Technology Leadership and Strategy Initiative

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Council on Competitiveness

SUMMARY REPORT

Innovation & Competitiveness Partnerships: A New Defense Industrial Base for the 21st Century

Summer Dialogue 2023

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Agenda

MORNING

8:30 Registration—Continental Breakfast

9:00 Welcoming Remarks

The Hon. Deborah L. Wince-Smith
President & CEO, Council on Competitiveness

Dr. Steven Walker
Vice President and Chief Technology Officer, Lockheed Martin; TLSI Co-Chair

9:20 Framing Options for the TLSI 2023 Agenda—Shape of the Dialogue

This session will review at a high level a set of potential TLSI project and engagement opportunities —summarized in the "ideas starter" paper shared prior to the Dialogue. Each idea presented in the paper will be discussed across the day.

Mr. Chad Evans
Executive Vice President, Council on Competitiveness

Dr. Steven Walker
Vice President and Chief Technology Officer, Lockheed Martin; TLSI Co-Chair

Dr. Sally Morton
Executive Vice President, Knowledge Enterprise, Arizona State University; TLSI Co-Chair

Dr. Patricia Falcone
Deputy Director of Science and Technology, Lawrence Livermore National Laboratory; TLSI Co-Chair

9:45 Innovation & Competitiveness Partnerships—A New Defense Industrial Base for the 21st Century

IDEA—Develop an Adaptive and Agile Industrial Base to Meet U.S. Economic, National Security, Energy, and Sustainability Needs

A host of emerging technologies are generating growing number of game-changing applications across the entire commercial sector, as well as in the broad defense, space, and energy sectors. Equally on the rise is demand for greater sustainability across the economy and society.

Increasingly, the defense and space industries are reaching into the commercial sector and the start-up ecosystem for technologies, innovations, and solutions. And on the flip side, many across the commercial sector are benefitting from advanced technologies originally developed to meet defense and space missions.

Yet, traditionally, many of these sectors have been treated as distinct, even as emerging technologies are increasingly dual-use, and flow back and forth across these sectors blurring their boundaries.

Discussion Questions and Possible Guidance for TLSI Action

- How can the United States overcome these traditional separations and boundaries to accelerate toward a more competitive, innovative, and integrated industrial base?
- What are the key challenges in adapting and aligning the defense, space, and commercial sectors to lever emerging technologies?
- What new or revised policies and regulatory frameworks could facilitate the flow of technologies and expertise across sectors, while ensuring national security and protecting intellectual property?
- How can the United States prioritize and allocate resources to support the development of an adaptive and agile industrial base that can quickly respond to evolving economic, national security, energy, and sustainability needs?

Confirmed Kick-off Discussant(s) to Date

Dr. David Parekh
Chief Executive Officer, SRI International

Mr. Justin Taylor
VP of Artificial Intelligence, Lockheed Martin

Moderator

Dr. Steven Walker
Vice President and Chief Technology Officer, Lockheed Martin; TLSI Co-Chair

10:45 Coffee Break

11:00 Innovation & Competitiveness Partnerships—A New Defense Industrial Base for the 21st Century
IDEA—Optimizing the Growing Reliance on New Knowledge and Technology Developed in the Commercial Sector and Universities

U.S. businesses and universities perform about a half trillion in U.S. R&D, generating new knowledge and technologies. Universities are also a major source of new high-tech start-ups.

The U.S. public sector in general, including the Department of Defense and its contractors, is reaching more frequently and deeply into these creators of new knowledge and technology for mission applications, and the commercial sector is reaching into universities for new knowledge, cutting-edge technology, and talent.

These connections will become more important with accelerating technological advancement, and in translating new generational U.S. investments in R&D, critical technologies, and clean energy into economic and national security impacts for the United States.

They also have the potential to undergird a new industrial base that integrates defense and commercial sectors to propel U.S. competitiveness, and national and energy security.

Discussion Questions and Possible Guidance for TLSI Action

- What strategies can foster, strengthen, reinforce, make more globally competitive a culture of collaboration and knowledge-sharing between technology users and creators, including the exchange of ideas, expertise, and research findings?
- What role can startups and small businesses play in driving innovation and integrating emerging technologies into the industrial base? How can they be effectively supported and incentivized?
- What measures can be taken to ensure a skilled workforce capable of adapting to and harnessing emerging technologies, particularly in sectors of incredible technology convergence (defense and space, bio, information tech, etc.)?

Confirmed Kick-off Discussant(s) to Date

Dr. Joe Elabd
Vice Chancellor for Research, The Texas A&M University System

Dr. Tommy Gardner
Chief Technology Officer, HP Federal, HP

Moderator

Dr. Sally Morton
Executive Vice President, Knowledge Enterprise, Arizona State University; TLSI Co-Chair

11:45 Innovation & Competitiveness Partnerships—a New Defense Industrial Base for the 21st Century

IDEA: Introduce Changes in the Department of Defense—Lowering DOD Cultural Barriers to Increased Use of Commercial Technologies, and Reforming Acquisitions to Speed Insertion of Cutting-Edge Tech

DOD's increasing need for technologies developed by commercial companies for commercial markets is creating challenges including developing or modifying organizations and business models to access the technology, and adapting DOD culture to seek and apply technologies developed outside of DOD, the United States, and its traditional contractor base.

Experiences have shown that major cultural change and new model adoption are challenging in large, long-established organizations like DOD. How can we help introduce change?

Additionally, a long-standing challenge in accelerating defense fielding of new technologies and concepts has involved the acquisition process, the budgeting process, and system integrators, but there have not been serious changes to that system.

Discussion Questions and Possible Guidance for TLSI Action

- What new strategies or initiatives could promote a cultural shift within the DOD that values and actively seeks out technologies developed outside of its traditional contractor base—and how do we encourage implementation?
- What are the key factors and stakeholders impeding reforms in the defense acquisition process to acquire new technologies?
- What role can Congress or the White House/ Administration play in driving changes in the defense acquisition process? What specific statutes or regulations need to be amended or created to allow for new business models and the inclusion of non-traditional partners?

- What are the barriers that prevent non-traditional partners and start-ups with innovative technologies from effectively contributing to meeting the DOD needs? How can these barriers be overcome?

Confirmed Kick-off Discussant(s) to Date:

Mr. Rob McHenry
Deputy Director, Defense Advanced Research Projects Agency (DARPA)

Dr. Dinesh Verma
Professor and Executive Director, School of Systems and Enterprises, Stevens Institute of Technology

Moderator

Dr. Patricia Falcone
Deputy Director of Science and Technology, Lawrence Livermore National Laboratory; TLSI Co-Chair

AFTERNOON

12:30 Group Photo

12:40 Lunch & Keynote

Dr. Nelson Pedreiro
Vice President, Lockheed Martin Advanced Technology Center, Lockheed Martin

Introduction by

Dr. Steven Walker
Vice President and Chief Technology Officer, Lockheed Martin; TLSI Co-Chair

1:30 Innovation & Competitiveness Partnerships—A New Defense Industrial Base for the 21st Century

IDEA: An Emerging Parallel System for Defense Innovation

A parallel DOD innovation ecosystem is emerging, driven by the need to access technology from non-traditional sources, and accelerate technology development and acquisition. DOD and its services branches have established a range of initiatives to this end. For example: DOD established the Defense Innovation Unit, and increasingly uses other transaction (OTA) authorities and limits R&D competitions to OTA consortia. Some efforts to acquire defense systems are based on desired product or system capabilities rather than traditional acquisition specifications. The Army established an Army Venture Capital Corporation, and Army Futures Command/Army Applications Lab, organized around eight broad cross functional teams. The Air Force established AFWERX as the Air Force's innovation arm, and Space Force set up SpaceWerx as its innovation arm. Some of these new innovation operations have outposts in U.S. high-tech hubs, and are working to making it easier for companies to bring their technologies to DOD.

Discussion Questions

- What lessons can be learned from the initiatives within the DOD's emerging innovation ecosystem that can be applied to moving technologies with commercial potential from universities, small businesses, and start-ups through the "valley of death" and towards scaling up for defense applications?
- What is the significance of establishing outposts in U.S. high-tech hubs for these innovation operations? How does this geographical presence contribute to making it easier for companies to bring their technologies to the DOD?

- What challenges and barriers exist in scaling up technologies from universities, small businesses, and start-ups for defense applications? How can the emerging innovation ecosystem address these challenges and facilitate the successful transition of technologies across the "valley of death"?
- What collaborative opportunities exist between the DOD's emerging innovation ecosystem and other stakeholders, such as universities, research institutions, and industry, to foster a more robust and inclusive innovation ecosystem?

Confirmed Kick-off Discussant(s) to Date

Mr. Chris Moran
Vice President, GM LM Venture, Lockheed Martin

Moderator

Mr. Chad Evans
Executive Vice President, Council on Competitiveness

2:00 Deploying Technology Statecraft with Strategic Allies

How do we ignite a transformational technology and pro-innovation statecraft with strategic allies and partners (AUS, UK, AUSUK, Japan, EU, transatlantic, etc.)? For example, the CHIPS Act includes $500 million in funding for an International Technology Security and Innovation Fund to provide for international information and communications technology security and semiconductor supply chain activities, including support for the development of secure and trusted telecommunications technologies and semiconductors. In addition, the new U.S.-EU Trade and Technology Council is providing a platform for the U.S.-EU to advance cooperation and democratic approaches to trade, technology, and security.

Discussion Questions

- How do we deploy a statecraft that advances U.S. domestic interests, advances liberal market principles globally, and counterbalances the technology statecraft China is attempting to deploy around the world?
- Can the AUKUS agreement be used as an exemplar of a new statecraft at least where the U.S., UK and AUS are concerned?
- Can we re-start the US-AUS CTO dialogue? Other options (UK, Japan, India)?

Confirmed Kick-off Discussant(s) to Date

Dr. Tony Lindsay
Director, Science Technology Engineering Leadership and Research Laboratory (STELaRLab), Lockheed Martin

Moderator

The Hon. Deborah L. Wince-Smith
President & CEO, Council on Competitiveness

2:30 Final Discussion, Summary Remarks, and Next Steps

Mr. Chad Evans
Executive Vice-President, Council on Competitiveness

Dr. Sally Morton
Executive Vice President, Knowledge Enterprise, Arizona State University; TLSI Co-Chair

Dr. Patricia Falcone
Deputy Director of Science and Technology, Lawrence Livermore National Laboratory; TLSI Co-Chair

Dr. Steven Walker
Vice President and Chief Technology Officer, Lockheed Martin; TLSI Co-Chair

The Hon. Deborah L. Wince-Smith
President and CEO, Council on Competitiveness

3:00 Exploring the Advanced Space Tech Center

A Set of Onsite Visits

Participants will divide into two groups. Two tours will be offered concurrently—the first group will start with the Space Sciences Lab Tour and finish with the AI Lab Tour; the second group with start with the AI Lab Tour and finish with the Space Sciences Lab Tour. Each tour will be about 50min long.

Space Sciences Lab Tour

Guide: Dr. Alison Nordt
Director of Space Science and Instrumentation, Lockheed Martin Advanced Technology Center

The AI Lab Tour

Guide: Dr. Eric Smith
Director of AI, Lockheed Martin Advanced Technology Center

5:00 Dialogue Adjourns

Participants

TLSI CO-CHAIRS & COUNCIL LEADERSHIP

The Hon. Patricia Falcone
Deputy Director for Science and Technology
Lawrence Livermore National Laboratory

Dr. Sally C. Morton
Executive Vice President, Knowledge Enterprise
Arizona State University

Dr. Steven Walker
Vice President & Chief Technology Officer
Lockheed Martin

The Hon. Deborah L. Wince-Smith
President & CEO
Council on Competitiveness

Mr. Chad Evans
Executive Vice President & Board Secretary & Treasurer
Council on Competitiveness

KEYNOTE SPEAKER

Dr. Nelson Pedreiro
Vice President
Advanced Technology Center
Lockheed Martin

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Deputy Director
Hypersonics and Advanced Materials
Lockheed Martin
Advanced Technology Center

Dr. Kenneth W. Bayles
Vice Chancellor for Research
University of Nebraska Medical Center

Mr. Omar Choudhry
Chief of Staff—Corporate Technology Office
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Space Security & Communications Directorate Lead
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Vice President of Research
Auburn University

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Senior Advisor

Ms. Candace Culhane
Senior Advisor

Ms. Yasmin Hilpert
Senior Policy Director

Introduction

On June 29, 2023, the Council on Competitiveness convened its Summer and 27th Technology Leadership and Strategy Initiative (TLSI) Dialogue, hosted by Lockheed Martin at its Advanced Technology Center in Palo Alto, California.

About 35 leaders from technology-intensive industry sectors, universities, national laboratories, and the Federal government came together to explore forces, challenges, and opportunities shaping the U.S. defense industrial base for the 21st century. Discussions centered around five themes:

- Developing an adaptive and agile industrial base to meet U.S. economic, national security, energy, and sustainability needs;
- Optimizing the growing reliance on new knowledge and technology developed in the commercial sector and universities;
- Lowering Department of Defense cultural barriers to increased use of commercial technologies, and reforming acquisitions to speed insertion of cutting-edge technology;
- An emerging parallel system for defense innovation; and
- Deploying technology statecraft with strategic allies.

The dialogue was led by TLSI Co-Chairs—the Honorable Patricia Falcone, Deputy Director for Science and Technology at Lawrence Livermore National Laboratory; Dr. Sally Morton, Executive Vice President, Knowledge Enterprise at Arizona State University; and Dr. Steven Walker, Vice President and Chief Technology Officer at Lockheed Martin.

Council on Competitiveness President and CEO Deborah Wince-Smith welcomed the dialogue participants, Chief Technology Officers, and leaders of research enterprises across industry, academia, and U.S. national laboratories. She cast the group as a think tank inside the Council providing intellectual leadership on issues affecting U.S. innovation capabilities and technology leadership. Core to the Council's mission is identifying on the horizon issues and challenges that could shape America's prosperity, productivity, and global competitiveness. National security has always been integral to that mission because, without economic progress and capabilities, we cannot have national security.

Changing landscape for technology and innovation. She discussed how, over the past two years, there has been tremendous change, and new national technology and innovation initiatives.

These include passage of the CHIPS and Science Act, which authorizes generational investments in R&D and critical technologies, investments in new innovation hubs, and an historic expansion of the National Science Foundation mission. To fulfill provisions of the CHIPS Act, Congress appropriated $50 billion to advance semiconductor R&D and build greater semiconductor manufacturing in the United States.

Other important trends, challenges, and opportunities reshaping the world include multiple technology revolutions, a massive energy transition, the rise of China as a major strategic competitor to the United States, accelerating automation, and new models of business and work. There is tremendous turbulence, and big things can happen almost overnight.

TLSI Co-Chair, and Lockheed Martin Vice President and Chief Technology Officer Dr. Steven Walker outlined the idea behind the dialogue's agenda—the landscape of threat to U.S. national security, the competitiveness of the defense sector, and the challenges of building a new defense industrial base for the 21st century. To deter that threat will require a combination of forces from allies, defense and commercial companies, small businesses, universities, laboratories, and the venture capital community.

Technology disrupting defense and the defense industrial base. Lockheed has been defense platform focused, but those platforms will be reshaped by emerging technologies and concepts such as artificial intelligence, machine learning, autonomy, crewed/uncrewed teaming, advanced communications, spectrum technologies, interoperability, and how digital technologies glue different platforms together for different mission applications to provide real deterrence capability for the future.

However, rather than in the defense sector, leadership in many of these technologies is in commercial firms, universities, and national laboratories. Lockheed must work with these companies and entities in a much closer way to bring that advanced technology to its military customers. To that end, Lockheed has developed partnerships with commercial companies such as Global Foundries, Microsoft, Nvidia, IBM, and Red Hat. It is also investing in start-ups and linking to the venture capital world to bring the leading edge of technology to military applications.

Key Takeaways

Building a New Adaptive and Agile Defense Industrial Base for the 21st Century

Changing technology landscape for national defense:

- Emerging technologies are disrupting defense and the defense industrial base. However, rather than in the defense sector, leadership in many of these technologies is in commercial firms, universities, and national laboratories.
- Many decision-makers in national security, science, and technology believe we can ensure the Nation's security with models that have worked well in the last century. But the conditions are not the same and, partnerships, models, and the defense industrial base must be different.

Opening the aperture to more players in the defense technology space:

- Opening competition to more players, including commercial firms of all sizes, can produce creative solutions, lower costs, and speed development.
- Commercial start-ups/small businesses and defense primes have different skill sets. For national security, we need to enable each to do what they do best.
- Defense does not have to wait to use what is on the shelf from the commercial side. It can take problems to commercial firms, and they can decide if it is worth their effort to solve them.

Barriers faced by small businesses in engaging with government:

- Friction all around doing business with government creates barriers that inhibit the ability of small businesses and other organizations to engage with the Department of Defense (DOD). These include export controls, getting clearances, compliance with DFAR, accounting rules, cost sharing requirements, and caps on salaries, pay raises, and overhead.
- For small businesses that might engage in DOD technology projects, there is no support for a longer-term transition, for example, moving to TRL-5 and above, and transitioning to a service. Someone has to take the technology across the valley of death, but nobody is there. If small companies can be tied to large companies, large companies can show them the pathway.
- There are tens of thousands of DOD suppliers, many working on promising technologies. But many do not want to grow, many will fail, and few will scale. But government metrics are driven around working with small companies. That may not help the industrial base; it seems to make it very fragile and not resilient.

Financing and the role of venture capital community:

- It is important for the major corporate investor to be a strategic partner as well as a customer of the small business venture in which it is investing. The corporate partner can provide access to corporate resources and capital, and allow the entrepreneurial culture to flourish in the small business venture.
- Most opportunities in the national security space are not big enough for venture capitalists, and are not going to return enough money.
- The venture capital community shares information which helps deal with risk. But government does not take advantage of the rich knowledge in that community. The government may have no idea whether a company that may win a competition is going to survive.
- Government does not share information about companies that respond to RFPs, even though that information might draw investments from a private venture fund.
- There is a feeling at universities that every idea gets funded by the venture community. But the funding conversion ratio is about 1 to 2 percent. Very few patents are going to turn into a big company. There is a high failure rate. Very few academics can become start-ups.
- There are differences in timescale and expectations. Developing technologies for defense often takes a very long time. But Silicon Valley is used to things that can be monetized and scaled quickly. Venture capitalists are looking for a certain scale of return and opportunity. Private equity is looking for something else. Companies that want to license or take a product to market are something else altogether. We need to identify where the gaps are and where there aren't enough options to get what is needed.

DOD culture and acquisition process:

- The incentive structure around contracting officers has been about risk aversion, cost savings, and technically acceptable solutions. When freed of that culture, they move into a different kind of mastery of the rules—not as a barrier but as an enabler. Also, we have a bureaucracy-based system engineering and risk mitigation strategy. These impact decision-making about innovative approaches for partnerships with commercial companies.
- DOD needs to use the authorities it has to drive partnerships that can create a combination of agility and speed, including broader application of OTA, the use of partnership intermediaries, and the use of non-profit foundations.

- The inherent culture may be too hard to change. But, unless we can address the culture issues, Schumpeter's creative-destruction might come into play—we have to destroy certain things, create new organizations, or at least set up a competitive system.
- At DARPA, transition is a pain point of increasing significance. We are innovating amazing technology, but if it is not going out and having impact for national security until years or decades later, we have lost inherent surprise. One big challenge is a sunk cost fallacy. DOD programs of record have a defined roadmap. One way to reevaluate those long-running roadmaps and programs could be an analysis of alternatives every five years built into the acquisition process.
- DARPA has developed new models to work transition within the current system. These include harvesting technology and capabilities coming out of long-running dark programs, and operationalizing and transitioning them; demonstrating technologies in operational military units and commands, and leaving a residual capacity in place while the rest of the system catches up; and embedding expert entrepreneurs with project performers that have met technical goals and have something of high interest to national security. It is also developing a new debt vehicle to advance companies toward technology commercialization.
- Access to Federal data is a big issue. For example, data is needed to train AI systems for defense, but important data on defense missions is classified. DOD has failed to enable the defense industrial base and defense primes to have classified networks needed to work with each other or even within their own companies. TLSI participants suggested models including providing access to limited data for proving concepts or value, and a consortium model in which DOD provides U.S. citizen participants access to public and restricted government data.

University intellectual property:

- A lot of IP is generated at universities, but commercialization is a hodgepodge across the United States. We need better incentives, and to expose academic researchers to the possibilities in the commercial world. We have to rethink promotion and tenure criteria for a greater emphasis on commercialization. The marquee Federal research sponsors could drive a shift in the university research culture.
- Universities should identify their real areas of expertise and leadership. That would augment their competitiveness in winning research grants. Alignment of the university IP portfolio, and putting together faculty clusters makes a difference.

International cooperation in technology:

- The strategic geopolitical landscape has changed. The United States should cooperate with its allies to build strategic capabilities, strengthen our capacity against threat, and to address critical supply chain issues, not just in defense but in transformation on a national engagement scale.
- Some of DARPA's international cooperative activity is because countries such as Australia have capabilities that exceed U.S. capability. Partnering makes sense for both parties.
- National laboratories cooperate with international partners on federally-funded R&D to do the best science and technology, work with the best scientists in all fields, and address common problems. They also collaborate to build strategic capabilities in science and technology for readiness and dual use. In many key technologies government does not own the technical edge and you cannot do national security in those domains without working with the best people in the global scientific community. Also, you also need to build these relationships so, when there is a crisis, the best science and technology knowledge can quickly be provided to decision-makers.
- We may have a blind spot with respect to Africa, the Caribbean, Latin America, and developing countries that are natural resource intensive, and may want to do scientific diplomacy in some of these countries. They are in the sight of our adversaries, and China is leaning in.

Framing the Options for the 2023 TLSI Agenda—Shaping the Dialogue

9:20 a.m. Session

Chad Evans
Executive Vice President,
Council on Competitiveness

Council on Competitiveness. The Council was founded in 1986 by John Young who was CEO of Hewlett Packard at the time. The Council was a follow-on from President Reagan's Commission on Industrial Competitiveness, which he chaired. That Commission was focused on the competitive challenge the United States faced from "Japan, Inc." and West Germany's export engine.

Young intentionally created a multisectoral group that bridged industry, academia, and government and, later, Deborah L. Wince-Smith brought in U.S. national laboratories. These four sectors represent critical stakeholders that drive the Council's mission of promoting policies and actions to support the long-term productivity and economic growth of the country, U.S. national security, and inclusive prosperity. Nearly 200 C-suite leaders across these four sectors drive that mission, supported and underpinned projects and initiatives including TLSI.

The Council is currently led by Brian Moynihan, Chairman and CEO of Bank of America. Janet Foutty, Executive Chair of the Board at Deloitte has served as our Business Vice Chair, and Dan Helfrich, Chairman and CEO of Deloitte Consulting recently assumed that role. Joan Gable, Chancellor of the University of Pittsburg, serves as our Academic Vice-Chair, and Kenneth Cooper, International President of the International Brotherhood of Electrical Workers services as our Labor Vice-Chair. Chad Holliday, former CEO of DuPont, former Chairman of Bank of American, and former Chairman of Royal Dutch Shell as well as Mahmood Khan, former Global Vice Chairman and Chief Science Officer for PepsiCo have been active Chairman Emeritus.

Evolution of Technology Leadership and Strategy Initiative. TLSI was founded 14 years ago under the leadership of BellSouth, IBM, Georgia Tech, and others to help the Council create a private sector innovation agenda for the country—*Innovate America*. It became the basis for significant bi-partisan legislation, the America Competes Act, which has had lasting impact.

Council members saw that the pace of technological change and how technology would drive the global economy were underappreciated and underestimated. That prompted the Council and Ray Johnson, Lockheed Martin's CTO at the time, to establish a group to think strategically about investing in technology, talent, and the infrastructure to drive long-term U.S. innovation capacity. Since then, we have held nearly 30 dialogues about shaping the U.S. innovation ecosystem and developing recommendations to the Council and the Nation. TLSI has produced a tremendous corpus of work. This includes a report produced in partnership with Deloitte, a comprehensive study on advanced technology frontiers for different sectors. TLSI leaders and members took that work to Congress, including engaging the leadership of the Technology Caucus.

With the approaching campaign season, the Council seeks to drive conversations around the country about U.S. competitiveness. We started in California with a two-day dialogue at the University of California at Davis, led by Chancellor Gary May. We will convene at Lawrence Livermore National Laboratory on September 21.

Also, we are in Phase 2 of the Council's flagship National Commission on Innovation and Competitiveness Frontiers, which brings together about 70 C-suite leaders as commissioners to develop a next set of recommendation on innovation for the next administration. There are four key pillars for this work—the future of sustainability, the future of work, the future of place-based innovation and, where the TLSI's dialogues will be crucial, the future of disruptive technologies and how we develop and deploy them at speed and scale. We will also have a special theme on the future of secure supply chains and advanced materials, an issue that has risen to the top of national agenda.

Dr. Steven Walker
Vice President and Chief Technology Officer
Lockheed Martin
TLSI Co-Chair

Dr. Walker emphasized the need for change in the defense community, and the blurring lines between national security and economic security. Many decision-makers in national security, science, and technology believe we can ensure the Nation's security with the models that have worked in the last century. However, the conditions are not the same, and the partnerships and models around national security, science, and technology, and the defense industrial base must be different. Work is needed in the defense community and elsewhere to explain why the rules, expectations, and metrics must change.

Not many years ago, when Dr. Walker gave a presentation about his laboratory—a big place for computing, data science, and simulations—he could not use the words artificial intelligence (AI), because it was viewed suspiciously and was not very technical, but could talk about machine learning, Bayesian systems, and computing. Now, suddenly, everyone is talking about AI. Those who do this work must explain what we are doing, what the benefits are, the dangerous world, and the vulnerabilities that

can come with new capabilities. It is important to engage the people who make rules on who we can collaborate with on research, but also how we reap benefits from Federal investments to the maximum degree for U.S. business and citizens.

TLSI has the multiple sectors at the nexus of the defense industrial base, innovation, collaboration, agility, and speed. We need to address the challenges and barriers of transforming the U.S. defense enterprise. The idea starters discussed at the dialogue are designed to kick-off that conversation about defense innovation and building a new defense industrial base for the 21st century.

IDEA

Develop an Adaptive and Agile Industrial Base to Meet U.S. Economic, National Security, Energy, and Sustainability Needs

9:45 a.m. Session

Kick-off Discussants

- Dr. David Parekh, Chief Executive Officer, SRI International
- Mr. Justin Taylor, VP of Artificial Intelligence, Lockheed Martin

Moderator

- Dr. Steven Walker, Vice President and Chief Technology Officer, Lockheed Martin; TLSI Co-Chair

A host of emerging technologies are generating growing number of game-changing applications across the entire commercial sector, as well as in the broad defense, space, and energy sectors. Equally on the rise is demand for greater sustainability across the economy and society. Increasingly, the defense and space industries are reaching into the commercial sector and the start-up ecosystem for technologies, innovations, and solutions. And on the flip side, many across the commercial sector are benefitting from advanced technologies originally developed to meet defense and space missions. Yet, traditionally, many of these sectors have been treated as distinct, even as emerging technologies are increasingly dual-use, and flow back and forth across these sectors blurring their boundaries.

Discussion Questions and Possible Guidance for TLSI Action

- How can the United States overcome these traditional separations and boundaries to accelerate toward a more competitive, innovative, and integrated industrial base?
- What are the key challenges in adapting and aligning the defense, space, and commercial sectors to lever emerging technologies?
- What new or revised policies and regulatory frameworks could facilitate the flow of technologies and expertise across sectors, while ensuring national security and protecting intellectual property?
- How can the United States prioritize and allocate resources to support the development of an adaptive and agile industrial base that can quickly respond to evolving economic, national security, energy, and sustainability needs?

Justin Taylor
Vice President of Artificial Intelligence
Lockheed Martin

The 2018 National Defense Strategy noted that "Success no longer goes to the country that develops a new technology first, but rather to the one that better integrates it and adapts its way of fighting." Advanced technology and Artificial Intelligence (AI), in particular, are seen as leveling the playing field. We must lean forward, do so with ethics, but not hold ourselves back. We should not regulate based on fear or a misunderstanding of the technology, lest we prevent the Nation from doing what it needs to do.

Artificial Intelligence Strategy at Lockheed Martin. Lockheed is working to drive AI and Machine Learning as an engineering discipline across the corporation with a strategy to bring the best from commercial companies and apply it to defense. Lockheed is partnering with tech giants such as Nvidia and Microsoft, but we are also tapping into the skill sets of companies of all sizes. We recognize there is no one size fits all solution or incentive structure that will transform the industry. It would be a mistake to have them all do things the way the Department of Defense (DOD) expects defense prime system integrators to operate. We need to enable those companies to do what they do best while enabling the defense primes to do what they do best.

> "We must innovate with urgency to be able to outpace these complex threats that are very real and clear today."
>
> **Justin Taylor**
> Vice President of Artificial Intelligence
> Lockheed Martin

Partners doing what they do best. Lockheed is working on a project with Nvidia to apply AI to wildland fire management. This problem was chosen because it is complex and has similar challenges to the defense domain. They are both cross-domain problems, and require us to bring a wealth of technologies to bear in a chaotic, ever-changing environment that is tough to predict.

The project demonstrated how AI can be applied to predict that a fire could happen, to generate the perimeter of an ever-growing fire, and predict expansion of a fire front. The team is currently working on resource management and coordination to optimize the use of the limited resources to suppress a fire. Lockheed is working with Nvidia and its Omniverse 3D photorealistic visualization technology. It is being used to train AI agents to present 3-D interactive visuals to commanders on the ground for making decisions about how to suppress a fire. The project has been a success because Lockheed and Nvidia were able to come together in a blended way and do what each does best.

A big part of Lockheed's vision is providing superior flexibility and fluidity to the warfighter—enabling spacecraft, aircraft, land, surface, and subsurface platforms to work together to handle the ever-changing environment in front of them. A key

part of that flexibility is being able to change roles, communicate with each other, and do so with the latest and greatest technology to host the software. However, what is available on the shelf from commercial companies does not always meet the requirements and mission assurance needs for defense.

For example, a technology called Kubernetes could orchestrate these software services across those different platforms, but it does not operate at the necessary security level to make it a reality. Lockheed took this problem to Red Hat- sharing that defense has a need, the current Kubernetes solutions was insufficient and, perhaps, there could be a commercial market for a more secure alternative.

Red Hat assessed if they could solve the problem, and if there was commercial potential and reason to invest. They decided yes, there was. They took their Kubernetes OpenShift platform, created a microchipped version of it, and released Red Hat Device Edge. Red Hat Device Edge addressed the defense problem but also Red Hat's need for a return on investment due to commercial interest. Device Edge will be the first in aerospace and defense to fly in a mission context on a fixed wing UAV. This year, a fleet management component will be added to control processors across domains, taking advantage of the computer power and AI capabilities across those platforms in mission—a big, distributed processing vision.

Lesson learned. The defense industry is not stuck waiting to use what is on the shelf from the commercial side. The commercial industry is moving so fast, and the investments are so big, the defense industry can never keep up, nor should we make it a goal. Instead, use a multi-pronged approach. Incorporate existing commercial technologies that fill a need, proactively work with commercial firms to build needed capabilities, and develop in house what only Lockheed can develop. We all have a part to play in the increasingly complex defense space.

Dr. David Parekh
Chief Executive Officer
SRI International

SRI, and the former Xerox PARC now part of SRI, have invented many things such as the graphical user interface, the mouse, laser printing, the PDF, and more. However, there have often been big ideas, but they would fail, tripped up by misaligned incentives, barriers, and culture.

Friction all around doing business with government creates barriers that inhibit the ability of organizations to engage. When trying to bring a commercial company in to do government work, there are issues such as export controls, getting clearances, DFARS, accounting rules, etc. So, when a commercial company does not have experience in dealing with government requirements, it is no surprise that is hard to bring those companies into government work.

When Dr. Parekh came to SRI, it did almost no work in energy, climate, and sustainability. SRI did not engage because the work was largely supported by government-funded programs that require a cost share. If an organization is a nonprofit, with no profit or endowment, it cannot meet a cost share requirement because it would go out of business.

The National Institutes of Health cannot pay full salary for the best people, world leaders in the field, or give raises during the project period of performance to keep pace with inflation. Similarly, in doing work to make pre-K-12 more accessible and equitable, big foundations may be willing to invest, but not pay all of the costs or put a cap on overhead. When thinking about creating a broader ecosystem that brings in non-profits or small companies that know nothing about government accounting, we must think about incentives, barriers, and culture.

In bring these diverse worlds together, including the defense and commercial world, we need "impedance matching," leveraging organizations that touch both worlds because they can be effective impedance matches in connecting the dots. For example, a commercial company may not want to work with the government or DOD, but may be willing to work with a defense prime because the prime is set up to work with government.

Language and culture can be very different among disciplines. For example, when Dr. Parekh was working on active flow control—bringing together the worlds of fluids, controls, and micromechanical systems—his team realized that it had completely opposite language for many things; for example, in terms of input to a system, plus or minus meant different things to an electrical engineer. We need to build places to bring diverse communities together to engage and work, and also provide boundary crossing opportunities for students and faculty. For example, the Air Force used to have a program where faculty could go to an operational base and see how things get done, then bring that knowledge back to their research groups and graduate students to help them understand real world constraints.

Incentives matter. One of the things that has made SRI successful with a strong track record of 50 spin outs is taking a light touch, not seeking to own a lot, and providing enough incentives for the founders and inventors. So rather than holding on to 80 percent and getting 80 percent of nothing, you hang onto 20-30 percent and spin the new venture out.

The Council's 2004 *Innovate America* report discussed the potential of applying the DARPA model to other areas such as energy. Years later, the Department of Energy created the Advanced Research Projects Agency-Energy (ARPA-E) to perform early-stage research on high-potential, high-impact energy technologies. Similar models are popping up across the Federal government (IARPA, ARPA-C, ARPA-H, and ARPA-I).

We need to take the long view. Change can take time. For example, in 2008, the Defense Science Board released its study on warfighters' use of fuel and reducing fuel demand. The study's first finding was that DOD had not implemented the recommendations the Defense Science Board had made in its 2001 report on the same challenge.

Points of Discussion

Access to Federal data is a big issue. For example, data is needed to train AI systems, and most of the important data on defense missions is classified. Some have suggested democratizing defense data, enabling companies of all sizes to access the data and work in classified environments. However, that may not be the right barrier to tackle to enable small companies to engage; DOD has failed to enable the defense industrial base and defense primes to have the classified networks needed to work with each other or even within their own companies.

Academics, and the Office of Science and Technology Policy promote open science, and believe all results of federally-funded research should be available immediately. But, in terms of economic secu-

rity, a lot of research data should be curated and may have economic value, including the accretion of data. For example, material design is advancing rapidly using simulation and AI tools. All data is not the same. ChatGPT trained on open Internet data. But the data that is going to allow us to make new materials, new body parts, and all kinds of things is different.

China is a highly instrumented society, and the government has close relationships with industry through which they share the right information with the right people, and the data sets and sources for AI training. In contrast, the United States is highly disadvantaged in our current structure. So, there is external impetus for change—we are losing a competition that could be critical to the future, both economically and militarily.

Dialogue participants suggested several approaches to lower the barrier:

- Access to all the data or real-world data is not necessarily needed to prove a new concept is valuable. Small, innovative companies need not be the ones to have full access all the way to the end state. Instead, use a a blended approach to democratize data to the point where the broader industry is able to access enough to prove concepts, have the right incentives to reward those companies for their breakthrough algorithms and techniques, but then allow the defense primes to leverage the unique data they have.
- Government wants to democratize data generally because it does not want to have vendor lock. That can be solved through open architectures and non-proprietary interfaces. What may be needed is an incentive model that allows data to be exposed to companies of all sizes to prove what is possible, but then allow companies that are paying the burden of being DFARS-compliant, such as defense primes, to use that data and create their own IP, and still get a broader base innovating. All would be incentivized to do what they do best, and the government gets the flexibility it needs without being handcuffed.
- In one successful model, DOD set up the Acquisition Innovation Research Center (AIRC), which collaborates with faculty and students at 25 leading universities to translate leading-edge research into acquisition-related applications. It provides collaborating faculty and students who are U.S. citizens with a range of public and restricted government information and data. AIRC set up the Defense Data Grand Prix prize, giving faculty and students access to data to tackle DOD problems with data science, for example, fusing the vast amount of data on goods and services handled by the Defense Logistics Agency, and how to optimize and analyze that data through cutting edge applications.

  However, a similar collaboration could not be established with DOD's Joint Pathology Center—which holds a tissue repository that includes 55 million glass slides collected over more than a century—even though the Defense Science Board characterized it as a priceless resource for health care data analysts, stating that a medical dataset of that size would rapidly accelerate biomedical research particularly in the fields of infectious disease and cancer, reducing misdiagnosis by orders of magnitude, and opening the door for more effective treatment options. No other pathology repository of this size and scope exists in the world. Barriers include the lack of digital images for the vast majority of the repository to facilitate sharing and analysis, and privacy issues since the digital images of slides must be linked to their associated medical records to enable substantive analysis.
- A data ombudsman was suggested for adjudicating and lowering barriers to access to government data.

Disincentives to risk-taking. DARPA's contracting officers come from other parts of the government, where their incentive structure has been around risk aversion, and the metrics around cost savings, technically acceptable solutions, and doing it the cheapest way. They do not set the requirements;

they are supposed to implement them. This prevents them from taking risks. When they are put into an environment where risk-taking is demanded, they break those chains and move into a different kind of mastery of the rules—not as a barrier, but as an enabler.

There is no doubt who is responsible for the success or failure of a program—a program manager. There are names associated with some of the great inflection points in security technology—Rickover and Kelly Johnson. We have replaced a leadership-based system engineering strategy with a bureaucracy-based system engineering and risk mitigation strategy that does not work or mitigate the kind of risk we experience. Two examples in the Federal government where personal responsibility and accountability are still used as the basis of authority are security officers, whose authority is based on training, and contracting officers, who go through a process. However, contracting officers can either be very supportive of innovative approaches for commercial development or partnerships, or they can take a conservative strategy.

New alternative models based on leadership may be needed. Venture capital offers one model; investment is as much about the founding team and leadership as it is about the technology or intellectual property, and it is operating in the real world. Can that model be brought into the government?

- At certain levels of investment, assign a program manager with the level of pedigree at which the government will let the program manager take responsibility, take risks that need to be taken, rely on that ability to navigate the process, and who is trusted to know when it is right to make a decision. This has worked well in high-level economic and trade negotiations.

Numerous and diverse challenges in engaging commercial companies and small businesses in defense work were identified:

Government never presents an attractive market. It will buy a little this year, and perhaps buy nothing for the next five years; no small company can survive that. That is probably why we have large defense primes because they can survive that. DARPA has a good model, but for a limited market. In many cases, providing product solutions for a small market is a start, but does not create the kind of incentives that that industry needs for the long term.

A large market supports multiple competitors, and creates more opportunity to bring more innovators into the space and, eventually, one is going to win and survive. But, if all these government programs such as hypersonics or laser weapons present as small markets, the competition will be limited.

Dealing with the bureaucracy. Contracting rules make it difficult to work with DOD. It does not make sense for small commercial start-ups to have to work with the Defense Federal Acquisition Regulation Supplement (DFARS) and all the regulations that go with that. At SRI PARC, a lot of small innovative companies partnered with SRI because it understands and developed the skills to deal with the bureaucracy.

No support for longer-term transitions. A large government spend—such as $2 billion or more over five years in a particular technology—might draw small business interest. But there is no support for a longer-term transition, for example, moving to TRL-5 and above, and transitioning to a service. Someone has to take that technology across the valley of death, but nobody is there.

There are examples where large companies stepped up, they wanted the small businesses, and brought the services in. Software and some technologies developed by small businesses can be inserted into larger programs of record if the software or technology is tied to large companies that can show them the pathway, how to insert it, bring the services in, and show the benefits.

Identifying small businesses that can strengthen the defense industrial base. Lockheed mines vast amounts of data to look at the industry, competition, and other ventures scouting. DOD publishes annually a list of suppliers, about 25,000, and Lockheed mines that and maps it against who are the companies raising venture capital. But the ratio has never changed. Less than 1,000 companies would show up in a venture capital search. So, 1,000 out of 25,000 is venture capital scale. That is problematic because that looks like the opportunity to have venture scale companies enter the defense industrial base is limited. Lockheed looks at its supply chain, and it is an exact mirror of that—thousands and thousands of small companies that never grow.

But government metrics are driven around working with small companies that probably just want to be small companies forever. That may not help the industrial base; it seems to make it very fragile and not resilient. But the incentive is that Lockheed has to work with small companies to check the box. The question, then, is should Lockheed be working with small companies that want to stay small companies, or work with small companies that want to be bigger and make a higher contribution to the defense industrial base?

Differences in time scale and expectations. Developing technologies needed for defense often takes a very long time. But Silicon Valley is used to things that can be monetized and scaled quickly, such as software. A big company may consider if it would fund an early-stage start-up, but may decide to wait until the risk-weighted return fits their model, for example, until they compete and become a $2-3 billion enterprise. Venture capitalists dabbled in energy a while back, but struggled with it, and now some energy funds are trying to take a longer view in terms of time for return on investment.

We can do things faster, but that seems only to happen in an emergency. For example, the United States is behind in hypersonics, so the government will use OTAs (Other Transactions Authority) and throw a lot of money behind it, and now we are catching up, but that is the exception.

We need to recognize that certain organizations are really good at what they do, and it may be best not to try to get them to do what they don't know how to do. For example, in technology commercialization, a venture capitalists are looking for a certain scale of return and opportunity. Private equity is looking for something else. Companies that want to license or take a product to market are something else altogether. The community needs to identify where the gaps are and where there aren't enough options to get what is needed.

University spin-outs, national laboratories, and IP. At universities, it may be hard to internally value their own IP. Often an external view is needed because a fantastic faculty member or member of some national academy who invented is always going to want to spin out a company. However, the best approach may be to combine that IP with other university IP or license it. So that outside view is important.

When U.S. universities and Federal laboratories protect IP, in many cases, they file for a U.S. patent only, with no protection rights outside of the United States. IP protection, especially for entrepreneurial ventures, is required or you are not going to get an investment or a predictable business model in certain areas.

Understanding the economics. At the end of the day, many of these issues are economic issues, for example, the data issue. It costs money to collect data, it costs money to store it, and costs money to use it. So, you must have a sponsor, someone that will say the results from this study or research are worth the cost of collecting, storing, and applying the data. If scientists and engineers do not look at

their work from an economic perspective, they are not going to understand the frictions that are there, and they are going to be left behind.

Driving change in the defense ecosystem. DOD needs to use the authorities it has to drive the partnerships that can create a combination of agility and speed, whether it is a much broader application of OTA, the use of partnership intermediaries, and the use of non-profit foundations.

There is interest now on the Hill to update the Stevenson-Wydler Act of 1980, which had one minor update in the decade immediately following its passage, and nothing more. We have archaic legislation and policy in place that stands in the way of doing some of the things we need to do. For example, issues with copyrighting government-funded works, and software that must be disclosed.

What is inherent in the culture may be too hard to change, although there can be seminal events that trigger change, for example, changes in tax policy. But, unless we can address the culture issues, Schumpeter's creative-destruction might come into play—we have to destroy certain things, create new organizations, or at least set up a competitive system.

IDEA

Optimizing the Growing Reliance on New Knowledge and Technology Developed in the Commercial Sector and Universities

11:00 a.m. Session

Kick-off Discussants

- Dr. Joe Elabd, Vice Chancellor for Research, The Texas A&M University System
- Dr. Tommy Gardner, Chief Technology Officer, HP Federal, HP

Moderator

- Dr. Sally Morton, Executive Vice President, Knowledge Enterprise, Arizona State University; TLSI Co-Chair

Dr. Sally Morton
Executive Vice President, Knowledge Enterprise
Arizona State University

U.S. businesses and universities perform about a half trillion in U.S. R&D, generating new knowledge and technologies. Universities are also a major source of new high-tech start-ups. The U.S. public sector in general, including the Department of Defense and its contractors, is reaching more frequently and deeply into these creators of new knowledge and technology for mission applications, and the commercial sector is reaching into universities for new knowledge, cutting-edge technology, and talent.

These connections will become more important with accelerating technological advancement, and in translating new generational U.S. investments in R&D, critical technologies, and clean energy into economic and national security impacts for the United States. They also have the potential to undergird a new industrial base that integrates defense and commercial sectors to propel U.S. competitiveness, and national and energy security.

Discussion Questions and Possible Guidance for TLSI Action:

- What strategies can foster, strengthen, reinforce, make more globally competitive a culture of collaboration and knowledge-sharing between technology users and creators, including the exchange of ideas, expertise, and research findings?

- What role can startups and small businesses play in driving innovation and integrating emerging technologies into the industrial base? How can they be effectively supported and incentivized?
- What measures can be taken to ensure a skilled workforce capable of adapting to and harnessing emerging technologies, particularly in sectors of incredible technology convergence (defense and space, bio, information tech, etc.)?

Dr. Joe Elabd
Vice Chancellor for Research
The Texas A&M University System

The Federal government is starting to incentivize development of the organized innovation ecosystem, including beyond the well-known innovation hubs in places such as Boston and Silicon Valley.

Regional Engines of Innovation. The National Science Foundation (NSF) will be investing in innovation. That is a complete cultural change. As an academic, NSF has been the place to get basic science research funding and grants for research centers, funding up to $30 million. Now, in the NSF Regional Engines of Innovation program, program Type 2 grants could be as high as $160 million. The Greater Houston Partnership is one of the Type-2 semi-finalists on energy innovation. The NSF program incentivized the major universities, the energy companies in the greater Houston area, and the Greater Houston Partnership to sit at the same table with start-up companies. There is a great energy incubator operating in Houston.

CHIPS Act. Similarly, the CHIPS Act is catalyzing action at the state level, for example, in Texas and Arizona. In Texas, the governor put together a task force that has been meeting weekly since 2021. The task force includes the Texas semiconductor community such as Samsung, SDI, NXP, and Applied Materials; the state's universities; the Public Sector Workforce Commission; the Higher Education Coordinating Board; and the Manufacturing Commission. The group is discussing things such as what would a CHIPS-related effort look like in terms of workforce.

Hypersonics. DOD funded the University Consortium for Applied Hypersonics at Texas A&M. It involves, not just large companies such as Lockheed and Raytheon, but also a lot of small companies and universities that meet regularly and work on transitioning to applied research.

Incentivizing commercialization of intellectual property in academia. A lot of IP is generated at universities such as Stanford, the University of California at Berkley, and Texas A&M, the largest university in the country and a top ten public research institution. But commercialization is a hodgepodge across the United States. We may not even have a system in which we are incentivizing and developing talent in that area. Government should consider incentivizing university technology transfer offices.

Recently, Texas A&M created a new Chief Innovation Officer position with the aim of making it easy for an IP creator. A lot of faculty will have a new idea and just publish it, because there is no incentive to protect the IP. Rather the incentive may be to publish as many papers as possible to get recognized by peers and get paid. Texas A&M started an Advancing Discovery to Market Fund that will award

"How do you bring academia, industry, start-up companies, the public sector, and the national labs all together in an organized ways to accelerate an idea or innovation from its generation and then over the valley of death?"

Dr. Joe Elabd
Vice Chancellor for Research
The Texas A&M University System

as much as $500,000, not for people who have already started to protect their IP, created prototypes, or who have advanced the technology to the point where it is commercially attractive. The fund is for researchers, faculty, staff, and students to advance the development or demonstrate the commercial potential of recent discoveries to advance them toward the market or a start-up.

Dr. Tommy Gardner
Chief Technology Officer
HP Federal, HP

Economic growth translates into defense security. It is critical to have a strong economy to support defense and intelligence community institutions. So, the first issue is how do you strengthen and reinforce our global competitiveness? There are three areas for three sectors—industry, academia, and government:

- Industry has to go out to other countries. In America, we are often too biased and think that all good things are invented here, and we look internally because, not only is it the best and the most successful, but we are familiar with it. But there are 175 countries with great thinkers.
- Academia should speak up, be vocal, get published. But tell us the good, bad, and the ugly. Make it as factual and data-based as you can, but make some projection of what looks good and bad because there are thousands of different ways to go, thousands of different approaches you can take. We cannot shotgun spread investments in all technologies.
- Government should partner with other governments. For example, what the United States is doing with the submarine force with Australia—transferring nuclear technology and how to build long term survivable submarine assets—is strengthening both countries against a Far East threat. Also, we need to look at things that are successful in other countries, for example, Singapore in the cybersecurity realm and their cybersecurity product labeling program. It will make us better if we can learn from others.

Industry, academia, and government need to decide which technologies are going to survive, and which have to be pushed away. In terms of small business tax incentives for innovation, we can continue what we have and build on that, specifically, direct tax incentives to those areas that industry, academia, and government agree are very fruitful to the growth of our country. However, there are tens of thousands of small businesses in the defense contracting world, and not all of them are capable. Perhaps the focus should be on a much smaller number.

Hands-on for innovation. Research shows there are a lot of good inventions that never become an innovation. They are great ideas, but do not become successful in the marketplace, usually for economic reasons. However, when users innovate, when people have their hands on the equipment and have the mission as their responsibility, they come up with the best ideas. The lesson learned is, if researchers do not work on the equipment and out in the community to see what the problems are firsthand, we are going to miss out on a lot of potential innovation.

Competition with China. Many are worried about China having a strategy to overtake U.S. industries in fields such as solar panels and cybersecurity. China is investing $10 billion annually in quantum. But their researchers are paid 80 percent less than U.S. researchers, so their investment in quantum is the equivalent of $50 billion a year. While some see the competition between China and the United States as a zero-sum game, and that the United States must counter China's strategy, we should work with adversaries such as China to grow both our economies together. If we are economically linked, we will never fight.

Education and the workforce. Community colleges are doing a good job at teaching and reskilling older workers. They need to teach cybersecurity, Java programming, Python—things you can learn at a collegiate level above the high school level—skills that are needed. We do not have people who can program quantum computers, which is much different than programming a conventional computer. What are we going to do? Hire all the Chinese people who know how to do that? We want to have people in the United States with U.S. clearances who have knowledge and skills, and community college is a place to develop that knowledge and those skills.

Points of Discussion

Exposing academic researchers to possibilities in the commercial world. Academics can get very excited about translating their ideas, and one way to do that is putting them to use by society through commercialization. Once faculty members understand that commercialization is a pathway to get those ideas put to good use, and they start to understand how satisfying it is to see impacts from their discoveries, that will spread like wildfire.

> "Look at the day Ukraine was invaded. If China had walked into Taiwan, they would have had it lock, stock, and barrel. And you have to think, why didn't they do that? They didn't do that because the Chinese communists would have been thrown out by the businessmen the next week. The businessmen do not want their golden goose cooked and thrown out the window. They are dependent on those resources with a good economic relationship and an equilibrium between the U.S. and China."
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> **Dr. Tommy Gardner**
> Chief Technology Officer, HP Federal, HP

It is important to get faculty members out of the laboratory—having that experience, understanding use and the market, and bringing that back into the view of students. It also brings the whole entrepreneurial pathway and start-up experience—successes and failures—into view.

Changing the culture at universities. The business model right now does not make sense. Universities get tuition dollars, and maybe a little money elsewhere, but they have to teach students and pay for the football team. They may already be subsidizing research because actual indirect costs

can be higher than allowed in research grants. So, you have to convince the university president that innovation is just as important as research and may have to be subsidized.

You have to rethink promotion and tenure criteria. Faculty can talk to a promotion and tenure committee and say I have two patents or two publications. They want to see the publications. Right now, the deliverables in research are publications. However, if the research sponsor changes that, which is happening at NSF, the universities will change. The marquee Federal research sponsors, such as NSF and NIH, have a big voice in this. Things would change if they wanted to see patents and disclosures in order to fund the next round.

Patenting and Patent Portfolios. In some cases, research organization have built patent portfolios. For example, Los Alamos National Laboratory had seminal patents in high temperature superconductivity, and built a patent portfolio around the technology. This was not just for commercialization and licensing, but also to demonstrate global leadership in the field. Anybody in the world that wanted to work in some of these areas had to engage them. Similarly, disclosures suggest that MIT now has the world's definitive patent portfolio in fusion. Universities should identify their real areas of expertise and leadership. That would augment the university's competitiveness in winning research grants, and help guide how an individual professor's patent fits into the overall strategy.

The alignment of the university IP portfolio, and putting together faculty clusters makes a difference. For example, the major pharmaceutical companies identified institutions they were going to work with and, as a result, transformed a challenging process of going from discovery at the university into a translational or commercial opportunity. Now, there is a conversation ongoing between a pharmaceutical company and six or seven institutions doing biomedical research. The University Consortium for Applied Hypersonics at Texas A&M is a similar model.

Increasing emphasis on patenting and incentives to patents should be thoughtful so the university does not lose its way. Universities do three things right—teach, research, and perform service. Translation and commercialization impacts all three and makes them better. Also, there is a cost to file a patent. Universities need to decide if they want to file every good idea of just the best good ideas. That is a business decision that should be made by industry, academia, or government.

From a defense aerospace contractor perspective, negotiating over IP represents some of the challenges in working with universities. Moreover, the patent process probably is not as valuable to the venture community as it once was because it moves too slowly, and does not work on software. No one patents software anymore. If it is copyrighted, it is mostly about hiding know-how. Some countries do not even care if there is a patent, they just copy it, we do not do anything about it, and suddenly a business is gone.

The realities of spin-outs and start-ups. There is a feeling that every idea gets funded by the venture community. But, in reality, the funding conversion ratio is about 1 to 2 percent. Not every professor is going to have a great idea. Not every patent is going to turn into a big company, in fact, very few will. There is a very high failure rate. Very few academics can become start-ups.

The corporate venture community has a very important role to play. It is important for the major corporate investor to be a strategic partner as well as a customer of the small business venture in which it is investing. The corporate partner can provide access to corporate resources and corporate capital, but allow the entrepreneurial culture to flourish in the small business venture without the corporate immune system crushing it. In the national security space, especially, the corporate partner can help provide that infrastructure necessary for success because small companies do not have what it takes to be a member of the defense industrial complex without it.

The China threat. China is working all over the world and establishing relationships and presence in places. There is a point where the United States needs to counter that strategy, but work with them in doing so. That is a diplomatic issue not a technology issue. But, to the extent we could, both nations would be better off.

Technology top ten. The emerging models could be tapped in the technology areas where we cannot afford to fail. We may want to identify the top ten and focus on, not just which ones they are, but why. If we cannot elucidate why a technology is on the top ten list, then it probably should not be there. And for those on the list, identify our assets. This could also be an opportunity to form an international hub in partnership with strategic allies.

IDEA

Introduce Changes in the Department of Defense

11:45 a.m. Session

Lowering DOD Cultural Barriers to Increased Use of Commercial Technologies, and Reforming Acquisitions to Speed Insertion of Cutting-Edge Tech

Dr. Patricia Falcone
Deputy Director of Science and Technology
Lawrence Livermore National Laboratory
TLSI Co-Chair

Kick-off Discussants

- Mr. Rob McHenry, Deputy Director, Defense Advanced Research Projects Agency (DARPA)
- Dr. Dinesh Verma, Professor and Executive Director, School of Systems and Enterprises, Stevens Institute of Technology

Moderator

- Dr. Patricia Falcone, Deputy Director of Science and Technology, Lawrence Livermore National Laboratory; TLSI Co-Chair

The Department of Defense's increasing need for technologies developed by commercial companies for commercial markets is creating challenges including developing or modifying organizations and business models to access the technology, and adapting DOD culture to seek and apply technologies developed outside of DOD, the United States, and its traditional contractor base.

Experiences have shown that major cultural change and new model adoption are challenging in large, long-established organizations like DOD. How can we help introduce change? Additionally, a long-standing challenge in accelerating defense fielding of new technologies and concepts has involved the acquisition process, the budgeting process, and system integrators, but there have not been serious changes to that system.

Discussion Questions and Possible Guidance for TLSI Action:

- What new strategies or initiatives could promote a cultural shift within the DOD that values and actively seeks out technologies developed outside of its traditional contractor base – and how do we encourage implementation?
- What are the key factors and stakeholders impeding reforms in the defense acquisition process to acquire new technologies?
- What role can Congress or the White House/ Administration play in driving changes in the defense acquisition process? What specific statutes or regulations need to be amended or created to allow for new business models and the inclusion of non-traditional partners?
- What are the barriers that prevent non-traditional partners and start-ups with innovative technologies from effectively contributing to meeting the DOD needs? How can these barriers be overcome?

Mr. Rob McHenry
Deputy Director
Defense Advanced Research Projects Agency (DARPA)

DARPA's mission is to prevent strategic surprise, and our inability to transition innovation is probably the largest strategic threat to the United States today. Time matters.

Transition is a pain point of increasing significance to DARPA. We are innovating amazing technology, which is happening every day across our whole ecosystem. But, if it is not going out and having the intended impact for national security until years or decades later, we have lost inherent surprise. This is not an academic discussion, but existential, and at the core of our mission.

The sunk cost fallacy. One of the biggest challenge is a sunk cost fallacy. As DARPA engages with its service partners, they have a defined roadmap—a program of record—a set of activities around some set of requirements. DARPA's mission is to provide orthogonal optionality to that baseline. When transition works well, it is almost always driven by a champion, a senior leader in the right place at the right time who is willing to disrupt that sunk cost mindset that persists within the service around that program of record activity.

One way to cause a reevaluation of those long-running roadmaps and programs of record is in the acquisition process where there is an analysis of alternatives stage when the program is being set up. Perhaps there should be an analysis of alternatives every five years built into the acquisition process, reevaluating whether this is the right roadmap for the options presented by DARPA or from anywhere.

New commercialization and transition models. The level of sophistication DARPA is bringing to commercialization of their technologies is dramatically different than what it used to be. It has developed ways, hacks, and activities to work transition within the current system, some of which DARPA is contemplating on a much larger scale to change the system.

- Constellation is a joint venture between DARPA and the U.S. Cyber Command. Cyber warfare and, in particular, some offensive cyber vulnerabilities are very transient. So, the concept of a DARPA multiyear program starts to fall apart at the intersection of cyber. Constellation is an intermediate entity that is constantly harvesting insights, technology, and capabilities coming out of long-running dark programs, operationalizing them, and transitioning them to CYBERCOM. It is help CYBERCOM from a budgetary perspective; they can budget for Constellation rather than having to identify what technology to exploit two years in the future and out of which dark program, because that is unknowable.
- EPIC involves demonstrating DARPA technologies with operational military units and commands, and leaving a residual capacity in place while the acquisition process catches up. With the pivot to the Indo-Pacific, EPIC is engaged with the U.S. Indo-Pacific Command all around the Western Pacific. DARPA is having good success showing the optionality to decision-makers who are out there and have to make decisions in a time of conflict. It is very powerful to give them at least a taste of some basic capacity to go do the mission.

  EPIC has been exploring a services model in which combatant commanders look at models where we can legally financially underwrite a market, and guarantee there will be a COCOM purchase over the next five years. DARPA is working with the Office of Strategic Capital where they may be able to come in under their authority and guarantee that market. But the idea is that private capital will flow to meet a now very firm demand signal integrated at a higher level. DOD is going to spend this much money on it and the rest of the ecosystem can go and deliver that capability. It is defining the market in a way that private equity understands and can operate on in the commercialization space.
- The Embedded Entrepreneurship Initiative is used when a project performer has technically met their goals and has something of high interest in national security. Depending on which stage of development and domain they are in, DARPA will find an expert with the domain expertise and experience taking companies through that stage. DARPA will hire them into the company and pay for it. DARPA has done this more than 50 times with tremendous effect—the survival rate and ability to get to the next stage is more than 70 percent. Also, a senior commercialization advisor works with these companies as they navigate complex changes in their structure and investments.

  Another part of the program is called the MVP (minimum viable product). Often, DARPA funds the big program until it has proven something can be done, considers the mission complete, and waits for the rest of the world to go figure it out. But just a little application of funding at that point can really push some of these things forward. MVP is reserving some funding to finish some of these programs to help fill that gap in a more sophisticated way.
- Sometimes the reason a venture is not operable is because the terms are not very attractive to an entrepreneur at that stage where they have a technology they are really excited about, but have

to give up so much to get that capital; but there is a certain scale where that is necessary. If it is of critical national security importance, and the scale of capital required relatively modest, DARPA is developing a debt vehicle through which DOD can provide the funding to stand up the first manufacturing capability, and then maybe earn out that debt through sales from a successful transition of that technology into DOD.

The pain and overhead costs of doing business with government. DARPA is trying to be creative about using authorities within the FAR. For example, during contract negotiations, time could be lost waiting for a subcontractor to provide their rental car expense forecast three years in the future. So how do we shift to other contract types that do not require that cost analysis, that allow us to use OTAs (which started at DARPA and evolved into a mechanism used largely with the big system integrators)? How do we bring that down to small businesses, so they do not have to comply with the overhead requirements FAR imposes? A lot of work is going on to accelerate the contracting timeline and lower that overhead.

Disrupting the system. DARPA has new leadership in its Tactical Technology Office, which does large integrated platform demonstrations. DARPA has seen the challenges in executing its research activities in the same way that the broader DOD sees challenges in cost, complexity, time, and risk management. The new leadership was brought in to specifically refocus that office on disrupting the whole system engineering process, and coming up with different risk management paradigms for these most complex systems.

Similarly, there's an office within DARPA called the Advanced Capabilities Office (ACO). In recent times, ACO has been doing billion dollar-scale activities in the special projects category. One of those big projects is in the process of transitioning out of DARPA. DARPA considered closing the office down, but made the decision to focus ACO on the transition challenge.

Dr. Dinesh Verma
Professor and Executive Director
School of Systems and Enterprises
Stevens Institute of Technology

Dr. Verma recounted a story that resonates with the issues of broadening the aperture for innovation to bring new players, business models, and technologies into defense.

The first digital sonar system was developed in the 1960s-70s, with an R&D cost of about $650 million. That system was replaced in the 1970s-80s by a system called BSY1, the system depicted in the movie The Hunt for Red October. The R&D costs for BSY1 were capped by Congress at $1.034 billion. That system was replaced in the 1980s-90s by BSY2, developed for the Seawolf class nuclear attack submarine at a cost of $1.76 billion.

The escalating cost trend prompted Navy officials to run an experiment. They issued a BAA defining the sonar problem in a sanitized way and asked how it could be solved, to see what non-traditional players would say about how to design the system. The BAA fine print said that if you had ever done any work with us in the past, you are disqualified from submitting a response. They got three new players—AT&T, BBN, and TRW. All three asked why does the Navy have to have its own operating

system? You can just have macros. The companies came back with what they thought the architecture should be for sonar, and it was common across the three players. The Navy used that to run the solicitation, and leveraged the SBIR program to create alternatives to Lockheed Martin.

The Navy adopted an open architecture, which reduced the cost of entry into the system and increased competition. The R&D cost for sonar for the Virginia class submarine program was $300 million, down from $1.6 billion spent for Seawolf. The production cost of BSY1 was $150 million a copy and production costs for the Seawolf system was $250 million a copy. The production cost for the Virginia system was $30 million, and the production cost of the fifth version was $19 million.

In a case of creative-destruction, it totally transformed Lockheed, reduced its size, but made it a ton more creative. That was painful at the Lockheed site where Dr. Verma worked. It had 6,000 people but, at the end of this process, there were 1,600.

Today, the Navy is using a process called Advanced Processor Build in which you can have a passive sonar algorithm built at the Applied Physics Laboratory or University of Texas at Austin, and it can be on a submarine in eight months. The only reason it cannot be done in less than eight months is because of a gating function—the training of the sailors who will use that capability.

Strong leaders are needed. In 1965, 55 percent of all Air Force officers had an engineering or science degree. By 2010, it was far less. We can have 20 DOD offices for innovation, but it is not going to work. We are investing in processes and offices, and not investing in people.

Contracting officers are often maligned, but they are worthy of respect. They sign the contract, and some of them have to take out personal liability insurance. When Paul Kaminsky led the Stealth program, every time he went to a test event or major demonstration, he never went without his contracting officer because he wanted the contracting officer to understand the mission. They knew what the risk profiles were, and they were a partner.

All of the policies and authorities are there. We are just not leveraging them. There may be something to be done in Congressional oversight to help change the risk-adverse culture. The culture does not think about risk in a more nuanced way, which has led to the entire ecosystem becoming more risk averse. We may need more analysis of alternatives, and encouragement of government to use commercial vendors and commercial technologies.

The bias is toward the path of least resistance. For example, in numerous programs there was a need to leverage creativity in AI and machine learning, and there were amazing suppliers. But they were not chosen because a classic supplier already had a contract in place. Instead of just encouraging companies to use commercial technology, consider having them request a waiver if they do not use commercial, so they do not have to take the path of least resistance.

Contracts for solutions may have too high an integration level. Perhaps the government could reduce the level at which there is competition, but then the burden is on the government to have a fix on the technical baseline and architecture. That is harder to do if you don't have that skill base. But, if you can, you can have more competition at a lower level in the tech stack. In addition, over constraint on requirements may result that they get keyed to one or two specific sources rather than opening up competition. Could government do pilots where the prime is the software vendor, and then the hardware vendor has to be a good subcontractor?

Over classification. There is a sense that there is over classification. Can that be handled in a way that would make it easier for the non-traditional players to compete?

Commercial vendors do not take the time to understand how the system supplies. They seem to think if the combat commands like your idea, DOD will just buy your solution. They need to understand that the point of entry is not the combat commands. They at least need to invest in understand how the deal works.

LUNCHEON KEYNOTE

Lockheed Martin and the Advanced Technology Center

Dr. Nelson Pedreiro
Vice President
Lockheed Martin Advanced Technology Center

About Lockheed Martin: Lockheed Martin has about 115,000 employees; 49,000 of them are scientists, engineers and technologists. Lockheed Martin has made a concerted effort to expand operations beyond the United States and is now operating in more than 70 countries, with more than 7,000 employees overseas and close to 590 facilities worldwide.

Lockheed Martin has four different business areas:

- **Aeronautics**, home to the renowned Skunk Works®, delivers breakthrough capabilities and landmark aircraft that continually redefine flight.
- **Missiles and Fire Control** develops, manufactures and supports advanced combat, missile, rocket, manned and unmanned systems for military customers.
- **Rotary and Mission Systems** delivers mission-first innovation across its portfolio of rotorcraft technology, sensors, radar systems, command and control, combat simulation and training, advanced cybersecurity and undersea systems.
- **Space**, which includes Dr. Pedreiro's Advanced Technology Center, delivers next-generation space and missile capabilities through partnerships that raise global communications, weather forecasting, space exploration and national security and defense to new levels.

Recently, Lockheed Martin Space's Executive Vice President, Robert Lightfoot, announced a reorganization of the company's Space business, consolidating it into three sectors—National Security Space, Strategic and Missile Defense, and Commercial Civil Space—to leverage synergies where missions overlap.

Lockheed Martin has had a number of firsts—the first U.S. intercontinental ballistic missile launch, the first meteorological satellite, the first remote sensing imaging satellite and Polaris, the first submarine-launched ballistic missile to name a few.

Lockheed Martin has had a successful 60-year partnership with the Navy with 100 percent mission success in the fleet ballistic missile program. The company has built close to 1,000 satellites, more than 300 payloads and has been part of every NASA mission to Mars.

The Advanced Technology Center (ATC): Starting operations in 1956, the ATC comprises the research and development labs for Lockheed Martin Space, creating foundational technologies that inspire, protect and connect our world. It is where Lockheed Martin designs and develops enabling technologies for future spacecraft and missile systems, that create new capabilities in remote sensing, navigation, early warning systems, missile defense, space sciences.

The ATC has capabilities in hypersonics, directed energy and advanced materials, such as high temperature materials, nanotechnology, advanced electronics and additive manufacturing.

The ATC is unique in how it does scientific discovery, technology and innovation. This approach starts with systematic reasoning. While the ATC can accomplish a vast array of innovative projects, the question is what should we do? Where do we spend our time and resources? The team comes up with new ideas all the time, but what is going to get back to Lockheed Martin's customers and their missions? What is going to be the benefit? The answers to those questions help guide our work.

The ATC is known for technology innovation but also innovates on processes and business models. For example, Lockheed Martin has many programs of national importance. Those government programs have very disciplined processes. However, if the ATC were to follow the same rigorous processes on smaller projects, it might slow down the mission timeline unnecessarily. So, the ATC streamlines processes significantly when it is beneficial to the customer.

The ATC has about 475 scientists and technologists, almost a third at the Ph.D. level, and close to 40 percent masters—typical of an R&D organization. At any given time, about 60 percent of them are deployed, embedded in different programs or part of the program team.

NASA and NOAA formulate missions and, once selected, external companies like Lockheed Martin generally build the instruments and some capabilities to maintain the spacecraft. In some cases, the ATC operates the instruments. For example, Lockheed Martin operates two instruments onboard NASA's Solar Dynamics Observatory—the Atmospheric Imaging Assembly and Geophysical Magnetic Imager. For the Solar Dynamics Observatory, the ATC receives about 2.5 Terabytes of data daily that it processes and makes available to the scientific community.

The ATC also contributed to the Geostationary Operational Environment Satellites (GOES). In that particular series, each of these spacecraft has instru-

ments built at the ATC, the Solar Ultra-Violet Imager (SUVI) to monitor the sun and its potential impact on systems on earth and in the near space environment and the Geostationary Lightning Mapper (GLM) that continuously monitors for the presence of lightning.

Space is getting congested and contested, so space security and communications are areas growing significantly, and the ATC has a number of capabilities developing in these areas. On the communications front, those capabilities include laser communications, photonics, integrated circuits and satellite networking.

Teams at the ATC designed and built NIRCam—one of the most sensitive infrared cameras ever built and a critical scientific instrument on NASA's James Webb Space Telescope, the largest, most powerful telescope ever built. The launch of the James Webb Space Telescope on December 25, 2021 represented a project nearly two decades in the making. Many of us saw President Joe Biden unveil the telescope's first images.

Since the time of Galileo we capture images of objects in space or elsewhere by collecting and focusing the light in the focal plane, but that is not the only way to get an image. We can also do interferometric imaging. When you think of interferometric imaging, generally, you think of a few large apertures collecting the light to be interfered. But we have taken interferometric imaging in a different direction by using an array with thousands of small lenses (lenslets) that focus photons on an integrated circuit that combines light from different pairs of lenslets creating thousands of interferograms from which we compute the image. We have demonstrated that in the laboratory and are now partnering with NASA to do an Earth observation mission and a helio-physics mission.

Something perhaps even more radical is replacing a train of optical elements with a thin film—a few microns thin, low-cost material that can be made conformal and in very large sizes. Our team has developed the process to imprint holograms on this thin film so that it can replace conventional optical systems consisting of lenses and mirrors. This technology will significantly reduce the cost of optical systems and change the way optics is built in the future.

The ATC has a group of chemists and physicists focused on answering the question: What does nature allow us to observe? These are critical questions in planning and designing space missions — What is to be observed? What are the orbits? How many spacecraft are needed? This capability is also essential after deployment and during the mission when data is received, to ensure we extract most information from that data.

Lockheed Martin is very excited about Quantum Information Science. Its practical applications to remote sensing and communications are probably three to five years out and the ATC has breakthrough demonstrations on those areas. We have an architecture we demonstrated on the ground, that

scales to bandwidth of interest for actual missions while providing unbreakable security and increased information density, i.e. bits per photon.

The ATC has a long history modeling, developing and demonstrating atmospheric effects in communications, remote sensing and directed energy systems. We pioneered the atmospheric compensation that is used today in directed energy laser weapon systems, which are transitioning from technology development into operational systems.

Around 2009, Lockheed Martin started investing in Natural Feature Tracking to enable proximity operations, automated rendezvous and docking, and repair of assets in space that were not originally designed with proximity operations capabilities. A few years later, we expanded the NFT technology to support the OSIRIS-REx mission to collect a sample from the Bennu asteroid at around 250 million miles from Earth. This required a high-level of autonomy and the NFT technology developed at the ATC was critical to the successful sample collection.

What could space look like 30 years from now? In answering that question, some fundamental capabilities and technologies come up over and over again, such as: nuclear power and propulsion, on-orbit repair, assembly and manufacture; large constellations with very high autonomy that rely on the architecture for reliability, telepresence and human-robotic teams. These are critical to the future of space and we have started development to expand humanity beyond Earth.

IDEA

An Emerging Parallel System for Defense Innovation

1:30 p.m. Session

Kick-off Discussant

- Mr. Chris Moran, Vice President, GM LM Venture, Lockheed Martin

Moderator

- Mr. Chad Evans, Executive Vice President, Council on Competitiveness

A parallel DOD innovation ecosystem is emerging, driven by the need to access technology from non-traditional sources, and accelerate technology development and acquisition. DOD and its service branches have established a range of initiatives to this end. For example: DOD established the Defense Innovation Unit, and increasingly uses other transaction (OTA) authorities and limits R&D competitions to OTA consortia. Some efforts to acquire defense systems are based on desired product or system capabilities rather than traditional acquisition specifications. The Army established an Army Venture Capital Corporation, and Army Futures Command/Army Applications Lab, organized around eight broad cross functional teams. The Air Force established AFWERX as the Air Force's innovation arm, and Space Force set up SpaceWerx as its innovation arm. Some of these new innovation operations have outposts in U.S. high-tech hubs, and are working to making it easier for companies to bring their technologies to DOD.

Discussion Questions:

- What lessons can be learned from the initiatives within the DOD's emerging innovation ecosystem that can be applied to moving technologies with commercial potential from universities, small businesses, and start-ups through the "valley of death" and towards scaling up for defense applications?
- What is the significance of establishing outposts in U.S. high-tech hubs for these innovation operations? How does this geographical presence contribute to making it easier for companies to bring their technologies to the DOD?
- What challenges and barriers exist in scaling up technologies from universities, small businesses, and start-ups for defense applications? How can the emerging innovation ecosystem address these challenges and facilitate the successful transition of technologies across the "valley of death"?
- What collaborative opportunities exist between the DOD's emerging innovation ecosystem and other stakeholders, such as universities, research institutions, and industry, to foster a more robust and inclusive innovation ecosystem?

Chris Moran
Vice President. GM LM Ventures
Lockheed Martin

Lockheed started its venture fund in 2007, and operated nearly a decade before Mr. Moran arrived. The focus was mostly on enterprise software to meet corporate needs, not program needs. The notion was to steer the fund into the strategic space, and align it more closely with what the business groups are doing and the new technologies on which they were working.

Unlike the VCs who are mostly driven by finance, LM Ventures is much more focused on supporting the needs of the business groups and, ultimately, Lockheed's customers. LM Ventures does a lot of reporting and regular meetings with the business groups to understand their needs and show them the art of the possible.

Changing venture capital landscape. Around 2005, the venture industry did about 3,000 transactions and created about 1,000 companies a year. Last year, the industry closed about 45,000 transactions, and created more than 10,000 companies. The amount of money invested in 2005 was in the $60-$70 billion range. In 2022, in the United States alone, it was about $350 billion. When Mr. Moran went to college and started his career, none of that existed. It wasn't anything anyone was taught about or learned about. If you were a program manager, you never looked outside to work with small companies because they were not there.

Over the 1970s-90s, a lot of people in leadership roles at Lockheed and other corporations working with government got educated about venture investment as a tool. That has changed since 2010, with the collapse of the financial system, and availability of free money, such as zero percent on a checking account. Money poured into venture capital creating 500-1,000 venture firms a year over that period of time, and that capital was deployed at an extremely high rate resulting in an explosion of companies. Many researchers and technology developers who would have otherwise gotten their Ph.D. and gone into academia, instead, went straight into venture for the prospect of making a lot of money. They were not always the best managers, and companies did not always do well, but the technology was moving in that direction. Today, any major corporation that is not looking outside and paying attention to what is going on out there is going to get left behind.

The other change in the last several years is the emergence of mega venture funds, kicked off in 2017 by SoftBank with a $100 billion venture fund. But when you have a $100 million or $1 billion fund, you're not writing more checks, you are just writing bigger checks.

Start-up/small business success. Not all start-ups and small companies are going to be successful. The success rate of funding is 1 percent, and the success rate of companies is under that, about 0.1 percent, and the number of companies that hit it big—like Uber of SpaceX—is even lower than that. But the venture industry is very good at communications and marketing, so everyone thinks they can be successful and have a $1 billion corporation, but that is not the case.

Venture capital in the national security space. While government funds for public benefit, the venture capital industry is a for-profit business; if they don't make money, no limited partner (LP) is going to give them more money.

VCs invest opportunistically; about 1 percent of things get funded, even lower at the Sequoias because they just see so many things. A very large fund has to look for larger opportunities, and look at every single deal as if it is going to return $1 billion or $10 billion because that's how they make their money. However, most of the things in national security are not going to return $10 billion. There are not going to be those kinds of exits for these companies.

In contrast, government acquisition is to solve a problem, not make money. It has an issue and wants solutions to come in. VCs have a bunch of solutions looking for a market. So, they are trying to find where to put money to get the biggest ROI. Where those things align, amazing things happen. A sustained opportunity will drive more investment. A company is not going to invest in building an infrastructure or manufacturing capability for something it is going to sell one this year, none the next year, and then ten the next year.

LM Ventures. LM Ventures is a strategic venture capital fund. It is looking for technologies that complement or enhance what Lockheed is doing. So, the aperture is larger, and return expectations lower. LM Venture is more likely to look at things in national security than the Sequoias of the world that are looking for the next Facebook.

The DOD emerging innovation ecosystem is not emerging anymore, it is here—some 20 organizations and initiatives are encouraging a lot of companies to enter the space. LM Ventures works closely with AFWERX, SOFWERX, and others. For about seven years, LM Ventures has mined through their information and data looking for companies that maybe Lockheed should be involved with. However, very few of the ones they fund meet Lockheed's needs for technology and sustainability. A lot of them are small businesses and will remain small businesses, and are not attractive from that standpoint. LM Ventures also mines SBIR data, but 2023 data is not yet published, although 2022 is done. LM Ventures is trying to find early-stage companies to get money to grow, and it is a year behind. It would be helpful if the data were up to date.

> "I don't know how many times I've met with government officials, senators, congressmen, generals, admirals, who come through Silicon Valley at a regular clip. It's just amazing to me how little any of them understand capitalism and how it works and what drives money."
>
> **Chris Moran**
> Vice President, GM LM Ventures

The use of the open topic SBIR, an innovation that began a couple of years ago in which companies can bring a solution to a problem, has led to some innovation. Around 500 of those proposals were funded last year, up from 20 the year before.

The venture capital community operates like a community. The ability to deal with risk is enhanced when you can get multiple perspectives, and the venture community shares information all the time. The Defense Innovation Unit (DIU) operates like a procurement organization. They send out an RFP, and ten, hundreds, even thousands of companies could respond. But LM Ventures would never know, because DIU will never share that information. So, they take the burden of making those decisions entirely onto themselves. There is no use of this rich community of experience because the only decision they are probably capable of making is whether the technology is valid. But they have no idea whether the underlying company is going to survive or not. These two things have to go hand in hand.

There was a solicitation for quantum sensors, an area of interest to Lockheed. LM Ventures would like to know who submitted proposals, who is

"Government does not like to take risks with taxpayer dollars, and oversight is not kind. If a big program fails, there's hell to pay."

Chris Moran
Vice President, GM LM Ventures

working in that space, and what they are working on. LM Ventures might have even funded a couple of them if they knew who they were. They awarded a couple contracts, but there might have been 100 other companies that sent proposals. The idea was to bring more money into the space to enrich the ecosystem. But because they cannot share that information with anyone, those companies went either unfunded or had to find funding on their own.

Two standards for risk taking. When Elon Musk's Starship failed, people were applauding—cheering when $1 billion blew up in the sky. If that were Artemis, a NASA program in which Lockheed is very invested, it would not have looked like that. There is a different way of looking at companies like Lockheed—there are two standards.

National security—the bottom line. There is a Silicon Valley recipe when they have decided there is an area they like—go attack, disrupt, take down the big guy, and replace them with a new innovative, cost-effective technology. They are using that playbook in space now. But, when you go to Porter, there are competitors, suppliers, market power, etc. But there is one thing missing on Porter's chart—adversaries. The United States has those. There are adversaries that not only want to beat us economically, but they also want to beat us physically. They want to kill us. Silicon Valley does not get that. So, the real answer is not to replace Lockheed with a start-up, it is to have Lockheed work with start-ups to improve the technology.

Start-ups get a lot of traction on Capitol Hill. But a bunch of start-ups are not going to protect this Nation. There is a place for them, a lot of innovative technology that we as a nation can benefit from incorporating into our systems. But to replace Lockheed, Boeing, Northrop, and similar companies with a start-up company is not going to happen. Let them grow, get better, and do what they do right, and figure out how to do this together.

Points of Discussion

The venture industry behaves like Hollywood. The best directors see the best scripts, and the best actors want to work with the best directors. If one studio makes a superhero movie, then they all make superhero movies. That is what happened in electric flight. There are more than 200 electric vertical takeoff and landing companies, all of them with a business model that will not work. The batteries don't support the business model. Why do they raise $20-$30 billion? Because it's a fad. But probably 190 of those 200 companies will fail and that is money that did not get spent on other technologies or other regions. In addition, you have a diffusion of talent. All the best people are spread one to each company and that hurts the whole industry. There are more than 200 space launch companies. But, if you look at the United States, based on the number of launches, there is probably room for 30 or 40 of them, not 200.

There is a sort of herd mentality in the venture world; whatever Sequoia does, everyone else has to do it too.

Industry Days to find potential partners. SRI runs the Quantum Economic Development Council to bring in people from all walks of industry and academia to work together. One of the tricks of the trade in most of these organizations in an Industry Day where they talk about the RFP. If you look at the list of attendees, 80 percent of them submit, you know who won because that is announced, and you have a good idea who submitted and did not win. If you are doing hunting and fishing on who to team with, that is a great way to learn.

"I think technology development across the board suffers as a result of that that herd mentality."

Chris Moran
Vice President, GM LM Ventures

Government as a market. There was a lot of discussion focused on the government as a customer and market:

- We want more players and innovation in the game. But if you look at the history of successful companies in Silicon Valley, they did not start by going to a market and say "you have to change the market so that my product is successful." And that is the sort of small company approach to the Pentagon, telling the Pentagon you have to be different so that I can be successful.
- The government has something besides money that companies look for, that is to be a first customer. A small company knows that if it can deliver something that works, it has something close to a guaranteed customer, and that gives the company the ability to get the capital it needs.
- From a financial point of view, there is binary risk—you either get the contract and win the riches, or you did not get the contract and wasted a lot of money and time. That is the risk discounting that venture capitalists will do for companies looking only at defense as their target. Venture capitalists are looking for dual use, somebody who has a commercial use technology. If they have that, the benefit is large due to scaling.

  For example, Lockheed invested in a small radar company that was focused on automotive. They were able to design a full-on asset for about $25 million. They had to do three spins, so it was closer to $60-$70 million spent developing that. But that radar chip now costs under $200. If the government did it, it would be $1 million, a chip selling in very small quantities, and it would probably be an FPGA not an ASIC. So, how do we use that commercial market to scale some of this technology and then accept the result? There has to be a little bit of compromise on the government's side to say good enough is good enough, we will use it the way you provided it. If we want to change it, we realize we are going to have to pay for it. However, if it is a dual use company, that first customer can make a big difference, but need not be the only customer.

"It is a political issue—spread the money to small businesses in every district in the United States. It is not an efficient way to run a business. But then, you hold a Lockheed up against a SpaceX, who's completely vertically integrated, controls their entire supply chain, and you wonder why their costs are lower."

Chris Moran
Vice President, GM LM Ventures

Advancing semiconductors. The blue-chip venture firms are not investing in deep science, manufacturing, materials, or beyond Moore's Law for next generation semiconductors. They are not interested because of their rates of return and the speed. But, 50 years from now, when we look back at how we are investing and how China is investing, are we going to be remembered for Facebook and Airbnb, or the major things we need to do? Elon Musk is an outlier. It is unlikely that venture capitalists would have invested in another car company. Maybe they are now with autonomy.

Financing start-up to scale-up. The Council is very concerned about this financing issue—from start-up to scale-up. Banks do not give debt capital anymore, and we are not going to get it from the

venture industry. The Council had recommended a national infrastructure bank and, although there is interest on the Hill, it has not gone anywhere. Other countries are making large investments that are critical to the things that will determine our future. If we lose next generation semiconductor manufacturing and design to China, we will be in serious trouble.

During the Bush I Administration, when we were dealing with the competition from Japan, we had a plethora of flat panel display companies in a U.S. Display Consortium. We had liquid crystal displays come out of Kent State University, we had LED planar array. None of those commercialized, and we do not have a flat panel display industry. We never had any money that went into the manufacturing. It all went to Asia.

We had the same sort of thing with the A123 battery company. Millions of dollars from the Department of Energy and State of Michigan went into A123, and they ended up filing for bankruptcy. Its assets, including its IP, were acquired by a Chinese company. We have a serious issue in this country taking these things to full scale, and tweaking the venture capital model is not going to get us there.

In-Q-Tel model. Is there anything analogous to In-Q-Tel for the national security side where you can have multiple investors looking at opportunities? In-Q-Tel is the technology venture organization for the intelligence agencies. They see more companies than anyone else. They have tremendous reach, cover a lot of ground, do a lot of investments, around 60 or more a year. They give the agencies a taste of what's going on out in the world, and they have expanded to Europe, Israel, Singapore, and Australia and have sites in all those places. .

Strategically, financially, you can argue about the value of the In-Q-Tel model. LM Ventures is looking for better, stronger investment opportunities that have a national security implication and then provide additional funding for those that are actually worthy of funding, including debt-based instruments. LM Ventures syndicates the In-Q-Tel model.

Small businesses and the strength of the defense industrial base. Looking at Lockheed's supply chain as a proxy for all the primes' supply chains, Lockheed is expected to put at least half of its dollars into small businesses. It is a jobs program, but we are not in a jobs program world. We are in a competitive world. Is there some modification that could be done to allow Lockheed to work with companies that actually want to scale and grow?

Lockheed spends $39 billion a year on its supply chain. That is a vast amount of money. If you added up all the primes, it is probably close to $150 billion-$200 billion, more than any venture fund has. If we could apply that differently to companies, that will increase the strength and resiliency of the defense industrial base. But there would have to be a policy and legislative change to enable that. Right now, we are measured to that, and toe the line—49.8 percent of Lockheed dollars goes to small businesses. Lockheed has 21,000 suppliers, and we do not buy a whole lot from 12,000 of them. If Lockheed were able to design a supply chain that really worked, and was efficient and competitive, it would not look like what it is right now.

Deploying Technology Statecraft with Strategic Allies

2:00 p.m. Session

How do we ignite a transformational technology and pro-innovation statecraft with strategic allies and partners (AUS, UK, AUSUK, Japan, EU, trans-atlantic, etc.)? For example, the CHIPS Act includes $500 million in funding for an International Technology Security and Innovation Fund to provide for international information and communications technology security and semiconductor supply chain activities, including support for the development of secure and trusted telecommunications technologies and semiconductors. In addition, the new U.S.-EU Trade and Technology Council is providing a platform for the U.S.-EU to advance cooperation and democratic approaches to trade, technology, and security.

Discussion Questions:

- How do we deploy a statecraft that advances U.S. domestic interests, advances liberal market principles globally, and counterbalances the technology statecraft China is attempting to deploy around the world?
- Can the AUKUS agreement be used as an exemplar of a new statecraft at least where the US, UK and AUS are concerned?
- Can we re-start the US-AUS CTO dialogue? Other options (UK, Japan, India)?

The Honorable Deborah L. Wince-Smith
President & CEO
Council on Competitiveness

Since its inception, the Council on Competitiveness has had a long history of engaging internationally for many reasons, for example, to understand what our competitors and partners are doing. The Council has had many successful bilateral and multilateral partnerships over the years, including the creation of our sister organization, the Global Federation of Competitiveness Councils, chaired by the Council's Chairman Emeritus, Chad Holliday. Some 35 countries are involved, sharing best practices and knowledge around competitiveness.

During the first phase of the Council's National Commission on Innovation and Competitiveness Frontiers, a very interesting concept of technology statecraft emerged. In these dual use, strategic areas of technology defining the future, the United States should work more aggressively and collaboratively with our friends and allies such as the Five Eyes. There are other new partnerships that have emerged, such as the AUKUS in the naval arena. The Commission is very proud that its recommendation on technology statecraft was picked up very early in the Biden Administration by Secretary Blinken.

The idea of bilateral partnerships between TLSI and our close partners and allies came up a few years ago. Our first big bilateral partnership has been with Australia and, in 2019, we formed and signed at the ministerial level a partnership between the U.S. Council and the Australian Ministry of Industry, Trade, and Innovation. We identified several areas for collaboration, but then COVID emerged. We are looking forward to resurrecting the partnership.

In terms of partnership model and collaborating with allies, the change in the Japanese constitution to allow investment in the military is a watershed, and global tectonic shift. Before that, President Biden and Prime Minister Kishida established a government-to-government partnership in competitiveness, innovation, and resiliency. Through our long-standing relationship with Japan Science and Technology Agency and MITI, the U.S. Council is in deep discussions with the Japanese about having a partnership and pushing that forward from the private sector. TLSI would be the home for it, but also at the G7. Working with Japan in the area of advanced semiconductors, Council member Boise State University is now the university partner with the University of Tokyo, and Micron is the partner of one of the Japanese semiconductor companies.

Dr. Paul Monks was the chief scientific officer of the U.K. and is now working on energy and climate. Recently, he joined the Council's National Commission meeting at the University of California Davis.

Dr. Tony Lindsay
Director, Science Technology Engineering Leadership and Research Laboratory
Lockheed Martin

The strategic geopolitical landscape has changed. The disruptions have been significant, including the Russian invasion of Ukraine that has rippled around the world. The U.S.-China tensions are very high on the agenda in Australia. If the impact of the Ukraine situation was translated, for example, to a disruption in the Singapore shipping lanes, the consequences for Australia would be unimaginable. Australia's recent Defense Strategic Review (DSR) reflects the unprecedented change in policy in the INDOPACOM around nuclear submarines and the Japanese constitutional changes. These feel very proximate to Australia.

Australia's national defense strategy has traditionally been protection of the homeland. Now there is much emphasis on protection of the northern area called anti-access area denial, although that was always a conscious policy but not conveyed officially due to supply chain threats on which Australia is very vulnerable. There is public acknowledgement now of the loss of warning time—if anything goes bad, it is going to go bad very quickly, and there is likely to be a period of national isolation where

the country has to fight through and survive that initial period, as will any U.S. forces deployed in the region. So, there is a strong sense of the need for asymmetric capability and speed, not just conventional buildup of logistics, supply, and logistics assurance.

Cooperation on building strategic capabilities and critical supply chain issues—defense and beyond. The policy in Australia has been that defense forces would be satisfied with a minimum viable product and then evolve just to increase speed to capability. But, with the strategic geopolitical shifts, there are people who are concerned that the system in just moving along in a very measured way. It has a lot to do with the supply chains, and supply chain resiliency. The Australian DSR talks to a national response, not just a defense response. The Council on Competitiveness could ask if our strategic dialogue is appropriate for the times: Should there be an element looking beyond defense to transformation on a national scale?

Under AUKUS, pillar one is submarines. But pillar two is about very specific capabilities—undersea, quantum, advanced cyber, AI, autonomy, hypersonics and counter hypersonics, and electronic warfare—the specific technologies deemed to be critical for the nation to develop bilaterally, trilaterally, and also under AUKUS. It is technology information sharing, ITAR, etc., but could provide the opportunity for information sharing on aligning some of these strategic capabilities in critical technologies and on critical supply chain issues among the three nations.

The Australian DSR talks about adopting both internal and external strategic policy setting—statecraft effectively—and it has a chapter on that. So, it is legitimate under the DSR and AUKUS to talk about these other areas of national response such clean energy, climate, industry, and infrastructure.

For example, Australia recently released its critical minerals strategy, highlighting that Australia is the world's largest producer of raw battery materials. A company called Wesfarmers Chemicals produces about 50,000 tons per annum of battery grade lithium hydroxide. A company called Iluka Resources is refining praseodymium, dysprosium, neodymium, and terbium—rare earth metals for magnets. We have an alignment of government investment in a Northern Australia infrastructure facility, $500 million for downstream processing of these things. Australia has a national reconstruction fund with about $1 billion for value-added resources, $3 billion for renewables, and a number of bilateral and trilateral engagements already exist. There is an Australia Strategic Commercial Dialogue, Energy Security Dialogue, and a dialogue with the U.K. on critical minerals. In renewing the Council partnership post-COVID, there is a role that could be played in information sharing and strategic dialogue associated with these supply chain issues.

Dr. Patricia Falcone
Deputy Director of Science and Technology
Lawrence Livermore National Laboratory
TLSI Co-Chair

Lawrence Livermore is operated by the ten campus University of California. U.S. citizens pay for this federally-funded research work for defense and basic science, and there is concern about theft and being behind our competitors. But many do not totally understand innovation and education processes at universities, and that could be injurious to the health of our innovation ecosystem.

A balancing act. The United States has welcomed and respected excellence from all sorts of institutions and people no matter from where they come. Openness and putting lots of minds on problems is the driver of innovation and a rich, vibrant innovation ecosystem. But the facts are we have adversaries who behave badly, and we really do have to think carefully about giving them advantage from innovations in this open innovation ecosystem.

So, we have been spending time thinking about why we engage with colleagues from other nations on U.S. sponsored research. There is the benefit of capacity building and solving problems we share.

There is also science diplomacy, talking about science but not doing science, but talking about it matters.

Strategic science and technology. Then there is a category we do not talk about enough, which is strategic science and technology, where the intent is to support other policies, in particular, working with allies and partners on readiness and dual use. Our old national security model was we would put a lot of money into science and technology for defense, and defense would buy it—expensive semiconductor chips, and spaceships.

Today, in the big things, such as AI and bio, government does not own the technical edge. You cannot do national security in those domains without working with the best people in the global scientific community. But we do not have programs to support this. Open science is great, and we should spend a lot of money, but we need to have a little money that is more dedicated.

In Washington during crises, such as Fukushima, the information that comes in to support decision makers is not always as good as you might think because there is great knowledge that does not always end up in those decision-making rooms. With allies and partners in crisis, the most important thing to do is ensure our leaders get scientific information that is useful and have the same scientific content. So, the only way to have these partnerships during crisis is to build those relationships ahead of time, to have a sense of who are the scientists that are going to pick up the phone in a crisis and answer the questions. That is the point of these dual use areas—if it is a bad use of a new technology, you need to have the people that work on the side of bad use as well as just what's the potential.

There is now an office in the National Security Council on technology and national security. The Quad has a strategic technology subcommittee, and AUKUS pillar two is focused on technology. We do not yet have a clear idea about how to do the

science for strategic purposes. We are still in the diplomacy stage where we are talking about cooperation in technology, but the only model we really know how to do does not have continuity because it is always competition.

We have to have the strategic, and we have to have competition, but we know that the best way to do bad science is to put it in a closed environment. So, you have to have a quasi-open, but sustained effort. We have to have all these dimensions to get the benefits for national and economic security.

Points of Discussion

Bigger markets for partners and allies. DARPA is looking to Australia and the U.K. for start-ups because there is great technology there, and happens to be at a good price compared to U.S. technology at the moment from a venture perspective. But the problem is those companies are prevented from bringing that technology here because of national security concerns. So, they have to focus on a small home country market. We need to figure out how to leverage AUKUS to open up those channels so that technology can come here and address a bigger market.

Two-tier world, different models of collaboration. At DARPA, the emphasis on international activity and cooperation has changed dramatically. But it is really a two-tier world, for example, doing general European engagement and trying to foster more basic research with performers around the world, and then there are the Five Eye countries. Some of that activity is because countries such as Australia have capabilities that exceed U.S. capability. Finding those connections and partnering there makes sense for both parties. It is a win-win, and provides all the motivation necessary to break through the bureaucratic hurdles you have to go through.

DARPA may be setting some precedent. DARPA is going to have two Australian citizens in the DARPA building fully cleared at SAP levels, working on programs with us in a way that we have not been able to do before. But it takes months to get some of these things approved. DARPA is doing it and, at least among the Five Eyes, the sky's the limit. But there is a different sort of regime necessary to operate around the rest of the world.

Developing countries. We may have a blind spot with respect to Africa, the Caribbean, and developing countries that are natural resource intensive, and may want to do scientific diplomacy in some of these countries, especially since those countries are in the sight of our adversaries. The Global Federation of Competitiveness Councils is launching an Africa initiative. The GFCC partner is a U.S. citizen, formerly with the World Bank, and now the Chief Economist of the African Exim Bank. They are going to create an All-Africa Competitiveness Council.

Foreign students in U.S. universities. China used to be the number one source of graduate students in the United States. That has changed dramatically; India is increasing substantially the number of their students studying in the United States. But we are seeing an important change in the dynamics within higher education and the research enterprise. There is a great appetite for collaboration but also, increasingly, students and faculty that come here will go back to their home nations to contribute to their economies, although some will remain in the United States.

Need a new value proposition for supporting international collaboration. There are some small funds that can be accessed through NSERC and the National Science Foundation, but they have been applied in very limited areas for research collaborations in the United States and Canada. On the standards side, there has also been underinvestment by the United States in science and

technology collaborations around metrology. In contrast, China has dramatically leaned forward in their international collaboration and support in our own backyard, throughout Latin America, and in sub-Saharan Africa. The United States has some unique opportunities, but it will take Federal investment and a different mindset to open up the aperture to these strategic partnerships that are not necessarily dual use. They are, however, strategically important for competitiveness.

Speaker and Tour Host Bios

Dr. Joe Elabd
Vice Chancellor for Research
The Texas A&M University System

Dr. Joe Elabd is the Vice Chancellor for Research at The Texas A&M University System; a system of 11 universities and 8 state agencies with externally funded research expenditures exceeding $1 billion annually. As the leader of the A&M System Office of Research, Dr. Elabd is responsible for providing leadership and services to support all 19 system members in areas including intellectual property and commercialization, research compliance, research development, research partnerships, research security, and research strategy.

Dr. Elabd is also a Professor and the Axalta Coating Systems Chair II in the Artie McFerrin Department of Chemical Engineering at Texas A&M University. He is a Fellow of the American Physical Society and served as a Senior Fellow at the Instituto di Studi Avanzati, Università di Bologna and a Scholar in Residence at the Food & Drug Administration. He has received numerous research awards including the NSF CAREER Award, DuPont Science and Engineering Award, and the ARO Young Investigator Award.

His research focuses on electrochemical energy (batteries, capacitors, fuel cells) and materials and polymer science and he has authored over 130 research journal publications. Dr. Elabd has taught chemical engineering courses at all levels (freshmen, sophomore, junior, senior, and graduate). Dr. Elabd received his Ph.D. and B.S. both in chemical engineering from Johns Hopkins University and University of Maryland, Baltimore County, respectively, and was a National Research Council Postdoctoral Fellow at the U.S. Army Research Laboratory.

Mr. Chad Evans
Executive Vice President
Council on Competitiveness

As Council EVP overseeing all programs and initiatives, Chad develops and manages the Council's policy agenda and workstream, including: development and execution of the Council's flagship "National Commission on Innovation & Competitiveness Frontiers;" creating both the "Building University-Industry-Lab Dialogue for Advanced Computing" effort and the "Exploring Innovation Frontiers Initiative" with the National Science Foundation; forming the "American Energy & Manufacturing Competitiveness Partnership" with the U.S. Department of Energy; and, helping to shape and launch the "National Engineering Forum."

In addition, Chad has built and shepherded over the past nearly 15 years the Council's "Technology Leadership and Strategy Initiative," engaging Fortune 500 chief technology officers, university vice presidents of research, and national laboratory deputy directors to make the policy and business cases for America's innovation-enabling investments in talent, technology and infrastructure.

He has also helmed C-suite innovation summits, dialogues and immersions across Latin America, Europe, Asia and Oceania. Has focused, in particular in Brazil and Australia - having created 4 U.S.-Brazil Innovation Summits and 20+ innovation learning laboratories across both nations; and having launched the first-ever U.S.-Australia CTO Dialogue series.

Chad holds an M.S. from the Georgetown University School of Foreign Service, with an Honors concentration in International Business Diplomacy from Georgetown's Landegger Program. He has a B.A. in Political Science and International Affairs from Emory University.

He is both Secretary and Treasurer to the Board of the Council on Competitiveness; Treasurer to the Board of the Global Federation of Competitiveness Councils; a member of the Texas A&M Engineering Experiment Station Advisory Board; an ARCS Foundation National Science and Engineering Advisory Council member; a U.S. German Marshall Fund Fellow; and a past member of the Lawrence Livermore National Laboratory Industry Advisory Council and the World Economic Forum Advisory Board on Russian Competitiveness.

Dr. Patricia Falcone
Deputy Director of Science and Technology
Lawrence Livermore National Laboratory
TLSI Co-Chair

Patricia Falcone is the Deputy Director for Science and Technology at the Lawrence Livermore National Laboratory (LLNL). She is the principal advocate for the Lab's science and technology base and oversees the strategic development of the Lab's capabilities. She is responsible for LLNL's collaborative research with academia and the private sector, as well as its internal investment portfolio.

Falcone joined LLNL in 2015 after six years at the White House Office of Science and Technology Policy (OSTP), where she served as the Senate-confirmed Associate Director of OSTP for National Security and International Affairs. In that capacity, she led a team that advised on the science and technology dimensions of national security policy deliberations and on federal support of national security research and development.

Earlier, Falcone held technical and management positions at Sandia National Laboratories in Livermore, California, including Distinguished Member of the Technical Staff, and senior manager for Systems Analysis and Engineering. Her work at Sandia focused on the assessment of new technologies for mission applications and on advanced energy conversion technologies.

Falcone chairs the advisory committee for the Department of Mechanical and Aerospace Engineering at Princeton University and the board of trustees of the Georgia Tech Research Corporation. She is a commissioner on the National Commission on Innovation and Competitiveness Frontiers led by the Council on Competitiveness and a member of the Leadership Council of the Government-University-Industry Research Roundtable of the National Academies of Science, Engineering and Medicine.

Falcone earned a B.S.E. in aerospace and mechanical sciences at Princeton University, and M.S. and Ph.D. degrees in mechanical engineering from Stanford University.

Dr. Tommy Gardner
Chief Technology Officer
HP Federal, HP

Tommy Gardner is chief technology officer for HP Federal, spanning the US federal agencies, higher education, K–12 education, state and local government customer segments, and federal systems integrators. His responsibilities include technology leadership, strategic technology plans, product and technology strategies, sales force technical support, and customer and partner relationships.

He was previously chief technology officer for Jacobs Engineering, Scitor, and ManTech, and earlier in his career was a senior technical executive at Raytheon. In the US Navy, as deputy for science and technology for the Chief of Naval Research, he oversaw the Deep Submergence Program and Advanced

Technology Program, and commanded the nuclear submarine USS San Juan (SSN 751).

He is a professional engineer, an ASME fellow, and chair of the ASME Industry Advisory Board. Dr. Gardner's educational background covers multiple disciplines and fields of interest, including cybersecurity, data science, blockchain technologies, artificial intelligence, high-performance computing, and systems integration in government markets. He holds a BS in mechanical engineering from the US Naval Academy, a master's in public administration from Harvard University, an MS in management of technology from MIT, and a PhD in energy economics from George Washington University.

Dr. Tony Lindsay
Director, Science Technology Engineering Leadership and Research Laboratory (STELaRLab)
Lockheed Martin

Tony Lindsay is one of Australia's most respected defence scientists. In 2016, after 28 years with the Defence Department's Defence Science & Technology Group, he left his position as a Division Chief and, after a three day weekend, started work as the head of Lockheed Martin's STELaR research lab. Lockheed Martin is the world's largest arms manufacturer. Lindsay's rapid shift into industry was made with the full approval of Defence, including then Defence Minister Marise Payne.

Mr. Rob McHenry
Deputy Director
Defense Advanced Research Projects Agency(DARPA)

Mr. Rob McHenry is the deputy director of the Defense Advanced Research Projects Agency (DARPA). He rejoined DARPA in September 2022 after serving as founder and chief executive officer of Bright Silicon Technologies, an optical microdevice manufacturing company.

McHenry has been an executive leader of organizations at the forefront of advanced technology development. He began his career as a nuclear submarine officer in the U.S. Navy, serving aboard the USS Portsmouth (SSN 707) and as a special assistant to the Chief of Naval Operations. Upon leaving military service, he supported DARPA including technical development for the DARPA Grand Challenge for Unmanned Ground Vehicles, and managed a consulting firm where he served as director of future development for the Littoral Combat Ship program. From 2007 to 2012, McHenry was a program manager in DARPA's Tactical Technology Office, where he focused on complex autonomous systems in the maritime domain. His research in self-deploying unmanned ships (Sea Hunter) developed the first class of maritime vessels traveling long distances autonomously for months at a time. He also started the Long-Range Anti-Ship Missile program, which is a foundational breakthrough in autonomous weapons and successfully transitioned to the U.S. Navy as a program of record. In acknowledgment of his programs' impact on national security, he received the DARPA Gamechanger Award in 2019. McHenry worked from 2012 until 2020 at the Palo Alto Research Center (PARC), where he held the roles of energy technology program manager, vice president of public sector operations, chief operating officer, and executive-in-residence for the founding of a new business unit for advanced materials manufacturing.

McHenry received a Bachelor of Science in marine engineering from the U.S. Naval Academy, and Master of Science in nuclear engineering from the Massachusetts Institute of Technology.

He serves on the board of trustees of the USS Hornet Sea, Air, and Space Museum in Alameda, California, and is the coinventor of six patents for energy and optical systems.

Mr. Chris Moran
Vice President, GM LM Venture
Lockheed Martin

John Christopher "Chris" Moran is the Executive Director and General Manager of Lockheed Martin Ventures; the venture capital investment arm of Lockheed Martin Corporation. In this capacity, he is responsible for leading the Corporation's investments in small technology companies which support Lockheed Martin's strategic business objectives.

Prior to joining Lockheed Martin, Chris served in a variety of increasingly responsible positions at Applied Materials, Inc., Santa Clara, CA. He served most recently as the head of the Business Systems and Analytics group in the Applied Global Services Organization. Chris was with Applied for over 32 years. Prior to his most recent role, Chris was head of Corporate Strategy and General Manager of Applied Ventures LLC; the strategic investing arm of Applied Materials.

Chris is a graduate of the Massachusetts Institute of Technology where he obtained both his Bachelor's and Master's degrees in Mechanical Engineering.

Dr. Sally Morton
Executive Vice President, Knowledge Enterprise
Arizona State University
TLSI Co-Chair

Sally C. Morton is the executive vice president of Arizona State University's Knowledge Enterprise, which is responsible for the University's research and economic development ecosystem. Morton advances research priorities, oversees ASU's transdisciplinary institutes and initiatives, and drives corporate engagement and strategic partnerships, technology transfer, and international development. She is a professor in the School of Mathematical and Statistical Sciences and the College of Health Solutions and holds the Florence Ely Nelson Chair.

Morton's career has spanned both higher education and industry including being dean of the College of Science at Virginia Tech, vice president for statistics and epidemiology at RTI International and head of the RAND Corporation's Statistics Group. She is internationally recognized in the use of statistics and data science to help patients, their families and providers make better health care decisions. She has been involved in projects across a wide range of topics, including health care quality, homelessness, mental health and substance abuse. Her methodological work focuses on evidence synthesis, particularly meta-analysis.

Morton was the 2009 president of the American Statistical Association (ASA) and received the Norwood Award for Outstanding Achievement by a Woman in the Statistical Sciences in 2017. She currently serves on the Board of Scientific Counselors for the National Center for Health Statistics, the Patient-Centered Outcomes Research Institute (PCORI) Methodology Committee and the Research Advisory Committee of the National Collaborative on Gun Violence Research. Morton received a PhD in statistics from Stanford University.

Dr. Alison Nordt
Director of Space Science and Instrumentation
Lockheed Martin Advanced Technology Center

Dr. Alison Nordt is the Director for Space Science and Instrumentation at Lockheed Martin's Advanced Technology Center. She is responsible for developing and operating missions that provide observational data to advance space science knowledge. Her work involves maturing technology to support current and future space-based telescopes and instruments. She is currently the Principal Investigator for TechMAST (Technology Maturation for Astrophysics Space Telescopes) and related internal research and development efforts. Previously, Dr. Nordt was the senior manager for Astrophysics and held several roles on the NIRCam (Near Infrared Camera for the Webb Telescope) program including Program Manager, Integrated Product Team Lead and Principal Engineer. Dr. Nordt holds Ph.D. and M.S. degrees in Aeronautics and Astronautics from Stanford University and a B.S. degree in Mechanical Engineering from Cornell University. She is an AIAA Associate Fellow, member of the International Academy of Astronautics and serves on the Board of the Planetary Science Institute.

Dr. David Parekh
Chief Executive Officer
SRI International

David Parekh, Ph.D., is the chief executive officer of SRI International, a leading research and development organization serving government and industry. Parekh has more than 30 years of experience lead-

ing research for industrial and academic research organizations. He joined SRI International in December 2021.

Previously, Parekh served as corporate vice president, research, and director for United Technologies Research Center (UTRC), providing global leadership for United Technologies Corporation's (UTC) central research organization. Under his leadership, UTRC developed a broad portfolio of advanced aerospace, energy, manufacturing, and digital technologies for the UTC business units. Prior to joining UTRC, he served as deputy director of Georgia Tech Research Institute (GTRI) and associate vice provost for research at Georgia Tech. There he also led multi-disciplinary research programs in the emerging areas of active flow control and fuel cell powered flight.

Early in his career Parekh led advanced technology programs at Boeing Phantom Works and McDonnell Douglas Research Laboratories. Parekh serves on the Board of Trustees of the Connecticut Science Center and served as a board director of the American Council for an Energy-Efficient Economy. He is a Fellow of the American Institute of Aeronautics and Astronautics (AIAA) and a member of the Connecticut Academy of Science and Engineering (CASE).

Parekh earned a doctorate in mechanical engineering and master's degrees in mechanical and electrical engineering from Stanford University and a bachelor's degree in mechanical engineering from Virginia Tech.

Dr. Nelson Pedreiro
Vice President, Lockheed Martin Advanced Technology Center
Lockheed Martin

Nelson Pedreiro is a long-time Lockheed Martin executive currently serving as the vice president of the company's Advanced Technology Center.

Pedreiro has been the VP of ATC, a research lab for Lockheed Martin Space, for more than three years. His responsibilities include overseeing technology development and transition into spacecraft and missile products, according to his LinkedIn profile.

Having worked for Lockheed Martin for 25 years, Pedreiro has taken on various roles for the defense company.

He started out as a research scientist principal in 1996 and was later promoted to roles of increasing responsibility.

During his stint as senior manager for control systems technology, Pedreiro led the demonstration of a new high-energy laser weapon system capability and identified space-based autonomous operations as a strategic growth area.

As science and technology director, he played a key role in the success of Lockheed Martin's Near Infrared Camera program.

Prior to becoming VP, he served as chief engineer of strategic and missile defense systems. In the said role, he was in charge of more than 2,200 cross-functional engineers responsible for designing, developing, integrating and delivering flight missile systems. One of his career highlights was solving a significant problem on a ground-based directed energy system.

Pedreiro graduated from Instituto Tecnologico de Aeronautica in Brazil with bachelor's and master's degrees in aeronautical engineering. He also attended Stanford University, where he earned his PhD in aerospace engineering.

Dr. Eric Smith
Director of AI
Lockheed Martin Advanced Technology Center

Dr. Eric Smith is the Director of Artificial Intelligence, Data Analytics and Exploitation (AIDAE) at the Lockheed Martin Advanced Technology Center (ATC). Dr Smith's organization of 80 engineers and scientists works closely with government S&T organizations, universities, small business, and lines-of-business in Space to ensure delivery of mission-relevant technology built upon the state-of-the-art. Prior to this role, Dr. Smith worked at Alphabet's Waymo LLC as the systems engineering manager and technical lead for the sensing systems, responsible for understanding from physics first principles the behavior of the sens-

ing system, both current and next generation, in a wide regime of environmental conditions. Dr. Smith's previous roles include Google's next-generation payload leader and strategist at Terra Bella, Chief Systems Engineer for the James Webb Space Telescope's Near Infrared Imaging Camera (NIRCAM) at the ATC, which is the central science instrument and source of truth for alignment and wavefront maintenance of the observatory, senior program manager for the Talon visible imaging payload for a government contract, and department senior manager for the optics department at the ATC. Before joining Lockheed Martin, Dr. Smith held a post-doctoral position analyzing data from the Fermilab Tevatron, placing limits on a minimal supersymmetric model of a proposed charged Higgs Boson.

Mr. Justin Taylor
VP of Artificial Intelligence
Lockheed Martin

Justin Taylor is Vice President of Artificial Intelligence for Lockheed Martin within Corporate Engineering. In this capacity, he is responsible for leading the Corporation's development and implementation of an Artificial Intelligence (AI) / Machine Learning (ML) technology strategy, as well as leading the LM AI Center (LAIC).

Throughout his career, beginning as a Software Engineer at Lockheed Martin Aeronautics in May 2000, Justin has led advancements in innovative technology progressing from virtual simulation experimentation, to flight experimentation, to driving the future of mission systems open architectures. His previous leadership experience includes internal R&D to design and mature airborne open architectures as well as serving in a capture manager and program manager role on multiple DARPA R&D programs. Justin holds a Bachelor of Science Degree in Computer Science from the University of Texas and is a graduate of LM's Advanced Technology Leadership Program (ATLP) and Program Management Development Program (PMDP).

Dr. Dinesh Verma
Professor and Executive Director, School of Systems and Enterprises
Stevens Institute of Technology

Dinesh Verma served as the Founding Dean of the School of Systems and Enterprises at Stevens Institute of Technology from 2007 through 2017. He currently serves as the Executive Director of the Systems Engineering Research Center (SERC), a US Department of Defense sponsored University Affiliated Research Center (UARC) focused on systems engineering research. During his fifteen years at Stevens he has successfully proposed research and academic programs exceeding $175m in value. He has a courtesy appointment as a Visiting Professor in the Department of Biochemistry in the School of Medicine at Georgetown University. Verma served as Scientific Advisor to the Director of the Embedded Systems Institute in Eindhoven, Holland from 2003 through 2008. Prior to this role, he served as Technical Director at Lockheed Martin Undersea Systems, in Manassas, Virginia, in the area of adapted systems and supportability engineering processes, methods and tools for complex system development.

Before joining Lockheed Martin, Verma worked as a Research Scientist at Virginia Tech and managed the University's Systems Engineering Design Laboratory. While at Virginia Tech and afterwards, Verma continues to serve numerous companies in a consulting capacity. He served as an Invited Lecturer from 1995 through 2000 at the University of Exeter, United Kingdom. His professional and research activities emphasize systems engineering and design with a focus on conceptual design evaluation, preliminary design and system architecture, design decision-making, life cycle costing, and supportability engineering. In addition to his publications, Verma has received three patents in the areas of life-cycle costing and fuzzy logic techniques for evaluating design concepts.

Dr. Verma has authored over 100 technical papers, book reviews, technical monographs, and co-authored three textbooks: Maintainability: A Key to Effective Serviceability and Maintenance Manage-

ment (Wiley, 1995), Economic Decision Analysis (Prentice Hall, 1998), Space Systems Engineering (McGraw Hill, 2015). He was honored with an Honorary Doctorate Degree (Honoris Causa) in Technology and Design from Linnaeus University (Sweden) in January 2007; and with an Honorary Master of Engineering Degree (Honoris Causa) from Stevens Institute of Technology in September 2008.

Dr. Steven Walker
Vice President and Chief Technology Officer
Lockheed Martin
TLSI Co-Chair

Dr. Steven H. Walker is Vice President and Chief Technology Officer of the Lockheed Martin Corporation, where he is responsible for the company technology strategy, global research, mission development, and emerging operations technologies. He assumed the role in January 2020, and under his direction the organization is shaping the next era of operational capability and innovation for Lockheed Martin. As the primary liaison to the US and international science and technology community, he manages strategic partnerships with government, industry, and academia to ensure the maturation and deployment of cutting-edge technologies.

Prior to joining Lockheed Martin, Dr. Walker was the Director of the Defense Advanced Research Projects Agency (DARPA) where he was responsible for driving development of emerging technologies for use by the military. Throughout his 30+ years in government, he also served in a variety of increasingly responsible positions as DARPA's Deputy Director and Deputy Assistant Secretary of the Air Force for Science, Technology and Engineering. In the later role he was responsible for developing the technology investment strategy for the Air Force's annual $2 billion science and technology program and for providing functional management of more than 14,000 military and civilian scientists and engineers.

Dr. Walker is a Fellow of the American Institute of Aeronautics and Astronautics and a Senior Member of the Institute of Electrical and Electronics Engineers. He received the AIAA Hap Arnold Award for Excellence in Aeronautical Management in 2014. He has also been awarded the Presidential Rank Award, the Air Force Meritorious Civilian Service medal, and the DoD Exceptional, Meritorious, and Distinguished Civilian Service medals. In February 2020, Dr. Walker was elected as a Member of the National Academy of Engineering. He holds a Ph.D. and B.S. in aerospace engineering from the University of Notre Dame, and an M.S. in mechanical engineering from the University of Dayton.

The Hon. Deborah L. Wince-Smith
President & CEO
Council on Competitiveness

Deborah L. Wince-Smith is the president & CEO of the Council on Competitiveness, a coalition of CEOs, university presidents, labor leaders and national laboratory directors, committed to driving U.S. competitiveness. She has more than 20 years of experience as a senior U.S. government official, as the first Senate-confirmed Assistant Secretary for Technology Policy in the U.S. Department of Commerce and Assistant Director for International Affairs in the Reagan White House.

As a globally recognized leader and practitioner in competitiveness strategy, innovation policy, technology commercialization, and public-private partnerships, Ms. Wince-Smith has served and is a current member on numerous national and global advisory boards and committees, as a University Trustee, and as a director on public and private corporate boards.

She has served on the University of California's President Council for the National Laboratories, the Board of Governors of Argonne National Laboratory, the US Naval Academy Foundation, the Smithsonian National Board, as a Trustee of Lehigh University, member of the Advisory Committee of the US Export-Import Bank, UNICEF, the Secretary of State's International Economic Policy Committee, as Chair of the Secretary of Commerce's Strengthening America's Communities Initiative (SACI), Chair of the World Economic Forum's Global Agenda Council on Competitiveness, member of Malaysia's Global Science and Innovation Advisory Council (GSIAC), and as a Corporate Director of NASDAQ-OMX.

Currently, Ms. Wince-Smith serves as a Commissioner on the Council on Competitiveness National Commission on Innovation and Competitiveness Frontiers, the National Commission of the Theft of American Intellectual Property, a Council Member of the Japan Science, Technology, and Society forum (STS forum), as a member of the Global Advisory Committees of the Japan Science and Technology Agency (JST) and the Delphi Economic Forum (DEF), the National Academies Strategic Council on Research Excellence, Integrity, and Trust, as Vice-Chair of the Trustees of the American College of Greece (ACG), the Strategic Research Advisory Committee of the University of Oklahoma, the advisory committee of Queen's Management School, Queen's University, Belfast, and as a Director of private technology companies in medical lasers, cybersecurity, and bio-therapeutics.

Ms. Wince-Smith graduated magna cum laude and Phi Beta Kappa from Vassar College and earned a Master's Degree in Classical Archaeology from King's College, Cambridge University. She received an Honorary Doctorate in Humanities from Michigan State University, an Honorary Doctorate of Public Administration from the University of Toledo, an Honorary Doctorate of Law honoris causa from the Queens University Belfast, an Honorary Doctorate of Humane Letters honoris causa from Worcester Polytechnic Institute and, most recently, an Honorary Doctorate of Public Service from the University of South Carolina.

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About the Council on Competitiveness

For more than three decades, the Council on Competitiveness (Council) has championed a competitiveness agenda for the United States to attract investment and talent, and spur the commercialization of new ideas.

While the players may have changed since its founding in 1986, the mission remains as vital as ever—to enhance U.S. productivity and raise the standard of living for all Americans.

The members of the Council—CEOs, university presidents, labor leaders and national lab directors—represent a powerful, nonpartisan voice that sets aside politics and seeks results. By providing real-world perspective to Washington policymakers, the Council's private sector network makes an impact on decision-making across a broad spectrum of issues—from the cutting-edge of science and technology, to the democratization of innovation, to the shift from energy weakness to strength that supports the growing renaissance in U.S. manufacturing.

The Council's leadership group firmly believes that with the right policies, the strengths and potential of the U.S. economy far outweigh the current challenges the nation faces on the path to higher growth and greater opportunity for all Americans.