being able to balance sort of competing value propositions from many countries that have interest in mineral resources in their EEZs.

MR. CALHOUN: Yeah, no, there is a lot that can be done and engaging is the first step. The State Department has a large role to play in this, and there has been a lot of effort recently with the voyages I mentioned to the Cook Islands that has been good for us. We have not been present as much as we could have in the past few years, even though the Cook Islands has wanted to have American involvement.

Generally speaking, there is a greater affinity for the Pacific island states with the United States when we do engage, and there are a lot of people in Washington that have done a lot of great work on this topic, in ways that the United States can engage. I know Andrew Harding at the Heritage Foundation has done a lot of work on this. I recommend it to you all. But yeah, there is a lot that can be done, and showing up is the first step, and that is what we started doing last fall, but I encourage more of that.

VICE CHAIR KUIKEN: Mr. Calhoun, you had talked a little bit about the Chinese companies that are active in this space. I did not hear you talk about European, American, or allied countries that are

active in this space. Who are the companies that are not Chinese that are developing technology to sort of exploit these resources, to make sure that the engineering problems have been solve and the science problems have been solved, so that we can start building whatever capabilities we need?

MR. CALHOUN: For sure, and Seaver can add onto this, as well. There is The Metals Company, of course, which has been active in the Clarion-Clipperton Zone, a Canadian firm that has also been seeking an alliance, a license with NOAA recently. And then there is also, in Belgium, Global Sea Mineral Resources under the DEME Group that has been very active in the Clarion-Clipperton Zone, as well, and they also have, I believe, a subsidiary in the Cook Islands that has been active there. There are also two U.S.-backed firms in the Cook Islands. So there are three companies that have exploration licenses in the Cook Islands. None of those are Chinese. Two are U.S.-backed, one European-backed. There is also Transocean, based in the United States. That has been involved in a key operations element for these

companies, I think including one of the Cook Islands companies. And then also Allseas has been one of the main partners with The Metals Company.

DR. WANG: Just to add on to David, I think in my view The Metals Company and Global Sea Mineral Resources are the most advanced contractors in terms of the development of their collector vehicle technology. They have both demonstrated very heavy, large, very close to full commercial scale collector vehicles at depth in the Clarion-Clipperton Zone, collecting thousands of tons of nodules in their initial tests.

In addition, both of these contractors already possess production vessels that have been modified to support seabed mineral recovery. And, in addition, both of these companies have conducted the resource surveying work that I was mentioning previously, so have a very good idea of which particular deposits and area that they would be initially targeting.

VICE CHAIR KUIKEN: All right. That is the end of my time. We will go to Commissioner Miller.

COMMISSIONER MILLER: Thank you, Vice Chair

Kuiken. I would like to dig deeper into subsea cable traffic to understand it a little bit better. And I am curious to whether the Chinese, for instance, have a level of sophistication sufficient enough to be able to understand which cables to cut to inflict which damage. Now, obviously, if a cable is going from Point A to Point B, then you can sort of clean some information, who is using it, what kind of information might be on it.

But is there a level of sophistication overall to understand if you are a Chinese naval vessel thinking about cutting subsea cables, would you understand, well, I have got to stay away from that cable because it could have Wall Street traffic that could affect markets, but maybe we target this other one because it would have other specific information? How much do we know? How much does the Chinese side know? Is this a factor? Please.

MR. HSU: Thank you, Commissioner, for your question. We have about 500 cable sets around the world, and we only have 23 cable repair ships that are in operation. So for China, if you look at this map,

the existing map that Taiwan's cable connecting Taiwan is now dealing with, what China is trying to do is to poke the vulnerable points where they can create small entry damage. And because the repairman is very long, normally take 45 to 60 days, so constantly cutting with a small amount of cost on them, would inflict a lot of cost and burden for the countries that are dealing with the cable damage and the cable repair.

Now, concerning how sophisticated China is in terms of where to damage those cables, they are particularly targeting three major cables that connect Taiwan, the Philippines, as well as one other cable connecting Taiwan, Hong Kong, and California. And those were particularly concerning to all the internet traffic that would be connecting Southeast Asia and East Asia to North America. And these are the three cables that also have the terminals on Taiwan, as well, and two major terminals are in metropolitan concentration points. So that would create a vulnerability, as well.

So I would say China tries to create all these flash points and to confuse as to how they develop the

pattern. But the pattern is clear. It is consistent and synchronized. And if the repairment is slow, the destruction can be prolonged and sustaining on their part.

COMMISSIONER MILLER: Okay. Let's keep digging on that. I am curious -- and the fact that there are only 23 ships, as you say, may answer this question before I ask it -- I am curious to what the global cable repair architecture looks like. Obviously, like most things, there is a U.S. side of this that is sort of bifurcated, and there is an ex-China side and a China side to the cable repair, because nobody wants someone working on the wrong cable.

But is there a difference between what happens in the Atlantic and Pacific? Do the Europeans go fix their European cables and the Asian countries fix their Asian cables? Or is this truly a global industry?

DR. WANG: Yeah. Thank you, Commissioner, for your question. A comprehensive system such as armored undersea cables that diversify landing stations and delegate a repair fleet as well as satellite ground

infrastructure, as well as a hardened terrestrial backup system would likely cost in the range of $5 to $10 billion, and spread over a decade. And this figure accounts for construction cost, typically $30,000 to $50,000 per kilometer for the modern fiberoptic cables. And, therefore, the repair vessels, it is between $200 to $300 million each, as well as the satellite system that is not being accounted for.

And again, countries that are now coming to deal with these situations are overwhelmed,, and because these situation that are happening are sporadic but also difficult to spot and yet synchronized.

So the way to really look at this is to develop an air, sea, and land comprehensive integration communication system. It is to integrate a LEO satellite system as the backup, but the satellite system only can account for 5 percent of the type of the data traffic that undersea cable can transmit.

But secondly it is to harden those facilities and to develop a regional, coordinated alliance patrol system, so that these militia boats, often they are

disguised as fishing boats or cargo ships, can be spotted when they are acting suspicious in the region.

And then, lastly, I would just say that it is an urgent need to revamp the ascension system as well as the penalty that would punish the proxy actors. Right now, the incident that I described for the Hongtai 58, they are Tanzanian-flagged around Taiwan, but then they are cutting those cables. And it is under international law that the ship that is flagged, the country, can only be the jurisdiction state that can punish the wrong actor. So it is very important to reexamine the existing legal framework to deal with this issue in a more coordinated and comprehensive manner.

COMMISSIONER MILLER: Thank you.

VICE CHAIR KUIKEN: Sorry. Commissioner Schriver is making me do this twice. Commissioner Price, you are up.

COMMISSIONER PRICE: Thank you, and thank you all for your testimony today. I want to go to your recommendations. The most important thing we do every year, in my humble opinion, are the recommendations

that we give to Congress. So I would like to ask each of you a question in relations to your recommendations. I want to start with Mr. Calhoun. You talked about a nodule processing plant. Can you give me another minute's worth of what that entails, what the scope is, what is the cost involved? How would that work?

MR. CALHOUN: Yeah, I am happy to start, and I know Seaver is more aware of the specifics of the processing that would be required. But some proposals have been for on the Gulf Coast, where we have a lot of infrastructure already built out, a lot of relatively affordable energy that would be necessary to support such a facility. It would be an expensive operation, though. There are different estimates of around $1 billion, I think, has been put around, but there are other considerations that would factor into that.

I will mention that China has already been doing extensive work on their own ability to process polymetallic nodules. Most of the patents that have been received by firms in the past few years have all

been Chinese firms for these technologies, these processes, and there is a recent operation that CRIMM did as a subsidiary of Minmetals, which again, there is a lot of overlap in capabilities within the metals that would be well suited to build out a very effective Chinese seabed mineral sector that we do not have domestically right now.

COMMISSIONER PRICE: So when you talk about building it out domestically, are you talking it as a public-private kind of partnership?

MR. CALHOUN: It could be public-private. In my recommendations I do think government-funded, government-backed, that has been thrown around by the Department of Energy in the past, to have a fully government-funded operation to derisk investments for other aspects of the supply chain. Right now we do not have a lot of this expertise domestically, and it is very cost prohibitive for investors to go to these projects with this elephant in the room.

COMMISSIONER PRICE: Thank you. Dr. Wang, you can continue on that one, and then I have another particular question.

DR. WANG: Thank you, Commissioner Price. A few things I would add. First, under the Deep Seabed Hard Mineral Resources Act any minerals collected in waters beyond America's national jurisdiction, like in the Clarion-Clipperton Zone, are currently required to be processed in the United States. So one of my recommendations was that this piece of statute in DSHMRA might be revised slightly to merely bar minerals recovered from going to foreign entities of concern, and this would open up additional potential U.S. partnerships.

Because, for example, one other promising region that has been floated for nodule processing is Eastern Canada, somewhere in the St. Lawrence tributary, where there is also a lot of abundant, affordable, and also clean energy, and Canada also has a lot of experience in nickel processing.

I would also indicate another difficulty being that a nodule processing facility, first off in order to support commercial-scale recovery it would have to support a throughput of around three million dry tons of nodules per year, and that kind of facility implies

such capital expenditure and operating expenditure that it would need to run at a very high output in order to be economically viable. It would have to run essentially 95 percent of hours of the year. So that makes it very sensitive to the reliability of seafloor nodule operations and also potentially to disruptions of seafloor nodule operations, either by, for example, direct action environmental activism or gray zone activities.

And so one option that I would also potentially flag is actually batch processing of nodules, where a quantity of nodules could be collected, and rather than having a dedicated processing facility, those nodules could be processed as a batch, potentially, at some existing processing plants, or through some alternative smaller scale arrangement, and that might create an alternative route that would convert those nodules into materials that could be used downstream, but at the same time would avoid the significant capital expense of creating a dedicated plant. But, of course, the cost benefit of such options needs to be evaluated in detail.

COMMISSIONER PRICE: You also make a recommendation about environmental monitoring and impact assessment, and also noted that there are a number of people who are already engaged and focused on this issue. How do you see that balance working out?

DR. WANG: I think environmental social license is actually very important for a long-term, sustainable seafloor nodules industry. For example, some potential downstream offtakers or companies that would use these minerals have actually expressed some reluctance, even some support for seafloor minerals moratorium until scientific knowledge can advance.

So I think that additional research on environmental impacts is actually very important to create a market for seafloor minerals to proceed. And, in addition, I think this work is also very important to develop viable working environmental standards that can govern the progress of this industry as it starts out, and provide a basis on which those standards can be iterated upon based on further knowledge gained during initial operation. So

I think that is very important.

COMMISSIONER PRICE: Thank you.

VICE CHAIR KUIKEN: Thank you, Commissioner Price. We will now turn to our beloved Chair, Commissioner Schriver.

CHAIR SCHRIVER: Thank you, Commissioner Kuiken. Mr. Hsu, I wanted to ask you about the possibilities of rapid repair and the implications of this, because if I understand from your testimony it on average about 50 days to repair, and that is a function of a limited number of repair ships and all that. But, I mean, it seems to me if you cut that in half, that would be incredible progress, but that is still 25 days. And if you are looking at an activity that is sort of the opening salvo of something more aggressive and kinetic, 25 days is forever. If you cut that in half, 12 days, that is forever.

So what are the alternatives? I mean, I think investments should be made in rapid repair capabilities, but can you talk a little bit more about resiliency and ways that provide some redundant capabilities beyond?

MR. HSU: Thank you, Chair Schriver, for your question. At the current rate, and dealing with the current state, it is impossible to repair all of the broken cables. So we need to look at what are our priorities, and our priorities are those connected to global data traffic. I think those are the priority ones. And secondly, I think there needs to be a stronger incentive from the public and private partnership to incentivize the private sector to also get into this field.

I mentioned that Japan has cable repair ships, and it is owned by NTT, and it is Japan's major telecom company. And there is no reason why Taiwan, Taiwans Mobile, or Chunghwa Telecom, or the state-owned telecommunication company cannot build or work with our allies to share those capacities, as well. So that is number one.

And secondly is to build redundancy of those data. You mentioned about 50 days seems to be even ridiculous in today's internet age, as well as considering everything is now in the AI space, as well. And so it is very important to develop and also

back up our data on the secure cloud storage, as well. So developing redundancy is probably the next remedy I would recommend.

And number three is to really look at what success would look like in 24 months. I would argue that right now, if China were to invade tomorrow, they could just cut off three cable clusters, and that would plunge the island into complete darkness. But we need to at least have 30 percent of the backup data in order to prevent the island from going dark.

So to be able to do that and also to maintain critical military communication cables, for the C2 and essential government functions. We need to have at least 30 to 35 percent of the data traffic running, and I would say that is the minimum. And I would stay, in stage one, focus on having those data availability.

And then lastly, in the next 3 to 5 year, Taiwan should be able to own at least one data repair ship, because this is also concerning to South China Sea as well as other adjacent water areas, as well.

CHAIR SCHRIVER: Thank you. Shifting gears to

the other topic here, I don't think anybody has mentioned the role of the Department of Defense in this particular space. And I have some awareness of what the Office of Strategic Capital is trying to do. Whenever you talk about commercial viability it is totally understandable, but it also triggers some of us because the Chinese don't typically care. They subsidize or they make investments, really, that are not commercially viable, for the purposes of cornering a market. And only if something is commercially viable, we are going to end up right where we ended up in other spaces like foundational semiconductors and other areas.

So could you comment a little bit on what the Department of Defense might be able to do in this area in terms of developing not only technology but the strategic capital investments, and using the DoD's buying power as a major customer, putting together consortiums of buyers and the like, and your assessment of how that is working.

MR. CALHOUN: Yes. Right now I know there have been talks about having a nodule stockpile. In the

interim period, until there is a processing facility built out, whether it is Canada, the United States, another allied country, having some kind of off-tank for companies, knowing that they will have someone to buy their product, incentivizing them to continue their operations, that is really important.

I think beyond the off-tank agreements, similar to the rare earth agreement last year with MP Materials, this is an industry that is obviously very strategic, highly strategic, and the Chinese are well aware of this and are moving accordingly, that it could merit some kind of full ownership or stake taken by DoD through OSC in one of these entrants, or multiple entrants, to make sure that they are able to stay competitive against a bunch of SOEs who are able to continue supporting potentially non-commercially viable activities.

DR. WANG: Yes, I suppose I might actually inject a bit of a note of caution on an equity-like stake being taken in seafloor mineral companies at this stage. You know, equity is a valuable tool in the U.S.'s toolbox for critical minerals policy, but in

this case I think these companies have not yet demonstrated their end-to-end production. And, as a result, the potential volatility and exposure to the taxpayer is higher risk than in the case of, say, MP Materials, that has a working mine and a plan and existing investments in place to get to a full mine-to-magnet supply chain.

And I do think that the point you made, Chair Schriver, is very important, that the contrast here is asymmetric, because the Chinese companies that are pursuing these developments are, on the private sector side, state-owned corporations with very wide portfolios, that have the balance sheets to support early stage ventures that may not turn a profit for decades. So that certainly is important to counterbalance.

MR. HSU: Yeah, Chair Schriver, also just to answer the other Commissioner's question that the cables that are cut that are concerning U.S.'s strategic assets, there are five cables: East Asia Crossing, Flag North Asia Loop/Reach North Asia Loop, Asia Pacific Cable Network 2, Asia Pacific Gateway,

Pacific Light Cable Network, Trans-Pacific Express. These are the sets of cables that are mostly heavily damaged and also impacting Asia-Pacific networks, as well as the Indo-Pacific alliances' communication.

VICE CHAIR KUIKEN: Thank you very much. We will now go to Commissioner Slevin.

COMMISSIONER SLEVIN: Thank you. Maybe picking up a little bit from the Chairman's question, the Commission has given a lot of thought to the Defense Production Act over the years and how to use its various tools for resiliency in strategic sectors. Congress is giving thought to DPA needs to be reauthorized I believe this year. I think the administration has been pretty thoughtful and strategic in involving DPA for the financing and grant side, MP, and I think even looking at other sectors. And I think the EO -- correct me, please -- also calls for exploring DPA for more seabed mineral mining processing.

I am curious. Kind of a jump ball, as well, but I am interested in your thoughts about the use the DPA here, connecting it more to seabed mining, what

operationally might be required to actually take that step versus sort of exploring it and thinking of it prospectively. Maybe, Mr. Wang, I am interested in your thoughts to begin, and I invite others to comment.

DR. WANG: Certainly. I will echo David's point that some people have discussed the viability of stockpiling nodules, which they have been stockpiled, essentially, on the seabed for millions of years already, so they are very stable. And DPA is a powerful authority.

The point I would make, though, is I think that before demand-pull and incentives come into play it is really regulatory red tape that needs to be addressed in order for this to be a viable enterprise, because these are, first off, untested licensing and permitting pathways. And second off, because there are these sorts of bespoke obstacles within the Deep Seabed Hard Mineral Resources Act, in particular, which actually, you have to use a U.S.-flagged production vessel, and at least one of the transportation vessels has to be U.S. flagged, which

isn't something that any of the current contractors have in their operating vessel fleets, and then you have to do U.S. processing. And then there is the question of also, I think, sort of long-term political support for this sector, because under DSHMRA the President and the NOAA administrator have significant authority to exercise discretion in pending license applications or to alter the terms of seafloor mineral licenses.

So these are areas of red tape that create significant uncertainty that I think have to be addressed before we talk about incentives or demand-pull.

COMMISSIONER SLEVIN: Yeah, Mr. Calhoun.

MR. CALHOUN: Obviously it is powerful tool. I think in addition to potentially helping the processing facility with stockpiling, but I think also infrastructure in the Pacific. The port of Pago Pago in American Samoa is a potential spot where trans-shipment could occur for polymetallic nodules procured by U.S. firms. So I think there are a lot of ways that that tool could be utilized to also strengthen

our presence in the Pacific, with our U.S. territories but also potentially with the Cook Islands, Kiribati, other countries interested in this.

COMMISSIONER SLEVIN: Mr. Hsu, any other comment? Okay. Mr. Vice Chair, I will yield back my time.

VICE CHAIR KUIKEN: Thank you very much. We will now turn to Commissioner Stivers.

COMMISSIONER STIVERS: Thank you. Mr. Hsu, I am cutting undersea cables. The Chinese government has argued they have never cut the cables of any country. How would you respond to that? And you talk about, in your testimony, this attribution challenge that Chinese entities, you know, they say it is an accident and there are mere coincidences. How do we overcome this attribution challenge, and how do we better respond to it? Or how does Taiwan respond to it, or Japan, or whoever's cables are being cut? Is it just a defensive approach that we should take, either sanctioning entities? Even though their attribution changes, is that enough, or should there be a very proactive retaliation? What would be the most effective way to respond?

MR. HSU: Thank you, Commissioner, for your question. And again, this cable cutting behavior is very difficult to monitor, and it is also difficult to be tracked as state-backed activities. And it is arguably challenging to even pin down Chinese PLA as being behind this.

But on the spot when the Taiwan Coast Guard is dealing with this situation, and from the various sources, Chinese authorities are involved, especially when it is tracing back to the financier of the boat as well as how the boat registries are shifted, and were especially operated by the Chinese nationals, and also captains that are part of it. And Taiwan, in a recent incident, has actually prosecuted a PRC national captain that actually was responsible for cutting the cable.

So to many countries that are dealing with this situation it is to keep a very vigilant stance in monitoring the situation, because once the cables are cut it is very hard to repair. And again, those are not major ships that are cutting those. Those are small commercial cargo ships as well as even fishing

boats that are messing around in the area.

Now concerning the sanctions as well as penalties, I think one of the important things is that the jurisdiction and control over the vessels registered under a country's flag pertains the authority to exercise the jurisdiction rights. And that needs to be changed, especially when the flag that they are flying under, one certain country, can only be prosecuted by the complicit or uncooperative behavior, then that is very difficult to do.

So U.S. needs to play a role in looking at this, and especially to coordinate ways to develop a more integrated response when it comes to this multi-registries and constantly shifting operational flagging situation.

COMMISSIONER STIVERS: Okay. Thanks for that answer. On page 6 of your testimony, you describe China's process in the South China Sea of withholding permits for cable projects of other countries that transit through the South China Sea. Can you explain this dynamic a little bit more, and is there any response from ASEAN as an entity or from individual

ASEAN countries? Are they going through that process and literally asking the Chinese government for permits?

MR. HSU: It is very clear that Chinese are now also intervening in that region, and particularly with the cable cuts around Taiwan, some of the traffic is rerouting through Southeast Asia, as well, particularly through the Philippines and Lusong Island. And those are the types of areas that China claim they also have the rights, as well. So they are performing the inspections and claiming that they also have the rights to have a say. And I mention that to you because the current mapping of the global cable is also administered by China, Japan, and Korea, so China effectively has a say as to how to further investigate the issue. So that is becoming a big problem, as well.

COMMISSIONER STIVERS: Okay. Thanks for that. If I can indulge for one more minute. Dr. Wang and Mr. Calhoun, on seafloor minerals exploration, we know Chinese entities have zero regard for the environment, and we see these entities going all over the world

depleting fishing stocks as far as Latin America and off the coast of Africa. Zooming out, the U.S. needs critical minerals, obviously, for the strategic competition and for our security. But zooming out, how can we avoid a race to the literal bottom that damages our environment, damages our oceans, in terms of this competition with China on seafloor mining?

DR. WANG: I would emphasize two dynamics that work in favor of avoiding a race to the bottom, one being that inherently, because of our regulatory system, operations taking place under U.S. jurisdiction would be held to a higher standards. You would need to go through NEPA review. You would need to abide by Coast Guard regulations on ocean dumping, et cetera.

But, second, I think this point is very important to emphasize, which is that one reason why domestic or allied critical mineral projects have struggled is because there is this unlevel playing field, where the negative environmental and labor and human rights externalities of Chinese production have not been internalized.

So I think that it is actually very important for the U.S., in conjunction with allies and partners, to raise that bar and work multilaterally to enforce consistent global high standards on minimum environmental standards, for example, or forced labor regulation, that can effectively exclude the bottom-of-the-barrel production from the global market, and thereby significantly level the playing field. Because even while the U.S. or allied production may often be higher cost in the current market, the current market is really not a free market where these externalities are being accounted for, and better regulation to price in those factors would position more higher standards production much more competitively.

MR. CALHOUN: One comment I will make is that right now China is looking to position itself within the ISA as the responsible stakeholder. So currently they have a call for papers right now to the *Journal of Applied Oceanography* for environmental impacts and management strategies for the development of deep-sea polymetallic nodule resources in 2026. So right now

China, especially after the executive order was released by the Trump administration, sought to portray itself as a defender environmentalism and as the positive actor in this space, when my testimony, I believe, shows that China is indeed the most active in trying to exploit these resources.

So I think being able to be aware of their efforts to extract these very valuable critical minerals is intentioned with their outward stance of being pro-environment in this regard. But also China views this is an engineering problem, something that can be solved.

And I think right now the United States would benefit from taking some of that mindset when it comes to this space, because on the surface seafloor minerals have a great potential to be one of the lowest impact sources of critical minerals in the world, measured in grams per square meter versus kilograms per square meter in a lot of key mining areas in the world, and also avoid a lot of the most significant, really damaging externalities from terrestrial mining. That doesn't means there are a

lot of ways to manage those impacts on land, but right now on the sea I think we are not being creative enough about the possibilities to do it efficiently and also sustainably.

COMMISSIONER STIVERS: Thanks. Thanks for your indulgence on the time.

CLOSING REMARKS

VICE CHAIR KUIKEN: Thank you very much, Commissioner Stivers, and with that I will thank our witnesses for their testimony.

And I am supposed to announce the next Commission hearing, which sadly has no Disney songs in the title. It will be on March 19th. The hearing title is "China's Expanding Interests in Latin America: Development, Leverage, Coercion, and Crime." And with that we are adjourned.

[Whereupon, the above entitled matter went off the record at 1:00 p.m.]