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Conceptualizing the Next-Generation DoD Innovation Ecosystem

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Abstract

The Department of Defense (DoD) and its supporting Defense Industrial Base must affordably sustain our long-term competitiveness. Peer adversaries are seeking to change the status quo of the international order in their favor. To deter their aggression, the DoD must learn to create, adopt and adapt new technologies, innovations and capabilities at ever-increasing pace and scale. This requires the development of new mental models and leadership and organizational strategies that leverage the exponential pace of technological development. This research study is a meta-study of relevant research, theory and practice to better understand and articulate the Defense Industrial Base future challenges, enabling conceptual constructs, leadership styles, cultural and operational attributes, technologies, processes and policies that can help provide and sustain competitive advantage. This study converges a range of lessons learned, best practices, and emerging opportunities to develop conceptual views of new and novel operating models at various levels of the innovation ecosystem. These models reflect the theoretical applications of Complex Adaptive and Anticipatory Systems (CAAS) thinking, continuous learning and process improvement, innovation management, advanced technologies, and leadership and management strategies for accelerating cultural change and transformation. The results provide conceptual views, perspectives and mental models that support accelerating the research, development and deployment of advanced integrated warfighting capabilities to deter and defeat adversary aggression.

Key Words: Acquisition, Strategic Thinking, Systems Thinking, Lead Systems Integration, Innovation, Technology, Ecosystem, Learning, Artificial Intelligence, Data Analytics, Complex Adaptive Systems, Value Stream, Leadership, Collaboration, Teaming, Defense Industrial Base

Introduction

The Department of Defense (DoD) faces significant challenges to meet its Title 10 and National Defense Strategy responsibilities. The rise of near-peer and peer threats with displays of aggression and clear strategic intent has led to decreasing global stability, exacerbated by the global COVID-19 pandemic, and created destabilizing disruption and uncertainty. Additionally, these volatile conditions are accentuated by highly competitive global market forces and the exponential acceleration of emergent technologies.

To provide context, the 2024 Annual Threat Assessment of the U.S. National Security Community stated, "During the next year, the United States faces an increasingly fragile global order strained by accelerating strategic competition among major powers, more intense and unpredictable transnational challenges, and multiple regional conflicts with far reaching implications." It also said that, "This competition also exploits technological advancements such as artificial intelligence (AI), biotechnologies and related biosecurity, the development and production of microelectronics, and potential quantum developments to gain stronger sway over worldwide narratives affecting the global geopolitical balance, including influence within it." A particular concern is expressed regarding contested spaces and disruptive technologies in that, "the convergence of these emerging technologies is likely to create breakthroughs, which could

lead to the rapid development of asymmetric threats, such as advanced UAVs, to U.S. interests and probably will help shape U.S. economic prosperity" (Office of the Director of National Intelligence, 2024; *The U.S. Defense Industrial Base: Background and Issues for Congress*, 2023).

To address this challenge, the 2022 National Defense Strategy states, "we will prioritize coordinated efforts with the full range of domestic and international partners in the defense ecosystem to fortify the defense industrial base, our logistical systems, and relevant global supply chains against subversion, compromise and theft" (*National Defense Strategy of the United States of America*, 2022), and the 2024 National Defense Industrial Strategy offers a strategic vision to coordinate and prioritize actions to build a modern defense industrial ecosystem that is aligned to the NDS" (*National Defense Industrial Strategy*, 2023).

Innovation ecosystems are considered to be dynamic and ever-changing co-evolutionary systems that compete and cooperate and that include a wide range of participants and contributing institutions with shifting patterns of resources, power and relationships that are continually influenced by internal and external forces. An innovation ecosystem takes an explicit systemic lens and is comprised of enabling policies and regulations, access to necessary capital and infrastructure, and a culture that promotes openness, digitalization, innovation and entrepreneurship through extensive and diverse networks and ubiquitous productive relationships taking a collective approach toward a common overarching vision and goals (Moore, 1996; Oh et al., 2016).

This research paper is a meta-study to converge, abstract and extend the most enabling and relevant research, theory and practice to better understand and articulate the Defense Industrial Base (DIB) future challenges, new and enabling conceptual constructs, leadership styles, cultural and operational attributes, technologies, processes and policies that can help provide and sustain competitive advantage. It synthesizes a wide range of insights and perspectives, lessons learned, best practices, and emerging opportunities to offer new mental models and conceptual frameworks for subsequent inquiry, reflection, dialogue and consideration at various levels of the DoD Innovation Ecosystem that can integrate these insights and foresights into a coherent whole.

Background

The complexity and scale of the DoD and its DIB makes adoption and adaptation of new and enabling technologies very difficult. The National Defense Industries Association Vital Signs 2023 Report states that the defense industry employs approximately 1.1 million workers and includes nearly 60,000 companies as of 2021 with spending and DIB contracts in all 50 states and the District of Columbia totaling $390 billion (*NDIA Vital Signs 2023*, 2023). The dramatic consolidation of the DIB since 1980 from 55 to 5 major defense firms has decreased competition and negatively affected cost, schedule and performance of defense acquisition projects (*The U.S. Defense Industrial Base: Background and Issues for Congress*, 2023). The DoD Innovation Ecosystem as currently articulated consists of 281 individual organizations (Defense, 2024). This complexity represents unbounded potential for ecosystem-wide synergies, innovation and transformation to sustain its competitiveness. The DoD suggests that the United States needs "healthy, resilient, diverse and secure supply chains to ensure the development and sustainment of capabilities related to national security (*The U.S. Defense Industrial Base: Background and Issues for Congress*, 2023).

With this complexity, a number of formidable efforts to help drive sustained competitiveness have been conducted. These have come in the form of strategies, plans and comprehensive assessments to help guide critical investments, actions and policies to improve.

The following synopses provide the design and architecture foundations for this study to help conceptualize the Next Generation DoD Innovation Ecosystem.

The 2023 DoD Small Business Strategy underscores the importance of small businesses. It highlights the desire to harness the power of America's small, innovative, and agile companies to grow their contributions to the defense mission and to make it easier for small businesses to work with the DoD. It recognizes that small businesses provide our most creative entrepreneurs and most driven workers and that it is imperative that they be more engaged (*Small Business Strategy*, 2023)**.**

The DoD Software Modernization Strategy is focused on accelerating the DoD Enterprise Cloud Environment, establishing a Department-wide Software Factory Ecosystem, transforming processes to enable resilience and speed, and institutionalizing the Development, Security, and Operations (DevSecOps) culture and process to automate, monitor and apply security at all phases of the software lifecycle (*Department of Defense Software Modernization Strategy*, 2021). The DoD DevSecOps Strategy Guide advocates for a Continuous Authorization to Operate (cATO) software governance process to underscore that "software is never done," as described by the Defense Innovation Board. It also recognizes the need for software factories as part of large software supply chains to create pipelines of continuous software feedback loops and delivery. These software factories are driven by the "Relentless pursuit of Agile principles and culture" and a "mandate for baked-in security via integral and comprehensive security practices across the entire supply chain leveraging Zero Trust" principles" (*DoD Enterprise DevSecOps Strategy Guide*, 2021).

The DoD Digital Modernization Strategy highlights the Joint Information Environment (JIE), which is comprised of a set of discrete initiatives to support continual and comprehensive Department-wide Information Technology Modernization and advanced DoD information superiority. It is designed to support innovation for competitive advantage, evolve cybersecurity and resilience, and cultivate talent for a digital workforce by modernizing network, service, cloud and data center capabilities to enhance enterprise collaboration and provide enabling tools most affordably (*DoD Digital Modernization Strategy*, 2019).

The National Defense Science and Technology Strategy 2023 emphasizes the need for closer alignment across the science and technology continuum throughout the broader DoD Innovation Ecosystem. This strategy identifies 14 critical technology areas (Defense, 2023). Similarly, the National Science and Technology Council identified 19 critical and emerging technology categories and 104 sub-categories. These technologies are being combined and integrated to provide synergistic effects and capabilities. It delineates strategies to create and field capabilities at speed and scale by fostering a more vibrant ecosystem, strengthening collaboration with international allies and partners, non-traditional partnerships, applying innovation in industrial processes, continuously transitioning capabilities, communicating clearly, and protecting critical technologies (Council, 2022).

The DoD Office of Strategic Capital (OSC) was established to rectify the investment gaps that exist to help attract and scale private capital to technologies critical to the national security of the United States. Currently, the OSC is focused on component-level technologies with broad commercial application using financial tools such as loans and loan guarantees to complement private capital and create a multiplier effect. Strategic capital will be focused on the application of public incentives and private funds to achieve national security priorities and is complementary to existing DoD Science and Technology, Research and Development, and Procurement Programs (DoD, 2024).

The DOD Adaptive Acquisition Framework represents the current baseline of guidance for DOD Acquisition Programs and provides new pathways for programs to follow to be more

responsive to warfighter needs. Much attention has been placed on Rapid and Mid-Tier Acquisition as well as Software Development using the DEVSECOPS approach (University, 2024).

The Section 809 Panel Report of the Advisory Panel on Streamlining and Codifying Acquisition Regulations provides an extensive assessment that includes moving toward a more market-based approach. Portfolio management and process improvement are identified as key areas of focus to help reduce risk, apply more agile and adaptive methods, enable innovation, streamline, be more flexible, eliminate non-value-added documentation and approvals, and facilitate better communications with industry. The intent of the study was to "understand that DoD's priority is defending the nation, and the DoD's acquisition systems mission is to delivery lethality to warfighters by providing innovative products and services that allow warfighters to obtain and maintain superiority over near-peer competitors and non-state actors," and to make recommendations that can "change from an industrial era bureaucracy to a more streamlined, agile system able to evolve in sync with the speed of technology innovation" (*Report of the Advisory Council on Streamlining and Codifying Acquisition Regulations*, 2019).

The Commission on Planning, Programming, Budgeting and Execution Reform highlighted 28 recommendations to help improve alignment of strategy and budget, foster innovation and adaptability, strengthen relationships between the DoD and Congress, modernize business systems and data analytics, and strengthen the capability of the resourcing workforce. The Commission's work was influenced by two persistent trends: first, the emergence of the People's Republic of China profoundly threatening the rules-based order, and second, the pace of global technological innovation and its continued acceleration. As a result, the Commission is calling for a transformational change in the Defense Resourcing System to support U.S. national security in an increasingly dangerous world (Hale & Lord, 2024).

The Atlantic Council Commission on Defense Innovation Adoption Final Report assessed the DoD innovation landscape and highlights the following challenges in adopting defense innovation (McNamera et al., 2023):

1) Outdated R&D Model
2) Long Timelines and Inflexible Execution
3) Fewer Companies Providing Defense Solutions
4) Valleys of Death
5) Hamstrung Workforce
6) Program-Centric Acquisition
7) Cumbersome Reporting from DoD to Congress
8) Limited Understanding of Emerging Technology

All of the insights from these strategies, studies and reports provide critical inputs to the design and architecture of the re-conceptualized Next Generation DoD Innovation Ecosystem as articulated in this study. A perspective worth noting is that the DoD has created a plethora of incubators, accelerators, pathways and various mechanisms to accelerate innovation. Concerns have been raised that these organizations are simply storefronts and orchestrators to help guide non-traditional firms where to go to make the right connections within DoD organic organizations who are responsible for and routinely perform the requisite research, development, integration, test and evaluation of new technologies and innovations for program offices supporting programs of record (POR). These interfaces are critically important, but opportunities for consolidating, integrating and streamlining these intermediaries should be considered (Carberry, 2023).

The DoD Innovation Ecosystem is a microcosm of our larger national society but is a critical component to our National Security Innovation Base (NSIB). The RAND Corporation

researched **“**The Sources of Societal Competitiveness: How Nations Actually Succeed in Long Term Rivalries,” which offers important insights to guide this research and the importance of taking a holistic ecosystem-level view. Key findings associated with national competitive success include national ambition and will, unified national identity, shared opportunity, an active state, effective institutions, a learning and adapting society, and competitive diversity and pluralism. As the study suggests, “learning is the essential foundation for adaptation, and adaptation is the practical application of learning” (p. 212), while “knowledge is the basic fuel for the engine of societal and competitive progress” (p. 217). Importantly, “Lasting competitive advantage in an uncertain global environment and a changing economic and technological context calls for emergent, bottom-up creativity, constant experimentation, and spirit of adaptation” (p. 3; Mazarr, 2022).

Considering the future, the NATO Science & Technology Trends: 2020-2040 report focuses on emerging and disruptive technologies as identified by over 6,000 active scientific and technical personnel with four overarching characteristics that are expected to guide future military development: intelligent, interconnected, distributed and digital. The report recognized the disruptive potential of data, AI, autonomy, space and hypersonics and expects the effects to come from their complex combinations and interactions. Organizationally, the five objectives of the NATO Science and Technology Organization are to be: innovative, integrated, inter-connected, insightful and to have impact (*Science & Technology Trends 2020-2040: Exploring the S&T Edge*, 2020).

The Air Force Global Futures Report: Joint Functions in 2040 provides an assessment of potential future operating scenarios and highlights the transformational potential of advanced technology and its impact and implications on the future joint force (Futures, 2023). Of particular interest for this study is the concept of the “metaverse” as highlighted in the Report. The metaverse concept merges both digital and physical domains into a fully immersive, virtual space transcending national borders and promoting continued interconnections and interactions at a global scale. The metaverse by its nature is an essential convergent technology for consideration in conceptualizing the future state of the DoD Innovation Ecosystem. It has been described as “a massively scaled and interoperable network of real-time rendered 3D virtual worlds and environments. These can be experienced synchronously and persistently by an effectively unlimited number of users with an individual sense of presence. The metaverse allows its users to have an immersive experience in a virtual environment, in which they can interact with each other, conduct business and forge social connections through their virtual avatars (Anderson & Trainie, 2022; “Toward a Successful Metaverse: The Case for Measuring Enabling Factors,” 2023)**.** The metaverse, as conceptualized, is well positioned to drive the next stage of the industrial revolution by transforming all aspects of business across enterprise functions, including new employee experiences, new ways of working, and new-generation operations. It represents an anticipated $5 trillion market by 2030 as it integrates transformative technologies across industry value chains, including digital twins, spatial computing, artificial intelligence, Web3 and blockchain. Cross-industry collaboration and synergy are required to fully build and realize the potential capabilities (Anderson & Trainie, 2022; *Exploring the Industrial Metaverse: A Roadmap to the Future*, 2023; *Value Creation in the Metaverse: The Real Business of the Virtual World*, 2022).

To place our U.S. innovation competitiveness in a global context, the World Intellectual Property Organization (WIPO) has released their Global Innovation Index 2023, which assesses 132 countries across seven major categories: Institutions, Human Capital Research, Infrastructure, Market Sophistication, Business Sophistication, Knowledge and Technology Outputs, and Creative Outputs supported by 27 detailed subcategories. The U.S. ranking is #3 overall. As the Index suggests, U.S. improvements can be achieved in its Institutions, Human

Capital and Research, Infrastructure, and Creative Output categories (*Global Innovation Index 2023: Innovation in the Face of Uncertainty*, 2023).

The Heritage Foundation produced its 2024 Index of Military Strength report to help place the present state of the U.S. military competitiveness in context. This report summarizes the Global Operating Environment, Threats to U.S. Vital Interests, and U.S. Military Power. They have assessed that the most concerning operating environment is the Middle East due to the political instability. The threats to U.S. Vital Interests come from China, Russia, Iran, North Korea and Non-State Actors, and are assessed as very concerning, and the Behavior of Threats, the Capability of Threats, and the Threats to U.S Vital Interests are assessed as high. As these threats emerge, the U.S. Military Power overall is rated as Weak, with the Army Capacity, Navy Readiness, Marine Corps Capacity rated as Weak and the Navy Capacity and Air Force Readiness rated as Very Weak (Wood, 2024).

This context and the significant challenges we face are the impetus for this study, and the expressed need to rethink and reimagine how the DoD can best position itself, harness its full potential, and transform its operations for a new paradigm of operations that is driven to out-innovate, out-compete and out-perform potential adversaries in this highly contentious and threatening global context. The DoD has expressed the need to develop ever-more affordable solutions to deter these challenges, at a pace and scale reflective of these contextual dynamics, and under increasingly difficult budgetary pressures. This situation necessitates new and better ways of thinking and performing, to develop the disruptive innovations needed, and to utilize the available resources most efficiently and effectively. To do so requires creativity, imagination, and ingenuity at all levels to unleash the latent potential that exists across the DoD DIB, including academia, industry and government, and to integrate the best research, theory and practice and to synergize enabling technological capabilities in anticipation of future deterrence and potential conflict.

“The DoD continues to face challenges quickly developing innovative new weapons. These challenges even with their recent reforms to its acquisition process intended to help deliver systems to the warfighter in a timely manner.”

2023 GAO Highlights

(*Weapon Systems Annual Assessment*, 2023)

“DoD must undergo a generational transformation to build the enduring advantages that will deter the nation’s adversaries far into the future.”

“DIU 3.0” Scaling Defense Innovation for Strategic Impact,

CNAS, 2024

The Research Questions for this meta-study are:

1. What are the major factors and trends that will impact the future of DoD Acquisition?
2. What are the barriers and constraints to accelerating innovation into enabling capabilities across the DIB?
3. How can the DoD’s Adaptive Acquisition Life Cycle evolve and transform to accelerate and exploit innovation, and best sense, anticipate and adapt for the future from a strategic perspective of the DoD innovation ecosystem?
4. How can the DoD be best organized, structured, and led to operate most affordably and meet the emergent and disruptive needs and requirements of the future?

Methodology

This study covers a broad span of disparate yet related and salient research topics to help conceptualize, develop and architect the DoD's Next Generation Innovation Ecosystem, as shown in Figure 1. Key terms and documents in each of these referenced areas were searched, reviewed, and assessed, while major themes and take-aways were identified. These were then assimilated and used for conceptualization and integration purposes into large-scale conceptual models to reflect the core concepts. The references used reflect a top-level holistic approach to scanning the broad range of the available literature to offer new insights and foresights focused on improving the DoD's Innovation Ecosystem. The convergence of these research sources and their findings, themes and concepts are brought into focus via highly abstracted and integrated mental models to help inform the design and architecture of a Next Generation DoD Innovation Ecosystem. Aggregated visual models are provided to simplify the complexity inherent in the existing DoD Innovation Ecosystem and to support and enable purposeful strategic thinking, understanding and dialogue to guide toward final design concepts and architectural solutions.

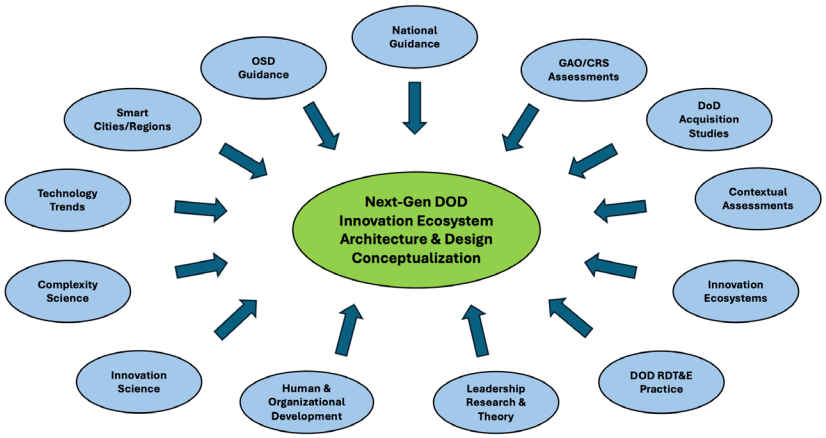

Figure 1. Meta=Study Domains for Conceptual Convergence

Research Questions

1. What are the major factors and trends that will impact the future of DoD Acquisition?

This research has identified major factors and trends that are impacting the future of DoD Innovation, including the ability of the DoD Acquisition system to adapt and adopt to changes and opportunities in the strategic environment. The following provides the major factors and trends identified in this research that require the development and deployment of a Next Generation DoD Innovation Ecosystem-level design and architecture.

A. Exponential Technology Accelerations/Emergent Disruptions: Technology is advancing at ever-faster rates, unleashing ever-more disruptive capabilities. The accelerated development of these critical and emerging technologies has been characterized as exponential, and even super-exponential, in terms of their rates of development. The strategic environment has been assessed and characterized as 'E-VUCA,' which represents the exponential acceleration of technology coupled with ever-increasing levels of volatility, uncertainty, complexity, and ambiguity. As a result, it is recognized that the DoD must generate more innovation faster, and at greater scale than ever before (Jensen & Largent, 2018; Kurzweil, 2005; West, 2017).

B. Pace and Scale of Commercial Technology Research and Development: There exists a vastly increasing opportunity landscape for the DoD as the result of advances in

emergent technologies. New innovations are being fueled by a complex combination of entrepreneurism coupled with angel and venture investments, the rapidly scalable global commercial technology sector, and a new generation of advanced developmental tools and capabilities facilitating the accelerated development of both software and hardware. The ability for the DoD to adopt, and in many cases adapt, these new developments from commercial industry is a significant paradigm shift that must be specifically addressed and seamlessly incorporated into the flows of system development. Commercial technology developments have been supported through various venture investments as well as Federal Government-wide Small Business Innovative Research (SBIR) and innovation-related programs. The awareness, assessment, development and transition of these enabling technologies in a timely manner remains challenging and is an important design and architecture consideration for the DoD Innovation Ecosystem (Board, 2023, 2024).

C. The Imperative for Continuous Change and Transformation at Scale and at Pace: To pace the threats and adapt to changing geopolitical conditions, it will be necessary for the Defense Innovation Ecosystem to embrace the need for agility and to create the conditions, climate and culture as well as the structural attributes that can evolve, morph and adapt at the pace and scale necessary – the speed of relevance. Core to enabling these conditions is the development and deployment of relevant change leadership skills that can engage and support continuous and adept reinvention and renewal in both organizational and system design, development and deployment. New leadership models and management capabilities are required to maintain competitiveness in a globally integrated and increasingly competitive landscape. Leaders must create and support the emergence of new cultural paradigms across the enterprise, and across broader ecosystems, to unleash human ingenuity and potential with the management and execution capabilities to bring new capabilities to the warfighter and every increasing rates (Garamone, 2024).

D. Need for End-to-End Acquisition Development Acceleration: It is recognized that the research, development, test and evaluation as well as manufacturing, production, assembly and delivery of new and enabling capabilities must accelerate well ahead of the rate of the threats, both current and anticipated. As DoD systems become increasingly complex, the demands for design, integration, testing and evaluation to produce the requisite data and analysis that ensure system effectiveness, safety, affordability and maintainability is an increasing challenge (Modigliani & Ward, 2019).

E. Continuous Innovation for Superior Capabilities at Scale: DoD capabilities must be appropriately scaled and deployed at the speed necessary to be relevant in a potential conflict. As systems become increasingly complex and integrated, the time and resources required to accelerate delivery in quantities across supply chains is particularly difficult. The DoD is becoming increasingly reliant on the robustness and resiliency of its supply chain, which has become extraordinarily complex, and potentially fragile and vulnerable to disruption.

F. Affordability: DoD acquisition system costs have continued to increase across the full life cycle. These costs can be attributed to increased government and contractor labor, material, and supply costs; inflation; and, most significantly, growing system complexity. Increasing system complexity drives data analysis, testing and integration expenses and remains a factor in the cost growth of weapon system development, production, deployment, and support. DoD cost growth is a growing challenge given CBO projections that the federal budget deficits total $20 trillion over the 2025–2034 period and federal debt held by the public reaches 116% of GDP (CBO, 2024; Porter et al., 2015).

G. Advanced Digital Tools and Enabling Capabilities: A major shift for the DoD and the commercial sector is the current digital transformation to create end-to-end digital threads,

which include digital twins, model-based engineering, and advanced analytical capabilities. The fundamental principles of system development remain unchanged; however, the ways in which technologies can augment the inherently complex processes is significant. As artificial intelligence (AI), generative AI, Large Language Models, and eventually the disruptive capabilities of quantum computing enter the flow of systems development, further evolutionary and revolutionary changes will be necessary (*DoD Digital Modernization Strategy*, 2019).

H. Smart City and Smart Regional Concepts: Around the world, the application of the concepts of Smart Cities and Smart Regions are growing rapidly. This can provide important insights into the various considerations for DoD Innovation Ecosystem design and architecture. Being "smart" is an amalgam of different components that are working together, taking quick actions and making efficient decisions. It implies the use of computing and associated technologies such as Internet of Things (IoT) instrumentation and sensors, algorithms and cloud computing to enable new insights and intelligence to improve operations and decision making. But it also reflects a new cultural norm and social way of life that by its nature is constantly improving and growing capabilities as an "organic whole." The major components of Smart Cities include Technology Factors, Institutional Factors and Human Factors. Technology includes both hardware and software with advanced computing, sensors and algorithms, virtual technologies, mobile technologies, and digital networks. Infrastructure includes governance and policy as well as regulations and directives that lead to smart communities and smart growth. The People component includes human factors such as knowledge and social capital, learning, creativity, diversity and education in this context (Nam & Pardo, n.d.; Yashar. n.d.).

I. Workforce Talent and Skills: With the rapidly accelerating emergence of new technologies and application toolsets, there are increased demands for personnel with the knowledge, skills and abilities to support weapon system acquisition across their life cycles. This is particularly true where subject matter experts in emerging technologies are required.

> *"One of the conclusions from studying the management of defense acquisition is that it requires specific technical knowledge and skills well beyond what many recent government managers, senior military officers, and assistant secretaries have acquired."* Defense Acquisition Reform 1960-2009 (Fox, n.d., p. 195)

The competition for talent continues to grow and challenge the ability of the DoD to support leading edge technology development activities at the pace and scale required. This demand signal comes from both national security and commercial industry and is only growing, necessitating aggressive strategies to attract, develop, retain and obtain the workforce needed to support next generation weapon system development and support.

> *"The first and absolutely necessary ingredient is knowledge. Technical innovation is itself, almost by definition, a new idea. But new ideas are rooted in knowledge that makes the new idea conceivable and practical…it is not possible to enable innovation unless one has a deep knowledge of the science and associated technology."*
>
> Frank Kendall,
>
> Innovation in the Defense Acquisition Enterprise (Kendall, 2015)

2. What are the barriers and constraints to accelerating innovation into enabling capabilities across the DIB?

A. Increasing System and Organizational Complexity: As DoD weapon systems become increasingly complex, the requirements to develop and deliver advanced capabilities become increasingly costly and time consuming. Commensurate with these developments, the

DIB is a highly complex organizational ecosystem with a broad range of actors, each working toward local, corporate, national and/or global goals and objectives. As a result, there are growing requirements for social networking and connectivity to "connect the dots" and to facilitate collaboration and learning to get to a requisite level of understanding for meaningful action. This combination of system and organizational complexity adds significant challenges for both leadership and management as well as Innovation Ecosystem design and architecture (Cross & Parker, 2004; Xu et al., 2017).

B. Lack of Awareness, Learning, Understanding and Actionable Knowledge: A prerequisite for accelerating innovation and its development to create new and enabling capabilities is to be aware of the range of opportunities and then to develop an understanding if and how that innovation can solve a critical need or requirement. Once that understanding occurs and is shared across the key stakeholders, the new knowledge becomes actionable. Once knowledge is actionable, a clear vision with strategies and plans can be developed to support and execute the developmental process. This can include prototyping, modeling, test and evaluation and ultimately an accreditation or certification of the innovation for warfighter application in the intended context. The importance of making knowledge available at critical junctures in the DoD Acquisition Process is highlighted in the GAO *Weapon Systems Annual Assessment* (2023) to support critical programmatic decision points.

C. Lack of Requisite Skills and Enabling Capabilities: To support the development and application of an enabling innovation, the knowledge, skills, abilities, and capabilities must be in place. Without adequate and sufficient knowledge and skills across the broad range of applicable actors, within developmental disciplines, the transition of enabling innovation will be substantially impeded as buy-in is often required. Salient capabilities must be in place in terms of infrastructure, tools and facilities that support the acceleration of enabling innovations. All capabilities and resources for innovation development, maturation, risk reduction, testing and evaluation must be available and ready to support the critical path for accelerated development to delivery (McNamera et al., 2023).

D. Lack of Creativity and Ingenuity: Enabling innovation requires the creativity and ingenuity of subject matter experts thinking in new and novel ways to develop new and novel solutions. The development and integration of these capabilities combines deep subject matter expertise and the ability to consider new and novel concepts, ideas and capabilities into larger scale architectures and designs. This often requires the ability to relate or associate new information with what is already known and to think in non-linear, creative, improvisational ways that challenge the status quo or existing paradigms (Feinstein, 2023; Koutstaal & Binks, 2015).

E. Bureaucracy – Lack of Streamlined & Accelerated Processes: Complex organizations, enterprises and ecosystems can often have confusing, duplicative, or uncertain roles and responsibilities which can hinder value stream process flows. Without requisite clarity of process flows, and associated roles and responsibilities, the development and delivery of innovation can become onerous and time-consuming. Streamlining processes via process mapping with associated data analytics is a first step to systematically accelerating innovation development and delivery. Once existing processes are well understood and practiced, process automation and reinvention can occur. Continuous process improvement can provide the foundations for re-imagining, re-engineering, ideation and ultimately the acceleration of innovation development to delivery (George et al., 2005; George Sr. et al., 2019).

F. Organizational Fragmentation: Organizations are typically hierarchical and decomposed into sub-organization elements to simplify their complexity. The interfaces between organizations can be poorly understood, while the motivations among various organizational elements may be misaligned. Organizations can be fragmented internally as well as between

organizations, within and across the enterprise or ecosystem. The establishment of social relationships and networks is critically important. These are built on trust and mutual respect so that actors and entities can seamlessly work together, leverage each other's capabilities, and align to produce commonly held outcomes. Geographic distance and organizational isolation are constraints that can hamper meaningful interactions and learning, potentially creating stovepipes versus a seamless value stream of productive activity where all entities can connect and align for a common purpose (Burt, 1992; Cross & Parker, 2004).

G. Organizational Rigidity: Organizational change has proven to be a very difficult challenge. Organizations often have entrenched cultures, i.e., norms, values, beliefs and artifacts, as well as inertia that can inhibit both the adoption and adaptation of new and enabling operations. Organizational change can be hampered by a lack of awareness and understanding regarding the need and essence of the change, the perception of risk and unclear expectations, and insufficient intrinsic and extrinsic motivations and incentives. Organizations tend to have momentum within an existing paradigm, which may require additional energy, time and resources to address the new needs and opportunities. In order to effectively compete, organizations must continually change and transform to position themselves and fit into the ever evolving and changing competitive landscape (Hess, 2020; Xu et al., 2017).

H. Lack of Innovation Adoption and Adaptation: The opportunity landscape for new and novel innovations continues to expand. Mastering the ability to adopt and adapt innovation opportunities for transition to DoD weapon systems is a critical and increasingly important component of ensuring superior warfighting capabilities. Accelerating this process necessarily must be considered the end-to-end acquisition life cycle to streamline process flows and the creation of value (*Data, Analytics, and Artificial Intelligence Adoption Strategy: Accelerating Decision Advantage*, 2023; McNamara et al., 2023).

I. Lack of Available Resources – People and Money: Not only are relevant knowledge, skills and abilities as well as capabilities required to develop and deliver meaningful innovations, but there must also be the absorptive capacity across the ecosystem to do so along the critical path for innovation delivery. All the requisite resources are required to establish the broad range of capabilities and capacities necessary to effectively streamline innovation development and transition in a timely manner (Hale & Lord, 2024).

J. Climate of Trust: Trust acts as the lubricant that enables social networks to be effective in sharing information through meaningful dialogue to align expectations and resources. Large enterprises and ecosystems need to purposefully develop the social capital necessary to rapidly adapt and build broad-based consensus and understanding that turns into meaningful action. Trust among actors may be hampered by different motivations, incentives and reward systems, so maintaining openness, transparency and fairness throughout enterprise and ecosystem-level operations becomes imperative (Cross & Parker, 2004).

3. How can the DoD's Adaptive Acquisition Life Cycle evolve and transform to accelerate and exploit innovation, and best sense, anticipate and adapt for the future from a strategic perspective of the DoD innovation ecosystem?

A. Expansive Contextual Awareness and Learning: Contextual awareness from the strategic to the operational and tactical levels is critical to informing DoD Innovation Ecosystem Operations. This is especially important regarding the need for awareness of rapidly emergent issues and opportunities that could be disruptive and fundamentally challenge existing paradigms. The exponential acceleration of advanced technologies is rapidly making existing systems obsolete and ineffective and is requiring continuous change, adoption and adaptation across a broad range of applications. It takes significant time for large-scale organizations or supply chains to develop, disseminate, deploy and institutionalize new ideas, concepts,

technologies and shift paradigms, often far longer than the rate at which new changes are emerging. As a result, Dr. Joseph Stiglitz suggests that the importance of developing and implementation technology and learning to do things better is a central focus for society's continuous development and adaptation (Stiglitz & Greenwald, 2014). He notes that the government has a responsibility to build and learning society and that "one of the most important aspects of learning is learning how to organize to manage collectivities of individuals" (p. 49). Learning is rooted in curiosity, inquiry and reflection processes as well as social dialogue and exchange. A leading with questions paradigm helps supports a meritocratic and open environment for increased workforce engagement, curiosity and the generation of new and novel ideas and supports and accelerates learning (Marquardt & Tiede, 2023). Crowdsourcing has been shown, as a form of democratization, to be a highly effective approach to catalyzing new ideas and accelerating learning, building consensus and alignment, and fostering change and transformation at scale (Abbate et al., 2021; Alam et al., 2019; Chesbrough et al., 2014; Chesbrough & Appleyard, 2007; Stadler et al., 2021; Whitehurst, 2015).

B. Master Data, Information and Knowledge Management: The establishment and performance improvements of Smart Cities and Regions as well as global industries highlights the importance of leveraging data, information and knowledge. The ability to sense, make sense and give meaning in complex environments is becoming increasingly commonplace. This phenomenon relies on a foundation of sensors, algorithms, compute capabilities, the cloud, and the human–machine interface and has formed the basis for the Internet of Things (IoT) concept. This paradigm relies on the social capital of human networks to share critical insights, foresights and perspectives to anticipate and develop forward leaning strategies and plans as well as support critical decision making (*Data, Analytics, and Artificial Intelligence Adoption Strategy: Accelerating Decision Advantage*, 2023; Davenport, n.d.; Hurwitz et al., 2015; Ichijo & Nonaka, 2007; Jucevicius & Grumadaite, 2014; Nam & Pardo, n.d.; Nonaka et al., 2008; Subramaniam, 2022; Von Krogh et al., 2000; Yashar, n.d.).

C. Support Mil-Specs/Standards and Commercial Specification Engagement for Innovation Adoption and Adaptation: DoD engagement in specifications and standards communities, both internal to DoD but also those across the government and commercial sectors, is essential to improving technological awareness and accelerating innovation development, adaptation, adoption and transition. These documents represent codified knowledge at the edge of accepted understanding across the broader community. New technologies must be characterized, quantified and qualified to be considered for safety-related engineering applications. Engineers need to know that they can rely on well-documented performance characteristics to meet stated and derived requirements and design criteria to inform analysis, develop prototypes and digital models, testing and evaluation to provide the basis for establishing confidence and reliability in procurement specifications, drawing callouts and work instructions, i.e., build-to packages for manufacturing, production, assembly and subcontracting. In some cases, emerging technologies can be adopted directly for DoD applications from commercial applications, specifications and standards, but often the unique warfighting requirements drive the requirement for adaptation of new technologies (Possehl, 2021; *Technical Standards, Invention, Innovation, and Economic Growth*, 2018).

D. Map & Streamline Processes and Organize around Process Flows – Create Trans-Enterprise Knowledge and Synergy: As complexity in both organizations and systems increase, greater confusion and obstacles to execution can emerge. Applying systems thinking and process improvement using visualization and data analytic techniques can clarify process flows and roles and responsibilities, as well as support continuous process improvement and automation initiatives. An increased understanding of process flows can help to inform organization design and reconfiguration efforts that further streamline value creation,

development and delivery processes. Improved understanding and analysis of end-to-end process flows can create substantial productivity improvements designed to increase speed, agility, and quality while reducing costs. This is particularly important as organizations, enterprises and ecosystems expand the scope of their supply, development, and delivery chains. Supply chains can become bottlenecks or impediments for expeditious innovation delivery, necessitating the ability to monitor and control processes at the ecosystem level. Value stream processes and innovation-based organizations, enterprises and ecosystems need to be purposefully designed for both continuous experimentation to accelerate learning and exploitation of existing innovations to sustain competitiveness. This dynamic, iterative, and integrative capability is the essence of the Ambidextrous Organization concept. Ambidextrous organizations work to strike the balance between focusing on the short and medium term with the longer-term investments in growth so that they are well positioned to change, adopt and adapt as needed. The interface between these two domains has been identified as the Adaptive Space where these critical interactions occur to promote and accelerate innovation development and delivery. An organization has an effective innovation ecosystem strategy when it has both explorative and exploitive activities, proactively aligns innovation efforts and knowledge flows, anticipates future requirements, and partners to secure a key role in the ecosystem (Arena, 2018; Fransman, 2018; George et al., 2005; Nonaka et al., 2008; Subramaniam, 2022; Visscher et al., 2021).

E. Build Social Capital via Mutual Trust and Respect: Innovation Ecosystems are composed of individuals, organizations and enterprises that often are extremely complex and difficult to lead and manage. They require an environment that is open and collaborative such that they can create opportunities for making new connections between individuals, teams, and organizations so that they can work together most effectively. Organizational isolates do not receive the advantages of interchange with knowledge sources that more collaborative organizations obtain. Sharing both tacit knowledge gained through experience as well as explicit knowledge that has been codified is essential to maximize the value that new knowledge and learning can offer. The Nonaka-Tajeuchi Socialization, Externalization, Combination and Internalization (SECI) model is based on leveraging critical opportunities to learn and improve. The SECI model scales from the individual level to the group and to higher organizational levels, transforming and sharing salient tacit knowledge so that it can become codified explicit knowledge that improves understanding and the overall corpus of knowledge the organization has to leverage. Continuously creating, updating and combining new knowledge through social interactions with timely documentation and associated learning/training activities helps to provide the latest knowledge and insights that helps to build alignment and inspire a culture of continuous improvement. Outside of organizations are rich sources of knowledge that few organizations think about how to manage to create value beyond an immediate and specific piece of knowledge or information. Social Network Analysis (SNA) can be used as a powerful tool to assess these internal and external social networks, the levels of social capital that exist, and to find gaps or holes in network structures and pathways (Ichijo & Nonaka, 2007; Nonaka & Takeuchi, 2019; Nonaka et al., 2008; Von Krogh et al., 2000).

F. Create Opportunities at Scale to Connect, Learn and Share: Creating opportunities for social exchange and knowledge sharing across the broader innovation ecosystem will increase knowledge awareness, understanding and social capital, leading to a more knowledgeable and stronger leadership-at-all-levels mindset, attitude and orientation. Forums for exchange and dialogue that span multiple enterprise domains can create the "collisions" that spark new ideas and concepts. As Clay Christensen has suggested, "Breakthrough innovation rarely occurs within a technical discipline, or within a market, but almost always where you create a novel intersection." Participation by actors in both focused and general events of interest provide important learning opportunities to expand knowledge

networks, confidence in leading, and coalitions with a common understanding. Expanding knowledge networks can improve the scale and scope of collaboration and accelerate learning, innovation, change and requisite transformation at scale. Connecting individuals within and across organizations, especially at the enterprise and broader innovation ecosystem level, can create new opportunities and ways of doing business, new ideas and concepts for product development, and help to accelerate the development and delivery of innovation products and services by unleashing the latent potential within the ecosystem overall (Cross & Parker, 2004; George et al., 2005; Yeung & Ulrich, 2019).

G. Embrace Continuous Change and Transformation: Leading continuous change and transformation requires the creation of a climate and environment that offers the opportunity for open-minded exchange and dialogue, collaboration, synergy and learning at scale at the pace necessary to remain competitive. Organizations need help making sense of their context and complexity to accelerate their learning as well as their developmental cycles. A key role for leadership is the giving of sense and putting contextual situations and opportunities in perspective so that they have meaning. Developing the best questions in an open and trusting environment with safety-of-voice helps to trigger new thoughts and ideas, spawn meaningful dialogue and exchange, catalyze imagination and ingenuity, and foster change and transformation at a rate commensurate with the rate of learning, understanding and leadership confidence and support. Creating these conditions, when consistently applied over time, can evolve to become an accepted cultural norm with expectations that motivate and unleash new possibilities as well as create visions for the future that otherwise could not have been imagined (Boulton et al., 2015; Goldstein et al., 2010; Hess, 2020; Koutstaal & Binks, 2015; Marquardt & Tiede, 2023; Reeves & Read, 2009).

H. Innovative Culture and Ecology: A culture and ecology for innovation is now becoming a prerequisite for sustaining competitiveness. Culture is viewed as the norms, values, beliefs and artifacts that embody the nature of the organization. The ecology reflects the mindsets and attitudes intrinsic to organizational operations, as value is created and flows across the interfaces of organizational entities. Cultural change is a top leadership challenge and needs to occur at the frequency and pace of the contextual changes in the external as well as internal environment. Change occurs when there is a strong and rational motivation, aligned incentives and rewards, clear expectations and communications, constancy of purpose and intent, and visibility of progress and alignment toward a common future vision. An innovation ecology depends on talent, firms involved, institutions, and capital, but more so on the identities, meaning, networking, capabilities, a culture of trust and pragmatic cooperation balancing on the edge of chaos where creativity and innovativeness are at the highest level (Davenport, n.d.; Fransman, 2018; Granstrand & Holgersson, 2019; Iansiti & Levien, 2004; Jucevicius & Grumadaite, 2014; Schein, 2016).

I. Technology-Enabled: Technology development continues to accelerate and disrupt institutions and shift paradigms of thought, operations, and the nature of deliverables as well as impact business models and strategies. Embracing new technologies to stay relevant in the highly competitive landscape is an imperative that mandates continuous adoption and adaptation of new technologies. New technologies are required to maintain relative agility and flexibility and require continuous learning, investment and assimilation into ecosystem-level operations. Technology refresh, while acknowledging the costs of technical debt, is a strategic focus area that requires continual attention and focus (Board, 2023; Council, 2022; Defense, 2023; Jones et al., 2021; Nam & Pardo, n.d.; *Science & Technology Trends 2020-2040: Exploring the S&T Edge*, 2020; Suleyman, 2023; Tapscott & Tapscott, 2016; Taylor, 2016).

J. Open Innovation and Open Strategy Development: The use of open innovation and strategy development collaborative forums, to include crowdsourcing within the innovation

enterprise, can accelerate the innovation processes, improve ideation, and promote the development of innovative strategies that promote the emergence of new ideas and competitive strategies. Using an open innovation and strategy approach can change the innovation ecology from ego-systems to an open innovation ecosystem. An ego-system refers to a traditional, rivalrous context in which firms adopt closed innovation strategies with strict control over resources and strong intellectual property rights. An open innovation ecosystem provides a participative and trusting collaborative and integrative context by sharing knowledge resources across organizational boundaries. The transition from an ego-system to an open innovation ecosystem relies on an ecosystem-wide realization of the need to engage and participate, to build cross-organizational and enterprise social ties, alignment toward common goals, and the establishment of multi-way openness built on trust and reciprocity. The democratization of ideas fosters engagement and learning and supports critical change and transformation efforts needed at large scale. Platform technologies issuing important challenges and inquiries have demonstrated significant utility across innovation ecosystems. They help to build consensus and lead to the formation of critical coalitions around innovative ideas and concepts as well as strategic thinking. These open approaches promote a highly democratic and meritocratic climate where the best ideas are surfaced, considered, challenged, refined and ultimately offered for consideration by decision makers (Alam et al., 2019; Chesbrough et al., 2014; Chesbrough & Appleyard, 2007; Jensen & Largent, 2018; Stadler et al., 2021; Whitehurst, 2015).

4. How can the DoD be best organized, structured, and led to operate most affordably and meet the emergent and disruptive needs and requirements of the future?

A network-based approach to understanding, organizing, managing, and leading this complex ecosystem, well-aligned to the DoD Adaptive Acquisition Framework and synergized through appropriate engagement in the DoD 5000.02 Acquisition Process, can further unleash latent ecosystem potential. This is deemed possible through expansive new knowledge creation, sharing and accelerated innovation transition into DoD Acquisition Programs of Record. Applying network analysis techniques with big data analytics and artificial intelligence can uncover important patterns and opportunities for improvement at large scale, making new and novel connections and building robust relationships for collaboration and synergy.

A. Emulate the Concepts and Theory that Support Complex Adaptive and Anticipatory Systems (CAAS) Thinking: CAAS are designed to reflect a strong sensitivity to contextual and environment changes with the intrinsic ability to rapidly adapt to sensory inputs while anticipating the implications of future trends, disruptions and scenarios. Leveraging Cyber-Cognitive capabilities, innovation ecosystems can combine and synergize advanced compute with human cognitive and open collaborative capabilities to create broad situational awareness, make sense and give information meaning in context, and filter and prioritize salient information to enable rapid decision making and organizational adaptation. This empowers a leadership-at-all-levels orientation and enables actions through trusting relationships that can respond at the required rate and scale to remain competitive (Boulton et al., 2015; De Jong, n.d.; Gharajedaghi, 2006; Goldstein et al., 2010; Obolensky, 2014; Tovstiga, 2013; Yarger, 2008).

> "Leaders who try to impose order in a complex context will fail, but those who set the stage, step back a bit, allow patterns to emerge, and determine which ones are desirable will succeed."
>
> David Snowden and Mary Boone,
>
> "A Leader's Framework for Decision Making" (Snowden & Boone, 2007)

B. Map, Integrate & Automate the End-to-End Value Stream: It is critical to understand the roles and relationships of various organizations and enterprises in creating and delivering value. The value stream is the flow of value creation across the continuum of

processes necessary to develop and deliver products and services. Identifying specific process steps and identifying those responsible for these steps is an important first step. This helps to clarify the roles and responsibilities, interdependencies, and the deliverables at each step, as well as the interfaces between process steps. As value stream inputs, processes, and outputs become better understood, process data can be gathered and analyzed. This can help to understand the barriers and impediments to the process flows so that they can be addressed. Gathering available data as well as instrumenting processes to gain a better understanding of the underlying performance can provide important insights for improvement. Typical process measures include metrics that address quality, speed and cost as well as performance to assess capabilities and capacities inherent in the value stream. Particular attention should be paid to the interfaces or hand-offs between processes to ensure that the needs of the upstream participants are being met and necessarily avoiding the "Valleys of Death." Envisioning an improved future state can help provide thoughts and ideas for further improvement. Technology is playing an increasingly important role as organizations automate and streamline processes through the augmentation and automation of tasks and workflow reinvention (Abbate et al., 2021; Defense, 2023; George et al., 2005; George Sr. et al., 2019; Yeung & Ulrich, 2019).

C. Educate, Form and Align Enterprises to Engage in the End-to-End Value Stream: Once the value streams are clearly identified and understood, participants need to be aligned to determine where they can add value. Once aligned, the enterprise at large can be engaged and enabled to provide value-added inputs, processes can be executed, and innovative products and services can be efficiently and effectively delivered. Leveraging the power of each organization in an enterprise and the combination of enterprises across the value stream to optimize engagement enables learning, innovation and value-added contributions at scale. This strategy ensures that the best ideas and thinking are made available at each step of the value stream across the diversity of the DIB (Haeckel, 2016; Moreira, 2017; Ross et al., 2006; Slama et al., 2016; *The U.S. Defense Industrial Base: Background and Issues for Congress*, 2023).

D. Build Synergistic Intra- and Inter-Enterprise Communities: Leaders can build alignment and synergy through developing, designing and deploying intentional interventions to drive connectivity, set clear expectations for ecosystem-level performance, and establish the metrics to measure progress toward goals and plans. Overcoming organizational inertia and cultural barriers as well as misaligned incentives can be major challenges to be considered. Building social relationships and capital through meaningful in-person and virtual interactions can promote the requisite conditions which maximize the performance of the innovation ecosystem and support the emergence of an inclusive overall innovation ecology (Burt, 1992; Cross & Parker, 2004; Jucevicius & Grumadaite, 2014; Moore et al., 2022; Pentland, 2014; Stiglitz & Greenwald, 2014).

E. Embrace Smart Ecosystem Concepts and Technologies: Smart Cities and Regions have now demonstrated the utility of large-scale digitization and virtualization using the Internet of Things (IoT) concept. IoT includes Advanced Compute and Cloud Computing and Big Data Analytics to enhance the understanding of highly complex and dynamic systems. Artificial Intelligence offers great potential to identify patterns in these hyper-complex systems. These applications are analogous to innovation ecosystems and are facilitated by multi/hybrid-cloud solutions offering the best available platform capabilities. The advent of Generative AI as well as Large Language Models, Quantum Computing and virtualization in the form of Augmented Reality, Mixed Reality and Virtual Reality can further support these concepts in the generation and analysis of data (Gershenfeld et al., 2017; Jucevicius & Grumadaite, 2014; Nam & Pardo, n.d.; Scoble & Israel, 2017; Yashar, n.d.).

F. Embrace Large Scale, Fully Integrated, High Fidelity Virtual Environments: Modeling and simulation representative of real-world entities and conditions offer important possibilities for rapid iterative system development and test that can accelerate learning and the overall design and development processes. Model-based Systems Engineering supporting Digital Threads with Open Architectures and comprised of Digital Twins provides a virtual testbed to streamline complex systems development and test. The DoD Joint Simulation Environment (JSE) provides an exemplary case for digitization and virtualization and is a premonition of future research, development, test and evaluation paradigms, methodologies, and strategies. Adding big data analytics and AI capabilities to these digital and virtual environments along with a desire for program data to be housed and stored in a trans-enterprise, secure multi/hybrid-cloud provides unique and enabling opportunities to develop 'sentient' capabilities across the entire DoD Innovation Ecosystem (Abbate et al., 2021; *DoD Digital Modernization Strategy*, 2019; Gershenfeld et al., 2017; Rogers, 2016; Siebel, 2019; Smith, 2018; Subramaniam, 2022; Wilson & Tyson, 2023).

G. Enhance Enterprise-level/Ecosystem-level Orchestration, Management and Leadership: To lead and orchestrate across the DoD Innovation Ecosystem, a comprehensive systems and strategic approach is required to continuously improve and develop operational capabilities. In hyper-complex organizational systems, fragmentation and disconnects can result that impede synergy and continuous improvement. Understanding how each organization or actor contributes to, and interfaces with, the larger scale value stream processes and programs is critical to accelerating innovation. Communication networks and interactive exchanges help to build awareness and understanding, while open collaborative platforms provide a venue for highly synergistic operations at the ecosystem level. Ecosystems have been described in terms of their scales, the activity at those scales, and the organizational knowledge required starting at the individual level up to small groups that evolve into micro-enterprises that then collaborate to create federations that catalyze activities across the ecosystem. Commensurate with those scales is a focus on individual development to get to mastery of value creation processes that then evolve to multi-scale capabilities for interdependent innovation development toward shared visions of the future, co-investments, and ultimately, the requisite wisdom and expertise in all scales across the ecosystem. A major trend that has been identified is the continued augmentation and expansion of individual human potential through digitization, combinatorial effects, awareness and knowledge expansion providing the foundations for human value maximization (Abbate et al., 2021; Alam et al., 2019; Fransman, 2018; Goldstein et al., 2010; Granstrand & Holgersson, 2019; Iansiti & Levien, 2004; Jucevicius & Grumadaite, 2014; Moore, 1996; Moore et al., 2022; Obolensky, 2014; Oh et al., 2016; Subramaniam, 2022; Visscher et al., 2021; Wilson & Tyson, 2023)**.**

H. Enhance Systems Thinking: Systems thinking is at the heart of learning organizations, and it supports an awareness and understanding of how all the individual elements work together to produce value. With this understanding, an inherent capability for continuous improvement is increasingly likely as ideas and new concepts emerge through dialogue across ecosystem elements. Improvements in one organization can more easily be transferred and replicated to others. The importance of systems thinking coupled with technical knowledge remains critical to identifying and mitigating program risks to cost, schedule and performance. The GAO has reported that more than half of the MDAPs that they have reviewed that have yet to deliver capabilities reported schedule slips over the past year and that these delays were often the result of technical and engineering challenges identified late in the program. Earlier attainment of knowledge has been found to improve program decision making and reduce cost and schedule growth. Systems thinking can provide the basis to better understand interdependencies and relationships within complex systems and organizations

(Chaminade et al., 2018; Gharajedaghi, 2006; Johnson et al., 2023; *Weapon Systems Annual Assessment*, 2023).

I. Enhance Strategic & Anticipatory Thinking: As the strategic context becomes increasingly uncertain and potentially disruptive, there is an ever-increasing need to maintain astute contextual awareness, agility and responsiveness. The timelines required for the development, adoption, adaptation, and deployment of new and emerging capabilities continues to accelerate. As a result, the ability to step back, look at the bigger picture, and connect the past to the present with an eye toward the future becomes increasingly important. It becomes necessary to continuously challenge assumptions, paradigms and enable and empower organizations, enterprises and ecosystems to effectively respond in a timely and collective manner. Anticipating the broad range of potential future scenarios, to deliberate and decide on a desired vision for the future, and to establish a long-range vision and critical strategies and plans are essential to ensuring sustained competitiveness. Today, the implications of critical and emerging technologies and the convergence of multiple technologies into new capabilities pose an increasingly difficult challenge to sustaining operational relevance and maintaining deterrence (Boulton et al., 2015; De Jong, n.d.; *DoD Digitial Modernization Strategy: DoD Information Resource Management Strategic Plan FY 19-23*, 2019; Huff & Jenkins, 2002; *Investment Strategy for the Office of Strategic Capital*, 2024; Tovstiga, 2013; DoD, 2024; *Weapon Systems Annual Assessment*, 2023; Yarger, 2008).

K. Create Agile and Adaptive Innovation Capabilities at the Speed of Relevance: To ensure sustained competitiveness, the DoD Innovation Ecosystem must adopt a mindset and attitude for continuous change and transformation. This is enabled by continuous improvement in processes, policies and practices that embrace the paradoxical combination of competition and collaboration across the life cycle of weapon system development. Competition is critical to motivate and promote new and novel opportunities, while collaboration is necessary when combinations of actors can offer better solutions that an individual. Economists have used the term ‘creative destruction’ as the key to maintaining economic competitiveness. Creative destruction embraces the process of creating the new and novel for products and services relevant to markets, adopting the new and novel as a new offering or paradigm, and shedding the old faster than the competition. Evaluating potential business models that consider alternate acquisition strategies that support continuous change and transformation of capabilities, most affordably and effectively, can provide these same types of continuously creative and adaptive outcomes (Aghion et al., 2021; Arena, 2018; Feinstein, 2023; Foster & Kaplan, 2001; Haeckel, 2016; Holbecher, 2015; Moreira, 2017).

L. Enable Generativity and Creativity: Creating open-minded meritocratic environments that enable safety of voice and freedom of thought, with the time to think about critical needs and applications, can improve learning, ideation and creativity to support and spark innovation. New research discoveries and inventions can lead to the generation of new ideas and innovations that can provide both enabling and disruptive outcomes. Developing workforce mastery in existing and emerging technology fields and providing the time, place, space and support to think independently are essential components to accelerate the development and deployment of innovations for application (Feinstein, 2023; Goldstein et al., 2010; Koutstaal & Binks, 2015; McNamera et al., 2023; Nonaka & Takeuchi, 2019; Policy, 2015; Taylor, 2016; Von Krogh et al., 2000).

M. Align and Clarify Expectations, Incentives and Motivations: Across organizations and enterprises, there must be clear and unambiguous end-state goals, fashioned under realistic conditions that reflect the more holistic innovation ecosystem and value stream needs and expectations for excellence. Aligning expectations with incentives and leadership support creates the intrinsic and extrinsic motivations that can drive exemplary organizational

performance. Leaders can articulate the importance and interdependence of each actor and element with their relationship to the value creation process across the organization, enterprise and ecosystem-levels to deliver on the desired end state vision, goals and outcomes. Leaders can effectively catalyze intrinsic motivation by identifying an enabling and empowering vision, providing the autonomy and opportunities to develop requisite mastery to pursue that vision and to support and promote their pursuit of the end state vision, goals and outcomes (Pink, 2011; Thomas, 2009; Visscher et al., 2021).

Discussion

"Things should be made as simple as possible, but not simpler."

Albert Einstein

To meet the DoD future needs, a degree of re-imagination is necessary to capture salient insights and foresights and to assimilate and synthesize the requisite changes to take DoD Innovation Ecosystem-level performance to the next level. A holistic DoD Innovation Ecosystem re-conceptualization can help to coalesce key concepts and ideas and to support the design and architectural changes that are needed. This reconceptualization has three major components that are inter-related and must be integrated to achieve the full intrinsic potential – the structural, the cultural, and the technological. These are the three pillars that embody a conceptualized Next Generation DoD Innovation Ecosystem.

"We seek an agile strategic approach that guides decentralized action across DoD, inspires campaigns of learning, and leverages all our people, processes, and enabling technologies."

Kathleen Hicks
Deputy Secretary of Defense

(*Data, Analytics, and Artificial Intelligence Adoption Strategy: Accelerating Decision Advantage*, 2023)

The Sentient & Wise DoD Acquisition Innovation Ecosystem – A Cyber-Cognitive Ecology for Continuous Sensing, Awareness, Understanding, Innovation, Transition, Improvement and Transformation

Conceptualizing and architecting the Next Generation of the DoD Acquisition Innovation Ecosystem requires the ability to scan, aggregate, assess, filter, synthesize and integrate disparate yet highly applicable fields of interest. Envisioning how the DoD Innovation Ecosystem, an extraordinarily complex concept, will and should evolve and emerge to ensure our national security is a paramount concern. Applying concepts, ideas and technologies that are continually identified and evolved provides a basis to take overall ecosystem-level performance to the next level. Today's complexity and tomorrow's chaos require both a level of abstraction to gain simplicity and a conceptual understanding, as well as an extrapolation to anticipate what the future may offer. Figure 2 provides a conceptualized view across the acquisition life cycle organized around the formation of enabling enterprises which engage as orchestrated collectives across organizational boundaries in the value creation process of the acquisition life cycle. These enterprises leverage emergent and enabling technologies to maximize value contributions across disparate organizational elements with the cultural elements and growth mindsets to maximize contributions where and whenever possible. Sentience and wisdom are two major pillars of a north star vision to achieve. Sentience, the ability to sense or feel, and to be acutely aware of the environment leveraging cyber-based systems along with human cognition to enable a human/machine consciousness to emerge from local and distant interactions. A sentient enterprise has been conceptualized to include an agile data platform, a behavioral data platform, a collaborative ideation platform, an analytical application platform, and an autonomous decisioning platform, while its agility depends on the

optimization of people processes and technology all convening around data. It is also considered to be proactive, frictionless, autonomous, scalable, and evolving and emergent in nature. Wisdom, on the other hand, represents the highest level of cognition and results from expansive and deep learning and experiences which provide unique and valuable perspectives and context that guide collective actions and behaviors. Phronesis, the concept of practical and altruistic wisdom, rooted in the interactions between theory, practice, sound reasoning and judgment, is particularly applicable to DoD Acquisition, national security, and its implications (Massingham, n.d.; Nonaka & Takeuchi, 2019; Ratzesberger et al., n.d.).

Creating an innovation ecology, buoyed by highly interactive social fields, requires continuous sensing and monitoring of the environment. It promotes learning, entrepreneurship and innovation, new technology transition, and continuous improvement and transformation. The convergence of applicable technologies, methodologies, concepts, and capabilities highlights the broad range of opportunities that can be integrated into a future state design, architecture and operations. This offers a template for a next generation DoD Acquisition Innovation Model for value-added deliberations and consideration. Of significance are the highly dynamic and expansive network of continuously evolving and emerging set of integrated digital capabilities that, as an innovation ecosystem, can seamlessly connect and synergize enterprise-level activities to provide substantial competitive advantage. A proposed attribute of this conceptual model is the aggregation and assimilation of essentially all DoD Acquisition-related program data anchored onto the value stream into a common, cloud-based architecture that can be analyzed, assessed, distributed, shared, reused and enabled at scale in real-time via platform technologies. This is designed to improve ecosystem-level and program-level responsiveness and timely outcomes, providing ready access to current knowledge and information while identifying important patterns and relationships that can provide critical insights and perspectives. Digitization and virtualization, using high fidelity system and organizational-level models linked across the continuum of the DoD Acquisition Lifecycle, provide the basis for programmatic synergies and new capabilities that are trans-programmatic. Housed in a multi-level, zero-trust secure enclave, these digital and virtual assets create what can be considered the DoD Mega-Verse (Fligstein & McAdam, 2012).

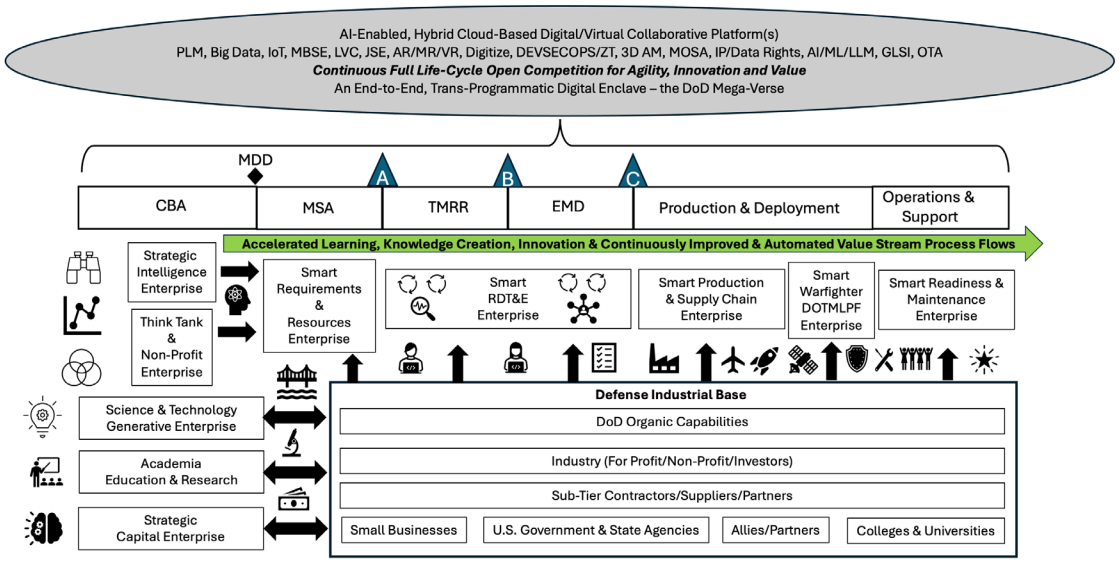

Figure 2. The Sentient & Wise DoD Acquisition Innovation Ecosystem – A Cyber-Cognitive Ecology for Continuous Sensing, Awareness, Understanding, Innovation, Transition, Improvement and Transformation

However, these efforts are just a starting place and insufficient to recognize and address the levels of agility, adaptiveness and anticipation required to compete in the future. The exponential acceleration of technology requires an extraordinarily rapid level of integration and synergy between humans and machines. Advancements have been demonstrated in Smart Cities and Regions around the world where sensors, data, algorithms and computing provide new and enabling insights and foresights to improve operations and efficiencies. These technologies enable new knowledge to be created, shared, assimilated, and institutionalized at ever-faster rates, fueling advances across the DoD acquisition life cycle at unprecedented levels, pace and scale. A key to achieving these outcomes is a new paradigm to effectively harness the power of advances in technology with streamlined and digitally enabled processes and an emphasis on mastery of human and organizational leadership, development, change and transformation.

Across the DoD Mega-Verse, reducing complexity and creating alignment and structure that allow maximum collaboration and innovation, coupled with streamlined and agile processes, and designed for continuous change and transformation is essential. By organizing the DoD Mega-Verse into distinct and highly networked collaborative enterprises operating within and across multiple portfolios, each enterprise plays a distinct and critical role in supporting the Adaptive Acquisition value stream. Enterprises are selected to maximize internal collaboration and synergy as well as provide unique and leading-edge inputs to enhance the DoD Innovation Ecosystem's ability to develop and deliver superior capabilities at scale. The innovation ecology, by design, supports a mission-driven entrepreneurial spirit with continuous and overarching emphasis on ecosystem-wide improvement. This includes the coalescence, convergence, synthesis, and deployment of best practices and creates campaigns of learning that support innovation, knowledge, policies, processes and systems improvement.

Capabilities-Based Assessments require the collective intelligence of the Strategic Intelligence Enterprise (SIE) to evaluate global conditions and threats, the strategic thinking associated with Think Tanks and Non-Profits, the Science and Technology Enterprise creating and generating the new discoveries and inventions, and the longer-range Academic Research and Education Enterprise that helps to create and proliferate new knowledge and understandings.

During Material Solution Analysis, a Smart Requirements and Resources Enterprise (SR&RE) integrates insights and perspectives from across the DIB and operational warfighter community in support of JCIDS processes and develops and releases draft Capabilities Development Documents (CDD). The SR&RE senses, aggregates, consolidates, curates and assesses the Analysis of Alternatives (AoA) for PORs using mission engineering and kill chains as an ongoing and iterative analytical process, which drives generational waves of capability development, shifting paradigms at pace, linking relevant enterprises in a continuously evolving and emerging cognitive environment, building deep understanding and consensus for the ongoing PPBE process, and supporting the planning and allocation of available resources and requirements. The importance of taking a holistic view during the AoA process is highlighted by the DoD Assessment of Analysis of Alternative Studies in the Department of Defense as Compared to Best Practices to include ensuring that adequate AoA team resources are provided, including funding, time and personnel, and that the DOTMLPF analysis is conducted prior to the AoA. The rigor, discipline, and foundations that the SR&RE provides in their draft CDD must consider the view of the future, opportunities as well as threats, and the complex dynamics and agility associated with the E-VUCA strategic environment to balance TMRR POR technical, cost and schedule risk (Army, 2021; Joseph, 2021).

The TMRR and EMD Phases require a Smart RDT&E Enterprise that operates as an open innovation and developmental environment leveraging available modular open systems

architecture (MOSA), platform and analytical technologies including high fidelity modeling and simulation, iterative virtual and physical prototyping, testing, and experimentation to accelerate learning, improve understandings, reduce risks and mature technologies, and refine concepts and technologies for follow-on development. During these phases, learning is maximized in a CAAS environment with engaged interactions across the DIB to support critical decisions that drive the trajectory of programs. This is where social networks built on competence, relationships and trust are critically important. To reduce operational complexity, processes should be clearly defined across the value stream with a clear articulation of expectations, roles and responsibilities as well as measures for continuous improvement. The ability to create streamlined processes with an open and collaborative innovation environment, where competition for value and innovation is essential.

The TMRR and EMD Phases represent the core activities where value is translated from science and technology to engineered and tested capabilities. This complex process is, by design, organized to replace old paradigms with a new, more competitive one in the current and future context within which it will be deployed. Acquisition strategies should consider how to maximize both the collaborative and competitive capabilities across the DIB to yield a continuum of affordable and effective improvements across the entire life cycle. Emphasis should be placed on embracing test and evaluation to support continuous learning and innovation. Test and Evaluation is enabled by robust live, virtual and constructive testing environments, a model-based environment, and a digital workforce to support a more iterative design and testing approach representative of real-word conditions and operations. Consideration should be given to new, novel and proven business models including the use of Government as the Lead Systems Integrator and the use of flexible and rapid contracting such as Other Transaction Agreements to best leverage available and the most affordable capabilities across the full acquisition life cycle.

The Production and Deployment Phase in this model are supported by a Smart Production and Supply Chain Enterprise, which operates across the entirety of the DIB as well as with the Smart Warfighter DOTMLPF Enterprise to ensure that the Doctrine, Organization, Training, Materiel, Leadership and Education, and Facilities are in place to support acquisition system adoption in the warfighting environment. The Smart Production and Supply Chain Enterprise is designed to embrace next generation industry technologies, including artificial intelligence, digitization, the Industrial Internet of Things (IioT) and Industry 5.0 technologies, including digital twin virtualization of production processes and facilities to continuously monitor and improve productivity and agility. Smart Factory concepts and capabilities connected and applied across the Smart Supply Chain can provide the next generation of integrated capabilities required to meet future DIB challenges. Automating and streamlining the end-to-end acquisition life cycle of processes across the DIB is essential to optimizing innovation and technology transition at the speed for relevance. The Smart Warfighter DOTMLPF Enterprise provides the operational foundation for adopting and adapting new capabilities as they are delivered, while providing feedback loops back to the DIB where and when needed to take full advantage. This is the final capability handoff to the user community to take advantage of the new and emerging capabilities. Significant change leadership will be required to seamlessly transition these new innovative systems and technologies into advanced operational capabilities. Enabling ingenuity and improvisation on the front lines can provide valuable feedback that can be used for future systems development and delivery.

The Operations and Support Phase is supported by the Smart Readiness and Maintenance Enterprise to minimize maintenance and sustainment costs while maximizing system readiness. Using Smart technologies including digital twins, sensors, algorithms, and compute capabilities can support real-time maintenance and predictive planning to minimize

system downtime. Extensive data analytics are required to understand real-world performance and reliability that impact planned and unplanned maintenance actions. This data analysis is essential to provide feedback to system designers and acquisition planners to ensure that new knowledge is captured, codified, curated, assimilated and institutionalized as new Ecosystem-level understandings and considerations.

The operations within and across each enterprise of the Acquisition Lifecycle must be considered as an organic system that is continuously optimized through sensing and data analytics, process management, workforce development, social capital, leadership development and continuous and ongoing cultural evolution. Trans-Enterprise communication and collaboration, connecting actors across the continuum and fostering dialogue and exchange, are critical to improving and streamlining processes, building collective awareness and common understandings, aligning expectations, and optimizing the flow of data, information and knowledge as an integral part of a culture driven to consciously work together and improve warfighter outcomes.

Figure 3 provides a mental model for DoD Next Generation operations via ubiquitous and seamless interactions, built on social relationships and enabled by permeable organizational boundaries. These interactions across disparate activities start to build a clearer understanding of the end-to-end processes, the needs and requirements, the new and novel opportunities, and technologies, and help to promote creative and innovative thought as a cultural norm. To succeed in the future, the DoD Innovation Ecosystem must be world-leading in new knowledge creation, ideation, generative innovation, conceptual thinking, and continuous learning and process improvement.

"*The Department's agile approach to adoption ensures a tight feedback loop between technology developers and users through a continuous cycle of iteration, innovation, and improvement of solutions that enable decision advantage.*"

DoD Data. Analytics, and Artificial Intelligence Strategy

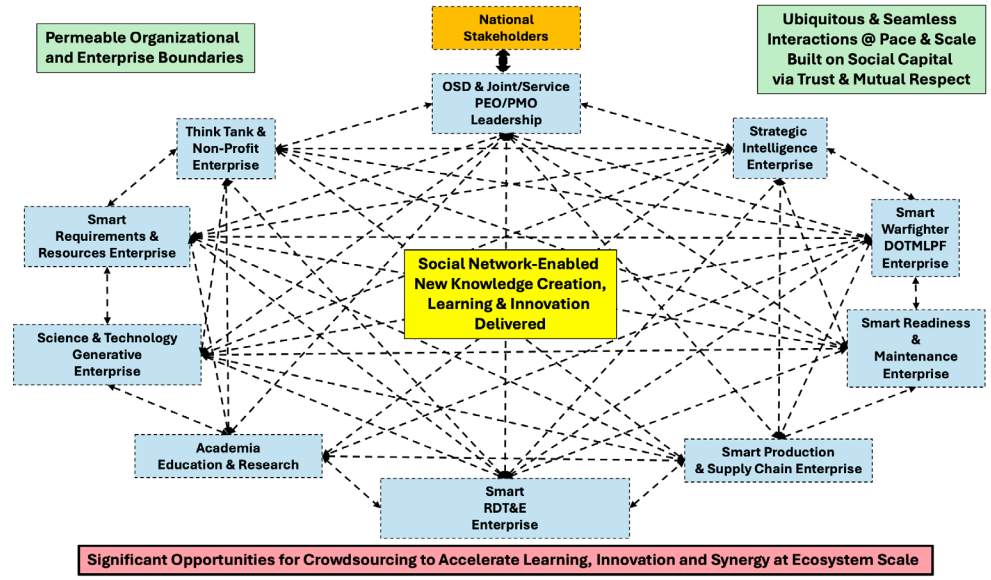

Figure 3. The Sentient & Wise DoD Acquisition Innovation Ecosystem via Emergent Social Networks: A Cyber-Cognitive Ecology for Continuous Sensing, Awareness, Learning, Innovation, Transition, Improvement and Transformation

Complex Adaptive and Anticipatory Ecosystem Model (CAAS)

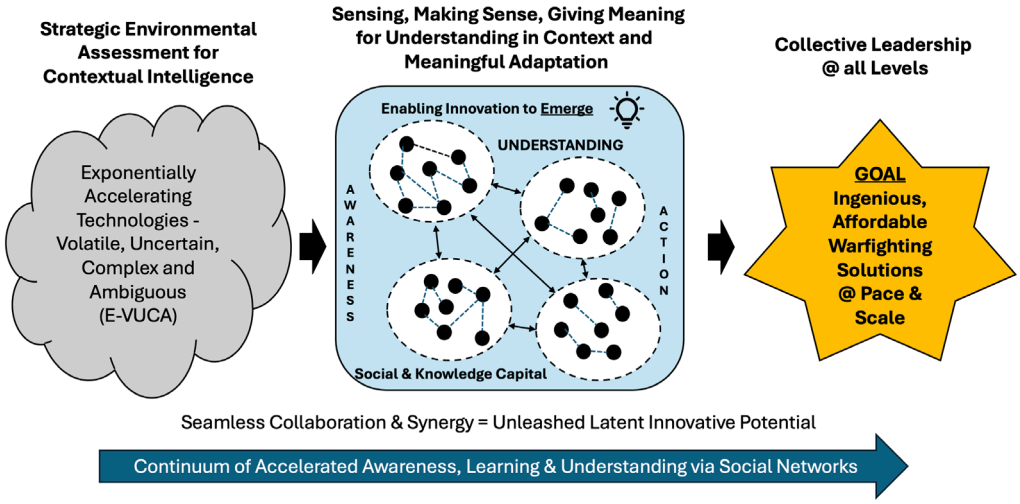

Figure 4. Complex Adaptive and Anticipatory Ecosystems Model

The CAAS Ecosystem Model, as shown in Figure 4, is designed to continuously sense the strategic and operational environment and provide the contextual awareness necessary for organizations to become aware, understand, and respond to emergent information at the pace and scale necessary to ensure competitiveness. Networks of actors, often grouped by organizational elements, are responsible to maintain awareness of their environment and interact across their social networks so that they can adapt to these sensory inputs. As dialogue and exchange occur, learning and understanding evolve, and a determination is made regarding how the system will respond and act. To achieve CAAS behavior, social networks create interactions across porous organizational boundaries in a seamless manner. Within the CAAS construct, leadership is acknowledged and recognized at all levels irrespective of position, but rather is dependent on value-added contributions. This creates the conditions that promote the type of open and meritocratic environment that is necessary for meaningful collaboration, ideation and the emergence of timely responses. These engaging and inclusive environments are specifically designed and deployed to unleash latent human potential, synergy, and ingenuity and accelerate action-oriented learning and collaboration while building both social and knowledge capital. CAAS provide a strong anticipatory element to recognize the high rates of change in the strategic environment and the time required for planning to make necessary changes. Actors within the CAAS are focused on mastery of their cognitive skills and capabilities, including their ability to learn and think in agile and adaptive ways, and at the rates and levels of complexity needed to maintain competitiveness. CAAS actors are empowered to self-organize and to promote emergent behaviors in an open and trusting environment. CAAS are internetworked in a boundaryless manner to maximize access to external insights and foresights and promote ubiquitous knowledge creation and sharing. CAAS are also highly dynamic, fluid and ever-evolving agile organizations. They are constantly adapting by design, shifting their operations and paradigms, continuously experimenting with new and novel concepts and ideas while simultaneously exploiting competitive advantages. CAAS embrace and seek mastery for leading continuous adaptation, change and transformation to keep pace with their strategic context.

Catalyzing New Knowledge Creation, Learning & Innovative Capabilities

To maintain competitiveness, organizations must continually create, disseminate, and institutionalize new knowledge and innovative capabilities. As shown in Figure 5, these generative and distributive capabilities are rooted in organizational learning and innovating to address key challenges and opportunities while generating key questions, new ideas and concepts. Organizations can streamline these processes by integrating critical value streams spanning research, development, test and evaluation, and ongoing experimentation in the intended environment with feedback loops that foster learning. New learning informs the development of new theory and understanding, which can provide competitive advantage. New theory and understanding take a two-pronged path to benefit the organization as well as the systems which are being developed. The first path is the necessary codification of the new theory and understanding so that it can be most easily distributed, applied, and reused. The second path informs system development and application to provide new system-level capabilities that can be tested, verified and validated in an operational environment. Insights and foresights from both paths can feed back into the organizational generative operating system to further develop the next level of understanding and capabilities.

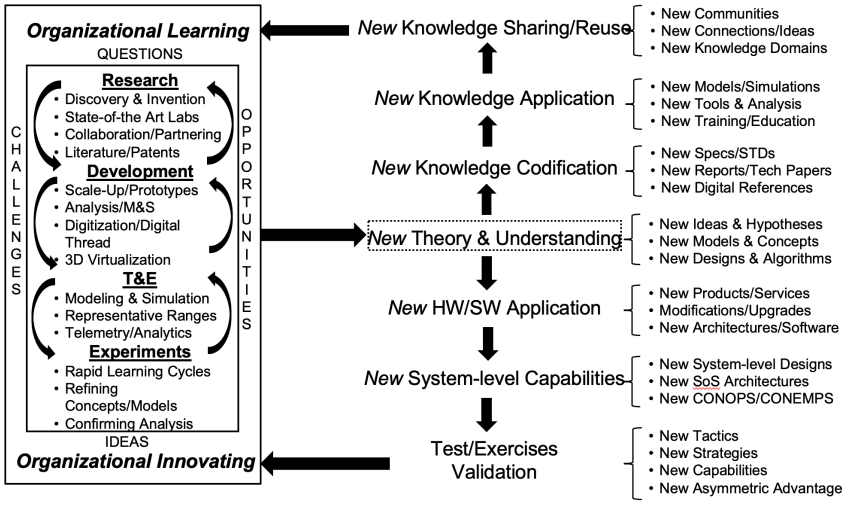

Figure 5. Catalyzing New Knowledge Creation & Innovative Capabilities

These proposed conceptualizations for the Next Generation DoD Innovation Ecosystem supports the DoD FY 2024 Annual Performance Plan Strategic Alignment Framework by focusing on transforming the foundation of the future force, enabling a construct to make the right technological investments, by strengthening the resiliency and adaptability of the Defense Ecosystem, supports the development and growth of the future workforce and warfighter, and attempts to address a number of the institutional management priorities.

Conclusion

This study converges and synthesizes organizational development, leadership, technology and DoD Acquisition related research and theory sources to develop new and novel DoD Acquisition mental models, strategies and approaches to help offer a new Defense Industrial Base operating paradigm. DoD Acquisition programs and their portfolios must leverage the latest research, best practices and technologies to transform and increase innovation at lower cost, greater speed and increased complexity. The results of this study help inform the development of a future state strategies and operating models that can be used across the services to unleash and more fully leverage human ingenuity and potential; increase

the diversity and complexity of value-added sources; enable learning and innovation as fundamental underpinnings to knowledge creation, management and utilization; leverage leading edge leadership theories and practice; and enable the accelerated adoption and adaptation of emerging technologies.

References

Abbate, T., Codini, A., Aquilani, B., & Vrontis, D. (2021). From knowledge ecosystems to capabilities ecosystems: When open innovation digital platforms lead to value co-creation. *Journal of Knowledge Economy*. https://doi.org/10.1007/s13132-021-00720-1

Aghion, P., Antonin, C., & bunel, S. (2021). *The power of creative destrcution: Economic upheaval and the wealth of nations*. Harvard University Press.

Alam, M. A., Rooney, D., & Taylor, M. (2019). From ego-systems to open innovation ecosystems: A process model on inter-firm openness. *Journal of Product Innovation Management*. https://doi.org/10:1111/jplm.12615

Anderson, J., & Trainie, L. (2022). *The metaverse in 2040*.

Arena, M. J. (2018). *Adaptive space: How GM and other companies are positively disrupting themselves and transforming in Agile organizations*. McGraw Hill.

Army, U. (2021). *Defense acquisition guidebook*. U.S. Government

Board, D. I. (2023). *An innovation strategy for the decisive decade: National Defense Science and Technology Strategy Review Task Force*.

Board, D. I. (2024). *Defense innovation board scaling innovation forward.* https://www.defense.gov/News/News-Stories/Article/Article/3680921/defense-innovation-board-scaling-innovation-forward/

Boulton, J. G., Allen, P. M., & Bowman, C. (2015). *Embracing complexity: Strategic perspectives for an age of turbulence*. Oxford University Press.

Burt, R. S. (1992). *Structural holes: The social structure of competition*. Harvard University Press.

Carberry, S. (2023, August 2023). Innovation acceleration: Companies ask if Pentagon's innovation ecosystem is getting out of hand. *National Defense*, 31–32.

Chaminade, C., Lundvall, B.-A., & Haneef, S. (2018). *National innovation systems*. Edward Elgar Publishing.

Chesbrough, H., Vanhaverbeke, W., & West, J. (2014). *New frontiers in open innovation*. Oxford University Press.

Chesbrough, H. W., & Appleyard, M. M. (2007). Open innovation and strategy. *California Management Review*, *50*(1), 57–76.

Congressional Budget Office. (2024). *The budget and economic outlook: 2024 to 2034*. https://www.cbo.gov/publication/59710

Council, N. S. a. T. (2022). *Critical and emerging technologies list update*.

Cross, R., & Parker, A. (2004). *The hidden power of social networks: Understanding how work really gets done in organizations*. Harvard Business School Publishing.

Data, Analytics, and Artificial Intelligence Adoption Strategy: Accelerating Decision Advantage. (2023).

Davenport, T. H. (n.d.). *Information ecology: Mastering the information and knowledge environment - why technology is not enough for success in the knowledge age*.

De Jong, R.-J. (n.d.). *Anticipate: The art of leading by looking ahead*. AMACOM.

Defense, D. o. (2024). *Innovation organizations*. OSD Research and Engineering. https://www.ctoinnovation.mil/innovation-organizations

Defense, U. S. D. o. (2023). *National Defense Science and Technology Strategy*.

Department of Defense Software Modernization Strategy. (2021).

DoD. (2024). *FY2024 investment strategy for the Office of Strategic Capital*.

DoD digital modernization strategy. (2019).

DoD digitial modernization strategy: DoD information resource management strategic plan FY 19-23. (2019).

DoD enterprise DevSecOps strategy guide. (2021).

Exploring the industrial metaverse: A roadmap to the future. (2023).

Feinstein, J. S. (2023). *Creativity in large-scale contexts: Guiding creative engagement and exploration*. Stanford Business Books.

Fligstein, N., & McAdam. (2012). *A theory of fields*. Oxford University Press.

Foster, R., & Kaplan, S. (2001). *Creative destruction: Why companies that are built to last underperform the market - and how to successfully transform Them*. Doubleday.

Fox, J. R. (n.d.). *Defense acquisition reform, 1960-2009: An elusive goal*. U.S. Army.

Fransman, M. (2018). *Innovation ecosystems: Increasing competitiveness*. Cambridge University Press.

Futures, A. A. A. F. (2023). *Air Force global futures report: Joint function in 2040*.

Garamone, J. (2024). *Hicks makes case that effective defense innovation is moving forward*. https://www.defense.gov/News/News-Stories/Article/Article/3661297/hicks-makes-case-that-effective-defense-innovation-is-moving-forward/

George, M. L., Works, J., Watson-Hemphill, K., & Christianson, C. M. (2005). *Fast innovation: Acheiving superior differentiation, speed to market, and increased profitability*. McGraw-Hill.

George, M. L., Sr., Blackwell, D. K., George, M. L., Jr., & Rajan, D. (2019). *Lean Six Sigma in the age of artificial intelligence*. McGraw Hill.

Gershenfeld, N., Gershenfeld, A., & Cutcher-Gershenfeld, J. (2017). *Designing reality: How to survive and thrive in the third digital revolution*. Basic Books.

Gharajedaghi, J. (2006). *Systems thinking - managing chaos and complexity: A platform for designing business architecture*. Butterworth Heinemann.

Global innovation index 2023: Innovation in the face of uncertainty. (2023).

Goldstein, J., Hazy, J. K., & Lichtenstein, B. B. (2010). *Complexity and the nexus of leadership: Leveraging non-linear science to create ecologies of innovation*. Palgrave-MacMillan.

Granstrand, O., & Holgersson, M. (2019). Innovation ecosystems: A conceptual review and a new definition. *Technovation*.

Haeckel, S. H. (2016). *Adaptive enterprise: Creating and leading sense-and-respond organizations*.

Hale, R., & Lord, E. (2024). *Defense resourcing for the future*.

Hess, E. D. (2020). *Hyper-learning: How to adapt to the speed of change*. Berret-Koehler.

Holbecher, L. (2015). *The Agile organization: How to build an innovative, sustainable and resilient business*. Kogan Page.

Huff, A. S., & Jenkins, M. (2002). *Mapping strategic knowledge*. Sage Publications.

Hurwitz, J. S., Kaufman, M., & Bowles, A. (2015). *Cognitive computing and big data analytics*. John Wiley & Sons.

Iansiti, M., & Levien, R. (2004). *The keystone advantage: What the new dynamics of business ecosystems means for strategy, innovation, and sustainability*. Harvard Business School Press.

Ichijo, K., & Nonaka, I. (2007). *Knowledge creation and management: New challenges for managers*. Oxford University Press.

Investment Strategy for the Office of Strategic Capital. (2024).

Jensen, G., & Largent, M. (2018). *Design for maritime singularity*.

Johnson, S., Yeman, R., Kersten, M., & Leffingwell, D. (2023). *Industrial DevOps: Build better systems faster*. IT Revolution Press.

Jones, M., Kavetsky, R., & Mayer, T. (2021). *Energetics and lethality: The imperartive to reshape the U.S. military kill chain*.

Joseph, B. B. (2021). *Assessment of analysis of alternative studies in the Department of Defense as compared to best practices*.

Jucevicius, G., & Grumadaite, K. (2014). Smart development of innovation ecosystem. *Procedia - Social and Behavioral Sciences*, *156*, 125-129.

Kendall, F. (2015). Innovation in the defense acquisition enterprise. *Defense AT&L*.

Koutstaal, W., & Binks, J. T. (2015). *Innovating minds: Rethinking creativity to inspire change*. Oxford University Press.

Kurzweil, R. (2005). *The singularity is near: When humans transcend biology*. Penguin Group.

Marquardt, M. J., & Tiede, B. (2023). *Leading with questions: How leaders discover powerful answers by knowing how and what to ask*. John Wiley & Sons.

Massingham, P. (n.d.). An Aristotelian interpretation of practical wisdom: The case of retirees. *Palgrave Communications: Humanitis/Social Sciences/Business*. https://doi.org/10.1057/s41599-019-0331-9

Mazarr, M. J. (2022). *The societal foundations of national competitiveness*.

McNamera, W. M., Modigliani, P., MacGregor, M., & Lofgren, E. (2023). *Commission of Defense Innovation Adoption - final report*.

Modigliani, P., & Ward, D. (2019). *Accelerating defense acquisition: Faster acquisitions produce a stronger force*.

Moore, J. F. (1996). *The death of competition: Leadership & strategy in the age of busness ecosystems*. Harper Business.

Moore, J. F., Rong, K., & Zhang, R. (2022). The human ecosystem. *Journal of Digital Economy*, *1*, 53–72.

Moreira, M. E. (2017). *The Agile enterprise: Building and running Agile organizations*. Springer.

Nam, T., & Pardo, T. A. (n.d.). *Conceptualizing smart city with domensions of technology, people, and institutions*. 12th Annual International Conference on Digital Government Research.

National Defense Industrial Strategy. (2023).

National Defense Strategy of the United States of America. (2022).

NDIA Vital Signs 2023. (2023).

Nonaka, I., & Takeuchi, H. (2019). *The wise company: How companies create continuous innovation*. Oxford University Press.

Nonaka, I., Toyama, R., & Kirata, T. (2008). *Managing flow: A process theory of the knowledge-based firm*. Palgrave McMillian.

Obolensky, N. (2014). *Complex adaptive leadership: Embracing paradox and uncertainty*. Gowrr Publishing.

Office of the Director of National Intelligence. (2024). *Annual threat assessment of the U.S. intelligence community*.

Oh, D.-S., Phillips, F., Park, S., & Lee, E. (2016). Innovation ecosystems: A critical examination. *Technovation*. http://dx.doi.org/10.1016/j.technovation.2016.02.004

Pentland, A. (2014). *Social physics: How good ideas spread - the lessons from the new science*. The Penguin Press.

Pink, D. H. (2011). *DRiVE: The surprising truth about what motivates us*. Riverhead Books.

Policy, N. E. C. a. O. o. S. a. T. (2015). *A strategy for Amercian innovation*.

Porter, G. H., Conley, K. M., Gordon, C. V., Kneece, R. R. J., Rieksts, B. Q., & Shaw, A. H. (2015). *Affordability of defense acquisition program*.

Possehl, S. L. (2021). *Participation in activities of non-government standards bodies.*

Ratzesberger, O., Sawhney, M., & Davenport, T. H. (n.d.). *The sentient enterprise: The evolution of business decision making*. Wiley.

Reeves, B., & Read, J. L. (2009). *Total engagement: Using games and virtual worlds to change the way people work and businesses compete*. Harvard Business School Publishing.

Report of the Advisory Council on Streamlining and Codifying Acquisition Regulations. (2019).

Rogers, D. L. (2016). *The digital transformation playbook: Rethink your business for the digital age*. Columbia University Press.

Ross, J. W., Weill, P., & Robertson, D. C. (2006). *Enterprise architecture as strategy: Creating the foundation for business execution*. Harvard Business School Press.

Schein, E. (2016). *Organizational culture and leadership.* Wiley.

Science & technology trends 2020-2040: Exploring the S&T edge. (2020). NATO.

Scoble, R., & Israel, S. (2017). *The fourth transformation: How augmented reality and artificial intelligence change everything*. Patrick Brewster Press.

Siebel, T. M. (2019). *Digital transformation: Survive and thrive in a era of mass extinction*. Rosetta Books.

Slama, D., Puhlmann, F., Morrish, J., & Bhatnagar, R. M. (2016). *Enterprise IoT: Strategies & best practices for connected products and services*. O'Reilly.

Small Business Strategy. (2023).

Smith, J. S. (2018). *Joint simulation environment*.

Snowden, D. J., & Boone, M. E. (2007). A leader's decision framework for decision making. *Harvard Business Review*.

Stadler, C., Hautz, J., Matzer, K., & Eichen, S. F. V. D. (2021). *Open strategy: Mastering disruption from outside the C-suite*. MIT Press.

Stiglitz, J. E., & Greenwald, B. C. (2014). *Creating a learning society: A new approach to growth, development, and social progress*. Columbia University Press.

Subramaniam, M. (2022). *The future of competitive strategy: Unleashing the power of data and digital ecosystems*. The MIT Press.

Suleyman, M. (2023). *The coming wave: Technology, power, and the 21st century's greatest dilemma*. Crown.

Tapscott, D., & Tapscott, A. (2016). *Blockchain revolution: How the technology behind Bitcoin is changing money, business and the world*. Penguin Random House.

Taylor, M. Z. (2016). *The politics of innovation: Why some countries are better than others at science and technology*. Oxford University Press.

Technical standards, invention, innovation, and economic growth. (2018). National Science Board. https://www.nsf.gov/statistics/2018/nsb20181/assets/1178/technical-standards-invention-innovation-and-economic-growth.pdf

Thomas, K. W. (2009). *Intrinsic motivation at work*. Barrett-Koehler Publishers.

Tovstiga, G. (2013). *Strategy in practice: A practitioner's guide to strategic thinking* (2nd ed.). John Wiley & Sons.

Toward a successful metaverse: The case for measuring enabling factors. (2023). *Economist Impact 2023*.

University, D. A. (2024). *Adaptive acquisition framework*. https://aaf.dau.edu/

The U.S. defense industrial base: Background and issues for Congress. (2023).

Value creation in the metaverse: The real business of the virtual world. (2022).

Visscher, K., Hahn, K., & Konrad, K. (2021). Innovation ecosystem strategies of industrial firms: A multilayered approach to alignment and strategic positioning. *Creative Innovation Management*, 619–631. https://doi.org/10.1111/calm.12429

Von Krogh, G., Ichijo, K., & Nonaka, I. (2000). *Enabling knowledge creation: How to unlock the mystery of tacit knowledge and release the power of innovation*. Oxford University Press.

Weapon systems annual assessment. (2023). Government Accounting Office.

West, G. (2017). *Scale: The universal laws of growth, innovation, sustainability, and the pace of life in organizations, cities, economies, and companies*. Penguin Press.

Whitehurst, J. (2015). *The open organization: Igniting passion and performance*. Harvard Business Review Press.

Wilson, R., & Tyson, J. (2023). *Age of invisible machine: A practical guide to creating a hyperautomated ecosystem for intelligent digital workers*. John Wiley & Sons.

Wood, D. L. (2024). *2024 index of U.S. military strength*.

Xu, G., Wu, Y., Minshall, T., & Zhou, Y. (2017). Expoloring innovation ecosystems across science, technology, and business: A case for 3D printing in China. *Technological Forecasting & Social Change*.

Yarger, H. R. (2008). *Strategy and the national security professional: Strategic thinking and strategy formulation in the 21st century*. Praeger Security International.

Yashar, Z. E. (n.d.) Smart cities and smart regions: An evaluation from smart cities to smart regions.

Yeung, A., & Ulrich, D. (2019). *Reinventing the organization: How companies can deliver radically greater value in fast changing markets*. Harvard Business School Press.

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