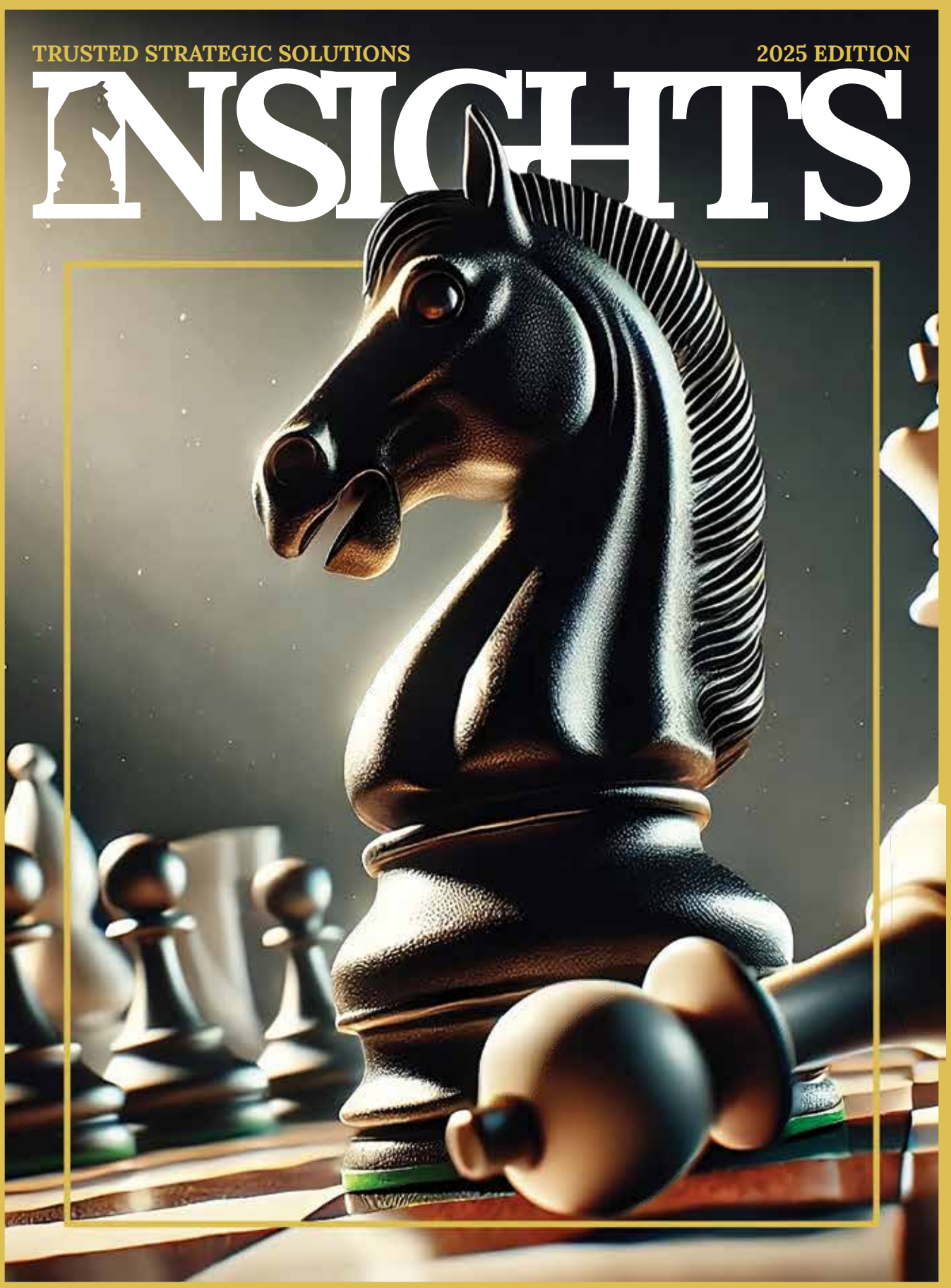
TRUSTED STRATEGIC SOLUTIONS

2025 EDITION

INSIGHTS



Dear Readers,

With great pride, I welcome you to this inaugural edition of the Trusted Strategic Solutions Insights Magazine. This publication is a testament to the incredible progress and innovation in technology, workforce development, and the microelectronics ecosystem over the past few years.

From serving as the Chief Strategy Officer at the Defense Microelectronics Activity to now leading Trusted Strategic Solutions as President and Managing Director, it has been my honor to have a front-row seat to tremendous evolution within the technology sector—particularly in microelectronics. These years have been marked by unprecedented challenges and transformative strides.

The COVID-19 pandemic laid bare the vulnerabilities in our global supply chain, as electronic component shortages disrupted US critical infrastructure. From washing machines to Ford F-150s, these delays highlighted the fragility of our supply chain . In response, the United States launched the CHIPS initiative, a historic investment in domestic R&D and manufacturing capabilities.

Now, we can celebrate significant progress on this path to resilience. The Microelectronics Commons Hubs recently concluded their inaugural year, marking a pivotal step in strengthening our domestic microelectronics ecosystem. Workforce development initiatives such as the Silicon Heartland University Supercluster are forging innovative and fruitful partnerships with major combatant commands, aligning capabilities to ensure the US workforce is equipped to meet future demands.

The alignment between the Department of Defense and the semiconductor industry has never been stronger, channeling defense investments into critical semiconductor companies and addressing challenges like the nation's radiation test infrastructure needs for space and strategic systems. These efforts collectively represent a new era of collaboration and innovation within this critical domain.

Trusted Strategic Solutions is privileged to play a vital role in these successes. From advising on groundbreaking projects to contributing to the transformative policies and initiatives you will read about in this magazine; our team of experts works tirelessly to help shape the technology landscape of today and tomorrow.
Within these pages you will find insights, strategies, and visionary thinking that reflect our dedication to driving meaningful change and provides thought for future direction.

Thank you for joining us on this journey. Together, we can continue to influence critical advancements for our partners, stakeholders, and our nation.

With gratitude and anticipation of a brilliant future,

Daniel Marrujo
President and Managing Director - Trusted Strategic Solutions

INSIGHTS

2025 Edition

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Sign up for the Insights Newsletter today and stay up to date with our latest stories.

Our Biggest Stories of the Year

Articles featured across our Insights Newsletter over the previous year. Subscribe today to follow along with the latest.

Originally Published in Insights No. 25 — Sept. 2, 2024

One Big Thing we see this week is that this is our special, 25th edition of TSS Insights! This marks a full year of our experts finding and sharing news that impacts the microelectronics industry, environment, and future. We've enjoyed compiling the stories and hope our readers found them useful.

This week we're sharing what news items over the past year that our experts considered were the biggest stories that impacted the microelectronics environment, ranging from the technical, international, defense sectors. And what to watch for in the year to come!

Here's what we thought was the biggest news.

Bong Gumahad

Senior Advisor - OSD, Former Senior Executive Service OUSD A&S and former Defense Microelectronics Cross Functional Team Director

TSS Insights #17, April 15, 2024 — included an article written by former leaders at the Pentagon, with whom I had the pleasure of working with as a former member of the Senior Executive

Service at the Department of Defense. The article "Innovation Adoption for All: Scaling Across the Department of Defense"[1] identifies six essential factors that can unlock the potential for successful innovation within the DoD. In an era of rapid technological advancement, the U.S. Department of Defense faces a critical challenge: effectively adopting and integrating innovative solutions to enhance military capabilities. Authored by Secretary Robert Work, Secretary Ellen Lord, and Mike Brown, former director of the Defense Innovation Unit (DIU), the article resonates with stakeholders throughout the DoD ecosystem, who are tasked with overcoming the "Valley of Death"—a significant barrier that hinders the implementation of transformative technologies necessary for maintaining a competitive edge against military adversaries.

This challenge has garnered attention within the Department, supported by Congress. Yet, effective solutions must also engage industry partners to shift the current acquisition culture toward a risk-balanced innovation mindset. The authors emphasize that talent is the "secret sauce" that binds these factors together; without the right talent, achieving innovation becomes unattainable. The factors outlined in the article will not surprise those familiar with the intricacies of the DoD. Still, collectively, they provide a framework for successful innovation efforts and a roadmap for broader cultural reform within the organization. By embracing these principles, the DoD can foster an environment where innovation thrives, ultimately enhancing its operational effectiveness and strategic advantage.

With increased focus on reform, the following year promises to be consequential. Through expanded acquisition strategies like Other Transaction Authorities, Middle Tier Acquisitions, and the Software Acquisition Pathway, alongside a $1B commitment to deploy the Replicator autonomous drone systems, the DoD acquisition workforce is well-equipped to tackle emerging challenges. These efforts are crucial in bridging the gap between innovation and warfighter execution, enabling a more agile response to an increasingly complex threat environment.

1. *Read the Article*

Heather McMahon

Senior Advisor – White House, Former member of Presidents Intelligence Advisory Board

TSS Insights #8, December 1st, 2023 — profiled the first-ever (or at least in a very long time) Defense Industrial Base Strategy, including analysis from our experts here at TSS. Meant to "catalyze generational change" in response to growing technological change, COVID supply disruptions and Russia's invasion of Ukraine, this strategy recognizes the defense industrial base's criticality to the National Defense Strategy in delivering resilient, dependable, innovative, and secure supply of goods and services to the DoD, essential to defend the national

interest. The key tenants of the Defense Industrial Base Strategy include creating resilient supply chains, workforce readiness, flexible acquisitions and a focus on economic deterrence and economic security.

Our adversaries also recognize the centrality of the industrial base and companies should take heed. Russia's targeted assassination attempt of a prominent German defense company CEO is but one colorful example of adversarial attempts to hinder defense production. Adversarial nation-state strategies on intellectual property theft, cyber risk, and economic coercion aligned at undermining our economic security also play a starring role. For those microelectronics enthusiasts among us, look no further than China's stockpiling of ASML tools, the recent cyber-attack targeting Microchip Technology, and ongoing concerns of hardware backdoors as evidence of risk exposure.

For those of you who recall President Eisenhower's words "Beware the defense industrial base," you may be rightfully perturbed with the current state of the "DIB," however fixing it requires both recognition of the problem and strategy. With everyone's interests at stake, it behooves us all to roll up our sleeves and work to design and apply the all-necessary "ways and means."

Mark Weatherington

Senior Advisor, Former Deputy Commander, AFGSC and Deputy Commander, Air Forces Strategic-Air, U.S. Strategic Command, AFGSC

Earlier this year, FBI Director Chris Wray warned that the PRC poses a significant threat to US national and economic security, highlighting the extent of Chinese infiltration of US critical infrastructure. "The PRC has made it clear that it considers every sector that makes our society run as fair game in its bid to dominate on the world stage, and that its plan is to land low blows against civilian infrastructure to try to induce panic and break America's will to resist," he said in remarks at the Vanderbilt Summit on Modern Conflict and Emerging Threats in Nashville.

Wray's comments complement the August 2023 Center for Strategic and International Security (CSIS) Report, Competing Without Fighting[2], which offers a comprehensive look at an "unprecedented campaign below the threshold of armed conflict to expand the influence of the Chinese Communist Party (CCP) and weaken the United States and its partners." Though not specifically addressed in the report, TSS notes trends in strategic materials, microelectronics, and semiconductor supply chains that suggest these vital areas are part of that larger strategic competition.

Over the next year, we should continue to watch this space for signs of economic coercion and potential supply chain disruptions that could disadvantage US national security. In addition, identifying steps to make these areas more resilient in the face of China's ongoing efforts.

2. *Read the Article*

Ken Label

Senior Advisor – Space, Former PM NASA Electronics Parts and Packaging Program

TSS Insights #19, May 13, 2024 — TSS Insights included an article entitled "The surprising reason few Americans are getting chips jobs now."[3] This article highlighted a major challenge for the success of the CHIPS Act and the domestic semiconductor infrastructure in general: adequately trained workforce to provide full operational capabilities. While this article focused on the Arizona initiatives (Silicon Desert) by the large foundry efforts such as TSMC and Intel (aka fabs), this is a pervasive issue across the greater overall domestic landscape.

The interesting portion of this article emphasized the need for all levels of workers: entry level factory workers to engineers to higher level educated personnel. TSS is in full agreement with this concern. We've noted that many of the government programs focus workforce development (WFD) on university-based 4-year and higher education while missing the critical need for trained technicians, apprentice programs, 2-year, and community college curricula. TSS has championed this STEM (K-12) to PhD WFD for both commercial industry and US Government needs and continues to do so. Related areas such as standardized curricula and accreditation for the semiconductor fabs has been undertaken by the SEMI organization. However, this still leaves many gaps from chip design to specialty areas of the military. Success will be based on this holistic view and not micro-focused on just fabs, but the overall supply chain needs.

3. *Read the Article*

Mark Cheng

Senior Advisor – White House, Former Executive Director of Presidents Intelligence Advisory Board

In TSS Insights #24, August 8, 2024 — we talked about how Television producers in Taiwan plan to release a 10-part series called "Zero Day,"[4] which will present a realistic depiction of a PRC invasion of Taiwan. The series will include PRC cognitive warfare and incitement of unrest.

Ninety percent of the globe's leading-edge chips are produced by a company on an island only 100 miles off the coast of China. Beijing has stated clearly that it will reunify Taiwan with China. This upcoming Taiwan TV show dramatizes one possible scenario that, bottom line, denies US and western access to those leading-edge microelectronics.

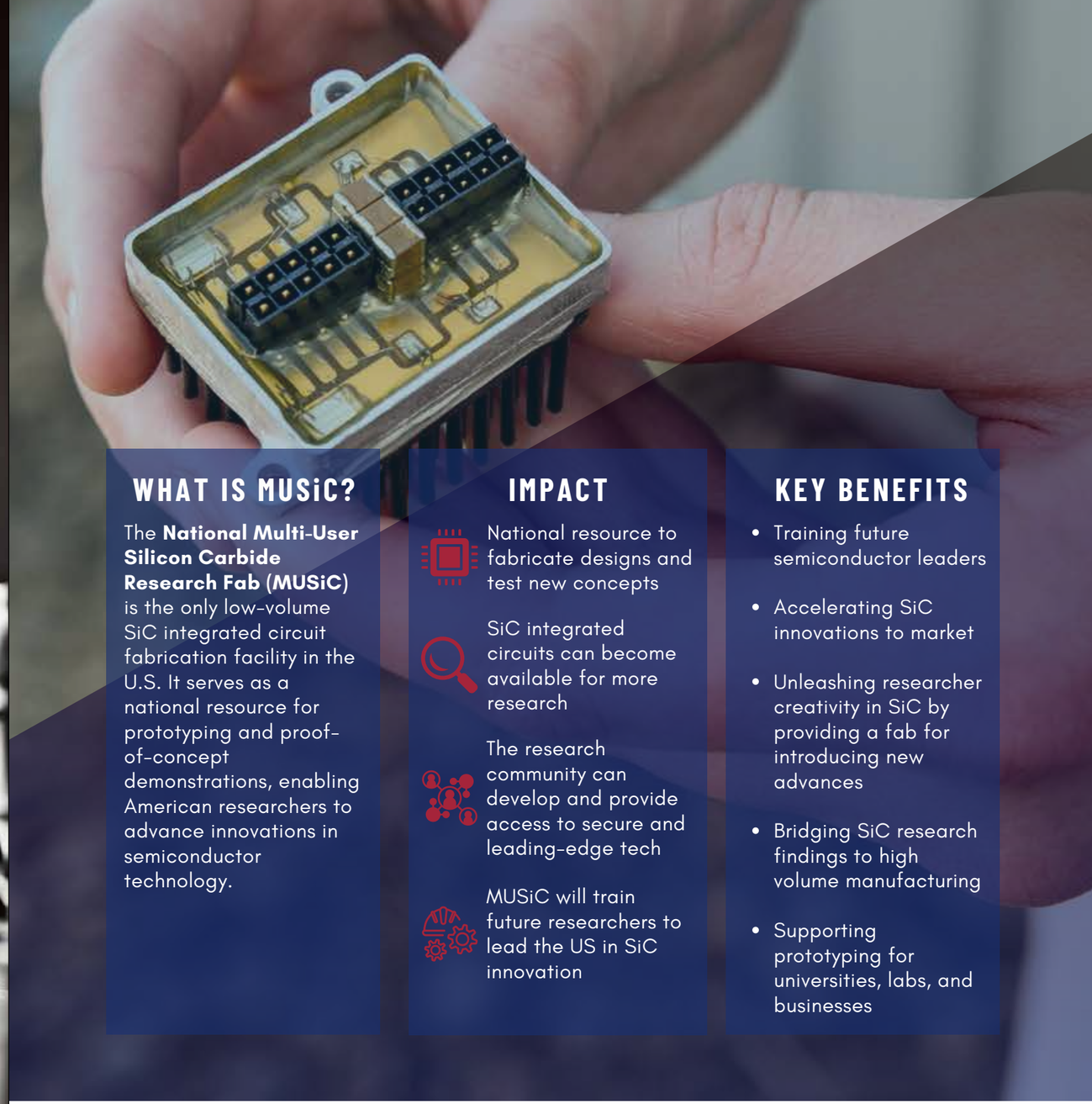
Over the next year we should be monitoring the political and military developments in the region and how USG (CHIPS Act) and commercial actions reduce our near total reliance on Taiwan for advanced ME.

4. *Learn More*

Thanks to everyone for reading and sharing over the past year!

From the TSS Insights team

There is a Cold War chill lingering this summer. What one US legislator called, “a Cuban Missile Crisis in space” is potentially developing right over our heads. Our experts have analyzed what’s happening and have recommendations for how the microelectronics industry can help combat this growing threat. In the next article “Preventing a Cuban Missile Crisis in space.”



WHAT IS MUSiC?

The **National Multi-User Silicon Carbide Research Fab (MUSiC)** is the only low-volume SiC integrated circuit fabrication facility in the U.S. It serves as a national resource for prototyping and proof-of-concept demonstrations, enabling American researchers to advance innovations in semiconductor technology.

IMPACT

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SiC integrated circuits can become available for more research

The research community can develop and provide access to secure and leading-edge tech

MUSiC will train future researchers to lead the US in SiC innovation

KEY BENEFITS

- Training future semiconductor leaders
- Accelerating SiC innovations to market
- Unleashing researcher creativity in SiC by providing a fab for introducing new advances
- Bridging SiC research findings to high volume manufacturing
- Supporting prototyping for universities, labs, and businesses

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PREVENTING A CUBAN MISSILE CRISIS IN SPACE

Russia is developing a nuclear anti-satellite weapon that potentially threatens global commerce and communication. We can prevent this threat from manifesting. The United States, allies, partners, and the microelectronics industry should pursue a long-term strategic campaign to deter Russia, defend against this threat and preserve the use of space.

Background – What happened?
The Cold War returned to the United States over the summer, if it was ever completely gone.

The reappearance began on February 14, when Representative Mike Turner suddenly demanded that President Biden declassify all information about what he only identified as "a serious national security threat."

Speculation about Turner's cryptic message immediately followed, which often cited government sources. Politico reported that Turner referred to a Russian nuclear antisatellite (ASAT) weapon. PBS News Hour also called the threat an ASAT, "possibly nuclear-powered, has an electronic warfare capability to target American satellites. . .." CNN said that the US holds intelligence on a Russian nuclear ASAT but it was unclear if the capability was nuclear-powered or a nuclear-armed weapon.

White House spokesperson John Kirby confirmed government knowledge of a Russian ASAT that he called "troubling" but not operational and declined commenting on nuclear capabilities. Congressional leaders emphasized that there was no evidence of a threat to US citizens and urged calm. Moscow denied the weapon's existence and called the claims a ruse to justify support for Ukraine.

Nevertheless, speculation in articles on Russian space nuclear capabilities, possible intent, and the threat to global commerce appeared across news outlets.

Much of the reporting highlighted that the idea of nuclear weapons in space is an extremely dangerous remnant of the Cold War. Between 1958 and 1962, both the US and the Soviet Union tested the effects of nuclear detonations in space. The US Starfish Prime experiment in July 1962 exploded a 1.45 megaton warhead at an altitude of 280 miles over Hawaii. The blast's electromagnetic pulse (EMP) and radiation destroyed or damaged eight of the 24 satellites that were then in orbit. International recognition of the dangers led to the 1967 Outer Space Treaty, which banned weapons of mass destruction in space.

> **"I believe that this is a Cuban Missile Crisis in space."**
> **— Rep. Mike Turner**

This year, the conjecture about a new Russian weapon became confirmation with spring. On April 25 National Security Advisor Jake Sullivan confirmed the Biden administration's belief that Russia is pursuing a nuclear ASAT. The announcement came a day after Russia vetoed a UN Security Council reaffirmation of the 1967 treaty. On May 1, Assistant Secretary of Defense for Space Policy John Plumb testified about Russia's ASAT intent to the House Armed Services Committee. Plumb called it "a threat to all satellites operated by countries and companies around the globe as well as the vital communication, scientific, meteorological, agriculture, commercial, and national security services we all depend upon."

At the same hearing, Rep. Mike Turner, who had sounded the alarm in February, told Defense Secretary Lloyd Austin, "I believe that this is a Cuban Missile Crisis in space."

What does all that mean?
Turner of course referred to when the US detected the installation of Soviet nuclear medium and intermediate range ballistic missiles in Cuba in October 1962. President Kennedy threatened to invade Cuba unless the Soviets removed the missiles. The superpowers faced off over 13 days and nuclear war threatened. Soviet Premier Khruschev eventually withdrew the missiles in exchange for American removal of obsolete Jupiter missiles from Turkey.

Today, this new threat from a Russian nuclear ASAT is just as real as Khruschev's missiles in Cuba were. Russia showed its ability and interest in nuclear space

weapons during the Cold War, and White House officials believe the Russian Cosmos 2553 satellite, launched in 2022, is an ASAT. Assistant Secretary of Defense for Space and Missile Defense Policy John Hill testified to the Senate Armed Services Committee that Russia relies on counterspace weapons to make up for their losses in the Ukraine war, has called commercial satellites legitimate targets, and is developing an ASAT carrying a nuclear device.

Such a weapon is incredibly dangerous. A kinetic ASAT would create dangerous debris fields, as Russia showed in a 2022 test. Some experts believe that the new ASAT probably carries an EMP weapon which would fry the electronic components in the thousands of satellites in line of sight of the burst, wrecking global communications and commerce. The uncontrolled satellites and debris would then crash into each other, disabling more satellites and creating more debris in the theoretical Kessler Syndrome. An actual nuclear detonation is less likely but even more dangerous. Such a blast would destroy satellites, and its resultant radiation and field of space junk would eliminate all human space flights for decades.

Even if years away from deployment, as a US Space Force officer said to the Economist, a Russian nuclear weapon in space would be akin to a "gun to our head."
The international community diffused the Cuban Missile Crisis through a series of powerful and carefully orchestrated steps. The US can lead similar efforts again in a coalition and prevent this new crisis from getting as far as it did in 1962. Here's how we can do it.

First – We Have the Parts for Comprehensive Space Defense

The US Government and the ME industry has been working for years on protecting systems and satellites against EMP.

Obviously, the US has been aware of the effects from a space nuclear blast and EMP since the Cold War tests. From the Congressionally appointed commission on EMP threats in 2004, through the Strategic Radiation Hardened Electronics Council in 2018, the 2020 Defense Space Strategy, and recent Space Force focus on survivable spacecraft, the US government has multiple studies with recommendations for defenses against space nuclear weapons and EMP.

There are also some commercial efforts, with support from DTRA and DARPA, to develop systems to both identify nuclear-armed satellites and preemptively shut off microchips to protect against EMP damage.

All of that work forms a foundation for opportunity. The varied programs and initiatives are effective in their own spheres. They can be even more effective if orchestrated, resourced, and combined with other efforts. It would be a campaign, in DOD parlance, "a series of related major operations aimed at achieving strategic and operational objectives" intended to deter Russia.

Step Two – A Campaign with Industry, Allies and Partners

As a global threat, Russian ASAT capabilities merit a global response. There are 105 countries including China, the United Kingdom, Japan, India, Canada, Germany and the European Space Agency (and yes, Russia) with satellites in orbit. A Russian ASAT risks all those nation's interests. A coordinated, comprehensive campaign is a way to proactively outmaneuver Russia.

We could begin the campaign in the information sphere. In 1962 President Kennedy presented the US intelligence in a televised address and proclaimed the Soviet missiles an unacceptable threat to US and regional security. The Organization of American States and the United Nations reinforced the US, choking off any global support to the Soviets. Today, a similar US information campaign can help the US control the narrative and gain backing from other satellite-dependent allies and partners.

A coalition of satellite and ME producers should form a foundation for long-term economic action in the next phase of the campaign. Led by the US, major semiconductor suppliers such as Taiwan, Japan, South Korea and others could eliminate export of radiation tolerant materials to Russia. This would impact Russia across military applications, beyond space, since the up-screening required for defense applications and space require items like radiation testing, high reliability, and extended temperature range, among many factors.

Commercial engagement would be crucial. The ME industry can play a significant role with radiation hardening of new satellites and expediting the lengthy strategic radiation hardening qualification process. Heidi Shyu, Under Secretary of Defense for Research and Engineering, recently urged companies to improve space radiation protection. Being part of a larger, coordinated campaign may further inspire the ME industry to follow her lead and increase their efforts.

Step Three – Play the Long Game

Deterring Russia is never easy. Vladimir Putin is not likely to acquiesce to diplomatic cornering, nor will he simply give away a strategic space advantage. China also considers space as part of their national strategy and will view a US-led campaign as a threat to its own ambitions.

Executing a campaign will be a laborious, complicated and long-term task. But ignoring the developing threat or not coordinating our efforts leaves economic and national security at risk. A strategic campaign plays to the strengths of the US, allies and partners. The 2020 Space Strategy already calls for the DOD to work with the State Department and other agencies for coordinated efforts for peaceful space. Marshalling resources, people and technology to address threats to global security is one of the hallmarks of American leadership.

We control many of the chips in this in these high stakes game. Unlike in 1962, we see the threat developing. It's time for lawmakers, agencies and the commercial sector to take aggressive action to prevent another crisis before it's too late.

Microelectronics: Macro Impacts from Competition to Crisis

by Lt Gen Mark Weatherington, USAF (Ret.)

First Featured in The Mitchell Forum, No. 56, Sept 2024

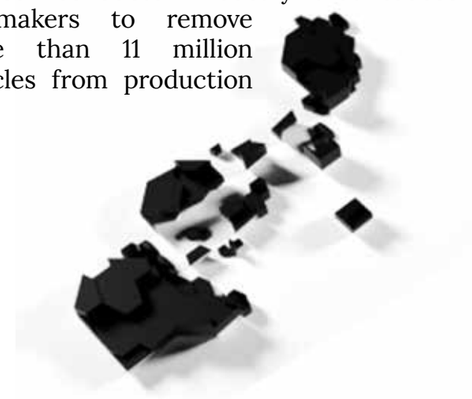
> **"[T]he erosion of U.S. capabilities in microelectronics is a direct threat to the United States' ability to defend itself and its allies."**
>
> **— Sujai Shivakumar and Charles Wessner "Semiconductors and National Defense: What Are the Stakes?"**

Introduction

The United States military fields a wide range of incredibly sophisticated and capable weapon systems to foster peace and global security. However the operating effectiveness of most of these systems relies on a host of small components called microelectronics, which are manufactured and supplied through a supply chain centered on the Pacific and increasingly in China. Disruption of this fragile microelectronics ecosystem would devastate our weapon systems and prove daunting to our military forces and their readiness before or during a crisis.

Microelectronics are the small electronic devices that bring many of our modern conveniences to life. Most people first think of the semiconductors and integrated circuits in their personal computer or cellular phone, but there is a remarkable diversity in the types of microelectronics and how they are used. The basic building block starts with transistors, essentially on-off switches, that can change the characteristics and performance of a device to create processors, RF sensors, memory devices, and more. Few of us likely appreciate that a modern automobile or advanced aircraft requires thousands of individual microelectronics to function.

As prevalent as these components are in modern society, their supply lines prove surprisingly fragile. For example, the cascading impacts of the global COVID-19 pandemic reached far beyond the immediate public health, medical, social, and even political spheres, offering the Department of Defense key insights on the state of the microelectronics supply chain. The pandemic also inflicted a persistent disruption of the semiconductor industry that caused automakers to remove more than 11 million vehicles from production



in 2021 and lose billions of dollars due to the shortage of the necessary chips, sowing chaos in both the new and used automotive markets.[1] Consumers were shocked at the sight of hundreds of new vehicles parked in lots, but these vehicles were unable to perform basic functions like raising and lowering windows or operating windshield wipers due to a lack of chips.

As the immediate crisis faded, consumer products once again lined the shelves and dealer lots filled up. Many naturally assumed that the problems had been fixed. Today's reality, however, is stark: though semiconductor supply is up and the industry is beginning to overcome the disruption, underlying structural risks have not changed. In fact, we may be more vulnerable now that potential adversaries recognize the fragility of the microelectronics supply chain.

The U.S. government, to its credit, has begun to respond. Congress passed the CHIPS and Science Act in 2022 with an aim to boost domestic research, development, and production of semiconductors. However, initial progress has been slow, and it is not clear if changes spurred on by the legislation will yield the specific improvements needed to ensure a resilient defense microelectronics supply chain.

The Modern Microelectronics Ecosystem

The invention of the Integrated Circuit (IC) sprang from contributions of many people; however, two American engineers, Jack Kilby of Texas Instruments and Robert Noyce of Fairchild Semiconductor, made the final breakthroughs in the late 1950's. The resulting monolithic IC remains the basis for modern chips.[2]

The United States dominated this new industry, initially with large-scale government funding and a voracious consumer in the Department of Defense. Though much more costly, the size, weight, and power consumption advantages of ICs over existing discrete transistor designs led to their adoption for use in aerospace vehicles and other military applications.[3] Some other early examples of military systems using ICs include the Minuteman II missile guidance set and the MIT-Lincoln Laboratories' Semi-Automated Ground Environment (SAGE) system that provided NORAD with an integrated air defense picture and command and control capability.

In these early years, government regulations and favorable industrial policies, coupled with purchasing agreements and the dollars behind them, ensured that the Department of Defense remained the customer of first choice.[4] These same factors and a strong anti-trust preference facilitated the rise of large government funded research labs that sustained the Defense Department's leading role.[5]

Commercial IC designs followed in the mid-1960s with applications in amplifiers, data converters, and power management devices, as well as specialty circuits for automotive, consumer, and communications applications.[6] For the next 10-15 years, the defense market and the commercial market coexisted without significant friction.

However, by the 1980s, rising commercial demand rapidly outstripped defense dollars. Microchips had become general purpose products and widely used in the commercial sector—the DoD no longer sat in the driver's seat. Along with changes to industrial policy and adjustments in the industry as microchips became commoditized, competition from Japanese firms and later the Asian tigers Taiwan, South Korea, and Singapore (and increasingly China) dramatically shifted the center of the microchip universe to the east.[7]

By late 1987, Japanese production of semiconductors surpassed U.S. production for the first time.[8] While the United States continues to lead in semiconductor design, the fabrication capabilities and advanced manufacturing processes needed to produce real chips in relevant quantities wholly relies upon a supply chain centered on the Pacific region.[9] Since then, vulnerabilities have not been addressed and only grown; a 2022 Center for Strategic and International Studies assessment of the semiconductor industry found the following:

- **U.S.-based chip manufacturing has declined to around 10 percent of the world total and lacks the onshore capability to make the most advanced devices at the seven- and five-nanometer (nm) nodes [state of the art]. U.S. firms depend on sources in Taiwan and South Korea for production of their most sophisticated designs.**
- **The United States has very little onshore capability for the outsourced assembly, testing, and packaging (OSAT) of semiconductor devices, holding less than a 5 percent share of these essential functions, with most OSAT operations conducted in Taiwan, China, and Singapore.**
- **The disaggregation and offshoring of significant elements of the U.S. semiconductor production chain heightens risks relevant to national security, including the potential for intellectual property theft, the introduction of counterfeit devices, and the disruption of the far-flung and delicate chip supply chain by natural disasters or geopolitical conflicts.[10]**

In other words, the United States can no longer produce highly sophisticated, state-of-the-art chips and semiconductor devices, nor does it have the capacity to scale up production within its own borders, leaving it highly vulnerable to various forms of industrial espionage.

Defense Microelectronics and Potential Disruption

While a lot of public attention gets paid to the cutting edge of microelectronics development, DoD is most vulnerable in the area of older chips. The bulk of the defense community's need, when it comes to sustaining the readiness of its fielded forces and weapon systems, is commodity chips and microelectronics produced in the last decade. For example, a typical guidance computer or military radio design uses commodity chips

Another Supply Chain Consideration: Rare Earth Minerals

China dominates the global rare earth economy, accounting for more than 60 percent of the world's rare earth mining, 85 percent of rare earth processing, and 92 percent of rare earth magnet production. With unique chemical and physical properties, rare earth elements prove crucial in the manufacturing of modern screens and displays, lighting, lenses, cameras, high powered magnets, batteries, and much more. Like microelectronics, rare earths enable critical defense technologies in computing, seekers, weapons, and other advanced applications. Perhaps recognizing the strength of their position, China has begun to restrict access to some of these critical materials. For example, China began restricting exports of gallium and germanium in August 2023 and followed with new controls on high-grade graphite exports in December. China dominates the global mining and production of these materials, which have significant commercial and national security uses. These restrictions further highlight the fragility of international supply chains for many critical materials.

Sources:
Lara Seligman, "China Dominates the Rare Earths Market. This U.S. Mine Is Trying to Change That," Politico, December 14, 2022; Mia Nulimaimaiti, "China's gallium and germanium exports tumble as controls on shipments to the West take toll," South China Morning Post, January 21, 2024; and "China's Export Controls on Critical Minerals – Gallium, Germanium and Graphite," FTI Consulting, December 19, 2023.

as it does not require the state-of-the-art chips that populate the newest generation smart phone or tablet. This stems from the lower computational demands and the component's more narrowly defined function. Long acquisition lead times for older chips exacerbates this problem, as the defense technology cycle does not align well with the modern commercial approach that quickly moves on to newer generations and simply throws the old gear out. Most weapon systems remain in service for decades.

For DoD, the ability to quickly package commodity components to repair, upgrade, or sustain weapon systems can be the difference between success and failure on the battlefield. Take a relatively simple weapon like the Joint Direct Attack Munition or JDAM. This satellite-guided tail kit comprises a vast portion of the U.S. Air Force, Navy, and Marine Corps air-to-air and air-to ground precision munitions inventory. A single JDAM contains various microelectronics subcomponents—actuators, sensors, guidance and control computers, for example. These are not cutting-edge chips, but rather standard commodity chips and subcomponents—and much of the JDAM's microelectronic supply chain would be affected by a disruption in the Pacific. If the supply chain was disrupted during a crisis, the nation's ability to replenish munitions stockpiles would prove extremely limited. Similarly, hundreds and thousands of subcomponents of the weapon delivery systems would be unrepairable, grounding the high dollar platforms designed to deter our enemies and assure our allies. This could mean U.S. forces could run out of munitions to take out adversary sensors and shooters relatively early in a conflict with no fast or viable solution to backfill inventory. As we have seen in Ukraine, maintaining a sufficient level of munitions stock can mean the difference between victory and mere survival, as well as survival and definitive defeat.

Considering this example, an extreme reliance on a supply chain deeply rooted in a few companies in the Pacific region carries significant national security risk. The recent pandemic-driven

disruption of industry served as a very clear example of how a range of incidents like political posturing, trade sanctions, natural disaster, blockade, or direct conflict could affect critical supply chains. As another more prescient example, when a 7.4 magnitude earthquake struck Taiwan on April 3, 2024, it caused significant damage and temporarily shut down chip fabrication. Though some processes an output resumed in the immediate aftermath, the industry is not yet back to operating at full capacity, and we should expect to see an impact in terms of costs and quantities. Because the island nation sits above the junction of two tectonic plates in a seismically active region of the world, the frequency and severity of seismic activity should not be surprising, but there are currently no alternatives or redundant manufacturing capabilities outside the region.[11] Any of these potential scenarios would challenge DoD's ability to sustain the readiness of its critical weapon systems. In the case of blockade or direct military conflict, this disruption would be aggravated by the increased wear and tear on weapon systems, attrition, and expenditure of weapons.

Though senior civilian and military leaders know that supply chain risks exist, the department has not fully explored the impact of a potential disruption—they do not understand the impacts in detail down to individual weapon systems and specific components. Without that detailed understanding, the department cannot act to prioritize actions and mitigate the risk. Embarking on the needed analysis to understand this challenge is needed now, followed by prioritizing weapon systems and attendant risk, then taking deliberate steps to mitigate that risk where possible.

This kind of approach will require broad government support beyond just DoD as well as industrial policy and investment.

The Government Respo

While DOD must better quantify the risks to communicate them effectively to the government and the American people, Congress and the administration recognize there are significant national security and competitive economic implications of the current state of the microelectronics ecosystem. This is why they enacted a federal statute in 2022 to revitalize domestic manufacturing of semiconductors, the CHIPS and Science Act. The act provides incentives and strengthens partnerships with the aim of bringing critical microelectronics manufacturing activities back to U.S. shores, but it's far too soon to realize its full effect. Evaluating the success of any legislation takes time—and it would not be fair to give the CHIPS Act a final grade today. Watching how U.S. industrial capacity and the commercial sector respond in the next decade will prove critical.

> The CHIPS Act was primarily intended to revitalize U.S. commercial leadership in semiconductors; it was not designed to reduce or eliminate vulnerabilities in the weapon systems the U.S. military relies upon. For example, the Chinese dominance in worldwide supply of Printed Circuit Boards (PCB) introduces susceptibility to everything from weapon systems to the nation's power grid. Former Deputy Undersecretary of Defense Al Shaffer describes this strategic liability:
>
> ***You're talking about something with over a hundred layers of substrate. Each of those layers has the potential for having something embedded. I have almost no doubt that we have pretty extensive vulnerabilities to systems being modified or***

shut down. The other thing that can happen: if you modify the data stream, which you can do by injecting code in a weapons platform, and the data that you're seeing is false? You lose.[12]

Similarly, 90 percent of semiconductor assembly and test activities is conducted outside the United States, underscoring the need for an end-to-end examination of the entire microelectronics supply chain from raw materials to fabrication to assembly into finished products.

What Must be Done Now?

The crucial first step toward a more resilient microelectronics ecosystem for DoD is identifying potential vulnerabilities that compromise its microelectronics supply chain. This includes analyzing everything from the sourcing of required rare-earth elements and other material required for fabrication to the impact of a potential disruption on critical warfighting capabilities. These efforts should prioritize weapon systems for analysis, catalog microelectronics components and subsystems, and determine the providence of those components. Relevant wargames and table-top analytic exercises to add operational context to the underlying analysis could further help decision makers more fully appreciate the warfighting impact.

With an accurate understanding of the vulnerabilities inherent in the microelectronics supply chain in hand, DoD would be well-positioned to raise awareness of the national security implications of the analysis across DoD, the Congress, and the administration. While these efforts are key to future success, it is also important to identify potential mitigation strategies today. DOD and the defense industrial base must take steps to help shape the implementation of CHIPS, follow on investments, and industrial policy to strengthen defense supply chains and build resilience.

Conclusion

Once the world leader in microelectronics and semiconductor manufacturing, the United States is now dangerously reliant upon a vulnerable global supply chain centered in the Pacific region. The disruption of that supply chain, similar to what was witnessed during the global COVID-19 pandemic, presents significant national security challenges at a time when the Chinese ability to affect the supply of chips has dramatically increased.

This effort must begin with a robust analytic effort that is shaped by real operational considerations and aimed at finding practical solutions. Understanding key supply chain nodes, potential risks, and the full implications of disruption to warfighters is a massive but necessary undertaking. Seeking the right economic and policy incentives, as well as practical manufacturing solutions and alternatives, to promote supply chain resilience is absolutely critical to the security of the United States and its allies.

Endnotes

1. "Navigating Complexities: The Semiconductor Shortage's Effect on the Auto Industry," Applied Energy Systems, November 30, 2023.
2. "1959: Practical Monolithic Integrated Circuit Concept Patented," Computer History Museum. Kilby and Noyce both received the National Medal of Science and are widely recognized as co-inventors of the integrated circuit. Kilby would receive the Nobel Prize in 2000 for this pioneering work, though Noyce died a decade earlier and did not share in the award.
3. "1959: Practical Monolithic Integrated Circuit Concept Patented."
4. Alex Williams and Hassan Khan, "A Brief History of Semiconductors: How The US Cut Costs and Lost the Leading Edge," Employ America, March 20, 2021.
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6. "IC at Fifty," Computer History Museum.
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9. Sujai Shivakumar and Charles Wessner, "Semiconductors and National Defense: What Are the Stakes?" Center for Strategic and International Studies, June 8, 2022.
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11. Gemma Conroy, "Taiwan hit by biggest earthquake in 25 years: why scientists weren't surprised," Nature, April 3, 2024.
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AD #5

Reading the National Defense Industrial Strategy with a Microelectronics Lens

The National Defense Industrial Strategy (NDIS) sets a solid foundation and direction for growing and modernizing microelectronics and defense industries.

Recommendation

The DOD must follow through on its goals. Doing so will require overcoming potential political risk, hard implementation deadlines and holding leaders accountable.

Why this Matters

If implemented, the NDIS ties microelectronics (ME) production to national defense in the present and future and bolsters the elements and investments that are critical to build and sustain the ME industry.

In December with **"What to Look for in the New Defense Industrial Base Strategy,"** we outlined some fundamentals for an effective strategy supporting the ME industry. The NDIS was published on January 11th and contains all the important factors we recommended, giving it the essential components for ME success:

- **Engaged Participants in the ME Supply Chain**
- **Vendor Diversity and Private Sector Cooperation**
- **A Flexible DIB for the Future**
- **Private Sector Incentives**
- **A Secure Development Ecosystem**
- **Improved Budgeting**
- **Updated Roles and Policies**

Diving Deeper

The NDIS names four strategic priorities: Resilient Supply Chains; Workforce Readiness; Flexible Acquisition and Economic Deterrence. The four priorities are part of the NDIS narrative of the defense industrial environment, need for change, goals, recommended actions, projected outcomes, and the consequences of not achieving the goals.

Here are some highlights that focus on ME, key actions that will impact the industry, and how they relate to the TSS-recommended fundamentals.

Introduction: This section justifies the NDIS with explanations of how the industrial base has changed over decades, the economic threat from the PRC, and the NDIS intent. It re-emphasizes microelectronics as one of the five critical sectors for DOD investment.

Resilient Supply Chains: This priority contains actions for strengthening supply chains to withstand and recover from multiple kinds of disruption. We applaud the actions for mitigating cybersecurity costs, enhancing cybersecurity and improving supply chain visibility which all support a secure development ecosystem and updated roles and policies. The DOD should continue to develop those actions and more for the integration of security in development, procurement, production and sustainment. Expanding DOD relationships with companies outside the traditional DIB supports engaged participants and vendor diversity. We note that vendor diversity will particularly support supply chain resiliency by creating contingency options among

suppliers. The call to increase investments in advanced automation technologies supports private sector incentives and improved budgeting, as does the action to incentivize industry for more capacity. The supply chain resilience in this priority will contribute to a flexible DIB for the future.

Workforce Readiness: Here, the DOD commits to significant investment in workforce development programs that will contribute to the ME industry. It includes investing in upskilling, reskilling, advanced manufacturing workforce pipelines, apprenticeships and internships, education partnerships, and broadening the workforce through diversity and inclusion programs. This goal notes the continued value of the Microelectronics Security Training (MEST) Center, among other programs. All of these will enhance the ME industry through updated roles, vendor diversity, enhanced private sector cooperation, and private sector incentives.

Flexible Acquisition: This is one area that will require substantial effort to implement. The DOD aims for dynamic acquisition to improve industry scalability and production. Among others, the action to support acquisition reform is particularly interesting. It includes steps to streamline processes, use flexible multi-year procurements, calls for increasing risk tolerances while reducing risk aversion, and provisions to include more small businesses. Part of this action is enhanced DOD outreach to strengthen public-private partnership, including innovation clusters and hubs. All support the concepts of a flexible DIB, updated roles and polices, and improved budgeting. More actions to incentivize requirements for interoperability and expanding the supplier base also apply to the ME industry through private sector incentives and private sector cooperation. This goal has significant potential to enable the ME industry to support defense with agility.

Economic Deterrence: This priority outlines how a healthy industrial base contributes to national security. Its action items for maintaining economic alliances, interoperability standards, and technology sharing are all part of updating roles and policies to meet the demands of the modern geo-political dynamics. Protecting U.S. assets from cyber-attack and strengthening polices on prohibited sources to prevent adversarial ownership supports a secure development ecosystem. The strategy specifically calls for eliminating dependencies on the PRC. This goal encapsulates the concept that economic strength and coordination equates to national security.

How it All Comes Together

As important as those fundamentals are, the whole of the NDIS is greater than its parts. According to the DOD's theory, the purpose of a national strategy is to orchestrate the instruments of national power to achieve goals. That is where the NDIS truly succeeds.

Although a federally managed defense industrial base and capacity reporting has existed for decades, the comprehensiveness of the NDIS is an encouraging step by the DOD. The NDIS is the first time that the U.S. has united elements that influence commercial defense industries – national needs, work forces, capacity, supply chains, security, and business needs – together through intelligent design, with flexibility for the future, under the cause of national security. It recognizes the impact and value of businesses small and large, people, technology, and adversaries.

Under the NDIS, a public-private defense industry ecosystem operates with mutually supporting roles. It provides additional focus and outlets for the productivity of the ME Hubs and innovation from University Superclusters, the modernization aspects in which the ME industry excels.

How the DOD, industry and nation execute the NDIS will be subject to the unforeseeable future, and dedicated effort. But the vision of a unified, focused industrial base can be a lighted path to follow through disorder and unprecedented peer adversaries.

With the NDIS, we're all in this together.

AD #6

Reading the National Defense Industrial Strategy "Commentary Update" 2 Pages

Reading the National Defense Industrial Strategy "Commentary Update" Continued

AD #7

Interviews with Polar CEO 4 Pages

Interviews with Polar CEO Continued

Interviews with Polar CEO Continued

Interviews with Polar CEO Continued

AD #8
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